Section 5

Environmental Features, Safeguards and Impacts

PREAMBLE

The assessment and management of the key environmental issues identified in Section 3 are generally addressed in the order of priority established in Section 3.6.

For each key environmental issue, the existing features are described and the constraint(s) the existing features would have on the design and operation of the Project are identified. The mitigation measures and operational procedures required to manage each issue are then outlined together with the predicted changes to that component of the environment on and/or surrounding the Project Site. Residual impacts are then assessed against statutory criteria, goals or relevant guidelines and/or policies. Where appropriate, a program of monitoring and documentation is proposed to demonstrate the predictions presented in this document are being achieved and compliance criteria or goals satisfied.

The text for the bulk of this section is drawn from studies undertaken by a range of specialist consultants commissioned by Metromix. Wherever possible, the study results have been summarised focussing only upon the key points. Readers should refer to the relevant part in the Specialist Consultant Studies Compendium in the event further detail is required.

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5.1 TRAFFIC

The following sub-sections provide a summary of the Traffic and Transport Assessment proposed for the Project by Halcrow Pacific Pty Ltd (Halcrow, 2011) and consider existing traffic levels and road conditions and the likely impacts ongoing traffic levels associated with Teralba Quarry would have on the road network, road users and adjoining land uses. The full assessment is presented in Volume 1, Part 1 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.1.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.5 and **Table 3.7**), the potential environmental impacts related to traffic and transport requiring assessment and their unmitigated risk rating are as follows.

- Increased traffic congestion (high risk).
- Road pavement deterioration (high risk).
- Risk of accidents/incidents on local roads (high risk).

In addition, the DGRs issued by the former Department of Planning, identify "*traffic and transport*" as a key issue for assessment in the *Environmental Assessment*. The DGRs require the assessment of traffic and transport include:

- "accurate predictions of the Project's road traffic generation and a detailed assessment of the potential impacts of project-related traffic on the safety and efficiency of road network; and
- a detailed description of the measures that would be implemented to upgrade and/or maintain these networks over the life of the Project."

The NSW Roads and Traffic Authority also listed a range of requirements to be addressed in the Traffic and Transport Assessment and the *Environmental Assessment*. The relevant requirements are as follows.

- Assessment of all relevant vehicular traffic routes and intersections for access to/from the quarry.
- Current traffic counts for all traffic routes and intersections.
- The anticipated trip distribution on the road network.
- Traffic impacts on existing and proposed intersections and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic generated by the Project including cumulative traffic impacts of any other proposed developments in the area.
- Identify any necessary road network infrastructure upgrades.
- Intersection analysis to determine the need for intersection and road capacity upgrades.

Lake Macquarie City Council sought similar requirements to be addressed but sought coverage of the "methods of mitigating impacts including monetary contributions, levies or like works to be undertaken by the developer."

This section effectively draws together the information previously presented in Sections 1.4 and 2.12 to include a comprehensive assessment of the traffic and transportation issues for the Project.

5.1.2 Existing Road Network and Traffic Levels

5.1.2.1 Existing Transport Network

Figure 5.1 displays the road network surrounding Teralba Quarry used by heavy vehicles to travel to and from the quarry. A total of seven principal transport routes are used by heavy vehicles travelling to and from Teralba Quarry. These routes effectively occur within four main transport corridors. All routes commence either at the entrance to the quarry from Rhondda Road (the "top gate") or the entrance to the quarry from a private road at the eastern boundary of the Project Site (the "bottom gate").

The four transport corridors and the seven routes are as follows, noting that the reference to route numbers 1 to 7 relate to trips away from the quarry and route numbers 11 to 17 correspond to trips towards the quarry.

Northeastern Corridor

The northeastern corridor commences at the bottom gate and runs through Teralba then northwards via Main Road 217 (Five Islands Road). The following specific routes lie within this route corridor.

- Routes 3/13 to and from Teralba via York Street (this route is common between the northeastern and southeastern corridors).
- Routes 4/14 to and from Glendale via Five Islands Road/Lake Road.
- Routes 7/17 to and from Speers Point via The Esplanade.

Southeastern Corridor

The southeastern corridor commences at the bottom gate and runs through Teralba then southwards via Main Road 217 (Toronto Road). The following specific routes lie within this route corridor.

- Routes 3/13 to and from Teralba via York Street.
- Routes 5/15 to and from Fennel Bay via Toronto Road.

Northwestern Corridor

The northwestern corridor commences at the top gate and runs westwards along Rhondda Road to Wakefield Road then northwards through Barnsley. The following specific routes lie within this route corridor.

- Routes 1/11 to and from West Wallsend via George Booth Drive.
- Routes 2/12 to and from Edgeworth via Main Road.

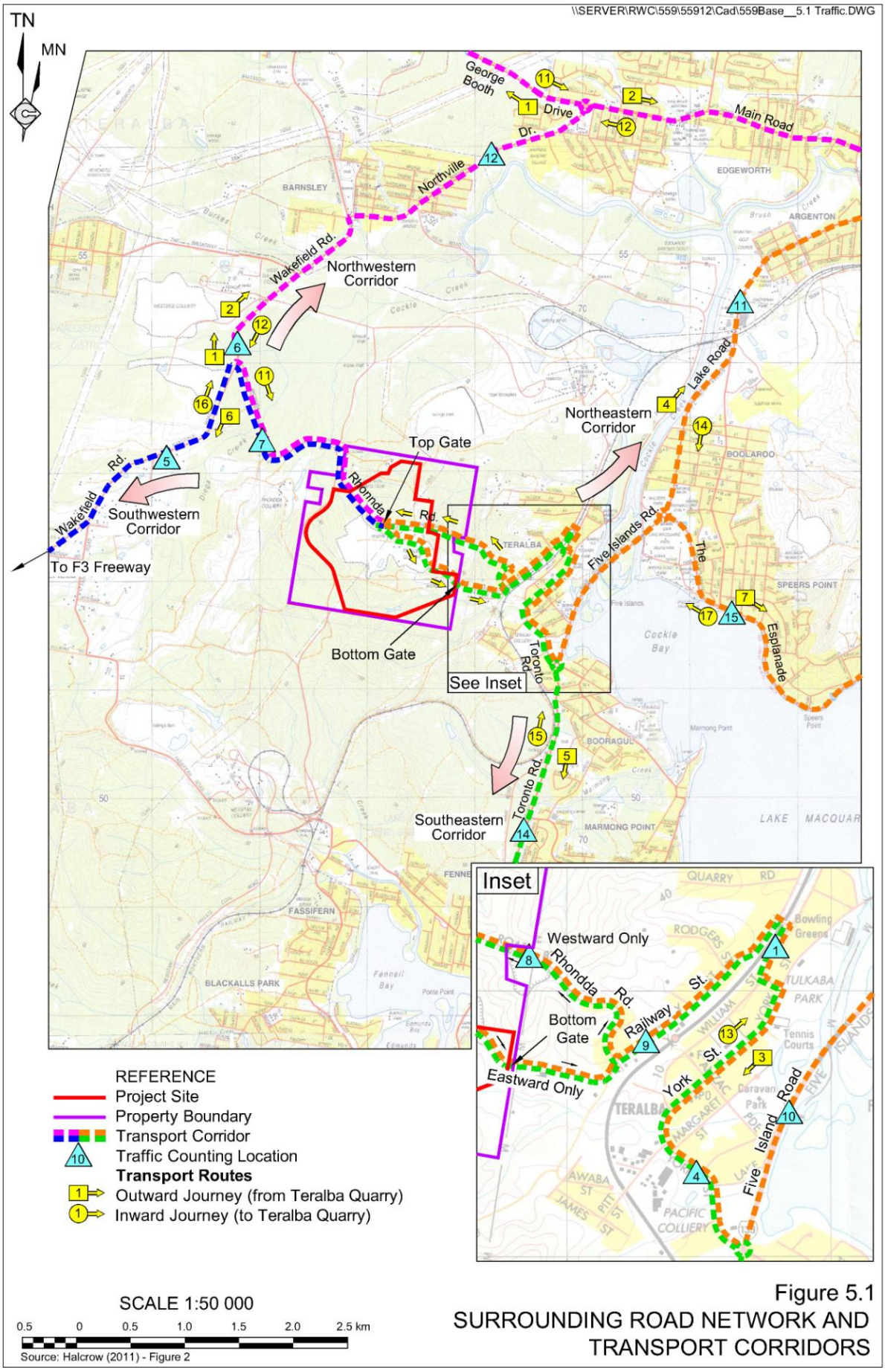


Figure 5.1
SURROUNDING ROAD NETWORK AND TRANSPORT CORRIDORS

Southwestern Corridor

The southwestern corridor commences at the top gate and runs westwards along Rhondda Road to Wakefield Road then southwards via Wakefield Road to Palmers Road and the F3. The following specific route fits within this route corridor.

- Route 6/16 to and from the F3 Freeway via Wakefield Road.

5.1.2.2 Traffic Levels

This sub-section incorporates information on the total traffic levels on the surrounding road network and the existing heavy vehicle movements entering and departing Teralba Quarry. Traffic levels are conventionally expressed in either average or 85th percentile levels. The use of 85th percentile levels reflects the levels on a typical busy day.

Total Traffic Levels

An appreciation of the traffic levels on the routes used by trucks travelling to and from Teralba Quarry has been established through the use of 14 automatic traffic counters. The locations of the traffic counters and the recorded traffic levels are displayed on **Figure 5.2**. A description of each location and the average weekday numbers of cars and trucks are listed in **Table 5.1**.

Table 5.1
Average Weekday Daily Traffic Flows

Traffic Counter Location*	Northbound/Eastbound			Southbound/Westbound		
	Cars	Trucks	Total	Cars	Trucks	Total
1 William St, north of Short St	1 471	161	1 632	1 601	141	1 742
2 York St, south of Short St	1 854	265	2 119	2 200	278	2 477
3 Railway St, north Railway Overbridge	661	36	697	658	37	695
4 Toronto Rd, south of Lake Crescent	1 480	303	1 784	1 323	301	1 624
5 Wakefield Rd, south of Rhondda Rd	1 385	145	1 530	1 352	126	1 479
6 Wakefield Rd, north of Rhondda Rd	1 132	136	1 268	1 188	162	1 349
7 Rhondda Rd, west of Metromix Access	501	102	604	473	99	572
8 Rhondda Rd, east of Metromix Access	490	59	549	508	98	606
9 Railway St, north of Rhondda Rd	668	122	790	649	120	769
10 Five Islands Rd, north of Anzac Pde	16 752	734	17 486	16 445	939	17 384
11 Lake Rd, Waratah Golf Course	12 348	696	13 044	12 652	680	13 332
12 Northville Rd, east of Carinda Ave	3 943	231	4 175	3 889	230	4 119
13 Toronto Rd, north of Enterprise Way	12 821	619	13 440	13 148	839	13 987
14 The Esplanade, Speers Point Park	10 348	580	10 927	10 344	460	10 804

* See **Figure 5.2**

Source: Halcrow (2011) – Table 2.1 based upon counts conducted by Northern Transport Planning and Engineering Pty Ltd

A total of eleven intersections across the seven transport routes to and from Teralba Quarry were surveyed during morning and afternoon peak periods using the SIDRA intersection analysis program to establish their existing efficiency and level of service. The results of the operating conditions at each of the intersections established they all operate at a good level of service during both the morning and afternoon peak periods with acceptable delays.

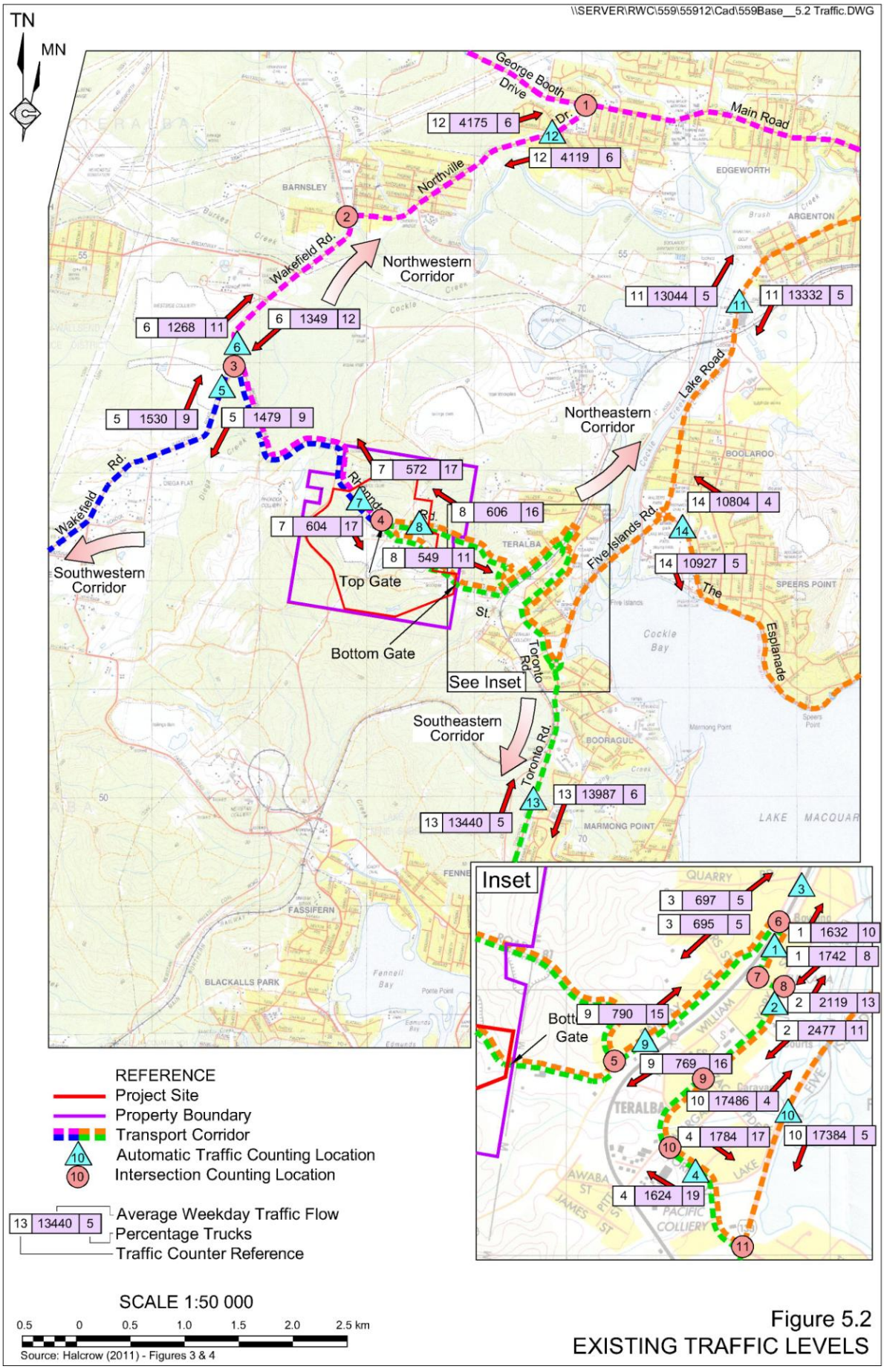


Figure 5.2
EXISTING TRAFFIC LEVELS

The observed two-way peak hour flows on the roads between the various intersections surveyed was also established. A record of the observed flows is provided in **Table 5.2** and Figures 5 and 6 of Halcrow (2011).

Teralba Quarry Traffic

The heavy vehicle movements attributed to the trucks travelling to and from Teralba Quarry have been compiled for two operating levels, i.e. with annual sales of 700 000tpa and 1 million tpa. A detailed evaluation of the truck movements associated with the annualised sales level of 700 000tpa was undertaken based on detailed records kept at the quarry in July 2008. Since then, the annualised sales level has increased to 1 million tpa for which distribution levels have been calculated by increasing the July 2008 data generally in a proportional manner. **Table 5.2** lists the heavy vehicle movements to and from Teralba Quarry for both 700 000tpa and 1 million tpa.

Table 5.2
Ongoing Heavy Vehicle Movements on a Busy Day – Teralba Quarry

		700 000tpa	1 million tpa
85th Percentile Daily Movements	- Eastward*	127#	127#
	- Westward	156	325
	- Total	283	452
85th Percentile Peak Hours Movements	- Eastward*	15	15
	- Westward	17	35
	- Total	32	50

* Through Teralba

Note: An 85th percentile level of 127 trucks per day is generally equivalent to a maximum level of 170 trucks per day, albeit on only one or two days per year.

Source: Halcrow (2011) Modified after– Tables 3.2 and 3.3

Without regulatory input, Metromix has recently made a decision to cap the level of heavy vehicle traffic travelling to and from the quarry through Teralba (equivalent to traffic levels at 170 per day or 18 per hour). The level of 170 trucks was comparable to the maximum level recorded on one day in July 2008 when the 85th percentile truck movements were 127. During each year, the maximum level is typically achieved on only one or two days per year. In addition, and since 2008, Metromix has been nominating for particular projects and customers, that on very busy days, they are required not to travel through Teralba and instead depart the quarry at the top gate and travel westwards towards Wakefield Road.

Halcrow (2011) presents the distribution pattern for heavy vehicles traveling on the road network surrounding Teralba Quarry – see Figures 7 to 12.

5.1.3 Design and Operational Safeguards

Metromix would continue to manage the distribution of its products from Teralba Quarry in a manner comparable to its present operations, i.e. through the adoption of the following design and operational safeguards.

1. All products would be despatched in a manner such that the number of trucks despatched hourly does not exceed the levels nominated in **Table 2.6**, i.e. for the nominated time periods.
2. No trucks would be despatched from Teralba Quarry and allowed to travel eastward through Teralba between 6:00pm and 6:00am.
3. Only Metromix-owned trucks and those of accredited contractors would be used to transport products between 6:00pm and 6:00am so as to ensure only those trucks with airbag suspension and other relevant noise controls are used along Wakefield Road during those hours.
4. All Metromix-owned trucks and those of its shareholders (Holcim and Hanson) would be regularly serviced to ensure engine efficiencies (and other mechanical components) are maintained at a standard that limits truck noise.
5. Metromix recognises that driver behaviour is an important contributor to the safe and quiet operation of trucks delivering its products. Accordingly, Metromix has recently introduced a Driver Code of Conduct that:
   - defines times of truck operation, especially through Teralba;
   - sets truck speed limits;
   - proposes duty of care to other drivers and especially pedestrians; and
   - incorporates a complaints and disciplinary procedure.

Metromix recognises that the trucks travelling to and from the Teralba Quarry, like all other trucks on the surrounding road network, contribute to the progressive deterioration of the road pavement. Accordingly, Metromix proposes, if a suitable project approval is granted, that for the ongoing life of the quarry, a quarterly contribution would be paid to Lake Macquarie City Council to assist with the ongoing maintenance of the Council-managed roads throughout the Lake Macquarie local government area that are used by trucks travelling to and from Teralba Quarry. This contribution would be established in consultation with Council prior to the determination of Metromix's application.

5.1.4 Assessment of Impacts

The assessment of impacts of the ongoing distribution of products from Teralba Quarry has been undertaken through reference to:

- existing and future traffic flows;
- environmental capacity;
- cumulative impacts with other committed developments; and
- intersection performance.

Existing/Future Traffic Flows and Environmental Capacity

Halcrow (2011) conservatively assessed the traffic flows for the Project based on the sales level of 1 million tpa and both current traffic levels and those forecast to occur in 2022. The traffic levels in 2022 were forecast based upon compound growth factor of 1.5%, a factor recognised by the RTA to be approximate for estimating future growth in the Newcastle area.

Effectively, there would be no change to existing traffic flows as a result of the ongoing operation of Teralba Quarry. **Table 5.3** lists the existing and future (2022) two-way 85th percentile hourly flows at a total of 28 mid-block locations assuming the 1 million tpa contribution from Teralba Quarry. Halcrow (2011) reviewed each of the existing and future 85th percentile hourly traffic flows listed in **Table 5.3** and concluded that with the exception of York Street, north of Anzac Parade all roads used by trucks travelling to and from Teralba Quarry would continue to operate below their environmental capacity. It is noted that the decrease in environmental capacity at York Street, north of Anzac Parade is attributable to general traffic growth.

Table 5.3
Existing and Future Two-way Peak Hour Flows

Locations	Existing		Future 2022#	
	AM	PM	AM	PM
George Booth Dr, west of Northville Dr	1 390	1 425	1 661	1 705
Main Road, east of Northville Dr	1 844	1 973	2 204	2 361
Northville Dr, south of George Booth Dr	800	932	955	1 117
Northville Dr, east of Wakefield Rd	488	567	582	681
Appletree Road, north of Northville Dr	336	384	402	459
Wakefield Rd, south of Northville Dr	412	513	491	616
Wakefield Rd, north of Rhondda Rd	290	311	345	374
Wakefield Rd, south of Rhondda Rd	329	342	397	422
Rhondda Rd, east of Wakefield Rd	141	145	170	189
Rhondda Rd, east of Railway St	136	152	168	179
Railway St, south of Rhondda Rd	31	43	31	44
Railway St, north of Rhondda Rd	159	155	188	181
Railway St, south of William St	195	207	231	243
Railway St, north of Railway Overbridge	134	142	160	170
Railway Overbridge, east of Railway St	319	331	379	391
William St, south of Short St	121	124	145	148
Short St, east of William St	245	230	291	271
York St, north of Short St	274	351	328	420
York St, north of Anzac Pde	472	490	562	582
York St, south of Anzac Pde	235	265	279	320
Anzac Pde, east of York St	351	439	420	518
Anzac Pde, west of York St	82	92	98	110
York St, west of Pitt St	315	304	375	366
Pitt St, south of York St	85	75	102	91
Toronto Rd, west of Five Islands Rd	332	391	394	469
First St, east of Five Islands Rd	624	601	746	719
Toronto Rd, south of First St	2 509	2 583	2 998	3 086
Five Islands Rd, north of First St	2 903	2 847	3 470	3 408

Note: # - Future 2022 flows include the 85th percentile peak hour traffic generation for Metromix with 1 million tpa sales plus 2022 future base traffic flows, which adopted compound growth factor of 1.5% per annum from the 2010 surveyed intersection flows.

Source: Halcrow (2011) – Table 5.1

Cumulative Impacts

The existing heavy vehicle traffic travelling to and from other surrounding enterprises near Teralba Quarry is already reflected in the existing measured traffic levels. Halcrow (2011) reviewed the current development applications lodged with Lake Macquarie City Council and established few such developments are approved in the Teralba area. Hence, cumulative impacts with heavy vehicles travelling to and from other committed developments would be negligible.

Intersection Operations

The comprehensive SIDRA analyses undertaken of the 11 key intersections established that all intersections used by trucks travelling to and from Teralba Quarry would operate satisfactorily with a level of service C or better for both the morning and afternoon peak periods in 2022. In fact, only one intersection would operate with a level of service C and the remainder would operate with a level of service B or better.

5.2 GROUNDWATER

The groundwater assessment was undertaken by RCA Australia (RCA, 2011). The full assessment is presented in Volume 1, Part 2 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.2.1 Introduction

Based on the environmental risk analysis undertaken by R.W. Corkery and Co Pty Limited for the Project (Section 3.5 and **Table 3.7)**, the potential impacts relating to groundwater requiring assessment and their unmitigated risk rating are as follows.

- Contamination of groundwater due to suspended solids associated with processing operations (high risk).
- Reduction of volume and flow rates of local groundwater resource and subsequent availability to local users (high risk).

In addition, the DGRs issued by the former Department of Planning and requirements issued by the former Department of Environment, Climate Change and Water, and Lake Macquarie City Council identified "groundwater" as one of the key issues that requires assessment within the *Environmental Assessment.* The assessment of impacts relating to groundwater is required to provide the following.

- A description of the existing groundwater environment.
- A detailed description of the proposed water management system.
- A detailed assessment of the potential groundwater impacts of the Project, including any potential impacts to Lake Macquarie.
- Contingency strategies containing measures that would be implemented to avoid, minimise and mitigate any potential impacts of the Project.

The groundwater assessment was undertaken in accordance with relevant guideline documents and planning policies.

The assessment of groundwater has been prepared by RCA Australia and comprised the following scope of work.

- A review of available groundwater information for the Project Site and surrounds.
- A review of the regional and local geological information relevant to the Project Site.
- An assessment of the extent of surface water / groundwater interactions.
- An assessment of current impacts of the quarry on groundwater quality and predicted future impacts of the proposed extension, including on groundwater dependent ecosystems.

5.2.2 Hydrogeological Setting

5.2.2.1 Regional Hydrogeology

The Teralba Quarry is underlain by strata belonging to the Moon Island Beach Subgroup of the Newcastle Coal Measures. The Newcastle Coal Measures are of Late Permian age and comprise dominantly coarse clastic and volcanogenic sediments with intervening coal seams. The Moon Island Beach Subgroup is stratigraphically the highest in the Newcastle Coal Measures and consists of:

- Munmorah Conglomerate;
- Wallarah Coal Seam;
- Teralba Conglomerate;
- Great Northern Coal Seam (GNCS);
- Eleebana Formation; and
- Fassifern Coal Seam (FCS).

Teralba Quarry is located to the northeast of the Macquarie Syncline, a broad flat fold structure which generally has all strata dipping to the south and southeast at approximately 2° to 4°. Detailed mine plans record elevations throughout the Great Northern Coal Seam and therefore the dip of the seam. Groundwater flows down dip toward the south and southeast. The subsurface catchment is of unknown size, with groundwater rising to the surface to the southeast of the existing Southern Extraction Area at a mine adit excavated during the life of the Northern Extended Colliery to assist in draining the former coal mine.

In the Newcastle Coal Measures, the majority of the aquifers comprise the coal seams with permeability values generally one to two orders of magnitude higher than the interburden strata. In addition, many of the coal seams have been mined and contain voids, which greatly increase the permeability and storage capacity.

The primary aquifer beneath the Teralba Quarry and its proposed extensions is the GNCS which has been extensively mined beneath the site (and beyond the site boundaries), leaving a remnant “room and pillar” void structure.

5.2.2.2 Local Hydrogeology

Metromix is currently extracting conglomerate from the Teralba Conglomerate, which lies directly above the GNCS. In this area, the GNCS is approximately 6m thick, with the underlying Eleebana Formation ranging from 6m to 20m thick.

The FCS, which is 95% flooded, is approximately 5m thick. Both the GNCS and the FCS have been mined extensively in the vicinity of the Teralba Quarry since the 1800s.

It is understood that coal was mined from the GNCS within the former Rhondda Colliery located immediately to the west of Teralba Quarry within 5m to 20m of the natural surface. It is highly likely, however, that the former mine workings beneath the quarry and those of Rhondda Colliery are joined for the passage of water, forming a continuous aquifer.

5.2.2.3 Surrounding Groundwater Users

A groundwater database search was conducted and the nearest licensed bore down-gradient is stock/domestic well GW080494, approximately 2.6km to the south.

Neighbouring coal mines also managing groundwater from the various coal seams are as follows (see **Figure 5.3**).

- The now-closed Rhondda Colliery (owned by Coal & Allied Industries Limited - Rio Tinto), immediately to the west. From approximately 1994 until 2006, fines-containing water (post process wastewater from the processing plant) was pumped from Teralba Quarry (among other sources) to assist in extinguishing an underground coal seam fire. Coal and Allied Industries Limited has a licensed discharge point at the southeastern corner of the Project Site for the water that continues to discharge to the east from its colliery (Mine Adit Dam: EPL 3139).
- Oceanic Coal Mines (owned by Xstrata) – underground West Wallsend Mine and open cut Westside Open Cut Mine. Located approximately 3km to the northwest of the Project Site, dewatering at a rate of approximately 2.6ML/day is undertaken from both the open cut void and underground workings. This water is currently discharged into Cockle Creek via a licensed discharge point (EPL1360).
- Centennial Coal Newstan Mine – 2.5km to the southwest. Newstan dewaters approximately 6ML/day to 7ML/day from the underground workings of the GNCS and FCS.

The neighbouring coal mining operations are not directly down-hydraulic gradient of Teralba Quarry.

5.2.2.4 Groundwater Beneath the Project Site

The primary aquifer beneath the Teralba Quarry and proposed extensions is the GNCS which has been extensively mined leaving a remnant "room and pillar" void structure. The top of the GNCS occurs at about a level between 19m AHD and 25m AHD, below the base of the existing and proposed extraction areas. This seam is a significant artificial aquifer having a large catchment and a large recharge source from the up-gradient Rhondda Colliery adjacent to the northwestern boundary of the Teralba Quarry.

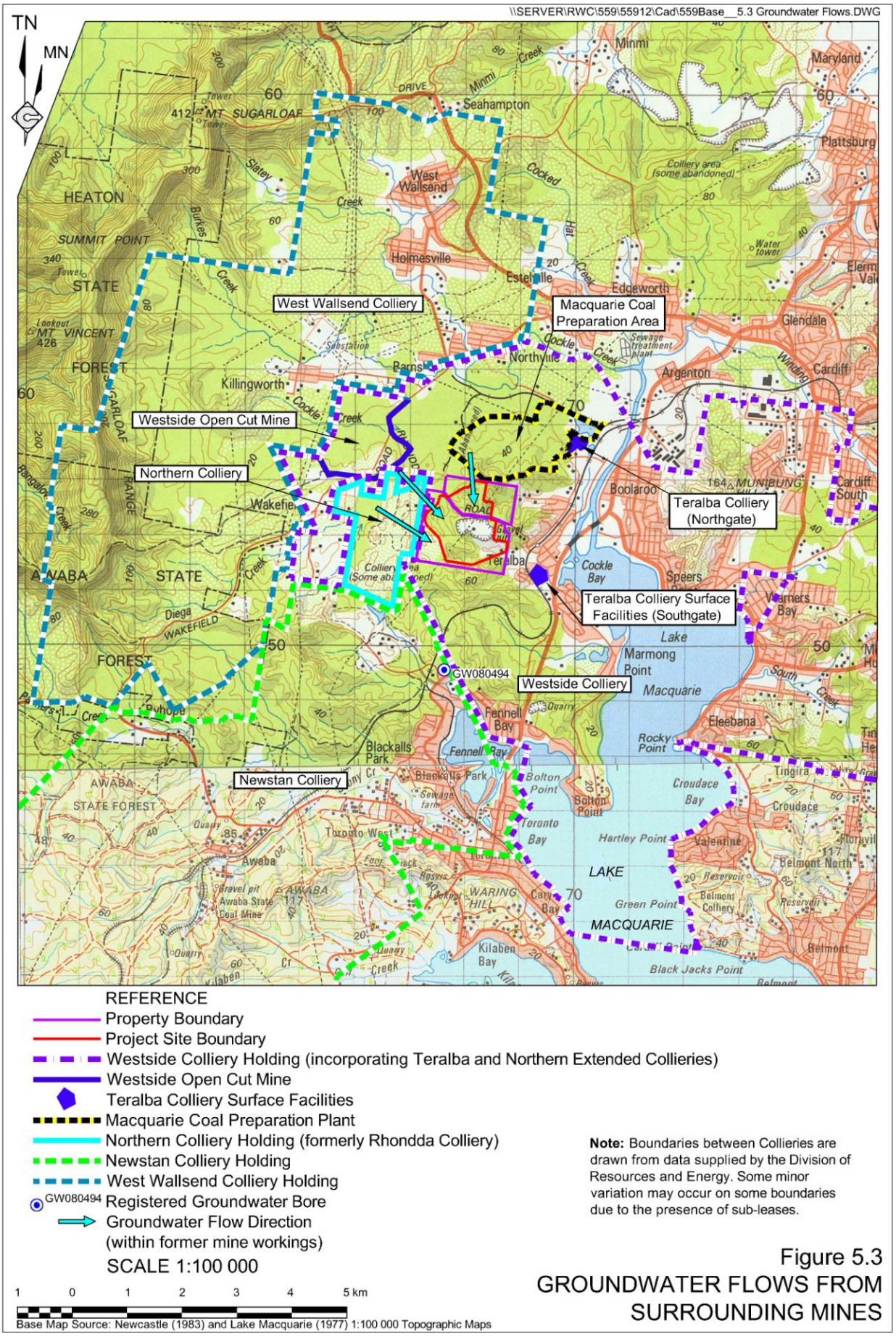


Figure 5.3
GROUNDWATER FLOWS FROM SURROUNDING MINES

Detailed mine plans and surveyed levels in the former mine workings have enabled the direction of groundwater flow through the GNCS to be established. Groundwater flow is governed by the dip of the coal seam which is to the south and southeast. Groundwater flows from the Rhondda Colliery and then underneath the Teralba Quarry and proposed Southern Extension.

Figure 5.4 presents the generalised schematic flow-path of groundwater beneath the Project Site and the groundwater – surface water interaction.

No water quality information has been obtained at the Teralba Quarry or in the proposed quarry extensions. A drilling exploration program was undertaken in 2004 (Rangott 2004) which comprised six percussion holes across the proposed Southern Extension, through the conglomerate profile and in some cases, intersecting the top of the GNCS or mined voids. No indication of groundwater within the conglomerate was recorded.

5.2.2.5 Surface Water – Groundwater Interaction

A disused mine adit is located to the southeast of the existing Southern Extraction Area. This was the key discharge point from the GNCS mine workings when Rhondda Colliery was operational and has remained an outlet for "groundwater" that is flowing through the former mine workings. This mine adit partially intercepts groundwater in the GNCS which flows to a holding dam, the "Mine Adit Dam". The groundwater flow is recharged by rainfall which flows through the permeable conglomerate layer above the GNCS across the Teralba Quarry and the surrounding properties. The dam occasionally receives surface water that flows through the series of sediment dams east of the processing plant. Overflow from the Mine Adit Dam flows over a weir (formerly a "v-notch weir", now a triple pipe discharge, with permanent data logger monitoring), before discharging to a small channel which flows through Teralba ("Murph's Drain") eventually discharging to Lake Macquarie near the entry of Cockle Creek. This creek and drain would have been ephemeral prior to coal mining activities, however, since the cessation of coal mining, the flow in this creek and drains has almost been permanent.

Flow leaving the Mine Adit Dam and the volume of water pumped for Metromix's use is recorded and available data for 2003 and 2008 was evaluated.

A detailed evaluation of the 2003 and 2008 data established the following with respect to monthly flows from the Mine Adit Dam and the quantity of water used by Metromix.

- 2003 – the total monthly flows varied from 136ML to 257ML of which Metromix used 37% to 69%.
- 2008 – the total monthly flows varied from 159ML to 389ML of which Metromix used 26% to 59%.

Metromix's total usage in 2003 and 2008 accounted for 53% and 34% of the total flow into the Mine Adit Dam respectively. The quantity used by Metromix was generally constant during this period and typically up to approximately 1 300MLpa.

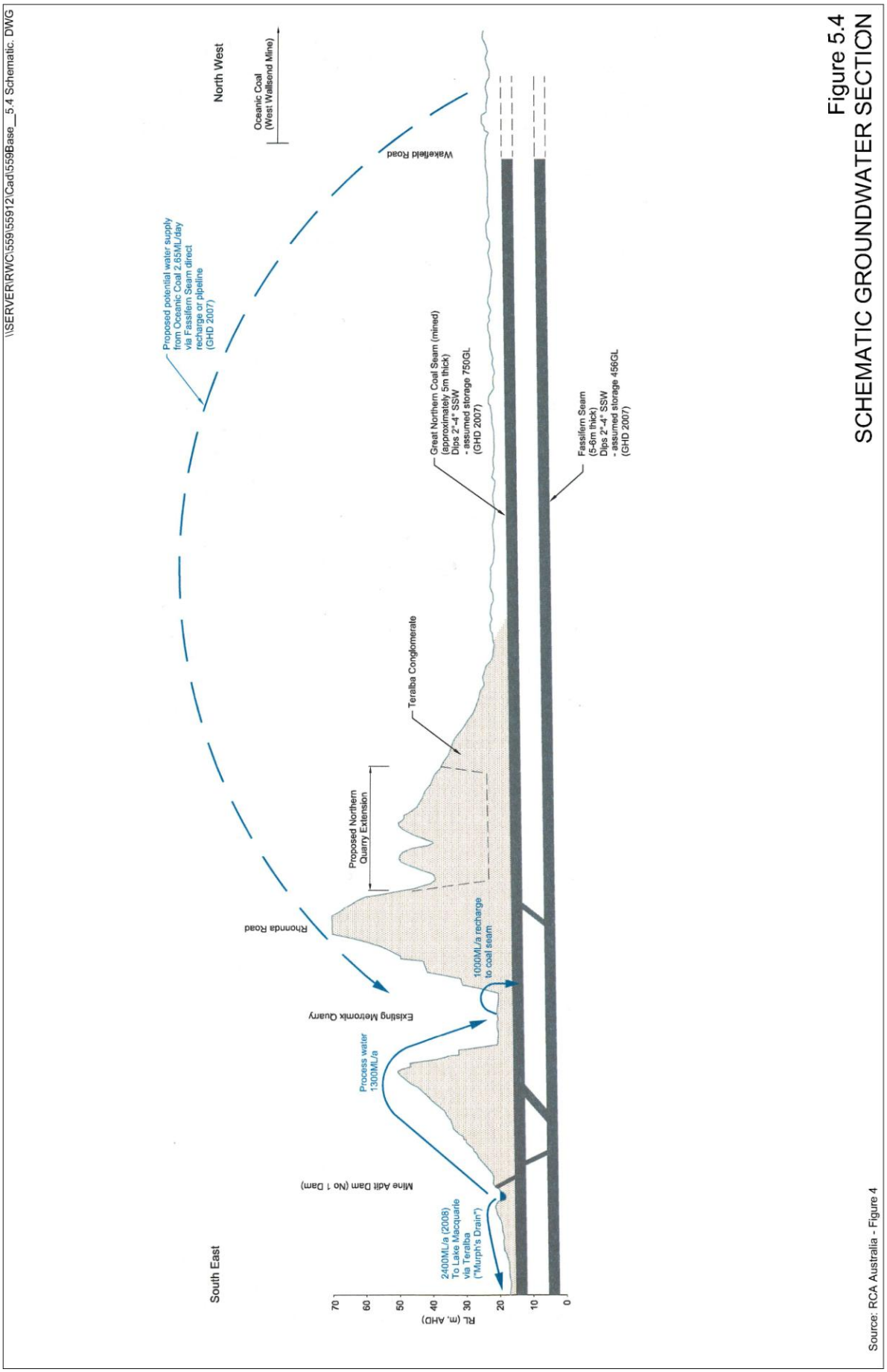


Figure 5.4
SCHEMATIC GROUNDWATER SECTION

Source: RCA Australia - Figure 4

5.2.2.6 Groundwater Quality

Available monitoring data from the Mine Adit Dam (from Coal & Allied Coal EPL 3139) are listed in **Table 5.4**.

Table 5.4
Summary of Available Groundwater Chemistry

Analyte	No of samples	Guidelines [a]	Concentrations		
			Mean	Min	Max
pH [b]	274[1]	6.5 to 8.5	7.1	6.2	8.6
Conductivity (µS/cm)	152[2]	N/A	6 541	471	13 600
Dissolved Organic Carbon (mg/L as C)	122[3]	N/A	3.7	0.5	32
Ammonia (mg/L as N)	260[1]	1.43	0.23	0.0025	4.02
TKN Filtered (mg/L as N)[c]	149[2]	N/A	0.85	0.02	3.4
Nitrates (mg/L as N)	275[1]	3.4	0.25	0.0025	10.9
Suspended Solids (mg/L) [b]	271[1]	50 [b]	21.4	0.5	248
Chloride (mg/L)	244[1]	No GL	1 800	86	5 200
Sulfate (mg/L)	123[3]	No GL	509	48	1 200
Total Phosphorus (mg/L as P)	272[1]	0.01	0.078	0.003	0.71
Zinc (mg/L)	123[3]	0.015	0.023	0.01	1.0
Selenium (µg/L)	123[3]	0.011	0.51	0.25	7
Arsenic (µg/L)	123[3]	0.094	1.31	0.05	8.6
Boron (mg/L)	123[3]	0.68	0.45	0.07	1
Bromide (mg/L)	123[3]	No GL	6.59	0.1	50
Fluoride (mg/L)	120[2]	No GL	0.4	0.2	1.2

Source: Rhondda Colliery Monitoring Records.

a ANZECC 2000 Freshwater Guideline for 90% protection. b EPL3139. c Total Kjeldahl Nitrogen.

N/A = Not Applicable.

Sampling Duration: 1 ~ Approximately 20 years.
2 ~ Approximately 10 years.
3 ~ Approximately 7 years.

In general, the results indicate the following.

- pH is found to be neutral on average with variation to alkaline and slightly acidic values.
- The average ammonia concentration was found to be low and below the guideline. Three samples (of 260 samples) were found to be above the guideline.
- The average nitrate concentration was found to be low and below the guideline. Two samples (of 275 samples) were found to be above the guideline.
- The average suspended solids concentration was found to be low and below the guideline. Twenty three samples (of 271 samples) were found to be above the guideline.
- The average total phosphorus concentration was found to be above the guideline.
- The average concentrations for zinc, selenium and arsenic were found to be above the guideline.
- The average boron concentration was found to be low and below the guideline. Sixteen samples were found to be above the guideline.

Salinity is very similar for both the Mine Adit Dam and downstream, in the caravan park samples with average electrical conductivity values of 6 000 to 7 000µS/cm and maximum values of 9 000 to 11 000µS/cm. This is contrasted with lower Cockle Creek (tidal, reflecting Lake Macquarie values) with an average salinity of approximately 29 000µS/cm and a maximum value of approximately 44 000µS/cm. There appears to be no evidence of a significant downstream effect from the quarry with respect to salinity.

Monitoring undertaken subsequently (to May 2011) indicates a continuing downward trend in salinity for water from the Mine Adit Dam.

5.2.2.7 Groundwater Dependent Ecosystems

No groundwater dependent ecosystems have been identified within the Project Site.

The flora survey of the Project Site confirmed that terrestrial woody vegetation potentially dependent on groundwater, such as swamp sclerophyll forest and wet heath do not occur in the Project Site (Idyll Spaces, 2011) (see also Section 5.4).

5.2.2.8 Groundwater Beneficial Use

Beneficial use classes have been assessed for the groundwater underlying the Project Site based on the available groundwater quality monitoring data (from monitoring at the Mine Adit Dam undertaken by Coal and Allied Industries Limited as part of EPL 3139).

The Mine Adit Dam receives groundwater via an adit from old workings in the Great Northern Coal Seam and Fassifern Coal Seam which are present beneath the existing and proposed extensions to the Teralba Quarry.

RCA (2011) assesses the beneficial use (environmental values) of the groundwater using limiting ANZECC Guidelines or water quality targets (where information is available) defined for southeast (NSW) lowland rivers ecosystems. The beneficial use of the groundwater reporting to the Mine Adit Dam was found to be limited stock watering (for tolerant species, e.g. sheep) and industrial water, based mainly on salinity.

5.2.3 Groundwater Use and Supply

5.2.3.1 Water Use and Availability

The quarry requires water for the wet production process (crushing/washing/screening raw materials) which, on average, constitutes approximately 65% of the quarry throughput. On this basis, the projected maximum water requirement is approximately 422ML/annum based on 900 000tpa annual average production and use of approximately 2 000L/tonne.

Small amounts of water are also required for dust suppression and wheel washing purposes.

Non-potable water for the quarry operations is currently sourced from the Mine Adit Dam. Water is pumped from the Mine Adit Dam to Dam G from where it is pumped to the processing plant.

Water not lost to quarry products or as evaporation either flows via surface drainage into the series of sediment dams or is collected and stored in a holding tank in the plant area.

In the past, this stored water containing up to 9% silt was directed into the GNCS aquifer, however, this water will soon be pumped to a series of silt cells on the floor of the Southern Extraction Area.

5.2.4 Potential Impacts of the Project

5.2.4.1 Groundwater Quality

The analyses of groundwater reporting to the Mine Adit Dam since the discharge of processing plant fines into the underlying coal mine workings commenced has indicated that there has been no significant impact on groundwater quality. This is illustrated by the Cumulative Sum (Cusum) charts which provide records of water quality parameters for pH, ammonia, suspended solids, nitrate, chloride, fluoride, total phosphorous, zinc, selenium, arsenic and boron (see Appendix 1 of BMT WBM (2011).

In light of these observations, and the fact that water from the processing plant would no longer be discharged into the GNCS, there is negligible potential for the Project to impact the quality of groundwater.

5.2.4.2 Groundwater – Surface Water Interaction

The proposed extension of existing extraction operations in a southwesterly and northerly direction would result in removal of the conglomerate resource to within approximately 1m of the underlying GNCS, and include the planned, induced collapse of conglomerate into mined voids (in the GNCS). This would potentially provide further interaction between surface water and groundwater as the voids have a higher permeability, allowing a higher infiltration of surface water into the underlying coal seam aquifer.

Given that surface water inflow is already occurring in the existing quarry area and, based on a statistical review of the water quality data, no significant changes in water quality have been detected, the proposed quarry extensions are not expected to have a detrimental effect on the groundwater quality, conditional on the exclusion of uncontrolled contaminating activities from the quarry surface catchment area.

5.2.4.3 Groundwater Recharge

The ongoing collapse of conglomerate in the floor of the lower level in the Southern Extension would continue to increase the recharge into the aquifer through rainfall. However, given the large aquifer catchment size, this would not have a significant effect.

For example, if the amount of infiltration over the extended quarry floor increased to 50% of rainfall, then a conservative estimate of the amount of water recharging would be in the order of 36ML/yr. The impacts from variable rainfall at the mine adit appear to be upwards of 1 000ML/yr based on a comparison of mine adit flow between years 2003 and 2008. The change from variable recharge in the quarry floor would thus represent less than 5% of the variation.

Additionally, as the mined voids within the GNCS are progressively filled by induced collapse of the overlying conglomerate (in order to maximise recovery of the conglomerate and provide quarry floor stability), it is envisaged that the transmissivity of the GNCS aquifer beneath the Teralba Quarry may be locally reduced as open voids are replaced by broken rock and fines materials. Minor local changes to the aquifer flow regime may occur, however, it is noted that the GNCS aquifer extends considerably further than the area beneath Teralba Quarry and it is likely that groundwater would continue to flow unimpeded through other voids in the former mine towards the Mine Adit Dam.

As a consequence, the use of the Mine Adit Dam as a water source for quarry operations may be affected only marginally, by this potential change in groundwater flow regime.

The Project could also impact on the volume of water stored in the albeit underlying coal seams. As part of the 2007 Water Management Plan prepared for Metromix by GHD, it was estimated that groundwater storage in the mined voids comprised 750 000ML in the GNCS (based on 50% flooded saturation), and 456 000ML in the FCS (based on 95% saturation). Using assumed average water usage rates (based on existing usage), it was estimated that by the end of the quarry life, nominally 2033, change in mined coal seam storage would have decreases of 0.74% and 4.9% for the GNCS and FCS respectively. These estimates assume recharge from the Oceanic Collieries to the FCS at 2.65ML/day (for the Fassifern option), and does not include any natural recharge (rainfall/infiltration). Hence, they considered conservative.

5.2.5 Controls and Management Measures

Consideration of the existing groundwater setting and potential impacts of the Project has determined that:

- there are no significant downstream groundwater users and no GDEs; and
- the water supply required for the quarry would have a minimal impact on groundwater quantities reporting to the Mine Adit Dam.

Nevertheless, should a substantial reduction in groundwater quantities be identified by monitoring, and that is identified to be an issue of concern, potential mitigation measures may include the commissioning of a study to assess if the cause of the identified reduction is a result of quarrying operations and, if so, development of alternative water supply options in consultation with New South Wales Office of Water (NOW).

A Groundwater Contingency Plan would be prepared as part of the Soil and Water Management Plan for the quarry identifying the trigger levels to be determined (potentially in consultation with OEH/NOW). It is considered that the plan would include a water quality monitoring program complementing the surface water monitoring program.

In the event that routine monitoring indicates that water quality parameters show an increasing trend, an increase in the analytes monitored and/or frequency of sampling would be undertaken to confirm the magnitude and extent of the change in water chemistry and verify the change is a consequence of quarry activities.

A spill management plan would be prepared and implemented at the quarry. The plan would form part of the Quarry's Hydrocarbon Management Plan.

5.2.6 Assessment of Impacts

Based on data from 2003 and 2008, it has been concluded that Teralba Quarry operations do not have a significant impact on the water quality of the underlying groundwater. This absence of impact is predicted to occur throughout the remaining life of the quarry.

Groundwater is currently drawn from the Mine Adit Dam where groundwater exits from the adit and mixes with small quantities of surface water, a practice which is soon to cease. The water from the Mine Adit Dam is used in simple physical processing (washing) operations. The quantity of groundwater used as make-up for the various on-site uses would decrease as a result of the re-use 70% of the water used in the processing plant. Overall, the amount of groundwater reporting to the Mine Adit Dam and flowing off site would be comparable to existing levels. This water would continue to flow via Murph's drain to Lake Macquarie. The absence of groundwater-related impacts in the past is expected to continue.

The proposed quarry extension, through further exposing the Teralba Conglomerate would increase infiltration in the operational areas. However, RCA (2011) concludes that given the large aquifer catchment size this would not have a significant effect. Notwithstanding, this observation, given direct flow and infiltration would occur from active extraction areas into underground voids, a monitoring program would be developed and implemented in order for impacts to be monitored (see Section 5.2.7).

RCA (2011) concludes that the nearest licenced groundwater well (GW080494) located down-gradient from the Project Site would be unlikely to be affected by the ongoing operation of Teralba Quarry.

It is noted that all impacts described in this section effectively account for the overall groundwater system that has, to varying degrees, been influenced by the actions of the surrounding coal mining companies over many years.

5.2.7 Monitoring

A groundwater monitoring program would be prepared and implemented for water reporting to and/or discharging from the Mine Adit Dam. This program would form part of the Soil and Water Management Plan for the quarry with all monitoring undertaken in conjunction with that proposed for surface water (see Section 5.3.7).

Monitoring of water quality at the Mine Adit Dam would continue to be undertaken at monthly intervals for the following analytes currently being monitored.

- pH
- Electrical conductivity
- Total Suspended solids
- Oil and grease

Flows/discharges would also be recorded from the dam and records also kept of quarry water usage.

The monitoring results would be reviewed following each monitoring round to identify trends which may indicate impacts and require adoption of additional mitigation. All monitoring data would be incorporated into each Annual Environment Management Report for the Teralba Quarry. Each annual review would also include a review of the value of the data being collected and whether it is meaningful.

5.3 SURFACE WATER

The surface water assessment for the Project was undertaken by BMT WBM Pty Ltd (BMT WBM, 2011). The full assessment is presented in Volume 1, Part 3 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.3.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery and Co Pty Limited for the Project (Section 3.5 and **Table 3.7**), the potential impacts on surface water requiring assessment and their unmitigated risk rating are as follows.

- Reduced downstream surface water quality (high risk).
- Reduction of recharge to groundwater systems (high risk).
- Contamination of surface water due to suspended solids associated with processing operations (high risk).
- Reduction of volume and flow rates of local surface water resources and subsequent availability to local downstream users (high risk).

The DGRs issued by the former Department of Planning and requirements issued by the former Department of Environment, Climate Change and Water, and the New South Wales Office of Water (NOW), identified "Surface Water" as one of the key issues that required assessment within the *Environmental Assessment"*. The assessment of impacts on surface water is required to include the following.

- Detailed modelling and assessment of potential impacts on:
  - the quality and quantity of existing surface water and groundwater resources;
  - affected licensed water users and basic landholders rights;
  - the riparian, ecological, geomorphological hydrological values of watercourses; and
  - impacts to agricultural lands.
- A detailed description of the proposed water management systems (including all infrastructure and storages) and water monitoring program.
- A comprehensive description of measures to minimise all surface water discharges.
- A detailed description of the measures to mitigate surface water impacts.

The following sub-sections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls, safeguards and mitigation measures. An assessment is included of the summarised residual impacts following the implementation of these safeguards and mitigation measures.

5.3.2 The Existing Environment

Local Setting

Teralba Quarry is located within the Lake Macquarie catchment area with three localised catchments covering parts of the Project Site (see **Figure 5.5**). **Figure 5.5** displays the northeastern and southeastern catchments draining via un-named first and second order streams directly to Lake Macquarie. The first and second order streams in the western catchment drain into Cockle Creek, which in turn flows into Lake Macquarie.

Project Site Catchments

The Project Site incorporates seven sub-catchment areas as summarised in **Table 5.5** and displayed on **Figure 5.6**. Sub-catchment areas A, B and C cover the existing Southern Extraction Area whilst Sub-catchment D is located south of the existing Southern Extraction Area in largely undisturbed bushland draining into Sub-catchment A via an ephemeral creek. Sub-catchments E, F and G are located north of Rhondda Road and are largely undisturbed bushland draining off site to the west (to Cockle Creek) or directly to Lake Macquarie via ephemeral creeks. The surface water characteristics of each sub-catchment area (including main flow paths and discharge points) are described in the following sub-sections.

Table 5.5
Project Site Sub-catchment Areas

ID	Location	Description	Approx. Area (ha)
A	Eastern side of existing Southern Extraction Area and proposed Southern Extension.	Metromix Office, Downer EDI Asphalt Plant, sediment dams, flooded mine adit and undisturbed bushland • Runoff draining east off site and infiltrated	48.0
B	Western side of existing Southern Extraction Area	Existing Southern Extraction Area Quarry • Runoff stored and infiltrated	26.9
C	Northern border of existing Southern Extraction Area	Civilake Pugmill and undisturbed bushland • Runoff draining west off site	8.8
D	South of existing Southern Extraction Area and proposed Southern Extension.	Undisturbed bushland and electricity easement • Runoff draining northeast into Sub-catchment A and infiltrated	47.0
E	North of Rhondda Road. Mid Pit Extraction Area.	Undisturbed bushland and electricity easement • Runoff draining west off site	22.9
F	Northern extent of Project Site. Proposed Northern Extension.	Gun Club and undisturbed bushland • Runoff draining west off site	12.9
G	Northeast extent of Project Site. Mid Pit Extraction Area.	Undisturbed bushland and electricity easement • Runoff draining east off site	20.4

Source: BMT WBM (2011) – Table 2.1

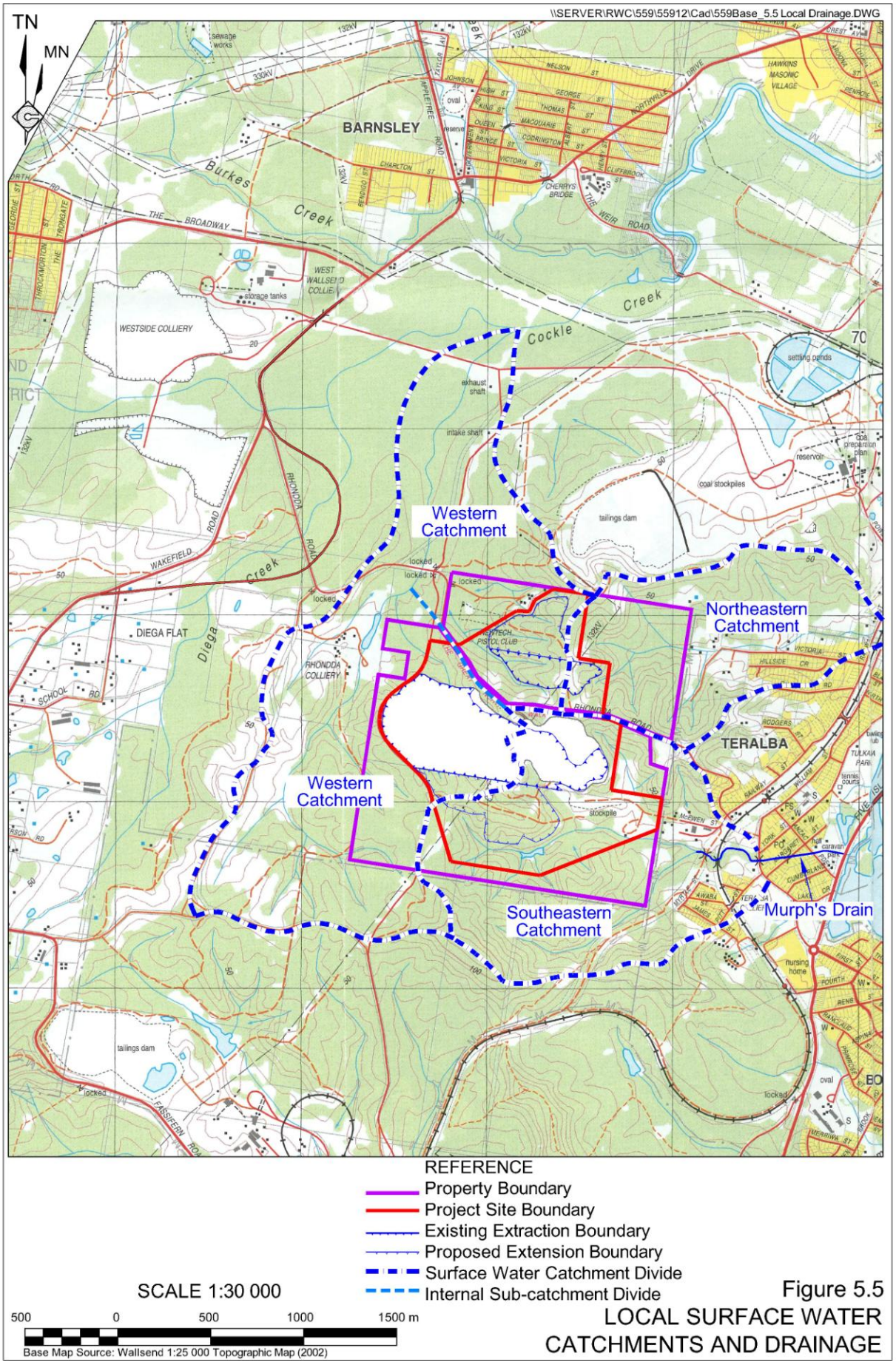


Figure 5.5
LOCAL SURFACE WATER CATCHMENTS AND DRAINAGE

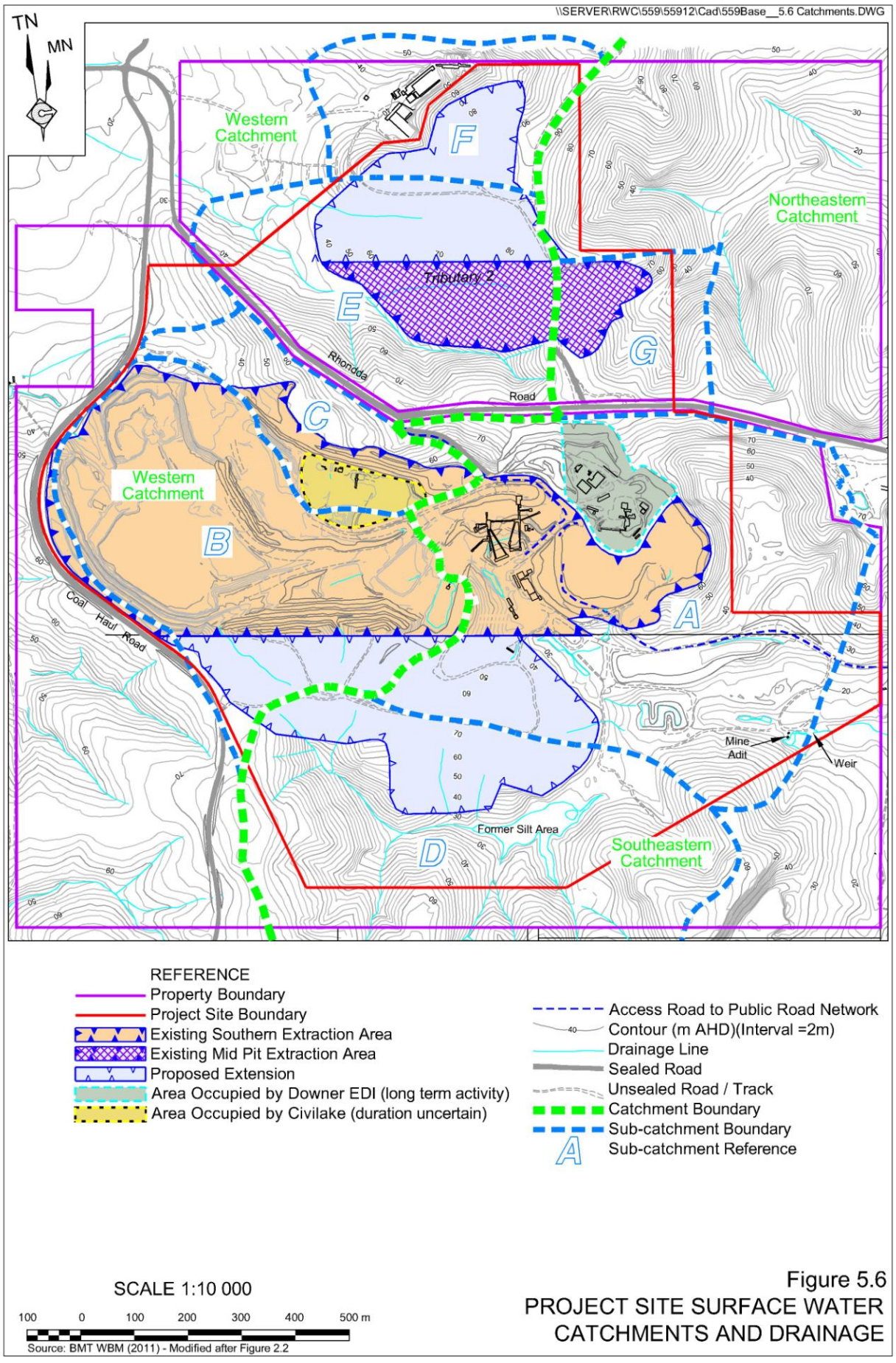


Figure 5.6
PROJECT SITE SURFACE WATER CATCHMENTS AND DRAINAGE

Surface Water Runoff

Surface water runoff within the Project Site occurs following substantial rainfall events and overflow from the processing plant. Rainfall runoff occurs from disturbed areas including the extraction areas, sealed and unsealed haul roads and stockpiles, as well as undisturbed and cleared bushland areas within the Project Site. A significant proportion of rainfall and surface water runoff across the Project Site infiltrates due to the highly permeable ground surface. The high level of percolation reflects the high permeability of the conglomerate and the surface cracking across the Project Site attributable to mine subsidence.

Surface water runoff from the existing Southern Extraction Area and surrounding catchment either infiltrates through the floor of the extraction area or flows eastwards via a series of formalised drainage paths including open table drains, pipes, culverts, weirs and sediment dams. Ultimately, during/following substantial rainfall periods, surface runoff currently reaches the Mine Adit Dam and mixes with water flowing from the mine adit before flowing off site.

Overflow from the Mine Adit Dam flows eastward via an overgrown vegetated drainage line and a large pond formed by the railway embankment which then flows below the embankment into a near-straight concrete open channel referred to as Murph's Drain. It is noted that this creek and drain would have been ephemeral prior to coal mining activities. However, since the cessation of coal mining, the flow in this creek and drain has almost been permanent. The open channel discharges into Lake Macquarie near the mouth of Cockle Creek and the Teralba Lakeside Caravan Park approximately 1.1km east of the Project Site. No licences are in place for the use of the water, nor is the water used for any purpose downstream from the Project Site before it flows into Lake Macquarie. It is noted that downstream of the Project Site land falls within the SEPP 71 Coastal Protection zone with a SEPP 14 Coastal Wetland located at the mouth of Cockle Creek. The existing Mid Pit Extraction Area and proposed Northern Extension drain to Cockle Creek in either a westerly or easterly direction.

Sub-catchment A is the largest catchment within the Project Site and encompasses the eastern side of the existing Southern Extraction Area to the eastern boundary of the Project Site, as shown in **Figure 5.7**. Sub-catchment A also contains a section of the proposed Southern Extension. Features of the sub-catchment area include:

- Metromix office;
- processing plant;
- undisturbed bushland;
- weighbridge;
- asphalt plant;
- sediment dams; and
- stockpiles;
- haul roads;
- workshop.

A series of sediment dams (B to F and H) are present in the south of the sub-catchment. Runoff from this sub-catchment is collected and drained to Dam B through a series of formalised drainage paths. At present, excess flow from Dam B discharges via a pipe to the Mine Adit Dam. Excess flow from the Mine Adit Dam discharges off site to an unnamed creek, which in turn flows into a concrete drain, referred to as Murph's Drain, draining directly to Lake Macquarie.

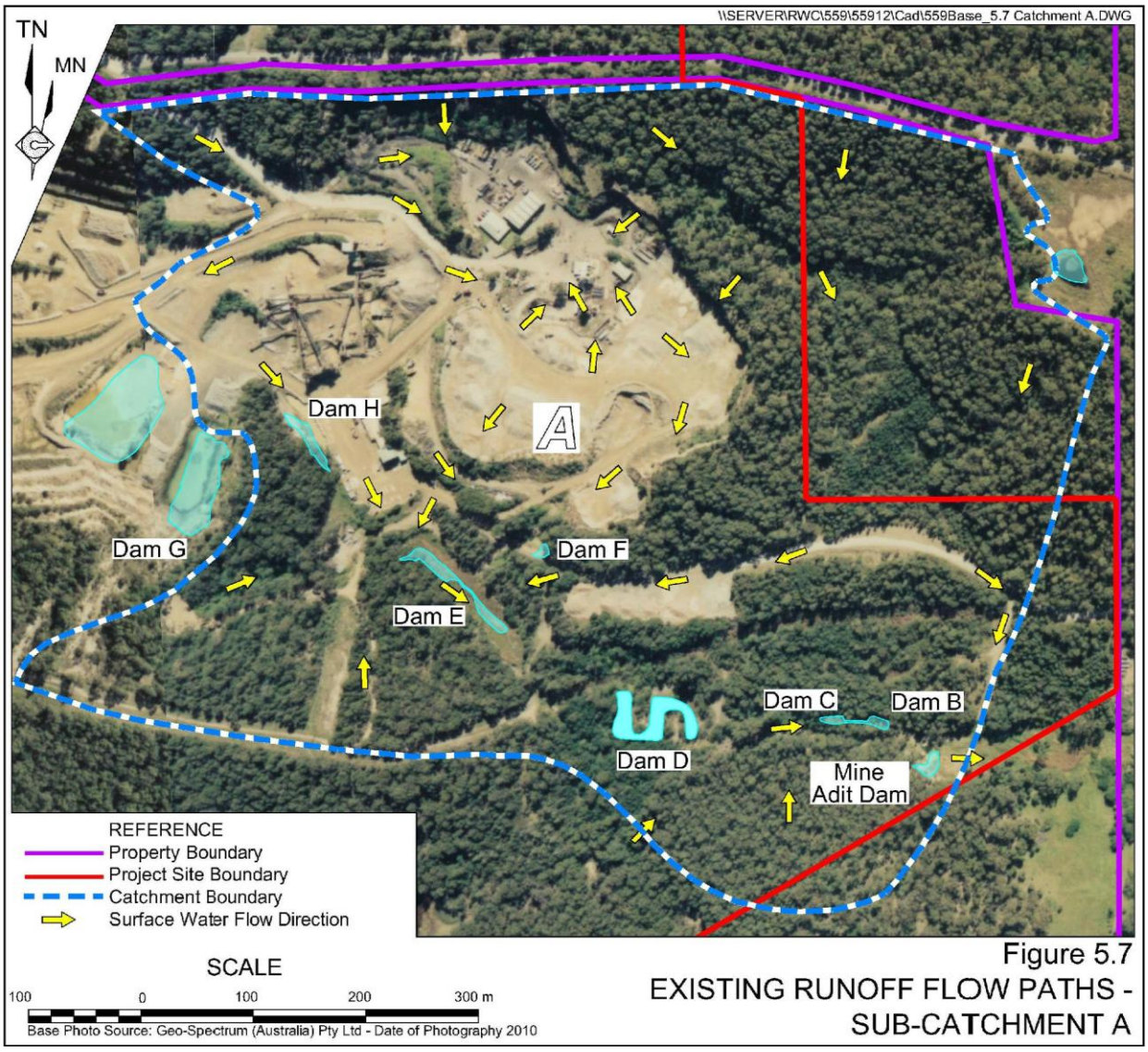


Figure 5.7
EXISTING RUNOFF FLOW PATHS - SUB-CATCHMENT A

Internal haul roads within this catchment are primarily unsealed, apart from the Downer EDI Asphalt Plant, with minimal formalised drainage systems present.

Sub-catchment B and C encompass the current main conglomerate extraction area of the existing Southern Extraction Area, the Civilake pugmill in the southeast, and a small area of undisturbed bushland to the south. The area features haul roads, a detention dam, old extraction pits, a holding dam and the pugmill.

Surface runoff from Subcatchment B flows to numerous low points where short-term ponding and infiltration occurs. The majority of surface water is expected to infiltrate in all but the most extreme rainfall events due to the highly permeable ground surface. A small amount of runoff from the haul road is directed southwards towards a detention dam and an old extraction pit. A small amount of runoff from the surrounding rock escarpment drains into Dam G. Dam G is a holding dam for water pumped from the Mine Adit Dam for site water use such as raw feed washing, dust control and the Civilake pugmill.

In the vicinity of the pugmill, surface runoff from the internal haul road, stockpiles and steep rocky escarpment to the north drains to a storage dam for infiltration/evaporation.

Surface runoff from the undisturbed bushland is diverted around the existing Southern Extraction Area to the west and off site via a small gully. The southern side of the gully comprises overburden from the quarry.

Sub-catchment D is located to the south of the existing Southern Extraction Area and includes approximately one half of the proposed Southern Extension area, as shown in **Figure 5.6**. The sub-catchment is predominantly undisturbed bushland with a cleared power transmission line easement orientated north-northeast/south-southwest.

Surface runoff within this sub-catchment collects in an ephemeral creek draining northeasterly towards Dam D located in Sub-catchment A. The location of significant surface runoff flow paths within Sub-catchment D are shown in **Figure 5.6**. The confluence of these tributaries has been modified by the construction of Dam D and past practices of coal chitter placement, etc. It is likely that collection and infiltration of runoff from this catchment would occur prior to runoff discharging into Dam D.

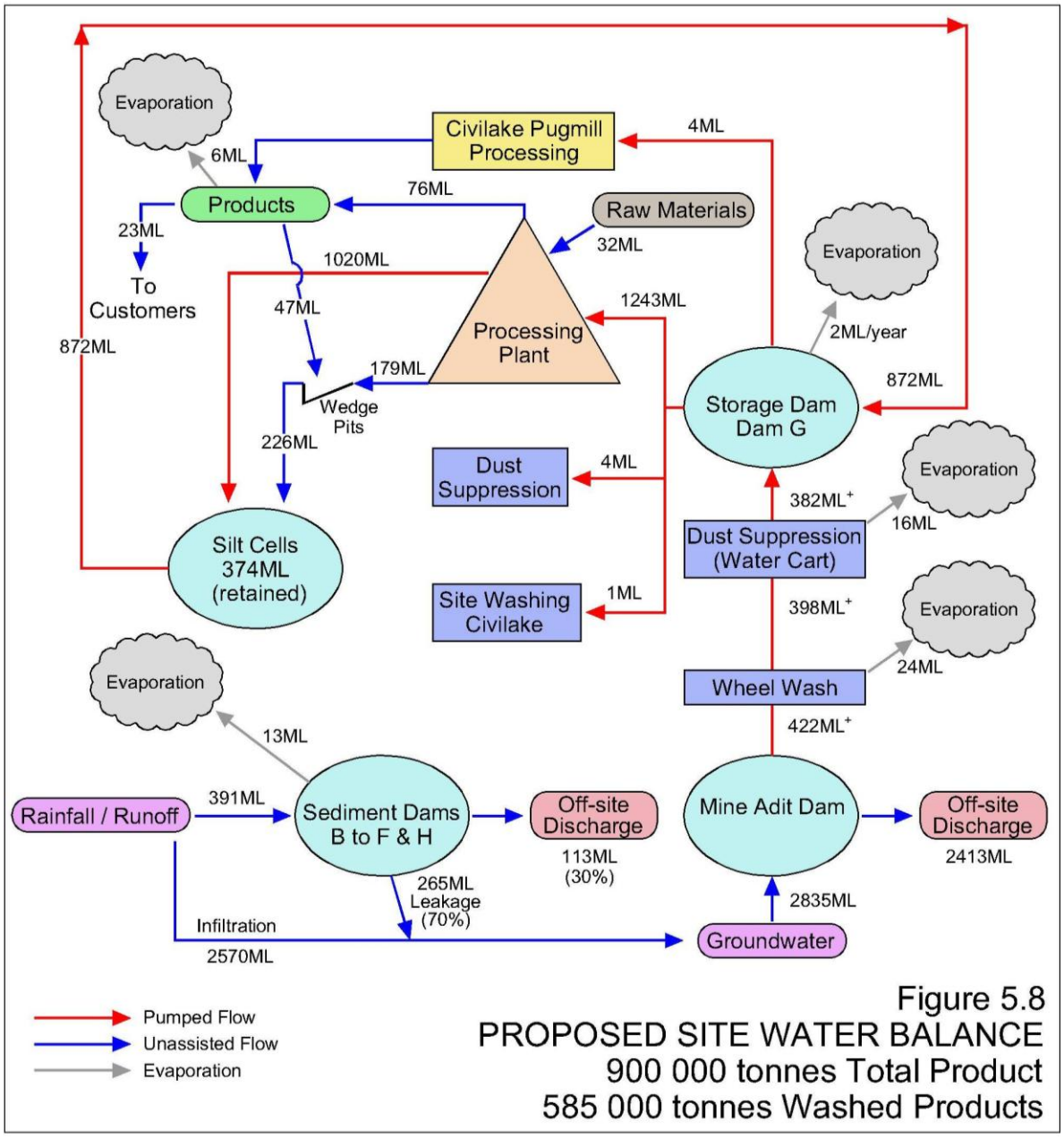
Sub-catchments E and F are located north of Rhondda Road. Between them they contain the majority of the existing Mid Pit Extraction Area and proposed Northern Extension, as shown in **Figure 5.6**. The catchment is predominantly undisturbed bushland but also contains an asphalt road (Rhondda Road) along the southern boundary, a cleared power transmission line easement, an unsealed access track along the eastern ridge, and also includes the area used by the Newtech Pistol Club. As works have now commenced within the Mid Pit Extraction Area, some bushland has been cleared. Stockpiles, sediment dams and a truck wash are also present. The land within Sub-catchments E and F fall from the eastern ridge and Rhondda Rd to several gullies. Surface runoff within this sub-catchment collects in these gullies, forming ephemeral watercourses which merge and drain off site to the west. The gullies do not display any substantive bed and bank development reflecting the limited flow conveyed in the gullies.

Sub-catchment G is located in the northeastern section of the Project Site and contains the eastern side of the existing Mid Pit Extraction Area, as shown in **Figure 5.6**. The catchment is predominantly undisturbed bushland but also contains a section of cleared power transmission line easement and an unsealed access track along the western ridge.

Surface runoff within this sub-catchment collects in several gullies forming ephemeral watercourses which merge and drain off site to the east. The gullies do not display any substantive bed and bank development reflecting the limited flow conveyed in the gullies.

5.3.3 Proposed Water Usage

The proposed ongoing usage of water for the quarry is illustrated in **Figure 5.8** and listed on **Table 5.6**.



It is important to recognise that a significant proportion of the water used on site would be re-circulated through the silt cells. The maximum harvestable rights dam capacity for the Project Site is 24.4ML.

Table 5.6
Proposed Extensions – Site Water Balance

Water Use	Flow Rate ML/yr	Notes
Processing Plant		
- Inflows	32	Assuming an average raw material extraction of 952 650t/yr, 65% wet processed (637 650t/yr) at 5% moisture by weight. (Note: 952 650t derived from 65% of 900 000t x 1.09 = 637 650t 35% of 900 000t = 315 000t)
Raw Material Moisture Content		
Process Water Demand	1 243	Water demand estimated at 2kL/t (for 637 650t) minus product moisture content (32ML).
Process waste water (slurry)	1 020	Estimated at 80% of water used in plant i.e. 0.8 x 1 275ML.
- Outflows		
Final Product Moisture Content	76	Water in products placed in stockpile = 13%, i.e. 585 000t x 0.13 = 76ML
Moisture in products to customers	23	Estimate based on 4% moisture in 585 000t of products = 585 000t x 0.04 = 23ML
Seepage from stockpiled products	47	Estimate based on moisture in products to stockpiles (76ML) less moisture in products to customers (23ML) less estimated evaporation (6ML) = 47ML
Incidental losses	179	Losses around processing plant = 1 275ML less moisture in products to stockpiles (76ML) and less processing waste water 1 020ML = 179ML.
Other Site Water Demands		
Dust Suppression	20	Estimates based on current uses by Metromix
Wheel Washes	24	
Water retained in silts	374	Assumed to be 30% of the waste water or slurry produced in the washing process (1 020ML) and inflow from the wedge pit (226ML)
Silt Dam Recovery	872	Assumed to be 70% of the waste water or slurry produced in the washing process (1 020ML) and inflow from wedge pit (226ML)
Evaporation		Estimate for dams based on the surface area, annual average daily evaporation for the Williamtown RAAF weather station (no. 061078) and applying an adjustment factor for water bodies of 0.75.
Dam G	2	
Sediment Dams	13	
Products	6	Estimates of water evaporated from products based on estimated 8% loss (based on site observations of runoff to the wedge pits).

Source: BMT WBM (2011 – Modified after Table 3.3

5.3.4 Potential Impacts

Both site clearing and general quarry operations have the potential to impact surface water quantity and quality by altering flow regimes and increasing erosion and sedimentation.

Activities within Teralba Quarry potentially influencing surface water impacts include:

- vegetation clearing;
- topsoil and subsoil removal;
- overburden removal;
- conglomerate extraction;
- hauling extracted raw feed;
- processing and stockpiling;
- hydrocarbon management; and
- overburden and waste management.

The potential impacts of these activities relate to both water quality and flow regimes. Water quality could be influenced by elevated levels of suspended solids or hydrocarbons and flow regimes influenced by modified catchment boundaries and varied rates of infiltration.

5.3.5 Design and Operational Safeguards

Figure 5.9 displays the range of surface water design and operational safeguards that Metromix already has in place or would be progressively installed throughout the life of the Teralba Quarry Extensions.

Process Water Management

Process water would continue to be sourced from the Mine Adit Dam by a single 98L/s pump operating on water level sensors and pumped to the lined storage dam, Dam G. When wet processing is underway, water from Dam G would be transferred to the processing plant by a 140L/s pump. The pugmill sources water from Dam G using a separate smaller pump and pipeline (see **Figure 5.8**).

Wastewater Management

Wastewater from the on-site amenities is collected in a single enviro-cycle unit on site. The waste water from the processing plant containing up to 9% solids would be pumped to the silt cells constructed within the Southern Extraction Area. Metromix anticipates recycling approximately 70% of the waste water pumped to the silt cells.

Erosion and Sediment Controls

The main existing and proposed erosion and sediment control measures on site are sediment dams. The sediment dams would be regularly inspected and cleaned.

As vegetated areas are cleared, vegetation would be pushed to the down-slope side of the cleared area and temporarily stockpiled acting as a sediment barrier. Reliance would be placed upon collection and diversion drains formed on the edges of internal haul roads.

Given rainfall and runoff infiltrates quickly on site, Metromix has not found it necessary to install sediment fences, diversion drains and turbidity barriers. However, as each area is cleared, the need for such controls would be reviewed. Where required, the controls would be constructed and monitored in accordance with the Blue Book (Landcom, 2004) guidelines for erosion and sediment control. If the required controls are proposed within 40m of any drainage lines they would also be undertaken in accordance with NOW Guidelines for Controlled Activities.

As no regular water quality monitoring is undertaken within the sediment dams, the effectiveness of the individual on-site erosion and sediment control works has not been established.

No additional erosion and sediment controls would be required on the main site road or access point off Rhondda Road. The main site access road to the existing Southern Extraction Area from Rhondda Road is a steep sealed road. The existing and proposed truck wheel washes would each be operated with a water recirculation system to contain sediment and minimise the use of make-up water.

The removal of vegetation would reduce evapotranspiration. The removal of topsoil, subsoil and overburden would reduce the soil moisture storage capacity. An increase in deep infiltration is expected on uncompacted areas as the permeable conglomerate rock is exposed. Increased runoff volumes are expected from compacted areas, however, such areas would be minimal.

The Southern Extension will increase the volume of ground infiltration. As the current ridge between Sub-catchment A and Sub-catchment D is extracted. The volume of rainfall runoff draining to the Sub-catchment A sediment dams will be reduced.

Surface water runoff within the proposed Southern Extension Area is to be detained and infiltrated through the conglomerate in a manner similar to the existing Southern Extraction Area. During all stages of the Southern Extension, sufficient storage will be available within the quarry area to prevent discharge off site of sediment-laden water in accordance with the Blue Book (Landcom, 2004) guidelines for sediment retention dams. Sediment retention dams would be managed and monitored to ensure they do not become overloaded with sediment.

Spill Containment

The site contains a bunded fuel bay incorporating one 15 800L and one 27 400L diesel fuel tank. The funding has been constructed in accordance with AS 1940 (2004). Oil drums are also stored in a neighbouring bunded shed. Both bunded areas are bordering Dam H. A spill containment kit is present on site which is located in the nearby workshop. Metromix would prepare a spill management plan addressing the contingency measures in place to manage any spillages from earthmoving equipment and areas where hydrocarbons are used on site.

Preliminary Sediment Dam Volumes

Preliminary sediment dam volumes have been estimated based on the Blue Book (Landcom, 2004) approach for Type D soils and the following criteria.

- Designed to contain runoff from a 5-day 90th percentile storm event.
- Designed with an embankment and spillway to remain structurally sound in a 1 in 50 year storm event.

Sediment dam volumes have been estimated for the following sub-catchment areas, which differ to those outlined in Section 5.3.2, as they are bound by the catchment areas and not the Project boundaries.

- Existing Sub-catchments:
  - Southern Extraction Area (Sub-catchment B), i.e. extraction area
  - Southern Sediment Dams (Sub-catchments A and D), i.e. Dams B, C, D, E, F and H
  - Mid Pit Extraction Area (portions of Sub-catchments E and G, limited to the Extraction Area), i.e. Dams B, C, D, E, F and H
- Proposed Sub-catchments:
  - Southern Extraction Area
  - Southern Sediment Dams
  - Northern Extension

The sediment dam volume is taken to be the sum of the settling zone and sediment storage zone. Preliminary estimates of sediment dam volumes for each extraction area are provided in **Table 5.7**.

Table 5.7
Preliminary Sediment Dam Volumes

Sub-catchment	Disturbed Catchment Area (ha)	Total Catchment Area (ha)	Sediment Dam Volume (ML)
Existing Sub-catchments			
Southern Extraction Area	26.85	26.85	9.92
Southern Sediment Dams	15.70	95.21	9.88
Mid Pit Extraction Area	7.42	7.42	2.74
Proposed Sub-catchments			
Southern Extraction Area	43.27	43.27	15.99
Southern Sediment Dams	15.70	80.50	8.51
Northern Extension	9.10	9.10	3.36
Source: BMT WBM (2011) – Table 5.2			

The current Site Water Management Plan (GHD, 2007) would be updated to take into account the proposed Southern and Northern Extensions, i.e. following the approval of the quarry extensions to provide details of all proposed erosion and sediment controls. The volumes of the individual dams within each of the sub catchments would be detailed in the updated Site Water Management Plan.

5.3.6 Assessment of Impacts

Surface Water Quality

The surface water assessment has established that surface water would be appropriately managed to ensure all sediment-laden water (exceeding relevant criteria) is retained on site, thereby ensuring an acceptable level of impact in the watercourses beyond the Project Site.

Metromix would achieve the acceptable level of impact through the adoption of a comprehensive range of on-site design and operational safeguards supported by a range of documentation.

Flow Regimes

The extraction of conglomerate would cause local changes in the catchments within the Project Site, however the impacts of such changes would be negligible given the existing and ongoing dominance of infiltration of rainfall and runoff rather than stream flow.

It is noted that Metromix's proposed water management involving the direct recycling of process water would result in greater flows from the Mine Adit Dam to the creek to the east and ultimately to Lake Macquarie.

Water Users

The absence of water users downstream from the Project Site would result in no impacts relating to either the quality or quantity of water flowing from the Project Site.

5.3.7 Monitoring

Metromix would adopt a monitoring program to review the effectiveness of all erosion and sediment controls and ensure any off-site discharge is monitored and reported in accordance with the relevant conditions of its environmental protection licence.

It is proposed to monitor water quality at six locations throughout the life of the ongoing quarry – see **Figure 5.9**. One of the monitoring locations is the Mine Adit Dam, the dam to be monitored for groundwater quality would continue to be monitored by Coal and Allied Industries Limited as part of its EPL 3193. In the event Coal and Allied Industries ceases to monitor the overflow from the Mine Adit Dam, Metromix would take over the monitoring for the parameters measured elsewhere on site albeit at a reduced level of frequency. Two of the five locations are within the sediment control system in Catchment A, i.e. at Dam H and below Dam B. The other three locations are north of Rhondda Road within the three key sediment dams.

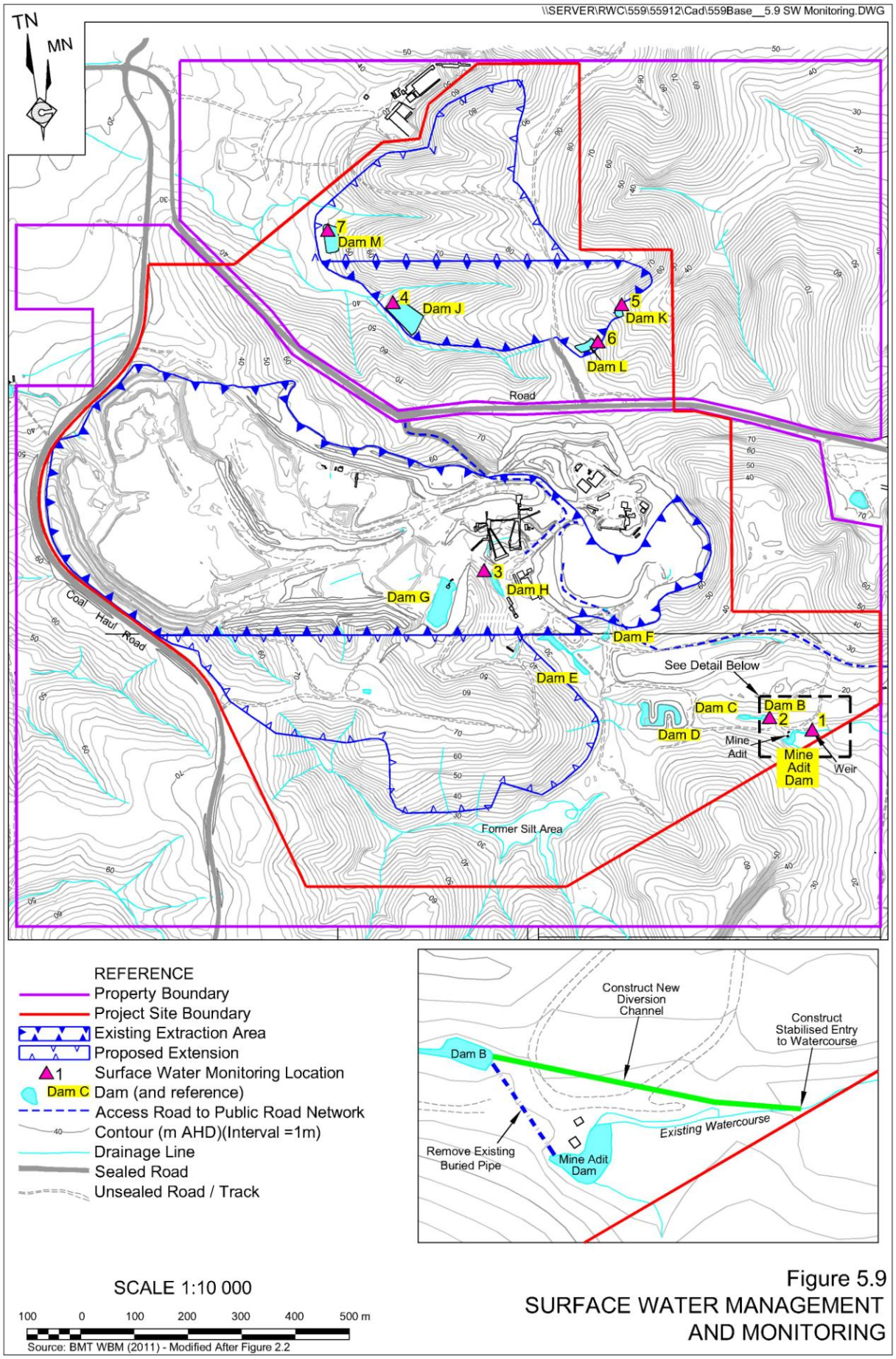


Figure 5.9
SURFACE WATER MANAGEMENT AND MONITORING

The need to monitor at all six locations would be regularly reviewed throughout the life of the quarry as it is likely that at some stages overflow from the dam(s) is unlikely.

Metromix may from time to time undertake monitoring of the sediment dams within Catchment A principally to determine the efficiency of the dams, if required. All surface water monitoring would be set out in a site specific water monitoring plan completed following the receipt of project approval.

5.4 FLORA

The flora assessment for the Project was undertaken by Idyll Spaces Environmental Consultants (Idyll Spaces, 2011). The full assessment is presented in Volume 1, Part 4 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.4.1 Introduction

The risk analysis undertaken by R.W. Corkery and Co Pty Limited, presented in Section 3.5 and **Table 3.7,** has identified the following potential impacts on flora (and fauna) relevant to the proposed Teralba Quarry Extensions.

- Removal of threatened flora and fauna species identified at the site through clearing activities (extreme risk).
- Loss of local and regionally important threatened species (flora and fauna) (extreme risk).
- Reduced local and regional biodiversity (extreme risk).

The following sub-sections describe and assess the existing threatened species and their habitat, identify the ecological management issues, proposed safeguards and mitigation measures for the threatened species and their habitat, provide an assessment on the proposed and residual impacts on local biodiversity following implementation of the proposed safeguards, mitigation measures and offset strategies. . The study area for the flora assessment is defined as all vegetation potentially impacted by the proposal, including that proposed within the biodiversity offset. This covers the Metromix lease area as well as the corridor for the proposed 33kV powerline immediately north of the Project Site (see **Figure 5.10**).

5.4.2 Study Methodology

5.4.2.1 Introduction

The study methodology involved a review of available literature and databases to gain an appreciation of the vegetation on and surrounding the Project Site and the threatened species or endangered ecological communities that could be present or have been recorded on or surrounding the Project Site.

5.4.3 Background Research

5.4.3.1 NPWS Mapping

Vegetation communities mapped within the study area by NPWS include:

- Coastal Foothills Spotted Gum – Ironbark Forest (NPWS map unit 15);
- Coastal Plains Smooth barked Apple Woodland (NPWS map unit 30);
- Alluvial Tall Moist Forest (NPWS map unit 5); and
- Coastal Plains Scribbly Gum Woodland (map unit 31).

Two of these communities, Coastal Foothills Spotted Gum – Ironbark Forest and Coastal Plains Smooth Barked Apple Woodland Vegetation Community, are mapped as occupying most of the study area. Both communities are identified as regionally significant habitat by of Lake Macquarie City Council (City of Lake Macquarie, 2008), but not listed as rare or threatened within NSW or the Hunter Central Rivers Catchment.

Two small areas within the study area were mapped as Alluvial Tall Moist Forest and Coastal Plains Scribbly Gum Woodland.

5.4.3.2 National Database Searches

The EPBC Act online database Protected Matters Search Tool predicts that six flora species of national environmental significance, or their habitats, may occur within 2km of the study area centroid – **Table 5.8**.

Table 5.8
EPBC Act Listed Flora known or Predicted to Occur within 2km of the Study Area

Scientific name	**EPBC Act Status**
Cryptostylis hunteriana	Vulnerable
Grevillea parviflora subsp. parviflora	Vulnerable
Melaleuca biconvexa	Vulnerable
Pterostylis gibbosa	Endangered
Syzygium paniculatum	Vulnerable
Tetratheca juncea	Vulnerable
Source: Idyll Spaces (2011) – Table 3	

No threatened ecological communities representing matters of national environmental significance under the EPBC Act are predicted to occur.

5.4.3.3 NSW Database Searches

The Wildlife Atlas of NSW database (extracted 2 December 2010) contains 4 775 flora records within 5km of the Project Site, of which 1 145 are threatened flora representing six species. **Table 5.9** presents a summary of the threatened flora species records within 5km of the study area.

Table 5.9
TSC Act Listed Threatened Flora Recorded within 5km of the Teralba Study Area

Scientific name	**TSC Act Status**	**Number of records within 5km**
Angophora inopina	Vulnerable	542
Callistemon linearifolius	Vulnerable	33
Cryptostylis hunteriana	Vulnerable	1
Grevillea parviflora subsp. parviflora	Vulnerable	27
Syzygium paniculatum	Endangered	2
Tetratheca juncea	Vulnerable	540
Source: Idyll Spaces (2011) – Table 4		

The Wildlife Atlas of NSW lists five Endangered Populations known to occur in the catchment and/or Local Government Area (LGA), namely:

- *Leionema lamprophyllum* subsp. *obovatum* population in the Hunter Catchment;
- *Cymbidium canaliculatum* population in the Hunter Catchment;
- *Acacia pendula* population in the Hunter catchment;
- *Eucalyptus parramattensis* C. Hall. subsp. *parramattensis* in Wyong and Lake Macquarie local government areas; and
- *Eucalyptus camaldulensis* population in the Hunter catchment.

5.4.4 Field Investigations

5.4.4.1 Field Surveys

Intensive flora surveys of the study area have been undertaken by Greg Elks of Idyll Spaces and Anne Clements & Associates over a 16 year period extending from January 1995 until early 2011. These surveys, which have involved both systematic survey and survey targeting threatened flora are summarised in **Table 5.10**.

Table 5.10
Summary of Flora Survey Personnel, Dates, Types and Locations

Page 1 of 2

Surveyor	**Date**	**Survey Type**	**Sample**	**Location**
Anne Clements & Associates	January, April and June 1995	systematic	13 x 0.03ha transects	South & west of existing quarry
		targeted	14 x 0.03ha spot locations	South & west of existing quarry
Anne Clements & Associates	September 2002	systematic	25 x 0.03ha transects	across study area
		systematic	2 x 0.03ha transects	Rehabilitation area
		targeted	8 x 0.03ha spot locations	across study area

Table 5.10 (Cont'd)
Summary of Flora Survey Personnel, Dates, Types and Locations

Surveyor	Date	Survey Type	Sample	Location
Anne Clements & Associates	November 2008	systematic	4 x 0.04ha quadrats	across study area
		targeted	parallel search	Proposed Southern & Northern Extensions
		targeted	0.03ha spot search	around *Tetratheca juncea* record
G. Elks	January 2011	targeted	6 random transects	across study area
		targeted	4 extended spot locations	around *Tetratheca juncea* records
	March 2011	systematic & Biometric	11 nested quadrats	across study area
Source: Idyll Spaces (2011) – Table 2				

Anne Clements & Associates

The first survey, undertaken by Anne Clements & Associates, sampled areas to the south and west of the extraction operations (within the Southern Extension Area) in January, April and June 1995. Another survey undertaken by Anne Clements & Associates in September 2002 sampled vegetation across the Project Site by means of 27 x 0.03ha transects and targeted searches at eight spot locations. A further survey by Anne Clements & Associates in November and December 2008 sampled the vegetation in eight 0.04ha quadrats and targeted searches during two months of the peak flowering time for *Tetratheca juncea*.

Targeted searches for *Tetratheca juncea* were undertaken on 15 and 16 November 2008 and 18 and 19 December 2008 by Anne Clements & Associates. Two persons searched parallel transects at 10m to 15m spacings. The parallel transect searches covered the whole of the Project Site, as well as other areas including where *Tetratheca juncea* had previously been recorded in September 2002 and rehabilitation areas in the east of the Project Site.

During the November 2008 survey, the relative frequency for all species detected was recorded. The percentage cover of exposed ground (bare soil and rock) and leaf litter, and the projected foliage cover of the following vegetation strata were estimated for each of the quadrats.

- Native canopy trees.
- Native midstorey trees.
- Native shrubs.
- Native grasses/graminoids.
- Native herbs.
- All exotic species.

Each 0.04ha quadrat consisted of four contiguous 10m x 10m subquadrats. The maximum height and number of individuals for each species greater than 2m high was recorded in each of the 10m x 10m subquadrats.

The relative frequency of plant species in the quadrats was assessed by recording the presence/absence of each species in each of four 5m x 5m subquadrats nested within each 10m x 10m subquadrat.

Idyll Spaces

Targeted searches for flora listed in the DGRs were undertaken along eight transects on 11 and 12 January 2011 by Greg Elks of Idyll Spaces Environmental Consultants. Total transect search time was 8.3 hours, total transect search distance was 1.3km. The study area was also surveyed on 23, 24 and 25 March 2011 by Greg Elks of Idyll Spaces Environmental Consultants.

Cover-abundance scores were recorded for all species detected by grid search in eleven 0.04ha quadrats more or less randomly located within strata of the Project Site**.**

Percentage foliage cover of exotics and cover of native overstorey, midstorey and the grass, shrub and other cover of the ground layer were estimated for a 0.1ha plot enclosing the 0.04ha plot using the methodology outlined in the Biometric Operations Manual. A plot disturbance and modification record, the number of trees with hollows and the total length of fallen logs were also recorded.

Total plot survey time was approximately 12.25 hours. Traverses between plots were utilised as informal targeted search for threatened flora.

Clumps of *Tetratheca juncea* identified by Clements were relocated and counted.

A supplementary targeted survey for *Tetratheca juncea* and *Grevillea parviflora* was undertaken along 2km of transect over six hours on 6 September 2011. The transect covered the area to be impacted and along the cleared transmission line easements, where OEH has indicated the species is known to occur elsewhere in the region. *Grevillea parviflora* was not detected by this survey or by previous surveys undertaken by Clements (2002, 2008) during the flowering period. Neither *Tetratheca juncea* nor *Grevillea parviflora* were detected in the powerline easement.

5.4.4.2 Field Survey Results

Anne Clements & Associates

Anne Clements & Associates concluded that the recorded vegetation best fits the map unit profile for Coastal Foothills Spotted Gum – Ironbark Forest. This community has been identified as regionally significant habitat by Lake Macquarie City Council (2008).

The canopy vegetation had not changed significantly from 2002 to 2008, despite a bushfire in the area in 2002.

No vegetation communities of National or State Conservation Significance were recorded.

One species of National and State conservation significance was recorded, namely *Tetratheca juncea*, listed as Vulnerable under the Commonwealth EPBC Act and the NSW TSC Act. Five populations of *Tetratheca juncea* were identified toward the western end of the Southern Extension and on the south-facing slope. Two previously located populations in the southeast of the Southern Extension, recorded in 2002, were not relocated in the 2008 targeted search. The 2008 targeted search identified a total of 124 clumps; populations varied in size from 2 to 64 clumps. Two clumps of *Tetratheca juncea* were recorded in the rehabilitation area.

One regionally significant plant species, *Macrozamia flexuosa,* was recorded. This species is listed as a regionally significant species by NPWS (2003). This species was recorded in Quadrats 6 and 7 (2008) and in Transects 2, 5, 10, 15, 16 and 24 (2002).

Three noxious weed species (*Ageratina adenophora*, *Cortaderia selloana* and *Lantana camara)* were recorded.

Idyll Spaces

Two forest vegetation communities (after Walker and Hopkins, 1990) were identified and mapped by Idyll Spaces as dominant within the study area, namely:

- Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland; and
- Blue Gum - White Stringybark Shrubby Open Forest.

Figure 5.10 presents the mapped locations of these vegetation communities on the Project Site. **Table 5.11** lists the key species of the two vegetation communities and their distribution throughout the Project Site.

No vegetation communities of National or State conservation significance were recorded within the Project Site.

Community descriptions and distributions are presented in **Table 5.11** and are displayed on **Figure 5.10**.

Table 5.11
Key Species and Distribution of Vegetation Communities in the Study Area

Community	Key species	Distribution
Spotted Gum – White Mahogany – Grey Ironbark Open Forest & Woodland	*Corymbia maculata, Eucalyptus acmenoides*	Most common trees throughout all drier parts of study area
	E. paniculata, E. punctata, Angophora costata, E. umbra	Less common trees throughout drier parts of study area,
	Acacia implexa, A ulicifolia, Podolobium ilicifolium	Most common understorey shrubs throughout drier parts of study area
	Lomandra filiformis, Entolasia stricta, Imperata cylindrica, Themeda australis.	Most common ground layer plants throughout drier parts of study area
Blue Gum – White Stringybark Very Tall Shrubby Open Forest	*Eucalyptus saligna*	Most common trees in moist protected part of the study area
	E. globoidea, Corymbia maculata	Less common trees in moist protected part of the study area
	Daphnandra apatala, Cryptocarya spp, Synoum glandulosum, Acmena smithii.	Occasional rainforest tree species in moist protected part of the study area
	Rubus moluccana, Dioscorea transversa, Eustrephus latifolius, Smilax australis	Most common vines in moist protected part of the study area
	Doodia aspera, Blechnum cartilagineum, Pteridium esculentum, Entolasia spp, Oplismenus spp,	Most common ground layer species in moist protected part of the study area

Source: Idyll Spaces (2011) – Table 5

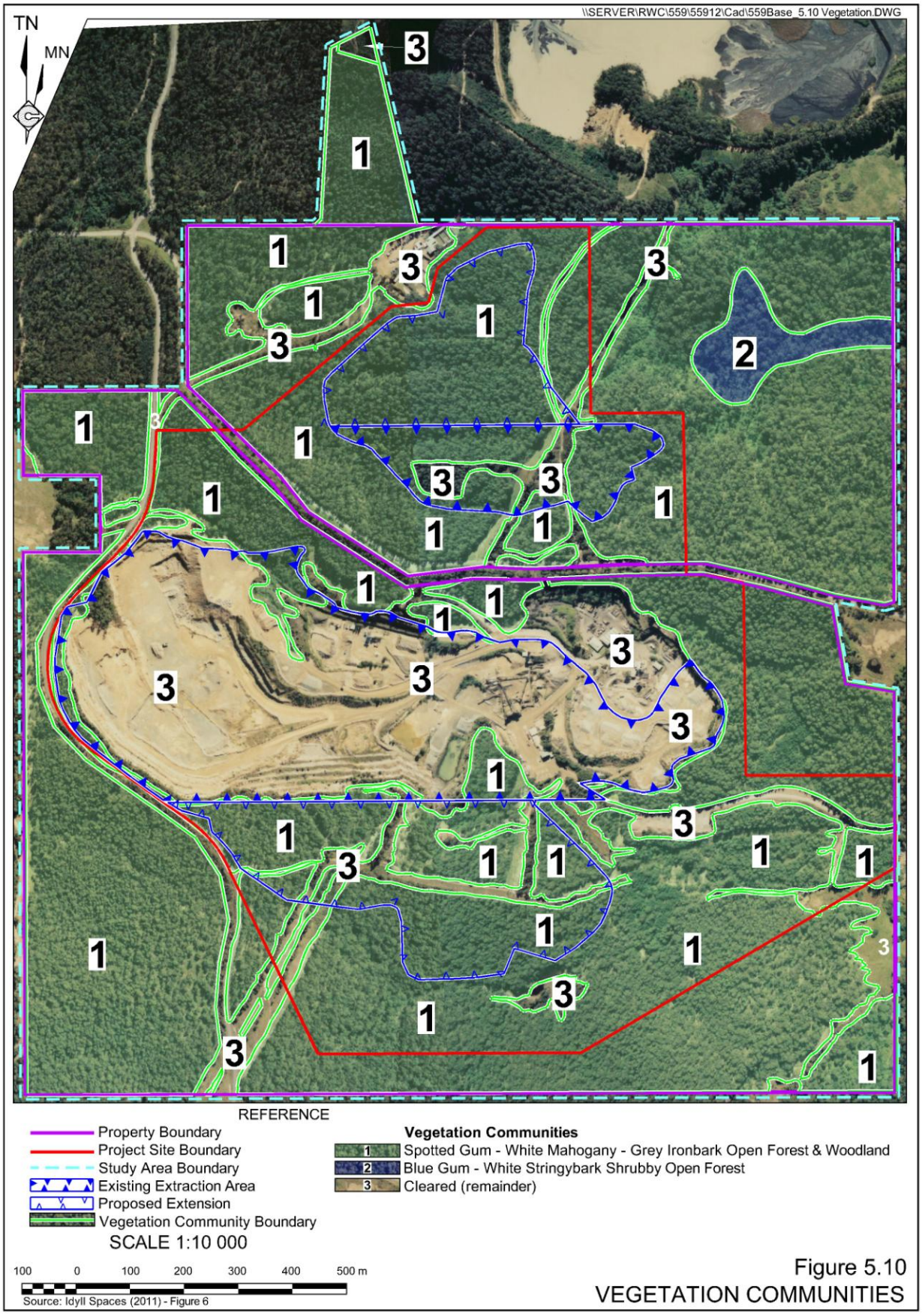


Figure 5.10
VEGETATION COMMUNITIES

In January 2011, *Tetratheca juncea*, previously recorded on the Project Site by Clements (2008) and listed as vulnerable under the Commonwealth EPBC Act and the NSW TSC Act, was identified by targeted search in January 2011. Four of the five populations of *Tetratheca juncea* identified by Clements (2008) were relocated, however, no new occurrences of *Tetratheca juncea* were detected. The 2011 targeted search identified a total of 77 clumps, with populations varying in size from 1 to 40 clumps. Due to the difficulty of identifying the extent of a clump, the number of clumps in 2008 and 2011 may not be comparable. Of the two clumps of *Tetratheca juncea* recorded in 2008 in the rehabilitation area, one has subsequently been smothered by fallen vegetation. **Figure 5.11** presents the locations of *Tetratheca juncea* sub-populations within the Project Site.

In September 2011, all populations identified by Clements (2008) were resurveyed and eight new sub-populations were detected in the southern part of the Project Site. These included 74 new clumps.

One regionally significant plant species, *Macrozamia flexuosa*, originally identified by Clements (2008) was recorded as occurring in two survey quadrats.

The three noxious weed species (*Ageratina adenophora*, *Cortaderia selloana* and *Lantana camara)* originally identified by Clements (2008) were also recorded. *Ageratina adenophora* and *Lantana camara* were widespread and common in moist sheltered positions.

The cleared areas of the Project Site comprise roads and access routes which are mostly devoid of vegetation, power line easements occupied by mixed grasslands with some native grasses and scattered seedlings, and cleared low lying areas dominated by exotic grasses associated with two artificial aquatic habitats formed by dams. It was established by Idyll Spaces (2011) that these areas are not likely to be potential habitat for threatened flora.

5.4.5 Issues of Conservation Significance

5.4.5.1 Threatened Flora Species

One flora species of National and State conservation significance was recorded, namely *Tetratheca juncea*, listed as Vulnerable under the Commonwealth EPBC Act and the NSW TSC Act. Five sub-populations of *Tetratheca juncea* were identified in the Southern Extension toward the western end of the area and on the south-facing slope. Two clumps of *Tetratheca juncea* were recorded in the rehabilitation area.

Figure 5.11 records the location of *Tetratheca juncea* identified within the study area.

5.4.5.2 Endangered Populations and Ecological Communities

Callistemon linearifolius and *Grevillea parviflora* subspecies *parviflora*, listed as Vulnerable under the TSC Act, known to occur in the locality and associated with the Spotted Gum - White Mahogany - Grey Ironbark Tall Open Forest & Woodland vegetation community, have not been recorded within the Project Site despite targeted searches. The possibility of their occurrence has subsequently been identified by Idyll Spaces (2011) as low.

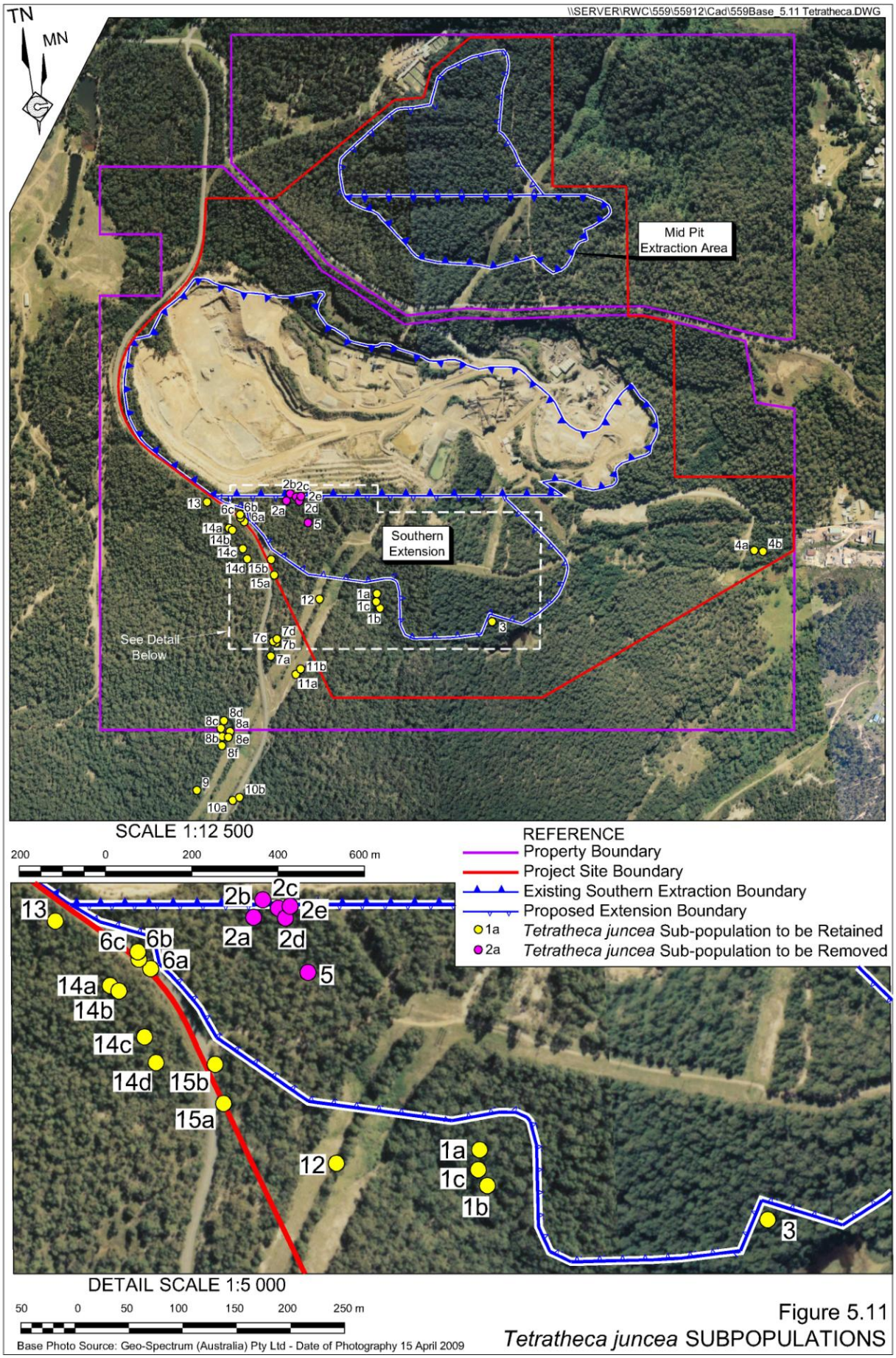


Figure 5.11
Tetratheca juncea SUBPOPULATIONS

No flora species characteristic of the Endangered Populations identified in Section 5.4.3.3 as known to occur in the catchment or LGA were recorded in the Spotted Gum - White Mahogany - Grey Ironbark Tall Open Forest & Woodland vegetation community during the survey work completed in the study area.

5.4.5.3 Regionally Significant Plant Species

One regionally significant plant species, *Macrozamia flexuosa*, was recorded. This species is listed as a regionally significant species by NPWS (2003). This species was recorded in six transects in 2002, two quadrats in 2008 (Clements, 2008) and in two survey quadrats in 2011 (Idyll Spaces, 2011).

Flora species characteristic of the EEC *Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion*, occur in the Spotted Gum - White Mahogany - Grey Iron Bark Open Forest and Woodland. However this EEC is not mapped by NPWS (2003) as occurring within the Lake Macquarie LGA. Furthermore, the floristics of both the overstorey and the understorey of the Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland of the study Area differ significantly from those of the EEC and the study area occurs on soil types not listed in the determination as occupied by the EEC. It is concluded that the EEC *Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion* is unlikely to occur within the study area.

Blue Gum - White Stringybark Shrubby Open Forest comprises an open forest to about 25m tall and is classified by OEH (2011) as Sydney Blue Gum Moist Shrubby Open Forest on coastal ranges of the North Coast and northern Sydney Basin. With *Eucalyptus globoidea* replacing *E. acmenoides*, and *E. microcorys* largely absent, it more closely resembles the regional vegetation type, Coastal Narrabeen Moist Forest (NPWS, 2003).

5.4.5.4 Koala Habitat

Based on the occurrence of koala feed trees, Grey Gum and Tallowood, which represent >15% of all trees present on the study area, the study area is considered to represent potential Koala habitat as defined in SEPP 44 (Kendall, 2011). Extensive field survey targeting the koala conducted by Kendall and Kendall Ecological Services did not confirm its presence and therefore the study area is not considered core Koala habitat as defined in SEPP 44.

5.4.6 Design and Operational Safeguards

The following design and operational safeguards and management measures would be employed on the Project Site to minimise and manage impacts to native flora from the proposed operations within the Project Site.

5.4.6.1 Biodiversity Offsets

It is proposed that 118ha of retained vegetation would be legally protected and managed as a biodiversity offset of the clearing of 28.7ha for the quarry extensions and associated infrastructure. Metromix has received approval from the landowner to legally establish the biodiversity offset on the property. **Figure 5.12** presents the proposed offset areas including vegetation to be removed, retained and enhanced as indicated in **Table 5.12**. It is noted that the 118ha of remnant vegetation to be retained in legal perpetuity represents approximately 80% of the native vegetation remaining on the entire property. The ratio of native vegetation to be included in the biodiversity offset is 4.1 times the area of native vegetation that would be removed in the development of the Southern and Northern Extensions.

Table 5.12
Areas of Vegetation to be Removed and Retained

	Area (ha)	Dimension (m)
Vegetation to be Removed		
Relocated Exit Road	0.2	
Southern Extension	13.8	
Northern Extension	9.3	
33kV Power Line (within property)	1.8	1 400 x 13
11kV Power Line (north of property)	0.6	460 x 13
11kV Power Line (within property boundary)	0.2	160 x 13
Conveyor and associated service road	0.1	
Subtotal	28.7	
Vegetation to be Retained within Property		
Vegetation identified for Biodiversity Offset	118	
Vegetation to be Enhanced		
33kV Power Line	1.2	
11kV Power Line	0.9	
Subtotal	2.1	
Source: Idyll Spaces Environmental Consultants (2011) – Modified after Table 7		

The area of offsets identified at the Teralba Quarry is considered against "The Principles for the use of Biodiversity offsets in NSW" as presented in Appendix II of "The Guidelines for Biodiversity Certification of Environmental Planning Instruments – Working Draft" published by the former Department of Environment, Climate Change and Water in April 2007 (now OEH Offset Principles). The proposed Biodiversity Offset Strategy is considered against each of the thirteen OEH offset principles as follows.

1. Impacts must be *avoided first* by using prevention and mitigation measures

   The quarry footprint has been designed to minimise clearing of native vegetation and to avoid sub-populations of the threatened flora species *Tetratheca juncea*.

2. All regulatory requirements must be met

   The Proponent would meet all regulatory requirements related to the construction, operation and rehabilitation of the Project. Offsets are not proposed to satisfy approvals or assessments under other legislation.

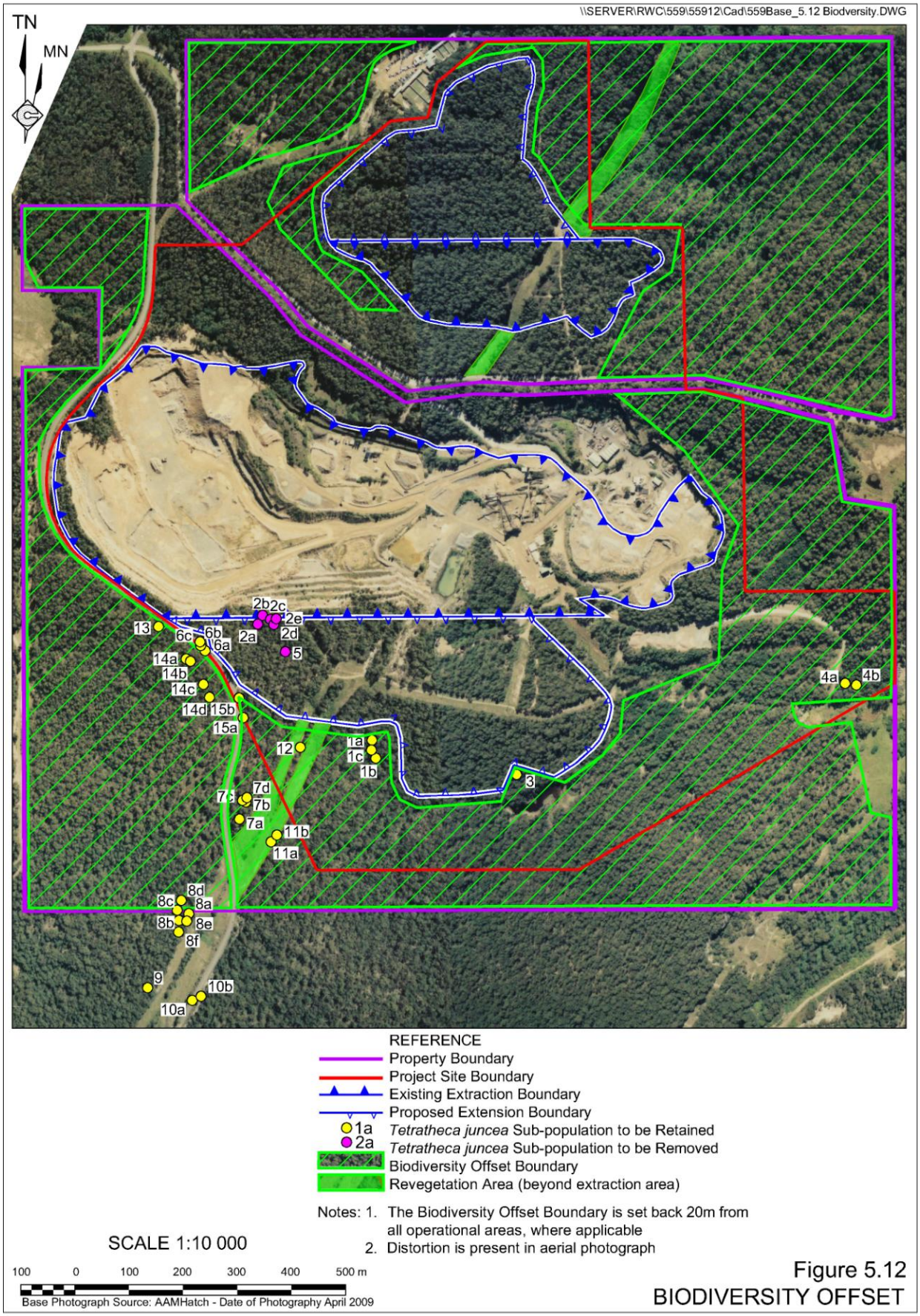


Figure 5.12
BIODIVERSITY OFFSET

3. Offsets must never reward ongoing poor performance

   The proposed offset would include a legal requirement for the landholder to manage the habitat for biodiversity according to the provisions of a vegetation management plan and would not encourage deliberate degradation or mismanagement of offset areas in order to increase the value from the offset.

4. Offsets will complement other government programs

   The proposed offset would help to achieve the NSW Government's conservation objectives by means of positive long-term biodiversity outcomes including legal protection and medium to long-term management of a significant area of native vegetation for conservation.

   Approximately 7ha of previously cleared land in the southeast of the Project Site has been rehabilitated to forest since 1992 (see Section 1.4.7). The rehabilitation method involved direct transfer of soil and biomass from vegetation clearing to the rehabilitation area and subsequent weed control over a period of approximately 15 years (Bill Sanderson pers comm.) The threatened flora species *Tetratheca juncea* has been recorded in the rehabilitation area by Clements (2008) and Elks (2011).

   Given the similarity, in terms of location and topography, between the power line easements and the areas previously rehabilitated since 1992 (within which *Tetratheca juncea* has been identified), vegetation enhancement of these power line easements is likely to be the most practical method of re-establishing *Tetratheca juncea* sub-populations on the Project Site. This 2.1ha area occurs on elevated land associated with a ridgeline in the southern part of the Project Site and extends southwards from between the main sub-populations of *Tetratheca juncea* in the study area.

   It is proposed that topsoil and vegetation extracted from the immediate area of the existing *Tetratheca juncea* sub-population 2 within the quarry footprint (see **Figure 5.11**) would be relocated to selected parts of the 11kV and 33kV power line easements to be decommissioned (see **Figure 5.12**). These would be prepared first by removal of the existing soil surface so as to minimise the number of remaining propagules of exotic species such as *Ageratina adenophora, Andropogon virginicus*, *Hypochaeris radicata* and *Senecio madagascariensis* then spreading the topsoil and vegetation removed from the areas of the proposed Southern Extension containing *Tetratheca juncea* subpopulation.

5. Offsets must be underpinned by sound ecological principles

   There are 169.3ha of Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland and 3.5ha of Blue Gum - White Stringybark Shrubby Open Forest in the Project Site. The proposed offsets would reserve 114.5ha of Spotted Gum - White Mahogany - Grey Ironbark and all 3.5ha of the Blue Gum - White Stringybark community.

The Spotted Gum - White Mahogany - Grey Ironbark community to be reserved as offset consists of the same vegetation community and has similar structural, floristic and functional elements, including soils and threatened flora, to those which would be lost to the proposal. 10.7ha of the proposed offset Spotted Gum – White Mahogany – Grey Ironbark community is rehabilitated forest dating to 1992, but is nonetheless suitable for the creation of ecosystem credits.

The Blue Gum - White Stringybark community to be reserved as offset is expected to occupy a similar habitat to the vegetation community that would be established in parts of the proposed quarry after extraction of the conglomerate resource. As similar communities are uncommon in the locality this offset would be important as a local source of propagules.

Reservation of Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland would contribute to the conservation status of the community, regarded as Regionally Significant Habitat in the Lake Macquarie LGA, and would contribute to wildlife movement in the locality. Proposed management of the offset, such as weed control, fire management and enhancement of existing habitat, would contribute to the value of the offset.

While it is acknowledged that reconstruction of the Spotted Gum - White Mahogany - Grey Ironbark and Blue Gum - White Stringybark communities as part of proposed rehabilitation involves some risks and uncertainties, the existing rehabilitation provides evidence that such communities and *Tetratheca juncea* habitat can be reconstructed in the Project Site and can contribute to the viability and functionality of biodiversity in NSW.

6. Offsets should aim to result in a net improvement in biodiversity over time

   The offset areas to be set aside for biodiversity conservation are approximately 4.1 times the areal extent of the areas to be cleared for the proposed quarry extensions and associated works and with additional management and increased security are expected to be sufficient to offset against the loss of biodiversity.

7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs

   As impacts on biodiversity are likely to be permanent, the offset would also be permanent and secured by a conservation agreement or reservation on the property title and management for biodiversity.

8. Offsets should be agreed prior to the impact occurring

   Legal commitments to the offset actions will be finalised within 12 months of the receipt of project approval.

9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.

   Proposed offsets have been based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology includes the area of impact, the types of ecological communities and flora habitat effected, its condition, conservation status, security and proposed management actions. Data was collected in a Biometric format suitable for application of the bio banking methodology. The data is presented in Kendall (2011). The following actions proposed would generate ecosystem credits.

   – weed control;
   – management of fire for conservation;
   – management of human disturbance;
   – retention of regrowth and remnant vegetation;
   – replanting or supplementary planting;
   – retention of dead timber; and
   – erosion control.

10. Offsets must be targeted

    They offset impacts on the basis of like-for-like or better conservation outcome. Offsets target biodiversity priorities in the area, based on the conservation status of the ecological community (regionally significant habitat), the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal to or greater in conservation status to the type of ecological community lost have been used for offsets. One type of environmental benefit has not been traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.

11. Offsets must be located appropriately

    Proposed offsets are located in a vegetation community that has the same or similar ecological characteristics as the area affected by the development.

12. Offsets must be supplementary

    Proposed offsets are beyond existing requirements and not already funded under another scheme.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract

    Offsets may be audited as required to ensure that the actions have been carried out. Monitoring would be undertaken as part of a vegetation management plan to confirm whether or not the actions are leading to positive biodiversity outcomes.

Uncertainties as to the ongoing scheduling of operations would require flexibility as to the precise location and timing of rehabilitation operations. Detailed prescriptions for rehabilitation would be contained in the Landscape Management Plan for the ongoing operation of the quarry.

Metromix is awaiting feedback from its neighbouring coal mining companies to respond to the issue raised regarding the potential to integrate offset strategies with two other companies in the area.

5.4.6.2 Weed Control

Lantana, Crofton Weed, Camphor Laurel, Privet, and invasive exotic grasses including Pampas, Kikuyu, Paspalum, Setaria, Veldt Grass and Green Panic are weeds of concern in the study area. All would need ongoing control in areas disturbed by quarry operations in order to prevent establishment of new loci of infestation near reserved vegetation. It appears likely that the weed infestations in this community have prevented establishment of new eucalypts and most rainforest trees, and in the absence of intervention to reduce weed cover would continue to do so for the foreseeable future.

The most significant of these weeds in terms of existing area of occupation and density of infestation are Lantana and Crofton Weed. They occur in both the Blue Gum – White Stringybark community and in moist protected parts of the Spotted Gum - White Mahogany - Grey Ironbark community.

It is likely that Myrtle Rust, a variant of the *Puccinia psidii sens*. lat. fungal complex, *Uredo rangelii*, has recently arrived and naturalised in Australia will be or has already been dispersed to vegetation of the Project Site by means beyond control of quarry management. Potential sources of infection are addressed in Idyll (2011). It is proposed that, among other things, actions identified by the Plant Biosecurity Unit of the NSW Department of Industry and Investment (2011) to limit the spread of Myrtle Rust would be implemented. These actions include:

- Undertake a risk assessment for quarry product export, rehabilitation and revegetation operations and employ appropriate measures as outlined in NSW Department of Industry and Investment (2011);
- Utilise direct transfer or stockpiling of soil and biomass from Project vegetation clearing operations, together with seed harvested from local trees, minimise opportunities of transfer of Myrtle Rust into the Project Site from outside as part of rehabilitation operations.

Weed control would be addressed in a Vegetation Management Plan for the Project Site. It is anticipated that bush regeneration activities associated with weed control would be required in rehabilitation areas and in the more severely Lantana infested areas of the Blue Gum – White Stringybark community in the medium to long term.

5.4.6.3 Fire Management

Recommended intervals for the burning of Spotted Gum - White Mahogany - Grey Ironbark community are 5 to 50 years, including some intervals greater than 25 years. Recommended intervals for the Blue Gum – White Stringybark community are 25 to 60 years. The Project Site was last burnt in 2002.

Recommended intervals between fires would be included as a consideration in the vegetation management plan. Fire intervals are to be applied at a landscape scale and accordingly decisions as to whether fire is required would need to consider the fire interval condition of other forest vegetation in the locality.

5.4.7 Impact Assessment

5.4.7.1 Vegetation Clearing

In total, 28.7ha of native vegetation classified and mapped in this report as Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland lies within the footprint of the proposed quarry extensions – see **Table 5.12**.

It is expected that all vegetation within the proposed extraction areas would be cleared up to a year before the area is required for the next stage of extraction. Where feasible, all commercially valuable logs/timber would be removed. All remaining felled trees and understorey brush would be retained for use as biomass for enhancement or rehabilitation of fauna habitat. This biomass would be relocated to suitable areas for rehabilitation in accordance with the Teralba Quarry Vegetation Management Plan to be developed for the Project Site. Topsoil and subsoil would be removed and relocated immediately to a final location in a rehabilitation area, or where this is not possible, to a stockpile.

5.4.7.2 Threatened Species

The proposed quarry extension would remove up to 68 of the 189 clumps of the threatened flora species *Tetratheca juncea* within the Project Site (**Table 5.13**). A clump is defined as a group of stems separated from the nearest group of stems by 50cm or more.

Table 5.13
***Tetratheca juncea* Sub-populations and Project Impacts**

Sub-population (Elks)	No of Clumps				
	Elks Sep 2011	Elks Jan 2011	Clements Dec 2008	Clements Nov 2008	Clements Nov 2002
1	33	27	37	31	49
2	66*	40	70	41	37
3	-	9	12	7	3
4	-	1	2	0	0
5	2*	-	0	2	5
6	7	-	6	4	0
7	11	-	-	-	-
8	29	-	-	-	-
9	10	-	-	-	-
10	3	-	-	-	-
11	9	-	-	-	-
12	1	-	-	-	-
13	1	-	-	-	-
14	37	-	-	-	-
15	5	-	-	-	-
Source: Modified After Idyll Spaces (2011) – Table 8. * To be removed.					

There are 102 clumps within the currently proposed offset area. A further 19 clumps are outside the offset but are also outside of the development footprint and would be retained.

In conclusion, impacts on *Tetratheca juncea* are assessed as not likely to be significant because of the proposed retention of almost two thirds of the known clumps in the study area together with large contiguous areas of potential habitat to be set aside as biodiversity offsets. In addition, rehabilitation of available habitat would be implemented in all available and appropriate areas across the Project Site. In addition, the area of habitat to be removed is not deemed critical to the long-term survival of the species in the locality.

Impacts on *Callistemon linearifolius*, *Grevillea parviflora* subsp. *parviflora* and *Syzygium paniculatum* are assessed as not likely to be significant because of the proposed retention of large contiguous areas of potential habitat as well as rehabilitation of potential habitat. Potential habitat would not be isolated or fragmented. The importance of the habitat to be removed is not likely to be of significance to the long-term survival of the species in the locality. In addition, the Project proposed constitutes or is part of key threatening processes already operating in the study area but the Project would incorporate measures that would avoid or reduce the impacts of those key threatening processes.

5.4.7.3 Impacts on any Local Corridor Links and Wildlife Movement

The proposed Southern Extension would increase the size of the current quarry without creating any new barriers or significant restrictions to the existing north-south corridors. It is unlikely that local wildlife movements, including that of flora propagules and of mobile insect fauna thought to be associated with pollination of *Tetratheca juncea*, would be significantly restricted by the resulting removal of vegetation.

The removal of vegetation in the proposed Northern Extension would increase the length of separation of two existing north-south corridors on the eastern and western sides of the property. It is expected that this would not result in a significant restriction to local wildlife movement, at least for flora and for mobile fauna associated with pollination and seed dispersal.

Data relating to the cumulative impacts of clearing are included in Idyll (2011).

5.4.7.4 Implications of Weed Infestation

Weed control in the quarry operational areas and the rehabilitation areas has been regularly undertaken for at least 15 years (Bill Sanderson, pers comm).

It is proposed that all weeds would be controlled, particularly in areas disturbed by extraction operations. This would be undertaken to prevent or remove infestations adjoining reserved vegetation and subsequent invasion of the vegetation communities of the study area.

From the point of view of biodiversity, Lantana and Crofton Weed are the most significant of the weeds because they occupy most of the moister and more fertile parts of the Project Site, in places so dense that they are preventing natural processes of regeneration. Because of this these weeds would be the focus of weed control and bush regeneration activities in rehabilitation areas, the Blue Gum – White Stringybark community and moister parts of the Spotted Gum – White Mahogany – Grey Ironbark Open Forest & Woodland.

Weed control is not expected to present any major problems and would be addressed in a Vegetation Management Plan for the Project Site.

5.5 FAUNA

The fauna assessment for the Project was undertaken by Kendall & Kendall Ecological Services (Kendall, 2011). The full assessment is presented in Volume 1, Part 5 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.5.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery and Co Pty Limited for the Project (Section 3.5, **Table 3.7**), the potential impacts on fauna requiring assessment and their unmitigated risk rating are as follows.

- Removal of threatened flora and fauna species identified within the Project Site through clearing activities (extreme risk).
- Loss of local and regionally important threatened species (flora and fauna) (extreme risk).
- Reduced local and regional biodiversity (extreme risk).

In addition, the DGRs issued by the former Department of Planning and requirements issued by the former Department of Environment, Climate Change and Water, identified "fauna" as one of the key issues that requires assessment at the Project Site. The assessment of impacts on fauna is required to include:

- an accurate prediction of any vegetation clearing on site;
- a detailed assessment of the potential impacts on any threatened species, populations or habitats, endangered ecological communities and groundwater dependent ecosystems;
- a detailed description of the implemented measures that would improve the biodiversity values within the Project Site in the medium to long term; and
- an offset strategy incorporating on-site and off-site proposals that contribute to long term conservation of threatened species, population or communities.

The following sub-sections assess the existing threatened species and their habitat, identify the ecological management issues, propose safeguards and mitigation measures for the threatened species and provide an assessment on the biodiversity following implementation of the proposed safeguards, mitigation measures and offset strategies. The study area for the fauna assessment is defined as all vegetation potentially impacted by the proposal, including that proposed within biodiversity offset. This covers the Metromix lease area as well as the corridor for the proposed 33kV powerline immediately north of the Project Site (see **Figure 5.10**).

5.5.2 Study Methodology

5.5.2.1 Introduction

The fauna assessment is based on information gained from searches of relevant threatened species databases and other relevant databases and listings and fauna surveys conducted by Kendall & Kendall Ecological Services within the period of 9 November 2008 to 9 January 2009 and 30 August to 3 September 2010. Vegetation community descriptions identified by Idyll Spaces (2011) were also used as a basis to identify the broad fauna habitats within the study area.

5.5.2.2 Background Research

Wildlife Atlas of NSW and Threatened Species Website

A search was conducted of the Wildlife Atlas of NSW (on 7 March 2011) of all fauna records on the Wallsend and Swansea 1:25 000 map sheets. The GIS program ArcMap was used to determine the threatened fauna listed recorded to occur within 5km of the Project Site. A search was also conducted of the threatened species website to:

- compile relevant information from individual species profiles for each target species including links to relevant recovery plans, threat abatement plans etc.;
- determine if the study area contains declared "critical habitat" (for any threatened species); and
- identify listed Key Threatening Processes and relevant Threat Abatement Plans.

DSEWPaC Database

A search was also conducted on the Environment Australia website using the protected matters tool to identify matters of National environmental significance and other matters protected by the EPBC Act in the locality around the study area.

Lake Macquarie City Council

A visit to the Lake Macquarie City Council public library provided two environmental assessment reports.

- Five Islands Road Project prepared by ERM Australia (Oct 2000) which did not contain information on significant fauna species relevant to the Project.
- Statement of Environmental Effects for a 19-lot subdivision of Lot 34 Section S DP447469 at 60 Victoria St Teralba. This report described "limited habitat" on the land that lies to the northeast of the study area, however, the report did indicate an "Anabat" record of the Eastern Bentwing-bat (listed as vulnerable under Schedule 2 of the TSC Act).

Previous Surveys of the Study Area

In 2003 and 2004, CES conducted fauna surveys on the study area. The results of the surveys included records of the Hooded Robin, Little Bentwing-bat, Grey-headed Flying-fox, Eastern Bentwing-bat and Greater broad-nosed Bat, all species listed as vulnerable under Schedule 2 of the TSC Act. The Grey-headed Flying fox is also listed as vulnerable under the provisions of the Commonwealth EPBC Act.

5.5.2.3 Field Survey

Two field fauna surveys were undertaken by Kendall & Kendall Ecological Services within the study area to survey for the species identified as target species (Kendall, 2011). The surveys undertaken over 10 days in November and December 2008 and 4 days in August and September 2010 were, where practicable, undertaken in accordance with the 'Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities' (DEC – November 2004).

The range of survey techniques used included:

- opportunistic observations;
- diurnal habitat searches;
- Elliott trapping – ground;
- Elliott trapping (B) arboreal;
- hair tubes arboreal;
- nocturnal call playback;
- diurnal call playback;
- spotlighting (vehicle);
- spotlighting (walking);
- cage trapping;
- infra-red photography;
- Anabat recording;
- harp trapping;
- scat searches; and
- hollow-bearing tree watches and mapping.

Section 3.2 and Tables 2 and 3 of Kendall (2011) provide a more detailed summary of the field survey undertaken.

Rain events occurred approximately 2 weeks prior to the initial field survey (November 2008) and on the second day of that survey provided the opportunity to search muddy sections of access tracks for prints and amphibians.

Pitfall trapping was not used due to the rocky nature of the ground.

5.5.3 Fauna Survey Results

5.5.3.1 Introduction

The range of fauna species recorded was typical of species associated with drier sclerophyllous vegetation types lacking in tree hollows. Some waterfowl were also recorded on the water quality control dams. The biggest terrestrial predators recorded were the introduced dog and fox.

The surveys recorded:

- one threatened species and six migratory species listed under the provisions of the EPBC Act within the study area;
- seven threatened species within the study area listed on the schedules of the TSC Act; and
- seven introduced species of which three are predators within the study area.

5.5.3.2 Fauna Habitat

The two vegetation communities identified in the study area by Idyll Spaces (2011) comprised:

- Spotted Gum – White mahogany – Grey Ironbark Open Forest & Woodland; and
- Blue Gum – White Stringybark Shrubby Open Forest.

The vegetation communities within the study area contain a range of flora species belonging to the *Myrtacea* and other nectar producing plant families. These species provide nectar flows that provide an important potential feeding resource to threatened species such as the Grey-headed Flying-fox but also to a variety of insects which are potential prey for diurnal insectivores including the Regent Honey-eater (which would also feed on the nectar) and nocturnal insectivores including a range of microbat species.

The Blue Gum - White Stringybark Shrubby Open Forest has an understorey containing various rainforest plant species and weed species, many of these species produce edible fruit which are a foraging resource for birds such as the threatened rainforest pigeons and mammals.

Very occasional *Allocasuarina* tree species were observed; fruit of this plant genus are the food source of the threatened Glossy Black-Cockatoo. Searches under these trees failed to find chewed *Allocasuarina* fruit an indication of the presence of Glossy Black-Cockatoo.

The Wildlife Atlas of NSW search identified seven records of koalas occurring within 5km of the Project Site, none of which occur within the study area. The closest koala record is approximate 3km (accuracy 10 000m) dated 1/7/2004 – 30/6/2006, the most recent record is dated 5/11/2008 and is approximately 6km (accuracy 500m) from the Project Site. It is considered that these records are not sufficient to indicate that a core koala population occurs within the study area. The study area contains Tallowwoods and Grey Gums, tree species both listed on Schedule 2 of SEPP 44, but also other koala browse tree species not listed on Schedule 2 of SEPP 44. Searches under these trees failed to find koala scats.

The occurrence of hollow-bearing trees within the study area is very limited as most of the vegetation is regrowth. However, a number of older trees containing hollows were observed at the western end of the gully in the existing Mid Pit Extraction Area at the western end of the study area south of Rhondda Road and in isolated areas north of Rhondda Road. Section 4.3.2.2 in Kendall (2011) provides further detail on the locations of hollow-bearing trees. Some of these trees are located within the proposed Northern Extension. The field survey did not reveal the presence of koalas within the study area and therefore did not confirm the study area as containing core koala habitat.

The geology of the study area is dominated by conglomerate, no caves, rock crevices or rocky area habitats were observed within the study area. In most areas the substrate rock lies beneath a thin layer of clayey topsoil. However, subsidence due to historic underground coal mining has created localised cracks in the ground surface in some locations. It is considered these cracks may provide sheltering habitat for cave dwelling microbats.

Seven introduced vertebrate species were detected during the field survey these being the:

- House Mouse (*Mus musculus*);
- Black Rat (*Rattus rattus*);
- Brown Hare (*Lepus capensis*);
- Rabbit (*Oryctolagus cuniculus*);
- Dog (*Canis lupus familiaris*);
- Fox (*Vulpes vulpes*); and
- Feral Cat (*Felis cattus*).

5.5.3.3 Aquatic Fauna

Water is scarce within the study area. Creek lines are ephemeral and appear to drain quickly after rain events, no pools were observed in the creeks within the study area. However, permanent water is present in several dams situated along the easterly flowing creek in the southernmost section of the Project Site. The sedimentation dams southeast of the existing quarry contain and are surrounded by reedy vegetation. No water pondages were observed north of Rhondda Rd.

The only areas that could be called riparian are reedy areas confined to sediment ponds and a man-made water supply dam of the existing quarry. Ephemeral creeklines within the remainder of the study area do not contain riparian vegetation.

5.5.3.4 Threatened Species

No species listed as endangered under Schedule 1 of the TSC Act was recorded within the study area during the field surveys.

Five species listed as vulnerable under Schedule 2 of the TSC Act were detected within the study area during the two Kendall & Kendall Ecological Services field surveys, these being the:

- Little Lorikeet (G*lossopsitta pusilla*);
- Barking Owl (*Ninox connivens*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Little Bentwing-bat (*Miniopterus australis*); and
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*).

A further three species were recorded during the CES field surveys, these being:

- Hooded Robin (*Melanodryas cucullata*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

The locations of these species identified during the field surveys are presented in **Figure 5.13**.

Seven-part tests have been undertaken for those TSC Act threatened species confirmed as occurring on the study area or considered likely to occur within the study area, presented in Appendix 2 of Kendall (2011).

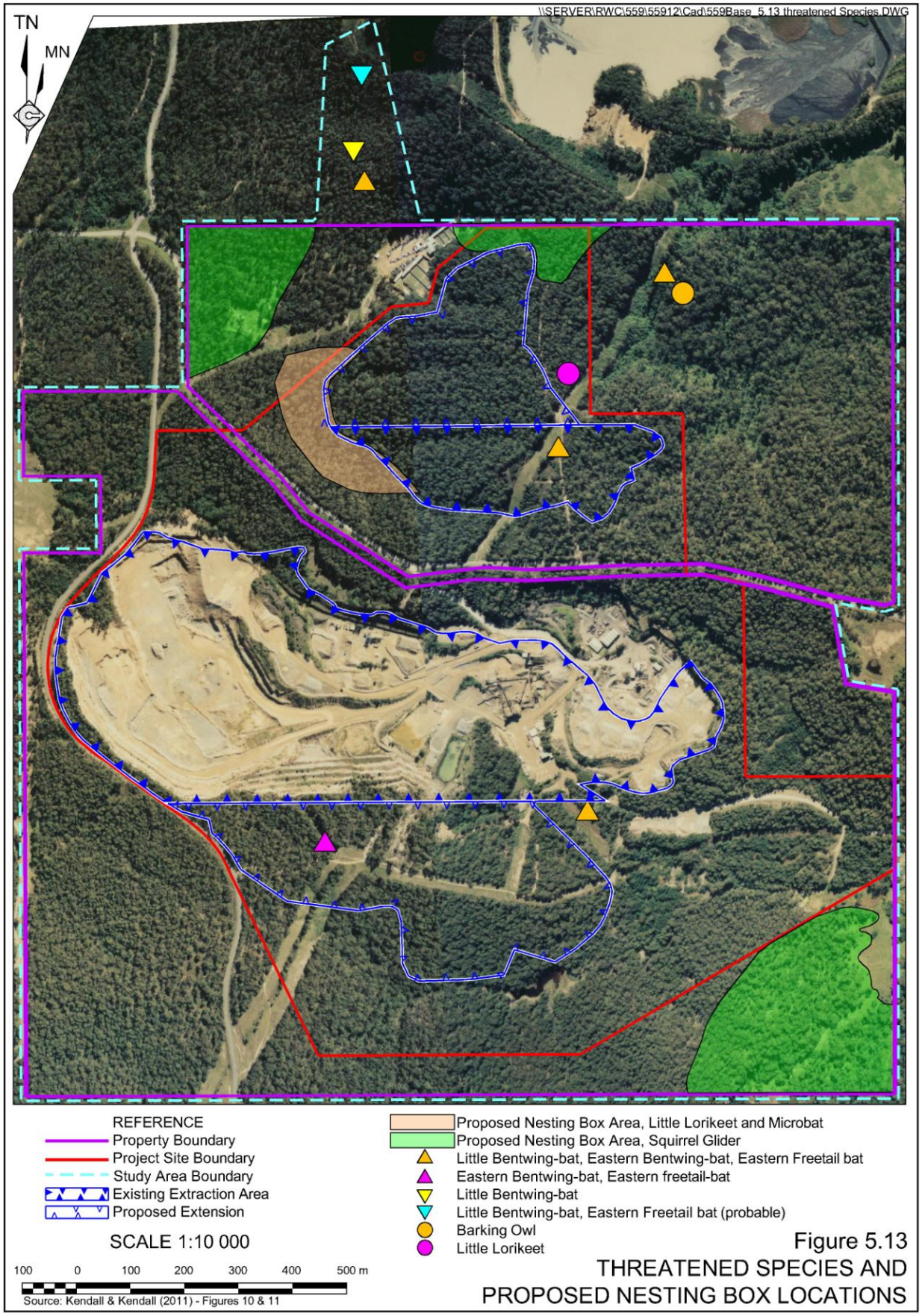


Figure 5.13
THREATENED SPECIES AND PROPOSED NESTING BOX LOCATIONS

Seven-part tests have been prepared for groups of species that have similar habitat requirements, e.g. the large forest owls, hollow-dependent micro bats, non-hollow dependent microbats etc. These seven part-tests are presented in Appendix 8 of Kendall (2011).

Seven-part tests have not been prepared for the species considered likely to occur within the study area but whose habitat will not be affected by the Project, the habitat of these potentially occurring species is restricted to the Blue Gum - White Stringybark Shrubby Open Forest (Elks 2011).

The design and operational safeguards presented in Section 5.5.4 have been specifically developed to ameliorate the potential impacts to the threatened species.

5.5.3.5 Environment Protection and Biodiversity Conservation Act 1999 Matters

The EPBC Act referral focused upon the removal of some clumps of the plant species *Tetratheca juncea*, but also describing all other EPBC Act matters associated with the Project Site.

The Grey-headed Flying-fox was the only species listed under the threatened species provisions of the EPBC Act detected within the study area during the field surveys.

Two listed EPBC Act migratory species were recorded within the study area during the surveys of Kendall (2011), namely the:

- White-throated Needletail (*Hirundapus caudacutus*); and
- White-bellied Sea-eagle (*Haliaeetus leucogaster*).

The White-throated Needletail and White-bellied Sea-Eagle, are known within the property, both of these species were observed flying over the property. The White-throated Needletail is an aerial species unlikely to land within the property but is expected to forage over the property. The property could provide roosting habitat for the White-bellied Sea-Eagle and may be provide nesting habitat for the species, a large stick nest was observed in the property by G. Elks (pers comm.) which may be a White-bellied Sea-Eagle nest, this nest will not be disturbed by the proposed clearing and as extraction and related activities already occur in the locality it is expected that the birds that use the nest are accustomed to associated disturbances.

A list of the migratory species listed under the provisions of the EPBC Act recorded within 10km of the study area on the Wildlife Atlas of NSW were noted. Apart from the two species listed above, which were recorded within the study area, many of the species are waders whose habitat does not occur within the study area, However, some species may at times frequent or fly over the study area. These species being: Osprey; Rainbow Bee-eater; Regent Honeyeater; Rufous fantail; and Black-faced Monarch.

The EPBC Act guidelines utilise eight tests to examine whether an action has, will have, or is likely to have a significant impact on an endangered or vulnerable species. Assessments in accordance with the eight tests have been prepared for each of the EPBC Act threatened fauna species considered known or considered likely to occur on the study area, these being:

- Regent Honey-eater;
- Spotted-tailed Quoll;
- Grey-headed Flying Fox; and
- Large Pied Bat.

Further details on the eight tests are presented in the fauna report written by Keith Kendall of Kendall and Kendall Ecological Services.

5.5.4 Design and Operational Safeguards

5.5.4.1 Introduction

The impacts of habitat removal within the proposed Southern and Northern Extensions would be minimised by conducting clearing operations during February/March to avoid the peak maternity periods of most potentially nesting/denning locally recorded threatened fauna species.

Impacts of habitat removal would also be minimised by conducting clearing incrementally, whilst also implementing revegetation works. Clearing of habitat for each area would be conducted incrementally, within the first few years for each extraction area.

Prior to each clearing event, a pre-clearance survey would be conducted according to the protocols described in Appendix 9 of Kendall (2011). Trees containing tree-hollows would be identified by an ecologist during survey works prior to any vegetation clearing commencing. Any hollow-bearing tree would be left at the felled site for at least 24 hours after being felled.

Incremental clearing during the four stages would not only be of a far less impact than removal of the habitat in one event but would provide the opportunity for revegetation and rehabilitation works to become established prior to removal of the habitat during the later stages. Details of the revegetation would be documented in the Vegetation Management Plan prepared for the quarry.

Metromix would continue to implement measures to control dust within the operational areas of the Project Site to ensure dust levels experienced by native fauna are acceptable.

5.5.4.2 Nesting Boxes

In order to mitigate against the impact of loss of hollow-bearing trees, 20 microbat nesting boxes would be installed in the proposed biodiversity offset area near the area where the hollow-bearing trees occur. When the hollow-bearing trees are felled, the number of hollows suitable for microbats would be assessed, and two microbat nesting boxes would be installed for every hollow suitable for microbats removed, if the number of suitable hollows exceeds ten in number.

In order to mitigate against the impact of loss of hollow-bearing trees, 20 Little Lorikeet nesting boxes would be installed in the proposed biodiversity offset area near the area where the hollow-bearing trees occur. When the hollow-bearing trees are felled, the number of hollows suitable for Little Lorikeets would be assessed, and two Little Lorikeet nesting boxes would be installed for every hollow suitable for Little Lorikeets removed, if the number of suitable hollows exceeds five in number.

Due to the paucity of tree hollows within the study area, and the lack of records of Squirrel Gliders attained during the field surveys, it is considered that the study area is not known Squirrel Glider habitat. Nevertheless as there are 27 records of Squirrel Gliders within 5km of the Project Site on the Wildlife Atlas of NSW (7/3/2011) it is proposed to enhance Squirrel Glider habitat within the Project Site by installing 30 nesting boxes in three clusters of ten boxes. Each cluster to be located in the northwest corner and southeast corners of the Project Site, in the area north of Rhondda Rd and east of the existing transmission line near the northern boundary of the Project Site. These areas are closest to Wildlife Atlas of NSW records for the Squirrel Glider in the locality. These boxes would be monitored annually for a period of five years, if Squirrel Gliders are shown to use the nesting boxes additional boxes would be installed between the clusters to create connectivity for the Squirrel Glider through the Project Site.

The proposed areas for nesting box installation are indicated on **Figure 5.13**.

Existing logs located within the areas to be cleared would be placed on the edges of the habitat to be retained, or in areas of former transmission lines to increase habitat quality for ground dwelling fauna.

5.5.4.3 Rehabilitation

Metromix has been implementing a successful revegetation program over a number of years as part of their existing operations. This success is attributed to:

- the on-going weed removal, which reduces competition, hence aiding germination and establishment of the native species;
- the transfer of biomass including large logs, branches and fine twigs which provide shade for the emerging seedlings;
- the transfer and placement of topsoil and biomass providing food and habitat for the active soil flora and fauna, resulting in nutrients for the native vegetation, as well as plant seed and other propagules;
- the depth of subsoil providing the natural medium for native plant roots; and
- the climatic conditions, with an average rainfall of about 1 000mm and mild temperature throughout the year.

It is proposed to conduct future revegetation works consistent with the principles described above. These rehabilitation works would continue to be regularly assessed by suitably trained and/or experienced botanists and the methods adapted to reflect the results of these assessments.

5.5.4.4 Weed Control

The proposed weed control program discussed in Section 5.4.6.2 would equally benefit the fauna frequenting the Project Site.

5.5.4.5 Transmission Lines

Disturbance to habitat would be minimised by erecting the 33kV and 11kV transmission lines on the same poles.

5.5.5 Impact Assessment

5.5.5.1 Current and Long Term Impacts

The most obvious disturbance to the habitat within the study area is the existing quarry and asphalt plant and their associated infrastructure, which have replaced the original habitat. The Project Site also includes a number of transmission lines under which clearing has occurred resulting in a grassy ground cover.

Past disturbances within the naturally vegetated habitats within the Project Site include timber harvesting, mine subsidence, weed invasion and impacts from fire.

The absence of regenerating tree cover and the canopy dieback to date are likely to be a result of severe infestation of lantana and large bellbird populations respectively, although the two causes are known to be linked. The establishment of an offset covering the bulk of the vegetation on the property that is cleared would create positive long term impacts as the existing vegetation matures.

5.5.5.2 Impacts from the Proposed Extensions

The direct impact would be the removal of approximately 28.7ha of existing habitat confined to one vegetation community identified by Elks (2011) as Spotted Gum - White Mahogany - Grey Ironbark Open Forest & Woodland.

Indirect impacts identified that could impact fauna are:

- operational noise which includes heavy plant use, crushers and blasting;
- vibration; and
- dust.

It is considered that as these impacts are already operating within the study area and within the locality, locally occurring fauna species are considered likely to be accustomed to the impacts. Furthermore, it is considered that the dust control measures to be implemented would negate the impact of dust on locally occurring fauna.

Roads within or adjacent to the Project Site i.e. Rhondda Rd, the private coal haul road and other access roads do and would continue to be a partial barrier to wildlife movement.

The remaining habitat would continue to provide connectivity for wildlife movement, particularly since the bulk of the remaining habitat would be incorporated into the biodiversity offset for the Project. The remaining habitat includes broad bands of habitat, averaging several hundred metres wide along the southern and eastern sides of the Project Site. These areas include a variety of landforms including ridges, ephemeral creeks and slopes. These areas would continue to facilitate wildlife movement in a north-south and east-west direction. Wildlife connectivity would also be retained along both sides of Rhondda Rd. These areas are sufficiently wide to allow many of the species recorded within the study area to breed thus facilitating genetic flow across the Project Site for many species.

Clearing would occur incrementally throughout the life of the quarry i.e. the impact of the loss of habitat on wildlife connectivity would not occur as one event. This impact on wildlife connectivity would be further ameliorated by the implementation of revegetation and rehabilitation works progressively throughout the life of the quarry.

A number of key threatening processes are currently operating in the Project Site, namely:

- competition and grazing by the feral European rabbit;
- competition from feral honeybees;
- forest Eucalypt dieback associated with over-abundant psyllids and bell miners;
- predation by the European red fox; and
- invasion, establishment and spread of *Lantana camara*.

It is assessed that the Project would not further exacerbate or contribute to the impacts of these threats within the Project Site.

5.5.5.3 Conclusion

With the proposed ameliorative measures implemented across the Project Site, it is considered that the degree of the impact of the Project is unlikely to have an adverse effect on the life cycle of any threatened fauna species known or likely to occur within the Project Site to the extent that a viable local population of the species is likely to be placed at risk of extinction.

5.6 NOISE

The noise and vibration assessment for the Teralba Quarry Extensions was undertaken by Spectrum Acoustics Pty Ltd (Spectrum Acoustics, 2011). The full assessment is presented in Volume 2, Part 6 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.6.1 Introduction

Based on the environmental risk analysis undertaken by R.W. Corkery & Co Pty Limited for the Project (Section 3.5 and **Table 3.7**), the potential impacts relating to noise and vibration requiring assessment and their unmitigated risk rating are as follows.

- Noise from fixed and mobile plant and equipment on site and product trucks on site and off site resulting in:
  - reduced amenity for local residents both locally and along transport routes (high risk);
  - sleep deprivation relating to noise emissions at night (high risk);
  - increased complaints to Metromix by community (high risk); and/or
  - relocation of and or reduction of local native fauna species due to noise disturbance (low risk).

- Sleep deprivation resulting from the noise caused by night-time transport operations (low risk).
  - Vibration from blasting and other extraction operations on site resulting in:
  - reduced amenity for local residents both locally and along transport routes (high risk); and/or
  - damage to surrounding residences and buildings (high risk).

In addition, the DGRs issued by the former Department of Planning and requirements issued by the former Department of Environment, Climate Change and Water, identified "*Noise and Vibration – including a quantitative assessment of construction noise and vibration, operational noise and vibration and off-site road noise impacts*" as one of the key issues that requires assessment for the Project. The DGRs require that the noise and blasting assessment refer to the following guideline documents.

- The NSW Industrial Noise Policy (INP) (EPA, 2000).
- The Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). (This document would be superseded after 1 July 2011 when the "*Road Noise Policy*" takes effect.)
- The Interim Construction Noise Guideline (DECC, 2009).

The DECCW also identifies coverage of:

- the existing noise environment;
- potential impacts and proposed noise amelioration measures;
- sound power levels measured or estimated for all plant and equipment;
- construction noise assessed in accordance with the Department's "*Interim Construction Noise Guidelines*" (DECC 2009);
- an assessment of cumulative noise impacts;
- transport route(s), hours of operation and noise impacts; and
- a detailed outline of noise monitoring.

The following sub-sections describe and assess the existing noise environment, identify the relevant noise assessment criteria and describe the noise attenuation and other controls, safeguards and mitigation measures proposed by Metromix. Additionally, the assessment of the residual noise-related impacts following the implementation of these safeguards and mitigation measures is presented.

5.6.2 Existing Noise Climate

5.6.2.1 Introduction

The existing meteorological and acoustic environment surrounding the Project Site has been reviewed in order to determine the atmospheric conditions under which noise modelling is required, as well as to establish noise criteria at representative receivers surrounding the Teralba Quarry and adjacent to the transport routes. The following sub-sections provide a summary of the existing noise sources and meteorological and acoustic conditions.

5.6.2.2 Existing Noise Sources

The existing acoustic environment of the Teralba area (to the east of the Project Site) is characterised by noise from traffic, trains and industrial noise associated with the Teralba Industrial Estate, Macquarie Coal Preparation Plant and Teralba Quarry. In the Wakefield area (to the west of the Project Site), the existing acoustic environment is characterised by traffic noise (from Wakefield Road and the F3 Freeway) and occasional industrial noise from the Westside Open Cut Mine.

5.6.2.3 Meteorological Conditions

A comprehensive set of daily wind data collected in 2003 at the former Pasminco smelter at Cockle Creek has been assembled in order to understand the meteorological conditions relevant to the Project. The analysis of wind vector components up to 3m/s[1] at angles of $\pm 45^{o}$ relative to each primary direction established that there were no winds at speeds of 0.5 to 3.0m/s for more than 30% of any season or time period (day/evening/night).

In accordance with the INP, therefore, the noise modelling does not need to consider any directional wind conditions.

5.6.2.4 Background Noise Levels

In order to determine ambient noise levels, five noise loggers were placed at representative locations near the Teralba Quarry and the transport route through Teralba. The locations of these noise loggers are presented on **Figure 5.14**. Attended noise measurements were carried out at the conclusion of each monitoring period.

Noise levels were continuously monitored at 15-minute intervals and the data analysed to determine the L_{90} noise level on each day of monitoring, i.e. the noise level which is exceeded 90% of the time. The L_{90} Rating Background Noise Level (RBL) was then calculated as the median L_{90} noise level over the duration of the noise survey. After the noise monitoring data was reviewed, it was considered appropriate to separate out the measured noise levels between 6:00am – 7:00am and refer to this period as the "morning shoulder" period. The morning shoulder period referring to when background noise levels were elevated, due principally to early morning traffic on local and regional roads. **Table 5.14** provides the calculated RBLs for the five noise logger locations.

[1] The Industrial Noise Policy (INP) requires assessment only under wind conditions of 3m/s or less.

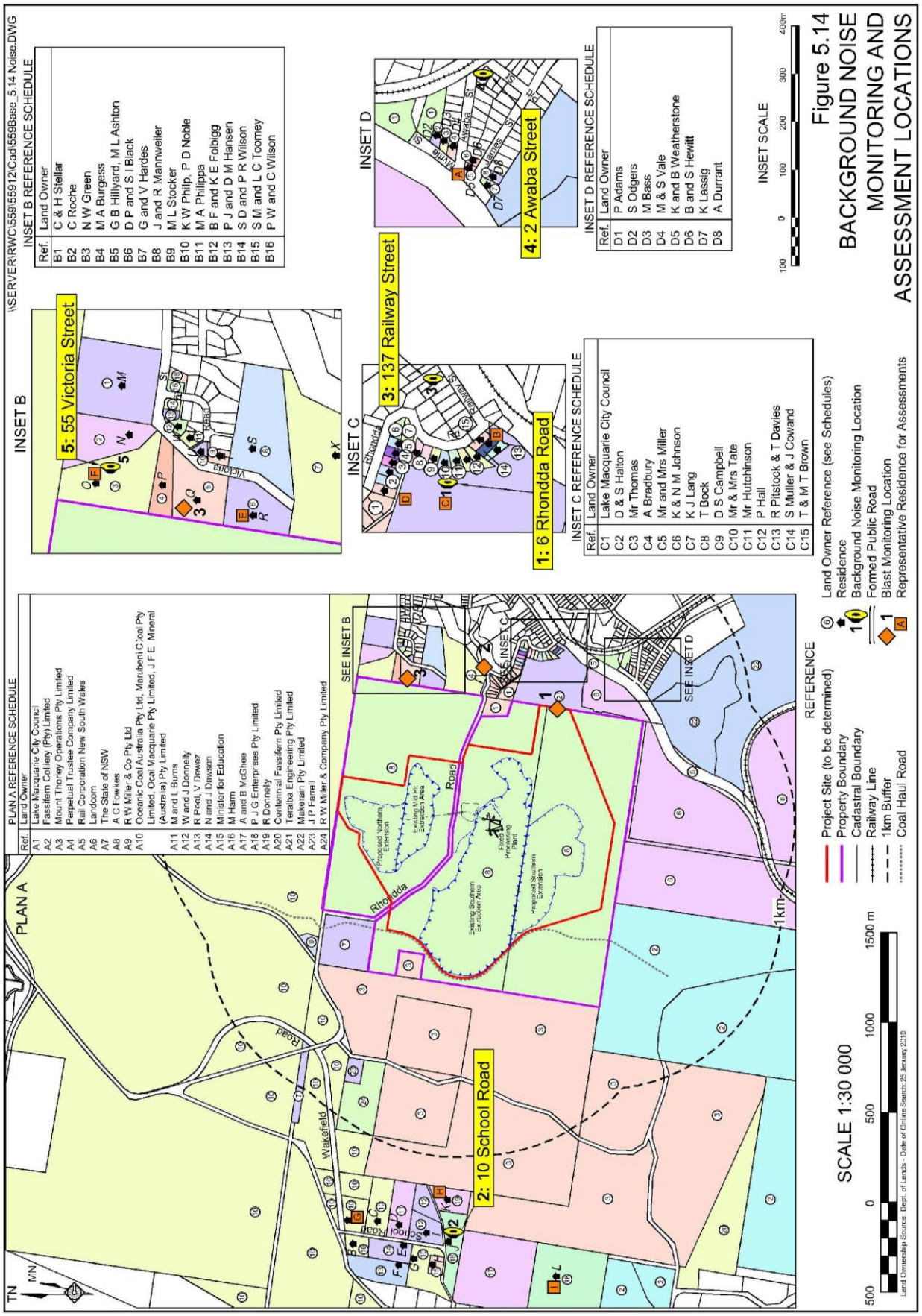


Figure 5.14
BACKGROUND NOISE MONITORING AND ASSESSMENT LOCATIONS

Table 5.14
Measured Ambient Noise Levels

Location	Period	L_{A90} Noise Levels				L_{Aeq} Noise Levels			
		Shoulder*	Day	Evening	Night	Shoulder*	Day	Evening	Night
1.– 6 Rhondda Road Teralba	19/6/2008 to 25/6/2008	37	41	37	33	55	60	52	51
2.– 10 School Road Wakefield	19/6/2008 to 25/6/2008	37	34	38	34	46	48	47	42
3.– 137 Railway Street Teralba	4/7/2008 to 10/7/2008	42	39	41	31	59	61	54	53
4.– 2 Awaba Street Teralba	30/6/2010 to 6/7/2010	41	39	38	30	53	58	51	51
5.– 55 Victoria Street Teralba	8/10/2010 to 20/10/2010	37	35	36	30	47	45	47	42
* Morning Shoulder Period = 6:00am to 7:00am									
Source: Modified after Spectrum Acoustics (2011) – Tables 4.4 to 4.9									

The following provides a summary of the dominant noise sources recorded at each monitoring location.

- At 6 Rhondda Road, Teralba (Logger 1) and 137 Railway Street (Logger 3), the acoustic environment was dominated by traffic noise and industrial noise from the nearby Teralba Industrial Areas.
- At 10 School Road, Wakefield (Logger 2), the acoustic environment reflects the rural / residential setting with some influence from distant traffic, predominantly on Wakefield Road.
- At 2 Awaba Street, Teralba (Logger 4), industrial noise and distant traffic were the major contributors to the measured LAeq noise levels.
- At 55 Victoria Street, Teralba (Logger 5), distant traffic and industrial noise from the direction of Teralba Industrial Area were the most significant contributors to the noise environment at the times of the attended monitoring.

On some days when noise levels were recorded at 55 Victoria Street, activities were underway in the existing Mid Pit Extraction Area. However, attended measurements and a comparison of unattended noise monitoring between periods when activities were undertaken within the existing Mid Pit Extraction Area and when they were not, established that no noise attributable to those activities was audible at the monitoring location.

Given the absence of audible noise from Teralba Quarry at each of the five monitoring locations, Spectrum Acoustics records that the measured ambient noise levels can in fact be considered as background noise levels for the determination of the noise criteria for the ongoing operation of the Teralba Quarry.

The data in **Table 5.14** indicates that the background noise levels at all measurements locations were considerably higher (3 to 11dB(A)) during the morning shoulder period than for the remainder of the night-time period.

5.6.3 Environmental Noise and Vibration Criteria

5.6.3.1 Introduction

The following sub-sections summarise the noise and vibration criteria that were used to assess the noise and vibration impacts of the Teralba Quarry Extensions on the surrounding environment. As the Project is effectively a continuation of an existing operation, construction noise criteria (as provided in the Interim Construction Noise Guideline (DECC, 2009)) are deemed not to apply.

For the purposes of defining noise criteria relevant to the Project, the following times are relevant to the morning shoulder, daytime, evening, night-time periods, (Monday to Saturday).

- Morning Shoulder – 6:00am to 7:00am
- Daytime – 7:00am to 6:00pm
- Evening – 6:00pm to 10:00pm
- Night-time – 10:00pm to 6:00am

For Sundays and public holidays, the night-time period extends from 10.00pm to 8.00am.

5.6.3.2 Operational Noise Criteria

The Industrial Noise Policy specifies two noise criteria:

- an *intrusiveness criterion* which limits L_{Aeq} noise levels from the industrial source to a value of 'background plus 5dB(A); and
- an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed.

Table 5.15 applies the intrusiveness and amenity noise criteria to the ongoing operation of Teralba Quarry. In each case the applicable criteria is that which provides for the lowest noise level. **Table 5.15** identifies that with only one exception the intrusiveness criteria applies.

Table 5.15
Operational Noise Criteria

Location	Criterion	Shoulder (6:00am-7:00am)	Day (7:00am-6:00pm)	Evening (6:00pm-10:00pm)	Night (10:00pm-6:00am)
Rhondda Road	Intrusiveness dB(A),$L_{Aeq(15\text{-}min.)}$	42	46	42	38
	Amenity dB(A),$L_{Aeq(period)}$	55	55	45	40
	Project-Specific Noise Criteria	**42 (15min)**	**46 (15min)**	**42 (15min)**	**38 (15min)**
School Road	Intrusiveness dB(A),$L_{Aeq(15\text{-}min.)}$	39*	39	39*	39
	Amenity dB(A),$L_{Aeq(period)}$	50	50	45	40
	Project-Specific Noise Criteria	**39 (15min.)**	**39 (15min)**	**39 (15min)**	**39 (15min)**
Railway Street	Intrusiveness dB(A),$L_{Aeq(15\text{-}min.)}$	44*	44	44*	36
	Amenity dB(A),$L_{Aeq(period)}$	55	55	45	40
	Project-Specific Noise Criteria	**44 (15min)**	**44 (15min)**	**44 (15min)**	**36 (15min)**
Awaba Street	Intrusiveness dB(A),$L_{Aeq(15\text{-}min.)}$	44*	44	43	35
	Amenity dB(A),$L_{Aeq(period)}$	56	56	42	41
	Project-Specific Noise Criteria	**44 (15min)**	**44 (15min)**	**42 (Evening)**	**35 (15min)**
Victoria Street	Intrusiveness dB(A),$L_{Aeq(15\text{-}min.)}$	40*	40	40*	35
	Amenity dB(A),$L_{Aeq(period)}$	55	55	45	40
	Project-Specific Noise Criteria	**40 (15min)**	**40 (15min)**	**40 (Evening)**	**35 (15min)**
* Application notes accompanying the INP indicate evening background criteria cannot be higher than daytime.					
Source: Spectrum Acoustics (2011) – Table 4.10					

5.6.3.3 Sleep Disturbance Criteria

The OEH recommends an $L_{A\ (1\text{-minute})}$ sleep disturbance criterion at the facade of a residence should be the RBL plus 15dB(A) during the night-time period which for the Teralba Quarry is from 10:00pm to 6:00am.

Based on the measured night-time background noise levels at the various representative receivers, the sleep disturbance criteria at the five representative residences are as follows.

- Rhondda Road 48dB(A) $L_{A1\ (1\ min)}$
- School Road 49dB(A) $L_{A1\ (1\ min)}$
- Railway Street 46dB(A) $L_{A1\ (1\ min)}$
- Awaba Street 45dB(A) $L_{A1\ (1\ min)}$
- Victoria Street 45dB(A) $L_{A1\ (1\ min)}$

5.6.3.4 Road Traffic Noise and Vibration Criteria

Noise criteria for traffic on public roads were sourced from the ECRTN. For the purposes of setting noise criteria, Rhondda Road, Wakefield Road and roads in the suburb of Teralba are considered to be collector roads and Five Islands Road is an arterial road. The applicable ECRTN criteria are as follows.

Category	Day (7:00am-10:00pm)	Night (10:00pm-7:00am)
Land use development with potential to create additional traffic on collector roads	60dB(A),$L_{Aeq\ (1hr)}$	55dB(A), $L_{Aeq\ (1hr)}$
Land use development with potential to create additional traffic on arterial roads	60dB(A), $L_{Aeq\ (15hr)}$	55dB(A), $L_{Aeq\ (9hr)}$

The former DECCW released its Road Noise Policy (RNP) in March 2011. The RNP takes effect from 1 July 2011. The RNP discusses "Principal Haulage Routes" which relate to some industries such as quarries that, by necessity, are in locations that are not served by arterial roads. The RNP notes that where a local authority identifies such a principal haulage route the noise criteria for the route should match those for arterial/sub arterial roads. Adoption of morning shoulder periods is also recognised in the RNP.

Road traffic vibration is assessed against the criteria defined in the DECCW's publication "Assessing vibration: a technical guideline".

Various authorities have set maximum limits on allowable ground and building vibration in different situations. The DECCW has limits for vibration in buildings set out in their "Assessing Vibration: A Technical Guideline (AVTG). These limits are directed at personal comfort for continuous and intermittent vibrations.

Spectrum Acoustics (2011) reviews a range of vibration criteria and concludes that the governing criteria to avoid damage at roadside residences is 5m/s.

5.6.3.5 Blasting Criteria

The OEH adopts blasting assessment criteria based on the human comfort criteria identified in the document *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990* published by the Australian and New Zealand Environment and Conservation Council (ANZECC). These criteria have been adopted for blasting at the Teralba Quarry and are as follows.

- The recommended maximum overpressure level for blasting is 115dB(L).
- The level of 115dB(L) may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120dB(L) at any time.
- The recommended maximum vibration velocity for blasting is 5mm/s Peak Vector Sum (PVS).
- The PVS level of 5mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10mm/s at any time.

Building damage assessment criteria are nominated in AS 2187.2-1993 *Explosives – Storage, Transport and Use Part 2: Use of Explosives*, however, as the ANZECC annoyance criteria are more stringent, these are taken as the governing criteria for the Teralba Quarry Extensions.

5.6.4 Design and Operational Safeguards

5.6.4.1 Introduction

The design and operational safeguards or mitigation measures required for the ongoing operation of the Teralba Quarry centre around the retention of natural topographic barriers, construction of acoustic bunds and controls on equipment noise and hours of operation. At the outset, it is recognised that the existing quarry operations have been undertaken in an area with considerable natural topographic shielding and that quarry operations are often inaudible because of that fact. Notwithstanding the past and current practices and surrounding topography, Metromix would continue to adopt the following mitigation measures to ensure compliance is achieved.

With respect to blasting, the type of blasting used at Teralba Quarry is low impact blasting designed principally to assist disaggregation of the conglomerate. As such, the principal safeguards relate to blast design and the adoption of standard blasting practice which Metromix has demonstrated over many years to be very effective and not attracted any complaints.

5.6.4.2 Operations South of Rhondda Road

All earthmoving equipment used in operations south of Rhondda Road have a sound power level and frequency spectra consistent with those nominated in Table 6.1 of Spectrum Acoustics (2011). This requirement would equally apply when new or temporary equipment is brought to site.

All earthmoving equipment would not be fitted with high-frequency reversing alarms and would be regularly serviced.

It is proposed that the eastern side of the Southern Extension is extracted in such a manner that the active extraction face is retained on the eastern side which would provide a topographic barrier between operating earthmoving equipment and residences to the east.

5.6.4.3 Operations North of Rhondda Road

The key design and operational safeguards for the operations north of Rhondda Road relate to the design of the extraction area.

The eastern side of the existing Mid Pit Extraction Area would be excavated leaving a substantial 5m to 6m high barrier. This barrier would be complemented by a bund constructed of a similar height around the remainder of the eastern side of that area.

The Northern Extension has been designed such that all extraction would occur on the western side of the prominent north-south ridge across the Project Site north of Rhondda Road. The retained natural topography provides significant acoustic attenuation between the Northern Extension and the residences on the northwestern side of Teralba. Furthermore, the entrance road to the Northern Extension and proposed conveyor alignment would be located close to the eastern extraction faces thereby achieving the maximising noise attenuation to the east.

The operational controls to be implemented for equipment operating north of Rhondda Road would also be implemented for operations south of Rhondda Road.

5.6.4.4 Transport Operations

The following design and operational safeguards would be implemented to ensure the noise attributed to trucks travelling to and from the Teralba Quarry is acceptable.

1. All trucks under the control of Metromix, or accredited contractors would comply at all times with the RTA's noise limits.
2. Only those trucks under the control of Metromix, or accredited contractors and fitted with airbag suspension would be used to transport products from the quarry between 4:00am and 6:00am.
3. All drivers would be required to sign a Code of Conduct requiring a high standard of driver performance, avoidance of using exhaust brakes in built-up areas and travel at the required speeds. For the section of road between the bottom gate and Railway Street Metromix would instruct drivers to travel at speeds of less than 15km/hr, as recommended by Spectrum Acoustics (2011).

It is noted that these operational controls are already enforced at Teralba Quarry.

5.6.4.5 Blasting

Metromix has established a site law for blasting whereby each blast is designed within parameters recognised through years of experience to be appropriate to achieve compliance with all blasting criteria.

5.6.5 Assessment Methodology

5.6.5.1 Operational Noise

Assessment of operational noise was conducted using RTA Technologies Environmental Noise Model (ENM) v3.06. Noise modelling was carried out for 12 different operating scenarios representing different phases of the Project throughout the ongoing life of the quarry. The scenarios modelled reflect operations in each of the three extraction areas and during different periods of the day/evening when different equipment is operating (or not operating). **Table 5.16** lists the 12 scenarios and the respective operational extraction stage and operational period. The stages referred to are drawn from the extraction sequence outlined in **Appendix 4**. Details of the various scenarios and diagrammatic representations of the modelled location of the various noise sources are displayed in Appendix 3 of Spectrum Acoustics (2011).

Table 5.16
Operational Noise Scenarios

Scenario	Southern Extension	Mid Pit Extraction	Northern Extension	Night-Time Product Sales
1A	Stage A 6:00am – 6:00pm Drilling Rig Operational	Stage E 7:00am to 6:00pm No Drilling Rig	-	-
1B	Stage A 6:00am – 6:00pm No Drilling Rig	Stage E 7:00am – 6:00pm Drilling Rig Operational	-	-
1C	Stage A 6:00pm - 8:00pm	Stage E 6:00pm – 8:00pm		
2A	Stage B 6:00am – 6:00pm	-	-	-
2B	Stage B 6:00pm – 8:00pm	-	-	-
3A	-	-	Stage A 7:00am – 6:00pm	-
3B	-	-	Stage A 6:00pm – 8:00pm	-
4A	-	-	Stage C 7:00am – 6:00pm	-
4B	-	-	Stage C 6:00pm – 8:00pm	-
5A	Stage C 6:00am – 6:00pm	-	-	-
5B	Stage C 6:00pm – 8:00pm	-	-	-
6	-	-	-	Product Sales Only 10:00pm – 6:00am

The model for each operational noise scenario was developed by placing the various noise sources (of known sound power levels) in typical/worst case locations. The model output has been displayed as contours of equal sound pressure level superimposed upon the topographic map of the area surrounding Teralba Quarry.

The operational noise modelling incorporates the worst case prediction of 14 trucks in a 15 minute period (i.e. 56 truck movements in an hour, i.e. between 6:00am and 7:00am). Of these truck movements, 36%, or five truck movements, would travel along the eastern site access road beyond the bottom gate. It is recognised that the maximum truck movements would only occur occasionally and would not be occurring all the time.

The noise model was also operated to provide predicted noise levels at nine representative residences surrounding Teralba Quarry.

For both the predicted noise contours and predicted noise levels at the nine representative residences, Spectrum (2011) assumed only calm conditions as their assessment of winds <3m/s established that gentle winds were not a feature of the local environment around Teralba. Hence, it was not necessary to consider the noise assessment under any atmospheric conditions other than neutral conditions.

5.6.5.2 Traffic-related Noise

The traffic noise assessment was undertaken by adopting a theoretical receptor point 10m from the centre of traffic on the transport route. This is considered a conservative approach as the closest residences to the transport routes through Teralba are set back 10m from the edge of the road and not the centre of the road. Trucks travelling on Railway Street (and other roads in Teralba) were assumed to be travelling at 50kph. Trucks travelling on Wakefield Road were assumed to be travelling at 80kph. It is noted that the closest residence adjacent to Wakefield Road is set back approximately 12m from the road edge.

The worst case assessment assumed a scenario of 56 truck movements in an hour (i.e. representing 28 trucks in and 28 trucks out of the quarry) during the period 6:00am to 7:00am weekdays. During this period, there would be a maximum of 18 truck movements through Teralba.

For the assessment, the sound levels produced by trucks (both laden and unladen) transporting various quarry products were sourced from measurements made at locations adjacent to Railway Street in Teralba, locations along Wakefield Road and from data in the Spectrum Acoustics technical database.

5.6.5.3 Traffic-related Vibration

The effects of vibration can vary according to a number of factors including the magnitude of the vibration source, the ground type and conditions between the source and the receiver and the integrity of foundations and the foundation footing interface.

The RNP states that *"vehicles operating on a roadway are unlikely to cause a perceptible level of vibration unless there are significant road irregularities, particularly if the affected receiver is more than 20m from the roadway. Often, vibration of lightweight building elements such as windows is wrongly thought to be caused by ground borne traffic vibration travelling up into the building via the building's foundations. However, this phenomenon is often due to airborne low frequency noise emissions, typically from heavy vehicles or buses, that cause lightweight building elements to vibrate."*

Vibration levels for trucks travelling on different road surfaces were taken from the Spectrum Acoustics technical database for comparison with the adopted vibration criteria.

5.6.5.4 Blasting

The future levels of ground vibration and airblast overpressure attributable to blasting have been as assessed through the use of a suite of standard formulae and data from historical blast monitoring at monitoring sites around Teralba Quarry. This information has been used to develop specific blast emission site laws for the quarry.

The site laws were applied to a range of a range of maximum instantaneous charge (MIC) values and distances to determine the potential or adverse impacts.

5.6.6 Assessment of Impacts

5.6.6.1 Operational Noise

Figures 5.15 and **5.16** display the predicted noise contours attributable to four of the operational scenarios described in Section 5.6.5.1 i.e. for operations in the Northern and Southern Extensions. These scenarios potentially reflect the period of greatest impact of the proposed operation. The noise contours for all other scenarios are presented in Appendix 3 of Spectrum Acoustics (2011). **Table 5.17** lists the component areas of the quarry that are operational and the hours of operation for each scenario. The scenarios nominated relate to operations underway in both the Southern and Northern Extensions and for the daytime and evening periods. Appendix 3 of Spectrum Acoustics (2011) nominates the locations and elevations of each item of earthmoving equipment/truck fixed equipment assessed in the noise model. It is noted that activities north of Rhondda Road would only occur between 7:00am and 8:00pm.

Table 5.17
Operational Scenarios for Noise Assessment

Scenario	**4A**	**4B**	**5A**	**5B**
Hours of Operation	**7:00am-6:00pm**	**6:00pm-8:00pm**	**6:00am-6:00pm**	**6:00pm-8:00pm**
Southern Extension	No	No	Yes*	Yes*
Mid Pit Extraction Area	No	No	No	No
Northern Extension	Yes*	Yes*	No	No
Processing Operations	Yes*	Yes*	Yes*	Yes*
Product Loading and Despatch	Yes	Yes	Yes	Yes
* The nominated activities would only occur until 8:00pm during busy periods.				
Source: Spectrum Acoustic (2011) – Appendix 3				

Table 5.18 lists the predicted noise levels at the nine representative residences for the proposed extraction operations in the Northern and Southern Extensions respectively.

Table 5.18
Predicted Noise Levels – Scenarios 4 and 5

	Shoulder/Daytime			**Evening**		
Receiver No.	**Criterion**	**4A**	**5A**	**Criterion**	**4B**	**5B**
A	40/44	36.6	36.6	42	33.6	34.1
B	42/46	44.6	44.5	42	27.0	27.0
C	42/46	39.2	38.0	42	25.6	25.5
D	42/46	33.6	33.8	42	29.7	29.5
E	38/40	28.5	27.2	40	27.6	26.5
F	38/40	25.6	23.3	40	26.7	22.9
G	39/39	25.2	21.6	39	26.4	22.5
H	39/39	17.6	17.2	39	16.7	16.4
I	39/39	22.4	22.4	39	23.9	21.9
Source: Spectrum 2011 sourced from Table 6.9, 6.10, 6.11 and 6.12.						

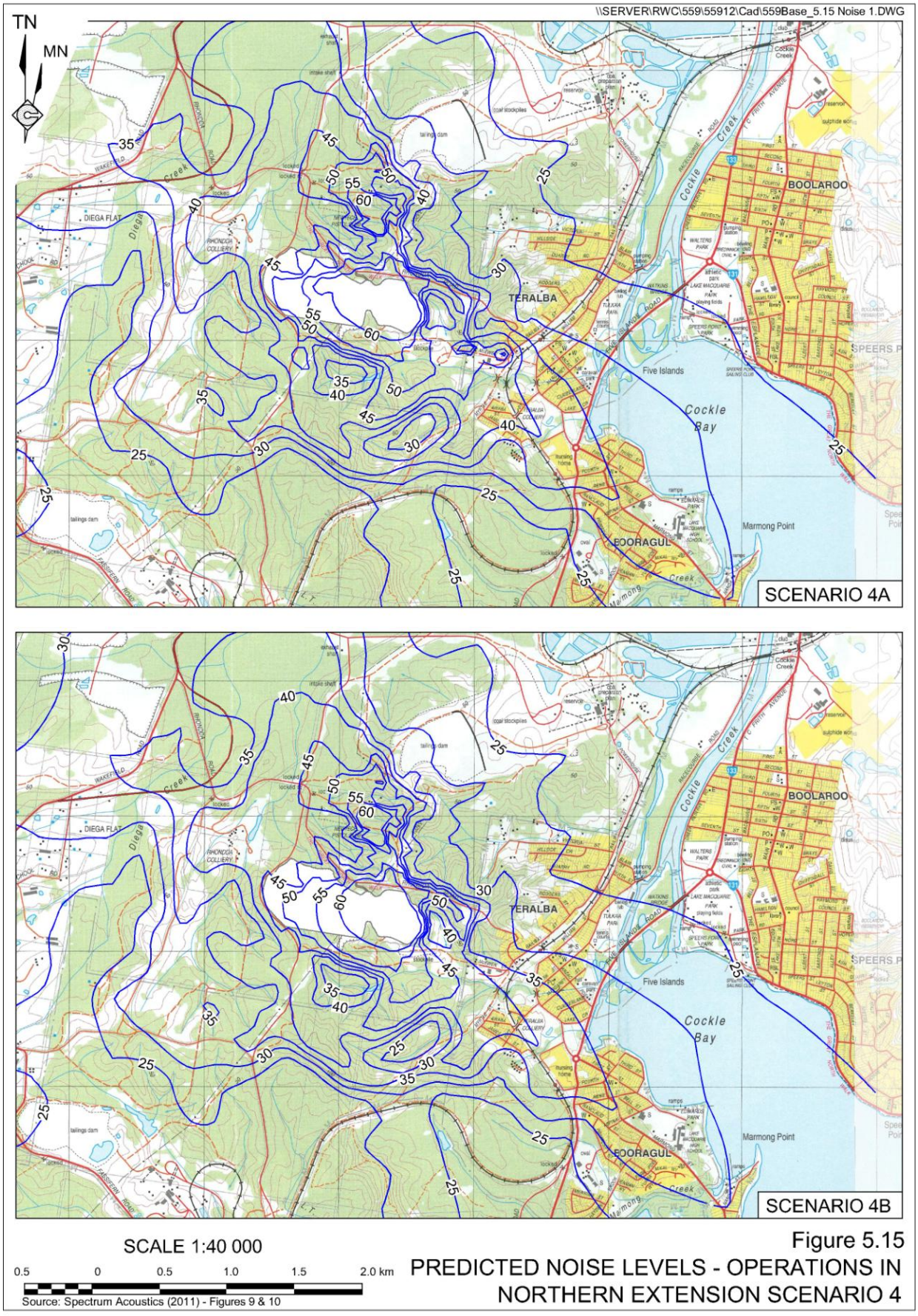


Figure 5.15
PREDICTED NOISE LEVELS - OPERATIONS IN NORTHERN EXTENSION SCENARIO 4

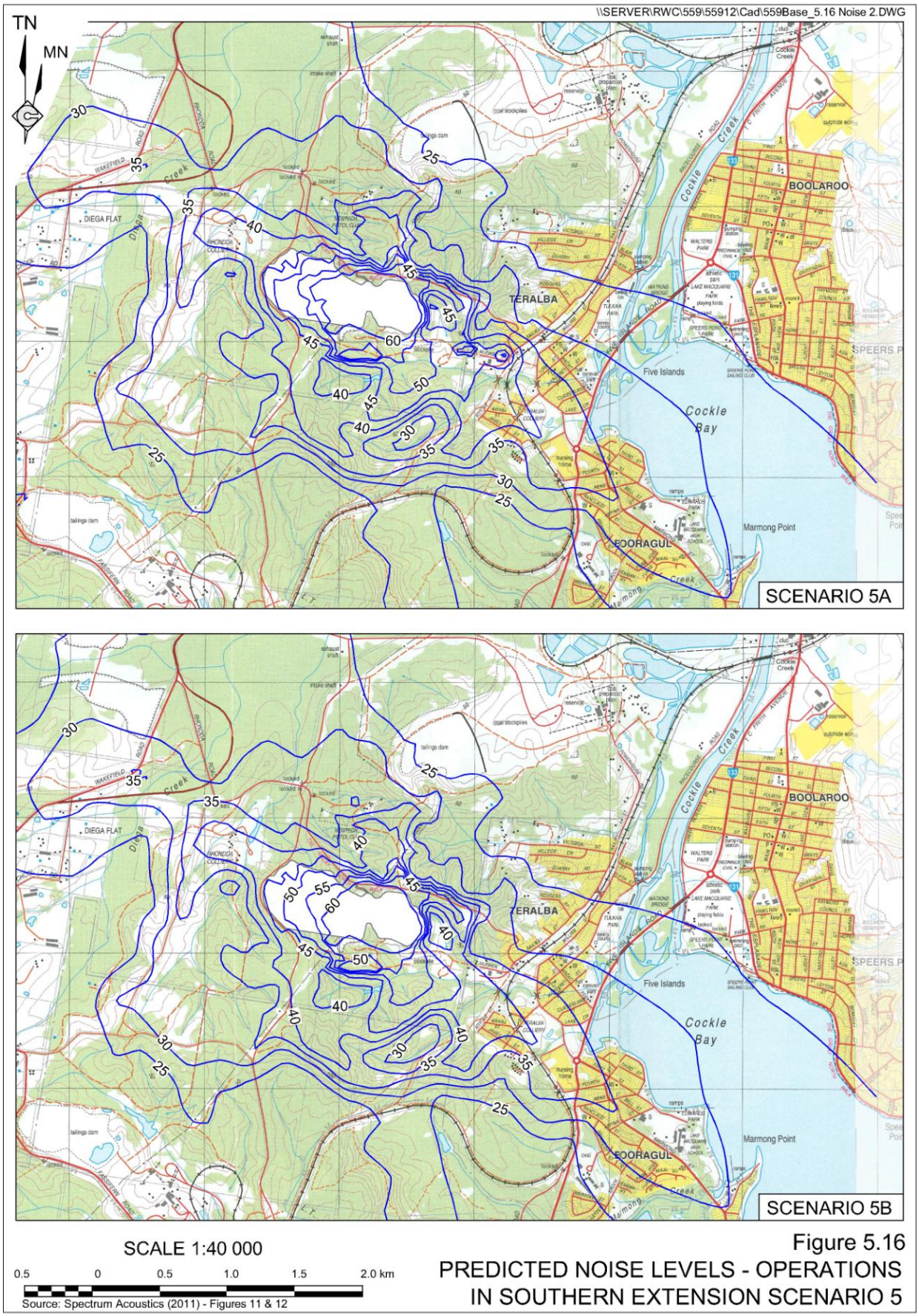


Figure 5.16
PREDICTED NOISE LEVELS - OPERATIONS IN SOUTHERN EXTENSION SCENARIO 5

A further eight operational scenarios were assessed by Spectrum Acoustics (2011). The predicted noise levels, expressed as either contours or tabulated noise levels at the nine representative residences for all 12 operational scenarios and tabulated point calculations, established that the received noise would not exceed the relevant noise criteria at any surrounding residences.

It has been established that there is a potential for noise levels to approach the criteria for the morning shoulder period near the intersection of the private access road (from Teralba Engineering) to Railway Street. This scenario resulted in the recommendation by Spectrum Acoustics to recommend truck speeds in this area are kept below 15km/hr.

5.6.6.2 Sleep Disturbance

Spectrum Acoustics (2011) assessed the likely noise attributable to the impact noise associated with loading trucks which create impact noise. The assessment established that the loading of trucks at night would not cause noise levels at any residences to exceed the relevant sleep disturbance criteria.

5.6.6.3 Cumulative Impacts

The assessment of cumulative noise levels for Teralba Quarry and other noise sources around Teralba (particularly the Teralba Industrial Estate) established that the cumulative noise impacts would be negligible i.e. they would be <1dB(A) higher than the levels predicted for the Teralba Quarry operating on its own. This conclusion was drawn based upon a comparison of the existing $L_{Aeq\ 15min}$ noise levels attributable to existing recorded noise levels and the predicted worst case.

It is noted that received noise at all receivers is affected by the prevailing atmospheric conditions. The location of the various industrial noise sources within and around Teralba are such that winds resulting in increased noise from other industrial sources would result in reduced noise from the quarry and vice versa.

5.6.6.4 Traffic-related Noise

Based upon the approach set out in Section 5.6.5.2, the $L_{Aeq\ 1hour}$ noise levels attributable to trucks travelling to and from Teralba Quarry adjacent to Railway Street would be 54dB(A) between 6:00am and 7:00am and 53dB(A) between 7:00am and 6:00pm. Both predicted levels are below the criteria nominated in Section 5.6.3.4.

Similarly, for trucks travelling to and from Teralba Quarry via Wakefield Road, the predicted $L_{Aeq\ 1hour}$ noise level for all periods of the day would be 52dB(A), a level below all relevant criteria.

5.6.6.5 Traffic-related Vibration

The Spectrum Acoustics technical database contains measurements of vibration levels from a series of heavy vehicle pass-bys (coal trucks) travelling on both sealed and unsealed roads at speeds of 40 to 60kph. The measurements ranged from not measureable to 0.2mm/s PPV for trucks travelling on smooth sealed roads at distances of between 10m and 20m from the vehicle. For trucks travelling on uneven surfaces on unsealed roads the vibration levels ranged from 0.1 to 2mm/s PPV at distances of between 10m and 20m from the vehicle.

Product trucks from the quarry will invariably travel on sealed roads. The higher vibration levels from the database relate to unsealed roads with uneven pavement surfaces. Even under the worst case for unsealed roads, the received vibration level is lower than the acceptable criterion for intermittent vibration and is, therefore, unlikely to cause discomfort to any residential receivers. The vibration level is also significantly lower than the adopted building damage criterion.

5.6.6.6 Blasting

Spectrum Acoustics (2011) calculated theoretical ground vibration and airblast overpressure levels for a range of maximum instantaneous charges and setback distances – see **Table 5.19** based on the developed site law for the quarry.

Table 5.19
Theoretical Overpressure and Ground Vibration Values

Distance	Airblast Overpressure (dB)	Ground Vibration (PVS)
12kg MIC		
450m	114.3	0.64
600m	112.6	0.45
700m	111.7	0.37
800m	110.9	0.32
1000m	109.6	0.24
20kg MIC		
450m	115.3	0.88
600m	113.6	0.62
700m	112.7	0.51
800m	111.9	0.44
1000m	110.7	0.33
40kg MIC		
450m	116.4	1.34
600m	114.7	0.94
700m	113.8	0.78
800m	113.0	0.66
1000m	111.7	0.50
60kg MIC		
450m	117.0	1.71
600m	115.3	1.20
700m	114.4	1.00
800m	113.6	0.85
1000m	112.3	0.65

MIC = Maximum Instantaneous Charge
Source: Spectrum Acoustic (2011) – Table 6.8

The closest point of the proposed area of blasting from the proposed extensions to the approved extraction areas to the nearest residence would be approximately 450m to 700m. Based on the results in **Table 5.19**, the potential impacts of blasting can be kept within the ANZECC guidelines provided the maximum MIC is kept below 60kg when blasting at 700m from residences. The limiting factoring achieving compliance would be the level of airblast overpressure.

The fact that blasting north of Rhondda Road would occur at distances of between 450m and 700m from residences means that Metromix would be able to adjust its blast design and maximum instantaneous charge to achieve compliance. An MIC as low as 12kg may be necessary.

The impacts of blasting on the surrounding community is predicted to be negligible based on the predictions set out in **Table 5.19** and Metromix's experience to date which has not attracted any complaints over a period in excess of 20 years.

5.6.7 Monitoring

5.6.7.1 Operational Noise

Metromix proposes to commission a program of attended noise monitoring during the first 3 months of operations within the Southern and Northern Extensions.

The lack of noise-related complaints to date and the monitoring undertaken by Spectrum Acoustics supports this approach to commence monitoring only when activities commence in a new area. The frequency of monitoring beyond the initial period would be nominated in the Noise Monitoring Plan prepared for the Project following the receipt of project approval. As a minimum, monitoring would occur biannually for the first year after extraction commences or resumes in either the Southern or Northern Extensions. After that period, monitoring should revert to periods following the receipt of a substantiated noise complaint.

5.6.7.2 Blasting

Metromix proposes to continue to monitor blasts at the two long term blast monitoring locations, i.e. at the bottom gate and on site 970m east of the top gate adjacent to Rhondda Road (see **Figure 5.14**). All blasts would continue to be monitored at those locations.

5.7 AIR QUALITY

The air quality assessment was undertaken by SLR Consulting Pty Ltd (SLR Consulting, 2011). The full assessment is presented in Volume 2, Part 7 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.7.1 Introduction

Based on the risk analysis undertaken by R.W Corkery and Co Pty Limited for the Project (see Section 3.5 and **Table 3.7**), the potential air quality impacts requiring assessment and their unmitigated risk ratings are as follows.

- Increased deposited dust and associated nuisance for local residences and businesses (high risk).
- Reduction in local air quality and resultant health effects for both human and vegetation populations (high risk)
- Greenhouse and other gas emissions (low risk)

In addition, the DGRs issued by the former Department of Planning and requirements issued by the former Department of Environment, Climate Change and Water, require that the assessment of air quality refer to *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005a).* The assessment is required to include:

- A description of local topographic features and sensitive receptor locations;
- A quantitative assessment of potential air quality impacts;
- A qualitative assessment of the potential Scope 1, 2 and 3 greenhouse gas emissions of the Project;
- A qualitative assessment of the potential impacts of greenhouse gas emissions on the environment;
- An assessment of all reasonable and feasible measures that could be implemented on site to minimise greenhouse gas emissions and ensure the Project is energy efficient.

The following sub-sections describe and assess the existing air quality environment, identify the air quality management issues and the proposed air quality controls, safeguards and mitigation measures. Additionally, the assessment of the residual impacts upon the air quality following the implementation of these safeguards and mitigation measures is also presented.

5.7.2 Existing Air Quality

5.7.2.1 Introduction

Dust generation is the main air quality issue relevant to the Project in terms of air quality. Airborne contaminants that can be inhaled into the human respiratory system are classified on the basis on their physical properties such as being gases, vapours or particulate matter. Particulate matter refers to a category of airborne particulates, typically less than 30 microns (µm) in diameter and ranging down to 0.1µm. This type of dust is termed Total Suspended Particulate (TSP).

Emissions of particulate matter less than 10µm and 2.5µm (termed PM_{10} and $PM_{2.5}$ respectively) are considered important pollutants to human health as their ability to penetrate the respiratory system can cause cardiovascular and respiratory diseases, pulmonary and heart diseases, as well as reduced lung capacity.

Particles that are too large to remain in suspension in the air are referred to as 'deposited dust' and are typically in the order of greater than 35µm in diameter. Even though these particles lack the ability to cause significant harm to humans, they can contribute to reductions in amenity and therefore are considered within the assessment, e.g. dust on window sills or cars.

Greenhouse gases would be produced as a consequence of the Project primarily through the use of diesel fuel to power mobile equipment on the Project Site and the transportation of product by trucks. These 'direct' emissions are used to calculate Scope 1 emissions with Scope 2 emissions calculated from 'indirect' emissions such as the burning of fossil fuels at the power station to create the electricity consumed by the Project. Scope 3 emissions are estimated from other indirect sources such as fuel consumed by staff and contractors travelling to and from the Project Site, as well as electricity lost in delivery in the electricity network.

5.7.2.2 Deposited Dust

The description of the existing air quality surrounding the Project Site has been established from dust deposition measured on a monthly basis from three dust deposition gauges located to the east of the Project Site since 2004. Two additional deposited dust gauges were installed in Teralba into supplement the existing long term gauges. All measurements of the dust deposition rates are expressed monthly and are attributable to all sources around Teralba, i.e. the quarry operation and other sources. The location of all gauges is shown in **Figure 5.17**. It is noted that the data from the two dust deposition gauges installed in March 2011 (at Rogers Street and Margaret Street) have not been included in the analysis of annual average dust deposition rate (see **Table 5.20**). However, an initial review of the results suggests these to be comparable to the original dust data discovered in the existing monitoring network. Future results would include all five deposited dust monitoring sites.

The recorded dust deposition rates for the period June 2004 to August 2010 are tabulated in **Table 5.20** and presented in **Figure 5.18**.

Table 5.20
Dust Deposition Monitoring Result Summary

	Rhondda Rd*			Myrtle St*			Hillside Cres*		
	Insoluble Solids	**Ash Fraction**	**% Ash**	**Insoluble Solids**	**Ash Fraction**	**% Ash**	**Insoluble Solids**	**Ash Fraction**	**% Ash**
OEH Guideline	4.0 (Annual Av)			4.0 (Annual Av)			4.0 (Annual Av)		
Total Monitoring Average	1.2	0.7	67.0	1.2	0.7	62.5	1.3	0.7	55.8

Source: SLR Consulting (2011) – Table 8 * See **Figure 5.17** for gauge locations.

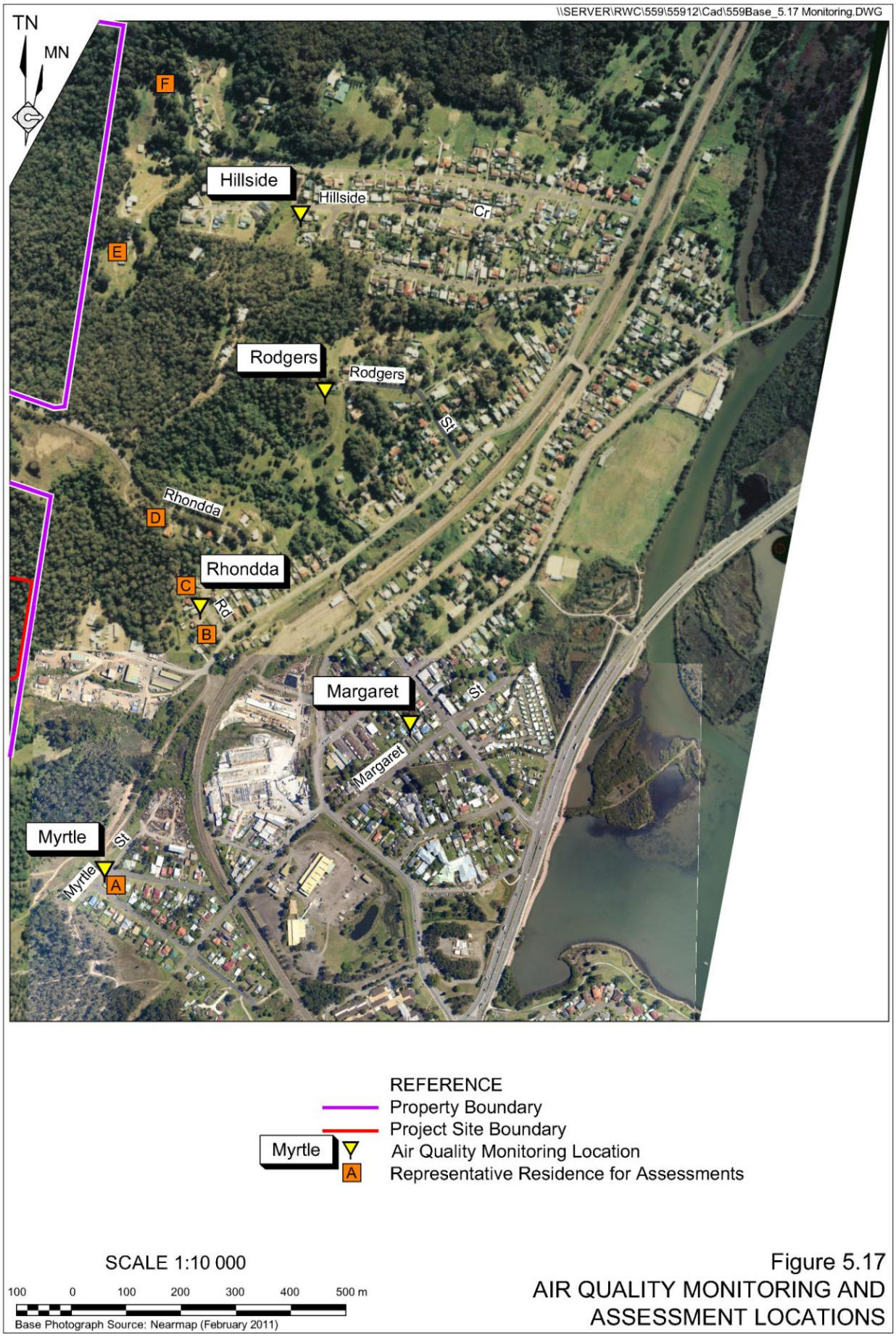
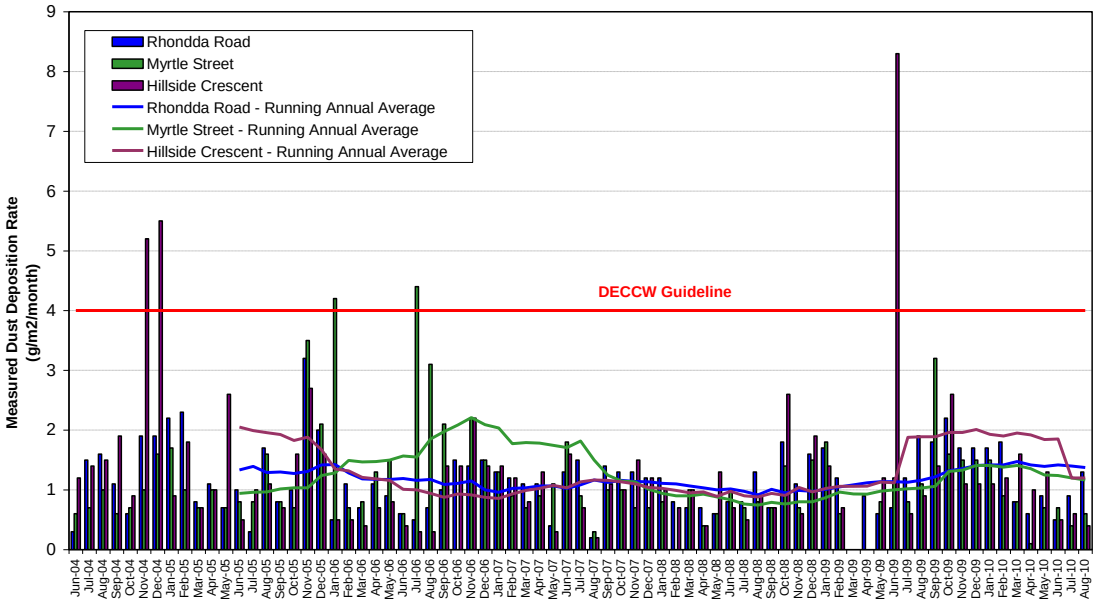


Figure 5.17
AIR QUALITY MONITORING AND ASSESSMENT LOCATIONS



Source: SLR Consulting (2011) – Figure 11

Figure 5.18
MEASURED DUST DEPOSITION RATES

The annual dust deposition rates fall well below OEH guidelines of 4g/m^2/month. Short term fluctuations (monthly averages) have been recorded on occasion as exceeding the OEH guidelines, however, SLR Consulting (2011) notes that the results appear to be isolated events and are most likely due to activities either occurring in close proximity to the gauge or external dust sources (as all three gauges did not record elevated levels at the same time).

Based upon the data summarised in **Figure 5.18** and **Table 5.20** a conservative background level of 2g/m^2/month has been used in this assessment.

5.7.2.3 Particulate Matter

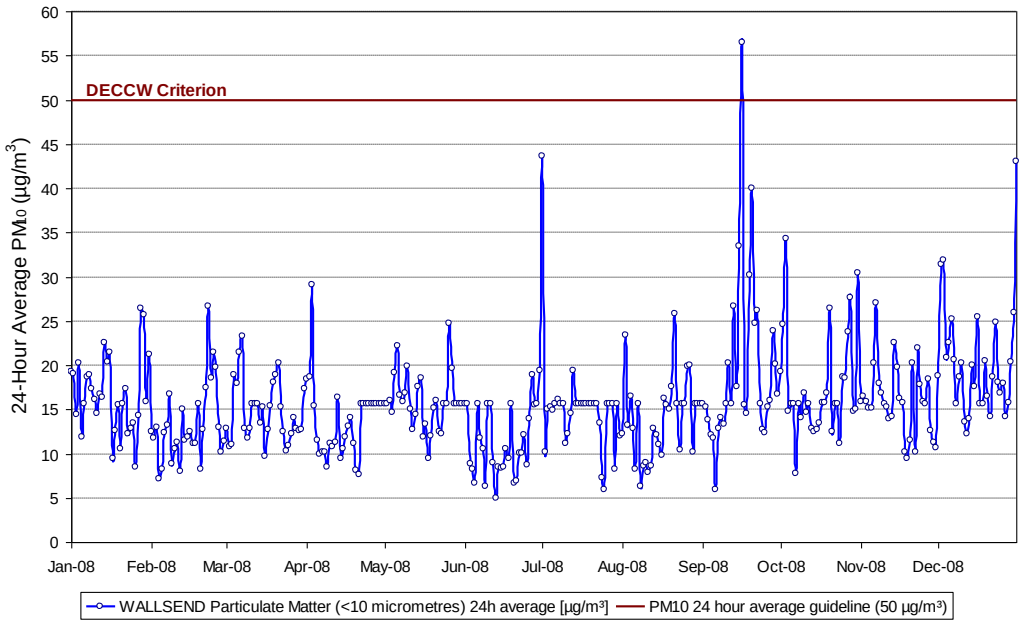
The closest OEH registered air quality monitoring station that includes particulate matter is approximately 9km northeast of the Project Site at the Newcastle City Council Swimming Pool off Frances Street in Wallsend. This site was seen as the most relevant data collection point for particulate matter as it included the PM_{10} data needed for background analysis. It is noted that there is no monitoring data available within the local area for TSP or $PM_{2.5}$.

PM_{10}

The ambient PM_{10} concentrations (averaged over 24 hours) recorded at Wallsend between January – December 2008 are summarised in **Table 5.21** and **Figure 5.19**.

Table 5.21
Measured 24-hour Average PM_{10} Concentrations: Wallsend 2008

Station	Maximum Measured Concentration ($\mu g/m^3$)	6th Highest Measured Concentration (µg/m3)	Average Concentration (µg/m3)	Days with No Results
Wallsend	57	33	16	63
Source: SLR Consulting (2011) – Table 7				



Source: SLR Consulting (2011) – Figure 10

Figure 5.19
MEASURED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS: WALLSEND 2008

The data indicates that the only exceedance of the OEH criterion occurred on 16 September 2008 with a peak reaching 56.5µg/m^3. This level is almost certainly attributed to a number of major dust storms over the regional area that included the Wallsend monitoring site. The annual average PM_{10} concentration for the 2008 Wallsend dataset was 15.7µg/m^3.

$PM_{2.5}$

No $PM_{2.5}$ monitoring data is available for the Project Site or the wider region. Although $PM_{2.5}$ is a sub-set of PM_{10} (and TSP) particles, is it not appropriate to assign a PM_{10}/ $PM_{2.5}$ ratio to a single PM_{10} concentration or ranges of concentrations as there is a number of wide ranging sources contributing (soil erosion, combustion, etc.). Furthermore, given that $PM_{2.5}$ is not an OEH adopted assessment criterion no $PM_{2.5}$ background concentration has been assumed.

TSP

No monitored TSP was available for the Project Site or the wider region so a conservative assumption has been applied to the assessment. The subsequent assumption is based upon PM_{10} comprises 40% of the total TSP. Therefore, with an annual average PM_{10} concentration of 15.7µg/m^3 presented above, the assumed background annual average TSP concentration for this assessment is 39.3µg/m^3.

5.7.2.4 Summary of Existing Air Quality

Taking into account the locally collected (dust deposition) data, as well as data obtained from the most appropriate monitoring station (Wallsend), the following site specific ambient (background) air quality levels have been adopted for this assessment.

- Dust Deposition 2g/m^2/month
- 24 hour maximum PM_{10} Daily Varying [2]
- Annual Average PM_{10} 15.7µg/m^3
- Annual Average TSP 39.3µg/m^3[3]

5.7.3 Potential Sources of Air Contaminants

5.7.3.1 Particulate Emissions

Project activities that would generate particulate emissions are related to the following specific operational and on-site transportation activities.

- Extraction activities (drilling/blasting, front-end loaders, bulldozers, trucks loading).
- Crushing and screening (dry only).
- Conveyors.
- Vehicle movements on unsealed roads.
- Product loading and despatch.
- Wind erosion from disturbed areas.

5.7.3.2 Greenhouse Gas and Other Gas Emissions

The primary source of greenhouse gas emissions from the Project would be a result of Scope 1 emissions. These emissions relate to combustion of fuel (particularly diesel) powered equipment and vehicles, front-end loaders, excavators, bulldozers, drill rigs and haul trucks. Greenhouse gases would also be generated as a result of temporary on and off-site power generation (Scope 2 emissions) with Scope 3 emissions (indirect emissions associated with the Project) being the result of fuel burned by vehicles travelling to and from the Project Site.

[2] As the background 24 hour PM_{10} concentration would vary each day, the assessment of SLR Consulting Pty Ltd (2011) indicates that background and increments attributed to the Project should not exceed 50µg/m^3

[3] Assumes that PM_{10} makes up 40% of TSP and the annual average PM_{10} is 15.7µg/m³.

Although carbon dioxide (CO_2) would be the principal gas produced, greenhouse gases emitted as a result of the Project would also include carbon monoxide (CO), methane (CH_4) oxides of nitrogen (NO_x), SO_2 and non-methane volatile organic compounds (NMVOCs). All greenhouse gas emission levels have been correlated and expressed in CO_2 equivalent units by way of an index entitled the 'Global Warming Potential' (GWP) created by the Intergovernmental Panel on Climate Change (IPCC 1996).

5.7.4 Assessment Criteria

5.7.4.1 Particulate Matter and Dust Deposition

Goals Applicable to PM_{10}

The NSW OEH PM_{10} assessment goals, as expressed in the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (DEC 2005), are:

- a 24 hour maximum of 50µg/m^3; and
- an annual average of 30µg/m^3.

Goals Applicable to Total Suspended Particles

The annual goal for Total Suspended Particles (TSP), as recommended by the National Health and Medical Research Council (NHMRC), is quoted as 90µg/m^3.

Goals Applicable to $PM_{2.5}$

The ambient Air Quality NEPM was amended in 2003 to extend its coverage to $PM_{2.5}$. This document references the following goals:

- a 24-hour maximum of 25µg/m^3; and
- an annual average of 8µg/m^3.

Goals Applicable to Deposited Dust

The OEH identifies is that dust-related nuisances occur when average levels exceed 4g/m^2/month and is subsequently the goal applicable to the Project.

5.7.4.2 Project Air Quality Goals

In summary, the Project specific air quality goals are as follows.

PM_{10}:	A 24-hour maximum of 50µg/m^3 An annual average of 30µg/m^3
$PM_{2.5}$:	A 24-hour maximum of 25µg/m^3 An annual average of 8µg/m^3
TSP:	An annual goal of 90µg/m^3
Dust:	An annualised monthly average of 4g/m^2/month

5.7.5 Environmental Controls and Management

Metromix proposes to continue its mitigation practices that limit the generation of dust from the potential sources of air-contaminants identified in Section 5.7.3. Current dust mitigation practices are as follows.

- During periods of extended dry weather and/or high winds, when dust emissions have the potential to occur as a result of quarrying activities, dust is managed through the use of a water truck to supress emissions.
- Material stockpiles are located in sheltered locations and not close to sensitive receptors.
- Conveyors are shielded from the wind.
- Conveyor transfer points are enclosed.
- Internal roads would be surfaced with well graded materials to limit dust lift-off.
- All vehicles travelling on internal unsealed roads would be limited to a speed appropriate for the conditions and safety, i.e. less than 40km/hr.
- Load sizes would be limited to ensure product does not extend above truck sidewalls.
- Care would be taken to avoid spillage during loading.
- Activities on dry windy days when plumes of dust are visible would be stopped or modified.
- Dump heights from trucks, front-end loaders and conveyors would be minimised.
- Exposed areas that are not covered in gravel under dry and windy conditions would be watered (visible dust plumes being the trigger for this action).
- Blasts are scheduled so that they do not occur in very high wind conditions.
- A complaints management system would be adopted to ensure that all complaints are dealt with through investigation and implementation of corrective treatments.
- Truck queuing, unnecessary idling of trucks and unnecessary trips would be reduced through logistical planning where possible.
- The on-site wheel washes would reduce mud tracking caused by trucks travelling eastwards along Railway Street and westward along Rhondda Road.

Metromix intends to improve upon current mitigation measures by using conveyors instead of haul trucks to transfer extracted material from the Northern Extension and eastern section of the Southern Extension to the processing plant i.e. once the relocatable crusher is installed.

Metromix has and would continue to implement the following measures to minimise the emissions of greenhouse gases during the ongoing life of the Project.

- Optimise quarry design to minimise:
  - travel distances for equipment; and
  - rehandling of overburden and products.
- Use quarrying equipment which is regularly maintained and serviced to maximise efficiency.
- Minimise the quarry footprint to reduce land disturbance and travel distances for mobile plant.
- Optimise the design of the Processing Plant to:
  - maximise the use of gravity to move material throughout the plant reducing the need for pumping; and
  - maximise the use of energy efficient motors in major items of equipment.

The use of conveyors to transfer raw materials from the Northern Extension and eastern section of the Southern Extension would also reduce the consumption of diesel fuel by haul trucks and therefore reduce greenhouse gas emissions.

5.7.6 Assessment Methodology

5.7.6.1 Particulate Matter Emissions

The potential dust-related impacts of the Project have been assessed by SLR Consulting (2011) in accordance with the OEH published guidelines for the assessment of air pollution sources using dispersal methods (DEC 2005). In order to model the likely dispersion of particulate matter, the prevailing meteorological conditions of the local area were required. In the absence of site specific meteorological data two separate meteorological models were used to generate a meteorological model for the Project Site. These were:

- The Air Pollution Model (TAPM) – produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO); and
- CALMET – A division of CALPUFF.

TAPM is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations. The model predicts wind speed, direction, temperature, pressure, water vapour, cloud, rain water and turbulence to generate synthetic observations by referencing databases (covering terrain, vegetation, soil type, sea surface temperature and synoptic scale meteorology analyse). These inputs allow the creation of site-specific hourly meteorological observations at user defined levels within the atmosphere.

CALMET is a meteorological model that develops wind and temperature fields on a three dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties were also included to combine with topographical influences to develop a final wind field.

Dust generating activities were represented in the model by three operational scenarios. The estimated dust emissions from those sources are listed in **Table 5.22**. Details of the calculations conducted, specific activities that were considered in preparing the emissions inventory and the emissions factors used for each scenario are presented in full in SLR Consulting (2011).

Table 5.22
Estimated Dust Emissions from Three Worst-case Scenarios of the Proposed Actions

Dust Source	Total Annual Dust Emissions (kg)		
	Scenario 1B	Scenario 4A	Scenario 5A
Blasting	810	810	810
Excavator on overburden	296	296	296
FEL on overburden	296	296	296
Drilling	1150	1150	1150
Truck dump overburden	6920	6920	6920
Primary crushing (HMCO)	5760	5760	5760
Screening (LMCO)	46100	46100	46100
Tertiary crushing (HMCO)	7780	1180	7780
Loading Stockpile	2310	2310	2310
Handling, transferring and conveying including wheel and bucket reclaimers (HMCO)	2880	2880	2880
Asphalt plant	29	29	29
Southern excavation to receival hopper	1768		
Mid Pit to receival hopper	445		
Product off site eastern stockpile	445	9801	
Product off site western stockpile	5336	11227	
In pit transport 1		3926	
Dump Truck processing plant		1309	1963
South boot hopper			9801
Mid boot hopper			42269
Off site east			1963
Off site west			1309
Wind Erosion			
Total	82325		

Source: SLR Consulting (2011) – Modified after Tables 11, 12 and 13

These scenarios are as follows.

- Scenario 1B – Extraction in Southern Extension (Stage A) and Mid Pit Area (Stage E) only.
- Scenario 4A – Extraction in Northern Extension (Stage C) only.
- Scenario 5A – Extraction in the Southern Extension Area (Stage C) only.

Dispersion modelling predictions incorporating the generated meteorological model into the CALPUFF dispersion model program for dust deposition, TSP, PM_{10} and $PM_{2.5}$ concentrations were generated by SLR Consulting (2011). The predicted emissions are provided for nine representative privately-owned residences (see **Figure 5.17** or **Figure 4.5**). The results are presented as an increment value due to the on-site operations, as well as cumulative value which are defined as the sum of all operations plus relative background concentrations.

These scenarios are considered to capture the worst case impacts at surrounding residences for operations in the Southern, Northern and Mid Pit Extraction Areas.

5.7.6.2 Greenhouse Gas Emissions

The primary source of greenhouse gas emissions from the Project would be attributed to the combustion of fuel (particularly diesel) used by the earthmoving equipment and transportation of products. Greenhouse gas emitting sources are classified as either Scope 1, 2 or 3 emissions as follows.

- **Scope 1 Emissions**

  These are the direct emissions from sources within the boundary of the Project Site such as the combustion of fuel by diesel-powered equipment and vehicles.

- **Scope 2 Emissions**

  These are the indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.

- **Scope 3 Emissions**

  These emissions are defined as all other indirect emissions that are a consequence of the organisations activities but are not from sources owned, or controlled, by the organisation. In the case of the Project, this includes the transportation of quarry products from the Product Site to markets.

5.7.7 Assessment of Impacts

5.7.7.1 Deposited Dust and Particulate Matter Impacts

Tables 5.23 and **5.24** summarise the annual average predicated particulate matter and deposited dust concentrations at each of the nine non-project related privately owned residences (shown in **Figure 5.17** or **Figure 4.5**) for the three scenarios modelled. **Table 5.23** presents the maximum incremental contribution for TSP, $PM_{10,}$ $PM_{2.5}$ and deposited dust for annual averages attributed to the Project and **Table 5.24** compares the 24 hour averages for PM_{10}, $PM_{2.5}$. Both tables are compared against the Project goals defined in Section 5.7.4.

Table 5.23
Summary of Annual Average Dispersion Model Prediction due to Project

Annual Average	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)	TSP ($\mu g/m^3$)		Dust deposition (g/m^2/month)	
Air quality goal	***30***		***8***	***90***		***4***	
Residence ID*	**Incremental**	**Cumulative**	**Incremental**	**Incremental**	**Cumulative**	**Incremental**	**Annual**
Scenario 1B							
A	0.4	16	0.1	1	40	0.1	2.1
B	0.9	16	0.2	3	42	0.2	2.2
C	0.1	15	0.0	0	39	0.0	2.0
D	0.8	16	0.1	2	42	0.1	2.1
E	0.6	16	0.1	1	41	0.1	2.1
F	0.4	16	0.1	1	40	0.0	2.0
G	0.1	16	0.0	0	40	0.0	2.0
H	0.1	16	0.0	0	40	0.0	2.0
I	0.1	15	0.0	0	40	0.0	2.0
Scenario 4A							
A	0.4	16	0.1	1	41	0.1	2.1
B	0.9	16	0.2	4	43	0.2	2.2
C	0.1	15	0.0	0	40	0.0	2.0
D	0.9	16	0.1	3	42	0.1	2.1
E	0.7	16	0.1	1	41	0.1	2.1
F	0.5	16	0.1	1	40	0.0	2.0
G	0.1	16	0.0	0	40	0.0	2.0
H	0.1	16	0.0	0	40	0.0	2.0
I	0.1	15	0.0	0	40	0.0	2.0
Scenario 5A							
A	0.5	16	0.1	1	41	0.1	2.1
B	1.0	16	0.2	4	43	0.2	2.2
C	0.1	15	0.0	0	40	0.0	2.0
D	0.9	16	0.2	3	42	0.1	2.1
E	0.6	16	0.1	1	41	0.1	2.1
F	0.4	16	0.1	1	40	0.0	2.0
G	0.2	16	0.0	0	40	0.0	2.0
H	0.2	16	0.0	0	40	0.0	2.0
I	0.1	16	0.0	0	40	0.0	2.0

* See **Figure 5.17** for Representative Residence Locations

Source: SLR Consulting (2011) Modified after Table 17, 18 and 19

Table 5.24
Summary of 24-Hour Average Summary of Dispersion Model for PM_{10} and $PM_{2.5}$

24hr Average	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)
Air Quality Goal	**50**		**25**
Residence ID*	**Incremental**	**Cumulative**	**Incremental**
Scenario 1B			
A	0.7	40	0.9
B	1.3	41	1.4
C	0.0	39	0.3
D	1.1	40	1.4
E	0.5	40	0.9
F	0.3	40	0.6
G	0.0	39	0.6
H	0.0	39	0.3
I	0.0	39	0.3
Scenario 4A			
A	0.6	40	0.9
B	1.4	41	1.5
C	0.0	39	0.3
D	1.2	41	1.4
E	0.8	40	1.0
F	0.5	40	0.9
G	0.0	39	0.5
H	0.0	39	0.3
I	0.0	39	0.3
Scenario 5A			
A	0.9	40	1.2
B	1.5	41	1.5
C	0.0	39	0.3
D	1.2	41	1.8
E	0.3	40	1.0
F	0.2	40	0.5
G	0.0	39	0.7
H	0.0	39	0.5
I	0.0	39	0.3
* See **Figure 5.17** for Residence Locations			
Source: SLR Consulting (2011) Modified after Tables 19 and 20			

Figures 5.20 and **5.21** respectively display the contour values for the predicted Incremental Annual Deposited Dust level and the Predicted 24 hour Average PM_{10}.

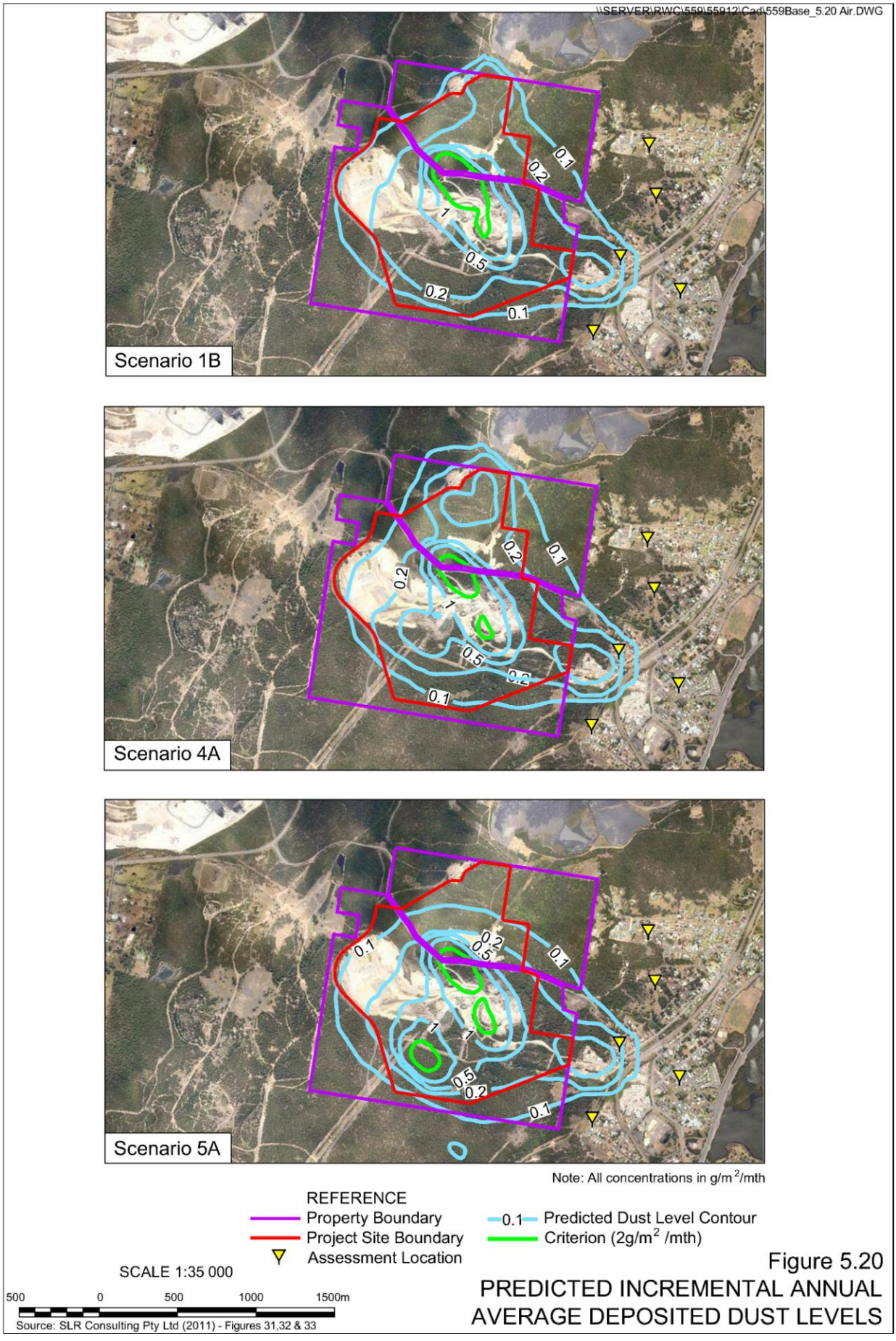


Figure 5.20
PREDICTED INCREMENTAL ANNUAL AVERAGE DEPOSITED DUST LEVELS

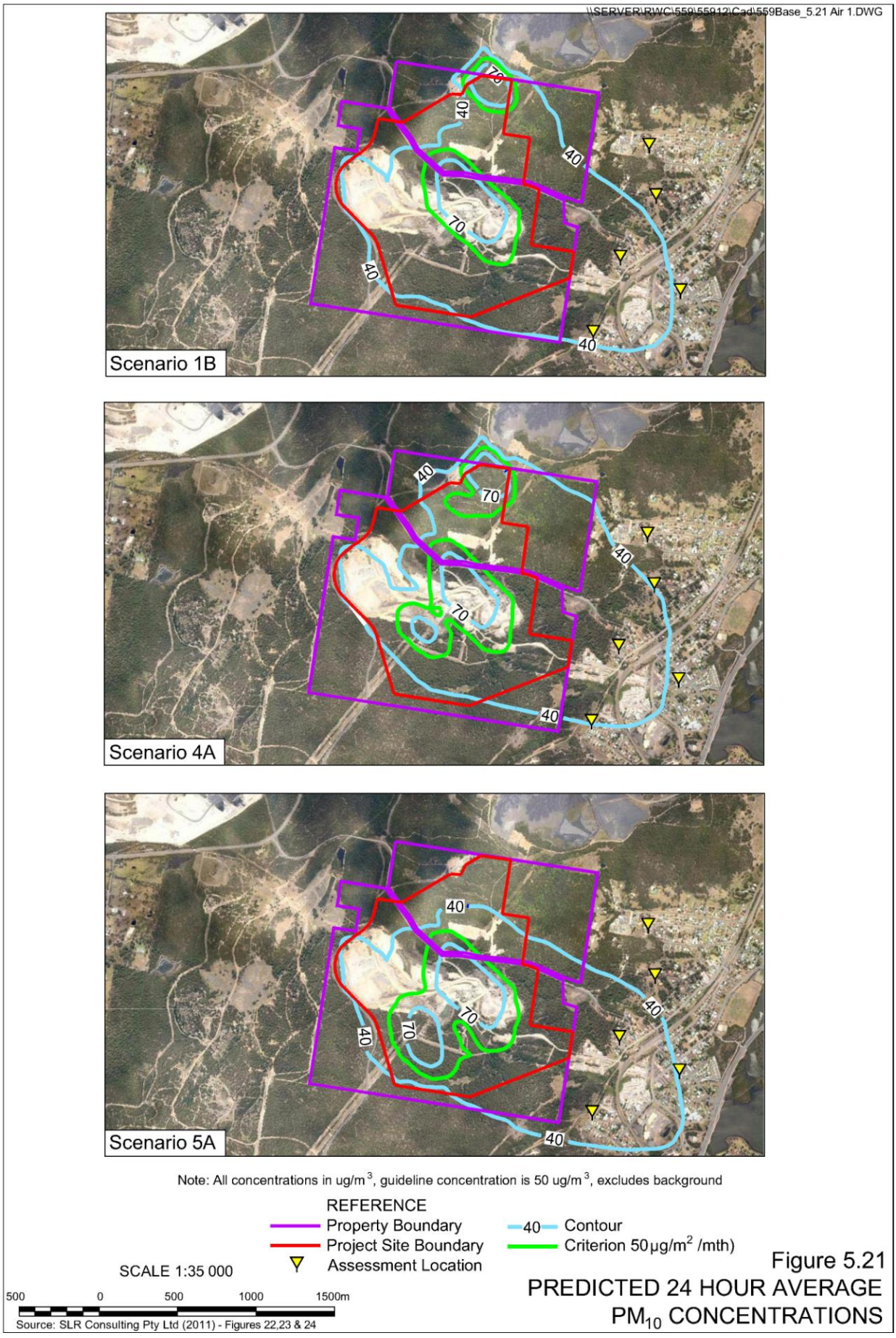


Figure 5.21
PREDICTED 24 HOUR AVERAGE PM_{10} CONCENTRATIONS

5.7.7.2 Greenhouse Gas Emissions

Considering anticipated activity levels on the Project Site, product delivery routes, and standard emission factors provided by publications such as National Greenhouse Account Factors (NGA Factors) (DCC 2009), the greenhouse emissions of the Project have been estimated.

Scope 1 Emissions

- **Diesel Usage**

  The primary fuel source on site for vehicles, plant and equipment is diesel, the consumption of which is estimated as 393 000 litres for sales level of 665 000t increasing to 590 000 litres per annum for a sales level of 1Mtpa. This estimated rate assumes that all road transport sources are within direct control of Metromix.

- **Explosives**

  The quantity of explosives used within the Project Site has been valued at having an emission factor equivalent of 0.17t CO_2 per tonne of explosive as sourced from the February edition of the NGA Factors (DCC 2009).

Scope 2 Emissions

- **Electricity Indirect Emissions**

  Emissions of greenhouse gases result from the consumption of purchased electricity and are therefore included in the overall assessment of greenhouse gases. Electricity consumption for the Project has been calculated as 1 560 000 Kilowatt-hours (kWh), increasing to approximately 2 400 000kWh when sales reach 1Mtpa. An emission factor for Scope 2 has been defined as 0.89 tonnes of CO_2 per kWh as represented by purchased electricity in NSW.

Scope 3 Emissions

- **Other Indirect Emissions**

  Greenhouse gases attributable to diesel used at the Project Site include the extraction, production and transport of product.

- **Vehicle Use by Employees**

  Based on information provided by Metromix, employees travel on average 19km a day to the Project Site from their residence. The level of employment when operating at a sales level of 1Mtpa would be 34 persons. Consequently, a total distance travelled by employees to and from work over the year equates to 335 900km. Assuming an equivalent diesel fuel rate of 10L/100km, the total fuel use would be approximately 33 600L of diesel per year.

Table 5.25 presents the calculated greenhouse gas emissions (as CO_2 equivalents where necessary) for Scope 1, 2 and Scope 3 sources.

Table 5.25
Greenhouse Gas Emissions from the Project

Emission Source	Activity Rate		Emission Factor	Calculated Emissions t CO_2/annum		
	665 215tpa	1Mtpa		665 215tpa	1Mtpa	Difference
Scope 1						
Diesel Combustion – On site	392kL	589kL	69.9	1058	1590	532
Diesel Combustion – Road Transport	476kL	716kL	69.9	1284	1931	646
Explosive Use	0	0	0.17	0	0	0
Total Scope 1				2342	3521	1179
Scope 2						
Electricity Consumption	1 595 002 kWh	2 397 726 kWh	0.89	1420	2134	714
Total Scope 2				1420	2134	714
Scope 3						
Electricity Consumption	1 595 002 kWh	2 397 726 kWh	0.18	287	432	144
Diesel Consumption – On site	392kL	589kL	5.3	80	121	41
Diesel Consumption – Road Transport	476kL	716kL	5.3	97	146	49
Diesel Consumption – employees	24kL	34kL	5.3	5	7	2
Total Scope 3				470	705	236
Total				4232	6360	2129
Source: SLR Consulting (2011) Modified after Table 25						

5.7.8 Monitoring

Metromix proposes to continue the program of monthly monitoring for the Project. The results of all monitoring would be documented for the quarry that would include the frequency and location of deposited dust information and the comparison wind speed and direction data. All results would be included in each Annual Environmental Management Report.

5.8 VISIBILITY

5.8.1 Introduction

Based on the risk analysis undertaken by RW Corkery & Co. Pty Ltd for the Teralba Quarry Extensions, the potential impacts relating to visual amenity requiring assessment and their unmitigated risk ratings are as follows.

- Reduced visual amenity of local residents and passers-by (High risk).
- Reduced visual amenity of residents on the eastern side of Lake Macquarie and recreational users of the lake (High Risk).

In addition, the DGRs issued by the former Department of Planning issued in November 2010 required the visual assessment to provide a detailed description of the measures that would be implemented to minimise the visual impact of the Project.

It is noted that the Project Site lies within a substantial area on the western side of Lake Macquarie that has been classified as Scenic Management Zone A within Lake Macquarie City Council Development Control Plan (DCP) No.1. Zone A has been assigned as the area of highest scenic quality largely because of the abundance of remnant native vegetation. The DCP No.1 nominates that these areas are of "critical" value to the scenic image of the local government area and are most vulnerable to loss through development.

The assessment of visual impact in this document reflects the relevant elements of the scenic quality guidelines developed on behalf of Lake Macquarie City Council (LMCC, 2004) to accompany DCP No.1.

The visual aspects of the proposed Teralba Quarry Extensions have been an integral part of the quarry extension planning and design process, in particular with respect to the staging of extraction in the within the Southern Extension.

5.8.2 The Existing Visual Landscape

The Project Site is located within undulating topography (see also Section 4.1) with a range of landforms and natural bushland.

The area around the Project Site does not accord within any specific landscape setting unit within LMCC (2004). Rather, it lies to the west of a low north-south oriented ridge line that forms part of the foreground to the more prominent and elevated Watagan Mountains (see **Plates 5.1** to **5.3**). The low ridge line displayed in the foreground in **Plates 5.1** to **5.3** comprises a number of prominent north-south ridges and less prominent east-west oriented ridges. The existing Mid Pit Extraction Area and the proposed Northern Extension lie immediately to the west of a north-south oriented ridge whereas the existing Southern Extraction Area and the proposed Southern Extension are located to the west of an east-west oriented ridge.

The Project Site is criss-crossed by minor access roads and power transmission and distribution lines and the large open area of cleared land comprising the Teralba Quarry and associated operations. Visually, the existing quarry operations are well screened from Rhondda Road and all other publicly accessible local and longer distance vantage points principally due to the surrounding vegetation and topography. Only glimpses of the operations south of Rhondda Road between the thick vegetation are possible by motorists travelling along or pedestrians walking on the edge of Rhondda Road.

In terms of visual accessibility, the only area[4] that could be considered to have a level 1 accessibility is on the eastern shores of Lake Macquarie, particularly at well-patronised foreshore parks such as Lions Park at Eleebana. These areas are generally in the order of 4km to 5km from the existing/proposed quarry extension. The only area with level 2 accessibility[4] would be areas used for boating on Lake Macquarie. All other public or private vantage points in the vicinity of the Teralba Quarry have a low accessibility level[4].

[4] According to the Scenic Quality Guidelines (LMCC, 2004)

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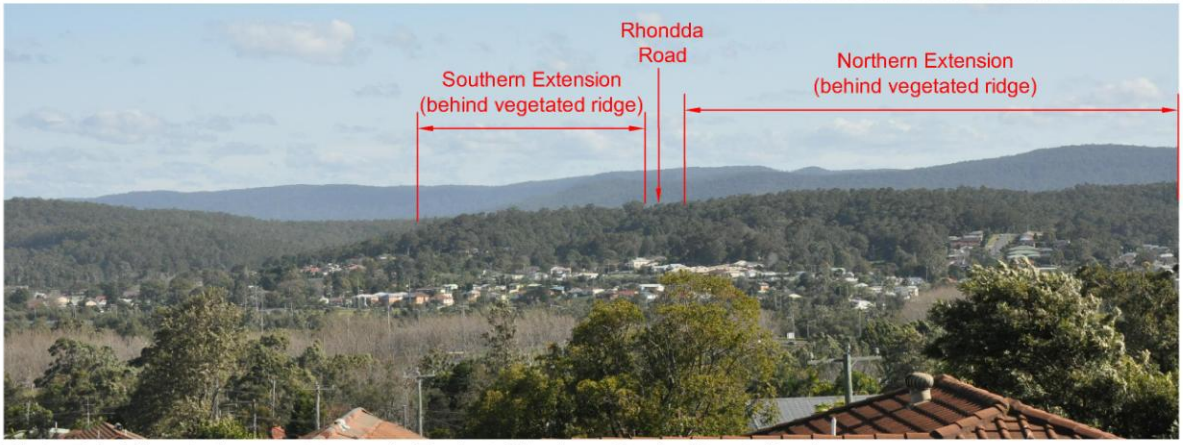

Plate 5.1: View to the west towards Project Site from Davis Street, Boolaroo.
(Ref: E559U-005)

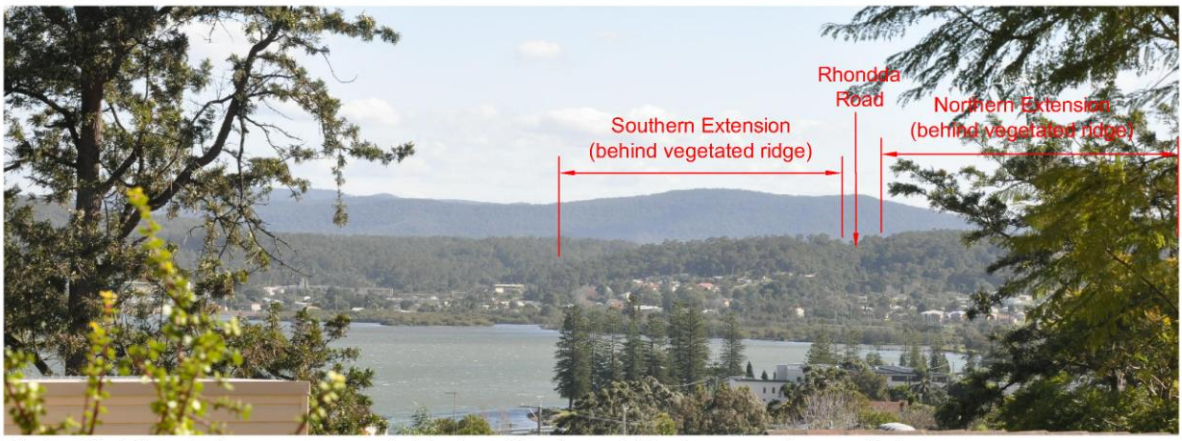

Plate 5.2: View to the west towards Project Site from Atkin Avenue, Speers Point.
(Ref: E559U-009)

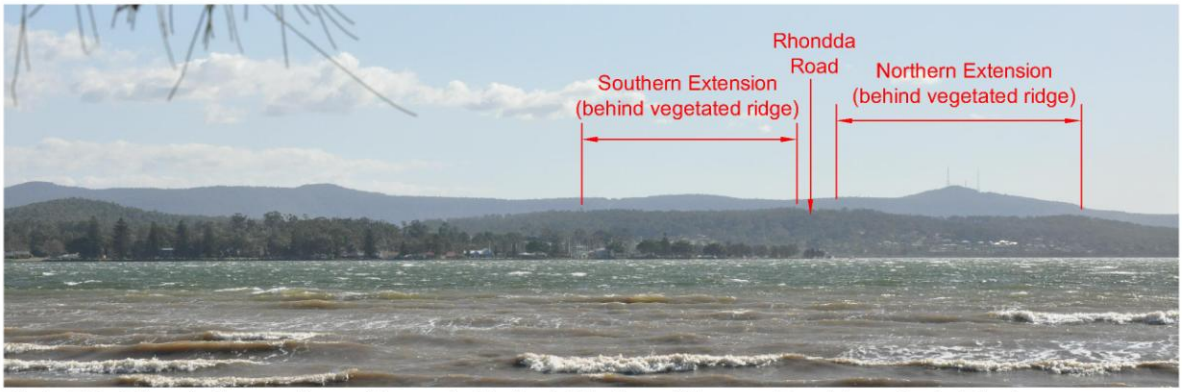

Plate 5.3: View to the northwest towards Project Site from Warners Bay Lions Park, Eleebana.
(Ref: E559U-001)

Both the topography and remnant native vegetation provide substantial shielding of the existing quarry operations from residences in Teralba. Views westward from residences on the eastern side of Myrtle Street comprise vegetation on the eastern end of the east-west ridge with a small section of the clearing for a power transmission line partly observed.

Longer distance elevated vantage points occur only to the east and southeast of the Project Site. Representative vantage points referred to as A^1, B^1 and C^1 are 3.2km, 3.6km and 5.1km respectively from the eastern side of Teralba Quarry (see **Figure 5.22**).

- Location A^1 is representative of elevated areas within Boolaroo e.g. Davis Street (see **Plate 5.1**).
- Location B^1 is representative of elevated areas within Speers Point e.g. Atkin Avenue (see **Plate 5.2**).
- Location C^1 is representative of publicly accessible areas on the eastern side of Lake Macquarie e.g. Warners Bay Lions Park, Eleebana (see **Plate 5.3**).

Existing views from these representative vantage points comprise the tree-lined natural slopes to the east of the existing Mid Pit Extraction Area and the existing Southern Extraction Area. Both of the existing extraction areas are not visible from viewing areas to the east as Metromix has intentionally maintained its operational areas well shielded, i.e. through retaining both landforms and remnant native vegetation on the eastern side of the Project Site. **Plates 5.1**, **5.2** and **5.3** present the existing views from vantage points A^1, B^1 and C^1 looking towards the Teralba Quarry. It is noted that no operational areas within Teralba Quarry are currently visible from any of these three distant vantage points.

Due to the nature of the topography of the surrounding land to the north and west of the site, the lack of public access on the surrounding land to the north and west of the Project Site and the orientation of the quarry extraction areas, there are no other publicly accessible short or long (<5km) distance vantage points towards the Teralba Quarry.

Regionally, the lower vegetated ridgelines on the western side of Lake Macquarie provide an immediate backdrop to the lake. However, these ridgelines are in turn dominated by the higher ridgelines further west within the Watagan Mountains. Prominent peaks like Mount Sugarloaf, provide publicly accessible viewing areas that are able to view all land uses throughout the Lake Macquarie Local Government Area. Teralba Quarry is visible from Mount Sugarloaf, principally due to colour contrast between the light brown colour of the exposed rock and the surrounding green native vegetation.

5.8.3 Changes to the Visual Amenity of the Project Site

Figure 5.23 presents the topographic profiles of each between the representative vantage points A^1, B^1 and C^1 and remnant vegetation that would remain at the completion of the proposed quarry extensions. Details A, B and C in **Figure 5.23** show the extent of proposed extraction and proposed final topography and landform upon which the visual assessment has been based.

The main activity that would contribute to changes in the visual amenity from the three distant representative vantage points would be the removal of overburden and conglomerate from the proposed Southern Extension specifically the elevated section of an east-west oriented ridge. The proposed changes are displayed in Sections B and C of **Figure 5.23**.

It is noteworthy, that there would be no noticeable changes in the landscape and visible vegetation within the area south of Rhondda Road when viewed at distances >3km, i.e. from suburbs on the eastern side of Lake Macquarie. Consequently, changes to the view of this area from the representative vantage points A^1, B^1 and C^1 would not be impacted upon.

As can been seen in **Figure 5.22** (Detail A), operations within the proposed Northern Extension would be screened by the north-south ridge and its remnant vegetation on the eastern boundary of the extraction area.

It is not anticipated that there would be any further visual impacts due to the extraction operations in the proposed Northern Extension due to the absence of any private or public vantage points to the north.

5.8.4 Environmental Controls and Management

Metromix's approach to the controls required to manage environmental impacts reflects the following key objectives of LMCC's Scenic Management Zone A particularly as it relates to ridgelines which feature predominantly within and surrounding the Project Site.

- "Protect the natural character of all ridgelines and the dominant nature character of hillsides by ensuring the visual impact of development is minimised."[5]

An important strategy in achieving this objective would be the retention of a continuous canopy of the remnant vegetation.

Metromix has identified the potential impacts upon visual amenity of the extraction operations within the proposed Southern Extension on visual amenity to the east of the Project Site as requiring specific attention in the design of the extraction operations. Mitigation of this impact would be achieved by the staging of both the extraction and rehabilitation operations in the proposed Southern Extension. **Figure 5.23** presents the staged sequence of operation and rehabilitation reflecting the emphasis placed upon avoiding visual impacts.

- Activities would commence in the western section in order to maintain the elevated topography in the east of the proposed Southern Extension. Therefore no visual impacts would be evident from the east at this stage. Extraction activities are scheduled in the western section of the proposed Southern Extension during the Years 3 to 10 (**Figure 5.23b**).
- Rehabilitation activities, focusing upon the establishment of trees and shrubs on the exposed western and southwestern benches within the Southern Extension would commence as soon as each bench is completed and the required overburden is placed on the final bench. The revegetation would be undertaken on the benches above 50m AHD as these are the benches (and accompanying extraction faces) that would become exposed to the east as the eastern section of the Southern Extension is removed (**Figure 5.23c**).

[5] Appendix 5 in Scenic Quality Guidelines (LMCC, 2004)

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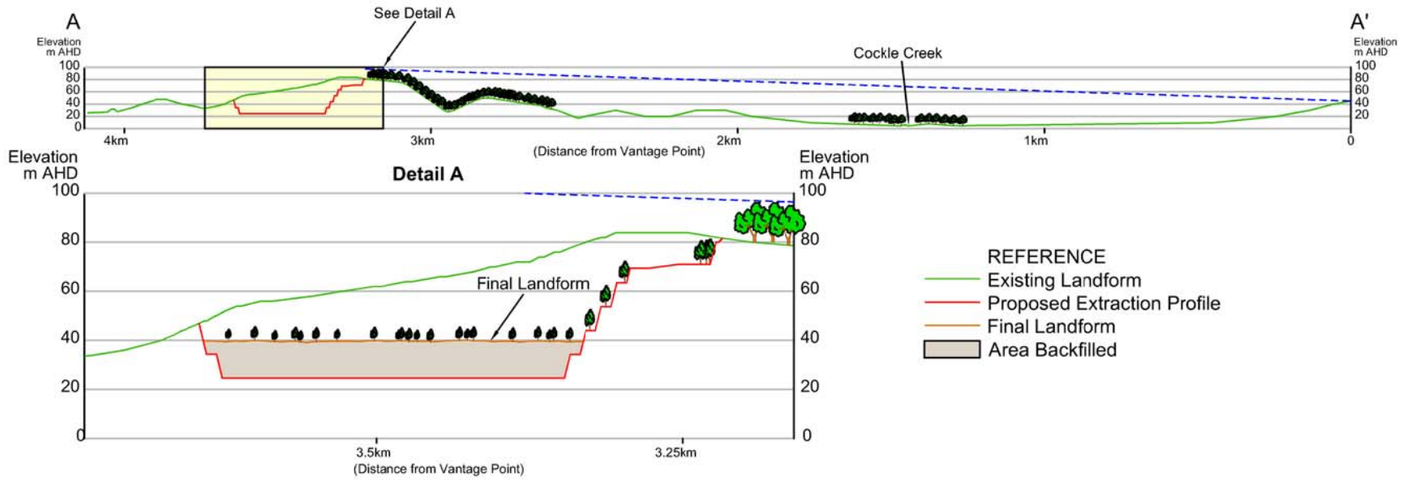

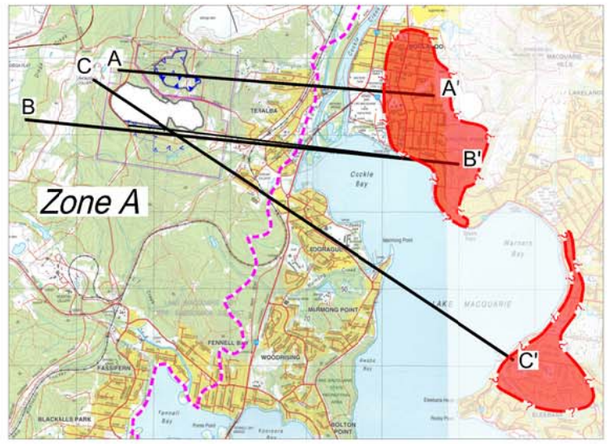

REFERENCE
Scenic Management Zone Boundary (Source: LMCC 2004)
Indicative Area of Visual Catchment or Viewshed for Teralba Quarry

Note: Not all areas in viewshed have views towards Teralba Quarry due to local topography and intervening vegetation

SECTION SCALE 1:20 000
DETAIL SCALE 1:5 000
(Vertical Exaggeration = 2)
200 0 200 400 600 800 1000 m

Figure 5.22
VISIBILITY SECTIONS

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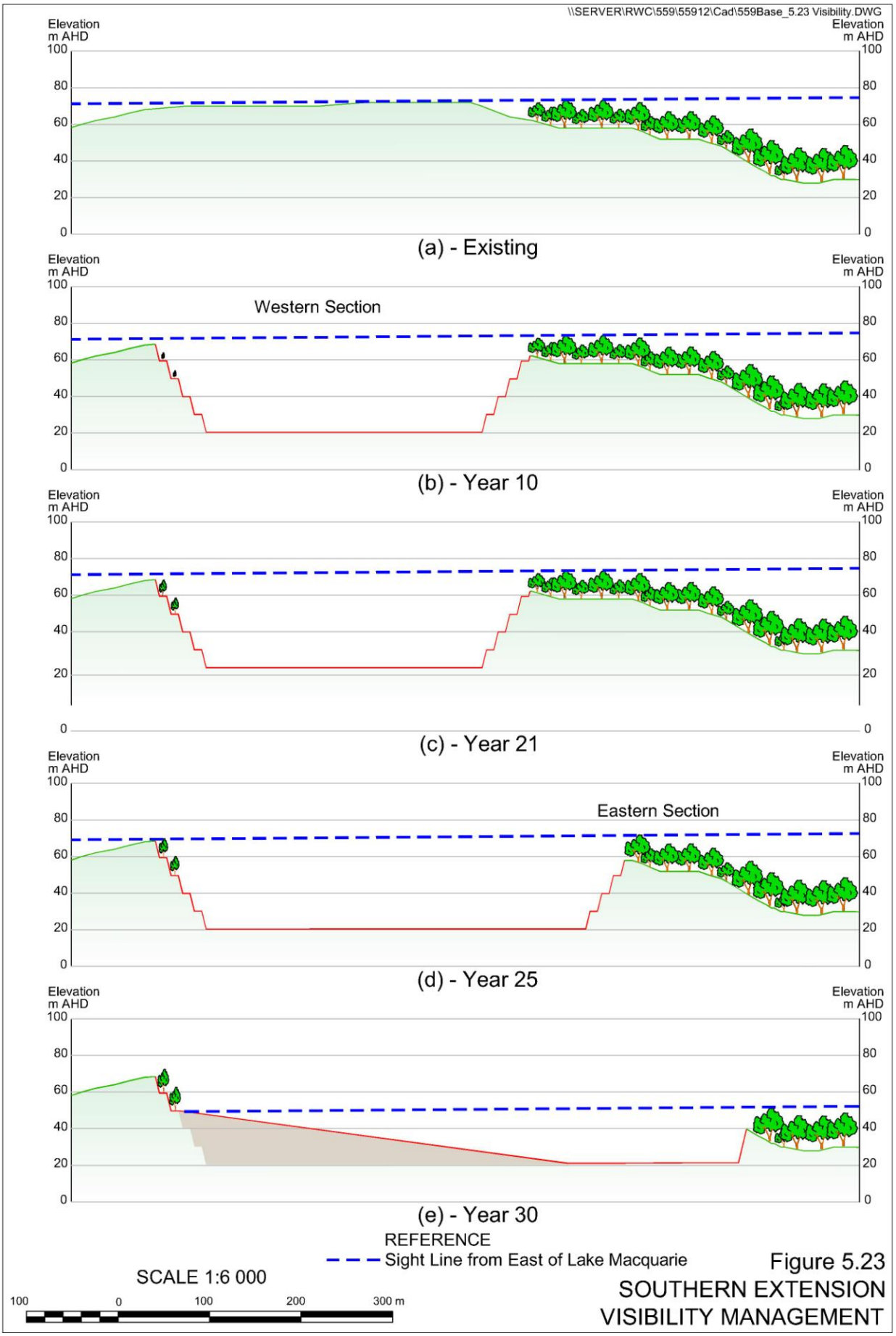


Figure 5.23
SOUTHERN EXTENSION
VISIBILITY MANAGEMENT

- Extraction would only recommence in the eastern part of the Southern Extension after vegetation is well established on the western quarry benches above 50m AHD (anticipated to be Year 22). Extraction activities would be undertaken in the eastern section with the extraction operations advancing in small strips parallel to the north-south faces. The earthmoving equipment operating on the surface would not to be visible and it would be shielded behind the nearby remnant downslope vegetation (**Figure 5.23d**).
- From about Year 25, the elevation of the eastern section of the Southern Extension is reduced, the previously shielded benches and extraction faces on the western and southwestern side of the Southern Extraction Area would progressively become visible, albeit with limited impact as the benches would incorporate vegetation at least 10 years old (**Figure 5.23e**).

Other visual controls and management measures would include the following.

- Vegetation removal would only occur to the eastern boundary of the Southern Extension. Existing remnant native vegetation up to 18m high would remain along its eastern side, thus affording visual screening of the lower extraction faces to the west**.**
- The overall site would be kept clean and tidy at all times.

5.8.5 Assessment of Residual Impacts

Visual impacts of extraction operations in the Northern Extension would be minimised and maintained at an acceptable level throughout the operational life of the extraction activities principally through the design of the extraction area and the retention of the tree canopy on the top of the north-south ridge (north of Rhondda Road) and the eastern slopes of the proposed Southern Extension.

The planned staged extraction in the western section of the Southern Extension would not be visible until about Year 22 when extraction resumes within the eastern section of the Southern Extension. Beyond about Year 25, the western faces of the Southern Extension above approximately 50m AHD would gradually become visible, however, the overall reduction in elevation would have minimal impact as there would be no change in the skyline when viewed from the east as the vegetated north-south ridge to the west of the southern extension (following the alignment of the private coal haul road). Furthermore, the advanced revegetation of the western and southwestern benches would substantially minimise views of the completed extraction faces. In reality, it would be difficult to discern the difference in vegetation at distances of at least 3km, i.e. from the eastern side of Lake Macquarie. The assessment of impacts of the activities within the proposed southern extension and the effectiveness of the proposed controls would be equally applicable for views from the western side of Teralba near Myrtle Street as those on the eastern side of Lake Macquarie. In fact, the impacts upon views from Myrtle Street would be more limited given that area is topographically lower than the elevated areas east of Lake Macquarie, albeit they are considerably closer.

The opportunity would still exist for motorists driving along or pedestrians walking adjacent to Rhondda Road to the occasional obscured glimpses of operational areas both north and south of Rhondda Road.

In summary, with the implementation of the proposed visual controls and management and the long term staging of the extraction in the Proposed Southern Extension, impacts to the visual amenity from local and distant locations and vantage points would be acceptable.

5.8.6 Monitoring

Metromix would observe the status of revegetation on the western benches of the Southern Extension to ensure that revegetation is sufficiently advanced by Year 22. Annual photographic records from Locations A^1, B^1 and C^1 would be presented in each AEMR beyond Year 22 (or when the benches above 50m AHD become exposed to the east).

5.9 SOILS, LAND CAPABILITY AND AGRICULTURAL SUSTAINABILITY

A Soils Assessment has been completed by GSS Environmental hereafter referred to as GSSE (2011). The full assessment is presented in Volume 2, Part 9 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following sub-sections.

5.9.1 Introduction

Based on the risk assessment undertaken by R.W. Corkery and Co Pty Limited for the Project (see Section 3.5, **Table 3.7**), specific soils-related impacts that may result as a consequence of the Project and their unmitigated risk rating include the following.

- Insufficient soil quantities for rehabilitation (extreme risk).
- Temporary disturbance to soil quality (extreme risk).
- Degradation of soil quality (extreme risk).
- Elevated erosion or erosion potential (high risk).
- Erosion of rehabilitated areas and/or final landform (high risk).
- Decreased land and agricultural capability of the final landform (high risk).

In addition, the DGRs issued by the former Department of Planning, request that the *Environmental Assessment* include an assessment of "soil and water". As part of this assessment, OEH requires the *Environmental Assessment* to include:

- an assessment to determine whether contaminated soils are likely to be disturbed during the proposed works; and
- an assessment of contingency strategies containing measures that would be implemented to avoid, minimise and mitigate any potential impacts of the Project.

The following sub section describes the soils within the Project Site that would be disturbed, identifies the soil and land management issues associated with the Project and the appropriate mitigation measures. The potential impacts of the Project on soils, particularly for use in land rehabilitation, have also been assessed.

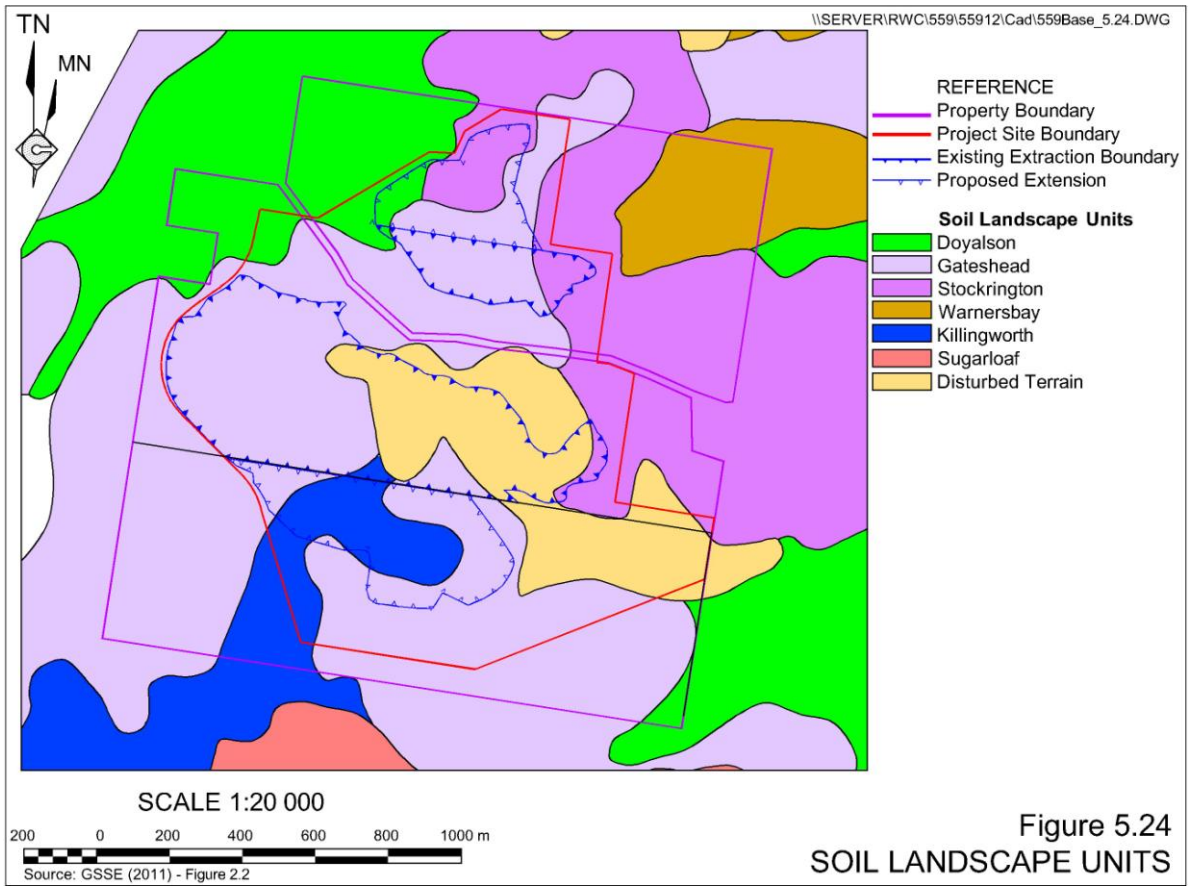
5.9.2 Soils

5.9.2.1 Local Setting and Soil Landscape Units

The soil landscapes within the Project Site have been mapped by the Land & Water Conservation incorporating the Soil Conservation Service of NSW at the scale of 1:100 000 by Murphy (1993) and Matthei (1995). The soil landscape units as described by these publications are "areas of land that have recognisable and specific topographies and soils that can be presented on maps and described by concise statements". The soil landscape units that occur within the Project Site are as follows.

- The Gateshead unit, the most common, is present in the Project Site's north, west and south.
- The Stockrington variant unit occurs to the Project Site's east and northeast.
- The Doyalson unit occurs in a small pocket over the northwest of the Project Site.
- The Killingworth unit occurs as a small strip in the Project Site's south.

The Soil Landscape Units across the Project Site are displayed in **Figure 5.24**. Full descriptions of the Soil Landscape Units are included in GSSE (2011).



5.9.3 Soil Survey

A desktop study and field survey were undertaken for the proposed extension areas for the purpose of identifying the soil types across the Project Site. This process involved three stages.

1. Reference Mapping – An initial soil map (reference map) was developed using aerial photographs and topographic maps, reference information, previous reports and stratified observations.

2. Field Survey – The field survey undertaken was an integrated survey and was a qualitative survey type. The soil and land capability field survey covered the undisturbed areas within the Project Site which covers approximately of 87ha and is referred to by GSSE (2011) as the "study area". The actual observation density utilised for the study area totalled three detailed profile descriptions, three laboratory assessments and ten minor class observations. This exceeds and satisfies the observation requirements for a 1:25 000 survey scale. **Figure 5.25** illustrates the distribution of these soil sampling and survey observations throughout the Project Site.

3. Soil Laboratory Assessment – Soil samples from the three soil profile sites were utilised in the laboratory testing program. In total, 10 soil samples were sent to the Department of Lands Scone Research Centre for analysis. The selected physical and chemical laboratory analysis parameters and their relevant application are listed in Table 3.2 of GSSE (2011).

Within the study area three soil types and one variant were identified. **Figure 5.25** illustrates their distribution across the study area. The physical and chemical characteristics of the soil types are listed in Tables 3.5 to 3.7 of GSSE (2011) with a brief description of each provided as follows.

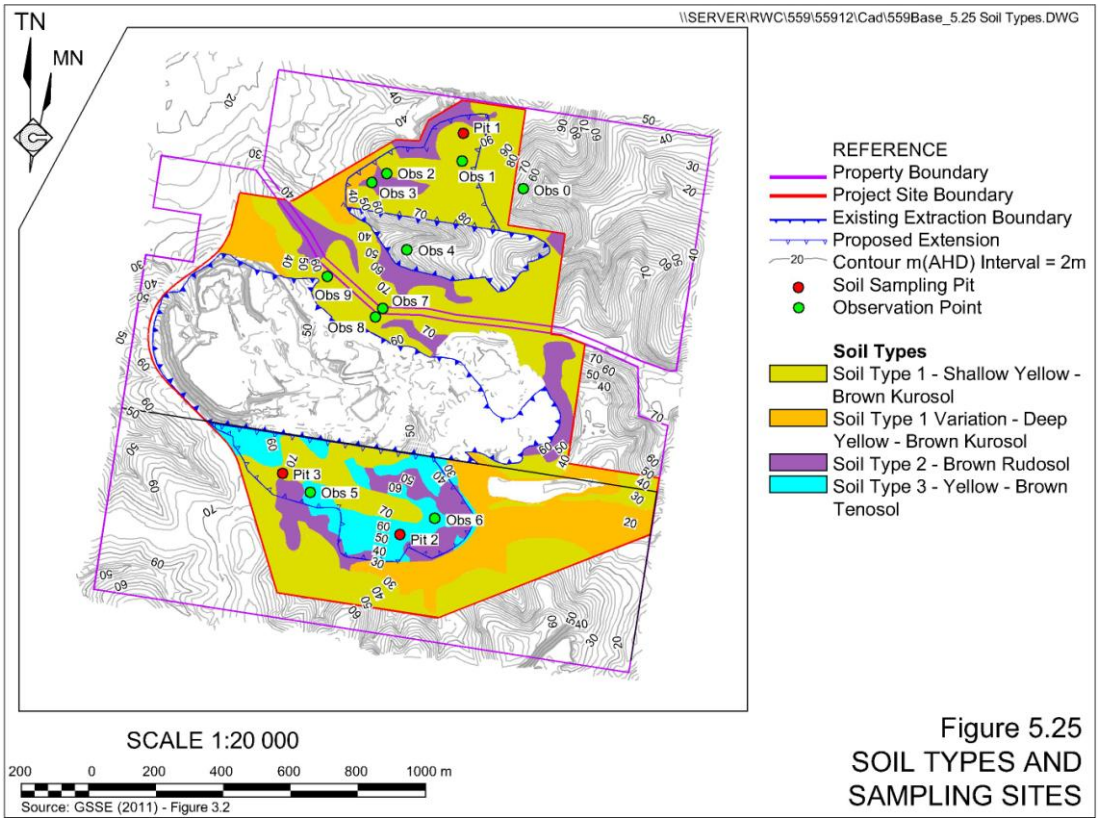


Figure 5.25
SOIL TYPES AND SAMPLING SITES

Soil Type 1: Yellow-Brown Kurosols (shallow)

Soil Type 1 is a Yellow-Brown Kurosol characterised by a clear or abrupt textural B horizon in which the major part of the upper 0.2m of the B2 horizon is strongly acidic. The topsoil has a drainage characteristic of moderate to rapid, while the subsoil drainage is very slow.

These soils cover 55% (48.3ha) of the study area and are associated with moderately inclined slopes as well as level benches and crests. This soil type occurs throughout the study area and is the dominant soil type in the proposed Northern Extension.

The top 0.5m of soil is suitable for stripping and re-use as a topdressing in rehabilitation. The lower layers are generally unsuitable due to heavy clay content and prohibitive stone content. This soil requires significant amelioration prior to its use to increase soil aggregate stability and lime increase soil pH.

Soil Type 1 Variation: Yellow-Brown Kurosols (deep)

A variation of the Yellow-Brown Kurosols (Soil Type 1) occurs within the study area. This variant termed Soil Type 1-Var occurs where a greater amount of topsoil can accumulate, predominately on the lower slopes. The soil is comprised of a higher level of deposited material leading to a deeper soil profile, higher fertility characteristics as compared to Soil Type 1.

This unit covers 16.6ha, is present throughout much of the study area. It forms only a minor portion of the western edge of the proposed Northern Extension and is absent from the proposed Southern Extension. It occurs on slopes that are very gently inclined to moderately inclined (0-18%; 0-10^{o}).

The top 0.7m of soil is suitable for stripping and reuse as a topdressing in rehabilitation. The lower layers are generally unsuitable due to heavy clay content and high acidity. This soil requires some amelioration prior to its use to increase soil aggregate stability and liming to raise soil pH.

Soil Type 2: Brown Rudosols

Soil Type 2 is a Brown Rudosol. This soil type is a shallow soil showing minimal profile development and is dominated by the presence of weathering rock and rock fragments. This skeletal soil is discontinuous throughout the study area and rock outcrops are a common feature. Fertility is generally low due to strong acidity and the absence of organic matter and shallow topsoil.

These soils cover 14.2ha of the study area and occur on steep to very steep slopes, where natural erosion is sufficiently rapid to ensure that only a thin cover of soil is maintained. This soil type occurs in both the proposed Southern and Northern Extensions to a limited extent.

The soil is not suitable for stripping due to its weak textural structure, shallow topsoil and high presence of rock outcrops.

Soil Type 3: Yellow-Brown Tenosol

Soil Type 3 is a Yellow-Brown Tenosol. This soil type shows greater soil profile development than Rudosols, but less development than Kurosols. The soil is weakly structured dark brown silty loam overlying a brown loam overlie a lower horizon dominated by gravels with strong saprolite presence. The soil profile topsoil is slightly dispersive, with the subsoil being moderately to highly dispersive The exchangeable sodium percent was also measured, however, due to the topsoil's very low clay content and associated low cation exchange capacity content, this is not relevant indicator for soil aggregate stability.

Fertility is minimal throughout the poorly developed profile. This soil type has a consistent drainage characteristic of moderate to rapid throughout the profile.

These soils cover 8.5ha of the study area and are found on the mid to lower slopes with moderate to steep slopes. They occur in the southern sections of the study area and extensively within the proposed Southern Extension. This soil type does not occur in the proposed Northern Extension.

The top 0.3m of soil is suitable for stripping and re-use as topdressing material in rehabilitation. This soil is constrained by poor structure, prohibitive subsoil stone content, and high acidity. This soil requires some amelioration prior to its use to increase soil aggregate stability and liming to increase its pH.

5.9.4 Land Capability

5.9.4.1 Introduction

The aim of the land capability classification system is to delineate the various classes of rural lands on the basis of their capability to remain stable under particular land uses. This system classifies the land in terms of its inherent physical characteristics or physical constraints and denotes measures needed to protect the land from soil erosion and other forms of land degradation.

5.9.4.2 Pre – Mining Land Capability Results

The study area is dominated by Land Capability Class VI land with a minor coverage of Class VII land. The distribution of these classes across the study area is displayed on Figure 4.1 in GSSE (2011).

Class VI Land

Class VI land consists of Soil Types 1 (Shallow Yellow–Brown Kurosol), 1-Var (Deep Yellow-Brown Kurosol), and 3 (Yellow-Brown Tenosol). This classification indicates that this land should not be cultivated for cropping or for establishing pasture grasses, however, the land can be used for grazing if careful management and stocking practices are implemented.

The primary constraint of Soil Type 1 is its associated moderately inclined slopes, clayey sub soils, strongly acidic profile and high stone presence. Soil Type 1-Var is constrained by its weak topsoil texture, heavy subsoil clay content and impeded soil profile drainage. Soil Type 3 is constrained by a high stone presence, and is strongly to very strongly acidic.

Class VII Land

Class VII land consists of Soil Type 2 (Brown Rudosol). This classification indicates that this land is not suitable for cropping or grazing due to severe limitations and is land best protected by green timber. Soil Type 2 is constrained by steep slopes, a shallow/skeletal soil and abundant rocky outcrop exposures.

5.9.5 Agricultural Suitability

The agricultural suitability system consists of five classes, providing a ranking of rural lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for crop growth within certain limits. Class 1 ranks the land as most suitable for agricultural activities and Class 5 the least suitable. Classes 1 to 3 are generally considered suitable for a wide variety of agricultural production, whereas, Classes 4 and 5 are unsuitable for cropping however are suitable for some grazing activities.

The study area is dominated by Agriculture Suitability Class 4 land with a minor coverage of Class 5 land. The distribution of these classes across the study area is displayed on Figure 4.2 in GSSE (2011).

5.9.6 Soil Contamination

Since the commencement of the involvement of the current Manager Quarries at Teralba Quarry in 1993 and on the advice of Metromix's botanist from that period, Dr Anne Clements, Metromix has not accepted any soil from external sources. In the Quarry Manager's opinion, it is very unlikely that contamination of soils has occurred on the Project Site.

5.9.7 Environmental Controls and Management

5.9.7.1 Topsoil Stripping Methodology

Identification of soil suitable for later use in rehabilitation was conducted by GSSE in accordance with Elliott & Veness (1981). **Table 5.26** summarises the recommended stripping depths by soil type.

Table 5.26
Stripping Depth for each Soil Type

Soil Type	ASC	Average Recommended Soil Stripping Depth (m)		Main Limitations
#	Name	Topsoil	Subsoil	
1	Shallow Yellow – Brown Kurosol	0.5	Nil	Moderate to strongly acidic soil.
1-Var	Deep Yellow – Brown Kurosol	0.7	Nil	Weak topsoil structure and clayey subsoil texture.
2	Brown Rudosol	Nil	Nil	Shallow topsoil overlying bedrock. Not suitable for stripping due to weak textural structure, shallow topsoil and prevalence of rock outcrops.
3	Yellow – Brown Tenosol	0. 3	Nil	Weak topsoil structure. High presence of stones in subsoil. Very strongly acidic subsoil.
Source: GSSE (2011) – Table 5.2				

5.9.7.2 Topdressing Volumes

Table 5.27 lists the volumes of the topsoil that would be recoverable from the proposed extraction areas based upon the recommended stripping depths of each soil type. The estimated total volume available for reuse from the study area is 88 380m^3.

Table 5.27
Topsoil Volumes

Disturbance Area	Soil Type #	Average Recommended Soil Stripping Depth (m)	Area (ha)	Total Volume (m^3)	Storage Area Required (m^2)
Proposed Northern Extension	1	0.5	6.9	34 500	17 250
	1-Var	0.7	0.5	3 500	1 750
	2	Nil	1.9	0	0
	3	0.3	0	0	0
Subtotal			9.3	38 000	19 000
Proposed Southern Extension	1	0.5	5.5	27 500	13 750
	1-Var	0.7	0	0	0
	2	Nil	3.6	0	0
	3	0.3	7.4	22 200	11 250
Subtotal			16.7	49 700	25 000
Rhondda Road Corridor	1	0.5	2.1	10 500	5 250
	1-Var	0.7	0	0	0
	2	Nil	0.6	0	0
	3	0.3	0	0	0
Subtotal			2.7	10 500	5 250
Total			28.5	98 200	49 250
Total Volume with 10% handling loss (approx.)				88 380	44 300
Source: GSSE (2011) – Modified after Table 5.3					

5.9.7.3 Soil Management

5.9.7.3.1 Soil Stripping, Transfer and Stockpiling

Where topsoil stripping transfer and storage is required, the following topsoil handling techniques would be employed to prevent excessive soil deterioration. Those techniques equally apply to subsoil management.

- Strip material to the depths recommended in GSSE (2011) and **Table 5.27**.
- Maintain topsoil in a slightly moist condition during stripping. Avoid stripping material in either an excessively dry or wet condition.
- Place stripped material directly onto reshaped overburden and spread immediately (if quarrying sequences, equipment scheduling and weather conditions permit) to avoid the requirement for stockpiling.
- Employ less aggressive soil handling systems where possible, e.g. grading or pushing soil into windrows with graders or bulldozers for later collection for loading into rear dump trucks by front-end loaders. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.
- Transport soil by overburden trucks so it may be placed directly into storage.
- Leave the surface of soil stockpiles in as coarsely structured a condition as possible. This will promote infiltration and minimise erosion until vegetation is established, as well as prevent anaerobic zones from forming.
- Maintain a maximum topsoil stockpile height of 3m. Clayey soils would be stored in lower stockpiles for shorter periods of time compared to coarser textured sandy soils.
- Seed and fertilise stockpiles as soon as possible where stockpiling is planned (i.e. greater than 12 months).
- Prior to re-spreading stockpiled topsoil onto reshaped overburden (particularly onto designated tree seeding areas), an assessment of weed infestation on stockpiles would be undertaken to determine if individual stockpiles require herbicide application and/or "scalping" of weed species prior to topsoil spreading.
- Maintain an inventory of available soil to ensure adequate topsoil materials are available for planned rehabilitation activities.
- Spread topsoil to a minimum depth range of 0.1m (steep slopes) to 0.2m (flatter areas). Specific topsoil respreading depths for different post mining landform elements would be specified in a Landscape Management Plan to be prepared following the receipt of project approval.

5.9.7.3.2 Topsoil Re-spreading and Revegetation

Where practical, suitable topsoil would be re-spread directly onto reshaped areas of the final landform. Where topsoil resources allow, topsoil would be spread to a nominal depth of 100mm on all re-graded overburden/substrate. Topsoil would be spread, treated with fertiliser (if required) and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion.

The surface of the placed topsoil would be lightly contour ripped (after topsoil spreading) to create a "key" between the soil and the underlying overburden/substrate. Ripping would be undertaken parallel to the contour when the soil is moist and immediately prior to sowing. The respread topsoil surface would be scarified prior to, or during seeding to reduce run-off and increase infiltration.

5.9.8 Assessment of Impacts

5.9.8.1 Soils

The management procedures for the topsoil and subsoil resource as set out in Section 5.9.7 have been designed to ensure their proper handling and re-use and to provide the maximum opportunity for the successful rehabilitation of the Project Site. These practices have been developed based on the operating experience gained to date on the Project Site, which have been shown to be successful (see **Plates 1.5** and **1.6**). As such, the impact associated with topsoil/subsoil removal, storage and re-use is anticipated to be minimal. A review of soil management practices would documented within each of the Annual Environmental Management Report (AEMR) and variations to the described controls implemented, as appropriate.

Considering the immediate transfer of topsoil and other soil management controls to be implemented, it is assessed that the impact on the soil resources would be moderate and temporary.

5.9.8.2 Post – Project Land Capability Results

The post-project land capability of the proposed Southern and Northern Extensions would be Class VI. The post-project landform would typically incorporate slopes of 0-18% (0-10^{o}) which could sustain light grazing. However, Metromix proposes that the bulk of the final landform would be incorporated into a revegetated landform to be conserved.

5.9.8.3 Post – Mining Land Agricultural Suitability

The post-mining agricultural capability of the proposed Southern and Northern Extensions would be Class 4. The post-quarrying landform would typically incorporate slopes of 0-18% (0-10^{o}) which would sustain light grazing. As noted in Section 5.9.8.2, however, the proposed final land use would be predominantly native vegetation conservation.

5.10 ABORIGINAL HERITAGE

An Aboriginal heritage assessment has been completed by Archaeological Surveys & Reports Pty Ltd (AS&R, 2011). The full assessment is presented in Volume 2, Part 8 of the Specialist Consultant Studies Compendium. Relevant information from the assessment if summarised in the following sub-sections.

5.10.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.5 and **Table 3.7**), the potential impacts upon Aboriginal heritage requiring assessment and their **unmitigated** risk ratings are as follows.

- Impact on identified sites and/or artefacts of Aboriginal cultural heritage as a result of the proposed activity and with the permission of Aboriginal stakeholders or OEH (moderate).
- Impact on unidentified sites and/or artefacts of Aboriginal cultural heritage as a result of the proposed activity and with the permission of Aboriginal stakeholders or OEH (low).

In addition, the DGRs issued by the former Department of Planning and requirements issued by the former Department of Environment, Climate Change and Water, require that the *Environmental Assessment* include an assessment of "Aboriginal heritage". The assessment is required to include:

- An Aboriginal heritage assessment that includes:
  - the identification and extent of impacts on Aboriginal cultural heritage values with appropriate mitigation strategies;
  - an assessment of any sites documented as having Aboriginal heritage significance and values;
  - an assessment of the proposed impacts on Aboriginal cultural heritage values and cumulative impacts in the context of 'inter-generational equity'; and
- The inclusion of surveys and community consultation documents conducted by qualified archaeological consultants.

The following sub-sections present the objectives of the assessment, methodology employed, a review of results from the heritage surveys undertaken, the proposed management of Aboriginal cultural heritage and an assessment of the significance of any impacts.

5.10.2 Method of Investigation

5.10.2.1 Aboriginal Consultation

Consultation with the Aboriginal community of the local area commenced in 2003 (in conjunction with the preparation of an earlier Environmental Impact Statement for the Teralba Quarry [which was not finalised]) and continued in 2009. Section 2 of AS&R (2011) (Part 8 of the *Specialist Consultant Studies Compendium* provides descriptions of the key consultation undertaken in 2003 and 2009. In 2010, Metromix again requested AS&R to consult with the local Aboriginal community. The following provides a summary of this most recent consultation completed in compliance with the requirements of "Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010" (DECC, 2010). On 8 November 2010, letters were sent to each of the following organisations requesting that they provide a list of registered Aboriginal stakeholders with an interest in the area.

- NSW Native Title Services.
- Lake Macquarie City Council.
- DECCW: Hurstville.
- Office of the Registrar, ALRA.

Advertisements were concurrently placed in the *Newcastle Post* and the *Newcastle Star* (10 November 2010) inviting Aboriginal stakeholders to register their interest in the Project.

As a consequence of the advertisements and the letters to government agencies, the following stakeholders were identified.

- Awabakaba-Ngariliko A& TS Men's Corporation.
- Westlake Aboriginal Elders Inc.
- Awabakal Local Aboriginal Land Council.
- Cacatua Culture Consultants.
- Arwarbukarl Culture Resource Association.
- Koompahtoo Local Aboriginal Land Council.
- Awabakal Traditional Owners Aboriginal Corporation.
- Awabakal Newcastle Aboriginal Co-op.
- Awabakal Descendants Traditional Owners Aboriginal Corporation.

Three of the nine stakeholders expressed their interest in visiting the Project Site and on 10 March 2011 the following personnel participated in a field survey as representatives of the following stakeholder groups.

- Paul McBride - Westlake Aboriginal Elders Inc.
- Charmaine Talbot - Westlake Aboriginal Elders Inc.
- Xander Beale - Awabakaba-Ngariliko Mens Corporation.

- Robert Donovan - Awabakaba-Ngariliko Mens Corporation.
- Deidre Perkins - Cacatua Culture Consultants.

Following the completion of the field survey, a draft Aboriginal Heritage Assessment Report was prepared summarising the results of the field survey (see Section 5.10.2.4) and proposed management measures to be implemented (see Section 5.10.6) was prepared and sent to each of the nine registered Aboriginal stakeholders (on 21 April) requesting feedback on the description of field survey results and the proposed management of Aboriginal heritage on the Project Site. No responses were received within the DECC (2010) nominated 21-day response period, however, two responses were received on later dates, one from Awabakal Descendants Traditional Owners Aboriginal Corporation and one from Awabakal Traditional Owners Aboriginal Corporation. AS&R (2011) includes a detailed response to the issues raised by these two stakeholders.

5.10.2.2 Background Research

The Aboriginal Sites Register (Aboriginal Heritage Information Management System – AHIMS) was searched on 29 September 2003 for all sites within a 10km^2 area centred on the Project Site. A second search of the Site Register was made on 8 April 2010, however, because of the restrictions now placed on how large a search area can be, the search was restricted to Lot 2, DP 224037.

5.10.2.3 Development of a Predictive Model and Field Survey

Site Types and their Location

In order to design an investigative strategy, it is firstly necessary to develop a predictive model for the site location. This is not to determine where the investigation should be conducted, but to establish a theoretical model for the distribution of archaeological material against which the effectiveness and subsequent analysis of the survey results can be tested, compared and reasoned. The basis upon which the predictive model is derived must, however, be one of consideration of that archaeological which material might realistically be expected to not only be present, but also detectable.

Based on a detailed investigation into sites and their locations, the following model for site distribution was proposed by AS&R (2011) for the Project Site.

- Isolated artefacts may be present and visible in erosion features.
- Low-density artefact scatters may be present and visible in erosion features, but it is unlikely that any debitage would be visible.
- If there are surviving trees of 150 years old or more there is a potential for them to exhibit scarred surfaces, although it is unlikely that any such tree has survived.
- If there are surviving trees of 150 years old or more there is a potential for them to exhibit carved surfaces, although it is unlikely that any such tree has survived.
- There would be no stone quarries.
- In the absence of any shelters there would be no art sites.

- In the absence of any exposed sandstone there would be no engravings, or grinding grooves within the Project Area.
- There would be no shell middens.
- There would be no intact occupation deposits.
- There would be no visible evidence of burials.
- There would be no surviving Bora rings.
- There would be no surviving stone arrangements.
- There is always the potential for Potential Archaeological Deposits (PADs) to exist.

Within the Project Site, no shelters overhangs, no exposed rock surfaces suitable either for grinding axes or for engraving, and no known cultural associations were observed. However, there are abundant sources of stone suitable for knapping tools and implements, and a drainage system that might have retained water for a week or two after heavy rain.

5.10.2.4 Field Surveys

Field surveys of the Project Site (or parts thereof) have been completed on three occasions since 2003. The following provides a brief summary of the field survey undertaken on each occasion.

- **October 2003 –** An investigation of an area to the south of the existing Southern Extraction Area was undertaken by AS&R. The investigation was performed with the assistance of Mr Kenneth J. McBride, Sites Officer, Koompahtoo Local Aboriginal Land Council (LALC).
- **February 2008 –** An investigation was performed over the proposed Southern and Northern Extensions with the assistance of Miss Ashley Hudson, Aboriginal Cultural and Heritage Officer, Koompahtoo LALC.
- **October 2010** – Metromix determined that an additional area to those previously investigated was required for a power-line easement to the north of the Northern Extension.

The survey strategy involved walking tracks and roads, and targeting soil exposures and erosion features, drainage lines, and any tree that appeared to be old growth. During the 2003 and 2008 surveys, dense grass cover and a deep leaf litter limited the effective survey coverage to the ridge tops and crests where there were cleared vehicle tracks and ground exposures, and patchy ground exposures in the existing power-line easement.

With the recent clearing of newly erected fence lines and their access tracks, there were additional cleared strips to investigate during the October 2010 survey providing ideal linear ground exposures across a number of land units. This provided cleared transect sampling strips to investigate various environments, in addition to the vehicle tracks along the ridges and ground exposures in the existing power-line easement.

Figure 5.26 displays the 2011 survey coverage based on the assumption that most artefactual material if exposed and visible can be observed for up to 10m to either side of the path of the observer. Clearly this would vary significantly between a path walked through dense vegetation, and a path across a claypan, and is given as a guide only. Effective coverage is discussed in detail in Section 6.5 of AS&R (2011).

During all three surveys, a dense grass cover in most areas was observed but there was sufficient ground surface exposure on tracks, other erosion features, and in environments in which artefactual material was most likely to be present for an effective sampling of the survey area. In addition to the more obvious ground surface exposures, some areas contained minor erosion features, which provided samples of those environments less likely to contain artefactual material. Access to all old growth trees was available, and so the survey in respect of identifying scarred or carved trees was highly effective. Recently cleared fence-line transects in 2011 provided 5m wide (totally cleared) sampling transects through a variety of environments, thereby providing excellent archaeological visibility.

The survey technique was the most appropriate one to use in the circumstances, and the results are believed to be representative of the archaeological record in the survey area. It is noted, however, that although the entire Project Site was surveyed, the groundcover was a constraint to the effectiveness of the survey.

5.10.3 Results

5.10.3.1 Results of Aboriginal Sites Register Search

A total of 72 sites have been recorded within the original 10km^2 search area centred on the Project Site. However, only nine of these sites occur within a 4km and 6km area centred on the Project Site.

Four of the nine identified sites are axe-grinding grooves, with the remaining five sites including a rock engraving, an isolated find, an open campsite, a midden, and a natural mythological site. Excluding the midden which occurs near the lake edge, and the natural mythological site for which there is no material evidence, the sites can be summarised as consisting of either marks on rock surfaces or stone artefacts.

The low frequency of sites within the general locality of the Project Site is more likely to reflect the fact that few surveys have been undertaken in the area, rather than a genuine absence of sites.

From the second search of the Site Register on 8 April 2010, no additional sites were found to be listed.

5.10.4 Results of the Project Site Field Survey

No sites of Indigenous origin or Potential Archaeological Deposits (PADs) were observed within the Project Site during the 2011 survey or the previous surveys (AS&R, 2011).

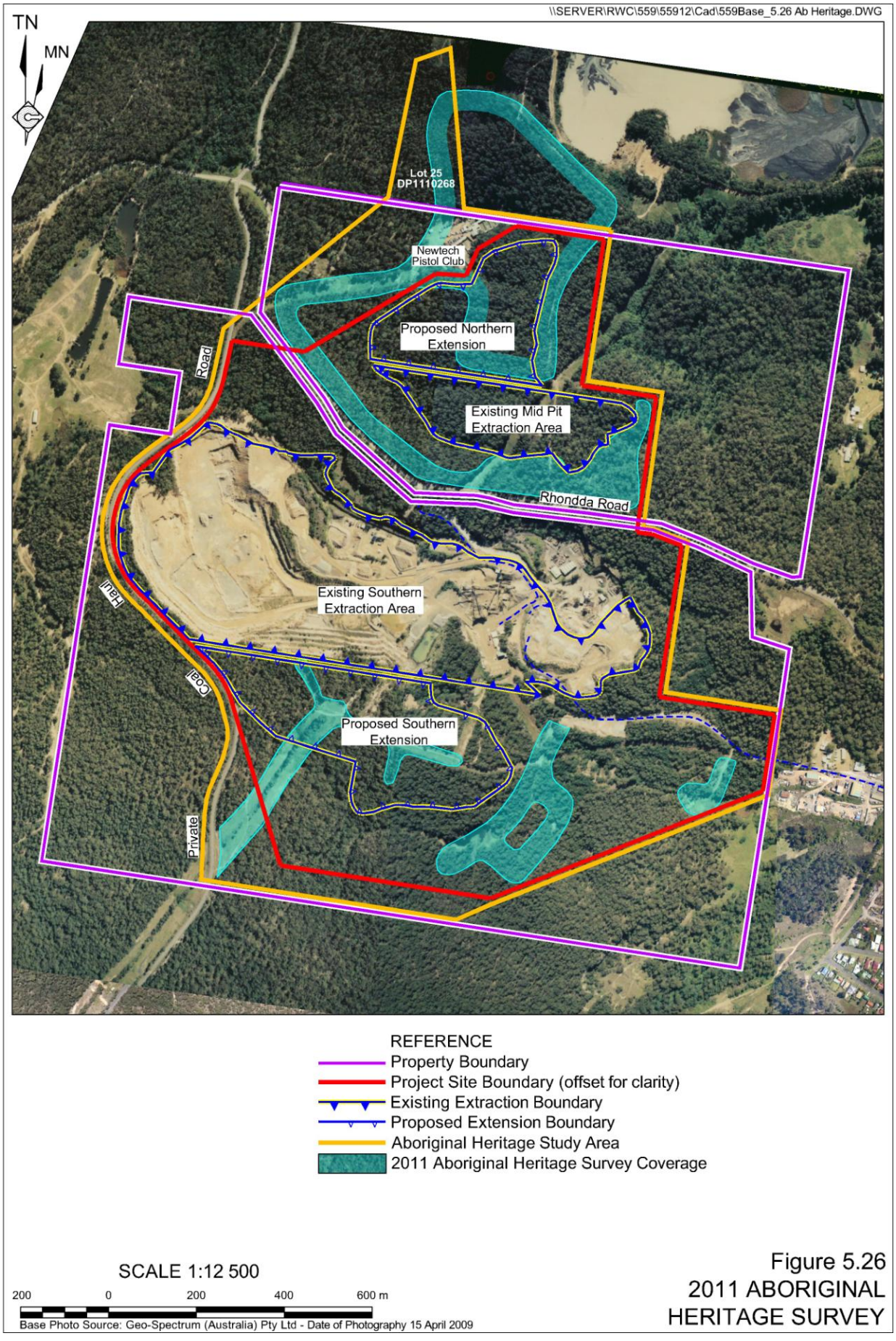


Figure 5.26
2011 ABORIGINAL
HERITAGE SURVEY

5.10.5 Significance Assessment

5.10.5.1 Introduction

The OEH policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of the sites is necessary. This is not only for the purpose of determining whether the Project can proceed, but also to provide Cultural Resource Managers with the information for future management of the area.

5.10.5.2 Cultural Significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the Proponent (or Proponent's archaeologist) to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form. The following provides a summary of advice provided to AS&R following each field survey (2003, 2008, and 2010).

2003 Investigation

In this instance Ken McBride, who had assisted in the survey, reported the results of the investigation and his recommendations to the Koompahtoo LALC by way of a written report. With the approval of the Chairperson Mr McBride provided AS&R with a copy of the report. The recommendations of the Koompahtoo LALC were that there are no cultural constraints to the further development of the Project Site.

2008 Investigation

Following the 2008 survey, Ashley Hudson, Aboriginal Cultural and Heritage Officer, Koompahtoo LALC conferred with the community Elders who agreed that there were no constraints on cultural ground to the proposed quarry extensions.

2010 Investigation

Following the investigation, the participants returned to the quarry site office to discuss the results, and the recommendations they would make on behalf of their stakeholder organisations. All of the Aboriginal representatives concluded that there were no cultural constraints to the proposed quarry extensions.

Copies of relevant correspondence (both to and from the registered Aboriginal parties) are included in AS&R (2011).

5.10.5.3 Research Potential

In the absence of any artefactual material in a depositional context, or of known specific Aboriginal association with the survey area, the research potential of the Project Site is assessed to be low.

5.10.6 Environmental Controls and Management

As a result of the background research, field investigations and consultation with Aboriginal stakeholders, there are considered to be no constraints on either cultural or archaeological grounds to the proposed extensions to Teralba Quarry. However, in line with OEH recommendations, Metromix is committed to the following management measures.

1. Halt all works in the immediate area if Aboriginal cultural objects are uncovered to prevent any further impacts to the object(s). Contact a suitably qualified archaeologist and Aboriginal community representative to determine the significance of the object(s). Register the site in the AHIMS (managed by OEH) and include the management outcome for the site in the information provided to the AHIMS. Consult the Aboriginal community representative(s) in developing and implementing management strategies for all sites, with all information required for informed consent being given to the representatives for this purpose.
2. Halt all works in the immediate area if human remains are located to prevent any further impacts to the remains. The NSW Police, the Aboriginal community and OEH would be notified. If the remains are found to be of Aboriginal origin and the Police consider the site not an investigation site for criminal activities, OEH would be contacted and notified of the situation and works would not resume in the designated area until approval in writing is provided by OEH. In the event that a criminal investigation ensues, works would not to resume in the designated area until approval in writing (*has been received*) from NSW Police and OEH.
3. All reasonable efforts would be made to avoid impact to Aboriginal cultural heritage values at all stages of the development works. If impacts are unavoidable, mitigation measures would be negotiated with the Aboriginal community and OEH.
4. Invite representatives of local Aboriginal stakeholders to monitor initial ground disturbance activities.
5. Develop an Aboriginal Cultural Education Program for the induction of all personnel and contractors involved in the construction activities on site. Records are to be kept of which staff/contractors were inducted and when for the duration of the project. The program would be developed and implemented in collaboration with the local Aboriginal community.

Each of the above measures are included as commitments in **Table 6.1**.

5.10.7 Assessment of Impacts

In the absence of any artefactual material in a depositional context, or of known specific Aboriginal association with the Project Site, the impact of the proposed Southern and Northern Extensions is assessed to be low.

5.11 EUROPEAN HERITAGE

5.11.1 Introduction

The DGRs issued by the former Department of Planning require that the *Environmental Assessment* include an assessment of "Non-Aboriginal heritage".

Based on the risk analysis undertaken for the Project (see Section 3.5 and **Table 3.7**), the potential impacts upon European heritage requiring assessment and their **unmitigated** risk ratings are as follows.

- Impact on identified sites and/or artefacts of Non-Aboriginal cultural heritage as a result of the proposed (high).
- Impact on unidentified sites and/or artefacts of Non-Aboriginal cultural heritage as a result of the proposed activity (high).

An assessment of European heritage was conducted by R.W. Corkery & Co. Pty Limited. The following sub-sections describe the desktop search that was undertaken, identified sites of heritage or historic significance, proposed operational controls and safeguards, and assessment of residual impacts.

5.11.2 Desktop Search of Heritage Listed Items

5.11.2.1 Introduction

A desktop search of the Project Site on the following heritage databases was conducted on 10 June 2011.

- Australian Heritage Council Database (which includes places listed in the World Heritage List, National Heritage List, Commonwealth Heritage list and Register of the National Estate).
- National Trust of Australia.
- Lake Macquarie City Council (DCP No.1 – Revision 06 – Part 4.6 – Teralba Area Plan – Heritage Precinct).

No listed heritage sites were identified within the Project Site, however, the Teralba Heritage Precinct borders the eastern boundary of the Project Site and the Great North Walk on Rhondda Road "through" the Project Site. The underground coal workings associated with the former Northern Extended Colliery are also noted.

5.11.2.2 Teralba Heritage Precinct

Lake Macquarie City Council considers the suburb of Teralba to have considerable social and historical significance as one of the earliest railway and mining settlements in Lake Macquarie. To date, the suburb has retained a distinctive traditional early twentieth century period character, due mainly to the consistency of timber and iron buildings and the cohesive streetscapes they form (LMCC, 2011). However, this is changing as Council is now allowing higher density housing to be developed throughout Teralba.

The original settlement, established in 1886, marked the arrival of both the railway and mining. The railway and its station were dominant physical elements in the landscape, as were the surrounding mines and quarries, however, the NSW Government demolished the Teralba Railway Station in 2010. Teralba is divided by the railway with each side of the suburb having its own distinct historical and aesthetic importance. Although most early cottages have disappeared, later cottages have generally adopted the traditional scale and form.

Despite the loss of many early buildings, the settlement remains one of the notable historic precincts of Lake Macquarie. In particular, the eastern precinct of the suburb continues to feature unified streetscapes characteristic of the early twentieth century.

The close physical proximity of the mines underlies the strong historical relationships between home and workplace. The location of the mines, in turn, was closely related to the siting of the railway station. The boundaries of the Teralba Heritage Precinct include several of these mining-related sites.

In March 2011, Lake Macquarie City Council adopted the Teralba Heritage Precinct in the effort to protect the suburbs history. **Figure 5.27** identifies the limits of the Precinct, within which future development needs to consider the following.

- The sense of social identity resulting from the area's history.
- The physical boundaries of the locality including the bushland setting and separation from adjoining areas.
- Heavy vehicle traffic from the mines and other industries generating noise and other pollutants.
- Development that is compact and in scale with surroundings, including medium density and mixed-use development sensitive to the area's heritage character.
- The proximity of the railway and provision of large lots that is appropriate for higher residential population densities.
- Business growth that is based on unique local character. This needs to complement growing competition from larger town and regional centres.
- Significance of Heritage Items listed in the Lake Macquarie LEP 2004 and properties listed in the *City of Lake Macquarie Heritage Study* (1993).
- Sensitive elements of the local topography and existing streetscapes.

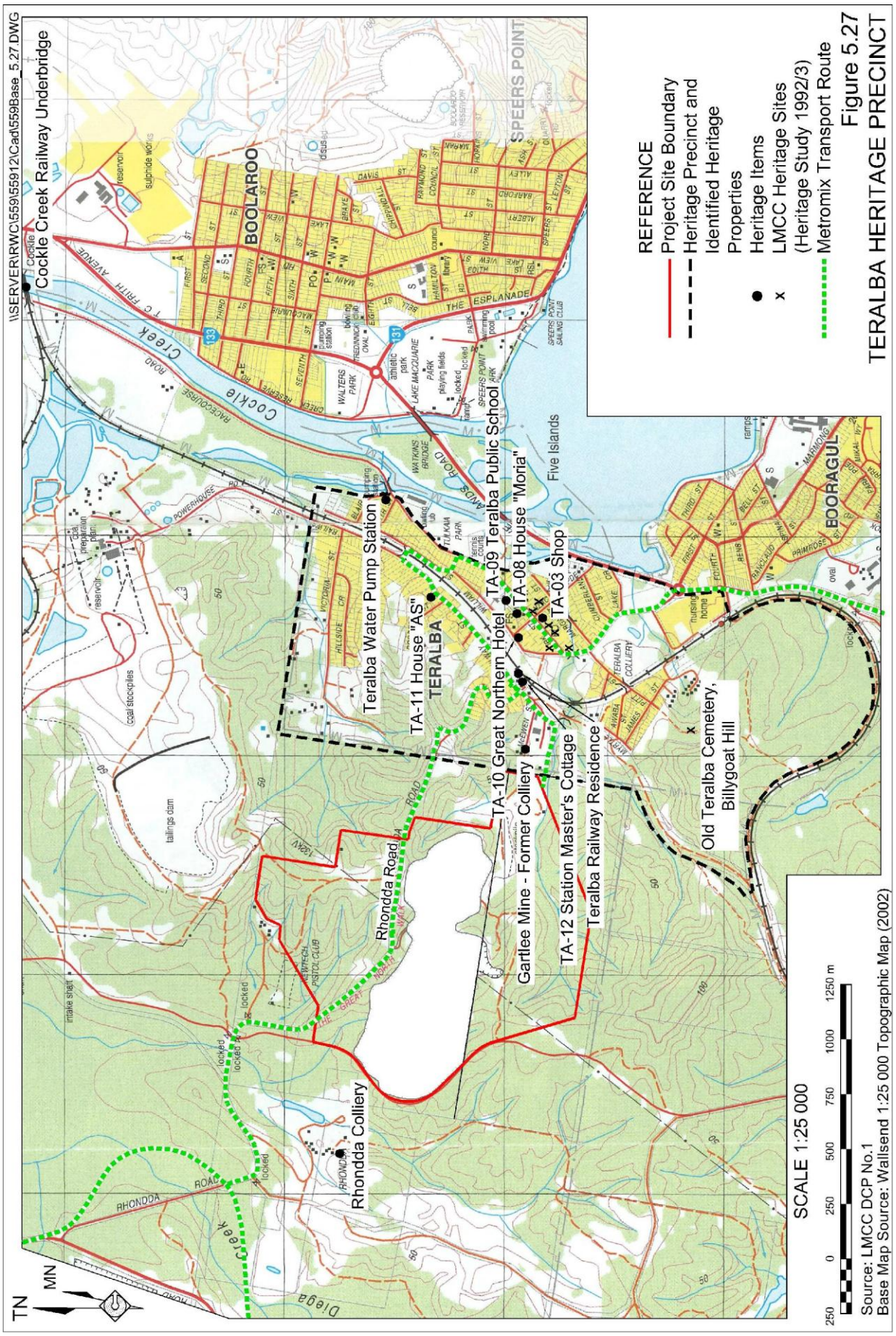

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Figure 5.27
TERALBA HERITAGE PRECINCT
REFERENCE
Project Site Boundary
Heritage Precinct and Identified Heritage Properties
Heritage Items
LMCC Heritage Sites (Heritage Study 1992/3)
Metromix Transport Route
Cockle Creek Railway Underbridge
Teralba Water Pump Station
TA-11 House "AS"
TERALBA
TA-10 Great Northern Hotel
TA-09 Teralba Public School
TA-08 House "Moria"
TA-03 Shop
Gartlee Mine - Former Colliery
TA-12 Station Master's Cottage
Teralba Railway Residence
Old Teralba Cemetery, Billygoat Hill
Rhondda Colliery
Rhondda Road
BOOLAROO
SPEERS POINT
BOORAGUL
Five Islands
SCALE 1:25 000
250 0 250 500 750 1000 1250 m
Source: LMCC DCP No.1
Base Map Source: Wallsend 1:25 000 Topographic Map (2002)
TN
MN

5.11.2.3 State Heritage Inventory

Figure 5.28 also locates the two following heritage items that were identified in a search of the State Heritage Inventory on 19 August 2011 as being within the suburb of Teralba but outside the Teralba Heritage Precinct.

- Rhondda Colliery (490m west of the Project Site).
- Cockle Creek Railway Underbridge (2.6km northwest of the Project Site).

5.11.2.4 The Great North Walk

The Great North Walk is a 250km walking track connecting Sydney and Newcastle. The track was formally established in 1988 as a bicentennial project and is now managed by the Land and Property Management Authority. The 14.8km leg of the track from Heaton Gap to Teralba Station passes through the Awaba State Forest past the Sugarloaf Range, down into Wakefield and along Rhondda Road to Teralba. There is no defined path along Rhondda Road, forcing walkers to walk along the edge of the road although it is understood the nominated track is on the northern side of Rhondda Road.

5.11.2.5 Underground Workings beneath the Project Site

Teralba Quarry is underlain by extensive workings in the former Northern Extended Colliery in the Great Northern and Fassifern Coal Seams, the Fassifern Coal Seam being approximately 7m to 10m below the Great Northern Coal Seam. It is noted that the former underground workings are not recorded to hold any historic significance, however, they have been included in this section in recognition that they contributed to the early development of the suburb of Teralba.

Workings in the Great Northern Coal Seam extend under most of the existing quarry floor (**Figure 2.3**), whilst workings in the Fassifern Seam are confined to below the eastern part of the existing quarry. There are also workings in the Young Wallsend Coal Seam at much greater depth below the quarry. All seams dip down gently from the northwest to the southeast under the existing quarry.

Limited subsidence cracking is observed on the surface typically where the amount of overburden above the Great Northern Coal Seam is <40m.

The Great Northern Coal Seam dips from 24m AHD at the northwestern limit of the quarry to around 19m AHD at the centre of the Southern Extension. The seam appears faulted down approximately 5m across the western dyke located in the western side of the quarry. The state of underground workings varies from fully collapsed to intact first workings. The area above the dykes has not been mined except for one cross cut. The conglomerate roof condition as a consequence ranges from fully subsided to spanning over intact workings. Of particular concern are areas where voids have developed in the conglomerate as a result of partial collapse.

The Fassifern Coal Seam underground workings are confined to the eastern side of the quarry where extraction is almost complete, and consist almost entirely of first workings beneath a strong Awaba Tuff roof that separates the Fassifern coal from the overlying Great Northern coal. The deeper longwall workings in the Young Wallsend Seam have no impact on the existing quarry as subsidence from these workings has ceased.

5.11.3 Environmental Controls and Management

From the desktop investigation, no constraints to the proposed extensions were identified with respect to the recorded European heritage. However, Metromix is committed to adopting all reasonable efforts to avoid impacts to European cultural heritage values of the Teralba Heritage Precinct.

Metromix also proposes to provide a safe and clear route for those walking along The Great North Walk adjacent to its quarry. This would be achieved through construction and maintenance of a defined path on the northern side of Rhondda Road for a distance of 1.2km.

5.11.4 Assessment of Impacts

Metromix recognises that the Project Site borders the western boundary of Teralba Heritage Precinct and that the Rhondda Colliery is located 490m west of the Project Site. While no significant sites of European heritage have been identified within the Project Site, operations would be undertaken with consideration given to the future development guidelines (of the LMCC, 2011). The ongoing product distribution through Teralba would not adversely impact upon the recorded European heritage sites given both noise and vibration levels would satisfy relevant criteria.

The ongoing extraction operations would cause the infilling of the voids in the former Northern Extension Colliery, however, this would not cause any substantial impacts on the European heritage of the Teralba area.

5.12 BUSHFIRE HAZARD

5.12.1 Introduction

Based on the risk assessment undertaken for the Project (see Section 3.5 and **Table 3.7**), specific **unmitigated** bushfire-related impacts that may result as a consequence of the Project include the following.

Initiation of a fire on the Project Site and spread to adjoining properties resulting in:

- injury or health impacts on project personnel (extreme);
- operational constraint posed by damaged equipment (extreme); and/or
- destruction/damage of native vegetation and fauna habitat (high).

The bushfire assessment was prepared by R.W. Corkery & Co. Pty Ltd based, in part, on information provided in Idyll Spaces (2011).

5.12.2 Existing Bushfire Hazard

Figure 5.28 provides the bushfire prone land status of the Project Site and surrounds as taken from the Lake Macquarie Shire Council Bushfire Prone Land Map (2007). Any areas coloured yellow, red or orange on a bushfire prone land map are considered to be bushfire prone.

The mapping indicates that while the existing Southern Extraction Area is not bushfire prone (white) due to the extensive clearing undertaken to date, the majority of the surrounding Project Site is considered to be bushfire prone. This includes large areas of Bushfire Vegetation Category 1 (orange) with small sections of Bushfire Vegetation Category 2 (yellow) and approximate buffer zones (100m for Category 1 and 30m for Category 2). On the basis of this mapping, the specifications and requirements of "Planning for Bushfire Protection 2006" (PBP) by the NSW Rural Fire Service (RFS, 2006) have been considered for the development (with specific attention provided to the consideration of an appropriate Asset Protection Zone (APZ) and construction requirements for the buildings and other structures on the Project Site). Reference is also made to Clause 33 of the Lake Macquarie LEP 2004.

This assessment aims to consider and assess the bushfire hazard and associated potential threats relevant to ongoing operation of the Teralba Quarry, and to outline the proposed mitigation measures which would be adopted from the provisions of the *Environmental Planning and Assessment Amendment (Planning for Bushfire Protection) Regulation 2007* and the *Rural Fires Amendment Regulation 2007 (RF Amendment Regulation, 2007).*

5.12.3 Bushfire Management Objectives

5.12.3.1 Planning for Bushfire Protection 2006

The objectives of RFS (2006) considered in this assessment of the Project are to:

i) afford occupants of any building adequate protection from exposure to a bushfire;

ii) provide for a defendable space to be located around buildings;

iii) provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;

iv) ensure that safe operational access and egress for emergency service personnel and residents is available;

v) provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the asset protection zone (APZ); and

vi) ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bushfire fighting).

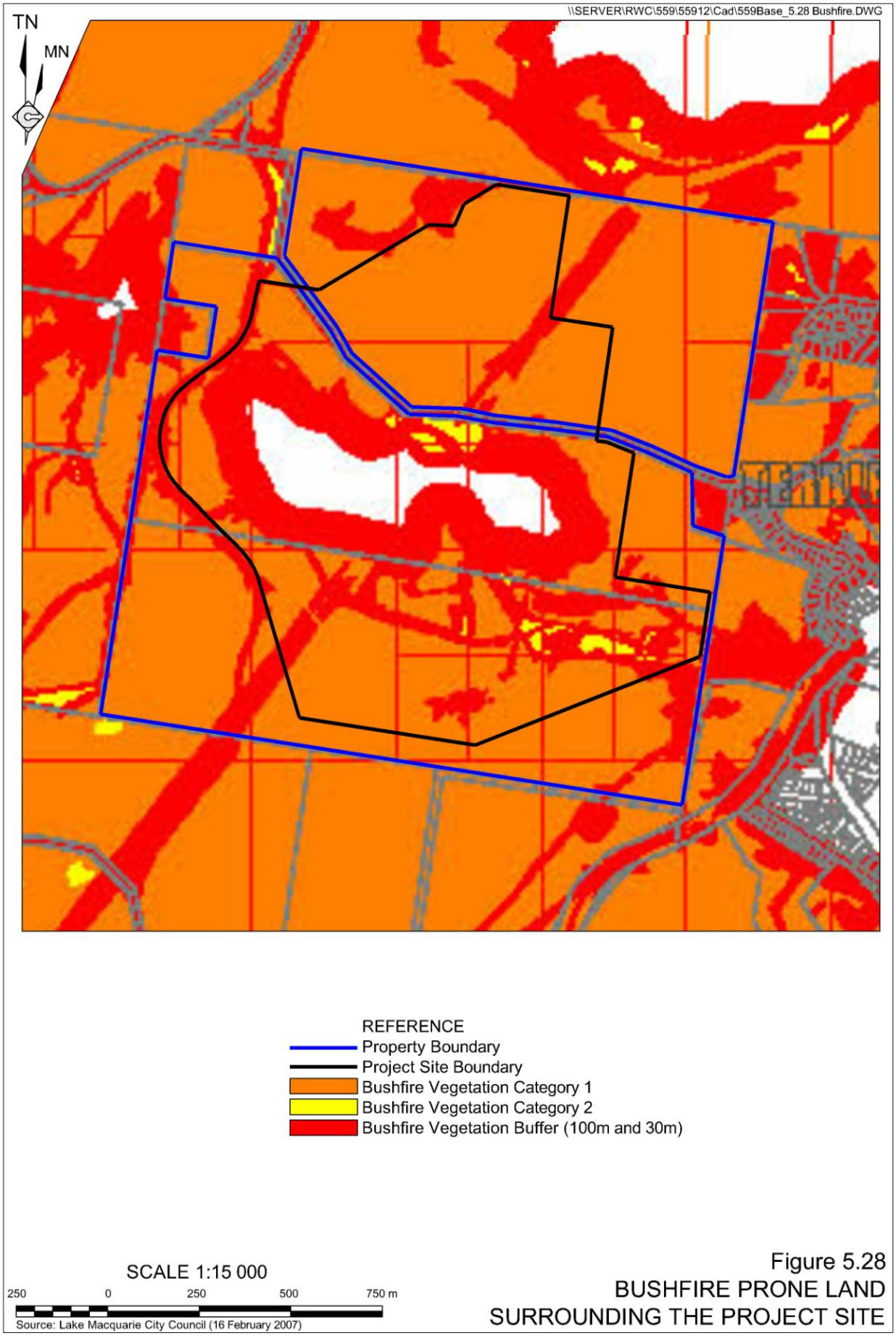


Figure 5.28
BUSHFIRE PRONE LAND
SURROUNDING THE PROJECT SITE

5.12.3.2 Lake Macquarie Local Environment Plan

Clause 33 of the Lake Macquarie LEP 2004 requires the following be considered where land is classified as bushfire prone.

- A person must not carry out bushfire hazard reduction work without development consent unless the person is authorised to carry out the work without consent by or under the *Rural Fires Act 1997 or* another Act.
- The measures proposed to avoid or mitigate the threat from bushfire, including the siting of the proposed development, the design of, and materials used in, any structures involved, the clearing of vegetation, and the provision of asset protection zones, landscaping and fire control aids (such as roads and water supplies), are adequate for the locality.
- As far as possible, the potential impact on the environment of mitigation measures proposed is minimised.

5.12.4 Assessment Methodology

5.12.4.1 Management of an Appropriate Asset Protection Zone

The method for determining an appropriate APZ for the Project Site buildings follows *Section A2.3* of RFS (2006).

a) **Fire Danger Index**. *Table A2.3* of RFS (2006) nominates Lake Macquarie LGA as occurring within the Greater Hunter NSW Fire Area, which has a Fire Danger Index of 100.

b) **Predominant Vegetation Class Formation**. The vegetation in and around the Project Site, to a distance of 140m, has been assessed in accordance with PBP (RFS, 2006). The vegetation in all directions from the Project Site would most accurately be defined as Dry Sclerophyll Forest (Open Forest) (shrub/grass sub formation) class in *Table A2.1* of RFS (2006) and would have a fuel load between 20t/ha than 25t/ha. The vegetation within the landholdings surrounding the Project Site is dominated by the same vegetation formation class as found on the Project Site.

c) **Effective Slope Classification**. The Project Site is characterised by gently inclined to moderately inclined slopes (41% of the Project Site), with some prominent moderately steep to steep ridgelines that have broad level to gently inclined crests. Within 100m of the proposed Southern and Northern Extension boundaries slopes are generally either downslope 10° to 15° (Class iv) or >15° to 18° (Class v).

d) **Minimum Specification for Asset Protection Zone**. Reference to *Table A2.4* of RFS (2006) nominates an APZ of 50m and 60m to effective slopes in Class iv and Class v respectively.

5.12.4.2 Site Bushfire Attack Assessment (Building Construction Requirements)

On the basis of the Fire Danger Index, Vegetation Class and Effective Slope classifications provided in Section 5.12.4.1 (Steps 1 to 4 of the Site Bushfire Attack Site Assessment methodology provided by *Appendix 3* of RFS, 2006), *Table A3.3* of RFS (2006) was reviewed to identify whether any specific construction requirements would be necessary for the Project Site infrastructure.

5.12.5 Operational Safeguards, Controls and Management Measures

Specific bushfire management measures to manage a local bushfire event would be prepared should project approval be granted and would incorporate the following. The approach to these measures would be discussed within both LMCC and RFS to ensure the measures adopted are practical and reflect the Company's experience on site over the past 25 years. Metromix thereby recognises the need for a balance between an effective APZ and the retention of remnant native vegetation around the quarry.

An Asset Protection Zone (APZ) of up to 100m would be maintained around the buildings of the Project Site. As defined by *Appendix 2* of RFS (2006) the APZ would provide for:

- minimal separation for safe fire fighting (access to fire front);
- reduced radiant heat;
- reduced influence of convection driven winds;
- reduced ember viability thereby limiting the impact of ember attack; and
- dispersal of smoke which would otherwise severely impact on residents affected by reduced mobility or health issues.

Fuel loads within the APZ would be monitored and reduced as required, i.e. no re-growth of shrub or tree vegetation would be allowed, grass growth would be monitored and cut back as necessary. Specialist advice would be sought, either from the NSW RFS or LMCC in relation to appropriate fuel load management within the APZ and elsewhere within the Project Site.

Access roads would be regularly maintained to ensure safe access and egress from the Project Site in the event an evacuation is called.

Water infrastructure would be accessible for management of ember attack on the buildings within the Project Site.

Training would be provided to site personnel in relation to specific fire fighting tasks and procedures.

- The existing Emergency and Evacuation Management Procedures relating to bushfires would be regularly reviewed.
- In the event of a local bushfire event, all personnel would be required to assemble at the designated Emergency Assembly Area. A head count would be undertaken to confirm all site personnel and visitors are accounted for. At this time, instructions as to specific procedures to be followed, i.e. site protection or evacuation, would be provided in accordance with the Emergency and Evacuation Management Procedures and advice provided by the NSW RFS.

Notwithstanding, the preparation and implementation of the above measures, Metromix would ensure that all personnel recognise the authority of the NSW RFS and other emergency services, e.g. NSW Police, and adhere to any and all instructions provided by these authorities. Furthermore, access to all Project Site facilities and water storages would be provided to the RFS and any reasonable assistance offered.

Management of On-site Operations

Activities on the Project Site would have the potential to result in the outbreak of fire which could in turn result in the development of a bushfire. These activities, and the controls proposed to limit risk, are presented in **Table 5.28**.

Table 5.28
Bushfire Hazard – Activities and Controls

Activity	Possible Ignition Source	Safeguards and/or Controls
Refuelling	• Spilt fuel ignited by spark	• Refuelling undertaken within designated fuel bays or within cleared area of the Project Site. • Vehicles to be turned off during refuelling. • No smoking policy to be enforced in designated areas of the Project Site. • Fire extinguishers maintained within all site vehicles and at refuelling areas.
General Activities	• Cigarette • Rubbish, e.g. glass, metal.	• No smoking policy to be enforced in designated areas of the Project Site. • Focus on housekeeping to be maintained by Metromix management. • Water cart available to assist in extinguishing any fire ignited. • Site vehicles to carry a fire extinguisher.

5.12.6 Assessment of Impact

5.12.6.1 Off-site Bushfires

The assessment of impacts of bushfires initiated off site is assessed in terms of the objectives of RFS (2006) and Clause 33 of Lake Macquarie LEP 2004.

Planning for Bushfire Protection 2006

Does the proposed bushfire management provide the following?

i) Afford occupants of any building adequate protection from exposure to a bushfire?

A suitable APZ would be provided around the buildings within the Project Site. Metromix maintains Emergency and Evacuation Management Procedures which would be implemented in the event of notification of a local bushfire event requiring all site personnel and visitors to assemble at the nominated Emergency Assembly Area prior to receipt of further instructions.

ii) Provide for a defendable space around buildings?

An APZ greater agreed within the RFS would be maintained around the buildings within the Project Site.

iii) Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition?

See management in response to (ii) above.

iv) Ensure that safe operational access and egress for emergency service personnel and residents is available?

The roads within the Project Site would continue to be regularly maintained and of suitable standard to allow for safe access and egress to and from Project Site facilities and active areas.

v) Provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the asset protection zone (APZ)?

Metromix would maintain contact with the RFS regarding fuel loads within and beyond the APZ. Fuel resolution programs would be undertaken, as required, in conjunction the RFS.

vi) Ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bushfire fighting)?

Mobile phones on vehicles, and UHF radio communications would be available to fire fighters. Water would also be immediately available from the water storages within the Project Site.

Lake Macquarie LEP 2004

Does the proposal provide the following?

- Unless already authorised, bushfire hazard reduction work can only be undertaken with consent by / or under the *Rural Fires Act 1997* or another Act.

  All bushfire hazard reduction work undertaken on the Project Site would continue to be undertaken under the supervision and with advice from Rural Fire Service.

- Are the measures proposed to avoid or mitigate the threat from bushfire adequate for the locality?

  Metromix would ensure that its annual consultation with the RFS identifies any issue that needs to be attended to achieve the required adequacy.

- Are the potential impacts on the environment of the proposed mitigation measures minimised?

  Metromix has an excellent understanding of the location of threatened species on the Project Site and would only clear as much vegetation within the APZs on the Project Site that are required by the RFS.

5.12.6.2 On-site Bushfires

Quarrying in the proposed extension areas, processing and ancillary activities undertaken on the Project Site would increase the number and type of ignition sources in the local area. However, the proposed controls and safeguards to be adopted would ensure that the potential for fire initiation and spread within the Project Site is minimised.

5.13 LAND USES

5.13.1 On-site Land Uses

For the purposes of this document, the existing on-site land uses comprise:

- Metromix's quarrying operations;
- Downer EDI's asphalt plant;
- Civilake's pugmill;
- private coal haul road;
- power transmissions lines: and
- nature conservation.

It is proposed that each of these land uses would continue throughout the ongoing life of the quarry. Periodic restrictions would be placed upon the activities on the Newtech Pistol Club site during periods of blasting within the Northern Extension. However, such restrictions would be discussed with the club representatives prior to their occurrence.

Metromix has liaised with Energy Australia to ensure that its plans to relocate the transmission lines that traverse the Southern and Northern Extensions do not adversely affect local consumers.

5.13.2 Off-site Land Uses

The land uses surrounding the Project Site comprise:

- nature conservation (to the south, southeast and west);
- rural-residential to the west (Wakefield);
- residential to the east (Teralba); and
- coal mining related activities to the west (former Rhondda Colliery) and to the north (Macquarie Coal Preparation Plant).

The traffic, noise air quality and surface water assessments undertaken for the Project and outlined in earlier sub-sections of this document have demonstrated that the ongoing operations would have minimal impacts on the surrounding land uses.

5.14 SOCIO-ECONOMIC SETTING

5.14.1 Introduction

In addition, the DGRs issued by the former Department of Planning require that the *Environmental Assessment* include an assessment of the "Social and Economic" setting, including an assessment of the socio-economic impacts of the Project, and the demand on local infrastructure and services.

The following sub-sections provide a brief profile of the local and wider community upon which to assess the impacts of the Project. Information has been obtained from census data produced by the Australian Bureau of Statistics from the 2001 and 2006 Census.

Metromix considers itself a responsible corporate citizen of Teralba and the wider Newcastle community given its role/support of various community projects and initiatives throughout Teralba, particularly with Teralba Public School and the Teralba Bowling Club. It is noted that Metromix's involvement with the Teralba Public School is such that the Company's Community Liaison Manager is one of the School's patrons. This sub-section also draws upon Metromix's involvement with the local community.

5.14.2 The Existing Socio-economic Setting

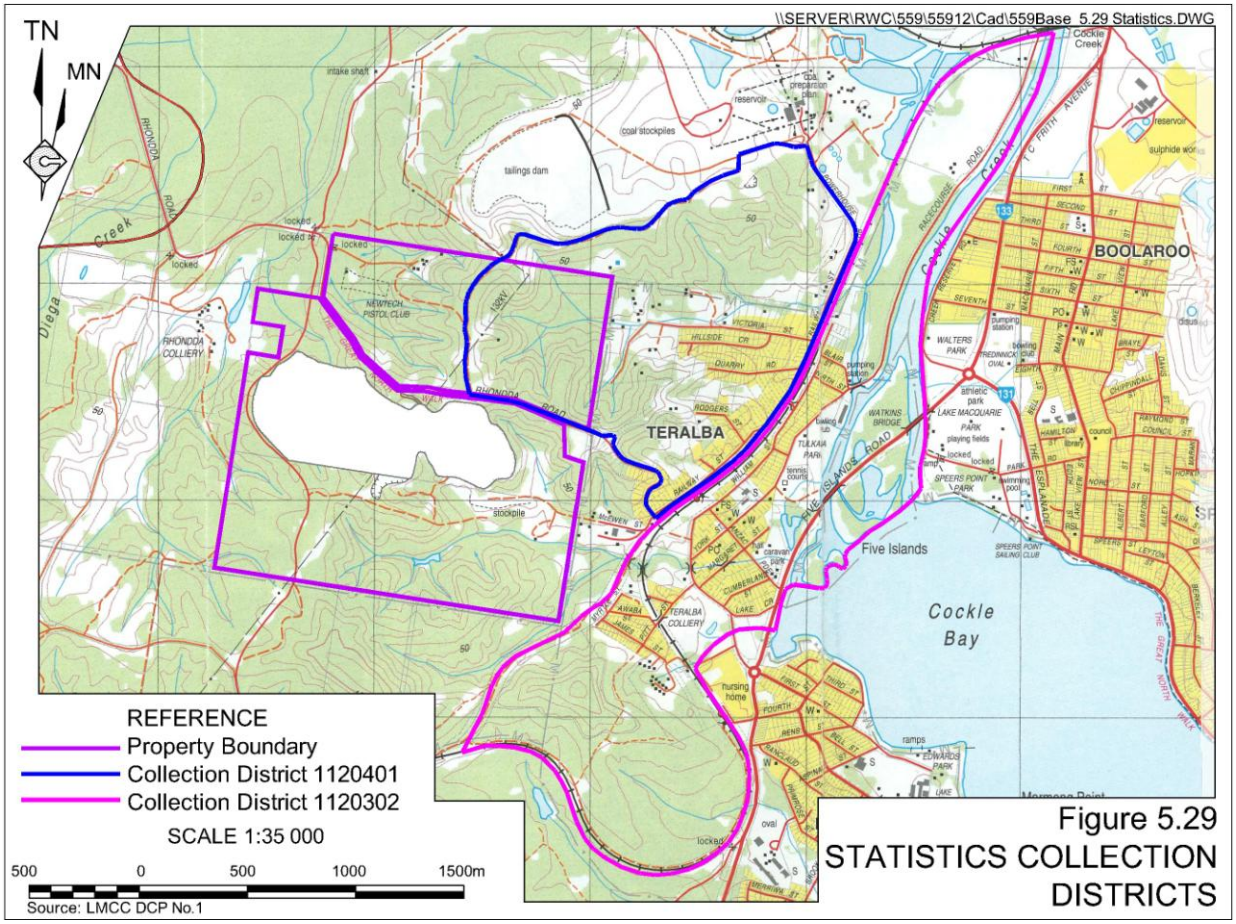
5.14.2.1 Local Setting and Community Structure

The Project Site is located within the Lake Macquarie City Council area, which corresponds to the Australian Bureau of Statistics Lake Macquarie Statistical Local Area (SLA 110054650). The Lake Macquarie SLA covers an area of 643.5km^2. Teralba is a small suburb of Newcastle that straddles the main North Coast Railway and lies on the southwestern edge of Newcastle. Surrounding suburbs to the southwest and northwest include Wakefield and Barnsley. Many of these suburbs developed around coal mining interests in the late 1800s and in many regards still reflect the working class characteristics of the early coal mining industry.

The suburb of Teralba and the immediate area surrounding the Teralba Quarry is straddled by two Australian Bureau of Statistics Collection Districts, namely, CD 1120302 and CD 1120401. Collectively, these two collection districts cover an area of 4.4km^2 and encompass the suburb of Teralba in its entirety (see **Figure 5.29**).

From a community structure perspective, Teralba is both a dormitory suburb for the greater Newcastle area yet exhibits local centres of cohesion such as through Teralba Public School and the Teralba Bowling Club.

The suburb of Wakefield to the southwest of Teralba is a very small locality with a number of rural-residential properties. The area is effectively a dormitory suburb for Newcastle, offering inhabitants a semi-rural life style. Further north, Barnsley lies on the southern side of a large residential area south of George Booth Drive. The bulk of the residences in Barnsley and nearby suburbs are conventional suburban lots.



5.14.2.2 Population and Population Growth

Table 5.29 provides a comparison of the educational and population setting for the broader Lake Macquarie district and the smaller Teralba collection districts.

Table 5.29
Population Profile

	Teralba Collection Districts				Lake Macquarie Statistical Local Area			
	Males	Females	Persons	% of Total Persons	Males	Females	Persons	% of Total Persons
Total Persons	725	730	1 455		89 638	93 502	183 140	
Aged 0 to 14 years	136	132	268	0.18	18 582	17 331	35 873	20
Aged 15 to 64 years	466	466	912	63	57 442	59 072	116 514	64
Aged 65 years and over	121	152	273	19	13 654	17 099	30 753	16
No. of people of Australian birth	638	648	1 286	88	76 570	79 746	156 316	85
No. of persons aged 15 years and over who have completed year 12 as the highest level of schooling	106	141	247	17	21 335	23 166	44 501	24
Persons who have achieved non-school qualifications	725	730	1 455		89 638	93 502	183 140	
Source: ABS- June, 2001 Census								

The Teralba area makes up only 1% of the greater Lake Macquarie population. Age distributions for the two areas are similar with the Lake Macquarie SLA having a slightly higher proportion of the population that has completed year 12 as their highest year of schooling.

It is to be noted that CD 1120401 has 25% of its population over 65 years of age as opposed to only 9% in CD 1120302. This suggests that CD 1120401, which covers the majority of the Teralba suburb (see **Figure 5.29**) contains a high proportion of retirees. This is reflected in the labour force figures.

Table 5.30 provides several critical socio-economic parameters of the two Teralba CDs and wider Lake Macquarie SLA (see **Figure 5.29)**. Due to the large difference between the median values for each parameter in the two Teralba CDs, they have been presented separately.

Table 5.30
Socio-Economic Overview

	Teralba Collection Districts		Lake Macquarie Statistical Local Area
	CD 1120302	**CD 1120401**	
Median age(b)	35	44	40
Median monthly housing loan repayments	1 300	1200	1 300
Median weekly rent	198	146	185
Median weekly individual income	424	308	394
Median weekly family income	1143	7041	1 102
Median weekly household income	118	592	922
Mean household size	2.9	2.2	2.6
Source: ABS- June, 2001 Census			

Although there is a large disparity in the median values for the socio-economic parameters presented in **Table 5.30** between the two Teralba CDs, the Lake Macquarie SLA median value lie in-between the two ranges.

5.14.2.3 Employment and Industry Participation

Table 5.31 presents data on the employment levels and industry participation of the two Teralba CDs and wider Lake Macquarie SLA. Again, due to the disparity between the Teralba CD values, they have been presented separately.

Table 5.31
Employment Levels and Industry Participation

	Teralba Collection Districts		Lake Macquarie Statistical Local Area
	CD 1120302	CD 1120401	
Employment (aged 15 and over)	**Total Persons (% of Total Population)**		
Employed(a):			
Full-time(b)	180 (27%)	157 (20%)	46 199 (25%)
Part-time	100 (15%)	85 (11%)	25 330 (14%)
Not stated(c)	12 (2%)	9 (1%)	6522 (4%)
Total	292 (44%)	254 (32%)	76 737 (42%)
Unemployed(a)	28 (4%)	41 (5%)	5 491 (3%)
Total labour force(a)	336 (50%)	295 (37%)	82 228 (45%)
Not in the labour force(a)	117 (26%)	334 (42%)	58512 (32%)
Unemployment rate(a)	180 (27%)	157 (20%)	46 199 (25%)
Industry Employment Percentages (aged 15 and over)			
Agriculture, Forestry and Fishing	0	3	219
Mining	6	3	1 396
Manufacturing	26	27	6 939
Electricity, Gas and Water Supply	6	3	1 092
Construction	45	25	6 047
Wholesale Trade	12	4	1 911
Retail Trade	37	12	3 881
Accommodation, Cafes and Restaurants	24	12	1 731
Transport and Storage	16	0	2 700
Communication Services	9	3	539
Finance and Insurance	6	0	911
Property and Business Services	3	0	588
Professional, Scientific, Technical Services	15	3	1026
Administration Support Services	3	9	2 662
Public Administration and Safety	26	6	1 956
Education and Training	14	6	2056
Health Care and Social Assistance	40	0	375
Art and Recreation	3	12	1 911
Not stated	9	7	1063
Total	**307**	**143**	**41 193**

Source: ABS- June, 2006 Census

Similarly to the socio-economic parameters presented in **Table 5.31**, although there is a disparity between the values presented by the two Teralba CDs, the Lake Macquarie (SLA) values generally lie in-between the two. CD 1120401 has a very high unemployment rate at 17%, possibly reflecting the higher proportion of retirees residing in that part of Teralba.

CD 1120401 has a higher percentage of people working in the accommodation, cafes and restaurants than CD 1120302, reinforcing the suggestion that this CD covers the majority of the Teralba township. A higher percentage of the combined Teralba population also work in the construction industry than the broader Lake Macquarie population.

5.14.2.4 Teralba Business Survey

A survey was distributed to local businesses to determine the adverse or beneficial impact that the existing transportation truck levels through Teralba have on individual businesses. Twelve businesses responded to the business survey, the results of which are summarised in Section 3.2.2.1.

Although responses were not obtained from all businesses in Teralba, the results of the survey are considered to represent a cross section of the local business community. The survey results indicate that there is mixed impact on local businesses from the existing level of product trucks through the town and that diversion of the trucks away from Teralba would have a significant adverse impact on some local businesses while not impact others.

5.14.3 Safeguards and Mitigation Measures

The primary safeguards and mitigation measures that influence the socio-economic climate in either a positive or negative manner generally also relate to the mitigation of other environmental aspects such as dust, noise and visibility. Each of these issues has been separately addressed, however, the key issue relevant to the local socio-economic climate relates to truck traffic through Teralba. In this regard, the two key measures Metromix would introduce to ensure the impacts of the truck traffic travelling to and from the quarry are as follows.

1. Metromix would require all truck drivers travelling to and from Teralba Quarry to sign a Drivers Code of Conduct setting out the standards that Metromix considers are the minimum for drivers. Issues that have been raised by the local community during the preparation of the *Environmental Assessment* would be covered by the Code such as hours of operation, speeding, caution when passing Teralba Public School, avoiding convoys, avoidance of exhaust brakes, driver courtesy and covering of loads.
2. Metromix has established a self-imposed limit on heavy vehicles travelling through Teralba. The limits would be no more than 18 vehicles per hour (both directions) and 170 vehicles per day (both directions). The limit was established following a review of traffic movements to and from the quarry when annualised sales were approximately 700 000tpa. Metromix considered these heavy vehicle traffic levels should not be exceeded even when annualised sales approach 1Mtpa.

A major safeguard against the potential impacts of the quarry extensions on the socio-economic environment has been the provision of extensive information through the community consultation process and the inclusion of the community in the environmental impact assessment process to ensure that all community concerns and issues have been identified and assessed appropriately.

5.14.4 Impact Assessment

5.14.4.1 Evaluation of Social Impact

The proposed extensions do not substantially alter the method of extraction, extraction equipment, extraction or processing rates, employment levels, product transportation levels or general environmental management strategies employed at the quarry. Generally, the principal impacts of the proposed extensions would be the sustained higher levels of extraction and the lengthening of the life of the Teralba Quarry. As such, the potential social impacts would generally be similar to those currently experienced by the communities of Teralba, Wakefield and surrounding areas which overall are comparatively well accepted in the local community. The ongoing direct and indirect employment through the quarry would contribute to underpinning maintenance of social values both locally and regionally.

Nevertheless, Metromix has acknowledged the existing concerns of the community and attempted to design the proposed extensions to minimise the existing and future potential impacts, particularly with respect to product transportation.

Metromix intends to continue its corporate philanthropy throughout the local community, particularly through Teralba Public School and demonstrate the Company's corporate citizenship, where and when required.

5.14.4.2 Evaluation of Economic Impact

The proposed extensions would provide the assured ongoing presence of Metromix in the Teralba area, ensuring the continued supply of reasonably priced quarry products to Civilake and surrounding customers. It would also result in the ongoing contribution to the local economy through employment, wages and support of local businesses and services. The current estimated value of the existing mobile plant and equipment, offices and on-site infrastructure is approximately $25 million.

Metromix currently spends approximately $2.6 million in the local area for its labour costs, consumables, rates and contributions to Lake Macquarie City Council and a further $6-7 million for its product transportation component. A further $3.1 million is spent regionally and throughout NSW and Australia. Included in this amount is $1.1 million for electricity, explosives, repairs and maintenance spent throughout the regional economy, while State and Federal taxes totalled $143 000 and $1.6 million respectively. Beyond 2012, Metromix will outlay almost $12 million annually thereby contributing to economic prosperity on all scales.

In addition to the above operating costs, if the extensions are approved, Metromix anticipates the company would outlay an average of almost $2 million per year ($ 2012) for the next 20 years to purchase new equipment, repair the mobile and fixed plant, fund electricity upgrades and cover other capital costs. This equates to an overall capital investment of approximately $39 million.

Apart from the direct operating and capital costs, the ongoing operation of the Teralba Quarry would generate a number of positive indirect economic benefits through flow-ons through the local, regional and State economies. Through the use of a conservative multiplier of "two times", the annual flow-on effects of Teralba Quarry would be in the order of $24 million per year.

From the construction industry perspective, particularly throughout Lake Macquarie LGA, the wide range of private and public building and construction projects would benefit from sourcing their raw materials from the Teralba Quarry. The quarry is the closest quarry to most local construction projects and therefore offers cost saving to those projects through restricted transport costs.

From a potentially negative perspective, the ongoing operation of the Teralba Quarry is unlikely to adversely influence local real estate values or other local businesses given the knowledge of the local community of the considerable period of time the quarry has been in operation and the absence of substantive environmental issues.

Overall, the ongoing operation of the Teralba Quarry would have a positive effect on the local, regional, State and federal economies.