Section 5
Environmental Features, Safeguards and Impacts

The assessment and management of the key environmental issues identified in Section 3 are generally addressed in the order of priority established in Section 3.5.

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 or 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 Rocla. 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 GROUNDWATER

5.1.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential groundwater impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Groundwater pollution as a result of leakage or spillage (moderate to high risk).
- Reduced water levels within the aquifer of the Lower Mangrove and Popran Creeks Groundwater Source of the Kulnura Mangrove Mountain Water Sharing Plan (WSP) (high risk).
- Reduction in the yield/saturated thickness of groundwater bores:
  - on the Project Site or Proponent-owned land (high risk);
  - by <15% on non-project related properties (high risk); and
  - by >15% on non-project related properties (high risk)
- Impacts on groundwater-dependent ecosystems (high risk).

In addition, the Director-General's Requirements issued by the Department of Planning require that the assessment of surface and groundwater include a "*… site water balance, and a description of the proposed water management system…*" as well as a "*… groundwater contingency strategy which details the measures proposed to minimise impacts on supply of water (quality and quantity) to the environment and local land owners …*", and refer to the *Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000), and the various *State Groundwater Policy* documents.

This section commences with a review of the existing regional and local hydrogeology, local availability and use of groundwater resources and current statutory framework for the management of groundwater. Potential sources of groundwater contamination are then identified and the operational safeguards, controls and mitigation measures described. The section concludes with an assessment of the residual impacts upon the groundwater resources beneath and surrounding the Project Site following the implementation of these safeguards, controls and mitigation measures.

The groundwater assessment was undertaken by GeoTerra Pty Ltd (GeoTerra, 2009). The full assessment is presented as Part 1 of the *Specialist Consultant Studies Compendium*, with the relevant information from the assessment summarised in the following subsections.

5.1.2 Hydrogeological Setting

5.1.2.1 Regional Hydrogeological Setting

5.1.2.1.1 Hawkesbury Sandstone

The groundwater resources in the Central Coast are located within two principal geological units, namely the Hawkesbury Sandstone and the underlying Terrigal Formation. Both of these geological units, which are widespread throughout the Central Coast, have been the subject of various investigations to supply good quality water for use throughout the Gosford City Local Government Area.

GeoTerra (2009) notes that the Hawkesbury Sandstone is the main source of groundwater in the area surrounding the Project Site, with virtually all irrigation and industrial registered bores obtaining water from this source. The sandstone contains predominantly deep, low yielding semi-confined aquifers that draw water at various depths below surface, mostly at depths between 10m and 50m below surface, with bore yields ranging from 0.1L/s to 1.0L/s, averaging around 0.4L/s.

The distribution of the water-bearing aquifers and horizons is a function of the distribution of sedimentary facies and structural features, with a marked lateral discontinuity, coupled with low-permeability sub-vertical discontinuities across the area.

Vertical faults can dissect and displace aquifers to the extent there may be limited lateral groundwater connection. Some joints can be open and facilitate groundwater movement in both a vertical and a horizontal direction. Conversely, joints in-filled with clay or mineral precipitates, particularly iron, can effectively seal the structure and form impermeable barriers to groundwater flow.

GeoTerra (2009) also suggests that disconformities, joints, faults and facies changes in the sandstone are likely to result in groundwater seepage and discharge into local streams in the headwaters of Cabbage Tree Creek.

5.1.2.1.2 The Kulnura Mangrove Mountain Aquifer System

The Project Site is located within the Zone 7 area of the Kulnura Mangrove Mountain Aquifer System with the storage and movement of groundwater controlled by the essentially flat lying aquifers in sheet sandstone and massive sandstone facies of the Hawkesbury Sandstone. Sheet sandstones are the main aquifers in the area and generally act as semi-confined aquifers in deeper layers or as unconfined aquifers higher up in the sequence. The massive sandstone facies generally acts as aquitards.

Alkhatib (2007) studied the interaction between rainfall and surface recharge, and the groundwater contained within the aquifer system and determined the dynamics of the system are clearly controlled by rainfall. Through modelling, Alkhatib (2007) assessed that on average 47% of total rainfall recharge appears as base flow in local streams, although much of the groundwater seeping from cliff lines (38%) would also eventually provide a delayed base flow to these streams. Approximately 20% of rainfall recharge is consumed by evapo-transpiration from shallow water tables supporting vegetation. Alkhatib (2007) determined that currently, less than 2% of groundwater recharge is consumed by groundwater extraction.

The Kulnura Mangrove Mountain Aquifer System is, therefore, a finite resource with limited groundwater storage and has a groundwater level defined by the cyclical input of rainfall recharge. The use of groundwater from this aquifer system is managed under the *Water Management Act 2000* through a Water Sharing Plan (WSP) (Kulnura-Mangrove Mountain Groundwater Sources WSP). Water is currently extracted from the aquifer for various industrial, commercial, agricultural and domestic purposes. The ‘sustainable yield’ of the aquifer is defined as the amount of groundwater that can be withdrawn from an aquifer system over one year that preserves the minimum amount of base flow that is acceptable to stakeholders. Alkhatib (2007) indicates that total sustainable yield at 10% base flow reduction from the Water Sharing Plan area is approximately 3 000ML/yr, although it can range from 1 000ML/year in dry years to more than 5 000ML/yr in wet years.

5.1.2.2 Local Hydrogeological Setting

The local hydrogeology is dominantly controlled by the presence of permeable sandstone horizons which constitute the major water storage units. The sandstone hydraulic conductivity is dependent on the presence of joints and bedding plane fractures. Fracturing, which may be present on a regional scale, constitutes a major component of the aquifer's transmissivity and a minor component of the aquifer's storage. The occurrence of structural discontinuities can mean that anisotropic hydrogeological conditions exist, which complicates analysis of regional and local groundwater flow.

The groundwater generally has low salinity and hardness, although it is often acidic (GeoTerra, 2009). Iron content can also be high and can result in staining problems.

5.1.2.3 Groundwater of the Project Site

5.1.2.3.1 Groundwater Monitoring

An understanding of the groundwater resources beneath the Project Site has been established through the construction and monitoring of a number of piezometers and private bores on and surrounding the Project Site. Monitoring of a number of these commenced in June 2001, with the standing water levels and field groundwater chemistry of up to 26 groundwater bores now monitored on a monthly basis to collect background data and to assess any impacts on water supply bores in neighbouring properties. Automatic water level recorders recording at six hourly intervals are installed in 10 of these bores and have collected data since June 2006.

Every 6 months, all monitoring piezometers and private production bores are sampled for laboratory analysis of major ions and dissolved metals.

Figure 5.1 presents the locations of the piezometers on and surrounding the Project Site.

5.1.2.3.2 Groundwater Level

A review of the results of standing water levels (SWLs) within the piezometers on and surrounding the Project Site, and comparison to the local rainfall record, indicates that the groundwater level beneath the Project Site is directly correlated to rainfall. Hydrographs, a graphical representation of rainfall and SWL levels over time, from the piezometers on and surrounding the Project Site (see **Figure 5.1**) prepared by GeoTerra (2009), demonstrate a steady increase in standing water level in all the piezometers since May 2006, corresponding with the above average rainfall received on and adjacent to the Project Site in September 2006, and throughout 2007 (with significant rainfall events which occurred in June, August, November and December 2007). **Figure 5.2** presents the hydrographs from Piezometers CQ07 to the north of the existing Calga Sand Quarry, and MW08 at the southern boundary of the Southern Extension Area, demonstrating the relationship between groundwater level and rainfall. Hydrographs for all other piezometers and private bores, which demonstrate the same relationship between rainfall and SWL are presented as Appendix B of GeoTerra (2009).

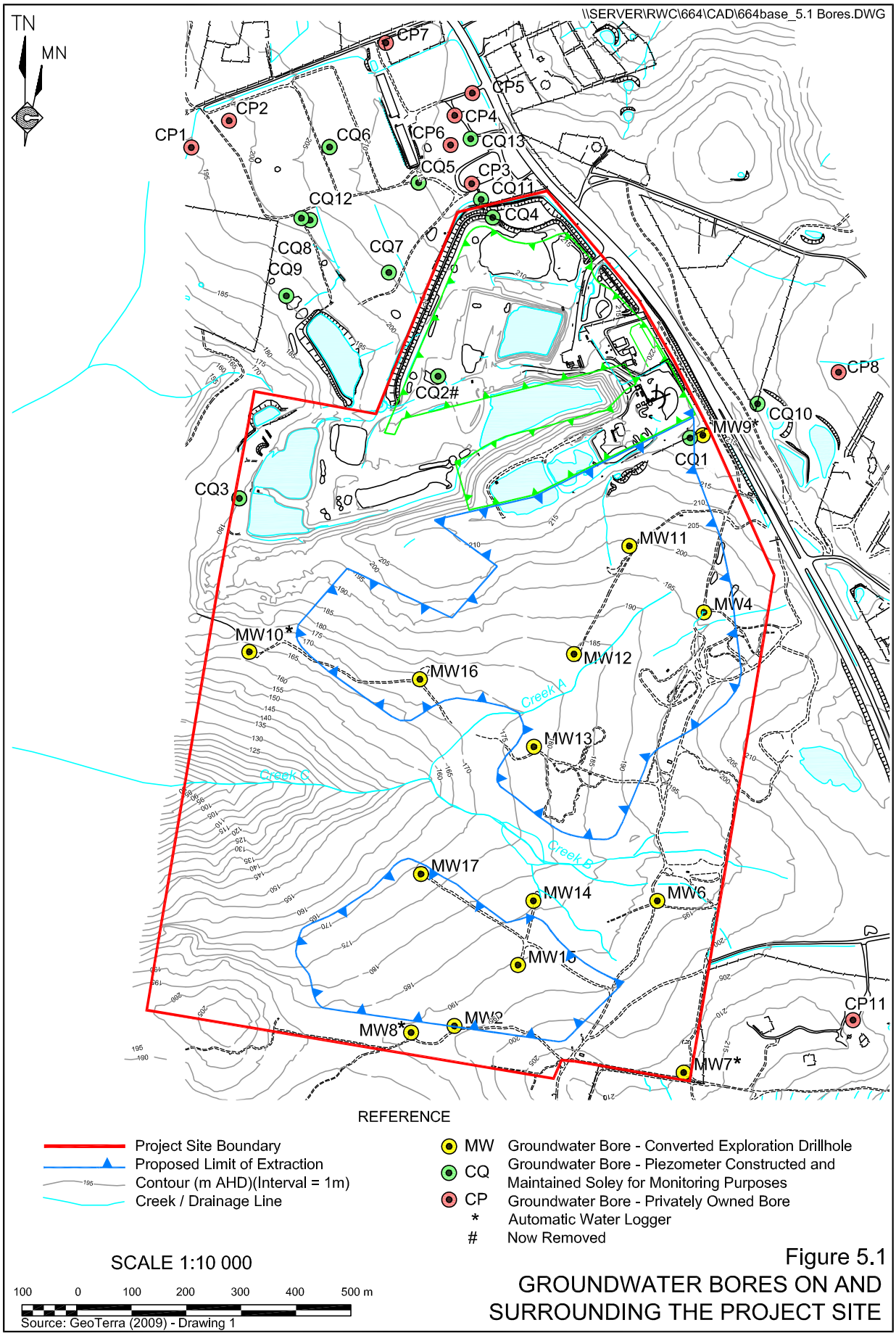

Figure 5.1
GROUNDWATER BORES ON AND SURROUNDING THE PROJECT SITE

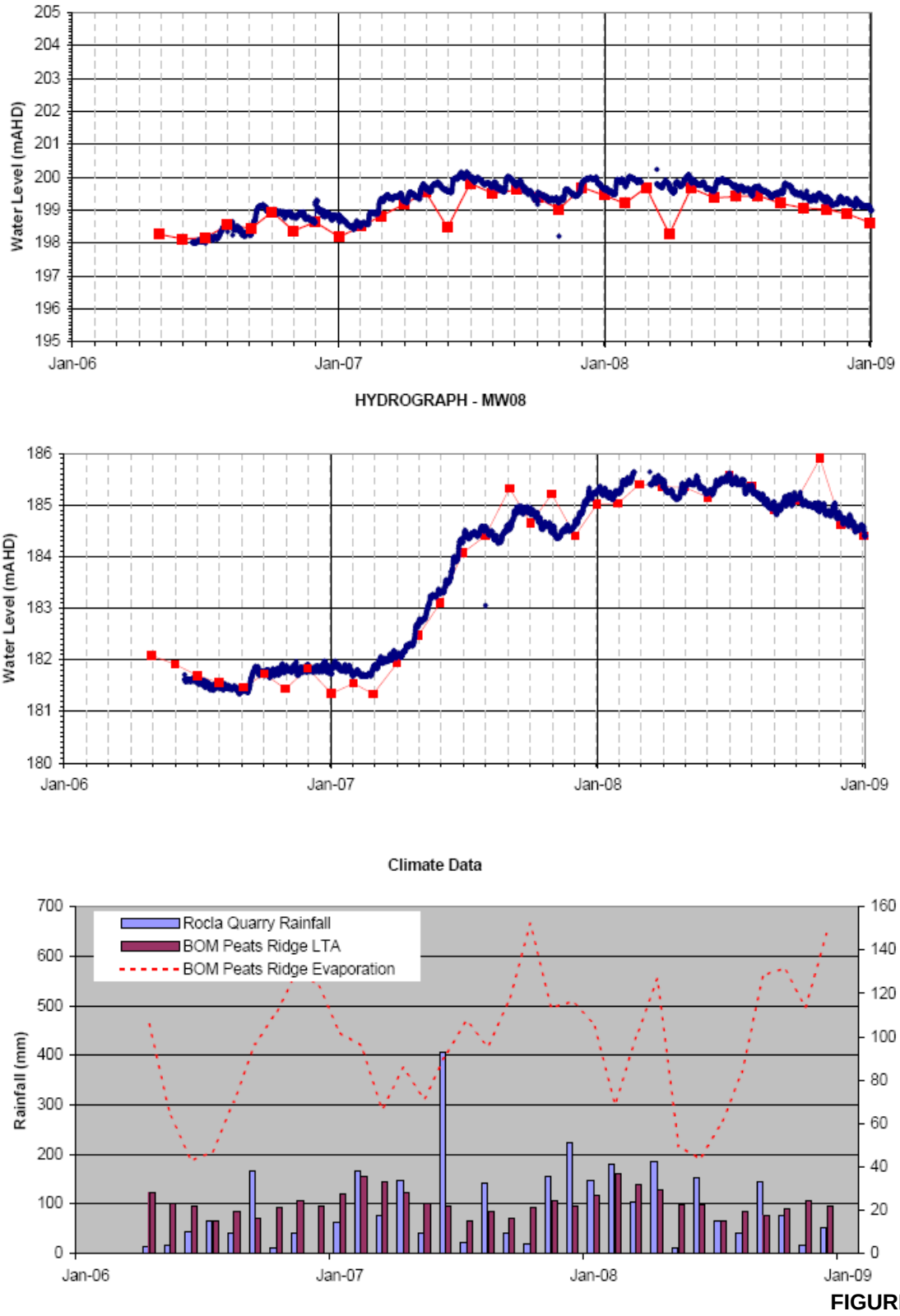

FIGURE 5.2
Piezometer Hydrographs and Data (CQ7 and MW8)

Source: Modified after Aquaterra (2009) – Figures 5 and 10

Long term hydrographs prepared by GeoTerra (2009) for piezometers CQ01 to CQ04 for the period of January 2001 to January 2008 illustrate that recharge from the rainfall events of 2007 has elevated the groundwater level beneath the Project Site almost back to the 2001 level.

Given the natural fluctuation of groundwater level beneath the Project Site in response to rainfall, it is difficult to provide a definitive level for the groundwater table. However, monitoring of the piezometers identified on **Figure 5.1** indicates that the depth below surface to groundwater fluctuates by approximately 5m within each piezometer, varying between 5m and 25m below surface (depending on which piezometer is considered).

5.1.2.3.3 Groundwater Flow

The elevation of the groundwater table, measured in Australian Height Datum, generally mimics topography, decreasing from up to 210m AHD within CQ14 to the northeast of the Project Site to 155m AHD within MW10 on the lower slopes of the Southern Extension area. Both in the piezometers to the north and south of existing Calga Sand Quarry, there is a general reduction in standing water level from east to west.

Figure 5.3 presents the interpreted groundwater contours of the Project Site based on the monitoring data of January 2008, illustrating a general flow from the east-northeast to the west-southwest towards Cabbage Tree Creek at a gradient of between 0.04 and 0.08 (GeoTerra, 2009). In sympathy with the local topography of the Project Site, the contours are depressed along the gullies of Creeks A, B and C, suggesting some discharge of groundwater to these creeks is likely. While no groundwater discharge to these creeks has been observed, the likelihood of at least occasional discharge is supported by the vegetation types identified along the creeks (see Section 5.2).

Localised flows to the north of the existing Calga Sand Quarry are likely to be drawn towards the void of the quarry, due to the higher hydraulic gradient created at the active extraction area face. Local groundwater levels and flows are also likely to be influenced by pumping from the private bores surrounding the Project Site.

5.1.2.3.4 Groundwater Quality

In accordance with the Calga Sand Quarry Site Water Management Plan, groundwater is sampled from each of the monitoring piezometers identified on **Figure 5.1** every month to measure pH and Electrical Conductivity (EC). In addition, every 6 months all monitoring piezometers and private production bores (pending landowner agreement) are sampled, with the groundwater samples sent for laboratory analysis of major ions and dissolved metals.

In order to assist in assessing the results of the water quality monitoring, the various monitoring piezometers and private bores have been categorised by groundwater area as follows.

- The "quarry" area refers to the zone immediately surrounding the existing Calga Sand Quarry, ie. CQ1 to CQ3 and MW9 piezometers.
- The "native" area refers to the undeveloped areas to the north and south of the approved Calga Sand Quarry, ie. CQ10 and MW7, MW8, MW10, MW13, MW16 piezometers.
- The "private bore" area refers to the wider area surrounding the Project Site, ie. CQ4 to CQ12 and CP1 to CP8.

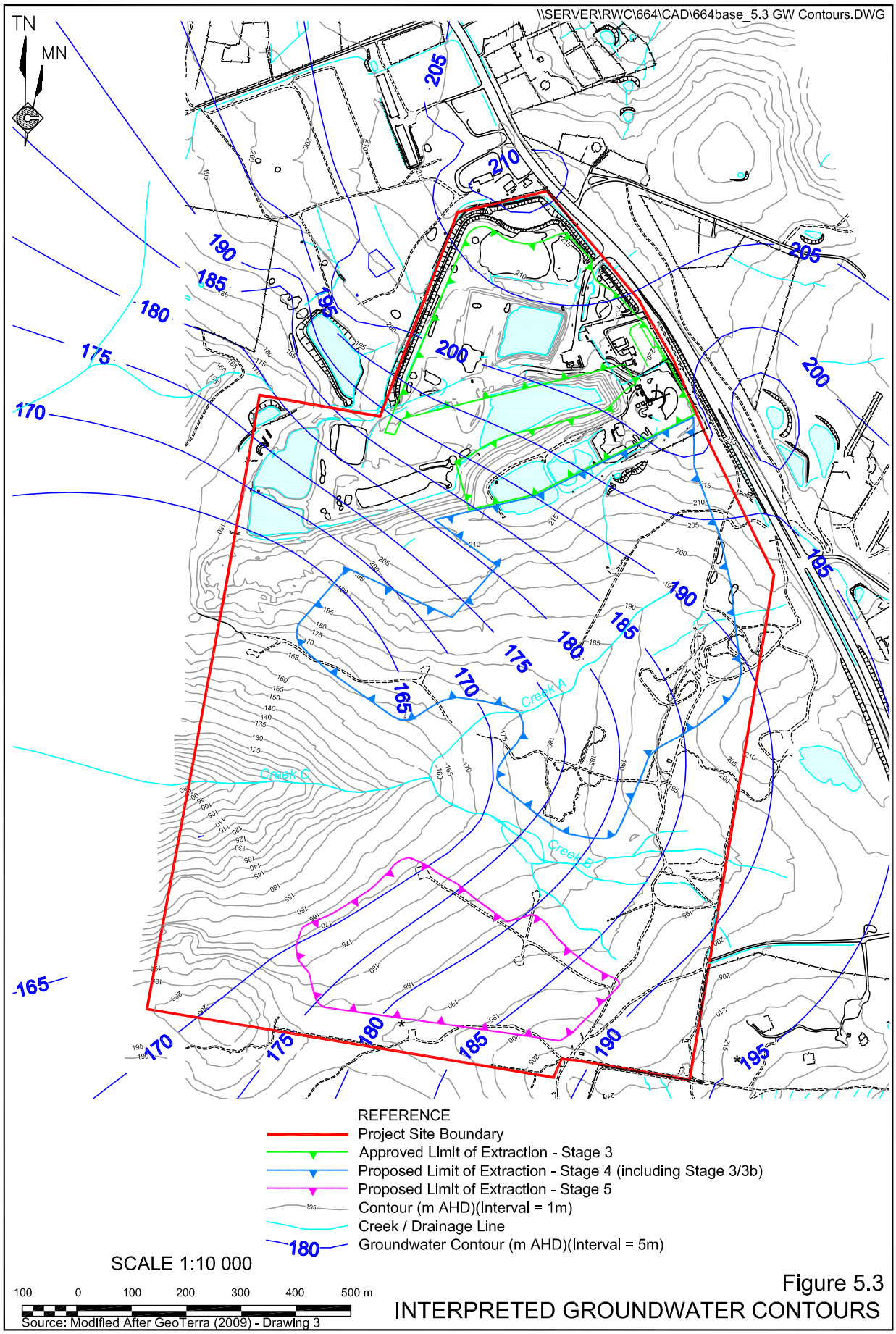

Figure 5.3
INTERPRETED GROUNDWATER CONTOURS

A full record of all water quality results is provided by GeoTerra (2009), however, the following provides a general overview of the local groundwater quality.

Groundwater salinity (measured as electrical conductivity) is generally low, with a maximum recorded value of 295µS/cm in the quarry area. Groundwater is also generally acidic with a pH of between 4.1 and 6.3. When compared against the ANZECC Guidelines For Fresh and Marine Water Quality (ANZECC, 2000), exceedances of the 95% trigger level for freshwater species were identified in all three groundwater areas.

- Quarry area. The measured levels and concentrations of pH, aluminium, copper, lead, zinc and nitrogen oxides regularly exceed the 95% trigger level of ANZECC (2000), whilst cadmium, manganese and nickel less commonly exceed the criteria.
- Private bore area. The measured levels and concentrations of pH, aluminium, copper, lead, zinc and nitrogen oxides regularly exceed the 95% trigger level of ANZECC (2000). In addition, the water also generally exceeds the NHMRC Drinking Water criteria for pH, aluminium and lead.
- Native area. The measured levels and concentrations of pH, aluminium, copper, lead, zinc and nitrogen oxides regularly exceed the 95% trigger level of ANZECC (2000).

The results of groundwater quality monitoring indicate that the quality of groundwater has not been adversely affected as a result of quarry operations to date and is of consistent quality between the three areas.

5.1.2.4 Surface Water – Groundwater Interaction and Local Groundwater Dependent Ecosystems

5.1.2.4.1 Aquifer Recharge

Aquifer recharge occurs through infiltration of excess precipitation and it has been demonstrated that local groundwater levels are strongly linked to this process (see Section 5.1.2.3.2 and **Figure 5.2**). The recharge zone for sandstone aquifers in the vicinity of the Project Site covers approximately 3km^2 which is broadly defined by the narrow ridge system extending some 2km north to the "Glenworth Valley" property. The recharge area is bordered to the west by the headwaters of Cabbage Tree Creek and Popran Creek and to the east by the headwaters of Mooney Mooney Creek.

Rainfall data indicates an average precipitation of 650mm during 'dry' years and 976mm during 'normal' rainfall years. Broad estimates of recharge for a 3km^2 area were calculated assuming a recharge proportion of 5% to 15%. On this basis, annual recharge would range from approximately 95ML to 145ML for 5% recharge, to 285ML to 435ML for 15% recharge. Some of this would provide base flow to the small number of minor creeks which ultimately drain into both the Popran and Mooney Mooney Creek systems.

Recharge is potentially limited by the vertical permeability of the sandstone rather than the availability of excess precipitation. Potential recharge may be reduced by hard sandstone surfaces, with infiltration through the shallow soils and flow at the bedrock surface to emerge a short distance down-slope, or infiltration through the weathered sandstone to perch at a shallow depth above less permeable horizons, than feeding ephemeral springs in the area.

5.1.2.4.2 Seeps and Springs

Groundwater discharge in the vicinity of the Project Site occurs through seepage from springs, evapo-transpiration, evaporation in exposed water table areas, infiltration to the Hawkesbury Sandstone basement and artificial discharge through abstraction for commercial water use, irrigation, stock watering, domestic or quarry use.

Potential spring types emanating from the Hawkesbury Sandstone (Russell, 2001) can be present as:

- sandstone contact: exposed intersection of stratified and cross-bedded sandstone with low permeability shale;
- fractured sandstone (A): groundwater movement through joints, bedding plane partings or cross bedded units, which discharges at surface where shale lenses are present;
- fractured sandstone (B): highly fractured sandstone with discharge at surface;
- perched water table sandstone: perched water above an extensive clay lens; or
- Hawkesbury Sandstone excavation: exposure of the water table due to excavation into the Hawkesbury Sandstone.

Creeks A and B drop over a rock platform in the centre of the Project Site, and join to form Creek C which flows towards Cabbage Tree Creek. A number of the pools along the creeks have a sandstone base and may be fed with base flow seepage, either by fractured sandstone or perched water table. As noted in Section 5.1.2.3.3, the swampy vegetation identified by Cumberland (2009), which supports dense stands of *Banksia ericifolia*, along the three creek lines provide further evidence to suggest that there is some discharge of groundwater (possibly for periods following heavy or sustained rainfall) along these creeks.

5.1.2.4.3 Groundwater Dependent Ecosystems

There is a wide range of ecosystem types that can be considered groundwater dependent (Eamus and Froend, 2006). The degree of dependence can include:

- aquatic ecosystems which are partially or occasionally dependent on groundwater, such as a river ecosystem where some portion of the dry-season base flow may be derived from an adjacent groundwater body;
- temporary or permanent springs, seeps and surface wetlands wholly fed by groundwater; and
- terrestrial ecosystems, with no surface water generally being present, but whose persistence in the environment is dependent on the presence of groundwater and on the depth of the groundwater table in relation to the root zone of key vegetation species (MacKay, 2006).

Cumberland (2009) notes that wetlands, scrub and woodlands on the sandstone ridges of the Calga area rely (at least partially) on groundwater from the underlying porous sandstone, with some vegetation on the Project Site therefore likely to be at least partially dependent on groundwater. While groundwater dependent ecosystems (GDEs) are common in the Kulnura-Calga area, a review of the Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources 2003 (map of high priority GDEs), and LHCCREMS vegetation maps of likely groundwater-dependent vegetation communities did not identify any GDEs recorded on the Project Site. The LHCCREMS mapping does, however, identify several GDEs downstream of the Project Site including:

- MU1 Coastal Wet Gully Forest;
- MU37 Swamp Mahogany – Paperbark Swamp Forest; and
- MU40 Swamp Oak – Rushland Forest.

All three GDEs are mapped as occurring in the lower reaches of Cabbage Tree Creek (600m due west of the southwestern boundary of the Project Site) and rely on water flowing through Cabbage Tree Creek.

On the Project Site itself, rainforest vegetation (E2 Sandstone Gully Rainforest) occurring within the drainage line of Creek C is dependent on maintaining sufficient soil moisture, which is recharged via the existing stream channel and within sandstone rock strata. This vegetation is therefore only partially dependent on groundwater during the drier periods of the year and is therefore considered as a facultative GDE (Cumberland, 2009). The limited areas of swampy vegetation on the Project Site (E54 Sandstone Hanging Swamp and E103 Gahnia/Banksia Swamp) are likely to be examples of perched, obligate GDEs, ie. totally dependent on groundwater, and support plant species that cannot survive for long periods without adequate soil moisture and water logging (Cumberland, 2009). The locations and distribution of these GDEs on the Project Site are described in greater detail in Sections 5.3.5.4 and presented on **Figure 5.15** (p. 5-62).

5.1.2.5 Water Use and Availability

A review of DWE Groundwater Works Summary records identified 45 licensed bores within a 3km radius of the Project Site (see **Figure 5.4**). It is possible additional bores may be located within the 3km radius, however, if present, they have not been entered into the publicly available database nor identified during the community consultation program. It has been established through consultation that at least six bores or wells are present on properties within Calga Village, however, only four bores are registered on the DWE database.

Bore depths range from 28m below ground level (bgl) to 120mbgl, although they are mostly between 30m and 60m deep and have water-bearing zones at various depths in mostly sandstone horizons less than 0.5m thick (suggesting the water-bearing zones are either fracture flow or perched aquifers).

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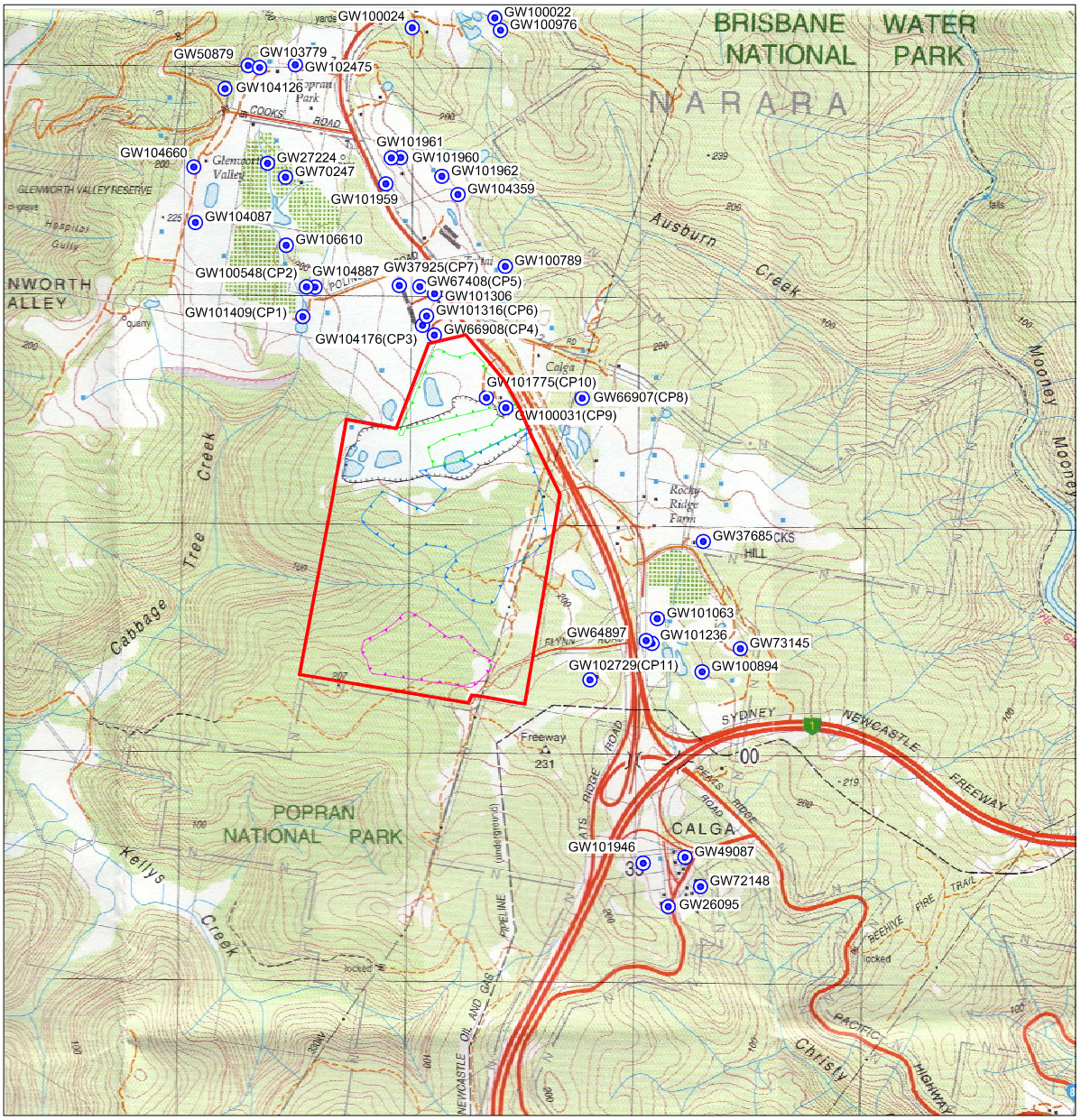


REFERENCE
Project Site Boundary
GW100031(CP9) Registered Groundwater Bore (Rocla Monitoring Bore Reference)

SCALE 1:30 000

500 0 500 1000 1500 m

Source: Modified After Golder Associates (2009) - Figure 1

Figure 5.4
REGISTERED GROUNDWATER BORES SURROUNDING THE PROJECT SITE

Table 5.1 summarises the authorised or intended purposes of the bores. The predominant use is for domestic water supply, which provides drinking water and/or is used to supplement general domestic water use.

Table 5.1
Summary of Local Groundwater Users

Authorised Purpose	No. of Registered Bores
Domestic/Stock / General	30
Industrial	6
Domestic/Industrial	2
Monitoring / Test	7
TOTAL	**45**
Source: Modified after GeoTerra (2009) – Table 4	

Standing water levels in the bores range from 3mbgl to 48mbgl, with the variability reflecting seasonal changes, the use of groundwater by local private bores and the presence of joint blocks, where sub-vertical joints bounding the blocks can act as semi-permeable barriers to groundwater flow.

GeoTerra (2009) provides further detail on the bores located in the immediate vicinity of the Project Site (Lot 121 DP755221, Lot 188 DP755221 and Lot 1 DP559892), however, it is noted that monitoring undertaken to date as part of the Calga Sand Quarry SWMP has not identified any significant change in the availability of water in these bores since the recommencement of extraction activities at the Calga Sand Quarry in early 2006.

5.1.3 Environmental Controls and Management

5.1.3.1 Potential Impacts of the Project

The voids created by the extraction of the friable sandstone would intercept the groundwater table, creating an elevated hydrostatic pressure gradient in the aquifer with water then ‘seeping’ into extraction voids. The dewatering of the in-flowing groundwater (“in-flow”) would also maintain the pressure gradient between the aquifer (high pressure) and voids (low pressure) resulting in the continuance of these in-flows. As a consequence of this seepage into the extraction voids, a reduction in the surrounding groundwater may occur more quickly than would occur if there were no change hydrostatic pressure gradients. This in turn may impact on the availability of groundwater and yield of local groundwater bores and the availability of groundwater to local GDEs.

It is also possible (although improbable) that water contaminated by leaking or spilt hydrocarbon products on the surface could, if untreated, seep into the ground and potentially contaminate this groundwater. This could reduce the quality and/or availability of this water to other groundwater users, including GDEs.

5.1.3.2 Management Measures to Reduce Impacts on Groundwater Availability

There are a few direct mitigation measures that can be adopted to avoid impacts associated with the reduction of groundwater levels.

Emphasis on the management of groundwater would therefore be placed on monitoring of surrounding groundwater bores to verify the predicted minimal impact on groundwater availability and developing mitigation measures to ensure that any reduction in available groundwater is replaced by a comparable water source or otherwise compensated. Replacement and/or compensatory measures would be developed in consultation with the affected land owner but may include:

- deepening of the effected bore to increase the available saturated thickness;
- drilling and installation of a replacement bore outside the area of drawdown impact;
- construction of surface water capture and containment structures such as dams or rainwater tanks to supplement reduced groundwater source; or
- transfer of groundwater drawn from a Rocla-owned bore or the extraction void itself.

Table 6.1 (Section 6) presents the details of commitments made in relation to groundwater monitoring and contingency planning.

5.1.3.3 Management Measures to Reduce Impacts on Groundwater Quality

Although it is not anticipated that the Project would have a significant or long-term impact on the quality of groundwater beneath landholdings surrounding the Project Site, specific controls and management practices have been proposed by Rocla for hydrocarbon management. These controls would ensure hydrocarbon products are prevented from seeping into the ground and ensure that water flowing from areas on the Project Site with the potential to generate hydrocarbon-contaminated water, eg. wash down areas, workshops, hydrocarbon storage and refuelling areas, is not contaminated by hydrocarbons.

- All hydrocarbon products and other contaminants would be stored securely within each Site Administration Area. All storage tanks would either be self-bunded tanks or bunded with an impermeable surface and have a capacity to contain a minimum 110% of the largest storage tank capacity.
- All but the less mobile equipment, which would be refuelled within the extraction area, would be refuelled within designated areas.
- In the event of a spillage of a potentially contaminating material, eg. oil, a 3-phase remedial action plan would be followed.
  - **Phase 1 – Initial Recovery:** Recover as much as possible at the source by pumping free material from the surface and excavating other contaminated materials.
  - **Phase 2 – Source Control:** Begin hydraulic control of the source to prevent spreading of contamination.
  - **Phase 3 – Recovery:** If necessary, install boreholes to remove and treat contaminated groundwater.

5.1.4 Objectives, Criteria and Assessment Methodology

5.1.4.1 Impact Assessment Objectives and Criteria

The extraction operation would intersect the local groundwater table and would therefore have the potential to impact on the water level, quantity, availability and quality of the local groundwater. Objectives and criteria for each of these components is nominated as follows.

Saturated Thickness: As discussed in Section 5.1.2.3.2, groundwater levels and the saturated thickness within bores on neighbouring landholdings would fluctuate naturally in response to rainfall and pumping regime. This notwithstanding, a change in saturated thickness of greater than 10% has traditionally be viewed as significant and potentially greater than natural fluctuation. As such, for the purposes of this assessment, the criteria for assessing the degree of impact upon groundwater level and saturated thickness has therefore been determined to be a >10% decrease in water level or saturated thickness.

Water Quality: It is an acceptable objective for groundwater quality at surrounding bores to remain comparable to the existing quality.

Annual Extraction: It is a requirement under Clause 4 of the Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources for total annual extraction of groundwater not to exceed 200ML/km^2. This would equate to a criterion of approximately 250ML/year for the Project Site.

Water Availability: It is an acceptable objective for water availability that the yield obtained from all surrounding bores remains comparable to the existing yield.

Water Use: It is a requirement that groundwater accessed by the Project, including any incidental water make as a result of groundwater seepage, be licensed under a Water Access Licence (WAL) and use restricted to the licensed quantity. GeoTerra (2009) recommends an initial allocation of 28MLpa, with additional allocation to be obtained as the volume of water actually accessed by the Project is more accurately identified.

It is noted that the following documents make specific reference to the Kulnura Mangrove Mountain Groundwater Sources Water Sharing Plan, hence these three documents are addressed through that water sharing plan.

- The NSW State Groundwater Policy Framework Document
- The NSW Groundwater Quality Protection Policy.
- The NSW State Groundwater Dependent Ecosystem Policy.

The relevant aims, objectives and principles from these documents that need to be addressed for the Project, as presented in the water sharing plan, are as follows.

36 – Extraction interference between neighbours

To minimise interference between extraction under different access licenses in each groundwater source, the following rules will apply to extraction authorised by an access licence:

(a) *extraction from a new or replacement water supply work (bore) for the extraction of basic landholder rights will not be permitted within:*

(i) *50m of the property boundary or,*

(ii) *100m of an approved water supply work (bore) from which basic landholder rights may be extracted.*

(b) *extraction from a new or replacement water supply work (bore) nominated by an access licence will not be permitted within:*

(i) *400m of an approved water supply (bore) nominated by an access license, (ii) 200m of an approved water supply (bore) from which basic landholder rights water may be extracted, or*

(ii) *50m of the property boundary.*

39 Protection of Groundwater Dependent Ecosystems

1. *Extraction of groundwater from a new or replacement water supply work (bore) for any purpose, is excluded within 100m of:*

(a) *high priority groundwater dependent ecosystems listed in schedule 5 and shown in Appendix 4;*

(b) *culturally significant sites, being areas of high conservation value for cultural reasons, as contained in the National Parks and Wildlife Service's or Cultural Site Register; or*

(c) *any river*

2. *Where an applicant can demonstrate to the Minister that the distance conditions in subclause (1) cannot be met, the Minister may consider the application providing the following construction criteria can be met:*

(a) *the water supply work (bore) must only draw water from an aquifer at depths greater than 40m from the land surface;*

(b) *the water supply work (bore) must have an impermeable seal, as specified by the Minister, constructed within the bore to isolate aquifers above 40m depth and to prevent water ingress; and*

(c) *the water supply work (bore) must comply with any access licence and water supply work approval conditions established to mitigate any risk to groundwater dependent ecosystems.*

3. *Pursuant to section 45(1) (b) of the Act, the Minister may amend the exclusion of distance in subclause (1) and (2), based on further studies of groundwater ecosystems dependency undertaken by the Minister.*

Section 5.1.5.8 (**Table 5.10**) presents a summary of how each of these aims, objectives and principles are addressed by Rocla and their consultants.

5.1.4.2 Impact Assessment Methodology

5.1.4.2.1 Groundwater Model

The extent of groundwater inflows into the extraction area voids and the effect the Project would have on groundwater levels, borehole yields, groundwater level re-establishment and availability of groundwater from existing bores has been predicted using a numerical groundwater modelling program, FEFLOW (version 5.3). The model was set-up by Golder Associates Pty Ltd to simulate the groundwater flow within and between the weathered (friable) and competent sandstone of the Project Site.

For consistency, the hydraulic conductivity assumed for the two sandstone layers are the same as used for previous groundwater modelling of extraction at the Calga Sand Quarry (CMJA, 2004). Testing completed by GeoTerra on monitoring piezometers and private bores suggests that the assumed conductivity values are accurate. **Table 5.2** presents the initial hydraulic conductivity parameters for the model.

Table 5.2
Groundwater Model Hydraulic Conductivity Parameters

Layer	Horizontal Hydraulic Conductivity (m/s)	Vertical Hydraulic Conductivity (m/s)
Weathered Sandstone	$1x10^{-6}$	$1x10^{-7}$
Competent Sandstone	$1x10^{-7}$	$1x10^{-8}$
Source: Modified after Golder Associates (2009) - Table 1		

The physical boundaries of the model were set along the major watercourses (Popran Creek and Mooney Mooney Creek) surrounding the Project Site. Mooney Mooney Creek, Mangrove Creek and Popran Creek were represented using Dirichlet (1st kind) boundary conditions. The remaining watercourses were modelled as drains, allowing for removal of groundwater but not allowing for recharge into the groundwater system. Elevation of the creeks was interpolated from the topography data.

Further technical information on the FEFLOW model and application to the Project is provided by Golder Associates (2009), provided as *Appendix A* to GeoTerra (2009).

5.1.4.2.2 Groundwater Model Runs

Modelling was conducted in three stages, as follows.

Stage 1: Steady-State Model Run

An initial steady-state model run was undertaken to calibrate the model to the measured pre-development (or unaffected by extraction) groundwater levels in available observation bores. The steady-state model allowed for identification of a relationship between hydraulic conductivity and recharge, which resulted in an acceptable match between measured and modelled groundwater head in the vicinity of the Project Site.

During calibration, the distribution of rainfall recharge to the model was modified to match the observed and modelled groundwater heads. **Table 5.3** presents the calibrated recharge rates of the model, separated into three zones based primarily on analysis of available maps and aerial photos.

Table 5.3
Model Calibrated Recharge – Base Case

	Zone I[1]	Zone 2[1]	Zone 3[1]
Recharge (mm/yr)	131	261	52
Percentage of rainfall[2]	15%	30%	6%
Note 1: see **Figure A4** of GeoTerra (2009)			
Note 2: Based on Mean Annual rainfall			
Source: Modified after Golder Associates (2009) - Table 2			

Higher recharge values for Zone 2 may indicate an artificial recharge related to the land use in this area.

Stage 2: Project Development Model Run

Following model calibration, four key development stages of the Project were chosen as representative of the progressive development of the Calga Sand Quarry. These model runs are referred to as the base case model scenario.

Insufficient transient monitoring data (including pumping rates from private bores and groundwater inflow rates to the existing quarry) combined with the limited knowledge of the characteristics and fracturing patterns of fractures in the regional Hawkesbury Sandstone restricted the potential for a transient model calibration and diminished the reliability of potential transient model predictions.

As a result, a steady-state model was selected as a more reliable and realistic representation of the long term status of groundwater conditions with the data available.

The four development stages modelled were:

- extraction at the completion of Stage 3;
- extraction at the completion of Stages 3 and 4;
- extraction at the completion of Stage 3, 4 and 5; and
- post-closure conditions following rehabilitation.

Stage 3: Sensitivity Analyses Model Run

Analysis of field tests conducted by GeoTerra (2009) identified that approximately 10% of measured hydraulic conductivities display conductivities lower than 1×10^{-7}m/s and approximately 50% lower than 5×10^{-7}m/s. In order to address the uncertainty of the model and outputs related to the applied hydraulic conductivities, a sensitivity analysis was carried out with hydraulic conductivity of the Hawkesbury Sandstone increased to 5×10^{-7}m/s.

Sensitivity analysis followed the logic outlined above for the steady-state model run in order to calibrate the model, with the same four project development model runs undertaken. These model runs are referred to as the sensitivity analyses model scenario.

Notably, the sensitivity analyses model scenario required far greater recharge values than for the base case model (see **Table 5.4**).

Table 5.4
Model Calibrated Recharge – Sensitivity Analyses

	Zone I[1]	Zone 2[1]	Zone 3[1]
Recharge (mm/yr)	493	588	118
Percentage of rainfall[2]	55%	66%	13%
Note 1: see **Figure A4** of GeoTerra (2009) for zone locations			
Note 2: Based on Mean Annual rainfall			
Source: Modified after Golder Associates (2009) - Table 4			

5.1.5 Assessment of Residual Impacts

5.1.5.1 Determination of Most Likely Model Scenario

When considering the base case and sensitivity analyses model runs, GeoTerra (2009) concludes that the base case represents the most likely scenario given the excessive recharge values required to calibrate the sensitivity analyses scenario (see **Table 5.4**). GeoTerra notes that this conclusion is supported by observation of groundwater level responses to current extraction, observed stream flows, observed extraction area wall inflows and the effect of rainfall recharge on groundwater levels on and surrounding the Project Site.

Based on this determination of the most likely scenario, assessment of residual impacts are restricted to those predicted by the base case model scenario.

5.1.5.2 Groundwater In-flow

Tables 5.5 to **5.7** present the predicted groundwater in-flow to the extraction areas at the completion of Stages 3, 4 and 5.

Table 5.5
Stage 3 Modelled Base Case Groundwater Inflows

Project Development Model Run	Extraction Area	Inflow		
		m^3/d	L/s	ML/year
End of Stage 3	Stage 3	79	0.9	28.4
Source: Modified after GeoTerra (2009) - Table 25				

Table 5.6
Stage 4 Modelled Base Case Groundwater Inflows

Project Development Model Run	Extraction Area	Inflow		
		m^3/d	L/s	ML/year
End of Stage 4	Stage 3	32.7	0.4	
	Stage 4	348	4.0	
	Total	**380.7**	**4.4**	**138.8**
Source: Modified after GeoTerra (2009) - Table 26				

Table 5.7
Stage 5 Modelled Base Case Groundwater Inflows

Project Development Model Run	Extraction Area	Inflow		
		m^3/d	L/s	ML/year
End of Stage 5	Stage 3	26	0.3	
	Stage 4	319	3.7	
	Stage5	95	1.1	
	Total	**440**	**5.1**	**160.8**
Source: Modified after GeoTerra (2009) - Table 27				

Based on the groundwater modelling of Golder Associates (2009), an inflow to the Calga Sand Quarry of 28.4ML/year at the completion of the Stage 3 Quarry, increasing to approximately 160.8ML/year at the end of Stage 5, is predicted.

Under the *Water Management Act 2000*, a water access licence (WAL) is required for any groundwater extracted, including incidental access as occurs as a result groundwater inflows to the extraction area. Based on the predictions presented in **Tables 5.5** to **5.7**, by the completion of Stage 5, a WAL of 161ML may be required. It is noted, however, that inflow rates to the quarry currently fluctuate with rainfall, ie. greater inflows are observed following heavy rainfall than following extended dry periods. It is also relevant to note that semi-quantitative measurements of groundwater inflow to Stage 3 taken by Rocla suggest that modelling over-estimates the actual in-flow rates. Given the relative uncertainty over future inflow rates, GeoTerra recommends a WAL of at least 28ML be obtained prior to commencement of extraction from Stage 4, with inflows monitored/calculated over the initial few years of the Project to establish actual inflow rates, allow for re-calibration of the model and more accurately estimate groundwater inflows. Rocla is currently finalising the purchase of a WAL for 46ML, which combined with WAL 20WA100255 which is assigned industrial usage (for 6MLpa) on Lot 2, DP229889, provides for twice the allocation recommended by GeoTerra (2009). As more accurate estimates of actual groundwater in-flow are made (following re-calibration of the groundwater model), additional WAL allocations would be sought and obtained from within the area covered by the Water Sharing Plan of the Kulnura-Mangrove Mountain groundwater sources.

5.1.5.3 Groundwater Levels/Drawdown

The drawdown in the groundwater table predicted by the model at the completion of Stages 4 and 5 are presented in **Figure 5.5**.

Drawdown at the End of Stage 4

Figure 5.5a illustrates that a relatively steep zone of depression would be created immediately beyond the Stage 4 extraction area. To the south and east, a 5m reduction in the groundwater table would be restricted to within 500m of the Stage 4 extraction area, with groundwater table reduction restricted to 1m within 1 250m of the Stage 4 extraction area.

Due to the presence of the Stage 3 void and moderate slope to Cabbage Tree Creek to the west, the reduction in the groundwater table is even less than to the south and east. A reduction in the groundwater table of greater than 1m would be restricted to within 600m of the Stage 4 extraction area. Up to eight bores are predicted to incur a standing water level reduction of between 1m and 5m, with the remainder located beyond the 1m drawdown contour.

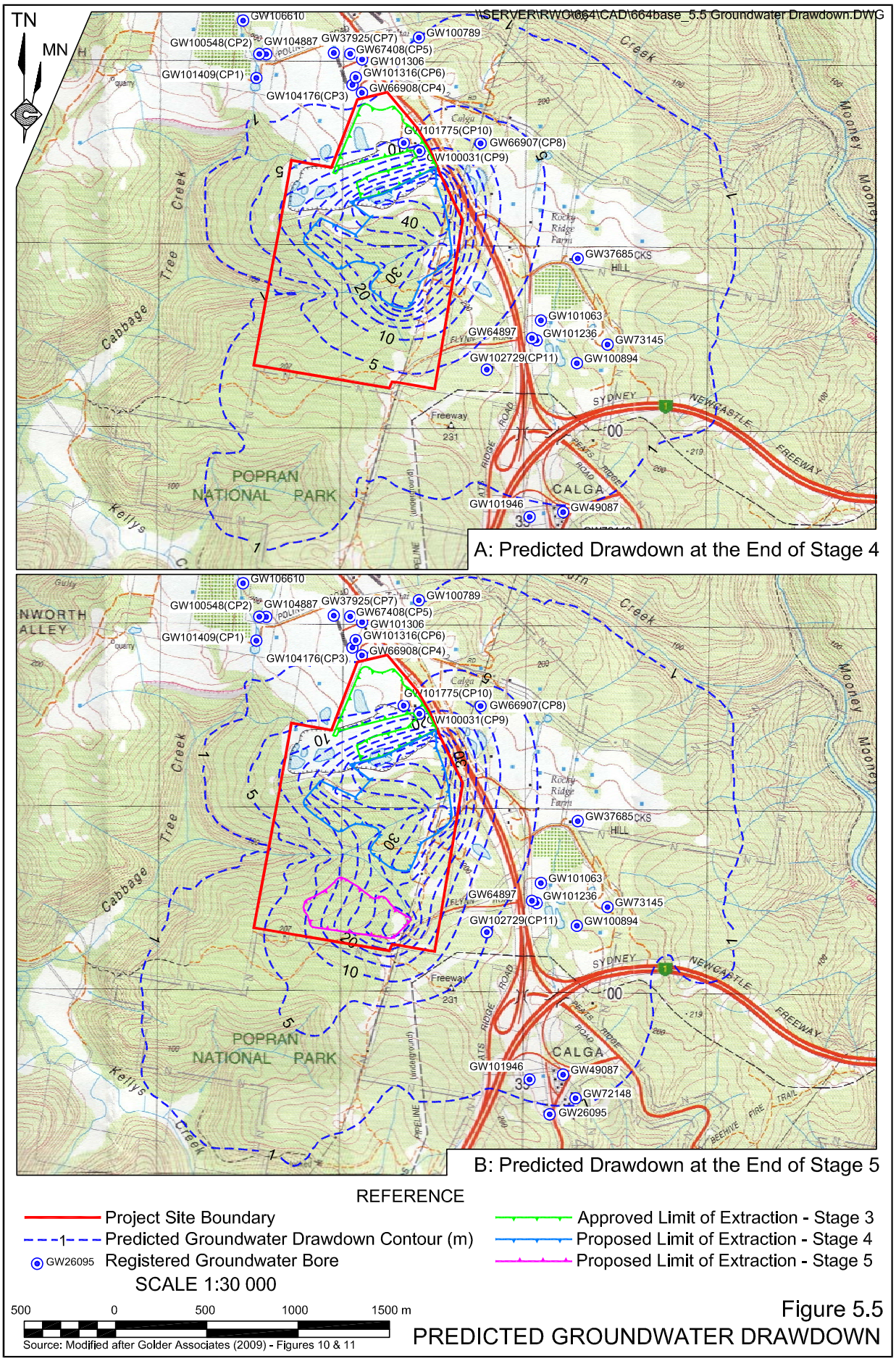


Figure 5.5
PREDICTED GROUNDWATER DRAWDOWN

Drawdown at the End of Stage 5

Figure 5.5b illustrates that at the completion of the Stage 5 extraction area, the area of groundwater depression resultant from the Project would extend slightly to the south, as a direct consequence of the extraction of sand from further south within the Project Site. While the area of influence would extend further to the south, the 5m and 1m groundwater table reduction would still remain at 500m and 1 250m to the south and east, with a 1m reduction in the groundwater table restricted to within 600m to the north and west.

Up to seven bores are predicted to incur a standing water level reduction of between 1m and 5m, with the bore on the Australia Wildlife Walkabout Park (GW102729) predicted to incur a drawdown of approximately 5m. The exact level of drawdown is yet to be established. Monitoring of groundwater levels in this bore is due to commence in December 2009. The remaining bores are located beyond the 1m drawdown contour.

Drawdown Following Completion of the Project and Rehabilitation

The modelling of Golder Associates (2009) anticipates that the long-term groundwater table beneath the Project Site would not vary significantly from that predicted to follow the completion of the Stage 5 Extraction Area. There would be a localised reduction below the Stage 3 and 4 extraction areas, as a consequence of the reduced recharge rates associated with the consolidated and capped silt cells which cover the majority of the profiled quarry floor. These localised reductions in recharge rate would be partially compensated by an increase in recharge within the Stage 5 final landform, resultant from the increased areas for pooling water created.

5.1.5.4 Groundwater Seepage to Local Creeks and Creek Flow

Due to the groundwater depressurisation created by the extraction, GeoTerra (2009) suggests that the quantity of groundwater seepage toward the west-southwest into the Cabbage Tree Creek system would reduce during the active extraction phase of the Project. This would be partially mitigated by the seepage attributable to ponded water in the extraction area water storages and silt cells, however, the general impact would be a reduction in base flow seepage to the southwest. However, following the cessation of extraction and rehabilitation of the extraction area, it is anticipated that discharge to the Cabbage Tree Creek system would increase as a result of the additional recharge from ponded water at the base of the extraction areas in silt cells and water storage dams as well as within the Stage 5 final landform.

Using the same FEFLOW model, Golder Associates (2009) modelled the current groundwater base flow received by the creeks of the Project Site prior to Project development, at the end of Stages 4 and 5, and following quarry closure and rehabilitation. **Table 5.8** presents the predicted discharge to the Creeks A, B and C within the Project Site as well as Cabbage Tree Creek.

The modelled steady-state rates should be regarded as long term averages, with actual groundwater contributions into the stream flow being higher during wet periods and lower (or nil) during the dry seasons.

Table 5.8
Current and Predicted Base Case Groundwater Discharge to Local Creeks

	Inflow (L/s)			Inflow (ML/yr)		
	Cabbage Tree Creek	**Project Site Creeks**	**Total**	**Cabbage Tree Creek**	**Project Site Creeks**	**Total**
Current Stage	6.8	4.5	**11.3**	214.4	141.9	**356.3**
End of Stage 4	6.4	3.2	**9.6**	201.8	100.9	**302.7**
End of Stage 5	6.4	3.4	**9.7**	201.8	107.2	**309**
Post-Closure	7.3	5.1	**12.4**	230.2	160.8	**391**
Source: Modified after GeoTerra (2009) - Table 28						

The modelling of Golder Associates (2009) confirms the original statement suggesting an eventual re-instatement of base flows to the local creek system. A steady-state discharge rate of 11.3L/s (356.3ML/yr), the development of the Project would be reduced by approximately 15% to 9.6L/s (302.7ML/yr) at the end of Stage 4, before increasing again to 12.4L/s (391ML/yr) following quarry closure and rehabilitation. This final base flow discharge represent an increase of approximately 10% on current rates.

5.1.5.5 Groundwater Quality

5.1.5.5.1 Groundwater

The groundwater quality on and to the north of the Project Site currently reflects the effects of:

- piezometric surface and rainfall recharge variability through wet and dry seasonal/climatic periods;
- minor depressurisation of aquifers to the north and east of the existing quarry, with limited to no additional oxidation of minerals in the sandstone and generation of dissolved metals in groundwater; and
- use and storage of mixed groundwater/rainwater and silt cell drainage in the base of the pits.

The groundwater quality to the south and east of the Project Site, however, currently reflects an essentially “undisturbed” groundwater quality signature.

Currently, local groundwater of private bores exceeds drinking water criteria for:

- pH;
- aluminium; and (to a lesser degree)
- lead.

Local groundwater also exceeds, to varying levels, ANZECC 2000 95% Freshwater Ecosystem Protection Guidelines for:

- pH;
- aluminium;
- lead;
- zinc;
- copper;
- nitrate/nitrite; and
- cadmium, manganese and nickel

None of the proposed activities of the Project would be likely to significantly alter quality of the groundwater in the monitoring and private bores surrounding the Project Site. It is therefore expected that local groundwater would continue to exceed drinking water and ANZECC (2000) 95% Freshwater Ecosystem Protection Guidelines criteria for the same parameters at similar concentration ranges to those currently measured.

GeoTerra (2009) suggests it is also possible that minor exceedances involving manganese, cadmium or nickel may occur at similar levels to those currently observed down-gradient of the approved Calga Sand Quarry.

Given the commitment made by Rocla in relation to the management of pollutants such as hydrocarbons, GeoTerra consider it as highly unlikely that there would be any contamination of groundwater, and subsequent discharge as base flows to local creeks.

5.1.5.5.2 Base Flows to Local Creeks

It is anticipated that water quality in Cabbage Tree Creek down-gradient of the Project Site would not be observably adversely affected by the activities of the Project and would continue to reflect the impact of acidic low salinity seepage from the Hawkesbury Sandstone intermixed with neutral pH, low salinity rainwater runoff.

It is equally unlikely that any observable change in water quality in Cabbage Tree Creek would occur following the creation of the final landform within the Project Site following quarry closure (GeoTerra, 2009).

5.1.5.6 Water Resources Use and Availability

As noted in Section 5.1.5.3, eight private bores are located between the 1m and 5m groundwater reduction zone, with one bore, GW102729 on the Australia Wildlife Walkabout Park, predicted to incur a groundwater reduction of approximately 5m, ie. subject to confirmation of measured groundwater levels. For all other bores, the predicted drawdown of the groundwater table would be less than 1m. **Table 5.9** presents the predicted drawdown in the registered bores that could potentially be affected by the Project.

Table 5.9 indicates that the drawdown in seven of the eight bores where the drawdown is predicted to exceed 1m represents a loss in available drawdown of less than 10%. The predicted drawdown within CP8 (GW66907) of approximately 4m is equivalent to 16% of its available drawdown (ie.4m/24m) which, based on limited monitoring data from this bore, is likely to be greater than natural fluctuation (see *Figure 8* of GeoTerra, 2009). However, the bore would still retain at least 20m of available drawdown and consequently, it is not anticipated that groundwater yield in this or other local bores would be adversely affected due to the proposed extraction activities. Any change to groundwater pumping flow rates in the adjoining private bores is anticipated to be indiscernible from the current status.

Table 5.9
Predicted Drawdown on Registered Groundwater Bores Surrounding the Project Site

Registered Bore Reference[#]	Local Bore Reference	Land Owner	Potential Drawdown			Available Drawdown Post Stage 5 (m)
			Stage 4 (m)	Stage 5 (m)	Post Closure (m)	
101409	CP1	T. & J. Gazzana	<1m	<1m	<1m	55
100548	CP2	T. & J. Gazzana	<1m	<1m	<1m	33
104176	CP3	T. & J. Gazzana	<1m	<1m	<1m	64
66908	CP4	B. Kashouli	<1m	<1m	<1m	23
67408	CP5	B. Kashouli	<1m	<1m	<1m	65
101316	CP6	B. Kashouli	<1m	<1m	<1m	76
37925	CP7	B. Kashouli	<1m	<1m	<1m	72
66907	CP8	F. & G. Rozmanec	1-5m	1-5m	1-5m	20
37685	-	Tokoloshe Pty Ltd	1-5m	1-5m	1-5m	unknown
49087	-	GIS Seddon	<1m	1m	1m	29
64897	-	N. Soulis	1-5m	1-5m	1-5m	40
72148	-	R. & D. Chancellor	<1m	1m	1m	20
73145	-	J. H. Hunt	1-5m	1-5m	1-5m	44
100894	-	J. H. Hunt	1-5m	1-5m	1-5m	67
101063	-	N. Soulis	1-5m	1-5m	1-5m	53
101236	-	N. Soulis	1-5m	1-5m	1-5m	53
101946	-	S. Hooper	<1m	1m	1m	56
CP11	Walkabout Park Bore	T. Barnard	1-5m	5m	5m	41

Source: Modified after GeoTerra (2009) – Table 24 # Locations displayed on **Figure 5.4**

5.1.5.7 Groundwater Dependent Ecosystems

Impacts on groundwater dependent ecosystems are considered in Section 5.3.7.3.

5.1.5.8 Regulatory Compliance

The predicted groundwater inflow into the extraction area of the Project (up to 161MLpa) would be well within the 250ML annual criteria nominated in the Kulnura Mangrove Mountain Groundwater Sources WSP. Hence, there would still remain a quantity of water for other users to recover from the Calga area.

Rocla is currently finalising the purchase of a WAL for 46ML, which combined with WAL 20WA100255 which is assigned industrial usage on Lot 2, DP229889, provides for twice the allocation recommended by GeoTerra (2009) (see Section 5.1.5.2). Through monitoring of groundwater drawdown, rainfall and water usage, Rocla would be able to calculate the actual in-flow of groundwater to the extraction area and through extrapolation of this data determine the total WAL allocation required as Stages 4 and 5 are progressively developed.

Table 5.10 sets out the status of the Project with respect to the aims, objectives and principles of the various NSW Groundwater Plans and Policies previously discussed in Section 5.1.4.1.

Table 5.10
Assessment of Proposal in Accordance with State Government Groundwater Plans and Policies

Clause from Water Sharing Plan	Comments
36 – Extraction interference between neighbours	
(1) To minimise interference between extraction under different access licenses in each groundwater source, the following rules would apply to extraction authorised by an access license: *(a) extraction from a new or replacement water supply work (bore) for the extraction of basic landholder rights would not be permitted within:* *(i) 50m of the property boundary or,* *(ii) 100m of an approved water supply work (bore) from which basic landholder rights may be extracted.* *(b) extraction from a new or replacement water supply work (bore) nominated by an access licence would not be permitted within:* *(i) 400m of an approved water supply (bore) nominated by an access license,* *(ii) 200m of an approved water supply (bore) from which basic landholder rights water may be extracted or* *(iii) 50m of the property boundary.*	The proposed Southern Extension extraction area is located: - in excess of 50m of the property boundary; and - in excess of 100m from approved bores and other water supply works with basic landholder rights. The proposed Southern Extension therefore satisfies the requirements of parts (a) and (b) of clause 36(1).
(2) Not withstanding the provisions of subclause (1), the Minister may, upon application by an access licence holder, vary the distance restrictions specified in subclause (1) if: *(2) Not withstanding the provisions of subclause (1), the Minister may, upon application by an access licence holder, vary the distance restrictions specified in subclause (1) if:* *(b) the applicant has sought written comment from the potentially affected licence holders, and submits these comments to the Minister for consideration, **and*** *(c) there is a process for remediation in the event that any local impact occurs in the future, specified as conditions in the licence.*	A hydrogeological study was undertaken to assess the potential for adverse impact in accordance with clause 36(2). A hydrogeological study has been completed. The impact in *Section 6* of GeoTerra (2009). Discussions have been held with potentially impacted land and licence holders regarding the potential drawdown of their bore. Section 5.1.3.2 provides a summary of the contingency measures to be implemented in the even remediation of impact on local water supply is required. Notably, a Groundwater Contingency Plan has been in place for the existing Calga Sand Quarry since early 2006 (ie. as a condition of Development Consent DA 94-4-2004). Rocla would update this plan on receipt of project approval for the Project (see Section 5.1.6.2).
(3) Subclause (1) does not apply to extraction under existing access licences until such time as the relevance water supply work (bore) is replaced.	This subclause is not applicable to this project.

Table 5.10 (Cont'd)
Assessment of Proposal in Accordance with State Government Groundwater Plans and Policies

Clause from Water Sharing Plan	Comments
(4) The maximum authorised extraction resulting from extraction authorised by a new access licence nominating a water supply work (bore) at a particular location, on the operation of Part 11 of this Plan, is not to exceed 200ML/yr per km^2	The Project Site covers an area of 130ha (1.3km^2). The predicted maximum annual in-flow is 161ML/year. Therefore, the maximum extraction rate for the nominated water supply work (bore) would approximate 161 / 1.3 = 124ML/year/km^2. The predicted maximum inflow of groundwater (extraction) is predicted to remain <62% of the maximum permitted under the WSP.
(5) Pursuant to Section 45(1) (b) of the Act, the Minister may amend the maximum extraction density established in subclause(4) if change is required as a result of further studies undertaken by the minister.	Not required
(6) Any change to the maximum extraction density result from subclause (5) is to be within the range of 12ML/year per sqkm to 200 ML/year per sqkm	Not required
39 Protection of Groundwater Dependent Ecosystems	
(1) Extraction of groundwater from a new or replacement water supply work (bore) for any purpose, is excluded within 100m of:	
(a) high priority groundwater dependent ecosystems listed in schedule 5 and shown in Appendix 4	There are no WSP identified high priority groundwater dependent ecosystems within 100m of the proposed extraction areas.
(b) culturally significant sites, being areas of high conservation value for cultural reasons, as contained in the National Parks and Wildlife Service's or Cultural Site Register, or	A buffer zone to the identified Aboriginal heritage sites has been included in the design of the extraction areas in accordance with the recommendations of ASR (2009) and the Darkinjung Local Aboriginal Land Council.
(c) any river	The WSP does not provide a definition of a river, however, in the dictionary of the WM Act a river includes: "*any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved.*" By this definition, incidental extraction of groundwater would be undertaken within 100m of a river.
(2) Where an applicant can demonstrate to the Minister that the distance conditions in subclause (1) cannot be met, the minister may consider the application providing the following construction criteria can be met:	Given the alignment of Creeks A, B and C, which traverse the Project Site from east to west, the distance conditions of subclause (1) cannot be met.
(a) the water supply work (bore) must only draw water from an aquifer at depths greater than 40m from the land surface;	It is predicted that groundwater would seep into the extraction area at elevations higher than 40m bgl. It is noted, however, that this would have minimal impact on base flows to the Creek C catchment (between 8% and 13% averaged over the life of the Project). Also notable is the fact that following the completion of extraction, it is predicted that the Project would provide for an increase in flow to the creeks, particularly for flows of less than 1ML/day, i.e. a net benefit to any GDEs of the local and regional catchments (see Evans and Peck, 2008 & Section 5.2.6.2).
(b) the water supply work (bore) must have an impermeable seal, as specified by the minister, constructed within the bore to isolate aquifers above 40m depth and to prevent water ingress and	Due to the nature of the water supply work construction (quarry), constructing an impermeable seal is impractical.

Table 5.10 (Cont'd)
Assessment of Proposal in Accordance with State Government Groundwater Plans and Policies

Clause from Water Sharing Plan	Comments
(c) the water supply work (bore) must comply with any access licence and water supply work approval conditions established to mitigate any risk to groundwater dependent ecosystems	An evaluation of groundwater dependent ecosystems is presented in Section 5.3.7.3 and considers the assessment of impact on GDEs provided by GeoTerra (2009) - Section 6.6 and Cumberland (2009) - Section 5.6.
(3) Pursuant to section 45(1) (b) of the Act, the Minister may amend the exclusion of distance in subclause (1) and (2), based on further studies of groundwater ecosystems dependency undertaken by the Minister.	An assessment of impact on GDEs is provided in Section 5.3.7.3. This assessment considers studies undertaken by Cumberland Ecology, 2009 (Ecological Impact Assessment), GeoTerra, 2009 (Groundwater Impact Assessment) and Evans and Peck, 2008 (Surface Water Assessment) and is considered to be in sufficient detail for the Minister to determine that the residual impacts of the Project on GDEs are acceptable.

5.1.6 Groundwater Monitoring and Contingency Strategy

5.1.6.1 Groundwater Monitoring

Rocla currently operates a comprehensive groundwater monitoring program over the Project Site and surrounding lands. **Figure 5.6** identifies the bores which are currently monitored for water level and/or water quality and **Table 5.11** summarises the monitoring undertaken within each bore.

Table 5.11
Groundwater Monitoring Program

	Location[#]	Frequency
Continuous Water Levels	CQ1, CQ3, CQ4, CQ7, CQ8, CQ10, CQ11S, CQ11D, CQ12, CQ13 & MW7 to MW10	Continuously recorded but downloaded and analysed monthly
Standing Water Levels	Bores CQ5, CQ6, CQ9, CP3 to CP8, MW13 & MW16	Monthly
Water Quality (pH & EC)	CQ1, CQ3 to CQ13, CP3 to CP8, MW7 to MW10, MW13 & MW16	Monthly
Water Quality (cations & anions)	CQ1, CQ3 to CQ13, CP3 to CP8, MW7 to MW10, MW13 & MW16	six monthly
Private Bore Yield	CP1 to CP11	In response to declining trend in groundwater level or request from private landholder
Note #: See **Figure 5.6**		

Rocla is soon to commence monitoring water levels and water quality at Bore CP11 within the Australia Walkabout Wildlife Park.

Rocla would continue, and adjust as required, this monitoring program specifically to ensure only meaningful data is being collected. Adjustments may relate to frequency and locations of monitoring and/or water quality analytes tested. Any changes to the existing groundwater monitoring program would be implemented only following consultation with neighbouring land owners and the Department of Planning and approval by the Director-General of the Department of Planning.

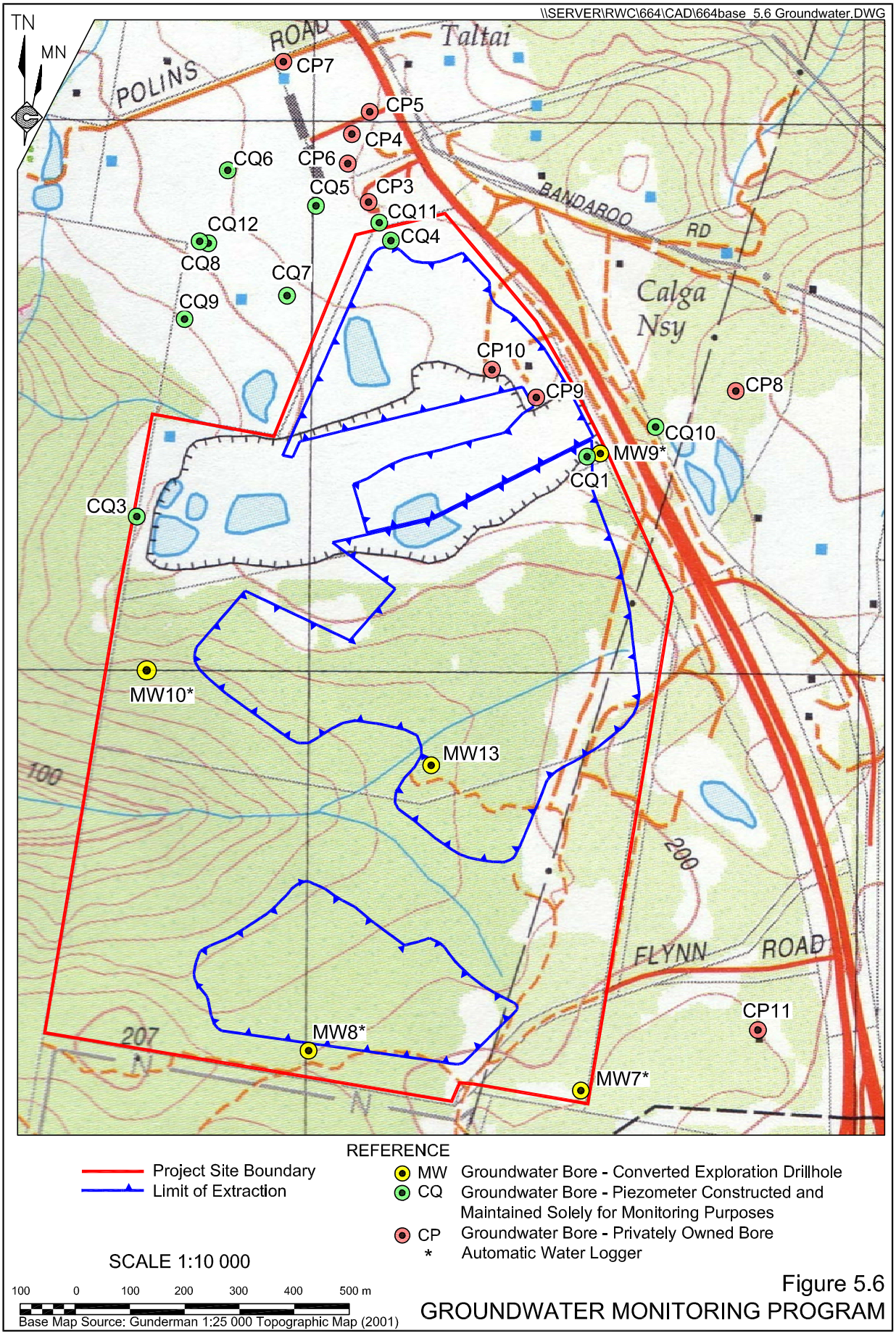


Figure 5.6
GROUNDWATER MONITORING PROGRAM

5.1.6.2 Groundwater Contingency Strategy

Sections 5.1.3.2 and 5.1.3.3 provide the proposed (contingency) measures to minimise impacts on the supply of water (quality and quantity) to the environment and local land owners surrounding the Project Site. These measures would be implemented in response to any impacts on groundwater quality, level or availability identified by the monitoring program.

Impact assessment criteria and implementation of the nominated contingency measures have previously been documented for the Calga Sand Quarry within the approved Site Water Management Plan (RWC/PDA/GSSE, 2006). The current contingency strategy is as follows.

- If at any annual independent audit review, there is a declining trend in groundwater levels which is not attributable to climatic conditions or other factors not related to the sand extraction activities, and if the groundwater level decline at monitoring bores CQ10 or CQ11 deemed due to sand extraction impacts exceeds 1.0m, then the adjoining landholders would be approached to arrange re-testing of their existing production bore(s). The test results would be compared to pre-extraction tests, and if it is determined that any bore has suffered a reduction in its pumping yield of greater than 10% (in accordance with *Condition 3(10)*, then arrangements would be made with the affected landholder to restore water supply potential, by one of the following means.
    1. Supply of an equivalent water supply by pumping from a production bore on Rocla's property.
    2. Deepening of the affected bore (if feasible).
    3. Drilling a deeper replacement bore.
    4. Another arrangement mutually acceptable to the landholder and Rocla.
- If at any other time, a landholder's bore within 500m of the quarry suffers a reported loss of yield >10% due to declining groundwater levels, the loss of yield would be notified to both the Director-General and the affected landholders (in accordance with *Condition 4(1)*). The Company would also commission an independent hydrogeologist to conduct an investigation regarding the loss of yield. The investigation would include a review of all monitoring data, and if necessary a re-testing of the bore to allow comparison of performance with previous tests. If the investigation reveals that the loss of yield is attributable to the sand extraction activities, then arrangements would be made with the landholder to restore the supply by one of the means described above.

This Groundwater Contingency Strategy would be reviewed and adjusted to reflect the extension to the extraction area and performance indicators relevant to the proposed southern extension. The Departments of Planning, and Environment, Climate Change and Water (DoP and DECCW) would be consulted to ensure all feasible contingent measures are included.

5.2 SURFACE WATER

5.2.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential surface water impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Erosion of disturbed areas on the Project Site (moderate risk).
- Erosion of rehabilitated final landform (high risk).
- Discharge of sediment-laden or turbid water from the Project Site (moderate to high risk).
- Reduced environmental flows to Cabbage Tree Creek catchment (high risk).
- Temporary degradation of downstream water quality through minor discharge/ spill of dirty or contaminated water (moderate risk).
- Long term contamination of downstream water quality through major or repeated discharge/spill of contaminated or dirty water (high to extreme risk).
- Reduced groundwater availability to groundwater dependent ecosystems downstream of the Project Site (high risk)[1].

In addition, the Director-General's Requirements issued by the Department of Planning require that the assessment of surface and groundwater include a *"… site water balance, and a description of the proposed water management system, including any sediment/water supply dams."* as well as a *"… surface and groundwater contingency strategy which details the measures proposed to minimise impacts on supply of water (quality and quantity) to the environment and local land owners …"*, and refer to the following guideline and policy documents:

- Soils and Construction: Managing Urban Stormwater (Landcom, 2004);
- Guidelines for Fresh and Marine Water Quality (ANZECC, 2000);
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC).

The following subsections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls safeguards and mitigation measures and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

The surface water assessment was undertaken by Evans and Peck Pty Ltd. The full assessment (Evans and Peck, 2008) is presented as Part 2 of the *Specialist Consultant Studies Compendium*, with the relevant information from the assessment summarised in the following subsections.

[1] This potential impact is considered in Section 5.3 of the *Environmental Assessment*.

5.2.2 The Existing Environment

5.2.2.1 Regional Drainage

The Project Site is located within the Cabbage Tree Creek catchment, an ephemeral stream that flows southwest into Kellys Creek and then, a further 500m downstream into the tidal section of Popran Creek. Popran Creek is a major lower tributary of Mangrove Creek, which in turn discharges into the Hawkesbury River. Popran Creek rises at Central Mangrove and follows a southerly path for about 17km before turning to flow westward for about 2km to join Mangrove Creek about 4km upstream of its confluence with the Hawkesbury River. Popran Creek has a catchment area of approximately 65km^2 at its confluence with Mangrove Creek of which nearly all lies upstream of Kellys Creek and Cabbage Tree Creek that drain from the vicinity of the Project Site.

For the majority of its length, Popran Creek flows in steep rocky gorges with slopes in excess of 70% on either side. These steep gorges typically extend 600m to 700m away from the creek. The hill slope above the gorges gives way to more gentle slopes of 3% to 5% near the ridge top. These more gentle slopes have been extensively developed for horticulture.

5.2.2.2 Local Drainage

Cabbage Tree Creek and Kellys Creek, covering areas of 7.0km^2 and 5.5km^2 respectively, draw water form the southwestern slopes of the Somersby Plateau. The general topography of the Cabbage Tree Creek catchment and surrounding catchments is gently sloping in the upper catchment areas near ridgelines, changing to steep sided valleys with gently sloping valley floors in lower catchment areas.

Figure 5.7 presents the Project Site within the upper section of the Cabbage Tree Creek catchment. Kellys Creek is identifiable in the southwestern corner of **Figure 5.7**, and tributaries of Popran Creek are identifiable in the northwestern corner of the figure.

5.2.2.3 Project Site Drainage

Figure 5.8 presents the topography (at 1m contour intervals) and surface drainage of the Project Site. The drainage of the Stage 3 extraction area has been highly modified with flows from the northeast diverted around the acoustic bund of the extraction area and diverted either into the Dam 7a/b on the existing Calga Sand Quarry site or downstream of the Project Site via a variable diversion weir structure. Surface water within the extraction area of Stage 3 flows to the southwest and into Dams 7a and 7b/c, with clarified water discharging from Dam 7b/c into the Cabbage Tree Creek catchment.

Stages 4 and 5 are located on a slope that generally falls in a westerly direction at slopes of between 1% and 11%. The main ridge that forms the catchment divide underlies Peats Ridge Road. Drainage over the Southern Extension area flows to the west is conveyed in a westerly direction by tributaries of Cabbage Tree Creek (located approximately 500m from the western boundary of the Project Site). These unnamed tributaries have been identified as Creeks A, B and C throughout this report (see **Figure 5.8**) and are described as follows.

- Creek A drains Stage 4 from northeast to southwest and flows into the westerly flowing Creek C. Creek A is a first order stream according to the Strahler system of classification (Strahler, 1957).

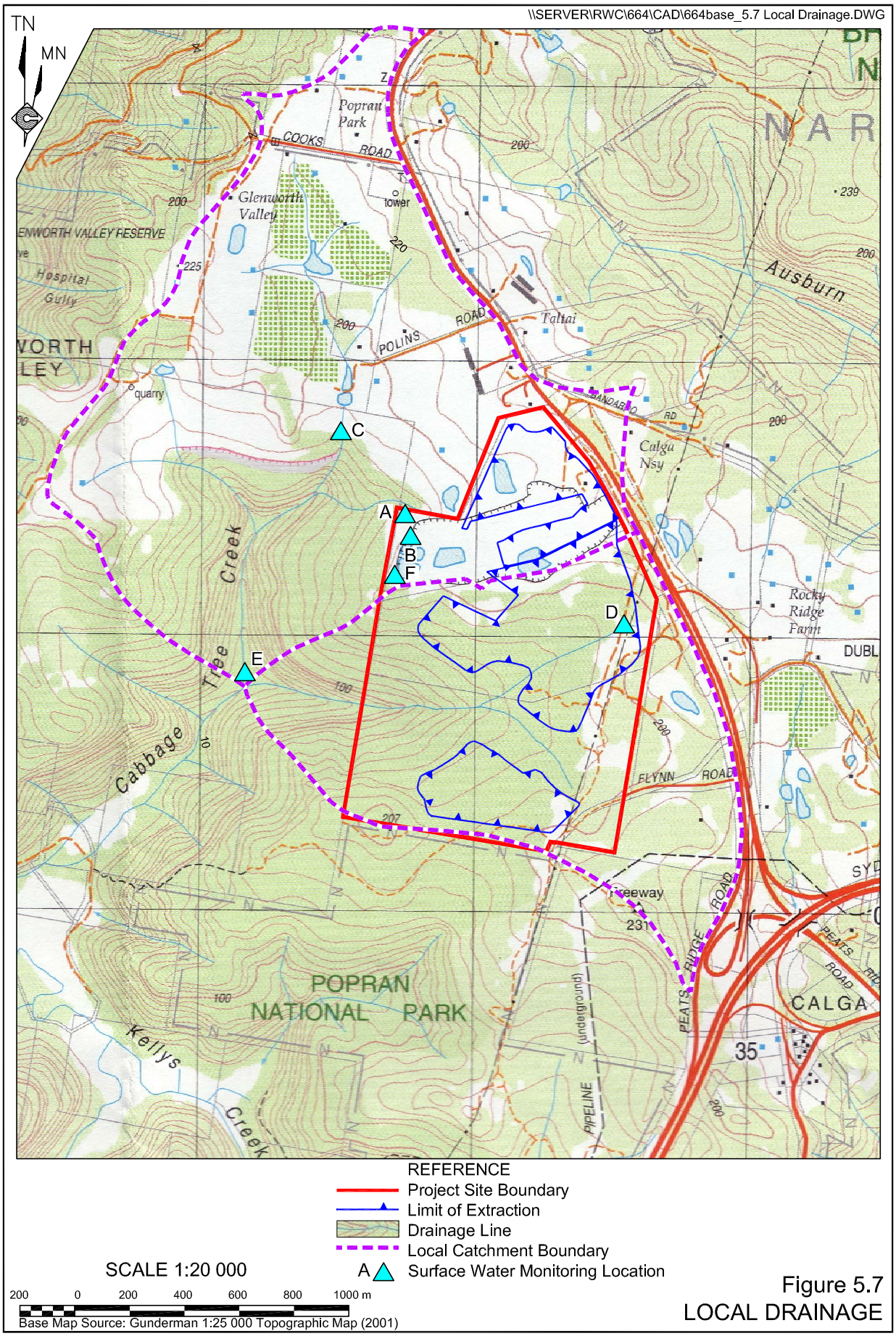


Figure 5.7
LOCAL DRAINAGE

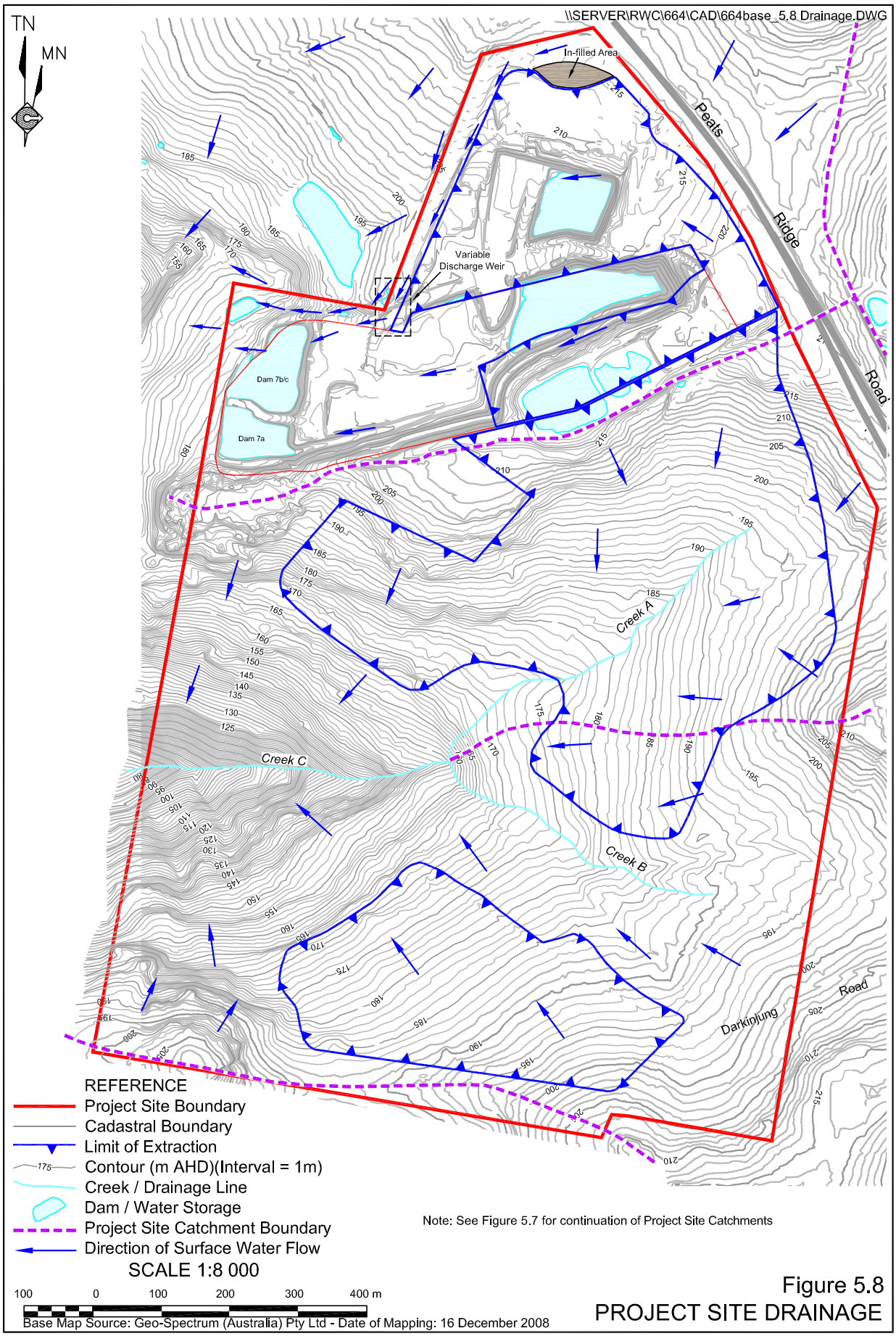


Figure 5.8
PROJECT SITE DRAINAGE

- Creek B lies flows from southeast to northwest joins Creek A to form Creek C. Creek B is a first order stream according to the Strahler system of classification.
- Creek C, which conveys flow from Creeks A and B to Cabbage Tree Creek, has a catchment area of 163ha (see **Figure 5.7**). Creek C is a second order stream according to the Strahler system of classification.

Observation of local flows and vegetation suggests that groundwater discharges into these creeks, presumably along the interface between the more permeable upper layers and the less permeable underlying rock. The flow regime in the local creeks can, therefore, be expected to exhibit less variation in flow than in creeks that do not have such a high proportion of base flow (Evans and Peck, 2008).

There are no stream flow records for Cabbage Tree Creek or Popran Creek, and therefore in order to provide a sound technical basis for the assessment of the impact of the Project on the hydrologic regime of the local creeks, Evans and Peck (2008) completed hydrologic modelling of Creeks A, B and C using a 38 year meteorological dataset and the AWBM program (Boughton, 1984). The AWBM model uses rainfall and evaporation data, together with parameters that reflect the hydrologic processes in a catchment, to generate daily runoff. **Table 5.12** presents a summary of the daily and annual flow data within Creeks A, B and C.

Table 5.12
Modelled Flow Statistics for Creeks A, B and C
(Pre-development Conditions)

Statistic	Daily Flow (ML/day)	Annual Flow (ML/year)
Average	1.08	395
10th Percentile	1.42	864
Median	0.165	264
80th Percentile	0.062	112
90th Percentile	0.039	84
95th Percentile	0.025	77
Source: Modified after Evans and Peck (2008) – Table 5		

Based on the hydrologic modelling, the estimated average pre-Project annual runoff from the catchment at the junction with Cabbage Tree Creek is 395ML/year. The flow in the creek would vary markedly as a result of the variations in weather, eg. in a 10th percentile wet year, an annual flow of 864ML/year can be expected to be about 10 times that in a 90th percentile dry year (84 ML/year).

5.2.2.4 Water Quality

Water quality has been monitored at five sites identified on **Figure 5.7** for a number of years (between 3 and 26 samples have been taken from each site), with the results summarized in **Table 5.13**.

Opportunistic surface water samples have also been taken from Creeks A and B, with the pH recorded varying from 4.61 to 5.42. The low pH value is likely to be due, at least partially, to the groundwater base flow contribution to surface water drainage in the creeks (the pH of groundwater within bores monitored on the Southern Extension area of the Project Site returned average pH of between 4.6 and 6.4).

Table 5.13
Summary of Surface Water Quality Monitoring

Site	Statistic	pH	Electrical Conductivity (µS/cm)	Oil & Grease (mg/L)	Suspended Solids (mg/L)
	ANZECC Criteria[1]	**6.5 – 7.5**	**125 – 2 200**	**<10**	**<50**
A	Number of samples	26	26	26	26
	Average	5.69	76	5.0	12
	Minimum	4.63	53	4.0	2
	Maximum	7.23	100	18.0	46
	Std Dev	0.67	16	na	10
B	Number of samples[2]	3	3	<5	3
	Average	6.07	105	<5	6
	Minimum	6.10	75	<5	6
	Maximum	6.30	131	<5	8
	Std Dev	0.25	28	na	2
C	Number of samples	4	4	3	4
	Average	6.13	113	9.3	4
	Minimum	6.00	110	4.0	2
	Maximum	6.20	120	16.0	5
	Std Dev	0.10	5	6.1	1
D	Number of samples[2]	4	4	<5	4
	Average	5.84	66	<5	119
	Minimum	5.70	42	<5	6
	Maximum	6.13	83	<5	320
	Std Dev	0.20	18	na	148
F	Number of samples	22	22	22	22
	Average	5.76	74	<5	22
	Minimum	4.36	56	<5	2
	Maximum	7.91	101	7	104
	Std Dev	0.91	14	na	25

Note 1: ANZECC (2000) values are default trigger values for lowland rivers in eastern Australia
Note 2: Sites visited on four other occasions when there was no flow
Source: Modified after Evans and Peck (2008) – Table 6

Table 5.14 summarises all available surface and groundwater quality data. The monitoring sites have been classified as either creeks unaffected by Stage 3 operations (Monitoring Sites C and D, and the opportunistic samples from Creeks A and B), water potentially affected by drainage from the existing Stage 3 operations (Monitoring Sites A, B and F) and groundwater.

Table 5.14
Summary of Water Quality Data

Analyte	Units	ANZECC (2000) Trigger Levels	Creeks Unaffected by Stage 3[1] (Sites C, D)	Creeks Potentially Affected by Stage 3[1] (Sites A, B, F)	Groundwater[1]
pH Value		6.5-7.5	5.9 (5.70 – 6.20)	5.8 (4.36 – 7.91)	5.1 (4.6 – 6.4)
Conductivity @ 25°C	µS/cm	125-2,200	97 (42 – 120)	74 (53 – 151)	126 (76 – 138)
Suspended Solids	mg/L	50	62 (2 – 320)	22 (2 – 104)	

Note 1 Range of values shown in parentheses

Typically, all sources show the following average characteristics.

- pH in the range of 5.1 to 5.9.
- Electrical conductivity in the range of 74µS/cm to126µS/cm.
- Suspended solids of surface water in the range of 22mg/L to 62 mg/L.

The electrical conductivity and suspended solids values are typical of freshwater streams and are well within ANZECC default trigger levels for lowland streams. Both surface water and groundwater exhibit pH levels (5.1 to 5.9) which are more acid than the ANZECC default trigger levels (6.5 to 7.5). However, the fact that the Project Site is near the top of the Popran Creek catchment suggests that the natural background pH in this area is below the ANZECC default trigger levels.

5.2.3 Management Issues

5.2.3.1 Introduction

The Project has the potential to impact upon both the quality and quantity of surface water flowing from the Project Site. The following subsections identify the potential impacts that have been considered in the design of surface water management controls for the Project Site.

5.2.3.2 Potential Sources of Water Pollution

The potential sources of water pollution from the proposed activities within the Project Site are as follows.

i) Runoff from areas disturbed in advance of and during extraction activities.

ii) Runoff from stockpiles of topsoil, subsoil and overburden stockpiles.

iii) Surface runoff from product stockpiles.

iv) Surface runoff from rehabilitated areas prior to full stabilisation.

v) Discharge of water from water storages.

vi) Runoff from hardstand areas including roads, processing and other areas.

vii) Leakage or spillage of hydrocarbons.

Suspended solids, ie. sand, silt, or clay particles in water and hydrocarbons are therefore likely to be the major sources of pollution.

Section 5.2.4.3.2 provides a summary of the design specifications for the controls to be implemented to reduce the potential risk of surface water contamination. Section 5.2.6.3 presents the residual impacts predicted following the implementation of these controls.

5.2.3.3 Potential Changes to Surface Water Flows

Development of the Project would necessitate the clearing of vegetation and construction of hardstand areas which could potentially result in increased surface water runoff within the affected sub-catchment and subsequently from the Project Site. It is also likely that the volume of water leaving the Project Site may decrease as a result of surface water being captured within the extraction areas and water storages constructed on the Project Site.

Hydrological modelling has been completed by Evans and Peck (2008) based on the proposed sequence of quarry development and construction of various water management controls and storages on the Project Site to predict the likely impact of these activities during dry, average rainfall and wet years. Section 5.2.5 provides an overview of the modelling undertaken. Sections 5.2.6.1 and Section 5.2.6.2 present an assessment of the residual impacts predicted by the modelling.

5.2.3.4 Water Availability

The proposed increase in production from 400 000tpa to 1 000 000tpa would require an increase in water use for sand washing and dust suppression of up to 2.5 times. The hydrological modelling completed by Evans and Peck (2008) has also considered the annual water requirements to determine whether it would be feasible to produce the proposed 1 000 000tpa based on the availability of surface and groundwater on the Project Site. Section 5.2.6 provides an overview of the modelling undertaken.

5.2.3.5 Erosion and Sedimentation

Uncontrolled runoff from active operational or cleared areas may lead to sheet, rill and/or gully erosion over areas of the Project Site. Recognising this potential, surface water management controls have been designed to provide controlled flow paths and minimise the number and velocity of water flows on the Project Site. Section 5.2.4.3.2 provides a summary of the design specifications for the controls to be implemented to reduce the potential risk of surface water contamination. Section 5.2.6.4 presents the residual impacts predicted following the implementation of these controls.

5.2.4 Environmental Controls and Management

5.2.4.1 Disturbance to Creeks

Rocla has designed the extraction areas to minimise the impact on the local creek system by:

- restricting the area of extraction so that it only directly affects Creek A;
- limiting extraction so that it is a minimum of 100m away from Creek B; and
- avoiding any disturbance to Creek C.

In addition, Rocla would construct diversion banks up-slope and around the active extraction areas to maximise the flow of surface water to the retained sections of Creeks A, B and C. **Figures 5.9** to **5.12** present the progressive development of these diversion banks and Section 5.2.4.3.2 provides the design specifications for these diversion banks.

By minimising the direct impacts on the local drainage lines of the Project Site, and maximising the catchment size captured by the retained sections of Creeks A, B and C, the impact on hydrological flows is likely to be minimised.

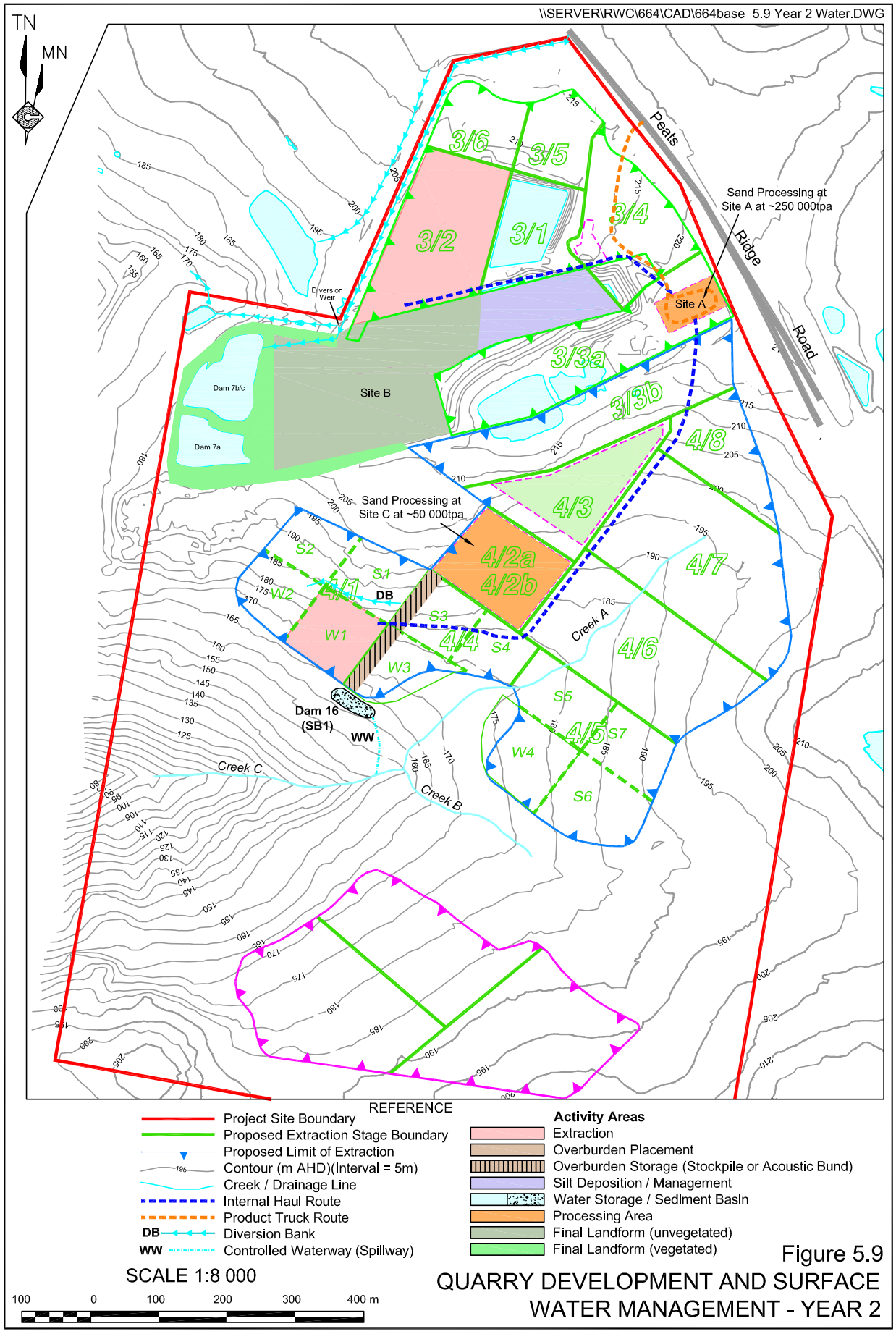


Figure 5.9
QUARRY DEVELOPMENT AND SURFACE WATER MANAGEMENT - YEAR 2

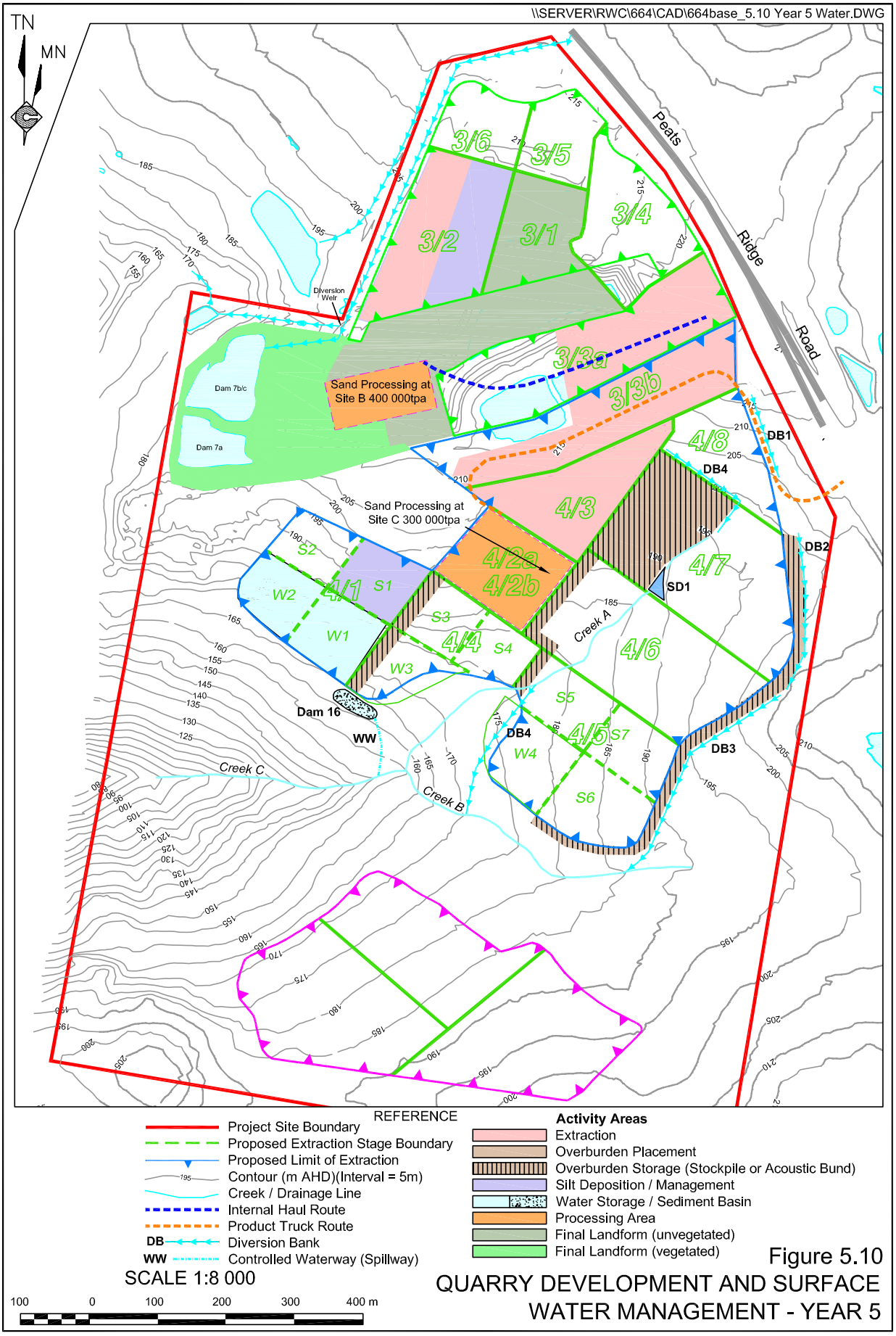


Figure 5.10
QUARRY DEVELOPMENT AND SURFACE WATER MANAGEMENT - YEAR 5

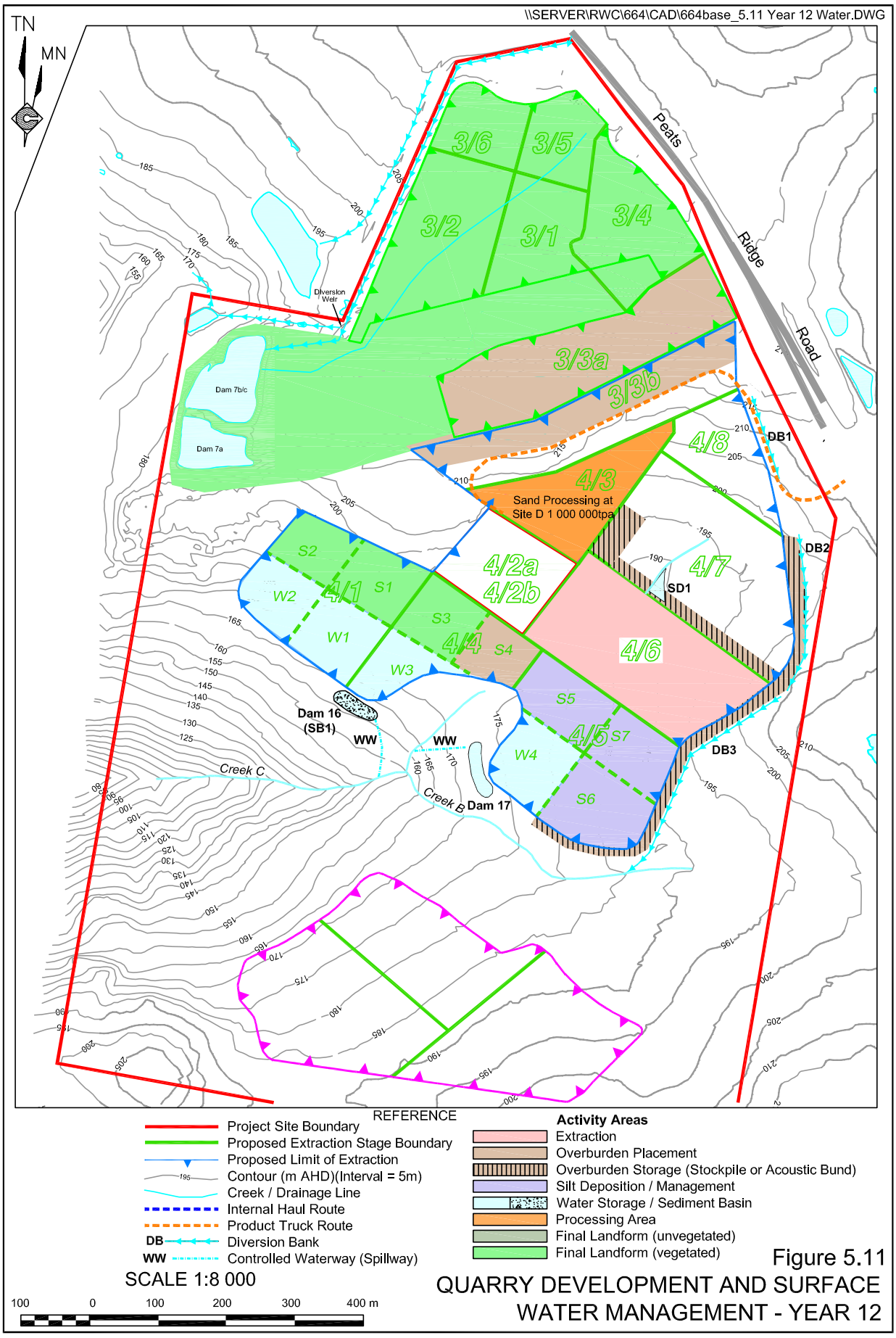


Figure 5.11
QUARRY DEVELOPMENT AND SURFACE WATER MANAGEMENT - YEAR 12

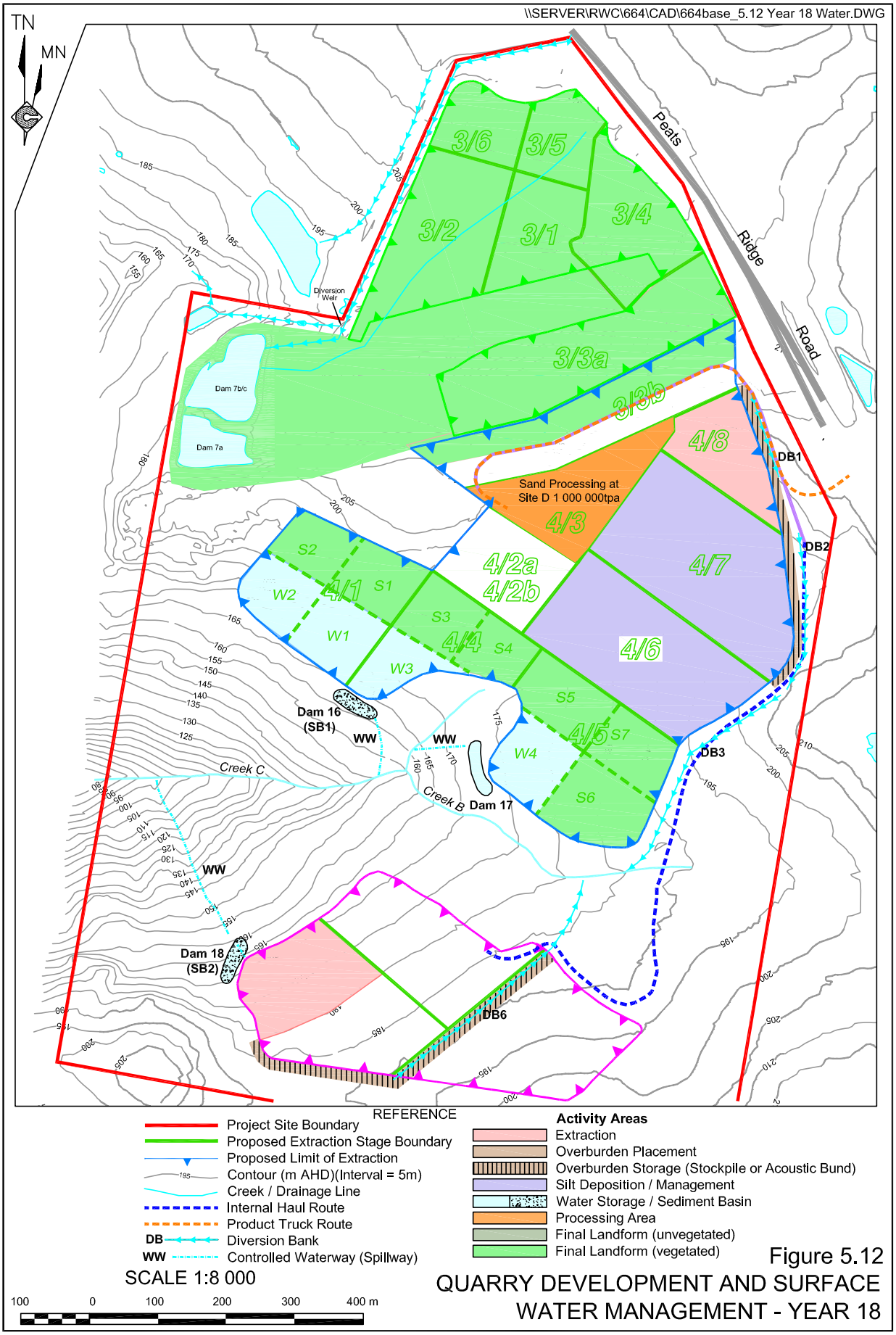


Figure 5.12
QUARRY DEVELOPMENT AND SURFACE WATER MANAGEMENT - YEAR 18

5.2.4.2 Water Recycling

Over a number of years of operation, Rocla has developed the silt/water management system implemented for the approved Stage 3 operations. A closed system is maintained whereby approximately 95% of the water added to the wash plant is re-used (see **Figure 2.10**), with water only lost from the system through use for dust suppression, incorporation into sand products, seepage to groundwater, encapsulation in the consolidated silt or evaporation[2].

By maximising the retention and re-use of water within the sand washing and silt deposition circuit, the volume of water which must be taken from the local setting to enable the production of the sand products can be minimised.

5.2.4.3 Water Management Control Structures

5.2.4.3.1 Classification of Water Streams and Key Management Strategies

For management purposes, the surface water catchments within the proposed areas of disturbance have been divided into two categories, namely:

- **"Clean" -** surface runoff from areas undisturbed by Project activities; and
- **"Dirty" -** surface runoff from areas disturbed by Project activities.

The key strategies to be implemented by Rocla to manage the clean and dirty water streams on the Project Site are as follows.

- Prior to the commencement of extraction operations in a new area, a sediment basin would be constructed immediately down-slope of the extraction area. Until such time as extraction has progressed sufficiently to allow water to accumulate without inhibiting extraction operations, dirty water runoff would be diverted to, or collected and pumped to these small basins (to be designed and operated in accordance with the sediment retention requirements for "Type C" soils as set out in Chapter 6 of *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004)).
- Dirty water would be diverted to large water storages progressively constructed around the western perimeter of Stages 4 and 5. These water storages have been designed to have sufficient water surface area to meet the sediment retention requirements for "Type C" soils as set out in Chapter 6 of Landcom (2004).
- Diversion banks would be constructed up-slope of the extraction areas and any stockpile areas within Stages 4 and 5. In addition, a sediment control dam would be constructed in Creek A downstream of the proposed overburden stockpile area within Stage 4/7. This dam would also be designed and operated in accordance with the sediment retention requirements for "Type C" soils as set out in Chapter 6 of Landcom (2004).

[2] During very heavy or prolonged rainfall events, water may be discharged from the water storages within the Project Site.

5.2.4.3.2 Design Specifications for Water Management Structures

Evans and Peck (2008) provides the design specifications for the water management structures identified in **Figures 5.9** to **5.12**. These design specifications are in accordance with the draft document by the Department of Environment and Climate Change and the Sydney Metropolitan CMA (2007) *"Managing Urban Stormwater: Soils and Construction: Volume 2E - Mines and Quarries"* (DECC/SCMA, 2007).

Evans and Peck (2008) provides the detailed workings used in determining the structure designs. This section provides the resultant design specifications for the structures identified on **Figures 5.9** to **5.12**, namely:

- diversion banks to convey runoff away from temporary overburden stockpiles and around the extraction area;
- two small sediment basins to treat controlled discharge from Stages 4 and 5 at the commencement of operations in each stage;
- a small sediment dam to protect Creek A treat runoff from a temporary overburden stockpile; and
- outlet pipes from the storages W1 to W4 of Stage 4. (These outlet pipes would be sized to ensure that the peak outflow rate into Creek A is no greater than from the existing catchment.)

Diversion Channels

At least six diversion banks (DB1 to DB6 on **Figures 5.9** to **5.12**) are planned for construction to divert water away from the disturbed areas of Stages 4 and 5 and into Creek B. Evans and Peck (2008) includes the detailed working for sizing these diversion banks which have been designed using the Probabilistic Rational Method (PRM) (*Australian Rainfall & Runoff*, 1995) and provide for:

- non-erosive hydraulic capacity to convey the 20 year ARI flow as per DECC/SCMA (2007);
- the differing grades of the diversion channels at various locations; and
- A trapezoidal channel shape with side slopes of 1:3 (H:V) has been assumed.

Table 5.15 provides the design specifications for the six diversion banks.

Sediment Basin Design

Two small sediment basins would be required to control sediment concentrations in controlled discharge from Stages 4 and 5 at the commencement of operations in each stage (see **Figures 5.9** to **5.12**).

Table 5.15
Diversion Bank Design Specifications

	Stage 4 Perimeter Acoustic Bund			DB4 Creek A Diversion	DB5 Stage 4 Overburden Diversion	DB6 Stage 5 Up-slope Diversion
	DB1: Upstream steep section	DB2: Upstream flat section	DB3: Downstream section			
Design storm	20	20	20	20	20	20
Max Channel slope	12%	1%	4.3%	4.4%	5%	1%
Catchment area (ha)	7.7	7.7	11.6	15.7	1.3	15.5
Flow (m^3/s)	1.3	1.3	1.8	2.3	0.3	2.3
Base width (m)	2.0	2.0	2.0	2.0	1.0	2.0
Flow depth (m)	0.23	0.46	0.37	0.42	0.19	0.57
Max velocity (m/s)	2.3	1.0	1.8	1.9	1.2	1.1
Source: Modified after Evans and Peck (2008) – Table 10						

Both sediment basins have been designed to enable the settlement of sediment generated by a 95th percentile 5-day event for Type C soils (in accordance with DECC/SCMA (2007)). Accordingly, the design of SB1 and SB2 has been based on meeting the surface loading rate criteria for settlement of particles up to 0.02mm diameter in accordance with the recommendations of Landcom (2004).

For SB1, the hydrological modelling of Evans and Peck (2008) indicates that the 95th percentile daily runoff from the contributing catchment would be 0.6L/d in Year 4 and a conservative design based on discharging and treating 1ML in 24 hours (0.012m^3/s) has been adopted. For SB2, the hydrological modelling of Evans and Peck (2008) indicates that the 95th percentile daily flow into the excavation area in Stage 5 in Year 18 is 0.26ML/d and a conservative design based on being capable of discharging and treating 0.5ML in 24 hours (0.006m^3/s) has been adopted. The proposed sediment basin dimensions are summarised in **Table 5.16**.

Table 5.16
Sediment Basin Dimensions

	Sediment Basin 1	Sediment Basin 2
Base length (m)	12	9
Base width (m)	4	3
Base surface area (m^2)	48	27
Top surface area (m^2)	148	108
Sediment storage volume (m^3)	29	16
Source: Modified after Evans and Peck (2008) – Table 11		

Sediment Dam (SD) 1

SD1 would be located on the boundary of Areas 4/7 and 4/6 of Stage 4 to accept runoff from the overburden stockpile within Stage 4/7. As for SB1 and SB2, it has been designed in accordance with the surface loading rate requirements for "Type C" soils.

The basin would have an operational life of about 5 years and accordingly has been designed for 5yr ARI flows. A peak design flow of 0.73m^3/s has been estimated by the hydrological modelling of Evans and Peck (2008) from the catchment draining to SD1. Given a basin surface area of 4,100m^2/m^3/s has been calculated as providing for the settlement of particles up to 0.02mm diameter, a surface area of 3,000 m^2 for the 5 yr ARI flow would be required.

DECC/SCMA (2007) requires spillways to be designed to be structurally sound for the 100 year ARI rainfall event. The estimated 100 year ARI discharge from the catchment draining to the sediment dam is 1.85m^3/s. This flow could be conveyed by a 4m wide spillway with a flow depth of less than 0.4m and a velocity of less than 1.2m/s (Evans and Peck, 2008).

Outlet Pipes for Peak Outflows from Stage 4 Water Storages

For purposes of assessing the interaction between the temporary detention volume in the storage and the hydraulic characteristic of the pipe outflow Evans and Peck (2008) used the DRAINS model. The analysis showed that 3 x 600mm diameter pipes at a grade of 1% would achieve the following peak outflow rates in a 100 year ARI storm.

- Dam W1/3: peak pipe outflow of 1.7m^3/s, with a peak water level increase in the basin of 0.8m.
- Dam W4: peak pipe outflow of 1.7m^3/s, with a peak water level increase in the basin of 0.9m.

The peak pipe outflow for each basin of 1.7m^3/s would limit flows to about half the peak natural discharges of 3.2m^3/s and 3.7m^3/s from these catchment areas.

5.2.5 Hydrological Modelling (Including a Site Water Balance)

5.2.5.1 Introduction

Evans and Peck (2008) outlines the detailed hydrologic modelling required to provide a sound technical basis for the assessment of the impact of the Project on the hydrologic regime of the local creeks. The modelling of Evans and Peck (2008) provides a basis for the assessment of:

- the existing flow conditions in the creeks that drain the catchment area in which the expansion of the quarry (Stages 4 and 5) is proposed to occur (see Section 5.2.2.3);
- the effect on surface runoff of the changes to the land surface within the operating quarry;
- the effects of the proposed use of water for sand washing and the subsequent deposition of waste silt products within the quarry void; and
- the overall effect of the quarry on the hydrologic regime in the creeks compared to baseline conditions.

5.2.5.2 Model Assumptions and Parameters

The AWBM hydrology model was calibrated by Evans and Peck (2008) against local historical flow data to derive hydrologic parameters characteristic of the sandstone landscape on the Calga – Peats Ridge area. The hydrologic parameters were then altered (based on published hydrologic data) to account for the physical changes to the landscape as described above.

Appendix C of Evans and Peck (2008) provides all the details of the inputs and assumptions included in the model, however, in essence, the model accounts for all water gains and losses occurring within the water management systems in Stages 3, 4 and 5 including:

- runoff from the various different types of surfaces within the Project Site, taking account of the changes in the areas of different surfaces on a year by year basis as the Project progresses;
- groundwater inflow to the quarry based on the predicted inflow rates of GeoTerra (2009);
- the effect of direct rainfall and evaporation loss from water storages and silt deposition cells;
- seepage losses from the water storage dams;
- dust suppression requirements, taking account of the changes in the areas of different surfaces on a year by year basis as the Project progresses;
- water retained within the silt cells; and
- water gains and losses attributable to the moisture in the raw friable sandstone, the moisture content of the sand product despatched from the site and the moisture in the oversize material placed back in the quarry.

The water balance model of Evans and Peck (2008) separately accounts for the water balance in each Stage, with transfers only occurring as necessary to maintain supply for processing purposes. The transfer of water in the model between Stage 3 and Stage 4 is based on the following principles.

- Processing operations occurring within each stage would be primarily reliant for water supply on the runoff generated with the particular stage.
- Water would only be transferred between stages if the available water in the storages within that stage has reached a critical low level (<10% storage capacity) and there is ample supply (>50%) in the other stage.
- The water balance model assumes that once extraction and rehabilitation have been completed in Stage 3, no further transfers of water to Stage 4 would occur.

The model incorporates the statistics for the entire period of climate data (38 years in this instance) to provide an assessment of how the water management system would operate under all climate conditions represented in the record.

5.2.5.3 Modelled Scenarios

Evans and Peck (2008) compiled data to represent the major features of the Project Site, ie. areas of extraction, silt deposition etc., each year, as well as for the post completion conditions. Evans and Peck (2008) modelled local hydrological conditions for the following years to represent conditions at significant milestones:

- Year 2: Commencement of extraction from Stage 4. Production = 250 000tpa.
- Year 5: Operation of a new processing plant within Stage 4. Production = 700 000tpa.

- Year 9: Two processing plants operating in Stage 4. Production = 1 000 000tpa.
- Year 12: Two processing plants operating in Stage 4. Production = 1 000 000tpa. Assuming without water from Stage 3.
- Year 18: Commencement of operations in Stage 5.
- Year 22: Completion of extraction operations.
- Post completion of the Project and rehabilitation.

For each year listed above, the water balance model was run for the full 38 year climate sequence. That is, the water balance model was used to assess how the water storage, water supply, and overflow would behave if the "snapshot" of the state of quarry remained static while subjected to the full range of climate variation represented by the 38 year daily record of rainfall and evaporation.

5.2.5.4 Model Results

5.2.5.4.1 Project Water Supply (Site Water Balance)

Results from the water balance analysis for each of the selected milestone years are summarised in **Table 5.17.**

5.2.5.4.2 Flow in the Creek C Catchment

Key aspects of the effect of the proposed Southern Extension on the flow in the Creek C catchment, ie. Creeks A, B and C are summarised in **Table 5.18** for each of the years modelled. Copies of the flow duration curves for years that represent the range of effects of the quarry (Years 2, 12 and post quarry closure) are presented in *Figures 11 to 13* of Evans and Peck (2008) (see Part 2 of the *Specialist Consultant Studies Compendium*).

5.2.6 Assessment of Residual Impacts

5.2.6.1 Water Supply

For purposes of assessing the reliability of the water supply for the Project, the most important stages (as reflected by the results of **Table 5.17**) are as follows.

- In Year 5, the modelling predicts that all requirements for water supply could be met in all years without the need for transfer of water between Stages 3 and 4.
- In Year 9, both processing plants would be reliant primarily on supply from within that stage, however, some water transfer may be required from Stage 3 in all but a 90th percentile (wet) year. This water would be available as the modelling predicts overflow can be expected from Stage 3 in all but a 10th percentile (dry) year.
- By Year 12, less water would be transferred from Stage 3 to supplement the supply in Stage 4.

- By Year 18, the modelling predicts Stage 4 would generate sufficient runoff to provide overflow in all but a 10th percentile (dry) year.

Table 5.17
Water Balance Statistics for Selected Years

Statistic	Rainfall	STAGE 3					STAGE 4				
		Contributing Catchment	Processed Product (x 1,000)	Runoff & Groundwater + Transfer from Stage 4	Transfer to Stage 4	Overflow Volume	Contributing Catchment	Processed Product (x 1,000)	Runoff & Groundwater + Transfer from Stage 3	Transfer to Stage 3	Overflow Volume
	(mm)	(ha)	(t)	(ML/y)	(ML/y)	(ML/y)	(ha)	(t)	(ML/y)	(ML/y)	(ML/y)
Year 2											
Average	1,243	37	250	140	0	65	5	0	47	0	32
10th percentile	854	37	250	76	0	0	5	0	35	0	20
Median	1,234	37	250	127	0	39	5	0	44	0	30
90th percentile	1,628	37	250	214	0	169	5	0	61	0	47
Year 5											
Average	1,243	37	400	164	0	68	11	300	86	0	21
10th percentile	854	37	400	84	0	0	11	300	58	0	0
Median	1,234	37	400	149	0	46	11	300	80	0	11
90th percentile	1,628	37	400	258	0	174	11	300	119	0	57
Year 9											
Average	1,243	37	0	145	23	104	32	1,000	202	0	18
10th percentile	854	37	0	47	66	0	32	1,000	109	0	0
Median	1,234	37	0	128	12	85	32	1,000	173	0	0
90th percentile	1,628	37	0	262	0	239	32	1,000	334	0	40
Year 12											
Average	1,243	37	0	127	12	111	32	1,000	222	0	18
10th percentile	854	37	0	37	56	11	32	1,000	134	0	0
Median	1,234	37	0	104	0	99	32	1,000	196	0	0
90th percentile	1,628	37	0	247	0	237	32	1,000	349	0	38
Year 18											
Average	1,243	37	0	125	0	122	32	1,000	268	0	62
10th percentile	854	37	0	36	0	24	32	1,000	187	0	0
Median	1,234	37	0	103	0	99	32	1,000	257	0	30
90th percentile	1,628	37	0	246	0	249	32	1,000	354	0	169

Source: Modified after Evans and Peck (2008) – Table 13

Table 5.18
Annual Flow Statistics in the Creek C Catchment

Rainfall Conditions	Rainfall (mm/y)	Quarry Year	Existing (ML/y)	Developed (ML/y)	Difference	
					(ML/y)	(%)
Average	1 243	Y2	395	415	+20	+5%
		Y5	395	389	-6	-1%
		Y9	395	336	-58	-15%
		Y12	395	337	-58	-15%
		Y18	395	370	-25	-6%
		Y22	395	324	-71	-18%
		Post Quarry	395	485	+91	+23%
10% Dry	854	Y2	84	101	+18	21%
		Y5	84	78	-6	-7%
		Y9	84	67	-16	-19%
		Y12	84	67	-16	-19%
		Y18	84	65	-18	-22%
		Y22	84	61	-22	-27%
		Post Quarry	84	160	+76	+91%
90% Wet	1 628	Y2	864	887	+23	+3%
		Y5	864	864	0	0%
		Y9	864	712	-152	-18%
		Y12	864	701	-163	-19%
		Y18	864	850	-14	-2%
		Y22	864	716	-148	-17%
		Post Quarry	864	955	+90	+10%

Source: Modified after Evans and Peck (2008) – Table 14

5.2.6.2 Local Hydrology

The results in **Table 5.18** indicate that, averaged over the life of the Project, the impact would be a slight reduction in the flow in the creek of about 31ML/year (8%) in average rainfall years, 11ML/year (13%) in 10th percentile (dry) years and 71ML/year (8%) in 90th percentile (wet) years. Considering the milestone years incorporated into the model, the following key outcomes of the Project on local hydrology are as follows.

- In Year 2, it can be expected that Project operations would lead to a small increase in low flows draining to the creek system. This situation would occur due to the increased runoff created by the extraction operations in Stage 4, and minimal additional demand for water. Accordingly, any increase in runoff associated with the change in the surface characteristics would be reflected in increased flow, particularly the low flows of less than about 0.5 ML/day.
- By Year 9, the increased demand for water for quarry operations combined with the limited area of operations within Stage 4 would limit the available supply of water reducing the volume of overflow from the storage dams, particularly in a dry year. The flows in the Creek C catchment can be expected to be reduced slightly (by between 15% [average year] and 19% [dry year]).
- Following the completion of extraction and the rehabilitation of the quarry, the flow statistics in **Table 5.18** indicate that an increase in flow is expected in the creeks, particularly for flows of less than 1ML/day. Despite the fact that Stage 5 would be a "closed" drainage system at that stage, the increase in flow is likely to occur because of the increase in runoff from the rehabilitated surfaces overlying the silt cells in Stage 4.

5.2.6.3 Surface Water Quality

Water quality monitoring indicates that the pH of surface water from areas unaffected by the existing quarry operations is similar to that sampled from areas likely to accept runoff from the existing operations and also that of groundwater. On this basis, it is assessed that:

- low pH is a characteristic of the local surface and groundwater;
- existing quarry operations do not have a significant impact on pH; and
- it can be expected that extraction from Stages 4 and 5 would not have a significant impact.

The water quality monitoring data reported in Section 5.2.2.4, indicates that water within the existing storage dams in Stage 3 and in the creeks downstream of Stage 3 have low concentrations of suspended solids. Given the construction of water management structures in accordance with DECC/SCMA (2007) and Landcom (2004), it is assessed that the operation of the Project would not result in increased concentration of suspended sediment in the local catchment.

The water quality data from the storage dams on Stage 3 (Monitoring Site F in **Table 5.13**) shows that quarry operations consistently achieve oil and grease concentrations of less than 5mg/L. It is expected that the operations in Stages 4 and 5 would achieve similar performance.

5.2.6.4 Erosion and Sedimentation

Assuming the construction of the water management structures at the locations identified in **Figures 5.9** to **5.12** and with the design specifications identified in Section 5.2.4.3.2, the Project should be operated such that erosion and sedimentation is managed appropriately.

5.2.7 Monitoring and Contingency Management

5.2.7.1 Monitoring

Rocla would continue to monitor surface water at quarterly intervals at the locations identified on **Figure 5.7**. In addition, a new monitoring site would be established on Creek C near the Project Site Boundary and would be included in an updated Surface Water Management Plan for the Calga Sand Quarry. The results of all monitoring would be incorporated into each Annual Environmental Management Report together with an evaluation of the monitoring over the previous 12 months. The frequency and/or location of monitoring or the parameters analysed would also be reviewed annually to ensure only meaningful data is being collected.

5.2.7.2 Contingency Management

5.2.7.2.1 Water Quality Contingency Management

As the location of the extraction and processing operations would generally be below natural surface level, and considering the large size of the water storage structures, there is a high level of inherent security against discharge of polluted water or unanticipated impact on the flow regime in the creek system into which the Project Site drains.

Evidence of this is provided by the surface water quality monitoring that has been undertaken downstream of the Stage 3 Calga Sand Quarry which indicates the discharge from the Calga Sand Quarry has been generally been within discharge limits of:

- Suspended solids < 50mg/L;
- Oil & grease < 5mg/L.

The size of the water storages, through which all discharge must flow, is expected to provide adequate assurance of maintaining discharge within the limit for suspended solids. However, if monitoring indicates that the suspended solids limit of 50mg/L is exceeded routinely, expert advice would be sought to develop a flocculant treatment system capable of ensuring that discharge quality is maintained.

No significant problems have been experienced with elevated levels of oil and grease in the main storage dam immediately adjacent to the outlet from the existing Stage 3 operations. Should a significant oil or fuel spill occur within the quarry, a series of remedial actions would be taken.

- Sand would be used to isolate and soak up the spill. The oil soaked sand would subsequently be disposed of to an appropriately licenced waste disposal facility;
- If an oil slick was observed on the water storage dam nearest the outlet, a protective boom would be installed around the outlet to prevent oil entering the outlet.

The historic monitoring data indicates that the pH of site discharge is comparable to that in the groundwater and the creeks. Accordingly, no pH correction is proposed for runoff discharged from the storage dams. Nevertheless, should this be required, the addition of appropriate chemicals prior to discharge would be feasible.

5.2.7.2.2 Water Supply Contingency Management

The water balance modelling undertaken for this assessment, supported by operating experience in Stage 3, indicates that there would be a high level of security of water supply for proposed operations of the Southern Extension. The water balance analysis indicates that the highest risk of water shortage would be most likely at the following times.

- Once sand production first reaches 1 000 000tpa (anticipated to be Year 9). At that stage, the operation would be reliant on water held within Stage 3 for a large proportion of supply because only a relatively small area of Stage 4 would have been opened up.

- Immediately after the Stage 3 rehabilitation is complete (anticipated to be Year 13) and water is no longer available from Stage 3 to supplement supply from runoff within Stage 4 (approximately Year 13).

A staged contingency response to an impending water shortage would be implemented as follows.

- In the first instance, alternative means of dust suppression (such as the use of polymers) would be assessed. This has the potential to reduce the requirement for water by about 20%.
- The operation of the silt cells would be critically assessed to determine options for minimising the area of active silt cell, and thereby reduce evaporation loss.
- Neighbouring landholders would be approached with a view to purchasing water from existing farm dams.

5.2.7.2.3 Response to Unforeseen Impacts

The procedure to be followed in the event of unforeseen surface impacts being detected throughout the life of the Project is as follows.

1. The nature of the suspected impact and all relevant monitoring data would be immediately referred to an independent qualified hydrologist for assessment.
2. An assessment would be made of the potential magnitude of the impact and the level of risk.
3. Alternative response and mitigation measures would be tabled for discussion with DoP and DECCW as appropriate.
4. A response / mitigation plan would be implemented to the satisfaction of DoP and/or DECCW.

5.3 ECOLOGY

5.3.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.6**), the potential ecological impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Disturbance to native vegetation/habitat within nominated areas (high risk).
- Disturbance to native vegetation/habitat outside nominated areas (moderate risk).
- Disturbance to threatened flora/fauna and endangered ecological communities (moderate to high risk).
- Reduced local biodiversity (high risk).
- Reduced regional biodiversity (high to extreme risk).

The Director-General's Requirements issued by the Department of Planning require that the assessment of threatened species and their habitat include "… *impacts on critical habitats (including riparian habitat), threatened species, populations or ecological communities, groundwater dependent ecosystems, native vegetation, and the adjacent National Park estate* …". The DGRs also require the Project provide "… *a comprehensive offset strategy which details the measures proposed to ensure that there is no net loss of flora and fauna values in the area in the medium to long term* …".

This section commences with a review of the regional ecological setting of the Project Site, details the assessment methodology, describes the operational safeguards, controls and mitigation measures described and concludes with an assessment of the residual impacts upon the local and regional flora and fauna following the implementation of these safeguards, controls and mitigation measures.

The flora and fauna assessments were undertaken by Cumberland Ecology Pty Ltd. This assessment is presented in full as Part 3 of the *Specialist Consultant Studies Compendium*, with the relevant information from each summarised in the following subsections.

5.3.2 Regional Ecological Setting

The Central Coast region contains a diverse range of floristic assemblages or 'vegetation communities'. Vegetation mapping on a regional scale has been completed as part of the Lower Hunter and Central Coast Regional Environment Management Strategy (LHCCREMS). The maps, generated following intensive survey effort carried out between March and July 1999, predict the vegetation distribution across the region at a scale of 1:25 000. The LHCCREMS mapping identified 55 vegetation communities within the Lower Hunter Central Coast region, broadly classified into the following 11 groups.

- Spotted gum-ironbark woodlands and dry open forests.
- Dry alluvial woodlands.
- Sheltered Narrabeen and Hawkesbury sandstone forests.
- Coastal wet sclerophyll and rainforests.
- Coastal swamp and wetland forests and heaths.
- Estuarine complex of mangroves and salt marsh.
- Exposed coastal Narrabeen sandstone forests.
- Exposed Hawkesbury sandstone forests and woodlands.
- Coastal sandmass open forests, woodlands and heaths.
- Coastal plains woodlands on Narrabeen and Permian geologies.
- Tertiary sands woodland, melaleuca scrubs and poorly drained wet heaths.

It is estimated that approximately 65% of the original vegetation coverage within the region remains, however, this proportion varies between community types. On the basis of clearing and presence of threatened species, the LHCCREMS project provides a summary of those vegetation communities considered conservation priorities due to lack of representation in the existing setting.

Within the Lower Hunter Central Coast region, the Project Site is located on the Somersby Plateau, where higher elevation Hawkesbury Sandstone soils support a mosaic of open forest and woodland vegetation, interspersed with heaths and scrubs where bedrock material is close to the surface (Bell, 2004). On and immediately surrounding the Project Site, the vegetation varies between dry open forests, Hawkesbury Sandstone forests and woodlands, scrubs and poorly drained wet heaths, depending on the underlying geology, soils, topography and drainage providing a wide range of microhabitats within the vegetation.

The vegetation communities within the region provide a wide range of habitat types for native fauna. There are varying estimates of the number of fauna species inhabiting the region, however, an intensive survey completed by Ecotone Ecological Consultants in 2001 (Ecotone, 2001) identified 237 species of fauna including 41 mammal, 136 birds, 23 reptiles and 18 frog species. Of the 237 identified species, nine were introduced and 22 considered threatened under NSW or Commonwealth legislation.

5.3.3 Study Methodology

5.3.3.1 Background Research

5.3.3.1.1 Introduction

In addition to a review of the LHCCREMS mapping and data, Cumberland (2009) undertook a desktop review of current legislation, policies and guidelines relevant to development on land containing native vegetation, existing literature concerning flora and fauna in the local area and relevant databases such NPWS Wildlife Atlas and the EPBC website. Background data on locally occurring flora and fauna is readily available due to the proximity of the existing Calga Sand Quarry (for which a number of ecological studies have been completed) and ongoing regional studies by government bodies such as Gosford City Council (GCC) and LHCCREMS.

5.3.3.1.2 Previous Ecological Studies

A summary of the results of previous flora and fauna investigations conducted over the Stage 3 area of the approved Calga Sand Quarry are provided as follows.

Anne Clements & Associates (2004): Flora Assessment – Calga Quarry Extension

ACA (2004) completed their survey in May 2004 to assess the likely impacts upon vegetation that would be affected by the proposed extraction activities within an area to the north (Stage 3) and northeast (then referred to as Stage 4) of the Calga Sand Quarry. No threatened species or communities were identified on that site during the May 2004 survey, however, a range of species were identified within the locality.

Anne Clements and Associates (2005): Target Flora Survey Parts 1 & 2 – Calga Sand Quarry Northern Extension

In response by a Department of Infrastructure, Planning and Natural Resources (DIPNR) request for additional information on threatened species and vegetation types, targeted surveys were undertaken for the then proposed Stages 3 and 4 of the Calga Sand Quarry (ACA, 2005). The objective of these surveys was to provide further detail on the presence and distribution of:

- two threatened plant species Hibbertia procumbens and Darwinia glaucophylla;
- "Sedgelands" as defined by Sydney Regional Environmental Plan (SREP) No. 8 in the area near the northwestern dam; and
- "Hanging swamps" upslope from a dam located on Lot 121, DP 755221 (as part of the then Stage 4 quarry proposal).

An intensive survey was undertaken to assess occurrences of *Hibbertia procumbens* and *Darwinia glaucophylla* using 10m x 10m squares overlain on a 100m x 80m grid laid along the western boundary of the proposed quarry extension. In addition, 1m wide transects of 50m and 100m lengths were used to record the location of individual plants of *H. procumbens. D. glaucophylla* was recorded in 27 of 80 grid squares searched and *H. procumbens* was recorded in 11 of the 80 grid squares searched.

No vegetation matched the criteria for sedgeland but two patches of hanging swamp were recorded.

Countrywide Ecological Service (2004): Fauna Assessment – Calga Sand Quarry Northern Extension

Countrywide Ecological Service carried out fauna surveys in 2003 and 2004 for the then proposed Stages 3 and 4 of the Calga Sand Quarry (CES, 2004). Extensive fauna surveys were carried out in summer (January 2003, February 2004 and March 2004) to identify the fauna of the Project Site and surrounds.

A wide range of species were recorded within the area surveyed, including 31 species of birds, 16 species of mammals (four introduced), six species of frogs and six reptiles. Two threatened birds were recorded: the Powerful Owl (*Ninox strenua*) and the Glossy Black-cockatoo (*Calyptorrhynchus lathami*). One threatened reptile, Rosenberg's Goanna (*Varanus rosenbergi*) was recorded.

Abel Ecology (2005): Red-crowned Toadlet Survey and Assessment – Calga Sand Quarry Northern Extension

Abel Ecology (2005) undertook a survey in early 2005 to determine whether the Project Site contained a population of, or potential habitat for the Red-crowned Toadlet.

Despite intensive survey of vegetated areas and possible toadlet habitat, no Red-crowned Toadlets were recorded.

CM Jewell and Associates (2004): Groundwater Assessment of the Calga Sand Quarry Northern Extension, 2004

The objectives of the hydrogeological investigation were, in general, to assess the impact of the proposed staged quarry expansion on groundwater conditions, including groundwater-dependent ecosystems (GDEs) (CMJA, 2004).

A map of high priority GDEs, contained within the Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources 2003, and LHCCREMS vegetation maps were reviewed to identify groundwater-dependent ecosystems and vegetation communities which may be impacted by the Project.

No GDEs were identified on the site of the then proposed Stages 3 and 4 of the Calga Sand Quarry, nor over the currently proposed Southern Extension. While CMJA (2004) identified the presence of GDEs downstream of the Calga Sand Quarry, associated with Cabbage Tree Creek, it was concluded that the loss of shallow groundwater discharge in the upper reaches of Cabbage Tree Creek would be unlikely to affect any GDEs in the lower reaches of Cabbage Tree Creek.

Summary

As a result of investigations undertaken over the then proposed Stages 3 and 4 of the Calga Sand Quarry and surrounds, the majority of flora and fauna that could be impacted by the Project is well known.

5.3.3.1.3 Database Searches

The NSW Government BioNet database (NSW Government, 2009), the NPWS Wildlife Atlas (DECC, 2009) and EPBC protected matters database search (DEWHA, 2009) were searched for threatened flora and fauna in the locality. The DECC database records are shown in **Figure 5.13** and identify one threatened species as having been recorded within the Project Site (Glossy Black-cockatoo) and 22 additional threatened species within 5km of the Project Site[3].

In addition to these database searches, probability of occurrence maps prepared for eight threatened species based on habitat modelling as part of the LHCCREMS studies (LHCCREMS, 2004), were reviewed. Based on these maps, and the known habitat preferences of the species, the predicted probability of occurrence for these species on, or surrounding the Project was identified by Cumberland (2009) as follows.

- Koala: 20 to 40%. Mid level probability is found around the Calga area.
- Squirrel Glider: 10 to 40%. The Calga area is shown mainly as very low probability, with small patches of slightly higher probability.
- Yellow-bellied Glider: 0 to 10%. The main predicted occurrences of habitat do not coincide with the Project Site.
- Tiger Quoll: 40 to 60%. The main predicted occurrences of habitat do not coincide with the Project Site.

[3] It is noted that this database does not include threatened species identified the ecological studies summarized in Section 5.2.3.1.2.

- Masked Owl: 0 to 10%. The main predicted occurrences of habitat do not coincide with the Project Site.
- Powerful Owl: 20 to 40%. The main predicted occurrences of habitat do not coincide with the Project Site.
- Sooty Owl: 0 to 40%. The main predicted occurrences of habitat do not coincide with the Project Site.

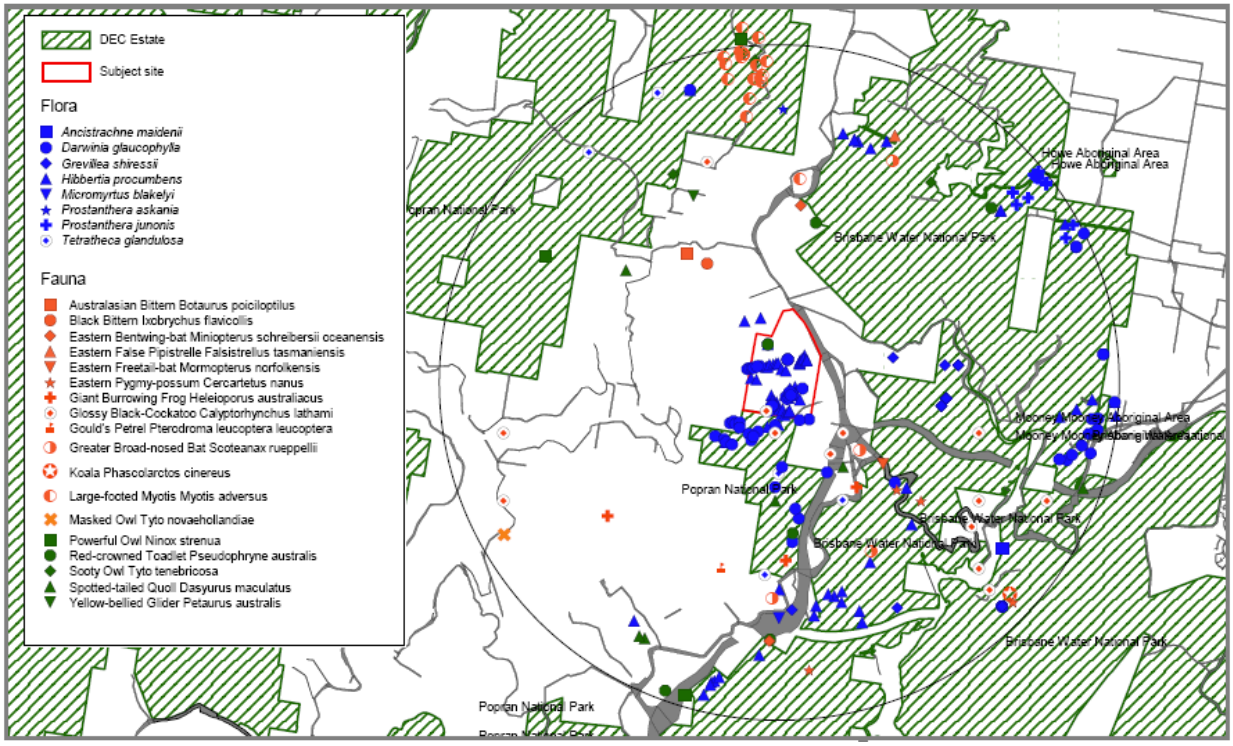


FIGURE 5.13
Threatened Species Within 5km of the Project Site
Source: Cumberland Ecology (2009) – Figure 4.1

The results of the database searches provide an indication of the conservation significance of local flora and fauna.

5.3.3.2 Field Survey

5.3.3.2.1 Introduction

Although the studies summarised in Section 5.2.3.1 provide a valuable database of threatened species records within the Project Site, additional field surveys were completed by Cumberland Ecology in order to add to the knowledge of the locations of threatened species (including endangered ecological communities) on the Project Site. **Figure 5.14** presents an illustration of the survey effort over the Project Site, which is described in the following sections.

5.3.3.2.2 Flora

Flora surveys were undertaken over the Project Site and surrounds by Cumberland Ecology in December 2005 and March 2009 and Eastcoast Flora Survey in November-December 2006 and March 2007. The following summarises the survey effort in each case.

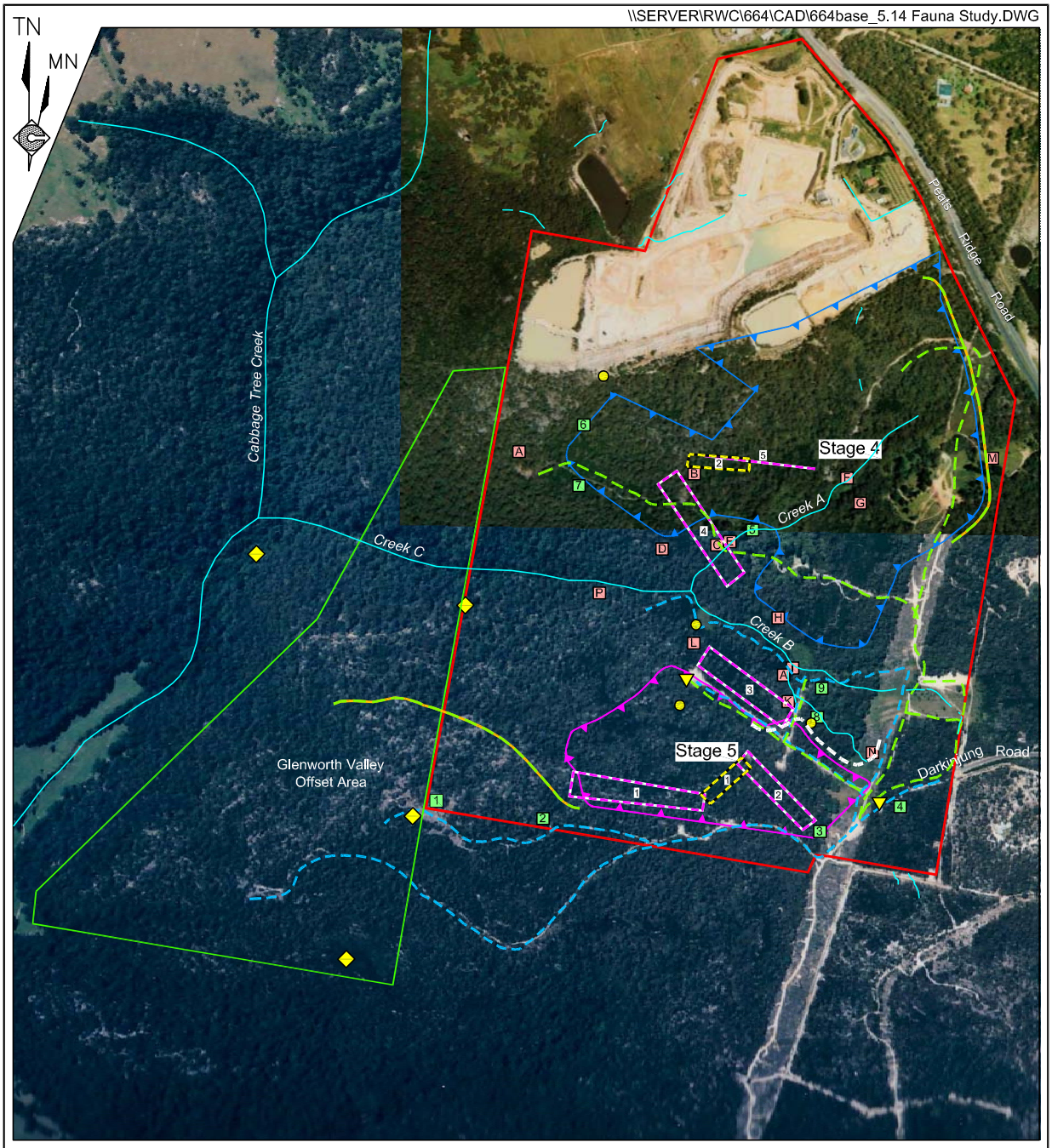


Figure 5.14
FAUNA AND FLORA SURVEY EFFORT

Cumberland Ecology Flora Survey, 2005 and 2009

In December 2005, nine vegetation quadrats (20m x 20m in size) were surveyed within vegetation communities identified over the Project Site by LHCCREMS in order to confirm the mapped vegetation type.

Quadrats were surveyed in each observed vegetation community in order to describe the communities accurately and to assess whether any was likely to conform to Final Determinations of Endangered Ecological Communities, under the *Threatened Species Conservation Act 1995* or *Environment Protection and Biodiversity Conservation Act 1999*. Within each quadrat, notes were made regarding dominant species in each stratum, all species present, percent cover of exotic species in each stratum, details of vegetation structure, and details about topography, soil and miscellaneous features. The survey of December 2005 also targeted the identification of the threatened species: *Darwinia glaucophylla* and *Hibbertia procumbens*.

Additional targeted threatened flora surveys were undertaken in March 2009 along the alignment of the proposed access roads within the Project Site, i.e. between Stage 4 and Stage 5, as well as the proposed access road from Darkinjung Road through the Project Site onto the "Glenworth Valley" property. An area of approximately 40m wide was searched along the alignment of each access road, defined by pre-programmed GPS references.

Figure 5.14 identifies the exact locations of the field survey undertaken.

Eastcoast Flora Survey, 2006 to 2008

Building on the initial flora survey of Cumberland Ecology, more intensive flora survey and vegetation mapping of the Project Site was completed by Mr Stephen Bell of Eastcoast Flora Survey over three days in November and December 2006, with a follow-up session in March 2007 on the Project Site and June 2008 over an area of approximately 45ha on the adjoining "Glenworth Valley" property (which encompasses the off-Project Site component of Rocla's biodiversity offset strategy (see Section 2.14.2)).

The field survey included the following elements.

- General traverses of the Project Site (in November and December 2006, and March 2007) and Glenworth Valley Offset Area in June 2008.
- Targeted surveys were undertaken in areas of suitable or potential habitat for threatened flora species known or predicted to occur in the region. A preliminary list was compiled and subsequently filtered based on the provision of suitable habitat within the survey area. Specific searches were then carried out for threatened species which were assigned a moderate or high chance of occurring within the survey area, namely:
  - *Hibbertia procumbens;*
  - *Prostanthera junonis;*
  - *Tetratheca glandulosa;*
  - *Darwinia glaucophylla;*

– *Eucalyptus camfieldii;*

– *Callistemon linearifolius;*

– *Diuris bracteate;*

– *Prostanthera askania;* and

– *Acacia bynoeana*.

On the days of survey, a known population of *Prostanthera junonis* elsewhere on the Somersby Plateau was inspected to ensure that flowering was occurring and therefore identification could be made within the Study Area.

- Vegetation mapping was completed by ground-truthing vegetation units delineated by aerial photo interpretation including a general survey of vegetation encountered within 0.04ha area plots. The location of the survey plots focussed on poorly sampled vegetation communities, to assist in their definitions.

Mr Bell is an expert on the flora of the Gosford LGA and has been involved in numerous vegetation mapping projects within the Lower Hunter Central Coast region. Based on the results of the survey a detailed vegetation map of the Project Site (and Glenworth Valley Offset Area) was prepared using the classification of Bell (Bell, 2004).

Cumberland (2009) provides further detail on the survey methods and **Figure 5.14** provides the locations of the survey plots.

5.3.3.2.3 Fauna

Field surveys for terrestrial fauna were undertaken by Cumberland (2009) during summer 2005/2006 and March 2009 in order to identify the types and locations of threatened fauna on the Project Site. The locations of survey sites are shown in **Figure 5.14**. A summary of the survey effort for each fauna group is as follows.

Frogs

In December 2005, Dr Arthur White of Biosphere Environmental Consultants Pty Ltd undertook surveys for frog species on the Project Site aimed at:

- assessing the diversity of the local frog populations on the Project Site;
- determining the presence or absence of habitat for the threatened frog species; and
- determining the presence or absence of threatened frog species if habitat for them was identified.

The survey period was chosen to coincide with spring/summer wet weather when two species of threatened frogs that have been identified in the locality are most likely to be active and therefore detectable. The following survey methods were employed.

i) **Habitat Identification:** All locations of freshwater on the Project Site were inspected and habitat for either of the two threatened frog species (Red-crowned Toadlet and Giant Burrowing Frog) noted. If present, the site was revisited at night for the purpose of targeted surveys.

ii) **Frog Surveys:** A total of 16 potential habitat sites within the Project Site were surveyed during the day and evening over two days. Logs, rocks or other items of solid ground cover were also overturned to search for sheltering frogs. Frogs were identified visually and by call.

iii) **Tadpole Survey:** A long-handled net was used to sample each of the freshwater habitats that contained open water. All tadpoles caught were transferred to a plastic holding bag, identified (Anstis, 2002) and released at the site of capture.

iv) **Call Playback:** Call imitation and call playback was used for the two targeted frog species at each of the survey sites (whether they contained suitable habitat or not). The calls were played during the day and at night at each location on both days in an attempt to get male frogs to respond.

In March 2009, Cumberland Ecology staff conducted additional frog surveys. The following provides a summary of the methods employed during the frog surveys of March 2009.

- Diurnal habitat searches and assessment, following creek lines and established tracks, conducted over two days.
- Nocturnal searches, conducted along established tracks using spotlights, for 2 hours (commencing at approximately 7:30pm) on each of 3 nights.
- Call playback at points of suitable habitat for threatened frogs during nocturnal and diurnal transect searches.

Birds

An early summer bird survey was undertaken in December 2005. Data were collected from four plots, each of 100m radius, using an area search method. Plots were located in different habitats (woodland, heath, cleared land, and riparian areas). Plots were searched for between 30 and 40 minutes each survey over two days and all bird species that were positively identified by sight or call were recorded. Birds were also recorded along all tracks and accessible areas.

In addition to the targeted bird survey, a record was kept of all birds observed or heard calling during the mammal survey periods.

Mammals

Four grids containing two parallel lines, and one grid of one line of traps were set with each grid containing tree traps, ground traps, cage traps and hair tubes separated by between 20m and 50m. Tree traps, ground traps and cage traps were set for four consecutive nights January/February 2006. Hair tubes were left for 10 consecutive nights. Cumberland (2009) describes the detail of trap location, size and bait.

In addition to the trapping, surveys were undertaken for microchiropteran bats using AnaBat ZCAIM bat echolocation call detector units. One unit was set overnight for three nights, recording for 12 hours each night during January/February 2006, and two nights recording for 2 hours just after dusk during March 2009. The unit was placed at different locations each night to sample different communities.

Nocturnal Mammal and Bird Spotlight Surveys and Call Playback

Spotlighting, for approximately 2 hours per night for three nights, targeted the identification of nocturnal mammals and birds and was conducted using a hand held lamp with a 100W halogen globe. The Project Site was traversed by foot and car to ensure that the majority of the Project Site was sampled. During spotlighting all species of vertebrates seen or heard calling were recorded.

The Masked Owl, Sooty Owl, Powerful Owl, Barking Owl, Squirrel Glider and Yellow-bellied Glider were surveyed using call playback during evening surveys. Taped calls were broadcast through a 15 watt amplifier and played for approximately five minutes followed by listening for 10 minute periods for approximately 30 to 45 minutes at a given sampling point.

Reptiles

A record was kept of all reptiles observed during the survey periods for other fauna groups.

Incidental Records

All vertebrate fauna species that were observed, heard calling or otherwise detected on the basis of tracks, scats or signs were recorded and listed in the total species list for the Project Site.

5.3.3.2.4 Tree Hollows Koala Feed Tree Survey

Due to the large area of the Project Site, the dense vegetation and restricted access to areas due to vegetation and topography, Cumberland (2009) deemed it impractical to complete a survey of tree hollows over the entire Project Site. Therefore, to provide an estimate of the size, number and distribution of tree hollows over the Project Site, two 100m x 20m plots were surveyed within the dominant treed vegetation communities found within the Stage 4 and Stage 5 extraction areas (Plot 1 within Exposed Hawkesbury Woodland (Vegetation Community E26 and Plot 2 within Hawkesbury Banksia Scrub-Woodland (Vegetation Community E29)). The surveyed plots are considered to provide a representative sample of the size, distribution and number of tree hollows within the areas to be disturbed by the Project.

Both plots were traversed by two ecologists with each hollow-bearing tree recorded using a GPS unit and the species, height, diameter at breast height (DBH), number of hollows and approximate size of hollows recorded. The number of hollow-bearing trees within this area was then multiplied by 5 to provide a per hectare density of hollow-bearing trees for the two vegetation communities sampled.

All preferred Koala feed trees according to the species listed in SEPP 44 were also recorded within each plot. The number of trees within each plot was also multiplied by 5 to provide a per hectare density of preferred feed trees in each community.

Figure 5.14 provides the location of the two tree hollow survey plots.

5.3.3.2.5 Aquatic Habitats and Fauna

The nature and quality of the aquatic habitats were determined by a survey in February 2006 involving the traversing of creeks and inspection of aspects such as flow rates, vegetation, erosion and water sources within the Project Site.

Habitat conditions were sampled following the AusRivAS requirements which incorporate information including the presence and abundance of aquatic plants, macroinvertebrates and fish, visible signs of degradation including bank erosion, sedimentation and weeds influx, and overall water quality (Turak and Waddell, 2001, and Turak et. al., 2004).

Fish were stunned, sampled and released using an Electrofisher unit, a dip net and Japanese Seine Net. Macroinvertebrates were also sampled using a kick net (0.25 mm mesh), over a 5 minute period at each location amongst water plants, sediment, rocks and logs. Some groups of macroinvertebrates are more tolerant to pollution than others, while other families are sensitive and would only occur in pristine environments. Macroinvertebrate families have been assigned a "Signal Grade". The signal score for a site is worked out by calculating the average signal grade of all the families present (Gooderham, 2002):

- >6 healthy habitat;
- 5-6 mild pollution;
- 4-5 moderate pollution; and
- <4 severe pollution.

5.3.4 Project Site Flora and Fauna

5.3.4.1 Flora

5.3.4.1.1 Vegetation Communities

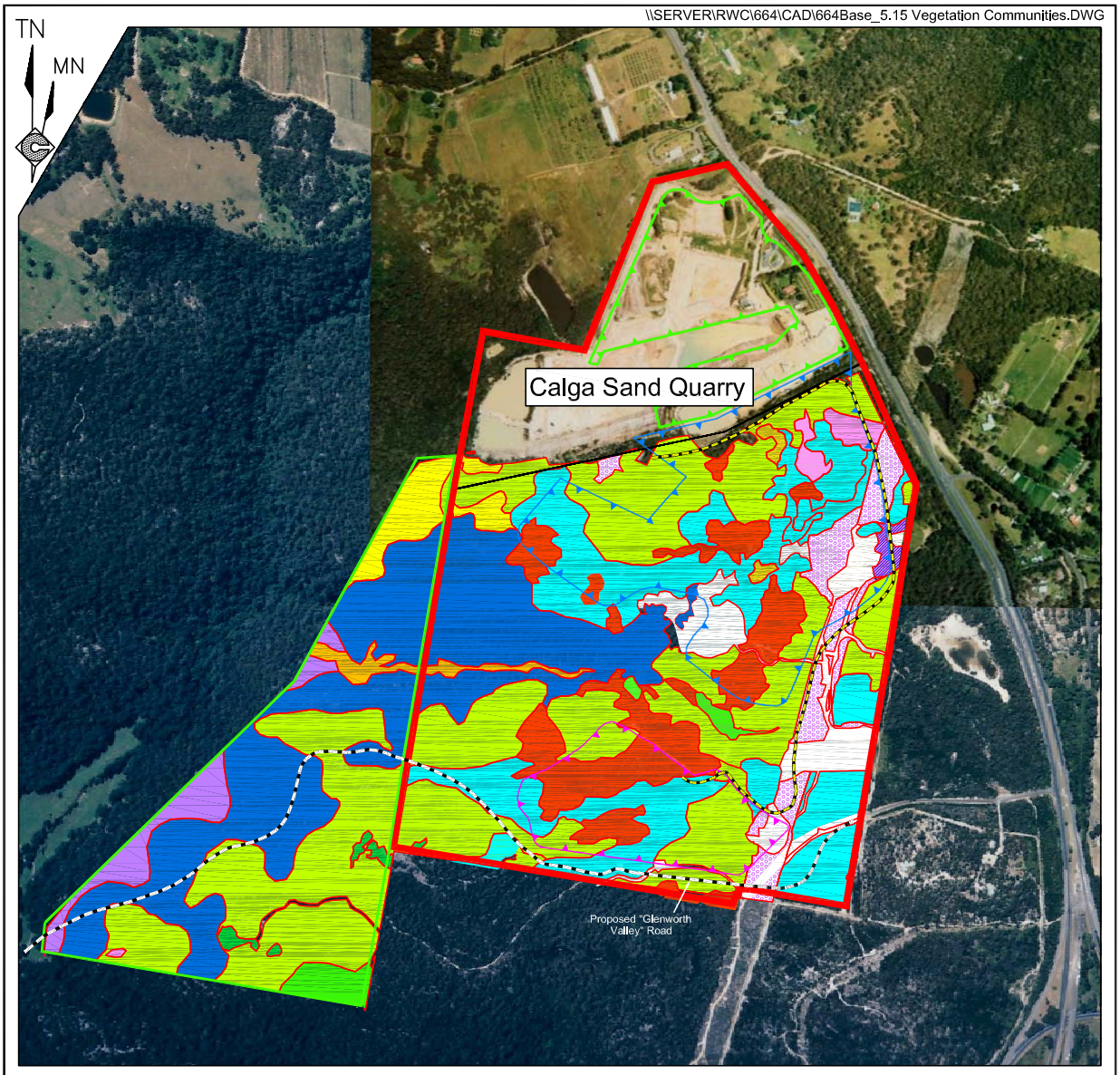
Figure 5.15 displays the distribution of vegetation communities mapped by Eastcoast Flora Surveys over the Project Site and proposed section of the "Glenworth Valley" property included in the Project's biodiversity offset strategy. The vegetation community classifications are based on the Gosford LGA vegetation classification of Bell (2004)[4]. The vegetation communities identified on **Figure 5.15** include:

- E2 Sandstone Ranges Gully Rainforest;
- E25 Hawkesbury Peppermint – Apple Forest;
- E26 Exposed Hawkesbury Woodland;
- E26a Hawkesbury Rock Pavement Heath;
- E29 Hawkesbury Banksia Scrub-Woodland;
- E29a Hawkesbury Banksia Scrub-Woodland (scrub);
- E29b Hawkesbury Banksia Wet Scrub;
- E54 Sandstone Hanging Swamp; and
- E103 Gahnia/Banksia Swamp.

Vegetation communities E2, E25, E26, E26a, E29, E29b and E54 were also identified on the "Glenworth Valley" property along with the following additional vegetation community.

- E20 Dharug Footslopes Apple-Redgum Forest.

[4] Equivalent LHCCREMS vegetation community classifications are provided by Cumberland (2009).



REFERENCE
- Project Site Boundary
- Approved Limit of Extraction Stage 3
- Proposed Limit of Extraction Stage 4
- Proposed Limit of Extraction Stage 5
- "Glenworth Valley" Offset Area
- Proposed Access Road
- Internal Haul Route

Vegetation Mapping
- E103 - Gahnia-Banksia Swamp
- E2 - Sandstone Ranges Gully Rainforest
- E20 - Dharug Footslopes Apple Redgum Forest
- E25 - Hawkesbury Peppermint Apple Forest
- E26 - Exposed Hawkesbury Woodland
- E26a - Hawkesbury Rock Pavement Heath
- E29 - Hawkesbury Banksia Scrub-Woodland
- E29a - Hawkesbury Banksia Scrub-Woodland (Scrub)
- E29b - Hawkesbury Banksia Wet Scrub
- E54 - Sandstone Hanging Swamps
- Xr - Disturbed-Canopy Only
- Xs - Disturbed-Regrowth
- Not Mapped

SCALE 1:15 000

250 0 250 500 750 m

Source: Vegetation Community Mapping provided by Eastcoast Flora Survey

Figure 5.15
VEGETATION COMMUNITIES OF THE PROJECT SITE AND BIODIVERSITY OFFSET AREAS

None of these communities equate to listed Endangered Ecological Communities under the TSC Act or the EPBC Act.

A more detailed description of each community type is provided as follows.

E2 Sandstone Ranges Gully Rainforest

Equivalent to the LHCCREMS MU2 Sandstone Ranges Warm Temperate Rainforest, a band of this community occurs along the lower reaches of the main drainage channel of the Project Site (Creek C). In general, this community is composed of a continuous canopy layer with an occasional small tree layer and a sporadic emergent tree stratum. Emergent trees include Turpentine (*Syncarpia glomulifera*) and Forest Oak (*Allocasuarina torulosa*). The groundcover is typically sparse below a dense canopy, but may increase in density and light breaks and along edges.

E20 Dharug Footslopes Apple-Redgum Forest

Equivalent to LHCCREMS MU 20, which is generally restricted to the richer sediments of the Narrabeen Sandstone series. Dominant species present include Rough-barked Apple (*Angophora floribunda*), Grey Gum (*Eucalyptus punctata*), and in a few locations Thin-leaved Stringybark (*Eucalyptus eugenioides*) and Grey Ironbark (*Eucalyptus paniculata*). The canopy layer is generally between 20-25m in height, with a Foliage Projection Cover (FPC) of 30-40%. A mid canopy layer, dominated by Forest Oak (*Allocasuarina torulosa*) and young eucalypt trees to a height of 15m, exists along with a shrub layer supporting more mesic species. The groundcover layer is considerably more diverse.

E25 Hawkesbury Peppermint – Apple Forest

Equivalent to the LHCCREMS MU25 Sheltered Dry Hawkesbury Woodland, the terrain upon which this community occurs comprises sandy soils on sandstone benches on mid to lower slopes. The upper canopy species, which include Smooth-barked Apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperata*), Grey Gum (*E. punctata*), Red Bloodwood (*Corymbia gummifera*) and Scribbly Gum (*E. haemostoma*), form an open forest structure. A mid canopy layer exists along with a moderately dense shrub layer. The groundcover layer is typically moderately dense and diverse.

This community provides habitat for the vulnerable *Callistemon linearifolius.*

E26 Exposed Hawkesbury Woodland

Equivalent to the LHCCREMS MU26 Exposed Hawkesbury Woodland, this community occurs in sandy soils on sandstone benches, gentle slopes and occasional sandstone outcrops and constitutes a common component of the vegetation on the Project Site. Two variants of this community were noted on the Project Site, namely:

1. Scribbly Gum – Stringybark – Red Bloodwood – Sydney Red Gum Woodland; and
2. Red Bloodwood – Grey Gum Woodland/Open Forest.

The shrub stratum varies from low and patchy to very dense and the groundcover is patchy to occasionally moderately dense and diverse.

This community provides habitat for the endangered *Hibbertia procumbens* and the vulnerable *Callistemon linearifolius* and *Darwinia glaucophylla*.

E26a Hawkesbury Rock Pavement Heath

Equivalent to a sub-formation of the LHCCREMS MU26 Exposed Hawkesbury Woodland, this community generally occurs on large exposed sandstone outcrops on ridges and upper slopes, and provides habitat for the vulnerable *Darwinia glaucophylla*. In general, upper canopy and secondary canopy species are absent, and the shrub layer varies from low and patchy to moderately dense.

E29 & E29a Hawkesbury Banksia-Scrub Woodland

Equivalent to the LHCCREMS MU29 Hawkesbury Coastal Banksia Woodland, this community occupies sizeable areas of the Project Site, with those areas with very little emergent eucalypt and dense stands of Banksia ericifolia been mapped separately as E29a. Canopy species include Brown Stringybark (Eucalyptus capitellata), Narrow-leaved Scribbly Gum (E. racemosa), Red Bloodwood (Corymbia gummifera) and Narrow-leaved Stringybark (E. sparsifolia). Occasional, isolated stands of upper canopy species can form a sparse woodland structure in some site. The shrub stratum is typically dense and a diverse groundcover exists.

E29b Hawkesbury Banksia Wet Scrub

This community is a sub-formation of LHCCREMS MU29 and occupies very restricted areas within the wider mosaic of woodland and scrub on Hawkesbury Sandstone geology. Dominated by a scattered shrub stratum, typically 0.5m to 1.5m high, including species such as Banksia (*Banksia oblongifolia*), Dagger Hakea (*Hakea teretifolia*), Teatree (*Leptospermum juniperinum*), *Leptospermum polygalifolium*, Coral Heath (*Epacris microphylla*), *Pultenaea elliptica*, *Platysace linearifolia* and *Hakea laevipes*, occasional isolated individuals from surrounding woodlands, such as Red Bloodwood (*Corymbia gummifera*) and Black She-oak (*Allocasuarina littoralis*), form a scattered emergent layer to 5m in height. The groundcover layer (to a maximum height of 1m) includes sedges such as *Lepyrodia scariosa*, *Leptocarpus tenax*, and *Dampiera stricta*.

E54 Sandstone Hanging Swamp

Equivalent to LHCCREMS MU54 Sandstone Hanging Swamps and Heaths, this vegetation community occurs on gently to moderate slopes in the central part of the Project Site and is typified by a dense groundcover of Button Grass (*Gymnoschoenus sphaerocephalus*). A range of shrubs and other groundcover species also occur.

No threatened species were recorded in this community.

E103 Gahnia/Banksia Swamp

This vegetation community type has no equivalent in either the Gosford LGA vegetation mapping or the LHCCREMS vegetation mapping and is restricted to one site on mid-slopes along one drainage channel in the central part of the Project Site. Upper and secondary canopy are generally absent, however the shrub stratum and groundcover are dense.

No threatened species were recorded in this community.

5.3.4.1.2 Conservation Significance

The regional significance of each of the identified vegetation communities has been considered by Cumberland (2009). This assessment of regional significance considered the following, which includes elements of Hunter-Central Rivers CMA Draft Catchment Action Plan (2006) and LHCCREMS (2003).

- Communities which have experienced greater than 50% clearing of pre-1750 distribution.
- Rare communities, where the total geographic range is generally less than 1 000ha.
- Communities which contain endemic plants with greater than 75% of predicted distribution within the region.
- Communities of low reservation status, ie. not well-represented in conservation reserves;
- Communities that are disjunct or at the distributional limit of their range.
- Particular structural vegetation formations (such as wetlands, headland vegetation, old growth forest, and rainforest).
- Vegetation landscapes (such as riparian vegetation, floodplain vegetation, and regional habitat and corridors).

Cumberland (2009) concludes that within the Project Site, the Sandstone Hanging Swamps (MU54) and the Sandstone Ranges Warm Temperate Rainforest (MU2) are vulnerable and specialised communities. Communities E2 Sandstone Ranges Gully Rainforest, E25 Hawkesbury Peppermint Apple Forest, E26 Exposed Hawkesbury Woodland, E26 Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E54 Sandstone Hanging Swamps have also been identified as locally significant (by Cumberland, 2009) due to threatened species habitat, restricted distribution or development pressure[5].

[5] This classification of local significance is provided for reference purposes only and does not imply any specific conservation significance requiring additional assessment, ie. as identification of an EEC or threatened species would.

5.3.4.1.3 Identified Flora

A total of 13 tree, 78 shrub, 10 fern, 40 herb and 6 vine species of flora were identified on the Project Site. Of these, three were identified as threatened flora species, namely:

- *Callistemon linearifolius*;
- *Darwinia glaucophylla*; and
- *Hibbertia procumbens*.

Figure 5.16 presents the identified locations of these three species.

5.3.4.2 Fauna

5.3.4.2.1 Fauna Habitats of the Project Site

Following a review of previous studies CES (2004) and Abel Ecology (2005), and the field surveys completed in 2005 and 2006, the following habitat components have been identified.

- Various plant communities and their ecotones.
- Trees with hollows.
- Rock outcrops.
- Logs.
- Leaf litter.
- Creeklines and ephemeral drainage areas.

Such habitat features are extensive throughout the Project Site, eg. forest and woodland style vegetation, and are likely to be relied on by a suite of native fauna, including a number of threatened species.

Habitat condition is generally good for native flora and fauna across a high proportion of the Project Site that has retained native forest and woodland. The factors that detract most from habitat condition in these areas are as follows.

- Weed invasion. While weeds are not currently a major issue in the Project Site, Small-leaved Privet, Blackberry and a range of exotic grasses are present.
- Exotic animals. Three introduced species were recorded in the Project Site (Brown Rat, House Mouse and European Fox). Cats and dogs are also likely to be present and these carnivorous pests are likely to predate on native fauna.

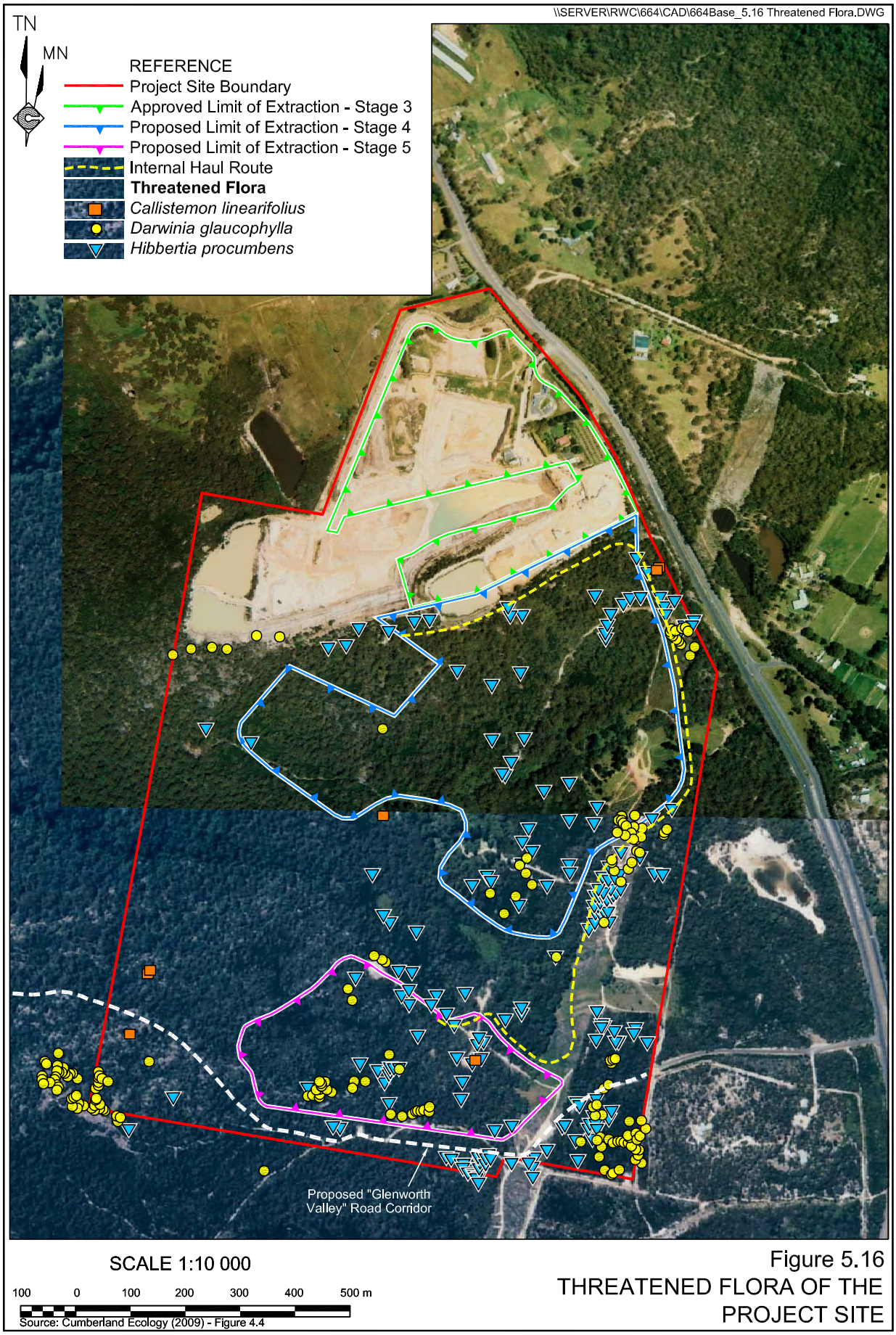


Figure 5.16
THREATENED FLORA OF THE PROJECT SITE

Important habitat features of the Project Site identified by Cumberland (2009) are described as follows.

Bird Habitat

In most areas of the Project Site, the ground or shrub cover is very dense, providing good quality bird habitat. As the Project Site is surrounded on three sides by similar contiguous habitat, it is unlikely many species would be confined to the Project Site.

Allocasuarina species found in patches across the Project Site would provide a resource for Glossy Black-cockatoos which feed exclusively on the seeds of *Allocasuarina* and *Casuarina* species. Hollows in eucalypts across the Project Site are likely to provide nesting opportunities for this species. As this species is highly mobile, it is likely to forage in surrounding areas of habitat as well as those on the site.

Bird Habitat Hollow-bearing Trees and Stags

The Project Site is likely to support a large number of hollow-bearing trees and Cumberland Ecology notes previous research suggests relatively undisturbed woodland can contain approximately 7 to 17 hollow-bearing trees per hectare (Cumberland, 2009). Hollow-bearing trees are vital to many fauna species in Australia, and are essential for the Squirrel Glider, Yellow-bellied Glider, forest owl species, Glossy Black-cockatoos and some microchiropteran bats (threatened species of the locality). Owls and Cockatoos require much larger hollows associated with old growth trees, while gliders and bats utilise smaller hollows. A number of large stags are also present on the Project Site.

Tree Species and Flowering Patterns

The Project Site supports a range of plant species within the different vegetation communities which provide pollen and nectar for animals. Many animal species rely on flowers for food, including the threatened Grey-headed Flying Fox, Yellow-bellied and Squirrel Gliders, and a number of threatened birds. It is noted that preferred food trees for the Swift Parrot and the Regent Honeyeater (Swamp Mahogany, *Eucalyptus robusta*, and Spotted Gum, *Corymbia maculata*) were not found on the site.

Tree Hollows

Hollow-bearing trees are used for diurnal and nocturnal shelter and as breeding sites and within the locality are essential for the threatened species such as the Squirrel Glider, Yellow-bellied Glider, forest owl species, Glossy Black-cockatoos and some microchiropteran bats. Owls and Cockatoos require much larger hollows associated with old growth trees, while gliders and bats utilise smaller hollows.

The results of the tree hollow assessment identified that both woodland communities surveyed contained a high proportion of hollow-bearing trees. The main hollow-forming species include:

- Broad-leaved Scribbly Gum (*Eucalyptus haemastoma);*
- Narrow-leaved Scribbly Gum (*E. racemosa*);
- Grey Gum (*E. punctata*); and
- Smooth-barked Apple (*Angophora costata*).

The E29 - Hawkesbury Banksia Scrub-Woodland (Plot 1) contained approximately 175 hollows per hectare, equating to approximately 2 013 hollows from 1 093 trees within the proposed areas of disturbance on the Project Site (approximately 60% of all tree hollows on the Project Site). The E29a – Hawkesbury Banksia Scrub-Woodland (Scrub) is a related community that is dominated by tall shrubs (*Banksia ericifolia*) but contains sparsely distributed low trees. The Exposed Hawkesbury Woodland (Plot 2) contained approximately 165 hollows per hectare, equating to approximately 2 229 hollows from 1 215 trees within the proposed areas of disturbance on the Project Site. Based on the areas of each community type to be cleared and the average size and number of hollows per tree, **Table 5.19** provides a summary of the estimated number and size of the tree hollows that occur and would be cleared as part of the Project.

It is important to note that the tree hollows occurred in a range of sizes, predominantly small (less than 5cm entrance diameter) and that not all hollows would be suitable for the full range of hollow-dependent fauna that has the potential to occur on the Project Site. The majority of hollows are not suitable for the Powerful Owl, which requires hollows at least 0.5m deep in trees with DBH 80cm to 240cm. The Glossy Black Cockatoo has been reported as using hollows of approximately 21cm entrance diameter, hence suitable nesting hollows are provided on the Project Site at a frequency of approximately 20 per hectare. Possums and gliders are able to use the smaller hollows from about 5cm entrance diameter or larger, and microchiropteran bats may use the smallest hollows including those of less than 5cm entrance diameter.

Table 5.19
Tree Hollows in Proposed Extraction Area

Hollow size	Hollows per plot	Hollows per hectare	Hollows to be cleared
Plot 1 – E29 - Hawkesbury Banksia Scrub-Woodland			
<5cm	12	60	690
5-10cm	9	45	518
10-15cm	4	20	230
15-20cm	6	30	345
>20cm	4	20	230
Total	35	175	2013
Estimate for E29a Hawkesbury Banksia Scrub – Woodland (Scrub)			
Total	21	105	903
Plot 2 – Exposed Hawkesbury Woodland			
<5cm	15	75	1013
5-10cm	5	25	338
10-15cm	7	35	473
15-20cm	2	10	135
>20cm	4	20	270
Total	33	165	2229

Several significant hollow-bearing trees, with numerous large hollows were also recorded while traversing the Project Site as part of other flora or fauna surveys of Cumberland (2009). **Figure 5.17** presents the locations of the hollow-bearing trees of the Project Site.

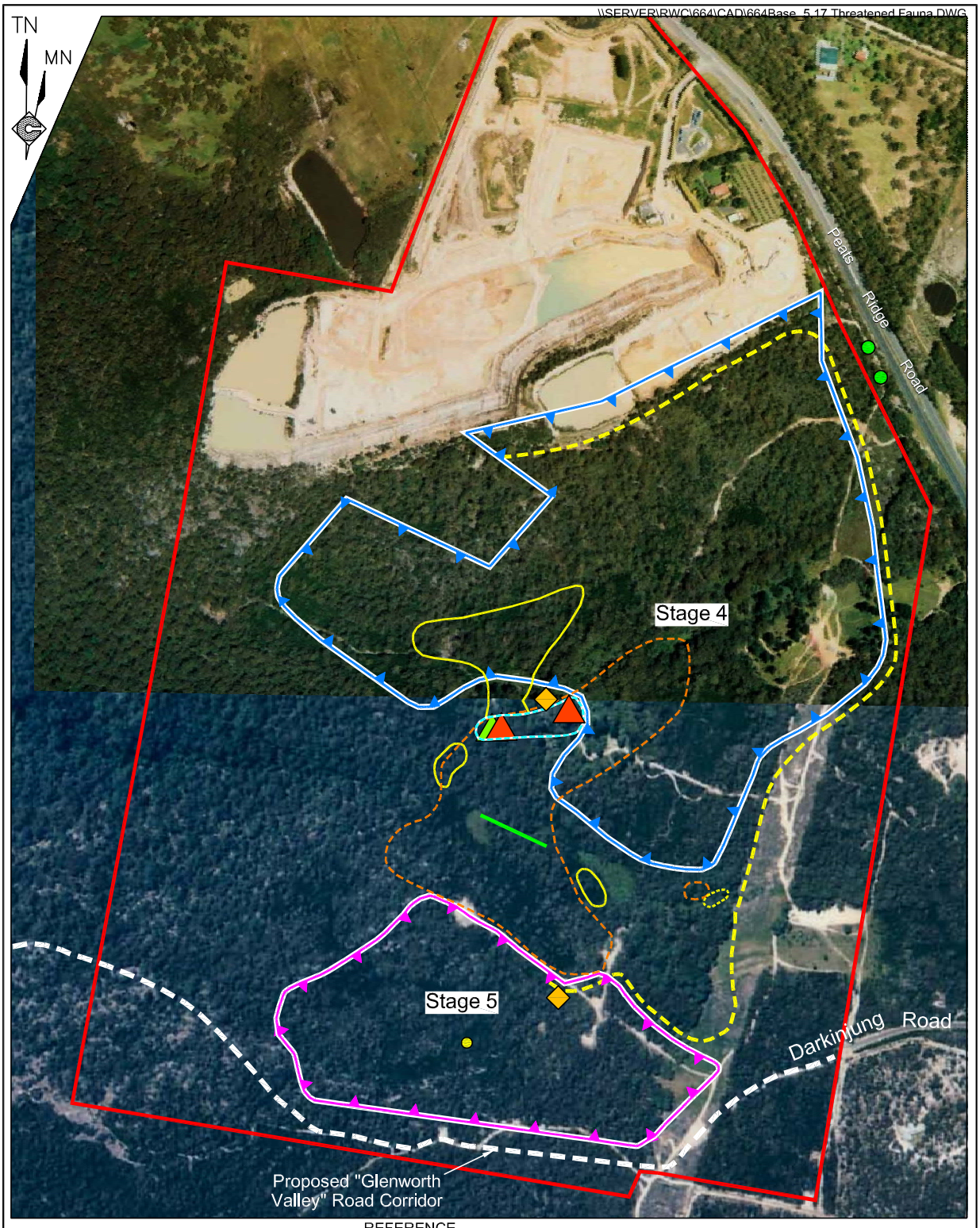


Figure 5.17
THREATENED FAUNA AND FAUNA HABITAT OF THE PROJECT SITE

Koala Feed Trees

Two preferred Koala food tree species (*Eucalyptus punctata* and *E. haemastoma*) occur relatively frequently within the woodland vegetation communities of the Project Site, although neither species is dominant in the communities in which it occurs. The Koala Recovery Plan (DECC, 2008) lists additional food species that may be used by the Koala in the Central Coast region. Notably, none of the primary Koala feed species for the Central Coast occurs on the Project Site. The only secondary species that occurs on the Project Site is *E. punctata*. The density of Koala food trees recorded in tree hollow plots was of 25 per hectare in Plot 1 (approximately 24% of all trees) and 20 per hectare in Plot 2 (approximately 21% of all trees).

By applying the SEPP 44 definition, the Project Site therefore consists of Potential Koala Habitat but because it does not show signs of use by any Koalas, it does not qualify as Core Koala Habitat. According to the Koala Recovery Plan, the type and density of feed trees would indicate that the Project Site could only support low densities of Koalas (in the order of <1 per hectare).

Logs

Some species are likely to use logs and rock outcrops for dens, in particular the Spotted-tailed Quoll and Rosenberg's Goanna. The woodland vegetation communities supply fallen branches and logs across the Project Site.

Rock Outcrops

There are many rock outcrops, particularly in the southern portion of the Project Site and associated with the cliff line that runs in a curve in the middle of the Project Site. The Red-crowned Toadlet may utilise rock outcrops in the Project Site, particularly those associated with drainage lines.

Creeks

Two creeks are present in the upper part of the Project Site, Creeks A and B, with these merging over a high cliff in the centre of the Project Site to form Creek C which discharges into Cabbage Tree Creek. These creek lines, and the moist areas that head them, provide important habitat and an ephemeral water source for many species in the locality, and may be of particular habitat value to frog species.

Swamps

Most of the hanging swamps mapped within the Study Area (see **Figure 5.15**) are at a long-unburnt seral stage and currently support dense stands of *Banksia ericifolia*, which frequently merge into adjacent scrub-woodlands. These swamps provide habitat for frogs and invertebrates, and thus provide foraging resources for other animal groups.

Habitat for Threatened Fauna

The habitat features described above may provide specific habitat for Threatened fauna species.

5.3.4.2.2 Habitat Corridors

Habitat corridors link primary landscape features and large areas of similar habitat. Popran National Park is one of a large group of predominantly sandstone parks and reserves surrounding Sydney and completes a corridor of bushland extending from Brisbane Water to the western side of the Blue Mountains (Cumberland, 2009). Specifically, Popran National Park is part of a system of parks and reserves which together conserve the biodiversity and catchment values of the lower Hawkesbury River and provide a vegetation and wildlife link between the national parks to the east and west. Located at the northern end of the Calga section of Popran National Park, the Project Site provides native vegetation which intergrades with the vegetation of Popran National Park, and is therefore a small part of the regional corridor system for flora and fauna.

On a local scale, the native vegetation on the Project Site intergrades with the vegetation of Popran National Park and remnant vegetation on the opposite side of Peats Ridge Road (adjoining Brisbane Water National Park). As such, the Project Site forms part of a local corridor between the Calga sections of Popran and Brisbane Water National Parks.

This corridor is likely to be particularly important to the Regent Honeyeater, Square-tailed Kite, Swift Parrot, Turquoise Parrot, Barking owl, Masked Owl, Powerful Owl, Spotted-tailed Quoll (HNCMA, 2007).

5.3.4.2.3 Fauna of the Project Site

Recorded fauna species within the Project Site included:

- 51 bird species (of which one is an introduced species);
- 20 mammal species (of which two are introduced species);
- two reptile species;
- eight frog species; and
- three introduced fish species (of which one is an introduced species).

A complete list of the fauna identified is provided by Cumberland (2009) (*Appendix A*). Threatened species listed on Schedule 2 of the TSC Act recorded during the field survey included the:

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Red-crowned Toadlet (*Pseudophryne australis*) ; and
- Eastern Pygmy Possum (*Cercartetus nanus*)

Fauna habitat was also identified for the Red-crowned Toadlet. Potential fauna habitat was identified for the Giant Burrowing Frog (*Heleioporus australiacus*), Green and Golden Bell Frog (*Litoria aurea*) and Littlejohn's Tree Frog (*Litoria littlejohni*). Previous surveys of the Project Site and surrounds identified the following additional threatened species.

- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Rosenberg's Monitor (*Varanus rosenbergi*); and
- Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*).

Figure 5.17 identifies the locations of the identified threatened species and their habitats on the Project Site.

An EPBC protected matters database search completed by Cumberland (2009) identified that a range of migratory birds may utilise the Project Site, including: the migratory wetland birds such as Great Egret, Cattle Egret, Latham's Snipe and Painted Snipe; and the migratory terrestrial birds White-bellied Sea-Eagle, White-throated Needletail, Rainbow Bee-eater, Black-faced Monarch, Satin Flycatcher and Rufous Fantail (DEH, 2009).

No endangered fauna population, ecological community or critical fauna habitat has been listed in the Gosford LGA or was identified within the Project Site.

5.3.5 Flora and Fauna Management Issues

5.3.5.1 Direct Impacts on Native Flora and Fauna – Key Threatening Processes

5.3.5.1.1 Clearing of native Vegetation

The clearing of native vegetation is considered a "key threatening process" under the Schedule 3 of TSC Act, ie. a process that threatens or could threaten the survival of native species, populations or communities. The clearing of native vegetation may include the following impacts.

- Destruction of habitats resulting in the loss of local populations of species.
- Fragmentation of habitat.
- Expansion of dryland salinity.
- Riparian zone degradation.
- Increased greenhouse gas emissions.
- Increases in habitat for invasive species.
- Loss of the leaf litter layer.
- Loss or disruption of ecological function.
- Changes to soil biota.

Figure 5.15 illustrates where the proposed Southern Extension would result in the clearance of native vegetation, as well as where vegetation is likely to be conserved in the long term. The magnitude, extent and significance of the proposed clearing is considered in Section 5.2.7.2.

5.3.5.1.2 Alteration to Natural Flow Regimes of Rivers and Streams

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is also classified as a key threatening process and can result in the following impacts.

- Reduction of habitat due to changes in area, frequency and/or duration of flooding.
- Increased flows causing more permanent flooding of some wetlands.
- Riparian zone degradation through altered flow regimes.
- Increases in habitat for invasive species.
- Loss or disruption in ecological function.

The interruption of the flow of two small tributaries (Creeks A and B) of Cabbage Tree Creek as a result of the Project has the potential to impact on the viability of riparian type vegetation on the Project Site, as well as reduce habitat for threatened frogs on the Project Site. The flow interruption could also potentially lead to the alteration of existing hydrological conditions in those areas that contain areas of hanging swamp (Community E54) between Creek A and B.

5.3.5.1.3 Loss of Hollow-bearing Trees

In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 85 birds, 32 reptiles and 16 frogs (Gibbons and Lindemayer, 2002). Of these, 45 species are listed as threatened on Schedule 1 and Schedule 2 of the TSC Act. The proposed Southern Extension of the Calga Sand Quarry would result in the clearing of hollow-bearing trees (possibly at a rate of approximately 7 to 17 hollows per hectare of good quality woodland (Gibbons and Lindemayer, 2002)). This has the potential to impact on species which use these hollows including the threatened Powerful Owl, Glossy Black-cockatoo and microchiropteran bats, as well as Sugar Gliders, Brush-tailed Possums and a range of non-threatened parrots.

5.3.5.2 Impacts on Regional Biodiversity

The proposed clearing of native vegetation on the Project Site may also have indirect impacts on aspects of regional biodiversity as follows.

Impacts on the Adjacent Popran National Park

The Project Site is located adjacent to Popran National Park, which is one of a large group of predominantly sandstone parks and reserves surrounding Sydney and is part of a large corridor linking Brisbane Water National Park and the Blue Mountains. The Calga section of the park, which is one of the smaller portions, protects part of the Kellys Creek catchment, a tributary of Popran Creek. The remnants of native vegetation on lower shale slopes and alluvium that the park conserves are particularly important as many such communities have been cleared along the Hawkesbury River. The protection of undisturbed catchments of tributaries to the Hawkesbury River is also critical to the persistence of aquatic life and natural systems associated with the river. The park provides areas of substantially natural habitats that support a wide range of species.

Fragmentation and Edge Effects

Fragmentation is the breaking down of large areas of habitat into smaller parcels. Larger areas of habitat can support greater numbers of species and higher levels of abundance within species. Fragmentation can affect plants and animals on a variety of scales. Fragmentation can affect the size of populations (and in some cases leads to local extinction of a species), can limit movement of species between areas, and can reduce genetic diversity of a population. Fragmentation also leads to greater edge effects.

"Edge effects" is the term given to impacts that occur at the interface between two contrasting landscape elements. Changes to ecological processes within the vegetation can extend between 10m and 100m from the edge. Certain species, such as Noisy Miners, are edge-specialists, and can take over an area, driving out other species of native birds. Edge effects include:

- invasion by weeds;
- habitat reduction or fragmentation;
- increased predation;
- reduction in tree health; and
- barriers to dispersal or distribution.

The proposed quarry extension would fragment the native vegetation of the Project Site and increase the interface between native and cleared/disturbed vegetation.

Wildlife Corridors

The purpose of wildlife (or habitat) corridors is to facilitate important ecological processes such as migration, colonisation and interbreeding of plants and animals between two or more larger areas of such habitat. The Project Site is located adjacent to Popran National Park which is part of a large corridor linking Brisbane Water National Park and the Blue Mountains. The Project Site provides native vegetation which is virtually continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna.

5.3.5.3 Groundwater Dependent Ecosystems

Many ecosystems have some degree of dependence on groundwater for functioning. Depending on the level of dependence on groundwater, these ecosystems are classified as either:

- Facultative GDEs: which are partially dependent on groundwater, ie. may survive without access to groundwater but whose function is greatly improved when it is available; or
- Obligate GDEs: which would not continue to function without access to groundwater.

Groundwater dependent ecosystems (GDEs) are common in the Kulnura-Calga area and some vegetation of the Project Site is likely to be at least partially dependent on groundwater for ecosystem functioning.

- Rainforest vegetation (E2 Sandstone Gully Rainforest) occurring within the main creekline (Creek C) is dependent on maintaining sufficient soil moisture, which is recharged via the existing stream channel and within sandstone rock stratas. Such vegetation should be considered as a facultative GDE.
- E54 Sandstone Hanging Swamp and E103 Gahnia/Banksia Swamp are likely to be examples of perched, obligate GDEs. These areas support plant species that cannot survive for long periods without adequate soil moisture and waterlogging.

A number of GDEs occur in the area which could be indirectly affected by the Project. In particular, MU1 Coastal Wet Gully Forest, MU37 Swamp Mahogany – Paperbark Swamp Forest, and MU40 Swamp Oak – Rushland Forest are mapped as occurring in the lower reaches of Cabbage Tree Creek (600m due west of the southwestern boundary of the Project Site) (LHCCREMS, 2003).

Any changes to surface hydrology or hydrogeology may have some impact on these communities.

5.3.5.4 Threatened Species, Populations and Ecological Communities

No endangered ecological communities (EECs) are present on the Project Site, although the Swamp Sclerophyll Forest on Coastal Floodplains EEC and Swamp Oak Floodplain Forest EEC are present downstream along Cabbage Tree Creek. The possible indirect impacts of the Project on these EECs are discussed in Section 5.2.7.3.

No threatened populations were identified on or surrounding the Project Site.

As noted in Section 5.2.4.1.1 and 5.2.4.2.3, three threatened flora species and six threatened fauna species have been identified on the Project Site. As noted in Section 5.2.3.1.3, a further 22 threatened species have been identified within 5km of the Project Site with a total of 78 species (34 plants, 15 birds, 19 mammals, 4 frogs, 3 reptiles, 2 fish and 1 invertebrate) identified through various database searches as occurring or potentially occurring within the Gosford LGA.

In order to determine the level of risk posed to each of these species by the Project, Cumberland (2009) completed a risk assessment for each threatened species. The risk assessment completed considered the likelihood and magnitude of impact and was based on the abundances of the different threatened species known to occur in the locality, whether they have been identified on the Project Site, and knowledge of their habitat preferences.

Factors taken into account by Cumberland (2009) to assess the likelihood and magnitude of potential impacts of the Project on threatened species included the following.

- Presence or occurrence of the species/community (either on site or within 5km of the Project Site), and potential habitat on site.

- Presence or occurrence of species is based on the current study, previous studies for Calga Sand Quarry and database searches (see Sections 5.2.3.1 and 5.2.3.2).
- Identification of potential habitat is based on the current study and information on habitat requirements provided in profiles for TSC Act and EPBC Act listed threatened species and EECs.

In assessing the risk posed by the Project to the threatened species known or considered as potentially occurring on the Project Site, ie. the 78 species identified as occurring or potentially occurring within the Gosford LGA, several key points can be made.

- The Project may result in the complete removal of up to 34.7ha of native vegetation.
- Some of the threatened plants are dependent on communities likely to be substantially impacted by the Project, while other threatened plants may be located in areas subject to lower level impacts.

The risk assessment of Cumberland (2009) allocated the following risk levels (for local extinction) to the 78 threatened species considered.

i) Low Risk: A significant impact is not considered likely for these species.

ii) Moderate Risk: A significant impact is considered unlikely for these species since the Project would not result in the removal of known occurrences of these species. Preferred habitat may, however, be indirectly impacted by the proposed extraction activities.

iii) High Risk: The project may result in the removal of known occurrences of these species and/or preferred habitat may be indirectly impacted by the proposed extraction activities.

The Cumberland (2009) risk assessment considers those species determined to be at moderate and high risk of adverse impact as follows.

Species at Moderate Risk

Cumberland (2009) determined that 22 threatened species were found to be at moderate risk from the Project. While most of these were not recorded during the field surveys of Cumberland (2009), they have been recorded within 5km of the Project Site and therefore may move into or forage over the Project Site.

- *Acacia bynoeana* (endangered under the TSC Act and vulnerable under the EPBC Act);
- *Prostanthera junonis* (endangered under the TSC Act and endangered under the EPBC Act);
- *Eucalyptus camfieldii* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Kunzea rupestris* (vulnerable under the TSC Act and vulnerable under the EPBC Act);

- *Melaleuca deanei* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Micromyrtus blakelyi* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Diuris bracteata* (endangered under the TSC Act);
- *Ancistrachne maidenii* (vulnerable under the TSC Act);
- *Grevillea shiresii* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- *Persoonia hirsuta* (endangered under the TSC Act and endangered under the EPBC Act);
- *Lasiopetalum joyceae* (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- Gang Gang Cockatoo (*Calocephalon fimbriatum*) (vulnerable under the TSC Act);
- Masked Owl (*Tyto novaehollandiae*) (vulnerable under the TSC Act);
- Barking Owl (*Ninox connivens*) (vulnerable under the TSC Act);
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (vulnerable under the TSC Act);
- Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*) (vulnerable under the TSC Act)[6];
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (vulnerable under the TSC Act and vulnerable under the EPBC Act);
- Little Bentwing Bat (*Miniopterus australis*) (vulnerable under the TSC Act);
- Spotted-tailed Quoll (*Dasyurus maculatus*) (vulnerable under the TSC Act and endangered under the EPBC Act);
- Long-nosed Potoroo (*Potorous tridactylus*) (vulnerable under the TSC Act and vulnerable (southeast mainland) under the EPBC Act);
- Squirrel Glider (*Petaurus norfolcensis*) (vulnerable under the TSC Act); and
- Yellow Bellied Glider (*Petaurus australis*) (vulnerable under the TSC Act).

Cumberland (2009) considers a significant impact is unlikely for these species, as the Project would not result in the removal of known occurrences of these species. Identified or potential habitat may, however, be indirectly impacted by the proposed activities and as such an assessment of significance in accordance with Section 5A of the EP&A Act has been completed by Cumberland (2009) for each of these species. A summary of the results of these assessments is provided in Section 5.2.7.5.

[6] Identified by CES (2004) on or adjoining the Project Site.

Species at High Risk

Cumberland (2009) determined that occurrences and/or habitat of 13 species may be removed or indirectly impacted, placing these species at high risk of being impacted should the Project proceed.

- *Callistemon linearifolius* (vulnerable under the TSC Act)[7];
- *Darwinia glaucophylla* (vulnerable under the TSC Act) [8].
- *Hibbertia procumbens* (endangered under the TSC Act) [8].
- *Tetratheca glandulosa* (endangered under the TSC Act and endangered under the EPBC Act);
- Red-crowned Toadlet (*Pseudophryne australis*) (vulnerable under the TSC Act)[8].
- Giant Burrowing Frog (*Heleioporus australiacus*) (vulnerable under the TSC Act and vulnerable under the EPBC Act).
- Glossy Black-cockatoo (*Calyptorhynchus lathami*) (vulnerable under the TSC Act)[8].
- Powerful Owl (*Ninox strenua*) (vulnerable under the TSC Act)[8].
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (vulnerable under the TSC Act).
- Large-footed Myotis (*Myotis adversus*) (vulnerable under the TSC Act);
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (vulnerable under the TSC Act and vulnerable under the EPBC Act)[9].
- Eastern Pygmy-possum (*Cercartetus nanus*) (vulnerable under the TSC Act)[8].
- Rosenberg's Goanna (*Varanus rosenbergi*) (vulnerable under the TSC Act)[9].

The Project may result in the removal of known occurrences of these species and/or preferred habitat may be indirectly impacted by the proposed extraction activities. While it is noted that significant areas of habitat exist for all these species in the locality, an assessment of significance in accordance with Section 5A of the EP&A Act has been completed by Cumberland (2009) for each of these species. A summary of the results of these assessments is provided in Section 5.3.7.5.

No species were considered to be placed at extreme risk of impact.

[7] Recorded by Cumberland (2009).

[8] Identified by CES (2004) on or adjoining the Project Site

5.3.6 Environmental Controls and Management

5.3.6.1 Introduction

The total area of disturbance associated with the proposed Southern Extension of the Calga Sand Quarry (including internal access roads) is approximately 45.7ha, including 34.7ha of native vegetation.

In line with the Step 4 of the Draft Guidelines for Threatened Species Assessment (DEC and DPI, 2005), Rocla has designed the Project to minimise impacts on threatened species by avoiding, then mitigating and finally offsetting impacts. Sections 5.2.6.2, 5.2.6.3 and 5.2.6.4 present the design features, operational controls and management measures proposed for the Project.

5.3.6.2 Design Features, Operational Controls and Management Measures to Avoid Impacts

Stages 4 and 5 of the proposed Southern Extension of the Calga Sand Quarry have been designed to limit impacts on threatened species, communities and important habitat. Notably, there would be no placement of overburden and other waste materials external to the proposed extraction areas. All material would be managed within the defined extraction areas of the approved and proposed stages of the Calga Sand Quarry.

The design of the disturbance footprint itself provides for the conservation of a number of locations where *Darwinia glaucophylla* and *Hibbertia procumbens* have been recorded, as well as habitat where these species are likely to occur. In addition, the following modifications have been made to the extraction area design to avoid impacts on threatened species, particularly the threatened frogs.

- Initially one large extraction area was proposed, however, to limit impacts on local hydrology, and protect areas of threatened frog habitat (see **Figure 5.17**), the extraction area within the Southern Extension has been split into two separate stages separated by Creek B. Stages 4 and 5 are set back in excess of 50m from Creek B.
- An area along the southwestern perimeter of the Stage 4 extraction area has been excised where Creek B joins with a second ephemeral drainage line (Creek A) to form Creek C (the main creek which runs to the west). This setback is designed to avoid disturbance to an Aboriginal heritage site and to protect the identified habitat for the Red-crowned Toadlet and potential habitat for the Great Burrowing Frog.
- The northeastern corner of Stage 4 has been aligned to avoid two of the identified locations of *Callistemon linearifolius* which have been identified. As a result only a single *C. linearifolius* specimen would be disturbed by the Project.
- The access road between Stages 4 and 5 would utilise, as far as practicable, the cleared easement for the transmission lines which traverse the eastern side of the Project Site.

Measures to avoid impacts on the potential habitat of the threatened frogs would also conserve potential habitat for *Darwinia glaucophylla* and *Hibbertia procumbens* on the site. Potential habitat for *Callistemon linearifolius* would also be preserved in these areas.

Rocla would ensure that the areas of native vegetation not required for site-related activities would be conserved. This would be achieved either through fencing and/or signage. By ensuring disturbance is limited to these areas, the retained vegetation would continue to provide habitat for those threatened species recorded from the Study Area, as well as other species which may occur in the area, including:

- tree hollows which provide nesting and roosting habitat for Powerful Owls, Glossy Black-cockatoos, threatened bats, and a range of other vertebrate fauna;
- dead wood which provides den sites for Rosenberg's Goanna and other fauna;
- flowering trees which provide foraging habitat for threatened woodland birds;
- species of *Allocasuarina* which provide foraging habitat for Glossy Black-cockatoos;
- rock outcrops and creeks which provide habitat for threatened frogs; and
- general habitat for threatened plants including *Callistemon linearifolius, Darwinia glaucophylla* and *Hibbertia procumbens*.

5.3.6.3 Design Features, Operational Controls and Management Measures to Mitigate Impacts

The revegetation of the final landform has been designed to provide for the re-establishment of native vegetation communities over the Stage 5 extraction area. As far as practicable, and with due consideration to the topography and drainage of final landform, Rocla would use vegetation species similar to those cleared. In particular, Rocla proposes to include *Callistemon linearifolius* and species of *Allocasuarina* in the revegetation of the Project Site. Successful establishment of these species would enable an increase in abundance of *Callistemon linearifolius* and foraging habitat for the Glossy Black-cockatoo within the region in the long term. Rocla would also manage the rehabilitation activities to encourage the growth of *Hibbertia procumbens* and *Darwinia glaucophylla*, although it is noted that as both these species are disturbance coloniser's there should be a natural encroachment of these species over the disturbed and rehabilitating areas of the Project Site.

Other operational safeguards proposed to mitigate the unavoidable impacts on native vegetation and threatened species include the following.

i) Throughout the life of the Project, vegetation would only be cleared as required with the area of vegetation clearing linked to the area required for each 12 months of activity.

ii) Topsoil would be directly transferred onto rehabilitation areas as often as possible to maximise the opportunity for retention of the natural seed stock, and thereby maximise the revegetation of the final landform with endemic species.

iii) During each vegetation clearing program, seed would be collected from felled vegetation for use in future re-vegetation programs.

iv) Cleared areas of Stage 5 and the final drainage channels of Stage 4 not required for Project-related activities would be replanted with *Allocasuarina* species to replace this source of foraging habitat for the Glossy Black-cockatoo.

v) Re-vegetation activities of Stage 5 and the final drainage channels and retained extraction face benches of Stage 4 would focus on the re-introduction of the species currently observed within the two main native vegetation communities on the Project Site providing habitat for the three threatened plant species.

vi) A program of weed control would be undertaken, firstly to remove/reduce weeds in soils prior to soil stripping activities and secondly following re-vegetation to ensure native plants are not overgrown during their early periods of growth.

In accordance with the recommendations of Cumberland (2009), Rocla is also committed to developing and implementing procedures to manage the native vegetation, threatened species and important habitat of the Project Site. The following provides an overview of the proposed management.

Vegetation Management

In accordance with the recommendations of Cumberland (2009), Rocla would prepare and implement procedures to manage vegetation clearing and remnant vegetation on the Project Site. These procedures would likely include but not be limited to the following.

- Vegetation clearing, including area identification, felling, stockpiling and re-use.
- Collection and management of provenance seed.
- Collection and management of important habitat elements such as tree hollows and leaf litter.
- Soil stripping (as it impacts on clearing of understorey).
- Weed management.
- Additional surveys of threatened species over the life of the Project (especially following bushfire given it is possible that locations that are currently unsuitable for *Darwinia glaucophylla* and *Hibbertia procumbens* could become suitable following fire).
- Revegetation of final landform, including species selection, revegetation techniques, key performance objectives and maintenance.

Threatened Species and Habitat Management

In order to manage the occurrence of threatened species on the Project Site, and to ensure habitat remains in a viable condition. The following management measures would be implemented by Rocla.

- **Internal Access**. All Project Site personnel would be properly inducted and made aware of the sensitive nature of frog habitat, threatened plants and potential roost and nest sites for bats and birds. Fencing would be erected between the Stage 4 and Stage 5 extraction areas to further discourage access by people or machinery. Similarly, access to the western portions of the Project Site would be prevented.
- **Nest Boxes**. These would compensate for the loss of trees with hollows from the Project Site. While various size and design boxes would be used to provide habitat for a various range of threatened and non-threatened fauna, the use of these nest boxes would be aimed at providing compensatory habitat for the following threatened fauna known or considered likely to occur within the Project Site.
  - Powerful Owl and Glossy Black-cockatoo.
  - Microchiropteran Bats including Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), and Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*).
- **Salvage of Individual Plants**. While the DECCW does not consider that translocation of threatened species, populations and ecological communities as an ameliorative strategy for the purposes of considering impacts of a particular development/activity, it may assist in the protection of the local population of this species.
- **Weed and feral animal control**. This would reduce the mortality rate of threatened species retained on the Project Site.
- **Protection of specific habitat features**. Natural features important to the ecology of threatened species, eg. termite nests, specific flora species, etc. would be retained or relocated where possible to maximise the habitat value of the Project Site to threatened species.

5.3.6.4 Biodiversity Offsets

In accordance with Step 4 of DEC and DPI (2005), the Calga Biodiversity Offset Strategy has been developed by Rocla (see Section 2.14) to ensure the Project results in “no net loss in biodiversity values” as a result of the impacts that cannot be avoided or mitigated.

The following considers the adequacy of the proposed Calga Biodiversity Offset Strategy against the 13 guiding "*principles for the use of Biodiversity Offsets in NSW*" (DECC, 2007) identified in Section 2.14.1.

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

Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.

The design of the proposed extraction areas has been modified substantially from that originally considered to ensure that areas of particular conservation significance, including Creeks B and C, known Red-crowned Toadlet habitat, potential Giant Burrowing Frog habitat, and known populations of *Callistemon linearifolius*, *Darwinia glaucophylla* and *Hibertia procumbens* were avoided. Section 5.2.6.2 provides further detail on the elements of Project design incorporated to avoid impacts on biodiversity.

Section 5.2.6.3 describes the various safeguards and controls to be implemented by Rocla to mitigate impacts on biodiversity. These measures concentrate on the optimal use of natural resources to be disturbed by the proposed extraction activities and progressive rehabilitation over the Project Site but also provide for the preparation and implementation of a Vegetation Management Plan and Threatened Species Management Plan to minimise and mitigate impact on native vegetation and threatened species.

The proposed mitigation and impact avoidance proposed by Rocla notwithstanding, the Project would still result in the disturbance to 34.7ha of native vegetation, including some threatened flora species and habitat that is or may be used by threatened fauna species. By providing an offset ratio of 2:1, the proposed Calga Biodiversity Offset Strategy addresses these impacts by providing for the long-term conservation of similar vegetation and habitat to that disturbed. This would ensure habitat for the identified threatened species is maintained locally, increasing the viability of local populations of these species as well as regionally significant communities.

Principle 2 All regulatory requirements must be met.

Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).

Rocla would meet all regulatory requirements related to the construction, operation and rehabilitation of the Project.

Principle 3 Offsets must never reward ongoing poor performance.

Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.

Rocla has not deliberately degraded or mismanaged any land under its control.

Principle 4 Offsets will complement other government programs.

A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.

The proposed areas of conserved vegetation share a boundary with Popran National Park, which is managed under the Popran National Park Plan of Management (POM), a legal document required under the *National Parks and Wildlife Act 1974* that outlines how the park is required to be managed. While primarily focused on the management of lands within the Popran National Park, the Popran National Park POM also provides policies for the management of adjacent lands, as these might impact on the national park. Section 3.2.4.5 identified and outlined the relevant policies to the management of the Project Site and offset area. These policies have been reviewed, with the proposed Calga Biodiversity Offset Strategy to be managed to comply with these.

Principle 5 Offsets must be underpinned by sound ecological principles.

They must:

- *include the consideration of structure, function and compositional elements of biodiversity, including threatened species;*
- *enhance biodiversity at a range of scales;*
- *consider the conservation status of ecological communities; and*
- *ensure the long-term viability and functionality of biodiversity.*

Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.

The proposed Calga Biodiversity Offset Strategy was established following consideration of not only the vegetation and habitat to be disturbed, but also that to be conserved. As illustrated in **Table 2.9**, with limited exception, each vegetation type to be disturbed is represented in the proposed offset area.

Further, the majority of the vegetation within the offset area is directly linked to native vegetation already conserved, thereby reducing the potential detrimental impacts of fragmentation and edge effects on the conserved areas. The proposed Calga Biodiversity Offset Strategy would also provide for greater certainty over the maintenance of wildlife corridors within the Central Coast area. That is, the Calga Biodiversity Offset Strategy would reduce the separation distance between conserved vegetation within Popran National Park to the southeast and Brisbane Waters National Park to the northwest, thereby improving the connectivity between these two major conservation areas.

As noted specifically by this principle, the efficacy of reconstructing ecological communities is uncertain. Therefore, as the proposed Calga Biodiversity Offset Strategy primarily involves securing and managing land for biodiversity, and does not focus on reconstruction of ecological communities, it would contribute significantly to ensuring the long term viability and functionality of biodiversity in the locality.

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

Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.

Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.

Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.

By conserving the areas identified on **Figure 2.14**, a total offset ratio of approximately 2ha of conservation for every one hectare of native vegetation to be cleared would be created, ie. the area conserved would be twice the area of that disturbed.

In its location adjacent to Popran National Park, the offset area would also provide several important functions in increasing the biodiversity values of the local area. Firstly, it would provide a buffer to the established conservation area. With weeds and feral pests to be controlled within the offset area, the risk of these infiltrated the national park area would be reduced. Secondly, the offset area would reduce the distance between the conserved vegetation of Popran and Brisbane Waters National Parks, thereby improving the connectivity between these two major conservation areas.

Principle 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 should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.

By conserving existing native vegetation in good condition, the proposed Calga Biodiversity Offset Strategy would provide the immediate offsetting of disturbance, which would be maintained for the life of the Project and beyond.

Rocla would secure the Calga Biodiversity Offset Area through an enduring covenant or restriction on the use of the land under Section 88B of the *Conveyancing Act 1919*, Part 4, Division 12 of the *National Parks and Wildlife Act 1974* or similar arrangement, to the satisfaction of the Department of Environment, Climate Change and Water. The purpose of such an arrangement would be to restrict the use of the offset area for the purposes of native vegetation conservation in perpetuity. In light of this commitment to ensure the ongoing maintenance and restriction of the use of the offset area, and the eventual rehabilitation of selected areas of the Project Site to native vegetation, the proposed offset measures would result in the offsets continuing longer than the period of impact associated with the Project.

Principle 8 Offsets should be agreed prior to the impact occurring.

Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.

The offset measures, and a timeframe for putting the appropriate legal arrangements and management strategies in place, would be agreed with the relevant government agencies prior to Project-related disturbance occurring.

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

Offsets should be 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 must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include:

- *the area of impact;*
- *the types of ecological communities and habitat/species affected;*
- *connectivity with other areas of habitat/corridors;*
- *the condition of habitat;*
- *the conservation status and/or scarcity/rarity of ecological communities;*
- *management actions; and*
- *level of security afforded to the offset site.*

The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets would be of greater value where:

- *they protect land with high conservation significance;*
- *management actions have greater benefits for biodiversity;*
- *the offset areas are not isolated or fragmented; and*
- *the management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).*

Management actions must be deliverable and enforceable.

The relative areas of disturbance and proposed conservation have been quantified and are provided in **Table 2.9**.

Principle 10 Offsets must be targeted – they must offset the impacts on a "like for like or better" basis.

They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, 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 or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be 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.

By conserving the areas identified on **Figure 2.14**, a total offset ratio of approximately 2ha of offset for every one hectare of native vegetation to be cleared would be established. Notably, with limited exception, the offset area provides for an equivalent area or better for each vegetation community to be disturbed.

It is acknowledged that as the field survey of the biodiversity offset area was largely limited to vegetation mapping survey, it is not possible to identify the presence or absence of particular threatened species. However, on the basis of occurrence within particular vegetation communities within those areas to be disturbed on the Project Site, the occurrence of these vegetation types within the offset area and known occurrences within Popran National Park, Cumberland (2009) has established that potential habitat for all threatened species at moderate or high risk of local extinction exists within the proposed offset area. **Table 5.20** provides a summary of the known occurrences and presence or absence of potential habitat for each threatened species.

Rocla has committed to undertaking additional targeted field survey within the offset area during spring to identify the presence of threatened species and confirm the suitability of these areas as a "like for like or better" offset.

Principle 11 Offsets must be located appropriately.

Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.

The offset is located adjacent to both the area of disturbance and Popran National Park and includes the same or comparable vegetation community types.

Principle 12 Offsets must be supplementary.

They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.

The proposed offset measures would supplement native vegetation conservation managed by DECC (NPWS) within Popran National Park.

The offset has not been provided for by any other scheme.

Table 5.20
Comparison of Offset Ecological Values

Threatened Species	Occurrence in Proposed Extraction Area	Occurrence in Project Site Offset	Occurrence in Glenworth Valley Offset Area	Occurrence in Popran NP
Hibbertia procumbens	✓ (92)	✓(94).	P	✓(19)
Tetratheca glandulosa	P	P	P	✓
Acacia bynoeana	P	P	P	P
Prostanthera junonis	P	P	P	P
Callistemon linearifolius	✓ (1)	✓ (24)	P	✓
Darwinia glaucophylla	✓ (200)	✓ (67)	✓ (23)	✓ (19)
Eucalyptus camfieldii	P	P	P	P
Kunzea rupestris	P	P	P	P
Melaleuca deanei	P	P	P	P
Micromyrtus blakelyi	P	P	P	P
Diuris bracteata	P	P	P	P
Ancistrachne maidenii	P	P	P	P
Grevillea shiressii	X	P	P	X
Persoonia hirsuta	P	P	P	P
Lasiopetalum joyceae	P	P	P	P
Gang-gang Cockatoo	P	P	P	✓
Glossy Black Cockatoo	✓	✓	P	✓
Powerful Owl	P	P	P	✓
Masked Owl	P	P	P	P
Sooty Owl	P	P	P	✓
Yellow-bellied Sheathtail Bat	P	P	P	P
Eastern Freetail Bat	P	P	P	P
Large-eared Pied Bat	P	P	P	P
Little Bentwing Bat	P	P	P	P
Eastern Bentwing Bat	P	P	P	✓
Greater Broad-nosed Bat	P	P	P	P
Grey-headed Flying-fox	P	P	P	✓
Eastern Pygmy Possum	P	✓	P	P
Spotted-tailed Quoll	P	P	P	✓
Yellow-bellied Glider	P	P	P	P
Squirrel Glider	P	P	P	✓
Long-nosed Potoroo	P	P	P	P
Red-crowned Toadlet		✓		✓
Giant Burrowing Frog	P	P	P	✓
Rosenberg's Goanna	P	P	P	P

✓**(23)** = Species recorded (number of individuals) **P** = Potential Habitat Occurs **X** = Potential Habitat Absent

Source: Modified after Cumberland (2009) – Table 6.2

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

Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.

Rocla has committed to the proposed Calga Biodiversity Offset Strategy and envisages this would be included as a condition of any project approval granted. In addition, it is anticipated that the conditions to any project approval would include a requirement for Rocla to undertake an independent compliance audit of the Project against the conditions of the Project approval.

5.3.7 Assessment of Residual Impacts

5.3.7.1 Introduction

This section assesses the residual impacts of the Project on flora and fauna, and in particular threatened species, in accordance with Step 3 of DEC and DPI (2005). This step involves identifying not only the magnitude and duration of impacts, but also the significance of the impacts as related to the conservation importance of the habitat, individuals and populations likely to be affected.

5.3.7.2 Clearing of Native Vegetation

Clearing native vegetation to make way for the proposed Southern Extension of the Calga Sand Quarry is the chief impact that would result from the Project, as it would lead to a reduction in available habitat for a number of threatened species which currently utilise the Project Site.

Magnitude of Impact

Table 5.21 summarises the exact areas and relative proportion of each vegetation community on the Project Site to be cleared.

The proposed Southern Extension would result in the clearing of approximately 34.7ha of native vegetation (including 2.8ha of previously disturbed land). As identified in Section 5.3.6.2, impacts on the most sensitive areas of vegetation, eg. those providing important habitat for threatened species, were avoided as far as practicable. A summary of the Project related vegetation clearing is as follows.

- Stage 4 would result in the clearance and removal of approximately 22.2ha of native vegetation consisting mostly of native forest and woodland. This is approximately 26.6% of the vegetated areas.
- Stage 5 would result in the clearance and removal of an additional 11.4ha (13.6%), bringing the total cleared to 33.6ha or 39.9% of the vegetated areas.
- Internal access roads would result in the clearance and removal of an additional 1.1ha (1.4%), bringing the total cleared to 34.7ha or 41.6% of the vegetated areas.
- The vegetation communities that would experience the greatest proportional losses through vegetation clearing are those in the upper portions of the Project Site:
  - E26 group Exposed Hawkesbury Woodland (39.8% cleared);
  - E29 group Hawkesbury Banksia-Scrub Woodland (56.7% cleared); and
  - E103 Gahnia/Banksia Swamp (which would be totally cleared by Stage 4).

  E2 Sandstone Ranges Gully Rainforest and E54 Sandstone Hanging Swamp would not be directly affected by clearing of vegetation.

Table 5.21
Project Site Vegetation Clearing

Vegetation Community	Project Site Vegetation (ha)	Stage 4			Stage 5			Internal Access Roads			Total		
		Area Cleared (ha)	% Cleared	% Retained	Area Cleared (ha)	% Cleared	% Retained	Area Cleared (ha)	% Cleared	% Retained	Area Cleared (ha)	% Cleared	% Retained
E103	0.4	0.4	100.0%	0.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.4	100.0%	0.0%
E2	0.5	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
E25	11.5	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
E26	31.8	8.4	26.4%	73.6%	4.1	12.9%	87.1%	0.7	2.1%	97.9%	13.2	41.5%	58.5%
E26a	1.4	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
E29	23.8	8.0	33.6%	66.4%	3.1	13.0%	87.0%	0.4	1.5%	98.5%	11.5	48.1%	51.9%
E29a	12.4	4.4	35.5%	64.5%	4.2	33.9%	66.1%	0.0	0.1%	99.9%	8.6	69.6%	30.4%
E29b	1.2	1.0	80.5%	19.5%	0.0	0.0%	100.0%	0.1	4.8%	95.2%	1.1	85.3%	14.7%
E54	0.6	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
Xr	0.6	0.3	49.9%	50.1%	0.0	0.0%	100.0%	0.1	20.0%	80.0%	0.4	69.9%	30.1%
Xs	5.4	2.1	38.7%	61.3%	0.1	1.8%	98.2%	0.6	11.6%	88.4%	2.8	52.2%	47.8%
Unmapped (exotic)	15.0	7.5	49.8%	50.2%	0.2	1.3%	98.7%	0.0	0.0%	100.0%	7.7	51.1%	48.9%
Total	**104.7**	32.1	30.7%	69.3%	11.7	11.2%	88.8%	**1.9**	1.8%	98.2%	45.7	43.6%	56.4%
Total (native)	**83.7**	22.2	26.6%	73.4%	11.4	13.6%	86.4%	**1.1**	1.3%	98.7%	34.7	41.5%	58.5%

Duration of Impact

The duration of the impacts is a consideration of the permanence and reversibility of impacts and considers both the resilience of the vegetation cleared and proposed mitigation measures proposed.

Resilience is the ability of native vegetation to recover to a pre-disturbance condition, with sites classified as having low, medium or high resilience depending upon the nature and extent of existing native vegetation, the abundance of weeds and the known site history, particularly factors that could impact upon the soils and seed bank. The assessed resilience of each of the communities to be cleared is considered as follows.

- **E26 Exposed Hawkesbury Woodland and E29 Hawkesbury Banksia-Scrub Woodland Groups**. These communities represent over 95% of the native vegetation to be cleared. According to mapping for the Gosford LGA, these communities are widespread, particularly in the locality. Significant areas of these communities would remain adjacent to the proposed areas of disturbance, which would aide in the re-establishment of these communities to pre-disturbance condition. *Highly Resilient*.
- **E25 Hawkesbury Peppermint Apple Forest**. Less than 3% of this community, which is well represented in the locality, would be cleared. Significant areas of these communities would remain adjacent to the proposed areas of disturbance, which would aide in the re-establishment of these communities to pre-disturbance condition. *Highly Resilient*.
- **E103 Gahnia/Banksia Swamp**. A small-sized vegetation community currently restricted to an area of 0.43ha on the more elevated portions of the Project Site. This community would be removed in its entirety and, given this community is patchily distributed in the region, it is unlikely to recover to pre-disturbance condition in the Project Site. *Low Resilience*.

Rocla has proposed to rehabilitate and revegetate the Stage 5 extraction area (11.7ha) to native vegetation, to re-establish areas of the Exposed Hawkesbury Woodland and Hawkesbury Banksia-Scrub Woodland vegetation communities. Based on the resilience of these vegetation communities, the impacts associated with Stage 5 would be reversible in the medium to long-term.

However, given the intended final landform of Stage 4 would involve some form of continued industrial or commercial use, the impact associated with clearing for the Stage 4 Quarry would be permanent and irreversible.

In order to offset the long-term and permanent impacts, Rocla has committed to the biodiversity offset strategy discussed in Sections 2.14 and 5.3.6.4. This would provide for a conservation to disturbance ratio of 2:1 in the short term, increasing to 2.4:1 in the long-term as the Stage 5 extraction area is successfully rehabilitated.

Significance of Impacts

The significance of impacts consider both aspects related to the vegetation communities themselves, ie. relative distribution, importance as habitat to threatened species, regional and local representation, as well as the mitigation and offset measures proposed.

The vegetation of the Project Site to be cleared is typical of the vegetation found elsewhere in the Hawkesbury Sandstone environments on the Somersby Plateau (Cumberland, 2009). Notably, the Project would not result in the clearance of any areas of "high conservation value" (Cumberland, 2009), nor either of the two communities considered regionally significant by LHCCREMS (2003) (Sandstone Hanging Swamps (MU54 – equivalent to E54) and the Sandstone Ranges Warm Temperate Rainforest (MU2 – equivalent to E2)). Of the vegetation communities to be cleared, Bell (2004) considers the Hawkesbury Peppermint Apple Forest (E25), Exposed Hawkesbury Woodland (E26), Hawkesbury Rock Pavement Heath (E26a) and Hawkesbury Banksia Scrub-Woodland (E29) as being locally significant due to threatened species habitat, restricted distribution or development pressure.

A large number of hollow-bearing trees and some stags, which may provide habitat for a variety of species, including microbats, sugar gliders, parrots and owls, would also be lost from the Project Site. Depletion of hollow-bearing trees, combined with fragmentation and clearing, may impact on populations of hollow-using fauna and reduce the number of species that an area can support. This is considered further in Section 5.3.7.3.

The impact of the proposed clearing on the distribution of native vegetation would be partially mitigated by the proposed rehabilitation of the Stage 5 extraction area to native vegetation. As noted above, the high resilience of the Exposed Hawkesbury Woodland and Hawkesbury Banksia-Scrub Woodland vegetation communities should accelerate the successful re-establishment of these communities within the final landform.

The impacts of clearing would be further offset by the establishment of the proposed biodiversity offset strategy. This strategy provides for the conservation of undisturbed native vegetation over 39.1ha of the Project Site and 44.7ha on a section of the adjoining "Glenworth Valley" property (see Section 2.14.2). The vegetation to be conserved includes:

- 1.3ha of Sandstone Ranges Gully Rainforest (E2);
- 3.3ha of Dharug Footslopes Apple-Redgum Forest (E20);
- 30.5ha of Hawkesbury Peppermint Apple Forest (E25);
- 32.3ha of Exposed Hawkesbury Woodland (E26);
- 7.0ha of Hawkesbury Banksia-Scrub Woodland (E29); and
- 2.0ha of Sandstone Hanging Swamp (E54).

The total conservation : disturbance ratio (83.8ha:34.7ha) exceeds 2:1, improving to 2.75:1 if the rehabilitated Stage 5 extraction area is included.

While the area of each vegetation community cleared on the Project Site is relatively small, the significance of this clearing needs to be considered in a regional context, ie. what proportion of this vegetation community in the region does this area represent. As identified in **Table 5.22**,

with the exception of Gahnia/Banksia Swamp (E103), the native vegetation to be cleared on the Project Site represents less than 1% of the known extent of the vegetation community in the region.

Table 5.22
Regional Vegetation Clearing

Vegetation Community		Regional Extent (ha)	Cleared - Stage 4 (ha)	Cleared - Stage 5 (ha)	Cleared – Access Roads (ha)	Cleared - Total (ha)	Cumulative Impact (%)
E2	Sandstone Ranges Gully Rainforest	740	0	0	0	0	-
E25	Hawkesbury Peppermint Apple Forest	13 061	0	0	0.1	0.1	<0.01%
E26	Exposed Hawkesbury Woodland	17 284	8.4	4.1	1.0	13.2	0.08%
E29	Hawkesbury Banksia Scrub - Woodland	3 609	13.4	7.3	0.5	21.2	0.59%
E54	Sandstone Hanging Swamps	662	0	0	0	0	-
E103	Gahnia-Banksia Swamp	N/A	0.4	0	0	0.4	N/A
N/A = unmapped regionally							
Source: Modified after Cumberland (2009) – Table 5.8							

Therefore, given the Project would result in the clearance of less than 1% of any vegetation community type, the regional significance of the proposed clearing is considered minor. This would be more than adequately compensated by the establishment of the proposed biodiversity offset strategy which would ensure the long-term security of a wildlife/habitat corridor between the Popran and Brisbane Waters National Parks within the region.

Conclusion

It is assessed that the 34.7ha of native vegetation clearing on the Project Site, including the loss of tree hollows and stags, would be partially mitigated through appropriate vegetation clearing and management techniques (in accordance with a Vegetation Management Plan), rehabilitation of the Stage 5 extraction area with vegetation of the Exposed Hawkesbury Woodland and Hawkesbury Banksia Scrub-Woodland communities (considered highly resilient by Cumberland, 2009), and establishment of nest boxes in the conserved vegetation of the Project Site. These impacts are determined to be either reversible in the long-term (Stage 5 clearing) or permanent (Stage 4 clearing), however, in the context of the regional distribution of native vegetation, the residual impacts of the proposed clearing have been assessed as having only minor significance which would be adequately offset by the proposed biodiversity offset strategy of Rocla.

5.3.7.3 Loss of Hollow-bearing Trees

Loss of hollow-bearing trees has been given a preliminary listing as a key threatening process by the Scientific Committee (NSW Scientific Committee, 2006). A total of 45 species of threatened fauna are reliant on tree hollows for shelter and nests (Cumberland, 2009). As noted in Section 5.3.4.2.1, the proposed activities would result in the removal of an estimated 5 145 hollows (see **Table 5.19**). Based on known records for threatened species locally and these tree hollows may be used by the threatened Powerful Owl, Glossy Black-cockatoo and microchiropteran bats, as well as Sugar Gliders, Brush-tailed Possums and a range of non-threatened parrots.

The significance of the reduction in the number of hollow-bearing trees would be partially mitigated by the establishment of nest boxes (which replicate the value of a large tree hollow) over the undisturbed and rehabilitated sections of the final landform. The residual impact related to the loss of tree hollows and stags would be further offset through the establishment of the proposed biodiversity offset strategy, which importantly would ensure the retention of a wildlife corridor between Popran and Brisbane Waters National Parks. Other possible mitigation measures, such as the relocation of tree hollows from felled trees to retained areas of native woodland, will be considered as part of the development of a Vegetation Management Plan or Threatened Species Management Plan that would be developed and implemented should the Project be approved.

The impact of the removal of tree hollows on individual threatened species is discussed in greater detail in Cumberland (2009), a summary of which is provided for those species considered to be at high risk of local extinction as a result of the Project.

5.3.7.4 Groundwater Dependent Ecosystems

The Project would result in the complete removal of the 360m section of the creek that traverses Stage 4 (Creek A), and modification of the hydrology of Creeks B and C (much of the surface and groundwater catchment of Creek B would be removed).

The Project would also result in the reduction in the groundwater level beneath and surrounding the Project Site, as well as a decrease in base flow to the Creeks B, C and Cabbage Tree Creek of approximately 15%, whilst extraction activities are undertaken. Notably, these changes to groundwater level and base flow discharge would occur gradually over the life of the Project (32 years) and would be temporary only. As noted in Section 5.1.5.3, groundwater levels would largely recover over the Project Site and surrounds following quarry closure and rehabilitation, with base flows predicted to increase on current rates by 10% (see Section 5.1.5.4).

As a result of the proposed clearing, extraction and subsequent reduction in groundwater levels and base flow discharge rates, the following impacts on GDEs are predicted.

- The Gahnia/Banksia Swamp community would be completely removed by clearing.
- As a result of the removal of part of the catchment to Creeks B and C, as well as the reduction in groundwater base flows caused by the reduced groundwater levels, the Sandstone Gully Rainforest community (E2) would lose some water. The potential impact of this reduction in groundwater would be mitigated by the following factors.
  - The reduction in groundwater level would occur over a period of greater than 20 years, allowing time for the vegetation of the community to adapt to the reduced levels.
  - Flows within Creek B, which recharges the groundwater as it seeps through the sandy substrate and represents the primary source of water to this community, would be reduced by <20% over the life of the Project (see **Table 5.18**).

Further, this community is likely to have experienced, and adapted to fluctuating groundwater levels over time, limiting the potential impact on the species of the community. Some modification to this community would be likely, however, given the predicted re-instatement of pre-Project groundwater levels and base flow discharge rates, over time it is expected that any typical vegetation of this community lost over the life of the Project would return following quarry closure and Project Site rehabilitation.

- The Sandstone Hanging Swamp community (E54), may also be modified over time as a result of the reduced flow of water within Creeks B and C. As in the case of the Sandstone Gully Rainforest community, however, this community is likely to have experienced, and adapted to fluctuating groundwater levels over time, limiting the potential impact on the species of the community. It is expected therefore that any of the most groundwater dependent species of this community lost over the life of the Project would return following quarry closure and Project Site rehabilitation. It is also worthy of note that 1.3ha of this community would be conserved within a biodiversity offset area established on the neighbouring "Glenworth Valley" property.

It is not anticipated that the predicted changes to groundwater levels or base flow discharge would have any noticeable impact on the vegetation of the remaining eucalypt communities (communities E20, E25, E26 and E29) retained within the Calga Biodiversity Offset Area. In any event, these communities are common in the locality, and impacts to the areas within the Project Site would be insignificant to the communities at large.

A number of GDEs occur within the Cabbage Tree Creek catchment which could be indirectly affected by the Project. In particular, MU1 Coastal Wet Gully Forest, MU37 Swamp Mahogany – Paperbark Swamp Forest, and MU40 Swamp Oak – Rushland Forest are mapped as occurring in the lower reaches of Cabbage Tree Creek (600m due west of the southwestern boundary of the Project Site) (LHCCREMS, 2003). These communities rely on water flowing through Cabbage Tree Creek, which itself is dependent on groundwater discharge. However, as the Project Site represents only a small part of the catchment for Cabbage Tree Creek (<5%), minor changes to local hydrology and hydrogeology are not expected to have any significant impact on these GDEs.

Notably, the final landform of the Project Site is predicted to result in a net gain of flow to the Cabbage Tree Creek catchment, in particular during periods of low flow (dry years) (see Section 5.2.6.2). Based on this prediction, it is considered that the Project would provide a net benefit to those vegetation communities with some reliance on groundwater base flows in the medium to long-term. On this basis, the limited and in many cases temporary nature of impacts on GDEs on the Project Site are considered acceptable and adequately mitigated by the proposed operational safeguards, controls and offset strategy.

5.3.7.5 Indirect Impacts on Regional Biodiversity

5.3.7.5.1 Impacts on Popran National Park

Popran National Park is located immediately to the south of the Project Site and is one of a large group of predominantly sandstone parks and reserves surrounding Sydney and is part of a large corridor linking Brisbane Water National Park and the Blue Mountains. The Project Site

incorporates native vegetation which is continuous with the vegetation of Popran National Park, and is therefore part of the local corridor system for flora and fauna and an ecological buffer for the conservation values of the national park.

The Project would not directly impact on the vegetation or habitat of Popran National Park, however, the proposed activities are considered with respect to the possible indirect impacts on this reserve that are identified by the Popran National Park POM, namely:

- the potential loss or degradation of native vegetation and threatened species habitat due to fragmentation, loss of connectivity and increased edge effects;
- inadequate provision of buffers to the proposed activities and other local industry and development;
- unsuitable provision of bushfire measures;
- impacts on the life cycle, foraging and/or movement patterns of mobile threatened species recorded on or nearby Popran National Park; and
- changes to local hydrogeological (groundwater) and hydrological (surface water) conditions within Popran National Park.

Cumberland (2009) considered each of these possible indirect impacts and the following reviews and builds upon this assessment.

Potential Loss or Degradation of Native Vegetation and Threatened Species Habitat

Indirect impacts on Popran National Park such as habitat fragmentation and edge effects including weed invasion, increased dust deposition, elevated or unnatural noise levels and feral animal invasion are possible.

The creation of the proposed biodiversity offset area on the Project Site and "Glenworth Valley" property would maintain habitat connectivity to the northwest reducing and therefore not fragment habitat locally. In fact, the creation of the proposed offset area would provide increased security for a habitat corridor running between Popran National Park to the southwest of the Project Site and Brisbane Waters National Park to the northeast.

It is notable that the greater the degree of habitat fragmentation, the greater the effect edge effects are likely to have on native vegetation, habitat and threatened species. Therefore, in establishing the proposed biodiversity offset area, improving the security of habitat connectivity and minimising habitat fragmentation, the Project already mitigates many of the edge effects likely to affect the habitat and species composition of Popran National Park. Specifically, the creation of the proposed biodiversity offset area on the Project Site and "Glenworth Valley" property would largely protect the conservation reserve from these impacts as follows.

- Any weeds which establish within the disturbed area of the Project Site may spread to areas of vegetation immediately adjacent to the disturbed areas. However, the distribution of the majority of these species would be restricted by the established remnant vegetation within the offset area preventing the spread into the national park. Weed species not restricted by the established vegetation of the offset area are likely to already be present with the conservation reserve given the presence of local industry surrounding Popran National Park. The

implementation of a Vegetation Management Plan would allow for the establishment of controls to minimise the establishment and spreading of weed species on the Project Site.

- Dust and noise emissions from the proposed activities are not predicted to be excessive (see Sections 5.7 and 5.5 respectively) with any edge effects restricted to the offset area within the Project Site.
- Proper management of rubbish, other waste materials and stockpiles would prevent any influx of feral animals to the Project Site. As such, the proposed activities are unlikely to contribute to any increase in the feral animal population of the local area. Notwithstanding, the implementation of a Vegetation Management Plan would allow for the establishment of controls to minimise the occurrence of feral animals on the Project Site.

Adequacy of Buffers between the Proposed Activities and Popran National Park

The proposed biodiversity offset area would provide a buffer between the proposed activities and Popran National Park of at least 50m wide along the southern edge of the proposed Stage 5 extraction area. The buffer would be much wider to the east and west of the Stage 5 extraction area. Although the proposed Glenworth Valley access road would be set back from the boundary of the park within the buffer around the southern edge of the Stage 5 extraction area, the proposed road would not substantially further fragment the existing native vegetation.

Bushfire Control Measures

The Project does not require the provision of asset protection zones. It is noted that the ecology of the local area is adapted to fire and the landscape would have been periodically burned by wildfires. Many of the threatened flora species that occur or have the potential to occur within Popran National Park (and the local area more generally) require fire to regenerate (although frequent burning would result in a loss of soil seed bank, decreasing the numbers of these species). To ensure the fire regime of the biodiversity offset area is consistent with that of Popran National Park, the Vegetation Management Plan to be implemented on the Project Site would provide for ecological burns coordinated with burns planned for Popran National Park[9].

Impacts on Mobile Threatened Species Recorded in, or Nearby Popran National Park

Habitat for mobile threatened fauna species that may use both Popran National Park and the Project Site is provided in the adjoining offset area. Although it is unknown as to whether these mobile species are using the proposed offset area, the habitats provided there are similar or contiguous with the habitats provided in the proposed extraction areas. As such, the Project is unlikely to have a significant impact on locally important habitat for mobile threatened fauna.

The Project is therefore not likely to significantly impact on mobile threatened fauna that may use Popran National Park. The types of species that are likely to use both the Project Site and the National Park are relatively mobile with large ranges, for example microchiropteran bats, owls and gliders. The Project would remove some nesting and roosting habitat that may be used by bats and gliders, however, hollow-bearing trees occur throughout the Project Site, including offset area and this type of habitat would be maintained in the offset area. Owls are unlikely to

[9] Assuming these burns can be completed safely whilst operations are ongoing on the Project Site.

roost on the Project Site due to a lack of large tree hollows within tall trees. Threatened fauna species would not be restricted from moving out of the park through a lack of habitat because a vegetated buffer and the proposed offset area, which would adjoin the park, provide connectivity to the north and west.

Changes to Hydrogeological and Hydrological Conditions within Popran National Park

Popran National Park is not expected to be affected by groundwater drawdown as a result of the Project. While the Stage 5 extraction area is located near the southern boundary of the Project Site, there would be little impact on groundwater to Popran National Park, as water supply to this area is unlikely to originate on the Project Site.

The Project Site forms an amphitheatre type topographic feature facing west, and as such any water on the southern portion of the Project Site drains to the northwest (via Creek C). Creek C drains west to Cabbage Tree Creek, which does not flow through Popran National Park.

The proposed activities would be unlikely to have any impact on the hydrogeological or hydrological conditions within Popran National Park.

5.3.7.5.2 Habitat/Wildlife Corridors

Due to the abundance of native bushland in the locality, regional connectivity is unlikely to be severed. In fact, the establishment of the proposed biodiversity offset strategy would ensure that the local corridor connecting the Popran National Park with Brisbane Waters National Park would be maintained beyond the life of the Project.

5.3.7.5.3 Assessment against Regional Strategies

As noted in Section 2.13.4.2, key environmental challenges of the Central Coast region have been identified by the draft Central Coast Regional Strategy (CCRS) (DoP, 2006). The key environmental challenge relevant to native flora and fauna, with a brief description of how the Project assists strategically in addressing it, is as follows.

- To improve the identification, protection and enhancement of natural environments including significant biodiversity corridors, regionally significant vegetation, coastal lakes and estuaries, and landscape values.

  The vegetation of the Project Site has been mapped in detail with species, communities and habitats of particular conservation significance identified. The Project Site, in particular the Stage 5 extraction area, would be rehabilitated to re-establish the occurrence of these species, communities and habitats. The land use of the rehabilitated Stage 5 extraction area has been proposed as "nature conservation" and would be linked to areas of native vegetation protected either through a long-term conservation arrangement over the land or within the NSW National Parks system (Popran National Park).

  Areas of the Project Site not disturbed would be included within a biodiversity offset strategy. This strategy, which would also incorporate 44.7ha of native vegetation on the Glenworth Valley property, would provide for the long-term conservation of native vegetation at a ration of 2:1 (conservation:disturbance). The conserved vegetation would ensure the long-term security of important habitat elements for threatened species as well as ensuring a local wildlife/habitat corridor connecting the Popran National Park with Brisbane Water National Park would be maintained beyond the life of the Project.

5.3.7.6 Impacts on Threatened Species

5.3.7.6.1 Introduction

The following sections consider the magnitude, extent and significance of the Project on those species considered to be at high risk of adverse impact (see Section 5.3.5.5). The significance of the impacts have been assessed by Cumberland (2009) based on:

- the importance of individual species, populations and/or plants and/or subpopulations that are likely to be affected by the Project in maintaining the long-term viability of the species, population or ecological community; and
- the importance of habitat features that are likely to be affected by the Project in maintaining the long-term viability of the species, population or ecological community.

A summary of the assessment for each species completed by Cumberland (2009) is provided in the following subsections.

5.3.7.6.2 *Callistemon linearifolius*

On the Project Site, this species was recorded in small groups in four scattered locations, of which only a single plant in one of these locations would be cleared (see **Figure 5.16**). In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC 2007c), a 'seven-part test' under Section 5A of the EP&A Act was completed for *Callistemon linearifolius* by Cumberland (2009). The following represents a summary of the findings of the test.

Based on available records, the occurrence of this species on the Project Site forms a disjunct local population. *Callistemon linearifolius* occurs in vegetation communities on the Project Site which are common in the sandstone plateaus at Calga and surrounding areas, eg. Exposed Hawkesbury Woodland (E26). Approximately 17 200ha of similar habitat are present within Gosford LGA, much of which is protected in Brisbane Water National Park while potential habitat exists in Dharug and Yengo National Parks. Habitat within the Project Site is contiguous with Popran National Park, and fragmentation and isolation of habitat would not occur.

Callistemon linearifolius would be unlikely to return to its pre-disturbance abundance by itself (low resilience), however, the replanting of this species through the rehabilitation stage, would be likely to increase its abundance on the Project Site in the medium to long-term.

The findings of the seven part test suggest that while the local sub-population may be at risk of local extinction as a result of a stochastic event such as wildfire (of which the four closely spaced groups are already at risk), the likely impact from the Project itself would not be significant.

5.3.7.6.3 *Darwinia glaucophylla*

Darwinia glaucophylla has been recorded throughout the Exposed Hawkesbury Woodland (E26) and Hawkesbury Banksia-Scrub Woodland (E29) communities within the Project Site, of which approximately half of the recorded locations within the Project Site would be disturbed (see **Figure 5.16**). 167 plants were recorded by Cumberland (2009), including along the edge of Popran National Park. Less than half of the recorded locations within the Project Site would be impacted by proposed surface disturbance activities with approximately 59 plants in total proposed for clearance (19 within Stage 4, 28 within Stage 5 and 12 along access road routes), providing for the retention of at least 108 plants. Notably, the proposed access roads have been aligned to avoid clearance of the majority of the *Darwinia glaucophylla* plants identified. It is also noted that potential habitat exists for this species in the proposed offset area and further targeted surveys for *Darwinia glaucophylla* would be conducted within these areas in spring 2009. In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC 2007c), a 'seven-part test' under Section 5A of the EP&A Act was completed for *Darwinia glaucophylla* by Cumberland (2009). The following represents a summary of the findings of the test.

Darwinia glaucophylla occurs entirely within the Gosford LGA, and is known from approximately 15 sites, several within or near Brisbane Water National Park and one within Popran National Park. It is listed with a conservation code of 2RCi (Briggs and Leigh, 1995), indicating a rare species with a geographical distribution of less than 100km^2 and with inadequate representation in conservation reserves.

Darwinia glaucophylla occurs in sandy heath, scrub and woodlands often associated with sandstone rock platforms or near hanging swamps and friable sandstone shallow soils. It occurs in vegetation communities on the Project Site which are common in the sandstone plateaus at Calga and surrounding areas. Approximately 20 000ha of similar habitat are present within the Gosford LGA including the conservation areas of Brisbane Water National Park and Popran National Parks. Habitat to be retained within the Project Site is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

Darwinia glaucophylla is a highly restricted species, and it is unknown at present how extensive this species is within secure conservation reserves. The seeds of this species require heat for germination, so any changes to the fire regime on the Project Site could impact on the sub-population on the Project Site.

Clearing of habitat would cause a significant impact on the species on the Project Site, however, the viability of the species as a whole is not at risk. Rehabilitation and revegetation activities would likely encourage the growth of *Darwinia glaucophylla*, which is a disturbance coloniser, and therefore increase its abundance in the medium term.

The findings of the seven part test suggest that while the sub-population of the species found on the Project Site may be adversely affected in the short to medium term, the likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant.

5.3.7.6.4 *Hibbertia procumbens*

Hibbertia procumbens is widespread across the Project Site within the Exposed Hawkesbury Woodland (E26) and Hawkesbury Banksia-Scrub Woodland (E29) communities (see **Figure 5.16**), and occurs in similar densities in other areas of the Somersby Plateau (Bell and Driscoll, 2005). 196 individuals of this species were recorded by Cumberland (2009). Approximately half of the recorded locations would be impacted by clearing for the Project, with approximately 91 plants in total proposed for clearance (41 within Stage 4, 28 within Stage 5 and 22 along access road routes), providing for the retention of at least 105 plants. Notably, the proposed access roads have been aligned to avoid clearance of as many of the *Hibbertia procumbens* plants identified as possible. It is also noted that potential habitat exists for this species in the proposed offset area and further targeted surveys for *Hibbertia procumbens* would be conducted within these areas in spring 2009. In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC 2005) and *Threatened Species Assessment Guidelines* (DECC 2007), a 'seven-part test' under Section 5A of the EP&A Act was completed for *Hibbertia procumbens* by Cumberland (2009). The following represents a summary of the findings of the test.

Hibbertia procumbens has been recorded from 22 locations in the Gosford LGA and 45 locations in the Sydney Basin Bioregion. Recently a large population was recorded in Yengo National Park, and smaller populations are also known from Popran and Brisbane Water National Parks. It occurs in vegetation communities on the Project Site which are common in the sandstone plateaus at Calga and surrounding areas. Approximately 20 800ha of similar habitat are present within the Gosford LGA including the conservation areas of Brisbane Water National Park and Popran National Parks, with potential habitat also present to the west in Dharug and Yengo National Parks. Habitat to be retained within the Project Site (along the southern and western boundaries) is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur.

Clearing on the Project Site would result in a significant impact on the species on the Project Site, however, the viability of the species as a whole is not at risk. Rehabilitation and revegetation activities would likely encourage the growth of *Hibbertia procumbens*, which is a disturbance specialist, and therefore increase its abundance in the medium term.

The findings of the seven part test suggest that while the sub-population of the species found on the Project Site may be adversely affected in the short to medium term, the likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant.

5.3.7.6.5 *Tetratheca glandulosa*

Tetratheca glandulosa has not been recorded on the Project Site, although it has been recorded close to the northern boundary of the adjacent Popran National Park. Potential habitat does exist, however, for this species on the Project Site within the E26 Exposed Hawkesbury Woodland, E25 Hawkesbury Peppermint Apple Forest, E26a Hawkesbury Rock Pavement Heath, E29 Hawkesbury Banksia Scrub-Woodland and E29a Hawkesbury Banksia Scrub-Woodland (Scrub). In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC 2005) and *Threatened Species Assessment Guidelines* (DECC 2007), a 'seven-part test' under Section 5A of the EP&A Act was completed for *Tetratheca glandulosa* by Cumberland (2009). The following represents a summary of the findings of the test.

Tetratheca glandulosa is considered to be adequately reserved north of the Hawkesbury River, with large populations occurring in Dharug National Park, Parr State Conservation Area, Yengo National Park and Ourimbah State Forest. This species has also been recorded at Mt White, Popran National Park and in the Mangrove Mountain area in the Gosford LGA (quoted in Cumberland, 2009). The types of habitats *Tetratheca glandulosa* occurs in are common on the sandstone plateaus at Calga and large areas of suitable habitat would be retained in the proposed biodiversity offset area. The habitat to be retained is contiguous with habitat within Popran National Park and therefore no isolation of habitat would occur. On the basis of the preceding, Cumberland (2009) assess it as unlikely that the Project would have a negative impact on this species.

5.3.7.6.6 Glossy Black-cockatoo, *Calyptorhynchus lathami*

One family group (three birds) has been recorded on the Project Site (see **Figure 5.17**), and also may be nesting on the Project Site, with the species being previously identified within 5km of the Project Site (see **Figure 5.13**) In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007c), a 'seven-part test' under Section 5A of the EP&A Act was completed for the Glossy Black-cockatoo by Cumberland (2009). The following represents a summary of the findings of the test.

The Glossy Black-cockatoo characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key *Allocasuarina* species. The Glossy Black-cockatoo has been recorded from 216 locations in the Gosford LGA and 1 469 locations in the Sydney Basin Bioregion. Locally nomadic, small flocks roam in search of feeding areas and roost communally.

Feeding and potential nesting habitat would be cleared, however, approximately 20 000ha of similar habitat is present in the Gosford LGA. Habitat to be retained within the Project Site is contiguous with habitat within the adjacent Popran National Park, and fragmentation and isolation of habitat would not occur. As the Glossy Black-cockatoo is highly mobile, it is likely to forage in the abundant surrounding areas of habitat as well as those on the site.

Clearing on the Project Site may interrupt the life cycle of the identified family group, however, as the species is highly mobile and therefore likely to forage in the abundant surrounding areas of habitat, a local population is likely to be maintained and would not be placed at risk of extinction. The proposed replanting of cleared areas within Stage 5 with Casuarina trees would replace some of the foraging habitat lost while the installation of nest boxes may also benefit this species by replacing lost tree hollows, encouraging the eventual return of the species to the Project Site.

The findings of the seven part test suggest that while the identified family group of Glossy Black-cockatoos may be displaced, the proposed mitigation measures should encourage the eventual return of the species to the Project Site. The likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant.

5.3.7.6.7 Powerful Owl, *Ninox strenua*

Previous field surveys over the Project Site identified the Powerful Owl calling from Popran National Park (CES, 2004), with the species being previously identified within 5km of the Project (see **Figure 5.13**). In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007a), a 'seven-part test' under Section 5A of the EP&A Act was completed for the Powerful Owl by Cumberland (2009). The following represents a summary of the findings of the test.

The Powerful Owl has been recorded from 79 locations in the Gosford LGA, including within the Popran National Park and 860 locations in the Sydney Basin Bioregion. The species maintains very large home ranges (400ha to 1 500ha) and therefore while no individual or breeding pair was identified on the Project Site, it may be used for foraging and nesting. Powerful Owls have a high fidelity to a small number of hollow-bearing nest trees, and as a result the proposed clearing may impact on the breeding potential should these occur on the Project Site. It is noted, however, clearing would impact on less than 35ha of habitat with extensive areas of habitat available surrounding the Project Site and in the locality.

Vast areas of habitat exist within the LGA, including habitat protected within the adjacent Popran National Park, which would not be isolated as a result of the Project. Therefore, while a single individual or breeding pair could potentially be impacted by the proposed clearing on the Project Site, extensive conservation reserves in the area are likely to support a number of breeding pairs, and as such, the population would remain viable.

The findings of the seven part test suggest that there is the potential for an individual or single breeding pair to be impacted through loss of a hollow-bearing nest tree and/or foraging habitat, the likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant. In the long-term, revegetation of the Project Site and establishment of nest boxes would partially mitigate impacts of clearing, returning the foraging and nesting habitat and encouraging the return of individuals to the Project Site.

5.3.7.6.8 Rosenberg's Goanna, *Varanus rosenbergii*

This species has been previously observed foraging to the north of the Calga Sand Quarry (CES, 2004) (see **Figure 5.17**). In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007a), a 'seven-part test' under Section 5A of the EP&A Act was completed for Rosenberg's Goanna by Cumberland (2009). The following represents a summary of the findings of the test.

The Rosenberg's Goanna has been recorded from seven locations in the Gosford LGA and 82 locations in the Sydney Basin Bioregion. Recorded locations within the LGA are mainly along the Hawkesbury River where it relies on termite mounds for laying its eggs. Foraging and nesting habitat are present on the Project Site with similar habitat available throughout the adjacent Popran National Park. Habitat would not be isolated as a result of the Project.

The findings of the seven part test suggest that should a local sub-population occur on the Project Site, the proposed clearing would remove foraging and nesting habitat, however, there is extensive similar habitat available elsewhere on the Project Site and within the contiguous vegetation of Popran National Park to the south and therefore the likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant.

5.3.7.6.9 Red-crowned Toadlet, *Pseudophryne australis*

Red-crowned Toadlet habitat was recorded from three locations within the Project Site, two sites on Creek A, one along Creek B. A single Red-crowned Toadlet was identified within a rock overhang away from the creeks (see **Figure 5.17**). The species has been recorded at several other locations within 5km of the Project Site (see **Figure 5.13**). In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007a), a 'seven-part test' under Section 5A of the EP&A Act was completed for the Red-crowned Toadlet by Cumberland (2009). The following represents a summary of the findings of the test.

The Red-crowned Toadlet has been recorded from 145 locations in the Gosford LGA and 756 locations in the Sydney Basin Bioregion, is limited to the Sydney Basin Bioregion and the northern margin of the South Eastern Highlands Bioregion, with its known distribution extending from Pokolbin State Forest and Wollemi National Park in the north, to the Nowra district in the south and Mt Victoria in the west (NSW NPWS 2001a & 2001b). The Red-crowned Toadlet generally occurs on the sandstone escarpment areas and plateaus in the Sydney Basin, usually within 100m of the ridge top where it utilises moist microhabitats rather than permanent water. Large areas of habitat for this species exist throughout the Somersby Plateau and habitat is protected within the adjacent Popran National Park.

The removal of section of Creek A and disruption to hydrology of Creek B would remove small areas of identified Red-crowned Toadlet habitat and other areas of potential breeding habitat on the Project Site. Notably, however, the extraction area was modified to retain Creeks B and C in their entirety which would maintain known and potential breeding habitat on the Project Site. Therefore, while the Project may impact significantly on some individuals, these individuals are not significant for the viability of the species as a whole, and the sub-population would remain viable as breeding habitat would be retained on the Project Site.

The findings of the seven part test suggest that while some individual Red-crowned Toadlets may be adversely affected by the Project, sufficient habitat would be retained such that the likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant.

5.3.7.6.10 Giant Burrowing Frog, *Heleioporus australiacus*

Potential habitat exists for this species in the centre of the Project Site where the two ephemeral creeks come together (see **Figure 5.17**). The species has been recorded at several other locations within 5km of the Project Site (see **Figure 5.13**). In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007a), a 'seven-part test' under Section 5A of the EP&A Act was completed for the Giant Burrowing Frog by Cumberland (2009). The following represents a summary of the findings of the test.

The Great Burrowing Frog has been recorded from 144 locations in the Gosford LGA and 417 locations in the Sydney Basin Bioregion, including Popran, Brisbane Water, Dharug and Yengo National Parks. The Giant Burrowing Frog shows a preference for sandstone ridge top habitat and broader upland valleys and is generally associated with small headwater creek lines and along slow flowing to intermittent creek lines. Limited observations on this species suggest an ability to range widely, frequently being observed on roads at considerable distance from suitable riparian breeding, or other moist habitat. Corridors are being maintained on the Project

Site, and habitat is unlikely to be fragmented or isolated, which would enable this species to move around. Habitat for this species exists throughout the Somersby Plateau and habitat is protected within the adjacent Popran National Park.

The retention of Creeks B and C would protect some of the potential habitat for this species, although with extraction undertaken on both sides of Creek B (set back 50m to 100m), the water levels would be likely to reduce in this creek, reducing its value as habitat. The Project may have an adverse impact on some individuals, these individuals are not significant for the viability of the species as a whole, and a sub-population (if present) would be likely to remain on the Project Site.

The findings of the seven part test suggest that while some individual Giant Burrowing Frogs may be adversely affected by the Project, sufficient habitat would be retained such that the likely impact from the Project on the abundance, range and distribution of the species as a whole would not be significant.

5.3.7.6.11 Large-footed Myotis, *Myotis adversus*

Cumberland (2009) recorded a possible identification of a Large-footed Myotis (by echolocation call) in the eastern part of the Project Site. However, given the habitat preference of this species (surrounding permanent water) if the recording was accurate the individual was likely to have been foraging over ephemeral water holes such as those provided along Creek C. Potential roosting habitat is also provided in hollow-bearing trees on the Project Site (although the Large-footed Myotis is usually recorded roosting in close proximity to aquatic foraging habitats. In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007a), a 'seven-part test' under Section 5A of the EP&A Act was completed for the Large-footed Myotis by Cumberland (2009). The following represents a summary of the findings of the test.

The Large-footed Myotis has been recorded from 43 locations in the Gosford LGA and 969 locations in the Sydney Basin Bioregion. Notably, this species has not been recorded from Popran National Park. As noted above, the Large-footed Myotis generally roosts close to water (in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings and dense foliage) and forages over water, raking its feet across the surface to catch insects and small fish. Only small areas of potential habitat occur on the Project Site for this species, in the form of ephemeral pools. More permanent pools would provide more suitable habitat further downstream in Creek C with the species is also more likely to roost in the gully surrounding Creek C compared with the proposed extraction areas. The proposed activities are therefore unlikely to directly impact on roosting or foraging habitat of this species.

The findings of the seven part test suggest that the Project would be unlikely to adversely affect any local or regional population of the Large-footed Myotis.

5.3.7.6.12 Grey-headed Flying-fox, *Pteropus poliocephalus*

The Project Site provides suitable foraging habitat for the Grey-headed Flying-fox but does not contain a roosting camp and individuals of the species have been recorded flying over land to the north of the Project Site. The Project Site is likely to form part of a large foraging range for the species.

There are many records of the Grey-headed Flying-fox from the Gosford LGA, in urban and rural areas, and in conservation reserves such as Dharug, Popran and Brisbane Water National Parks. The Grey-headed Flying-fox forages in subtropical and temperate rainforest, tall sclerophyll forest and woodland, heaths, swamps, urban gardens and orchards. It roosts in camps with high site fidelity. Camps are established in gullies with dense vegetation. Grey-headed Flying-foxes foraging across the Project Site are likely to roost at a camp near Mangrove Mountain.

The removal of 34.7ha of potential habitat is a small proportion of the home foraging range of this highly mobile species and the Project is therefore unlikely to significantly impact on this species.

5.3.7.6.13 Eastern Pygmy Possum, *Cercartetus nanus*

One Eastern Pygmy Possum was recorded along Creek A on the Project Site, beyond the southern edge of the Stage 4 extraction area. In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and *Threatened Species Assessment Guidelines* (DECC, 2007a), a 'seven-part test' under Section 5A of the EP&A Act was completed for the Eastern Pygmy Possum by Cumberland (2009). The following represents a summary of the findings of the test.

While heath and woodland are the preferred habitats of the species within the Gosford LGA, the individual observed surveys was in open forest. Notably, large areas of potential heath and woodland habitat are available throughout the Project Site and Offset area, and it is likely that the Eastern Pygmy Possum also occurs in these habitats.

As the removal of 34.7ha of potential habitat is offset by the proposed conservation of similar habitat within and adjacent to the Project Site, the Project is not likely to significantly impact on this species.

5.3.7.6.14 Species at Moderate Risk

In general, the species identified by Cumberland (2009) as being at moderate risk from the proposed activities (see Section 5.3.5.4) have not been recorded on the Project Site. Although potential habitat may occur on the Project Site, many of these species are more likely to occur in the tall forested gully of Creek C, which would be conserved, eg. *Grevillea shiresii,* Gang-gang Cockatoo and Yellow-bellied Glider. In the case of species that have potential to occur in the woodland and heath habitats, large areas of potential habitat would be retained within the Project Site East and Project Site West Offset Areas, as well as being conserved in the "Glenworth Valley" Offset Area and Popran National Park. These conservation areas would remain connected to each other, as well as other areas of native vegetation to the west of the study area.

Cumberland (2009) conclude that the Project is unlikely to have a significant impact on these species.

5.4 ABORIGINAL HERITAGE

5.4.1 Introduction

Based on the environmental risk analysis undertaken (see Section 3.3 and **Table 3.5**), the potential environmental impacts related to Aboriginal heritage requiring assessment and their **unmitigated** risk rating are as follows.

- Disturbance or destruction of identified sites and/or artefacts of Aboriginal cultural heritage without the permission of LALC or DECCW (extreme risk).
- Disturbance or destruction of currently unidentified sites and/or artefacts of Aboriginal cultural heritage without the permission of LALC or DECCW (high risk).

In addition, the Director-General's Requirements issued by Department of Planning require that the assessment of Aboriginal heritage refer to the draft *Guidelines of Aboriginal Cultural Heritage Assessment and Community Consultation* (Department of Environment and Conservation).

The following section presents a summary of the Aboriginal heritage assessment conducted for the Project by Archaeological Surveys and Reports Pty Ltd (ASR) (ASR, 2009) with the assistance of representatives of the Darkinjung Local Aboriginal Land Council (LALC). ASR was commissioned to identify any Aboriginal sites and relics that may be present and make recommendations both to the Darkinjung LALC and also to Rocla. The full report of ASR (2009) is presented as Part 4 of the *Specialist Consultant Studies Compendium*.

5.4.2 Method of Investigation

The Aboriginal heritage assessment comprised the following components.

1. A review of previous archaeological investigations on and surrounding the Project Site.
2. Consultation with the Darkinjung LALC, including on-site discussions with group representatives.
3. Invitation to the Aboriginal community (in accordance with the DECC's Interim Community Consultation Recommendations [ICCR's]) for involvement in the survey and assessment of cultural heritage items. Notably, no registration of interest was received by ASR.
4. A review of the Aboriginal Sites Register (Aboriginal Heritage Information Management System – AHIMS) covering the Project Site and surrounding local area and recent archaeological investigations within the local area.
5. An assessment of the archaeological potential of the Project Site based on the presence or absence of resources such as vegetation, water and stone.

6. The development of a predictive model for archaeological material that might realistically be expected to be present.
7. The completion of comprehensive field surveys over the majority of the Project Site.
8. An assessment of the cultural significance of the identified sites of Aboriginal heritage.
9. Development of recommendations for the management of identified sites of Aboriginal significance.
10. An assessment of the impact on Aboriginal heritage as a result of the Project as it relates both to identified sites and artefacts and the cumulative impacts on the regional record.

5.4.3 The Existing Environment

5.4.3.1 Results of Previous Investigations

Numerous studies have been undertaken on the Somersby Plateau, as accompanying reports to development applications or for more academic purposes. Two known reports have been completed in the immediate vicinity of the Project Site and these are summarised as follows.

Dean-Jones (1990)

Pam Dean-Jones undertook a field survey of Lot 2 DP 229889 in 1990 (Dean-Jones, 1990), over the area now covered by the Calga Sand Quarry. The study did not identify any Aboriginal sites or artefacts.

Aboriginal Surveys and Reports (2004)

Accompanying an application to extend the Calga Sand Quarry to the north, the undisturbed areas of Lot 2 DP 229889 and additional areas of Lot 121, DP 755221 was surveyed for an Aboriginal heritage assessment produced by Archaeological Surveys and Reports (2004). The survey failed to relocate two sites identified on the AHIMS register as being located on Lot 121, DP 755221, however, identified a shelter with art to the west of the quarry containing:

- pecked “panaramitee engraving” images;
- pecking of no distinguishable pattern;
- hack drawn lines and figurative drawings;
- indistinguishable but probable drawings/paintings; and
- numerous painted ochre shapes including possible human or anthropomorph images.

The location of the site, identified as Calga Art 1 is shown on **Figure 5.18**.

5.4.3.2 Results of Aboriginal Sites Register Search

The result of a search of the AHIMS Register for all sites within a 10km x 7km area surrounding the Project Site (references Eastings 331000-338000, Northings 6299000-6306000) provided a listing of 180 sites.

Using the original site recording forms and reference to contour lines and distances from permanent features of current topographic mapping, ASR (2009) plotted the locations of the 10 sites. On plotting the sites, ASR (2009) identified that seven sites occur within the coordinates[10] on, or immediately adjacent to, the Project Site, with a further three sites with coordinates placing them to the immediate east of Peats Ridge Road.

Further examination of the original Site Recording Forms and plotted locations has identified that two are duplicated (Sites 2 [#45-3-0119] & 5 [#45-3-2195]), four occurred within or on the boundary of the Project Site (Sites 1 [#45-3-1423], 3 [#45-3-2196], 4 [#45-3-0131] and 6 [#45-3-0132]), and the remaining four occurred outside the Project Site. **Figure 5.18** presents the location of Sites 1 to 7 (located on or immediately adjacent to the Project Site). **Table 5.23** provides a summary of the seven sites identified as on or immediately adjacent to the Project Site.

Table 5.23
AHIMS Registered Aboriginal Sites of the Project Site

Site Reference	Location		Description
	Easting	Northing	
(1) #45-3-1423	334249	6300598	Rock engraving
(2) #45-3-0119 (duplicate of #45-3-2195)	334020	6300940	Rock engraving
(3) #45-3-2196	333950	6300560	Axe grinding groove
(4) #45-3-0131	333982	6300227	Axe grinding groove/Rock engraving
(5) #45-3-2195 (duplicate of #45-3-0119)	334020	6300940	Rock engraving
(6) #45-345-3-0132	333950	6300560	Axe grinding groove
(7) #45-3-1794	334600	6300900	Axe grinding groove
Source: Modified after ASR (2009) – Section 4			

Further assessment by ASR (2009) suggests Sites 3 (#45-3-2196) and 6 (#45-345-3-0132) are probably duplicated records of the same site. Notably, all but Sites 2 and 5 are located outside the proposed area of disturbance. As is discussed in Section 5.4.5, the corrected locations of Sites 2 and 5 are also outside the proposed area of disturbance.

5.4.3.3 Potential for Additional Aboriginal Sites on the Project Site

Based on the results of previous investigations in the area, listings on the Register of National Estate and AHIMS listings, ASR (2009) concluded that there is potential for other Aboriginal heritage sites to be identified within the Project Site. As there existed no shelters or overhangs, and no sources of stone suitable for knapping tools and implements on the Project Site, ASR (2009) made the following predictions.

- 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.

[10] Some coordinate references were provided from imperial scale maps and were subsequently replotted through reference to the original maps.

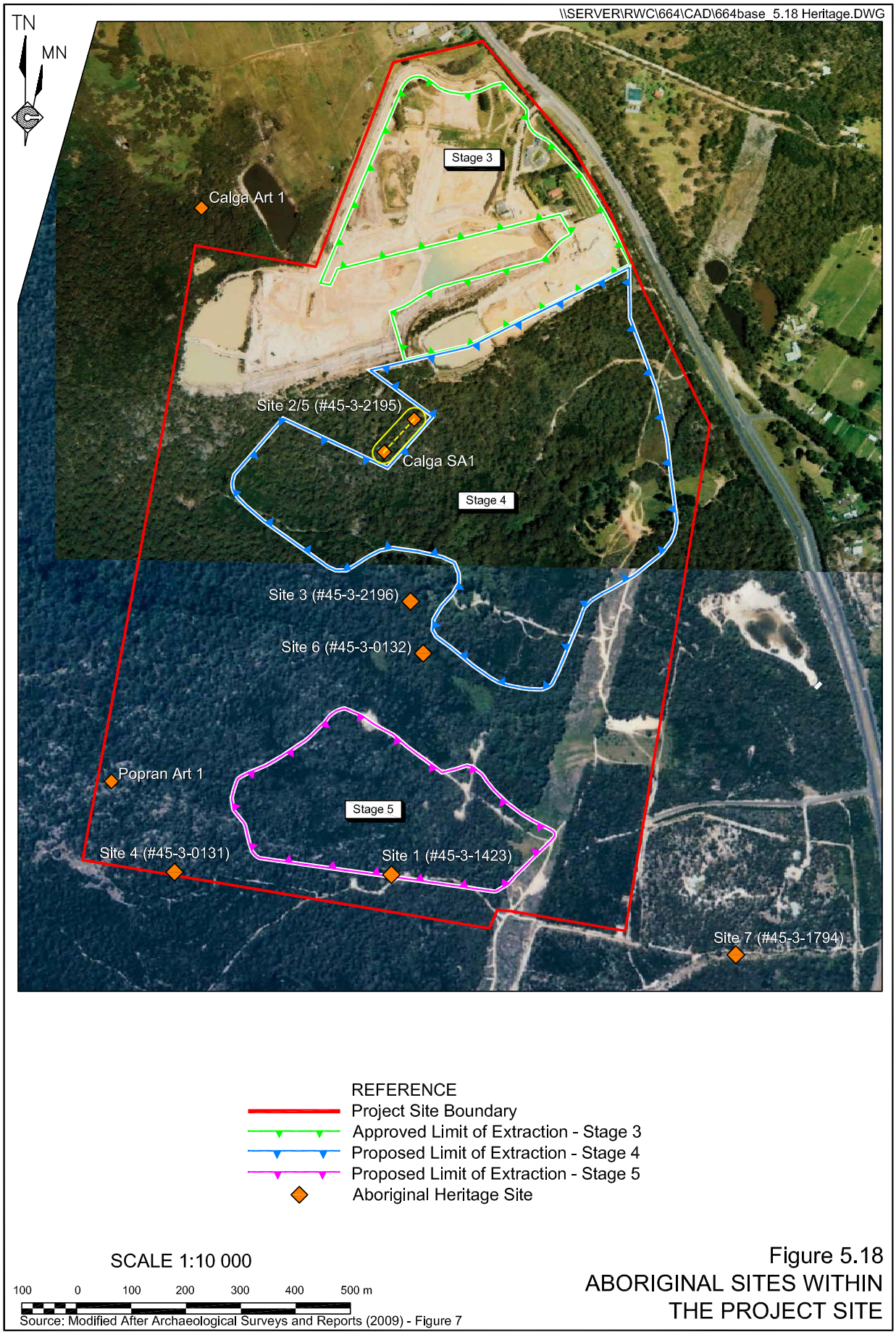


Figure 5.18
ABORIGINAL SITES WITHIN THE PROJECT SITE

- There is a potential for trees more than 150 years old to exhibit scarred surfaces.
- There is a potential for any trees more than 150 years old to exhibit carved surfaces.
- There is a potential for shelters to exist and therefore a potential for art sites.
- There is a potential for shelters to exist and therefore a potential for occupation deposits.
- There is a potential for engravings, and/or grinding grooves to occur wherever there is outcropping sandstone.

5.4.4 Results of the Project Site Field Survey

An initial field survey of the Project Site was completed over two days in December 2005 by Mr John Appleton of ASR and Ms Jodie Cameron of Darkinjung LALC. Due to the dense vegetation and steep terrain over much of the Project Site, the survey strategy entailed walking tracks, following the edges of drop-offs, and targeting soil exposures and erosion features, drainage lines, and any tree that appeared to be old growth. Several tracks were followed which provided a transect strip of exposed deposits through different environments and over different landforms. Where possible, the creek lines were also walked, although Creeks B and C were largely impenetrable.

Two sites were identified during the December 2005 survey, a shelter with art and occupation deposits (see **Plates 5.1** to **5.3**), and a group of axe grinding grooves (see **Plate 5.4**). The axe grinding grooves were later identified as being the site previously recorded as Site 3 (#45-3-2196) (which ASR, 2009, considers is also Site 6 (#45-3-0132) (see **Table 5.23**). Despite considerable effort, Site 2 (#45-3-0119) / Site 5 (#45-3-2195) was unable to be located at the grid reference quoted in the AHIMS register. Details of the shelter with art and occupation deposits, identified by ASR (2009) as Popran Art 1, are as follows.

Site name:	Popran Art 1
Site type:	Shelter with art and occupation deposits.
Location:	At the foot of cliff-line in the upper catchment of Cabbage Tree Creek GDA94: E333620 N6300460
Environment:	Dry sclerophyll woodland
Nearest water:	Tributary (ephemeral) of Cabbage Tree Creek (approximately 200m).
Site dimensions:	Habitable length – Approximately 10m. Habitable depth – Approximately 5m. Dripline height – Approximately 2m.
Aspect:	Due north (fully protected from southerly and southwesterly winds).
Deposits:	The floor of the shelter is composed of steeply inclined sandstone bedrock that ascends to within 20cm of the roof at the rear of the shelter. The bedrock dips below the ground surface short of the dripline. Six artefacts were observed in the deposits inside the dripline. The artefacts are described as flaked pieces, however, they are likely to have been brought to the site.

\\SERVER\RWC\664\CAD\664base_Plates 5.1-5.4.DWG

Plate 5.1: Popran Art 1: The shelter (viewed from the northwest)
(Ref: ASR (2009) - Plate 13)

Plate 5.2: Popran Art 1: Hand stencilled in white clay and traces of unidentified charcoal forms
(Ref: ASR (2009) - Plate 15)

Plate 5.3: Popran Art 1: Panel of charcoal drawings
(Ref: ASR (2009) - Plate 20)

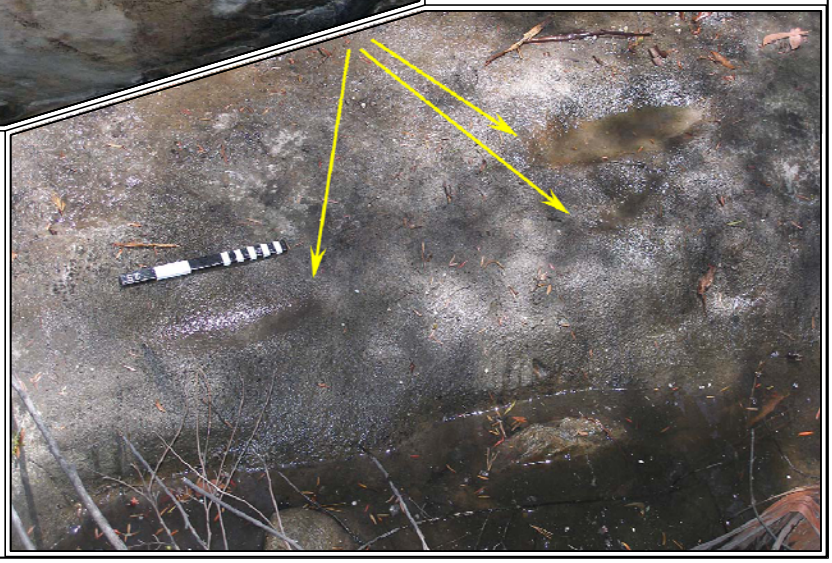


Plate 5.4: Site #45-3-2196: Axe grinding grooves.
(Ref: ASR (2009) - Plate 3)

Archaeological features:	There was one clear hand stencil, and a number of charcoal drawings, only two of which were recognisable forms, and they were of macropod-like figures. The motifs were applied in black (charcoal), red (ochre), and white (clay?).

A second survey of the Project Site was completed in October 2006 by Mr John Appleton of ASR and Mr Warren Bluff, an amateur archaeologist who was responsible for the original identification of Site 5 (#45-3-2195). The site of rock engraving was eventually found at the location identified on **Figure 5.18**. Approximately 80m to the southwest and on the same axis of the "woman's" torso, and on the nearest cleared area, a circle of rocks was observed in an area where there were no other free-standing rocks or boulders (referred to as Calga SA1). Details of Site 5 (#45-3-2195) and Calga SA1 are as follows.

Site name:	**#45-3-0119 / #45-3-2195** (Sites 2 and 5 on **Figure 5.18)**
Site type:	Rock Engravings.
Location:	GDA94: 334135 6301144 (corrected). Gunderman 9131-3S 1:25,000 Topographic Map.
Topographical Location:	Horizontal sandstone platform on upper to middle slopes of a spur ridge
Environment:	Dry eucalypt woodland, banksia and tea-tree understorey.
Nearest water:	Tributary (ephemeral) of Cabbage Tree Creek.
Distance:	Approximately 220m.
Other site(s) in the locality:	Numerous axe grinding grooves and rock engravings. Shelter with art 800m to southwest.
Site description:	"Woman" - Pecked and abraded/engraved grooved outline, approximately 3cm wide and 1cm deep at its deepest. "Emu" – The "emu" comprises two pecked and abraded/engraved grooved lines up to 3cm wide and approximately 1cm deep at their deepest. "Hand" – Stylised abraded/engraved hand 50cm long by 37cm wide on the edge of an adjacent section of the same series of sandstone platforms.

Site name:	"**Calga SA1**"
Site type:	Stone arrangement.
Location:	GDA94: 334078 6301082. Gunderman 9131-3S 1:25,000 Topographic Map.
Topographical Location:	Level ground amid terraces of sandstone rock platforms on upper to middle slopes of a spur ridge.
Environment:	Dry eucalypt woodland, banksia and tea-tree understorey.
Nearest water:	Tributary (ephemeral) of Cabbage Tree Creek.
Distance:	Approximately 220m.

Other site(s) in the locality:	Numerous axe grinding grooves and rock engravings. Shelter with art 800m to southwest.
Site description:	The stone arrangement comprised a circle of eight variously sized sandstone boulders around a centre-stone.

5.4.5 Significance Assessment

5.4.5.1 Introduction

An assessment of the significance of all sites, Aboriginal places, and archaeological material is required to firstly determine whether appropriate safeguards can be put in place to enable a Project to proceed. Secondly, it provides information to the Department of Environment, Climate Change and Water (NPWS) on the future management of the area. The assessment addresses both the actual cultural significance of the feature or site as well as the potential it offers for research into the history of an area.

5.4.5.2 Cultural Significance (Community Consultation)

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 archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

In this instance, Ms Jodi Cameron of Darkinjung LALC, who had assisted in the survey, reported the results of the investigation and her recommendations as to the management of Aboriginal site and heritage on the Project Site. At the time of reporting, Site 5 (#45-3-2195) had not been relocated and it was a recommendation of Darkinjung LALC that this site be located to determine whether they occurred within the proposed area of disturbance. As noted in Section 5.4.4, a targeted field survey was subsequently undertaken which identified this site as being within the then proposed limit of extraction (although based on the recommendations of ASR (2009) the extraction area was revised to ensure this site remained undisturbed). Darkinjung LALC were advised of the results of this subsequent survey who provided further advice on site management which requested the recommendations of Ms Jodi Cameron be adhered to and site monitors be present for surface disturbing activities on the Project Site.

On commencement of the survey process ASR (2009) considered the consultation held with the Darkinjung LALC was sufficient for the purposes of the assessment (as modifications to the proposed Project Site layout would ensure that no identified Aboriginal site or artefact would be disturbed by the proposed activities). ASR (2009) note that this survey and consultation process was consistent with other surveys and assessments completed around this time. It was subsequently decided, however, that it was appropriate and necessary to consult more widely with the Aboriginal community. In 2008, further consultation was completed in accordance with the Interim Community Consultation Requirements (ICCR's) of the Department of the then Environment and Conservation (DEC, 2004) as follows.

- An advertisement (public notice) was placed in the local press on 19 August 2008, notifying of the proposed extension to the Calga Sand Quarry and the investigations already completed by Darkinjung LALC and ASR.

- The advertisement provided any Aboriginal stakeholder with 14 days (later extended to the 11 September 2008 – 23 days) to register an interest in the Project and archaeological investigation.
- Letters notifying of the above project and archaeological investigations were also sent to:
  - the Department of Environment and Climate Change;
  - the Office of the Registrar of Indigenous Corporations; and
  - Gosford City Council.

While no registration of interest in the cultural heritage assessment process was received following the advertisement, representatives of the Guringai Tribal Link Corporation (Ms Tracey Howie – Chairperson, and Mr Dave Pross) had visited the Calga Sand Quarry on the 27 August 2008. During this visit, Ms Howie and Mr Pross were provided (by Rocla personnel) with an inspection of several of the identified Aboriginal sites on the Project Site, a description of the status of the Project and the archaeological investigations and consultation completed at that stage. The representatives of the Guringai Tribal Link Corporation were referred to ASR to register interest in the archaeological investigation, however, as noted previously, no registration of interest was ever lodged.

From the consultation and surveys completed in relation to the Project, the cultural heritage significance of the identified sites on the Project Site is best indicated by the 2005 report and 2008 correspondence from Darkinjung LALC (Darkinjung, 2005, 2008) (which have been included as *Appendix ii* to ASR, 2009). While these Darkinjung LALC documents do not refer specifically to the cultural significance of the identified sites, they do provide recommendations for the protection and management of these sites, illustrating the significance of these sites. In addition, and due to the fact that remnant sites are an ever diminishing resource, all archaeological sites are generally considered culturally significant as the archaeological sites:

- serve as cultural reminders of the Aboriginal peoples' prior existence and relationship to this region; and
- are important in ensuring the cultural identity of the Aboriginal people through connection with their land and knowledge of past practices is kept alive.

As, based on modifications to the proposed extraction area of the Project Site, no sites would be damaged as a consequence of the Project, no further advice was provided by Darkinjung LALC.

5.4.5.3 Research Potential

Popran Art 1

The discovery of the shelter with art and intact occupation deposits has produced a site of moderate to high research potential. While the art is culturally significant, it adds little new information to the vast record of art in the Sydney and Central Coast region. But the occupation deposits have the potential to contain datable material, and evidence of particular site activities, and information useful in providing a greater understanding of intra-site spatial activity, knapping techniques, subsistence strategies, diets, as well as be a potential repository of cultural material. The site Popran Art 1 is therefore assessed to be of moderate to high potential research significance.

Site #45-3-2195 and Calga SA1 (Rock Engraving and Stone Arrangement)

The site represents an archaeological and cultural site complex and is considered to be of moderate to high research potential due the rarity of the engraving style (anthropomorphic image, of which there are only 79 known examples within the Sydney Basin).

Site #45-3-2196 (Axe Grinding Groove)

Grinding grooves are a relatively common artefact type (38 of 103 known sites located within the AHIMS search area include grinding grooves – ASR, 2009), and the identified example is not unusual in formation, location or associated artefacts. Site #45-3-2196 is therefore considered to have low research potential.

5.4.6 Environmental Controls and Management

In order to retain the three identified Aboriginal sites, the boundary of the Stage 4 extraction area was revised to avoid disturbance to Sites 3 #45-3-2196 (Site 6 #45-3-0132), Site 5 #45-3-2196 (Site 2 #45-3-2195) and Calga SA1. All other sites are located outside the proposed extraction area of Stages 4 and 5 and no further variation to the extraction area was required.

It is recognised that some areas of the Project Site contain dense ground cover and impenetrable bush which was a constraint during the archaeological survey. Consequently, there remains a possibility that there are other engravings and/or axe-grinding grooves concealed beneath the vegetation.

Rocla intends to adopt a recommendation of the Darkinjung LALC following receipt of project approval to burn off the vegetation in and immediately adjacent to the approved extraction areas (in consultation with DECCW, the Rural Fire Service and surrounding landholders) to increase the visibility of the areas to be cleared for extraction. The burned area would be surveyed in the same manner as the previous surveys, with all registered Aboriginal stakeholders, once it is declared to be safe following the burn off.

In the event any additional sites/artefacts are located within the additional survey area, each site would be assessed for its significance and its management documented in a Cultural Heritage Management Plan, ie. prior to any vegetation clearing.

In line with the recommendations of ASR (2009) and others of the Darkinjung LALC, Rocla would implement the following safeguards and controls.

- A fenced buffer zone of at least 20m wide would be maintained around Site #45-3-2196. Erosion and sedimentation controls would be maintained upslope of this site.
- A fenced buffer zone of 120m x 50m would be maintained around Site #45-3-2195 and SA1.
- The location of the remaining three Aboriginal sites that exist within the Project Site would be marked on a map and site personnel informed of their location, significance and requirement for all activities to remain at least 20m from these sites.

- Appropriate erosion and sediment controls would be installed within the Project Site to ensure any sites or artefacts located downstream of the extraction area are not indirectly affected.
- Representatives of Guringai Tribal Link Corporation would be provided with the proposed protection measures and provided an opportunity to recommend additional controls.
- Amended Site Recording Forms for each of the sites on the Project Site would be lodged with the DECCW (NPWS) Sites Registrar.
- The Quarry Manager would provide the Darkinjung LALC 5 days notice of any soil stripping activities within the Project Site and invite field monitors onto the Project Site to observe surface disturbing activities.
- Representatives of Darkinjung LALC and Guringai Tribal Link Corporation would be informed if and when any Aboriginal sites are found.
- Rocla would conduct a Cultural Heritage Awareness Induction Course for its staff, contractors and any heritage monitors working on the Project Site. This would help raise awareness and ameliorate any impact on heritage sites during site establishment and subsequent Extraction activities. This induction would include making all staff and contractors aware of their responsibilities with respect to Aboriginal heritage under the *National Parks and Wildlife Act 1974.*

Following a review of these proposed protection and control measures, the DECC requested that further consideration be given to the proactive management and restoration of the Site #45-3-2195 / Calga SA1 complex. Additional protection measures of the Site #45-3-2195 / Calga SA1 complex have been further considered by the consultant archaeologist, ASR. This is discussed as follows.

1. "Restoration" of an open-site engraving is impractical, as the act of restoring the engraving would in fact be considered to be damaging the site.
2. The only way of further protecting the site (or at least reducing the pace at which natural degradation occurs), therefore, would be through the erection of a cover over the site. However, this in itself could result in an accelerated degradation of the site.
3. Given the discussion above, the only way to ensure the engraving does not deteriorate further is to construct a building over the site in which there is 24 hour temperature and humidity control. This is impractical, even if feasible, and well beyond the means of the quarry owner, Council, Darkinjung LALC, or any land claimants.
4. Erecting a barrier to prevent leaf litter from building up across the site would also produce a concentration of leaf litter thereby creating a fire hazard.

The DECC also requested consideration be given to the conservation of a broader area between Site #45-3-2195 / Calga SA1 complex by exclusion of the western part of Stage 4 from sand extraction. In considering this suggestion, it is noted that the conservation of additional area around the site would sterilise an even greater portion of the sand resource. This sterilisation would be for little environmental benefit as by widening the access point to the site, the potential for deliberate or inadvertent damage to the site would be increased. The proposed arrangement for conservation of the Site #45-3-2195 / Calga SA1 complex, described by DECC as the "convoluted narrow tongue of preserved land", actually provides for a better environmental outcome given:

- the site would be protected and conserved;
- the context of the site would be retained;
- access to the site would be retained but restricted (and easily fenced of if necessary) therefore reducing the potential for deliberate or inadvertent damage to the site.

5.4.7 Assessment of Residual Impacts

5.4.7.1 Identified Aboriginal Sites

The design and operational safeguards proposed by Rocla would ensure the identified Aboriginal sites would remain in-situ and undisturbed. Assuming the implementation of the proposed operational safeguards and controls, there would be no impact on these sites, and a reduced and acceptable risk of potential impact on as yet unidentified Aboriginal sites (should they occur over the Project Site).

5.4.7.2 Unidentified Aboriginal Heritage Sites and Artefacts

When compared to other areas of NSW, the Somersby Plateau has been the subject of a relatively high level of both professional and amateur archaeological survey. The Project Site itself has been surveyed not only by ASR (2009) but also Mr Warren Bluff who was responsible for a number of the recorded sites on the Project Site held within the AHIMS sites register. Therefore, while there are likely to be other sites on or surrounding the Project Site, it is also probable that those that have been found represent all or a high proportion of those that would be found (due to accessibility of location, visibility, environmental degradation and others reasons).

It is therefore assessed, that the potential impacts on unidentified Aboriginal heritage sites and artefacts that may be present on the Project Site are minor given those sites likely to be found have probably already been identified, but if present would be identified by representative(s) of the Darkinjung LALC and managed appropriately.

5.4.7.3 Assessment of Cumulative Impacts

As the Project would have no impact on identified Aboriginal heritage, there would be no cumulative impacts on the archaeology of the wider region. Should this change in the future, the individual assessment of sites to be affected would consider the impact on the regional archaeological record as a whole, as part of the normal process of site disturbance/destruction. It should be noted, however, that the landscape within the Project Site and its immediate surrounds does not appear to be unique and is unlikely to contain archaeological deposits not found elsewhere in the region.

5.5 NOISE

5.5.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.7**), the potential noise impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Increased noise levels associated with Project Site activities causing annoyance, distractions, ie. amenity impacts (Moderate Risk).
- Increased noise levels associated with Project-related road traffic activities causing annoyance, distractions, ie. amenity impacts. (Moderate Risk).

In addition, the Director-General's Requirements issued by Department of Planning require an assessment of "*Noise – including operational and off-site road noise impacts*". The noise assessment is required by the DGRs to be in accordance with the *NSW Industrial Noise Policy, Environmental Criteria for Road Traffic Noise* and *Environmental Noise Control Manual* (Department of Environment and Climate Change).

The following subsections describe the existing noise environment surrounding the Project Site, environmental noise criteria, proposed operational safeguards and mitigation measures and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

The information presented in this section is drawn from the noise assessment undertaken by Wilkinson Murray Pty Ltd (WMPL, 2009) whose full report is included as Part 5 of the *Specialist Consultant Studies Compendium*. This subsection presents a summary of the contents of the noise assessment report.

5.5.2 Environmental Noise Control General Objectives

The responsibility for the control of noise emissions in New South Wales is vested in local government and the Department of Environment, Climate Change and Water – Environment Protection and Regulation Group (DECCW - EP & RG). The former Environment Protection Authority released the Industrial Noise Policy (INP) in January 2000. The INP provides a framework and process for deriving noise criteria for projects and licences that would enable the DECC to regulate premises that are scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act). The Project would be scheduled under the POEO Act.

The policy objectives of the INP relevant to the Project are to:

i) establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses;

ii) use the criteria as the basis for deriving project-specific noise levels;

iii) promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;

iv) outline a range of mitigation measures that could be used to minimise noise impacts;

v) provide a formal process to guide the determination of feasible and reasonable noise limits for approvals or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and

vi) carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The DECCW also relies upon relevant sections of the *Environmental Noise Control Manual* (ENCM) (EPA, 1994), and the *Environmental Criteria for Road Traffic Noise* (ECRTN), (DEC, 1999) to assess the acceptability of noise related to construction and traffic noise.

5.5.3 The Existing Noise Environment

WMPL (2009) conducted background noise surveys between 14 and 22 December 2006 in order to characterise and quantify the acoustical environment in the area surrounding the Project Site. Unattended monitoring was undertaken at four representative locations surrounding the Project Site (CN6, CN7, CN8 and CN9 – see **Figure 5.19**) for 9 days with operator-attended monitoring undertaken on the first day of monitoring to check the background noise levels measured during the unattended survey (since the unattended measurements were potentially affected by the existing quarry operations) and to identify sources of background noise.

Background noise monitoring concentrated on the residential locations to the south of the Calga Sand Quarry as background noise monitoring had been previously completed at the residences to the north of the Calga Sand Quarry in 2004 (WMPL, 2004). WMPL (2004) used these background noise levels to develop impact assessment criteria for the then proposed Stage 3 Calga Sand Quarry. The assessment predicted compliance with these criteria and regular noise monitoring at these residences has confirmed this.

Table 5.24 presents the noise data processed in accordance with the requirements of the INP in order to derive the background and amenity (ambient) noise environment at the representative locations.

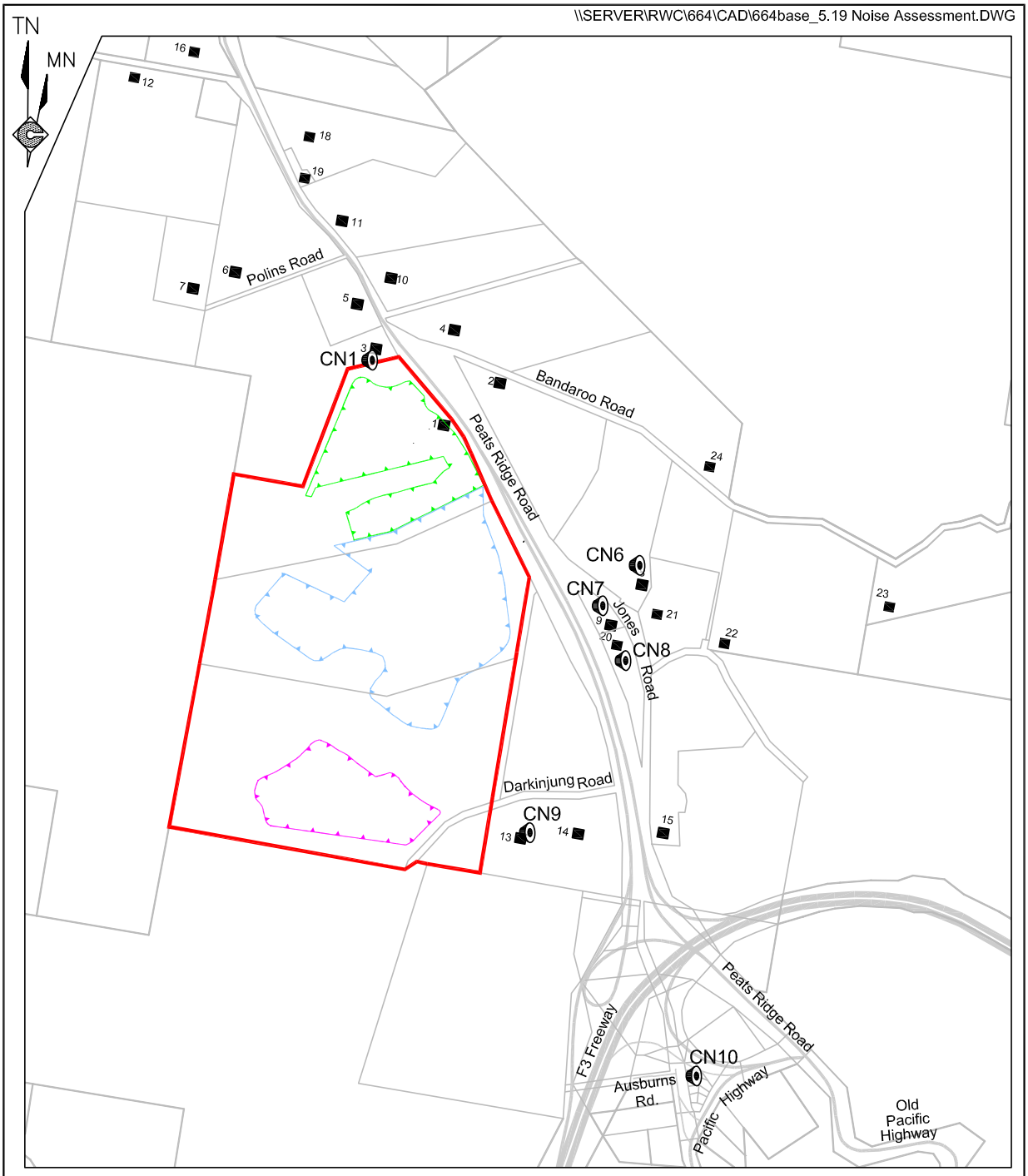


Figure 5.19
BACKGROUND NOISE MONITORING AND ASSESSMENT LOCATIONS

Table 5.24
Measured RBL and $L_{Aeq,period}$ Values

Location	Rating Background Level, RBL[1, 2] (dB(A))				Ambient $L_{Aeq,period}$ Level (dB(A))			
	Day	Evening	Night	Day Shoulder	Day	Evening	Night	Day Shoulder
CN6 – 3 Jones Road, Calga	38	38	37	40	50	53	48	53
CN7 – 24 Jones Road, Calga	38	39	33	37	49	51	45	49
CN8 – 30 Jones Road, Calga	43	41	34	41	54	52	45	47
CN9 – Australia Walkabout Wildlife Park	41	40	33	37	57	56	46	51

Note 1: The Rating Background Level for each period is the median value of the Assessment Background Level (ABL) values for the period over all of the days measured, where ABL is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period. There is therefore an RBL value for each period – daytime, evening and night time.
Note 2: Day: 7.00am-6.00pm; Evening: 6.00pm-10.00pm; Night: 10.00pm-7.00am; Day Shoulder: 5.00am–7.00am.
Source: Modified after WMPL (2009) - Table 1

Table 5.25 presents a summary of the operator-attended noise monitoring of 14 December 2006. The results suggest that noise levels at the monitoring locations are dominated by extraneous noises, particularly traffic on the F3 Freeway and Peats Ridge Road. WMPL (2009) note that as the measured L_{A90} noise levels from the limited period of attended monitoring (see **Table 5.25**) are higher than those from the long-term unattended noise monitoring (see **Table 5.24**), the RBL and ambient noise levels presented in **Table 5.24** can be considered representative of the general background noise levels at these locations, without influence from existing quarry operations.

Table 5.25
Attended Background Noise Levels

Location	Date & Start Time	Measured L_{A90} (dB(A))	Source of Background Noise
CN6 – 3 Jones Road, Calga	14/12/2006 - 11.00am	47	Traffic on F3 freeway, Peats Ridge Rd noise
CN7 – 24 Jones Road, Calga	14/12/2006 - 11.30am	54	Traffic on F3 freeway, Peats Ridge Rd noise
CN8 – 30 Jones Road, Calga	14/12/2006 - 12.00pm	43	Traffic on F3 freeway, Peats Ridge Rd noise
CN9 – Australia Walkabout Wildlife Park	14/12/2006 - 12.30pm	54	Traffic on F3 freeway

Source: Modified after WMPL (2009) - Table 2

In addition to the attended and unattended monitoring summarised in **Tables 5.24** and **5.25**, measurements of traffic noise and truck pass-by's were undertaken at CN6, CN7, CN8 and CN9 in December 2006, and CN10 (Pacific Highway Southern On-ramp – see **Figure 5.19**) in September 2009. The results of this monitoring is presented in **Table 5.33** (Section 5.5.6.2), together with an assessment of road traffic noise increases attributable to the Project.

5.5.4 Environmental Controls and Management

The Project has been designed with an objective to minimise the noise generated by sand extraction and processing activities, as well as the transportation of sand products from the Project Site. The design features and operational noise controls of the Project to meet this objective are as follows.

Design Features

- Extraction operations within Stage 4 are planned to commence within extraction Stage 4/1, which is located at the lowest elevation on the Project Site and is most distant from the surrounding assessment locations. Extraction operations within this stage would therefore result in the lowest extraction noise contribution to total noise emissions, allowing the design of future operations (which are likely to result in higher noise levels beyond the Project Site) to be modified (if necessary) to reduce these noise levels.
- Commencement of extraction within Stage 5, which would require the concentration of noise generating activities in closest proximity to assessment locations CN-6 to CN-9, would only proceed if it can be demonstrated that the noise levels at these locations from Stage 4 operations comply with the noise criteria and are equivalent to the noise predictions of WMPL (2009).
- The processing sites have been located below natural surface level (such that natural acoustic shielding would be achieved) and where distance between these operations and the assessment locations is maximised.
- Extraction operations within any extraction stage of Stage 4 or 5 would only proceed following the construction of a 5m high acoustic bund wall around the northern, eastern and southern perimeter of each stage.

Operational Safeguards

- All hours of operation presented in Section 2.10.1 would be strictly adhered to.
- All equipment on site would be regularly serviced to ensure sound power levels of each item remains at or below that nominated for noise modelling purposes (see Section 5.2 of WMPL, 2009).
- The internal road network would be graded as required to limit body noise from empty trucks.
- Noise monitoring would be undertaken at nearby residences and the results and performance of the site operations discussed with local residents and landholders. Monitoring is further discussed in Section 5.5.7.
- Noisy plant operating simultaneously close together would be avoided, wherever possible.
- Maintenance work on all plant and equipment would be carried out away from noise sensitive areas and be confined to standard daytime operational hours where practicable. Any inaudible maintenance could be undertaken beyond these core hours.

5.5.5 Environmental Noise Criteria and Assessment Methodology

5.5.5.1 Environmental Noise Criteria

The assessment of impacts of the proposed Calga Sand Quarry Southern Extension upon the local noise climate has been undertaken by calculating likely noise levels at the closest residential receivers to the Project Site ("Assessment Locations") under a range of operational scenarios and comparing those noise levels against the noise criteria established through reference to:

- the INP – for site operational noise;
- relevant sections of the ECRTN – for product transportation activities (on public roads); and
- the existing noise climate established residences surrounding the Project Site (see Section 5.5.3).

The Assessment Locations include the four residences where background noise levels were measured (CN6, CN7, CN8 and CN9) as well as CN-1, the closest residence to the north of the Project Site (see **Figure 5.18**).

Operational Noise Criteria

The environmental noise criteria for the operation of the Project need to consider both the "intrusiveness" criterion which limits $L_{Aeq(15minute)}$ noise levels from industrial sources to RBL + 5dB(A), and the "amenity" criterion which considers cumulative noise impacts in areas with competing industrial noise sources.

When establishing the intrusiveness criterion for each noise assessment location, the lowest RBL values in any relevant time period would be taken. **Table 5.26** identifies the intrusiveness criterion for five assessment locations during the day time, evening, night time and "day shoulder" period[11].

Table 5.26
Intrusive and Amenity Noise Criteria

Time Period	Intrusive Criteria, $L_{Aeq,15min}$ (dB(A))					Amenity Criteria, $L_{Aeq,period}$ (dB(A))				
	CN1	CN6	CN7	CN8	CN9	CN 1	CN6	CN7	CN8	CN9
Day (7.00am to 6.00pm)	41	43	43	48	46	50	50	50	50	50
Evening (6.00pm to 10.00pm)	35	43	44	46	45	45	45	45	45	45
Night (10.00pm to 7.00am)	35	42	38	39	38	40	40	40	40	40
Day Shoulder (5.00am to 7.00am)	35	45	42	46	42	N/A	N/A	N/A	N/A	N/A

Source: Modified after WMPL (2009) –Table 3 Shaded cells represent the more stringent and nominated noise criterion

[11] Operations on the Project Site during the night time period would be limited to between 5:00am and 7:00am. Noise monitoring identified a significant difference in the RBL for this period, when compared to the RBL for the remainder of the night time period, largely due to the effects of traffic noise on Peats Ridge Road and the F3 Freeway. The assessment therefore considers the intrusiveness of noise during this 2 hour "day shoulder" period against the RBL for this period.

The "amenity" criterion sets an upper limit to the total noise level (L_{Aeq}) in an area from all industrial noise (existing and future) during the day time, evening or night time. **Table 5.26** identifies the amenity criterion for five assessment locations, during the day time, evening, night time and "day shoulder" period, based on the classification of the potentially affected area as *"Rural"* by the INP.

The shaded cells of **Table 5.26** identify the more stringent and therefore nominated operational noise criteria for the Project. It is noted that as the amenity criterion is a comparison to the L_{Aeq} noise level measured over the entire time period in question, with higher noise levels tolerated over a proportion of the period, the intrusiveness criteria has been selected for the day shoulder period.

These criteria apply to $L_{Aeq(15min)}$ noise levels measured under specific meteorological conditions, determined as outlined in the INP. These "prevailing" meteorological conditions refer to wind speeds of up to 3m/s in the source-to-receiver direction which occur more than 30% of the time, during any period (day, evening or night), in any season.

As Project Site operations would commence at 6.00am and product transportation at 5.00am, there may be potential for intermittent activities during day shoulder period to cause sleep disturbance. Appropriate criteria for sleep disturbance is determined within the NSW DECC *Noise Guide for Local Government (NGLG)* (DECC, 2007b) to be an $L_{A1(60second)}$ level 15dB(A) above the Rating Background Level (RBL) for the night time period (10:00pm to 7:00am). **Table 5.27** presents the INP-based noise assessment criteria for sleep disturbance at the five assessment locations.

Table 5.27
Sleep Disturbance Criteria

Location	**Sleep Disturbance Criteria, L_{Amax} (dB(A))**
CN1 – 185 Peats Ridge Road, Calga	45
CN6 – 3 Jones Road, Calga	55
CN7 – 24 Jones Road, Calga	52
CN8 – 30 Jones Road, Calga	56
CN9 – Australia Walkabout Wildlife Park	52
Source: Modified after WMPL (2009) – Table 4	

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

Road Traffic Noise Criteria

Based on the ECRTN, Peats Ridge Road is classified as a "collector" road and the applicable noise criteria are presented in **Table 5.28**.

Table 5.28
ECRTN Traffic Noise Assessment Criteria

Road	**Policy**	**Assessment Criteria**	
		Daytime $L_{Aeq(1hour)}$	**Night-time (Day Shoulder) $L_{Aeq(1hour)}$**
Peats Ridge Road	Land use developments with the potential to create additional traffic on collector roads	60dB(A)	55dB(A)

Where existing traffic noise levels already exceed this value, the *ECRTN* indicates that:

> *"In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2dB(A)."*

5.5.5.2 Assessment Methodology

5.5.5.2.1 Introduction

Assessment of operational noise was completed by WMPL (2009) using the RTA Technologies Environmental Noise Model (ENM). The various noise sources of the Project were identified and located within the Project Site to simulate Project operations for three typical scenarios over the life of the Project. The predicted noise levels received at residential receivers surrounding the Project Site was then calculated under the prevailing meteorological conditions.

5.5.5.2.2 Noise Sources

With the exception of a primary jaw crusher to be installed below the feed hopper of the wash plant, the sources of noise would remain the same as the existing and approved operations of the Calga Sand Quarry. WMPL (2009) measured the sound power level (SPL) of each item of mobile or fixed equipment on site referenced the extensive database of SPLs held by WMPL, with these used as point noise sources in the modelling.

5.5.5.2.3 Noise Modelling Scenarios

WMPL (2009) modelled three operational scenarios, with each chosen to represent the potentially noisiest operating scenario to the assessment locations. *Figures 4, 5 and 6* of WMPL (2009) present the location of noise sources for the three scenarios which are as follows.

- Scenario 1 – includes extraction activities in Stage 3/2 and Stage 4/2, sand processing activities split between Site A (the existing location of sand processing plant) and Site B (on the floor of the existing Calga Sand Quarry)[12], and product transportation (including the use of front-end loaders and dump trucks) via the Northern Entrance.

  Scenario 1 represents operating conditions likely to result in elevated noise levels at residences to the north of the Project Site, the closest of which is CN1.

- Scenario 2 – includes extraction activities in Stage 3/6 and Stage 4/5, sand processing activities split between Site B and Site C (on the 10m bench of Stage 4/2a)[13], and product transportation (including the use of front-end loaders and dump trucks) via the southern and Northern Entrances.

[12] The noise modelling was completed prior to a revision of the extraction sequence. Under the revised extraction sequence, the sand processing operations would be split between Site A and Site C (located on the 10m bench of Stage 4/2a) rather than Site A and Site B. However, as Scenario 1 was chosen to predict elevated noise levels to the north of the Project Site, the location of these noise sources within Site B will provide a more conservative, ie. worst-case, predictions of noise levels.

[13] The noise modelling was completed prior to a revision of the extraction sequence. Under the revised extraction sequence, processing operations would be undertaken at Site D (on the completed floor of Stage 4/3). However, assuming processing operations within the more elevated Site C provides for more conservative, ie. worst-case, predictions of noise levels.

Scenario 2 represents operating conditions likely to result in elevated noise levels at residences to the north and east of the Project Site, the closest of which are CN1 (to the north) and CN6, CN7 and CN8 (to the east).

- Scenario 3 – includes extraction activities in Stage 4/8 and Stage 5/1, sand processing activities would be undertaken within Site D (on the completed floor of Stage 4/3)[14], and product transportation (including the use of front-end loaders and dump trucks) via the Southern Entrance.

  Scenario 3 represents operating conditions that could potentially result in elevated noise levels at residences to the east and south of the Project Site, the closest of which are CN6, CN7 and CN8 (to the east) and CN9 (to the south).

The following assumptions were incorporated into the noise modelling completed by WMPL (2009).

- Processing Site A is shielded topographically from the east and southeast by at least 5m.
- Processing Site C is shielded topographically from the north, east and south by at least 10m.
- All front-end loaders and excavators used on the Project Site would have a sound power emission level of 104dB(A) each, equivalent to the new loader which is currently in operation.
- All road trucks would have a sound power emission level of 102dB(A) each, equivalent to a measured truck currently in operation.

The noise model also assumed a 5m high acoustic bund wall was in place around the northern, eastern and southern perimeter of each extraction stage considered.

5.5.5.2.4 Noise Modelling Methods

Noise level calculations were performed by WMPL (2009) using the ENM environmental noise model. Topographic information was provided at 2m, with *Figures 4, 5 and 6* of WMPL (2009) identifying the locations of all point sources of noise emissions. All sources of noise were assumed to be operating simultaneously for the entire 15 minute period of calculation.

For daytime and evening calculations, 41 separate meteorological conditions were considered – wind speed of 0.5m/s to 3m/s in each of eight directions, and zero wind speed (representing both zero wind and wind speeds above 3m/s). Noise levels were calculated under each of these conditions, and the probability of occurrence of each condition for night time periods in each season was then used to calculate the L_{Aeq} noise level which would be exceeded for 10% of 15-minute periods[15].

[14] The noise modelling was completed prior to a revision of the extraction sequence. Under the revised extraction sequence, Site D would now be located the completed floor of Stage 4/3. As this location is further away from the closest residences to the Project Site, the modelled activities represent a more conservative, ie. worst-case, prediction of possible noise levels.

[15] This represents a more rigorous consideration of potential noise emissions (see Section 5.4 of WMPL, 2009).

For night-time (day shoulder) calculations, a single meteorological condition was used, representing zero wind and a temperature inversion of 3°C per 100m.

5.5.6 Assessment of Residual Impacts

5.5.6.1 Operational Noise

The predicted noise level exceeded for 10% of 15 minute periods during the worst case daytime meteorological conditions and day shoulder inversion conditions, generated by the operational activities of Scenarios 1 to 3 at the assessment locations are presented in **Table 5.29**. The predicted noise levels are listed together with the relevant noise criteria and an assessment of impact against these criteria (in brackets).

Table 5.29
Predicted 10th Percentile L_{Aeq} Operational Noise Levels

Scenario	Receiver	Criterion, L_{Aeq} (dB(A))			Predicted Operational Noise Level L_{Aeq} (relative compliance/exceedance of criterion) (dB(A))		
		Day Shoulder	Day	Evening	Day Shoulder	Day	Evening
Scenario 1	CN1	41	41	35	32 (-9)	32 (-9)	32 (-3)
	CN6	45	43	43	43 (-2)	41 (-2)	42 (-1)
	CN7	42	43	44	42 (0)	40 (-3)	42 (-2)
	CN8	46	48	45	42 (-4)	40 (-8)	41 (-4)
	CN9	42	46	45	39 (-3)	37 (-9)	39 (-6)
Scenario 2	CN1	41	41	35	35 (-6)	35 (-6)	35 (0)
	CN6	45	43	43	41 (-4)	39 (-4)	40 (-3)
	CN7	42	43	44	40 (-2)	39 (-4)	40 (-4)
	CN8	46	48	45	39 (-7)	38 (-10)	39 (-6)
	CN9	42	46	45	41 (-1)	39 (-7)	41 (-4)
Scenario 3	CN1	41	41	35	25 (-16)	25 (-16)	26 (-9)
	CN6	45	43	43	37 (-8)	36 (-7)	37 (-6)
	CN7	42	43	44	37 (-5)	35 (-8)	36 (-8)
	CN8	46	48	45	38 (-8)	36 (-12)	37 (-8)
	CN9	42	46	45	41 (-1)	39 (-7)	41 (-4)

Source: Modified after WMPL (2009) – Table 7

Assuming the construction of the relevant acoustic bund wall is complete, no exceedance of the relevant operational noise criteria was predicted for any of the operating scenarios.

It is acknowledged that the progressive establishment of the acoustic bund walls would generate noise during their construction and needs to be assessed as a cumulative source of operational noise. Assuming bund wall construction would be undertaken in place of, as opposed to in conjunction with, extraction activities within the relevant extraction stage, during day time hours only and requiring no additional mobile equipment, WMPL (2009) calculated the cumulative $L_{Aeq(15\ min)}$ noise levels during the progressive establishment of acoustic bund around the active extraction stages presented in *Figures 4, 5 and 6* of WMPL (2009).

Table 5.30 presents the calculated $L_{Aeq\ (15\ min)}$ noise levels attributable to the establishment of acoustic bund around the active extraction stages presented in *Figures 4, 5 and 6* of WMPL (2009)**.**

Table 5.30
Predicted $L_{Aeq(15min)}$ Operational Noise Levels Associated with the Establishment of Acoustic Bunds

Receiver Location	Daytime Operational Noise Criterion	Predicted L_{Aeq} Noise Levels dB(A)		
		Scenario 1	Scenario 2	Scenario 3
CN1	41	Acoustic bund existing within current extraction cell. No construction of additional acoustic bund is proposed.	4-7	9-13
CN6	43		22-32	17-21
CN7	43		18-23	17-21
CN8	48		17-21	18-22
CN9	46		22-26	27-30
Source: Modified after WMPL (2009) – Table 10				

Table 5.31 presents the calculated cumulative $L_{Aeq\ (15\ min)}$ noise levels during the progressive establishment of acoustic bund around the active extraction stages presented in *Figures 4, 5 and 6* of WMPL (2009)**.**

Table 5.31
Predicted Cumulative $L_{Aeq(15min)}$ Operational Noise Levels Associated with Progressive Establishment of Acoustic Bunds

Scenario	Receiver	$L_{Aeq(15min)}$ Operational Noise Level (dB(A))		
		Predicted Highest 10th %ile Operational Day L_{eq} Levels	Predicted Construction L_{Aeq} Noise Levels	Predicted Cumulative L_{Aeq} Noise Levels (relative compliance)
Scenario 2	CN1	35	4-7	35 (-6)
	CN6	39	22-32	40 (-3)
	CN7	39	18-23	39 (-4)
	CN8	38	17-21	38 (-10)
	CN9	39	22-26	39 (-7)
Scenario 3	CN1	25	9-13	25 (-16)
	CN6	36	17-21	36 (-7)
	CN7	35	17-21	35 (-8)
	CN8	36	18-22	36 (-12)
	CN9	39	27-30	40 (-6)
Source: Modified after WMPL (2009) – Table 11				

The predicted cumulative operational noise levels are well within the relevant daytime operational noise criteria for the acoustic bund construction and existing quarry operations behind previously constructed acoustic bund walls.

Table 5.32 presents the predicted maximum noise levels (L_{Amax}) generated by the Project that would be received at the five assessment locations.

The results in **Table 5.32** indicate the Project would comply with the sleep disturbance criteria at each surrounding residence.

Table 5.32
Predicted Sleep Disturbances Noise Levels L_{Amax}

Scenario	Receiver	Sleep Disturbance Noise Criterion (dB(A))	Predicted Sleep Disturbance Level (relative compliance/exceedance of criterion) (dB(A))
Scenario 1	CN1	45	35 (-10)
	CN6	55	49 (-6)
	CN7	52	50 (-2)
	CN8	56	50 (-6)
	CN9	52	46 (-6)
Scenario 2	CN1	45	38 (-7)
	CN6	55	48 (-7)
	CN7	52	46 (-6)
	CN8	56	46 (-10)
	CN9	52	47 (-5)
Scenario 3	CN1	45	30 (-15)
	CN6	55	43 (-12)
	CN7	52	44 (-8)
	CN8	56	44 (-12)
	CN9	52	48 (-4)
Source: Modified after WMPL (2009) – Table 8			

5.5.6.2 Road Traffic Noise

WMPL (2009) calculated the noise levels attributable to the additional truck movements traversing the section of Peats Ridge Road from the Project Site to the F3 Freeway using the ECRTN methodology, assuming:

- a mean vehicle speed 60km/hr (the speed limit of Peats Ridge Road is 80km/hr, although higher than the actual mean speed of each truck between the site entrance and the F3 Freeway, this accounts for the higher noise generation when vehicles turn onto the road);
- dense graded asphalt road surface; and
- 50% acoustically soft ground.

Combining this calculated contribution with the existing $L_{Aeq\ (1hr)}$ noise level (including truck movements from the existing Calga Sand Quarry operations), WMPL (2009) calculated the increase in total noise level for production levels of 600 000tpa and 1 000 000tpa during the day and night (day shoulder) time periods at the four closest assessment locations to Peats Ridge Road (CN-6, 7 and 8) and within Calga Village (CN-10) (see **Table 5.33**).

In all cases, the road traffic noise level, which is dominated by existing traffic on Peats Ridge Road and the F3 Freeway, would not increase by more than 2dB(A) and therefore remain compliant with the ECRTN criterion.

Table 5.33
Increase in $L_{Aeq,1hr}$ Road Traffic Noise Level Attributable to Proposed Production Increase

Production Level	Additional Truck Movements	Description	Assessment Location			
			CN-6	CN-7	CN-8	CN-10
600 000tpa	**Day Shoulder (5:00am to 7:00am)**					
	4	Calculated $L_{Aeq,1hr}$ (dB(A))	41	37	37	43
		Existing $L_{Aeq,1hr}$ (dB(A))	52	49	47	55*
		Total $L_{Aeq,1hr}$ (dB(A))	52	49	47	55
		Increase in $L_{Aeq,1hr}$ (dB(A))	<1	<1	<1	<1
	Day (7:00am to 6:00pm)					
	5	Calculated $L_{Aeq,1hr}$ (dB(A))	42	38	38	44
		Existing $L_{Aeq,1hr}$ (dB(A))	58	49	54	55*
		Total $L_{Aeq,1hr}$ (dB(A))	58	49	54	55
		Increase in $L_{Aeq,1hr}$ (dB(A))	<1	<1	<1	<1
	Day (6:00pm to 10:00pm)					
	2	Calculated $L_{Aeq,1hr}$ (dB(A))	40	36	36	40
		Existing $L_{Aeq,1hr}$ (dB(A))	46	47	47	51*
		Total $L_{Aeq,1hr}$ (dB(A))	47	47	47	51
		Increase in $L_{Aeq,1hr}$ (dB(A))	1	<1	<1	<1
1 000 000tpa	**Day Shoulder (5:00am to 7:00am)**					
	11	Calculated $L_{Aeq,1hr}$ (dB(A))	44	41	41	47
		Existing $L_{Aeq,1hr}$ (dB(A))	52	49	47	55*
		Total $L_{Aeq,1hr}$ (dB(A))	53	50	48	55
		Increase in $L_{Aeq,1hr}$ (dB(A))	1	1	1	<1
	Day (7:00am to 6:00pm)					
	19	Calculated $L_{Aeq,1hr}$ (dB(A))	46	43	42	50
		Existing $L_{Aeq,1hr}$ (dB(A))	52	47	51	55*
		Total $L_{Aeq,1hr}$ (dB(A))	53	49	52	56
		Increase in $L_{Aeq,1hr}$ (dB(A))	1	2	1	1
	Day (6:00pm to 10:00pm)					
	3	Calculated $L_{Aeq,1hr}$ (dB(A))	40	36	36	42
		Existing $L_{Aeq,1hr}$ (dB(A))	52	50	52	51*
		Total $L_{Aeq,1hr}$ (dB(A))	52	50	52	51
		Increase in $L_{Aeq,1hr}$ (dB(A))	<1	<1	<1	<1

Source: Modified after WMPL (2009) – Table 10

5.5.7 Monitoring

Rocla currently undertakes noise monitoring in accordance with a Noise Monitoring Program approved by the Director-General of the Department of Planning in December 2005. **Table 5.34** summarises relevant information for the Noise Monitoring Program.

Rocla proposes to expand this monitoring program to enable validation of the noise modelling predictions of WMPL (2009) (and thereby satisfy a commitment prior to progression to Stage 5), demonstrate compliance with the noise criteria presented in Section 5.5.5.1) and identify the need for any additional mitigation measures prior to significant disturbance occurring or complaints being received. Rocla proposes to include quarterly noise monitoring at Residences CN-6 to CN-9 in the expanded noise monitoring program. The results of all monitoring would be included in each Annual Environmental Monitoring Report for the extended quarry. It is proposed to review the frequency and locations of monitoring for each Annual Environmental Management Report to ensure only meaningful data is being collected.

Table 5.34
Current Noise Monitoring Program and Criteria

Purpose	Location *	Criteria ($L_{Aeq(15min)}$)				Frequency/Timing of Monitoring
		Day	Evening	Night	Construction	
Noise Compliance Monitoring	CN-1 (Adjacent to Residence 3 on Lot 121, DP755221)	41	35	35	56	Quarterly attended monitoring and yearly unattended monitoring
	CN-2 (Adjacent to Residence 4 on Lot 143, DP755246)	40	35	35	55	
	CN-3 (Adjacent to Residence 5 on Lot 188, DP755221)	39	35	35	56	
	CN-4 (Adjacent to Residence 6 on Lot 120, DP755221)	35	35	35	50	
Noise Prediction Validation	CN-5 (Adjacent to Residence 2 on Lot 1, DP559892)	35	35	35	55	Within 2 weeks of the commencement of construction and each extraction stage to validate predictions made
* See **Figure 5.19** for noise monitoring site locations.						

5.6 VISIBILITY

5.6.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential impacts on visual amenity with a moderate to high **unmitigated** risk rating, and therefore requiring assessment, are as follows.

- Temporary disturbance to the existing landform (high risk).
- Marginally identifiable change to landscape following rehabilitation and final landform creation (high risk).
- Highly identifiable change to landscape following rehabilitation and final landform creation (moderate risk).

In addition, the Director-General's Requirements (DGRs) identify "*visual (amenity)*" as a key issue for assessment in the *Environmental Assessment.*

5.6.2 The Existing Visual Landscape

The visibility of the approved Calga Sand Quarry operations is currently shielded by a 7m high vegetated earth bund and colorbond fence which commences at the quarry entrance and is aligned all the way around the northern, western and southern sides of the Stage 3 extraction area. Obscured and distant views of the most elevated areas of the existing quarry operations are visible from the residence of the Australia Wildlife Walkabout Park (Residence 13 on **Figure 4.4**). Although minimised by current dust suppression activities, the existing Calga Sand Quarry operations are understood to be evident to some surrounding land owners when meteorological conditions and on-site activities result in some dust generation.

The site of the proposed southern extension of the Calga Sand Quarry is dominated by dense woodland and forest vegetation, broken up by the transmission power line and easement which traverses Lots 1 and 2, DP 805358. Direct views of this landscape, however, are limited to the lands within defined areas of the Australia Wildlife Walkabout Park and the "Glenworth Valley" property. **Plates 5.5** and **5.6** present the current view of the proposed Southern Extension from the northern boundary and residence of the Australia Wildlife Walkabout Park.

Highly obscured and distant views may also be available of the Project Site from small parts of land or properties on the western side of "Glenworth Valley". Existing vegetation along the Peats Ridge Road edge of the Lots 1 and 2, DP 805358 obscure any views possible of the existing landscape from Peats Ridge Road and properties on the eastern side of Peats Ridge Road.

5.6.3 Changes to the Visual Amenity of the Project Site

The proposed southern extension to the Calga Sand Quarry would not change the visibility of the quarry operations from the north, as the vegetated earth bund and colorbond fence would continue to visually screen all activities. However, as the extraction area is extended into Stage 4 and then Stage 5, the existing vegetation of Lots 1 and 2, DP 805358 would be cleared increasing the visibility of operations to defined areas within the Australia Wildlife Walkabout Park, the elevated areas of the "Glenworth Valley" property and properties on elevated land to the west of "Glenworth Valley". While a strip of vegetation would be retained along the Peats Ridge Road edge of the Lots 1 and 2, DP 805358, the scale of the proposed clearing would inevitably be visible, although still obscured by the screening vegetation, to traffic on Peats Ridge Road (in particular north-bound traffic).

5.6.4 Environmental Controls and Management

The principal controls Rocla would adopt to minimise the visual impact of the Project from surrounding residences, Peats Ridge Road and other vantage points would be a continuation of those currently in place together with a range of additional controls. These existing controls consist of:

- the maintenance of a vegetated acoustic bund wall and colorbond fence around the Stage 3 extraction area;
- active revegetation of completed sections of the Project Site;
- a high standard of housekeeping to achieve a visually attractive site; and
- minimising the area disturbed to that required for the ensuing 6 to 9 months development.

In addition to these existing controls, the following additional controls would be implemented.

i) The construction of vegetated acoustic bund walls adjacent to the relevant perimeter of the active extraction stage(s). These bunds would be constructed predominantly as acoustic bund walls but would also provide an effective screen to the extraction operations from residences and motorists to the east and south.

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Plate 5.5: View towards the existing Calga Sand Quarry and proposed Southern Extension (from the northern boundary of the Australia Wildlife Walkabout Park)
(Ref: E664-C012)

Plate 5.6: View towards the proposed Southern Extension (from Residence 13)
(Ref: E664-C004)

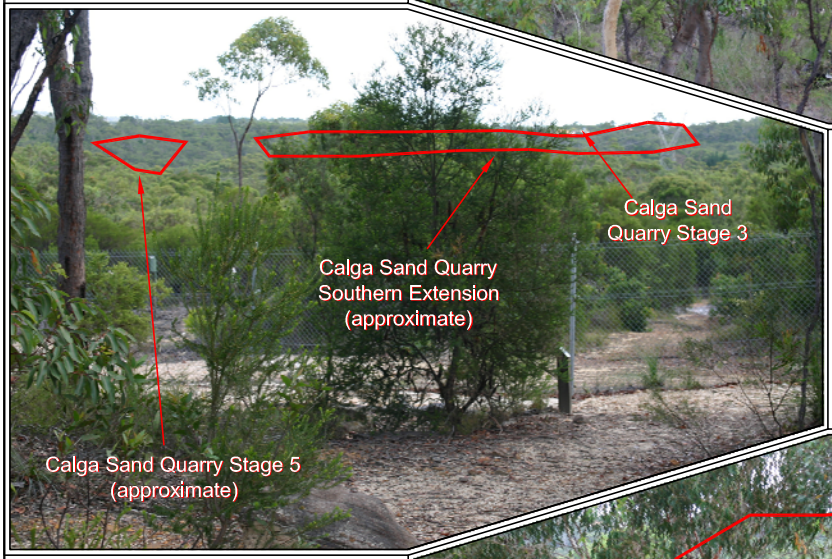


Plate 5.7: Anticipated view towards the proposed Southern Extension (from the northern boundary of the Australia Wildlife Walkabout Park)
(Ref: E664-C012 modified)

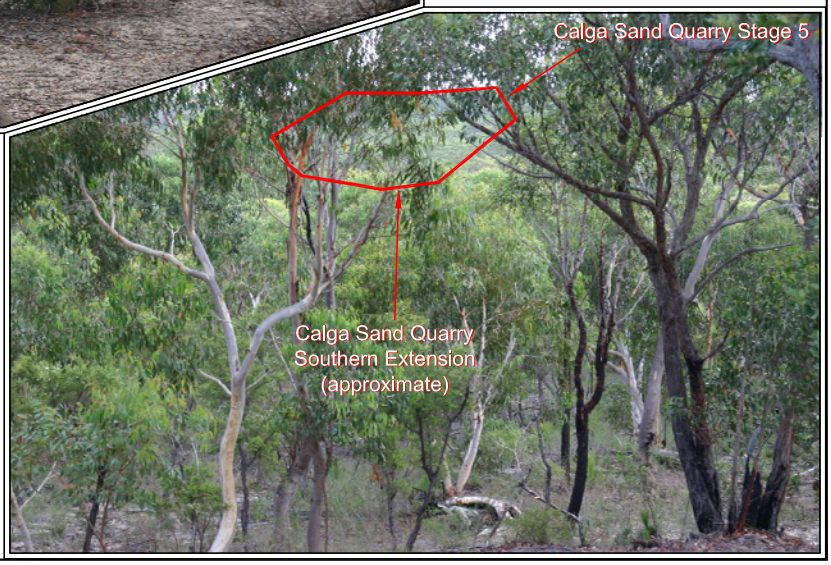


Plate 5.8: Anticipated view towards the proposed Southern Extension (from Residence 13)
(Ref: E664-C014b)

ii) The retention of the existing vegetation along the eastern boundary of the Project Site. This vegetation, together with a 10m to 20m strip of native vegetation along the Peats Ridge Road reserve, would provide a vegetation barrier of at least 30m which would restrict views onto the Project Site from Peats Ridge Road.

iii) Additional tree planting along the eastern boundary of the Project Site to improve the level of visual screening when viewed from Peats Ridge Road.

iv) The retention of at least 80m of the existing vegetation along the southern boundary of the Project Site. This vegetation would provide a vegetation barrier which would restrict views onto the Project Site from the Australia Wildlife Walkabout Park to the south.

v) The processing areas on the Project Site would be relocated to the quarry floor, not only removing this equipment from view through a reduction in elevation, but also providing for additional natural dust control.

vi) Any new buildings would be clad with dark, non reflective material, eg. dark green colour-bond cladding or similar.

5.6.5 Assessment of Residual Impacts

The southern extension to the Calga Sand Quarry would change the visual landscape through the clearing of approximately 36.1ha, including 33.6ha of native, predominantly woodland/forest, vegetation. However, through the continuation of the existing, and implementation of the proposed operational controls (see Section 5.9.4), the altered landscape would only be visible from a restricted number of vantage points including:

- sections of the western side of the Australia Wildlife Walkabout Park;
- the southern end of the "Glenworth Valley" property; and
- vantage points on the elevated land to the west of "Glenworth Valley".

Notably, the existing Calga Sand Quarry is already visible from these locations, albeit either more distant or more obscured.

Of these vantage points, the potentially most affected would be within the Australia Wildlife Walkabout Park, as the southern extension would encroach to within 80m of the park boundary and 270m from the residence on the property. In order to illustrate the visibility of the proposed southern extension from the park residence and notable points along the walking trails of the park, line of sight cross sections have been generated using contour lines at 2m intervals generated by Geo-Spectrum (Australia) Pty Limited from aerial photography (see **Figure 5.20**). **Plates 5.7** and **5.8** present an illustration of the visibility of the proposed activities from the northern boundary and residence of the Australia Wildlife Walkabout Park, ie. using the same photos as presented in **Plates 5.5** and **5.6** (and **4.5** and **4.6**).

The visibility of the Project Site from "Glenworth Valley" and properties to the west would undoubtedly increase, however, these would still remain significantly distant from the proposed operations such that the change in visual amenity would be minimal.

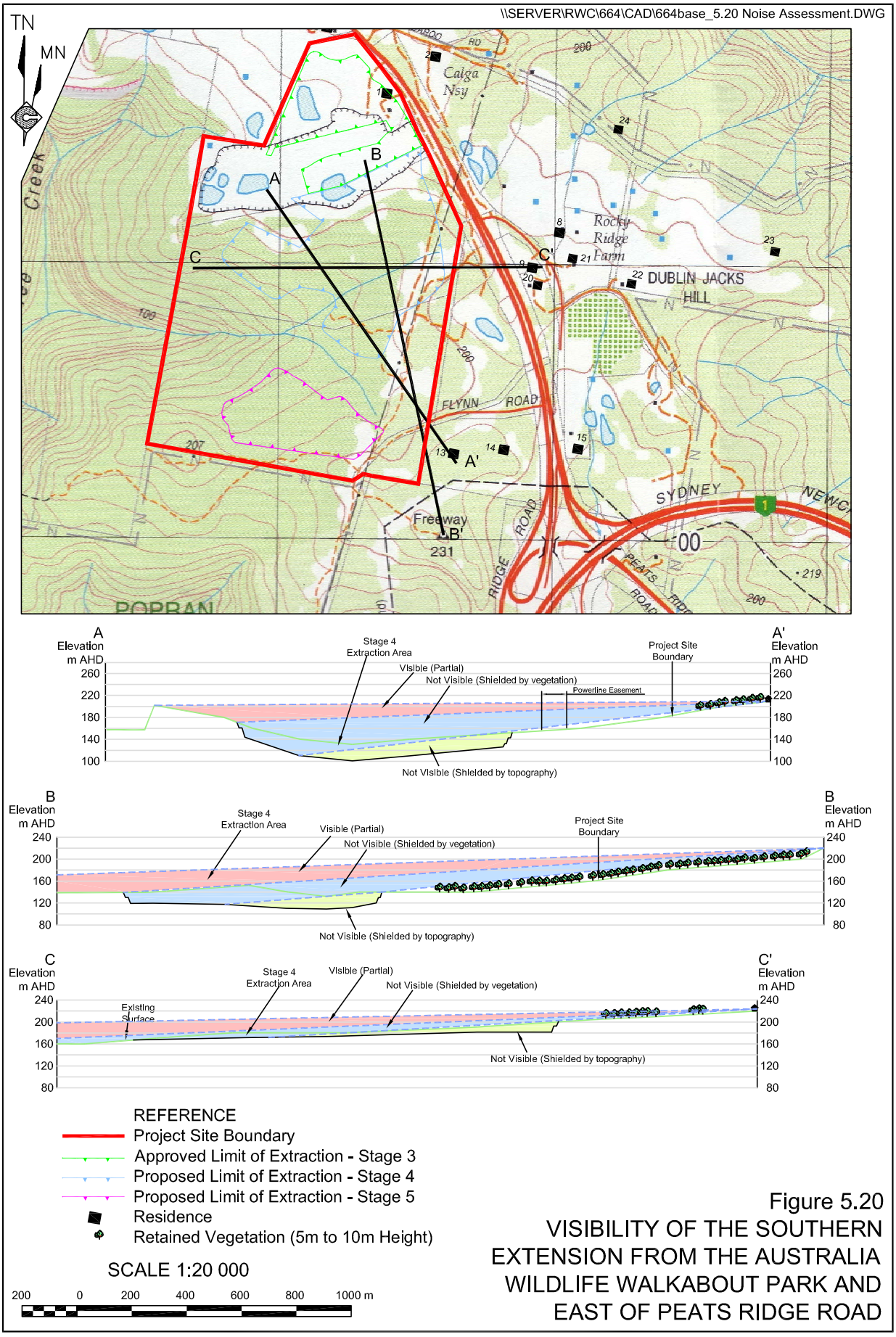


Figure 5.20
VISIBILITY OF THE SOUTHERN EXTENSION FROM THE AUSTRALIA WILDLIFE WALKABOUT PARK AND EAST OF PEATS RIDGE ROAD

5.7 AIR QUALITY

5.7.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential air quality impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Deposited dust levels attributable to the Project occasionally (for one or two months every year) above DECC guideline, affects only adjacent landholders (moderate risk).
- Deposited dust levels attributable to the Project regularly (>5 months per year) above approved limit, affects landholders some distance from the Project Site (high risk).
- PM_{10} levels attributable to the Project occasionally (once every 1 to 2 years) above the project goal, affects only adjacent landholders (moderate risk).
- PM_{10} levels attributable to the Project occasionally (>5 times per year) above the project goal affects landholders some distance from Project Site (high risk).
- Impacts extend beyond the Project Site or impact on extensive areas of native vegetation (high risk).
- Greenhouse gas emissions (moderate risk).

The Director-General's Requirements issued by the Department of Planning require that the assessment of air quality refer to *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).

Dust generation would be one of the main air quality issues relevant to the Project. Depending upon the size and concentration of particles in the air and their composition, airborne dust has the potential to affect human health as well as contribute to the general degradation of the environment. The term *"particulate matter"* refers to a category of airborne particles typically less than 50µm in aerodynamic diameter and ranging down to 0.1µm in size. The human respiratory system has a built-in defensive system that prevents particles greater than 10µm in diameter from reaching sensitive areas of the respiratory system. As a result particles less than 10µm (PM_{10}) and 2.5µm ($PM_{2.5}$), if in high enough concentration, may adversely affect human health. This section also addresses the presence of respirable crystalline silica component of PM_{10}, which has also been proven to detrimentally impact on the health of those exposed to elevated concentrations in their workplace.

As particles larger than 10µm can also contribute to environmental degradation, the air quality assessment also considers the total mass of particles suspended in the air, ie. Total Suspended Particulate matter (TSP). Particles that have an aerodynamic sufficiently large so as not to be suspended in air (typically >35µm) are referred to as deposited dust.

Greenhouse gases would be produced as a consequence of the Project, through the use of fuel to power mobile equipment on the Project Site and product carrying trucks which transport the quarry products from the Project Site to markets. The effects of greenhouse gas emissions on global temperatures, most notably the Greenhouse Effect, are well documented and an assessment of greenhouse gas emissions has been included in this assessment of air quality impacts.

The following subsections 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.

The information presented in this section relating to particulate emissions is drawn from the air quality assessment undertaken by PAEHolmes (PAEHolmes, 2009) whose full report is included in the *Specialist Consultant Studies Compendium* (Part 6). This subsection also presents a greenhouse gas emission assessment.

5.7.2 Existing Air Quality

5.7.2.1 Introduction

Air quality guidelines and goals refer to levels of "pollutants" in air which include both existing and operational sources. In order to fully assess impacts against all the relevant air quality guidelines and goals, it is therefore necessary to compile information or estimates on existing dust deposition levels and the existing concentrations of airborne particulates and gases such as SO_2 and NO_2. In the absence of site-specific air quality data for some "pollutants" background levels are described through reference to monitoring undertaken at nearby locations or the closest available location.

5.7.2.2 Dust Deposition

An estimate of background dust deposition levels for the Project Site has been derived from dust deposition data obtained from monitoring points within and surrounding the Project Site since 2001 (see **Figure 5.21**). The results presented in **Table 5.35** represent annual dust deposition attributable to the activities on the surrounding landholdings, natural sources and the activities undertaken at the Calga Sand Quarry.

Table 5.35
Results of Dust Deposition Monitoring

Monitoring period	Total Insoluble Solids (g/m^2/month)						
	CD-1	CD-2a	CD-2b	CD-3	CD-4	CD-5	CD-6
2001	0.9	0.6		0.5			
2002	0.9	1.7		1.1			
2003	0.7	1.5		0.9			
2004	1.0	0.9		0.6			
2005 [1]	1.3	1.3		1.2			
2006 [2]	1.6	3.3	0.9	0.7	1.2		
2007	1.4		1.6	0.9	1.2	1.0	1.3
2008 (to September)	0.9		1.3	0.5	0.8	0.7	1.1
Average	**1.1**	**1.6**	**1.3**	**0.8**	**1.0**	**0.9**	**1.2**

Note 1: No extraction or processing activities were undertaken for the period 31 December 2004 to January 2006 and monthly dust data was not collected for this period
Note 2: CD-1 relocated 1 May 2006 to beyond Stage 3 extraction limit
Source: Modified after PAEHolmes (2009) – Table 7

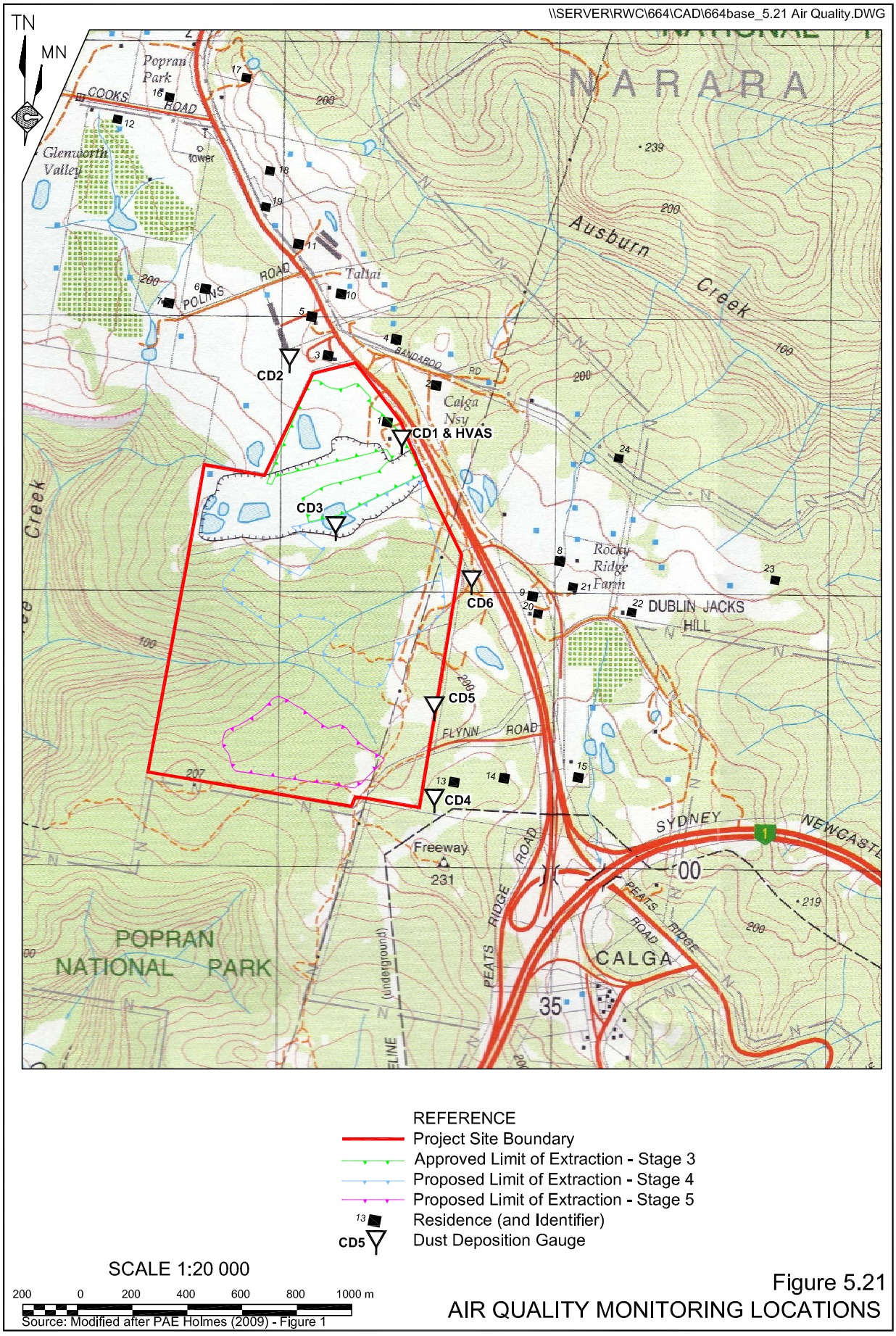


Figure 5.21
AIR QUALITY MONITORING LOCATIONS

The data presented in **Table 5.35** show that, on an annual average basis, dust deposition levels are generally very low, with the annual average less than 2g/m^2/month at each location.

For assessment purposes, background dust deposition has been determined to be less than 2.0g/m^2/month.

5.7.2.3 Particulate Matter

In order to gain an understanding of the particulate matter concentration in the existing air-shed, a DustTrak monitor was installed and operated over a 2 week period (16 May 2007 to 1 June 2007) at the residence of the Australia Wildlife Walkabout Park (see **Figure 5.20**). While due to the high density of trees surrounding the residence, the location did not meet the requirements of Australian Standard AS 2922 Ambient Air – Guide for Siting of Sampling Units, the location was chosen as that most likely to receive the highest possible impact from the Calga Sand Quarry and its proposed extension.

The results of the 2 week monitoring is presented in **Table 5.36** which indicates, with the exception of 17 May 2007 when the 24-hour average concentration measured was 64µg/m^3, low particulate matter concentration. It was later determined that the wind direction on the day of the elevated result was from the southwest, and therefore the quarry was unlikely to have been the primary contributor to this elevated level.

Table 5.36
Results of PM_{10} Monitoring (Walkabout Park - May 2007)

Date	PM_{10} 24-hour average concentration (µg/m^3)	Date	PM_{10} 24-hour average concentration (µg/m^3)
16/5/07	24	25/05/07	7
17/05/07	64	26/05/07	19
18/05/07	10	27/05/07	21
19/05/07	1	28/05/07	15
20/05/07	3	29/05/07	12
21/05/07	3	30/05/07	5
22/05/07	4	31/05/07	10
23/05/07	2	01/06/07	9
24/05/07	3	25/05/07	7
		Average	**12.5**
Source: Modified after PAEHolmes (2009) – Table 8			

A High Volume Air Sampler (HVAS) was installed at location to CD-1 in February 2007 and at the residence of the Australia Wildlife Walkabout Park in August 2007 to collect PM_{10} samples for a 24-hour period every three and six days respectively. During both monitoring periods, the average maximum 24 hour PM_{10} concentration remained well below the NEPM goal of 50µg/m^3 (14µg/m^3 and 3.8µg/m^3 respectively – see PAEHolmes, 2009).

While the results of the particulate matter monitoring provide an estimate of the existing air quality, for assessment purposes the DECC nominated that, a data set containing at least 12 months worth of continuous data was required. The closest continuous monitoring station considered representative of the local environment area is a DECC site located at Richmond (approximately 50km southwest of the Project Site).

Table 5.37 presents a summary of the maximum 24-hour PM_{10} concentrations measured each month at the DECC Richmond site for the period April 2006 to March 2007, a period corresponding to continuous meteorological data collection at the Calga Sand Quarry.

Table 5.37
Results of PM_{10} Monitoring (DECC Richmond Meteorological Station - April 2006 to March 2007)

Month	Monthly maximum 24-hour average	Monthly average 24-hour average
April 2006	26.3	18.4
May 2006	31.8	16.0
June 2006	23.3	12.6
July 2006	18.8	10.4
August 2006	23.7	15.7
September 2006	38.5	16.2
October 2006	31.7	20.9
November 2006	63.1	25.0
December 2006	60.7	23.4
January 2007	43.0	22.3
February 2007	29.5	15.8
March 2007	22.3	15.4
	Annual Average	**17.7**
Source: Modified after PAEHolmes (2009) – Table 10		

The daily maximum 24 hour concentration generally varied between 20µg/m^3 and 40µg/m^3, i.e. levels below the DECC assessment criteria of 50µg/m^3. The exceedances of the DECC criteria in November and December 2006 were both attributable to bush fires in the Blue Mountains (DECC, 2007). The annual average concentration of PM_{10} was 17.7µg/m^3, ie. well below the DECC assessment criteria of 30µg/m^3.

In order to estimate a background concentration of annual Total Suspended Particulates (TSP), which is the combined total of all particulate matter, this report has taken the annual average PM_{10} records at Richmond for April 2006 to March 2007 (16.5µg/m^3), and uses the multiplier of two for ambient air where road traffic is not the dominant particulate source, to derive the annual average background TSP concentration of 35.4µg/m^3.

5.7.2.4 Crystalline Silica

The existing background concentration of airborne crystalline silica originates from quartz (silicon dioxide) being emitted into the air as a component of particulate emissions produced by natural, industrial, and farming activities (US EPA, 1996). Within the Calga area, these activities may include dust from vehicles travelling on sealed and unsealed roads, agricultural activities, bushfires, wind erosion of unsealed surfaces, local construction and demolition activities and extractive industries. The sandy nature of the soils around Calga means they naturally contain high levels of quartz.

As exposure to crystalline silica is primarily an occupational health hazard, very little monitoring has been conducted to measure ambient concentrations. One study undertaken in Victoria (Toxikos, 2005) estimated the background concentration to be 0.7µg/m^3 and is comparable to another study undertake in a rural Californian area which estimated a background concentration of 0.6µg/m^3 (OEHHA, 2005). In the absence of any local data, it has been assumed the background level of 0.7µg/m^3 as measured in Victoria applies to the Project Site.

5.7.2.5 Nitrogen Dioxide and Sulphur Dioxide

Small concentrations of NO_2 and SO_2 would be emitted by vehicles travelling along Peat Ridge Road and the F3 Freeway. However, these levels are considered to be minimal given the minor concentrations of NO_2 and SO_2 emitted by vehicles.

5.7.2.6 Carbon Dioxide and Methane

Existing background concentrations of carbon dioxide and methane are recognised to be negligible and typical of a rural area.

5.7.2.7 Summary of Existing Air Quality

Taking into account locally collected (dust deposition data), data obtained from the most appropriate continuous monitoring station and existing land use, PAEHolmes (2009) has assumed the following background dust and particulate matter concentrations at residences surrounding the Project Site.

- Dust deposition: $2g/m^2$/month.
- 24 hour maximum PM_{10}: daily varying[16].
- Annual average PM_{10}: 10 to 15 $\mu g/m^3$.
- Annual average TSP: 20 to 30 $\mu g/m^3$.
- Crystalline Silica: $0.7\mu g/m^3$.

5.7.3 Potential Sources of Air Contaminants

5.7.3.1 Particulate Emissions

The main sources of particulate emissions (dust) that would be generated by the Project would include:

- vegetation clearing and soil stripping;
- sandstone ripping and loading to trucks;
- road and hardstand area construction (on-site);
- road construction and delivery of road construction materials;
- dry screening activities (mortar sand plant, front-end loader);
- wind erosion off areas within the extraction area and soil and sand stockpiles; and
- general movement of heavy vehicles on unsealed roads within the site (haul truck wheel dust).

[16] As the background 24 hour PM_{10} concentration will vary each day, the assessment of PAEHolmes (2009) has adopted the approach that the predicted 24-hour average PM_{10} concentration (background and increment attributable to the Project) should not exceed $50\mu g/m^3$ at the nearest residences.

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 the combustion of fuel by diesel-powered equipment and vehicles, including front-end loaders, excavators, bulldozers, scrapers, graders, drill rigs and haul trucks. Minor levels of greenhouse gas emissions would be generated by the combustion of diesel fuel for temporary on-site power generation for lighting towers etc.

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 levels, however, are expressed in CO_2 equivalent units.

5.7.4 Assessment Criteria

5.7.4.1 Particulate Matter and Dust Deposition

Goals Applicable to PM_{10}

Emissions of PM_{10} and $PM_{2.5}$ particles are considered important pollutants in terms of impacts due to their ability to penetrate into the respiratory system.

The NSW DECC 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.

The 24-hour PM_{10} reporting standard of 50µg/m^3 is numerically identical to the equivalent National Environment Protection Measure (NEPM) reporting standard except that the NEPM reporting standard allows for five exceedances per year.

Goal Applicable to Total Suspended Particulates

The annual goal for Total Suspended Particulates (or TSP) is given as 90µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC). This goal was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to PM_{10} concentrations.

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 for $PM_{2.5}$.

- A 24-hour maximum of 25µg/m^3.
- An annual average of 8µg/m^3.

Goals Applicable to Deposited Dust

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m^2/month.

In order to avoid dust nuisance the DEC (EPA) developed assessment goals for dust fallout. **Table 5.38** presents the allowable increase in dust deposition relative to the ambient levels.

Table 5.38
DECC Goals for Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m^2/month	4g/m^2/month
Source: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005)		

Based upon the maximum levels in **Table 5.38** and the initial site-based and longer term regional dust deposition data, a site-specific goal for all dust sources attributable to site activities would be 4g/m^2/month.

Goals Applicable to Crystalline Silica

Three separate goals have been developed for assessing the health-related impacts of exposure to respirable crystalline silica as follows.

1. Ambient respirable crystalline silica criteria.
2. Silicosis potency estimates.
3. Occupational health and safety goals.

Ambient Respirable Crystalline Silica Criteria

The chronic Reference Exposure Level (REL) for respirable crystalline silica, ie. the airborne level of respirable crystalline silica at or below which no adverse health effects are anticipated in individuals indefinitely exposed to that level, has been estimated as an annual average PM_4 of 3µg/m^3 by the Office of Environmental Health Hazard Assessment (OEHHA) in California. While no REL standard has been adopted by any NSW government department, this REL has been adopted by the Victorian EPA. This REL has subsequently been adopted for this assessment, given RELs are developed from the best available published scientific data, based primarily on health considerations.

Silicosis Potency Estimates

Cumulative exposure to respirable crystalline silica, ie. an estimate of the average respirable crystalline silica concentration to which a person is exposed over the course of a year multiplied by the number of years exposed, may result in an increased risk to diseases such as silicosis. Research conducted by the US EPA (1996), which examined the non-cancer epidemiological literature on silica induced diseases, concluded that the cumulative risk of silicosis at or below 1000µg/m^3, or 14.3µg/m^3 per year for 70 years, is close to 0% (US EPA, 1996).

NSW Occupational Health and Safety Goals

In New South Wales, WorkCover NSW is the primary statutory authority with regards to occupational exposures to dust and airborne concentrations of respirable crystalline silica. **Table 5.39** lists the occupational criteria for dust and quartz noted by the Australian Safety and Compensation Council (ASCC) and the American Council of Governmental Industrial Hygienists (ACGIH).

Table 5.39
Occupational Criteria for Dust and Quartz

	TWA mg/m^3	Organisation
Quartz	0.1	ASCC
Quartz	0.05	ACGIH
Respirable dust	3.0 *	ACGIH
Inhalable dust	10.0 *	ASCC
Note *: This level requires that inspirable dust has no toxic substances; otherwise a lower or alternative standard applies		
Source: Modified after PAEHolmes (2009)		

The Time-Weighted Average (TWA) is the concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, for a working lifetime without adverse effect.

The more stringent of these criteria, ie. those of ACGIH, would be adopted as goals for the workforce working on the Project Site.

5.7.4.2 Gas Emissions

Goals Attributable to Greenhouse Gas Emissions

There are no specific guidelines are provided for maximum emissions of greenhouse gases.

Goals Applicable to Nitrogen Dioxide and Sulphur Dioxide

The primary source of sulphur dioxide (SO_2) from the Project would be as a result of the combustion of diesel fuel by the mobile equipment on the Project Site and product carrying trucks on the transport route. PAEHolmes (2009) notes that the sulphur content of Australian diesel is too low to cause SO_2 goals to be exceeded even in quarrying operations that use large quantities of diesel. For this reason, no detailed study is required to demonstrate that emissions of SO_2 from the quarry would not significantly affect ambient SO_2 concentrations. Similarly, NO_x and CO emissions are too small to require a detailed modelling assessment.

5.7.4.3 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
Respirable Crystalline:	An annual REL of 3µg/m^3 A lifetime exposure to respirable crystalline silica of 1 000µg/m^3
Dust:	Nuisance expected to impact on surrounding residences when incremental annual average dust deposition levels exceed 2g/m^2/month

5.7.5 Environmental Controls and Management

Rocla proposes to adopt the following safeguards and management procedures to limit the generation of dust from site activities.

1. The area of surface disturbance available for wind erosion would be limited by ensuring that clearing and soil stripping is limited to the area required for immediate sand removal activities and conducting progressive rehabilitation on available areas.
2. Minor roads and access tracks created for soil stripping, extraction operations and rehabilitation would be kept to a minimum and would be watered.
3. A 12 000 litre water truck would continue to be used to regularly wet the active internal unsealed roads. Based on experience, watering of the unsealed roads would occur at least five times per day with an application of at least $2L/m^2$ per application.
4. Topsoil stockpiles, acoustic bund walls and areas where landform preparation is complete would be seeded with either native or pasture species to assist in stabilising the exposed surface.
5. Mobile equipment used for ripping and loading of friable sandstone would have enclosed cabs to avoid the exposure of operators to generated dust.
6. A wheel-wash facility would continue to be operated within the Project Site to minimise the tracking of mud onto Peats Ridge Road which in turn could generate dust.
7. The raw feed material delivered to the wash plant and mortar sand plant would have a degree of inherent moisture that would contribute to the overall control of dust.
8. The drop heights between front-end loader buckets and trucks carrying sand, soil or overburden would be minimised through operator training and education on the management of dust.

The safeguards and management procedures would be reviewed as part of the Annual Environmental Management Report and any changes to the operation reflected in the review of dust management strategies adopted on site.

5.7.6 Assessment Methodology

5.7.6.1 Particulate Matter Emissions

PAEHolmes (2009) has assessed the potential particulate matter-related impacts of the Project, in accordance with the DECC published guidelines for the assessment of air pollution sources using dispersion models (DEC, 2005), using the US EPA ISCST3 computer model. The model incorporates mathematical algorithms to estimate dispersion of a plume of dust, taking into account the location of emission sources and volume of dust produced at each location, as well as the effects of wind and topography on the estimated dust plume. This model has been accepted by the NSW DECC for assessing the dispersion of dust in the atmosphere.

The modelling has been based on the use of three particle-size categories (0μm to 2.5μm – $PM_{2.5}$, 2.5μm to 10μm – PM_{10}, and 10μm to 30μm - PM_{10-30}). The distribution of particles has been derived from measurements published by the SPCC (SPCC, 1986) which is as follows.

- $PM_{2.5}$ is 4.7% of the TSP.
- $PM_{2.5-10}$ is 34.4% of TSP.
- PM_{10-30} is 60.9% of TSP.

The ISC model attempts to estimate the dispersion of a plume of dust using actual meteorological data, including wind speed and direction, each hour over the modelling period, and calculating the relevant dust concentration and deposition rate at specified locations. In the present case, the co-ordinates of 23 surrounding residences were entered into the model as point receptors (see **Figure 5.21**). The data for each residence was then averaged over each 24-hour period and for the entire year, with the maximum 24-hour values for PM_{10} and deposited dust representing the highest concentration or amount deposited at that location in any 24-hour period during the year. Although wind speed and wind direction data are collected on-site, no parameters are collected to enable derivation of stability class and mixing height. Therefore, a set of site-specific, synthetic meteorological data for the Project Site was created using The Air Pollution Model (TAPM) developed by CSIRO. The local wind speed and wind direction were used in TAPM as an observation file.

Particulate matter emitting activities were represented by a series of volume sources positioned according to the location of activities for four operating scenarios. The four scenarios, which were chosen as they represented the operating conditions likely to generate the highest concentration of particulate matter at residences surrounding the Project Site, are:

- Scenario 1 (Year 2): Extraction from Stage 3/2 and W1 of Stage 4/1;
- Scenario 2 (Year 5): Extraction from Stage 3/3 and Stage 4/3;
- Scenario 3 (Year 9): Extraction from Stage 3/5, Stage 3/6, and W4/S5 of Stage 4/5; and
- Scenario 4 (Year 22): Extraction from Stage 5/3

Figures 2.7 and **2.8** provide an illustration of the location of extraction, processing, overburden management, silt deposition and rehabilitation activities for each of the scenarios. *Figures 6 to 9* of PAEHolmes (2009) provide the location of the dust sources within the active stages of each scenario.

The quantity of dust generated by each activity has been established through reference to emission factors developed, both locally and by the US EPA. These emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. **Table 5.40** presents the estimated dust emissions for four stages of the Project considered likely to provide the "worst-case" dust emissions for surrounding residences.

The estimates presented in **Table 5.40** assume the implementation of the operational controls presented in Section 5.7.5.

Table 5.40
Estimated Dust Emissions from Four Worst-case Stages of the Proposed Activities

ACTIVITY	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Stripping topsoil	1 120	1 680	1 680	840
Excavation	557	796	796	446
Dumping to stockpiles	279	398	398	159
Loading to trucks for haulage to processor plants	557	796	796	446
Hauling to processing plants	35 400	38 000	77 000	61 600
Dumping to dry processing plant	114	201	168	94
Dumping to wet processing plant	428	755	629	352
Dry screening	2 231	3 944	3 288	1 838
Wet screening	-	-	-	-
Product stacking from conveyor	478	765	637	382
Loading product to road trucks	478	765	637	382
FEL working on stockpiles	2 467	2 467	2 467	2 467
Wind erosion from exposed areas (extraction and overburden areas)	26 981	32 237	32 237	6 400
Wind erosion from product stockpiles	3 504	7 008	3 504	35 741
Transporting product off-site by road	4 250	16 133	5 333	3 504
Total	**78 844**	**105 944**	**129 570**	**114 651**

5.7.6.2 Crystalline Silica

In order to compare the predicted concentrations of crystalline silica in the ambient air due to the Project with the relevant assessment criteria, it was necessary to determine the crystalline silica content of the dust emissions from the Calga Sand Quarry operations. Samples of dust were taken in April 2008 to determine the crystalline silica content of dust resultant from:

- the ripping of the harder sandstone towards the base of the extractable resource (which is likely to produce dust emissions with the highest percentage of crystalline silica in the relevant size range); and
- activities that do not involve ripping.

The average crystalline silica content of the PM_{10} dust sampled from the sandstone ripping activities was 90% with this reducing to 6% for the activities where ripping of sandstone was not required. Therefore, while this would significantly overestimate the emission of crystalline silica because not all excavation involves ripping which is the process that generates the respirable crystalline material, for the purpose of this assessment it has been assumed that 90% of PM_{10} emissions from sand extraction is crystalline silica and that 6% of PM_{10} emissions from the remainder of the dust generating activities is crystalline silica.

Using these proportional concentrations of crystalline silica in the particulate matter emissions of the Project, and the estimated dust emissions for each of the four scenarios presented in **Table 5.40**, an estimate of the average crystalline silica in the particulate matter emissions of the Project has been calculated.

5.7.6.3 Greenhouse Gas Emissions

The primary source of greenhouse gas emissions from the Project would be from the combustion of fuel by diesel-powered equipment and vehicles on the Project Site and product trucks distributing the quarry products. The use of purchased electricity on the Project Site would also be a minor source of greenhouse gas emissions. In order to assess greenhouse gas emissions, the various greenhouse gas emitting activities were identified and through the use of established emission factors (AGO, 2005), annual CO_2-equivalent emissions were calculated.

Greenhouse gas emitting sources are classified according to accepted greenhouse gas protocol 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 an organisation's 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 Project Site to markets.

5.7.7 Assessment of Residual Impacts

5.7.7.1 Particulate Matter and Deposited Dust Impacts

Table 5.41 summarises the predicted particulate matter and deposited dust concentrations at each of the residential receptors attributable to the Project for the four scenarios modelled. The following compares the maximum incremental contribution for PM_{10}, TSP and deposited dust and assesses each against the Project goals identified in Section 5.7.4.3.

Annual Average PM_{10}

The most potentially affected non-project related residence (Residence 13) is predicted to experience annual average PM_{10} concentrations of 2.9μg/m^3 due to the operations during Scenario 4. Assuming that the existing annual average PM_{10} concentration for the area is 15μg/m^3 (see Section 5.7.2.7) the maximum resultant annual average PM_{10} concentration is 17.9μg/m^3. This is below the NSW DECC goal of 30μg/m^3.

Annual Average TSP

The maximum predicted concentration at the non-project related residences is 4μg/m^3 (Residence 13, Scenario 4). Assuming that the existing annual average TSP concentration for the area is between 20 and 30μg/m^3 (see Section 5.7.2.7), the 90μg/m^3 NHMRC goal would not be exceeded as a result of Project operations.

Table 5.41
Summary of Dispersion Model Predictions due to Project

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
Averaging period	**24-hour**	**Annual**	**Annual**	**Annual**
Air quality goal	*50*	*30*	*90*	*4*
Residence ID	**Scenario 1 (Year 2): Stage 3/2 and Stage 4/1**			
2	4	0	1	0.2
3	4	0	1	0.1
4	3	0	1	0.1
5	3	0	1	0.1
6	3	0	0	0.1
7	2	0	0	0.1
8	3	1	1	0.1
9	3	1	1	0.1
10	3	0	1	0.1
11	3	0	0	0.1
12	2	0	0	0.0
13	3	0	0	0.1
14	3	0	0	0.1
15	2	0	0	0.0
16	2	0	0	0.0
17	2	0	0	0.0
18	3	0	0	0.0
19	3	0	0	0.0
20	3	1	1	0.1
21	3	0	1	0.1
22	3	0	0	0.1
23	2	0	0	0.0
	Scenario 2 (Year 5): Stage 3/3 and Stage 4/3			
2	7	1	1	0.2
3	6	1	1	0.2
4	5	0	1	0.1
5	6	0	1	0.1
6	4	0	1	0.1
7	3	0	0	0.1
8	9	1	2	0.4
9	9	1	2	0.5
10	5	0	1	0.1
11	5	0	1	0.1
12	3	0	0	0.0
13	5	0	1	0.1
14	6	0	1	0.1
15	5	0	1	0.1
16	3	0	0	0.0
17	4	0	0	0.0
18	5	0	0	0.1
19	5	0	0	0.1
20	10	1	2	0.4
21	8	1	2	0.3
22	6	1	1	0.2
23	4	0	1	0.1

Table 5.41 (cont'd)
Summary of Dispersion Model Predictions due to Project

	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust deposition (g/m^2/month)
Averaging period	**24-hour**	**Annual**	**Annual**	**Annual**
Air quality goal	*50*	*30*	*90*	*4*
Residence ID	**Scenario 3 (Year 9): Stage 3/5, 3/6 & Stage 4/5**			
2	9	1	2	0.3
3	7	1	1	0.2
4	6	1	1	0.2
5	8	1	1	0.2
6	5	0	1	0.1
7	4	0	1	0.1
8	9	2	3	0.5
9	10	2	3	0.6
10	6	1	1	0.2
11	8	1	1	0.1
12	4	0	0	0.1
13	9	1	1	0.2
14	8	1	1	0.2
15	7	1	1	0.2
16	5	0	0	0.1
17	6	0	0	0.0
18	7	0	1	0.1
19	7	1	1	0.1
20	9	2	3	0.5
21	8	1	2	0.4
22	6	1	1	0.3
23	5	1	1	0.1
	Scenario 4 (Year 22): Stage 5/3			
2	9	1	1	0.2
3	10	1	1	0.1
4	6	1	1	0.1
5	9	1	1	0.1
6	6	0	1	0.1
7	5	0	1	0.1
8	15	2	3	0.5
9	17	3	4	0.7
10	8	1	1	0.1
11	8	0	1	0.1
12	5	0	0	0.0
13	22	2.9	4	0.7
14	15	2	3	0.5
15	11	1	2	0.3
16	5	0	0	0.0
17	5	0	0	0.0
18	6	0	0	0.0
19	7	0	1	0.1
20	17	3	4	0.7
21	15	2	3	0.5
22	13	2	2	0.3
23	10	1	1	0.1

Source: Modified after PAEHolmes (2009) – Tables 12 to 15

Dust Deposition

Dust deposition levels at the nearest residences are predicted to be less than 1.0g/m^2/month at all surrounding residences. Compliance with the NSW DECC goal of 4g/m^2/month would be anticipated with the existing dust deposition of 2g/m^2/month.

The minimal incremental increases in deposited dust (<1.0g/m^2/month) are considered extremely unlikely to have any influence on the growth of vegetation surrounding the Project Site, including native vegetation, pasture and nursery stock. An illustration of the tolerance of vegetation to dust accumulation is provided by Hunt (1999) who considered the accumulation of dust at a rate equivalent to 8g/m^2/day (at least 240 times the maximum predicted incremental increase to dust deposition predicted for residences surrounding the Project Site) on pasture palatability and production. Hunt (1999) concluded that the addition of the elevated rates of dust deposition had no effect on palatability or production.

Maximum 24hr Average PM_{10}

The predicted maximum 24-hour PM_{10} concentration at the most potentially affected non-project related residence (Residence 13) is 22µg/m^3 due to the operations during Scenario 4. This is below the NSW DECC goal of 50µg/m^3 for maximum 24-hour average PM_{10} concentrations. The impact of the Project on cumulative 24-hour PM_{10} concentrations, requires consideration of the background data collected at the DECC Richmond site, which has been assumed to be equivalent to the background at the Project Site.

The approach taken by PAEHolmes (2009) to assess the cumulative impact of the Project on 24-hour concentration of PM_{10} was to calculate for each of the scenarios modelled, the probability that a given background concentration might occur with the maximum predicted 24-hour average concentration at the worst-affected residential receptor and subsequently cause an exceedance of the 50µg/m^3 criterion.

For each scenario, PAEHolmes (2009) calculated the probability of each Project-related 24-hour PM_{10} increment occurring on the same day as a background 24-hour PM_{10} concentration greater than 50µg/m^3 minus the Project-related increment. By adding together all the individual probabilities (of exceeding the criterion), PAEHolmes (2009) was able to predict the probability that the cumulative 24-hour average concentration would exceed the 50µg/m^3 criterion.

Assuming that the background concentration remains the same as it was during the year the data was collected, PAEHolmes (2009) has the calculated the probability of a daily exceedance of the 24-hour PM_{10} concentration as follows.

- Scenario 1: The probability of a 24-hour average PM_{10} concentration exceeding 50µg/m^3 would be a 0.82%. Considering there is already 0.54% (2/365) chance that on any given day a 24-hour PM_{10} concentration above 50 µg/m^3 would be experienced, even without the contribution of the Project, so the increase in probability of an exceedance due to the quarry emissions is 0.27%. This is equivalent to approximately 1 extra day per year exceeding the criterion at the most affected residential receptor.

- Scenario 2: The probability of a 24-hour average PM_{10} concentration exceeding 50µg/m^3 would be a 0.83%. Therefore, the increase in probability of an exceedance due to the quarry emissions is 0.28%. This is equivalent to 1.05 extra days per year exceeding the criterion at the most affected residential receptor.
- Scenario 3: The probability of a 24-hour average PM_{10} concentration exceeding 50µg/m^3 would be a 0.85%. Therefore, the increase in probability of an exceedance due to the quarry emissions is 0.30%. This is equivalent to 1.1 extra days per year exceeding the criterion at the most affected residential receptor.
- Scenario 4. The probability of a 24-hour average PM_{10} concentration exceeding 50µg/m^3 would be a 0.86%. Therefore, the increase in probability of an exceedance due to the quarry emissions is 0.31%. This is equivalent to 1.1 extra days per year exceeding the criterion at the most affected residential receptor.

In each case, the predicted increase in the number of daily exceedances of the 24-hour average criterion is assessed to be insignificant. It should also be noted that in all cases where an exceedance of the 24-hour average criterion was predicted to be exceeded, the primary contribution was from the background, with the Project-related increment contributing at most 20% of the total concentration.

5.7.7.2 Crystalline Silica

Estimated Average Crystalline Silica Concentration

Using the PM_{10}/TSP ratio is 0.391 ($PM_{2.5}$ = 4.7% and $PM_{2.5-10}$ = 34.4% - see Section 5.7.6.1), **Table 5.42** presents the estimated PM_{10} emissions for each of the four scenarios, Based on data published by the SPCC (SPCC, 1986), the PM_{10}/TSP ratio is 0.391 ($PM_{2.5}$ = 4.7% and $PM_{2.5-10}$ = 34.4%).

Table 5.42
Predicted PM_{10} Emissions

Source	PM_{10} Emissions (kg/yr)			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Excavation/Ripping	9246	9246	9246	4623
All other sources	13730	33253	48528	56085
Total	22976	42499	57774	60708
Source: Modified after PAEHolmes (2009) – Table 16				

Based on the estimated PM_{10} emissions, the estimated average crystalline silica in the dust for each scenario is estimated using the following formula.

$$\text{Average crystalline silica in } PM_{10} \text{ emissions} = \frac{(PM_{10\ \text{excavation}} \times 0.9) + (PM_{10\ \text{all other activities}} \times 0.06)}{\text{Total } PM_{10} \text{ emissions}}$$

$$= 0.24 \mu g/m^3$$

Assessment against REL Criterion

At the most potentially affected residence, the predicted annual average PM_{10} concentration was 2.9µg/m^3. Therefore, based on a PM_4/PM_{10} ratio of 0.3 (SPCC, 1986), the estimated annual average respirable (PM_4) concentration of crystalline silica at this most potentially affected residence is 0.21µg/m^3 (2.9 x 0.3 x 0.24). This is approximately **14 times lower** than the adopted REL criterion of 3µg/m^3.

Assessment against US EPA Silicosis Potency Estimates

Based on a background respirable crystalline silica concentration of 0.7µg/m^3 and maximum annual contribution from the Project (at the most potentially affected residence) of 0.21µg/m^3, the total annual respirable crystalline silica (at the most potentially affected residence) would be 0.91µg/m^3.

Assuming a Project life of 30 years, the respirable crystalline silica exposure during the operation of the quarry is 0.91µg/m^3 x 30 years = 27.3µg/m^3.years. Then assuming an individual were to live for the remaining 40 years of their assumed 70 year lifetime in the same area (and therefore exposed to the same background respirable crystalline silica concentration), the exposure to respirable crystalline silica would be 0.7µg/m^3 x 40 years = 28.0µg/m^3.years. The total lifetime exposure would therefore be 27.3µg/m^3.years + 28.0µg/m^3.years = 55.3µg/m^3.years.

As discussed in Section 5.7.4.1, the US EPA concluded that the cumulative risk of developing silicosis is zero for cumulative exposures of less than 1000µg/m^3.years. The estimated total lifetime cumulative exposure for the proposed Project is approximately **18 times lower** than this.

5.7.7.3 Greenhouse Gas Emissions

Considering anticipated activity levels on the Project Site and product delivery routes, and the emission factors of AGO (2005), the greenhouse emissions of the proposal have been estimated.

Scope 1 and 2 Emissions

Fuel consumption rates of the mobile equipment of the Calga Sand Quarry are collected by Rocla and are as follows.

- 330 excavator (23L/hr) (2 to be used at maximum production);
- front-end loader (16L/hr) (4 to be used at maximum production);
- 375 dozer (66L/hr) (2 to be used at maximum production);
- 4 50t haul trucks (20L/hr) (4 to be used at maximum production); and
- 2 water carts (5L/hr) (2 to be used at maximum production).

Diesel is also used to power water transfer pumps on the Project Site, however, this represents a minor component of fuel consumption and is likely to be discontinued once the processing plant(s) are constructed in their long-term locations (when these pumps would be powered electrically). It has been assumed that the excavators, dozers, front-end loaders and haul trucks operate for 14 hours per day Monday to Friday and 10 hours per day on Saturday. The water carts are assumed to operate for an average of 6 hours per day, Monday to Saturday (although usage rates would vary significantly depending on meteorological conditions).

Based on the assumed diesel consumption and usage rates, it is estimated that at maximum production, the mobile equipment would use approximately 1 296kL of diesel fuel annually.

Electricity is currently, and would continue to be purchased to power the administration area and processing plant(s). Current monthly energy consumption approximates 26 000kWh. It has been assumed that the installation of a second wash plant, and increase in production rate up to 1 000 000tpa, would increase this consumption rate by a factor of 2.5. This would result in an annual energy consumption (at maximum production) of approximately 780MW/year.

Scope 3 Emissions

Indirect emissions of greenhouse gases from the transportation of quarry products to various customers has been estimated as follows.

- Road transportation between the Project Site and:
  - Sydney (80% - 53 660 return trips per year) with an average return distance of 170km[17]; and
  - the Central Coast (20% - 13 420 return trips per year) with an average return distance of 50km[18].

  Based on a fuel consumption rate of 0.5L per kilometre travelled, it is anticipated up to 4 900kL of diesel would be consumed.
- Private vehicle transportation by quarry employees and visitors between the Project Site and:
  - Sydney (50% - 9 360 return trips per year), with an average return distance of 170km; and
  - the Central Coast (50% - 9 360 return trips per year) with an average return distance of 50km.

  Based on a fuel consumption rate of 0.1L per kilometre travelled, it is anticipated up to 205kL of petrol would be consumed annually.

At maximum sale and despatch, annual off-site project-related fuel usage would approximate 5 105kL.

Table 5.43 presents the calculated greenhouse gas emissions (as CO_2 equivalents) for the Scope 1, 2 and Scope 3 sources.

[17] To provide an average distance, trip calculated to Parramatta.
[18] To provide an average distance, trip calculated to Ourimbah.

Table 5.43
Predicted Greenhouse Gas Emissions

Emission Source		Annual Use	Emission Factor	Emissions (t CO_2-e)
Scope 1 and 2 Emissions				
Diesel Fuel Consumption	Mobile Equipment	1 296kL	2.7 [1]	3 499.2
Electricity Consumption	Site Facilities and Processing Plant	780MW	0.835 [2]	651.3
Scope 3 Emissions				
Diesel Fuel Consumption	Product Transportation	4 900kL	0.3 [1]	1 470
	Employee Transport	205kL	0.3 [1]	61.5
Total Emissions				**5 682**

Note 1: Table 3 of the AGO document *Factors and Methods Workbook, December 2005.*
Note 2: Table 12 of the AGO document *Factors and Methods Workbook, December 2005.*

A comparison of the predicted maximum emissions from the Project with Australian 1990 Estimates are presented in **Table 5.44**. This demonstrates that annual average emissions would represent an increase of less than 0.001% on the 2005 Australian emissions (AGEIS, 2005).

Table 5.44
Comparison of Project Emissions of Greenhouse Gases with Australian 1990 Estimates

Emissions Estimation Period	Scope 1 & 2 Emissions CO_2-equivalent (%-age Comparison with Australian 2005 emissions[1])	Scope 3 Emissions CO_2-equivalent (%-age Comparison with Australian 2005 emissions[1])	Total Project Emissions CO_2-e (%-age Comparison with Australian 2005 emissions[1])
Annual Average	4150.5t (<0.001%)	1 531.5t (<0.001%)	5 682t (<0.001%)

Note 1: AGEIS (2005)

5.7.8 Monitoring

Rocla currently undertakes deposited dust monitoring in accordance with an Air Quality Monitoring Program approved by the Director-General of the Department of Planning in December 2005. The monitoring locations are identified on **Figure 5.20** and notably are located to the north, east and southeast of the Project Site, ie. where the closest residential receivers to the Project Site are located.

Rocla proposes to continue this program of monthly deposited dust monitoring. The results of all monitoring would be included in each Annual Environmental Report for the extended quarry with the frequency and locations of deposited dust monitoring to be reviewed as part of each Annual Environmental Report to ensure only meaningful data is being collected.

5.8 TRAFFIC

5.8.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential environmental impacts related to traffic and transport requiring assessment and their **unmitigated** risk rating are as follows.

- Increased traffic congestion (moderate risk).
- Road pavement deterioration (moderate risk).
- Elevated risk of accident/incident on local roads (high risk).

In addition, the Director-General's Requirements issued by the 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 "*… details of traffic volumes generated by the Project, and an assessment of the capacity and safety of the proposed transport route*" and that it is prepared with reference to the Guide to Traffic Generating Development and Road Design Guide (Roads & Traffic Authority), or relevant Austroads standards.

The following sections provide a summary of a Traffic Assessment completed for the Project by Transport and Urban Planning (TUP, 2008) and consider existing traffic levels and road conditions, the proposed changes to traffic levels resultant from the Project and the likely impact on the road network, road users and land uses. A full copy of TUP (2008) is provided as Part 7 of the *Specialist Consultant Studies Compendium* accompanying the *Environmental Assessment*.

5.8.2 Existing Road Network and Traffic Levels

5.8.2.1 Principal Road Network

The principal road network adjacent to, and/or providing access to, Calga Sand Quarry (see **Figure 5.22**) includes:

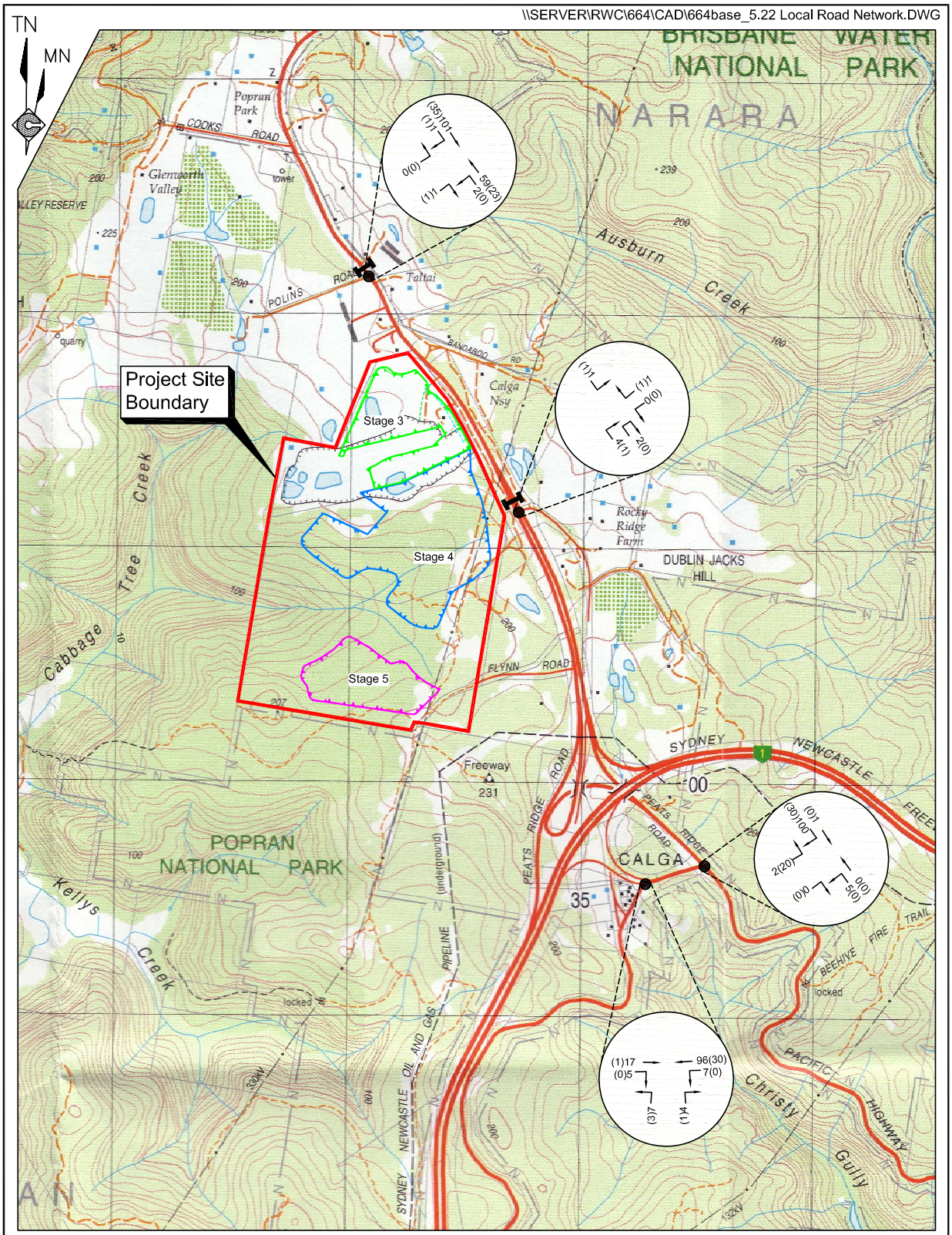
- Peats Ridge Road;
- The Calga Interchange; and
- F3 Freeway.

With the exception of occasional local deliveries of quarry products to local customers to the northwards of Calga Sand Quarry (northwest on Peats Ridge Road), all traffic movements from the Project Site are, and would continue to be south on Peats Ridge Road to the Calga Interchange and to the north and south via the F3 Freeway. The following text provides a brief description of these roads.

Peats Ridge Road

Peats Ridge Road is a major north-south road which links between the F3 Freeway and the Pacific Highway at Calga and Wisemans Ferry Road and George Downes Drive at Central Mangrove. Adjacent to the Project Site, Peats Ridge Road merges from a 4 lane divided road at the Calga Interchange of the F3 Freeway into a 2 to 3 lane rural road which provides overtaking opportunities for each direction of travel. Prior to the operation of the F3 Freeway, the bulk of traffic travelling between Sydney and Newcastle travelled on the section of Peats Ridge Road past the site of the Calga Sand Quarry. Hence, the road was carrying substantially more light traffic and heavy vehicles than at present or forecast throughout the life of the Calga Quarry.

Traffic management on Peats Ridge Road incorporates significant sealed shoulders, centre line, lane lines and edge line road markings, guide posts/reflectors (in the 2 to 3 lane sections), RPMs and advisory warning signs. Peats Ridge Road has a flat (level) grade adjacent to the Project Site.



Source: Transport and Urban Planning (2008) - Figure 5

Figure 5.22
LOCAL ROAD NETWORK

There are several minor T-intersections with Peats Ridge Road in the vicinity of the Project Site, including Jones Road, Bandaroo Road and Darkinjung Road providing access to a number of local properties.

Calga Interchange

Calga Interchange provides access to the F3 Freeway from Peats Ridge Road for northbound traffic towards Gosford and Newcastle or southbound traffic towards Sydney.

Exit and entry to/from the northbound carriageway of the F3, to/from Peats Ridge Road is via direct ramp connections. The southbound on-ramp for vehicles travelling from the Calga Sand Quarry towards Sydney is located on the eastern side of the F3 Freeway and requires vehicles to travel beneath the F3 Freeway, through two intersections on Peats Ridge Road and the Pacific Highway, and skirt past the edge of the Calga village to join the F3.

The speed limit at the Calga Interchange is 60km/h and 80km/h.

F3 Freeway

The F3 Freeway is a multi-lane divided freeway which travels between the Sydney suburb of Wahroonga and the Newcastle District. Two to three traffic lanes are provided for each direction of travel, although the RTA is currently widening the F3 to provide three lanes in each direction (six lanes total) between Calga and Wahroonga. The speed limit on the F3 is 90km/h to 110km/h.

5.8.2.2 Principal Intersections

The principal intersections of the transport route between the Project Site and the F3 Freeway are as follows.

- Peats Ridge Road/Calga Sand Quarry Access Road.
- Peats Ridge Road/Pacific Highway.
- Pacific Highway/F3 Freeway southbound carriageway on/off ramps.

The following provides a brief description of each.

Peats Ridge Road/Calga Sand Quarry Access Road

The Calga Sand Quarry Access Road forms a T junction intersection with Peats Ridge Road and provides:

- a Seagull channelisation for the right movements into and out of the Calga Sand Quarry providing a protected right turn bay, 150m long for the right turn in and a full acceleration lane for the right turn out; and
- two through lanes northbound in Peats Ridge Road plus a left turn deceleration lane, 150m long for the left turn into the Calga Sand Quarry Access Road.

The speed limit at the intersection is 100km/h and the available sight distance to the south of the Calga Sand Quarry Access Road is at least 250m in both directions.

Give Way control is provided on the Calga Sand Quarry Access Road and advance truck warning signs are provided in Peats Ridge Road.

Peats Ridge Road/Pacific Highway (East of F3 Freeway)

This intersection is a T junction intersection with a Seagull channelisation for the right turn movements.

Two lanes are provided on all approaches at the intersection with dedicated lanes for all turning movements. The available sight distance exceeds 160m and is considered satisfactory for the operating vehicle speeds and the posted speed limit (60km/h).

Pacific Highway/F3 Southbound Carriageway On/Off Ramps

This intersection is a T junction intersection with a seagull channelisation for the right turns to and from the Pacific Highway. Two lanes are provided in all approaches with dedicated turning lanes.

The speed limit is 60km/h and the available sight distance at the intersection exceeds 200m to and from the east, and 150m to and from the west is considered satisfactory for the operating vehicle speeds and the posted speed limit.

The southbound on-ramp is a single lane that enters an acceleration lane onto the F3 Freeway.

5.8.2.3 Traffic Volumes on Road Network

TUP (2008) compiled information on the traffic volumes of the principal road network in and around the Calga Sand Quarry from published RTA traffic volumes on the F3 Freeway and traffic counts on Peats Ridge Road and the Calga Sand Quarry Access Road undertaken between 7 and 13 December 2006. Peak hour traffic volumes were also collected at the principal intersections on the road network that adjoins the Project Site. **Figure 5.22** shows the traffic count locations.

Calga Sand Quarry Access Road

Two way weekday volumes using the Calga Sand Quarry Access Road for the period 7 to 13 December 2006 ranged between 49vpd and 78vpd (average of 60vpd). Average number of heavy vehicles (Austroad Classes 3 to 12) was 46vpd. The highest number of heavy vehicles on any weekday was 50vpd.

Peats Ridge Road

The results of the 2006 traffic counts on Peats Ridge Road south of the Calga Sand Quarry Access Road are presented in **Table 5.45**.

Table 5.45
Peats Ridge Road (South of Calga Sand Quarry) Traffic Volumes and Vehicle Classification

Direction of Travel	Weekday					
	5 Day Average			7 Day Average (AADT)		
	Light[1]	Heavy[2]	Total	Light[1]	Heavy[2]	Total
North	829	373	1202	919	291	1210
South	765	441	1206	864	358	1222
Total	1594	814	2408	1783	649	2432
Proportion of Total	66.2%	33.8%	100%	73.3%	26.7%	100%
Note 1: Light vehicles - Austroads 1 & 2 vehicle classifications & Motorbikes Note 2: Heavy vehicles - Austroads 3 to 12 vehicle classifications						
Source: Traffic Counts 7 to 13 December 2006						

Peats Ridge Road, south of the Calga Sand Quarry carries two way traffic volumes of 2 408 vehicles (vpd) with heavy vehicles representing 33.8% of total traffic on this section of Peats Ridge Road on an average weekday. TUP (2008) notes that during the traffic count period, heavy vehicles from the Calga Sand Quarry accounted for, on average, 5.7% of the heavy vehicle traffic. It is recognised the remaining heavy vehicles that travel on this section of Peats Ridge Road originate or travel on this section of Peats Ridge Road to other quarries on the Somersby Plateau and a range of agricultural enterprises, particularly poultry enterprises.

A review of hourly traffic volumes by TUP (2008) identified the morning and afternoon peak hours as occurring between 9:00am and 10:00am, and 4:00pm and 5:00pm. At these times, Peats Ridge Road, south of the Calga Sand Quarry Access Road carries:

- two way traffic volumes of 168 vehicles per hour (vph) with 83vph northbound and 85vph southbound between 9:00am and 10:00am; and
- two way traffic volumes of 162vph with 91vph northbound and 71vph southbound between 4:00pm to 5:00pm.

TUP (2008) also collected daily and hourly traffic volumes north of the Project Site, and based on these data, conclude that the traffic volumes using Peats Ridge Road in the vicinity of the Project Site are relatively low and traffic conditions are considered to be good with free flowing traffic in both directions of travel. Overall, the traffic conditions on the road network adjacent the Project Site are representative of Level of Service A operation.

F3 Freeway

The RTA's Publication Traffic Volume Data for Hunter and Northern Regions 2004 identifies the Average Annual Daily Traffic (AADT) volume on the F3 Freeway at Mooney Mooney (north of the Hawkesbury River Bridge) as 73 401 vehicle equivalents (two way).

TUP (2008) also notes that 24 hour traffic counts completed by the RTA in August 2006 indicate that the section of the F3 north of the Hawkesbury River Bridge experiences high traffic volumes.

- 3 500 to 4 100 vehicle equivalents per hour (veph) in the southbound direction during the morning peak hours of 6:00am to 8:00am.
- 3 500veph to 3 900veph in the northbound direction between 4:00pm and 6:00pm.

TUP (2008) suggests that based on these traffic volumes, the 2 lane sections of the F3 between Calga and Wahroonga would operate close to capacity during these periods. It is noted upgrading of the F3 to 3 lanes north and south between Berowra and Wahroonga (early 2010) will improve the capacity of the F3 Freeway for vehicles travelling to and from Sydney from the Central Coast. The traffic volume decreases to the north at the Reeves Road Overpass (Somersby) to between 2100veph and 2600veph (TUP, 2008).

5.8.2.4 Intersection Operating Conditions

Based on peak hour traffic volumes at the three intersections of the transport route, TUP (2008) conclude that traffic conditions at all three intersections are good with minimal delays to the minor movements. Traffic conditions are representative of a Level of Service A operation.

5.8.2.5 Road Safety

According to RTA road crash statistics, during the 5 year period from 1 January 2001 to 31 December 2005, there was a total 16 accidents of which one was a fatal accident and five were injury accidents. Of the 16 accidents, 10 were single vehicle run off the road type accidents, one of which involved an articulated truck. The fatal accident was a single vehicle run off the road accident involving a car. There were no accidents at the Peats Ridge Road/Calga Sand Quarry Access Road intersection during the 5 year period.

During the same 5 year period, the RTA recorded five intersection accidents spread between the Pacific Highway/Peats Ridge Road intersection and the Pacific Highway/F3 Southbound Carriageway On/Off Ramps intersection.

There is no treatable pattern to the intersection accidents and or a single treatable location where the run off the road accidents occurred.

5.8.3 Project-related Roadworks and Traffic

5.8.3.1 Project-related Roadworks

As noted in Section 2.7.2, access to the Calga Sand Quarry from Peats Ridge Road would vary throughout the life of the Project to accommodate:

- the changing layout of the Project Site;
- the increased production level, and therefore increased volume of traffic; and
- the recommendations of the NSW Roads and Traffic Authority (RTA) for traffic generating developments of this scale.

Sections 2.7.2.2 to 2.7.2.4 and **Figure 2.12** provided the design features of the Northern and Southern Entrances during the proposed three phases of traffic management.

These works would potentially impact on short term traffic flow conditions because of the proposed extent and physical nature the roadworks, however, all construction activities would be undertaken with a Section 138 Permit issued by Gosford City Council under the *Roads Act 1993*.

5.8.3.2 Project-related Traffic

Section 2.7 presented the proposed traffic types and volumes to be generated by the Project. Product transportation would operate approximately 312 days per year, ie. Monday to Saturday, 52 weeks a year. As presented in Section 2.7.5, as production and sales reach 1 000 000tpa, the Project would generate:

- 240 truck movements per day, ie. on an average weekday (120 trucks in and 120 trucks out);
- 90 truck movements on an average Saturday (ie. 45 trucks in and 45 trucks out).

Based on the proposed transport schedule (of **Table 2.6**), which reflects both Rocla's preference to avoid, where practicable, the morning peak period on the F3 Freeway and other Sydney roads as well as 2.5 to 3 hour return trip time for trucks between the Quarry and Sydney markets, **Table 5.46** presents the increase in average truck movements attributable to the Project in 2 hour intervals on a weekday and Saturdays.

Table 5.46
Average Increase in Product Truck Movements Due to the Project

Time Period	Increase in Product Trucks from Current Approval			
	Proposed (Stage 3, 4 & 5) - 600 000tpa		Proposed (Stage 3, 4 & 5) - 1 000 000tpa	
	Monday to Friday	Saturday	Monday to Friday	Saturday
5:00 am to 7:00 am	+7	+4	+21	+12
7:00 am to 9:00 am	+9	+5	+27	+15
9:00 am to 11:00 am	+9	+3	+27	+9
11:00 am to 1:00 pm	+9	+2	+27	+6
1:00 pm to 3:00 pm	+6	+1	+18	+3
3:00 pm to 6:00 pm	+2	+1	+10	+3
6:00 pm to 8:00 pm	+0	+3	+6	+5
8:00 pm to 10:00 pm	+2	+3	+4	+5
Total*	**+44**	**+22**	**+140**	**+58**

Source: TUP (2008) – Table 5.2 Note*: Average load of sand = 29t

The maximum hourly volumes on an average weekday would be higher than on a Saturday and would be in the order of 22 to 23 truck movements per hour (an increase in 13 to 14 truck movements per hour on the maximum average[19] traffic level associated the approved Calga Sand Quarry). Allowing for some bunching of product truck movements and/or higher day sales, the maximum hourly product truck volume is estimated to be 28 to 30 truck movements in a busy one hour period (an increase in 19 to 20 truck movements per hour on the maximum[7] traffic level associated the approved Calga Sand Quarry).

In addition to the product trucks, employee and visitor trips would increase from the existing 20 light vehicle movements up to an estimated 60 light vehicle movements per day on a weekday when sales reach 1 000 000tpa.

It is noted that the traffic assessment has been based on traffic levels at the maximum production level, however, as discussed in Section 2.10.2, production levels approaching 1 million tpa would only occur periodically and that the average production level throughout the life of the quarry would be approximately 550 000tpa.

[19] Assumes a production level of 400 000tpa is achieved.

5.8.4 Environmental Controls and Management

5.8.4.1 Design Features

Site Entrances

The proposed design of the Northern and Southern Entrances, during the three phases of traffic management are presented on **Figure 2.12**. The proposed intersection treatments are based on the recommendations of TUP (2008), and the requirements of the *Road Design Guide* (RTA, 1999) and "*Part 5: Intersections at Grade*" of the Austroads Guide to Traffic Engineering Practice series (Austroads, 2005).

Notably, the location of the Southern Entrance opposite the intersection of Peats Ridge Road with Jones Road on the eastern side of Peats Ridge Road was not possible due to land ownership constraints at that point (the access road from the intersection from that point would have had to cross privately owned land). The currently proposed location of the Southern Entrance was subsequently chosen to provide a suitable offset from Peats Ridge Road - Jones Road the intersection. It is noted that the approximate location of the Southern Entrance was nominated in the sale contract for the land, when purchased by Rocla from the RTA.

Internal Access Routes for Product Trucks

The internal access roads for product trucks would be aligned and operated as identified in Sections 2.7.2.2.2, 2.7.2.3.2 and 2.7.2.4.2 (for Traffic Phases 1, 2 and 3 respectively) and incorporate the following features.

- Horizontal alignment complying with the maximum grades and changes of grade outlined in the Australian Standards for Off-Street Commercial Vehicle Facilities. Maximum vertical grades would be approximately 10%.
- The site access road would be sealed from a wheel wash facility to Peats Ridge Road to reduce the tracking of mud onto the local road network.
- The road layout would ensure that all vehicles could enter and exit the site in a forward direction.

In addition, the on-site maximum truck speed would be signposted and restricted to 30km/h.

5.8.4.2 Operational Controls

The operational controls to be employed as part of the Project would be a continuation of those currently in place at the Calga Sand Quarry. These controls include:

- all exiting product carrying trucks would be required to pass over the site weighbridge, thereby preventing the exit of any overweight vehicles onto Peats Ridge Road, ie. all vehicle would have a Gross Vehicle Mass of less than 50t or a level approach by the RTA;

- all vehicles exiting the Project Site are required to pass through a wheel-wash facility to remove dust-generating material from the vehicles as well as reduce the risk of noxious weeds exiting the site;
- additional dust minimisation safeguards including the requirement for all product carrying trucks to have substantive dust covers over each trailer;
- speed limits would be enforced within the Project Site;
- all drivers would be required to adhere to Rocla's Driver's Code of Conduct which identifies the required safety requirements whilst on site and the required environmental controls and driving practices when travelling to and from the quarry;
- specific reference would be made to vehicle operation and driving practices in the vicinity of Calga Village, ie. adjacent to the southbound on-ramp to the F3 Freeway; and
- any complaints received would be immediately investigated and substantiated incidents acted on decisively, which could include the banning the offending driver(s) from the Project Site.

In addition, Rocla would manage any construction-related traffic in accordance with the relevant Australian Standards, including a short term reduction in the speed limit approaching and adjacent to road construction works, if required. All safety procedures to be adopted during road/intersection construction works involving Peats Ridge Road would be incorporated in the Section 138 Permit sought under the *Roads Act 1993*.

The transport operations of the Calga Sand Quarry would be continued to be undertaken in an open and transparent fashion.

5.8.5 Assessment of Residual Impacts

5.8.5.1 Introduction

The Project would require the construction of a new intersection with Peats Ridge Road to allow for the entry (and eventually entry/exit) of traffic from the Calga Sand Quarry with traffic progressively increasing as production levels and sales of quarry products increase to 1 000 000tpa. The following subsections assume maximum traffic levels are achieved by 2012 and assess the impact of this proposed additional intersection with Peats Ridge Road on the local road network function and operation. This estimate of traffic increase represents the maximum attainable increase in production at the Calga Sand Quarry, and would result in an increase (above currently approved traffic levels) of:

- 140 product truck movements on an average weekday (70 return truckloads); and
- 40 light vehicle movements per day associated with employee and visitor trips.

Traffic volumes associated with the Project would be higher on weekdays and therefore the impacts associated with the Project have been assessed for weekdays.

As previously noted in Section 5.8.3.2, the traffic assessment has been undertaken for the Project operating at the 1 million tpa whereas, in reality, the average production throughout the life of the quarry is predicted to be approximately 550 000tpa. Hence, undertaking the traffic assessment of the highest annual production level is considered conservative.

5.8.5.2 Road Network and Traffic Levels

With the exception of a possible small increase in the number of employee/visitor related vehicle movements (2 to 4 movements per day), there would be no discernible increase in vehicle movements north of the Project Site.

To the south of the Project Site, an increase in average weekday vehicle movements of 178 (including 140 truck movements and 38 employee/visitor movements) is anticipated.

Peats Ridge Road

TUP (2008) have estimated, based on linear traffic growth of 2% per year between 2006 and 2012, the AADT of Peats Ridge Road to be 2 933 of which 35.4% would be heavy vehicles (assuming no change to the proportion of heavy vehicles on Peats Ridge Road). The proposed increase in traffic from the Project Site would increase the AADT of Peats Ridge Road to 3 111 (an increase of 6.1%), with an increase in the proportion of heavy vehicles to 37.9% (an increase of 2.5%).

The maximum hourly weekday traffic volumes in Peats Ridge Road south of the Project Site are expected to increase from 168vph in 2006 to around 218vph in 2012 (168 x 1.12 + 30). While this increase represents a 30% increase in maximum hourly (two-way) traffic, TUP (2008) consider this still represents a relatively low two way traffic volume for a divided two way rural road, especially considering the separate entrance and exit arrangement proposed by Rocla.

F3 Freeway

Assuming a 50:50 split of employee/visitor vehicle to the north and south on and off the F3 Freeway, the estimated increase of traffic from the Project Site on an average weekday would be as follows.

- 50 (30 heavy vehicles and 20 light vehicles) movements per day towards the Central Coast.
- 128 (110 heavy vehicle and 18 light vehicle) movements towards Sydney.

TUP (2008) calculate this increase as less than 1% (178/73 401) of the total existing volume of traffic using the F3 Freeway on an average weekday.

Vehicle movements from the Project Site would be concentrated in the morning and early afternoon to satisfy the requirements of Rocla's customers (see Section 2.7.5), potentially exacerbating traffic congestion during the morning peak hour period. Based on the proposed

transport schedule (see **Table 2.6**), the maximum hourly volume of product trucks using the F3 Freeway during the morning period from 5:00am to 9:00am, corresponding to the peak traffic period on the F3 Freeway (see Section 5.6.2.3) would be:

- six product truck movements to and from the Central Coast; and
- 24 product truck movements to and from Sydney.

TUP (2008) calculate this increase as less than 1% (24/3 500) of the total existing traffic volume travelling in the peak hour period to and from Sydney.

These proportions would reduce further with future traffic growth on the F3 Freeway.

5.8.5.3 Intersection Performance

In order to examine the impacts of the additional traffic from the Project on the performance of the principal intersections, TUP (2008) undertook computer modelling using the SIDRA software package of the following intersections.

- Peats Ridge Road/Calga Sand Quarry Access Road (for both Phase 2 and 3 transport operations – see Sections 2.7.2.3 and 2.7.2.4).
- Peats Ridge Road/Pacific Highway.
- Pacific Highway/F3 Freeway southbound carriageway on/off ramps.

The modelling has assumed the peak hour traffic period coincides with a maximum traffic generating hour of the Project (30 heavy vehicle movements).

All of the principal intersections are, and/or would be managed under sign control, with the criteria for assessing the performance of each intersection as follows.

- *Degree of Saturation (DoS)*: is defined as the ratio of demand flow to capacity. As it approaches 1.0, extensive delays can be expected. For a satisfactory situation, the DoS should be less than the nominated practical degree of saturation, usually 0.9.
- Average Vehicle Delay (AVD): is the difference between interrupted and uninterrupted travel times and is measured in seconds per vehicle.
- Maximum queue length (MQL): refers to the number of vehicles waiting at the stop line and is usually quoted as the 95th percentile length to the back of queue, which is the value below which 95% of all observed queue lengths fall.
- Level of Service (LoS): describes the operation of an intersection based on the highest average vehicle delay, degree of saturation, and maximum queue length and ranges from A (indicating good intersection operation) to F (indicating over saturated conditions with long delays and queues). **Table 5.47** presents the Level of Service Criteria for intersections as reproduced from the RTA's Guide to Traffic Generating Developments. The desirable design criteria for an intersection is a LoS of C or better.

Table 5.47
Level of Service Criteria for Intersections

Level of Service	Average Delay per Vehicle (s/vehicle)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents would cause excessive delays. Roundabouts require other control mode	At capacity, requires other control mode
Source: Table 4.1 RTA Guide to Traffic Generating Developments October 2002			

The results of the SIDRA modelling (presented in full in TUP, 2008) indicate that:

- the maximum DoS was 0.157 for traffic turning right from Peats Ridge Road onto the Pacific Highway, well below the nominated practical degree of saturation of 0.9.
- the maximum AVD was 13.4 seconds for southbound (right turning) traffic exiting the Northern Entrance (during Phase 2 transport operations).
- the MQL predicted was 10m for traffic turning right from Peats Ridge Road onto the Pacific Highway.
- all intersections would continue to operated with a LoS of A with low vehicle delays expected even at maximum production/transport levels.

Acknowledging safety concerns raised by the RTA over the concept of having an acceleration lane interacting with the proposed right turn lane into Jones Road, Rocla commissioned a road safety audit of the intersection treatment by Roadnet Pty Ltd (Roadnet, 2009). The audit was completed in accordance with the procedures nominated in the Austroads Road Safety Audit Guidelines (2nd eds.) and the RTA's Accident Reduction Guide, Part 2: Road Safety Audits 2005 and considered physical features and potential safety hazards of the proposed intersection treatment that may affect road user safety. Critical elements considered included:

- sight lines;
- length of turning bays;
- intersection layout;
- turning paths for large vehicles;
- relationship to nearby accesses and intersections;
- lighting; and
- provision for other road users, eg. bicycles.

The road safety audit of Roadnet (2009), which is provided in full as **Appendix 4**, concluded that "*the design is essentially sound and contains no serious safety issues.*"

5.8.5.4 Road Safety

While the Project would increase the number of heavy vehicles entering and using Peats Ridge Road, the Pacific Highway and the F3 Freeway, there is unlikely to be any detrimental impact on road safety given:

- there is no treatable pattern or single treatable location where recorded accidents occur on these roads;
- all of the roads to be used are engineered to current standards with the RTA currently improving the F3 Freeway to provide additional lanes and capacity between Gosford and Wahroonga;
- the proposed changes to Calga Sand Quarry vehicle access to and from Peats Ridge Road would be designed and constructed to RTA standards and without any serious safety issues (Roadnet, 2009); and

5.9 SOILS AND LAND CAPABILITY

5.9.1 Introduction

This section provides information on the existing soil landscapes, soil types and land capability of the Project Site, and operational safeguards proposed to manage the soil resources. The potential impacts of the Project on the soil resources is then assessed (assuming the implementation of the proposed safeguards).

The post-extraction land use is yet to be determined, however, it is suggested it would include:

- largely horticultural, agricultural or commercial/industrial activities within the free-draining landform of the Stage 3 and 4 extraction area (as discussed in the 2004 EIS for the then proposed northern extension of the Calga Sand Quarry); and
- native vegetation conservation within the Stage 5 extraction area.

The emphasis of this section is given to classifying soil types in the context of these land uses.

5.9.2 Local Setting

5.9.2.1 Soils of the Project Site

Murphy and Tille (1993) recorded four soil landscape units on the Project Site (see **Figure 5.23**). A description of these soil landscapes is as follows.

So (Somersby)

This soil landscape unit occurs on the gently undulating to rolling rises on deeply weathered Hawkesbury Sandstone plateau and covers the majority of the Stage 3 extraction area and the northern-most area of the Stage 4 extraction area. The soils are generally highly permeable (due to a high sand content), moderately erodible and display very low soil fertility.

St (Sydney Town)

Mapped as occurring on the undulating to rolling low hills and moderately inclined slopes on quartz sandstone along the edge of the Somersby Plateau and occurs along Creek A and C of the southern extension area of the Project Site. The soils are highly permeable, moderately to strongly acidic, display low soil fertility and pose a very high soil erosion hazard.

Ha (Hawkesbury)

Mapped as occurring on the rugged, rolling to very steep hills of the Hawkesbury Sandstone and occurs over the lower slopes in the western section of the Project Site, associated with narrow gullies where the sandstone outcrops. The soils are very shallow, stony, highly permeable, of low fertility and pose an extreme soil erosion hazard.

Of (Oxford Falls)

Mapped over the hanging valleys on predominantly Hawkesbury Sandstone and occurs as the predominant soil landscape over the southern extension area of the Project Site. The soils, which are highly permeable, erodible and of low fertility, occur among localised rock outcrops. The soils can be associated with perched water tables and swamps.

Geological investigations conducted by Rocla's consultant geologist L. Koncek in 2002, 2004 and 2006 suggest the soils of the Project Site generally reflect the underlying sandstone and is therefore very sandy and porous. These sandy soils are covered by a very shallow layer of humic soils, derived from woodland detritus over some of the southern extension area of the Project Site. The upper 0.15m to 0.3m generally contains moderate levels of organic matter, progressively decreasing with depth before grading into a slightly more clay dominant, cream-orange subsoil.

5.9.2.2 Land Capability of the Project Site

"Land capability" was defined by Houghton and Charman (1986) as "*the ability of land to accept a type and intensity of use permanently, or for specified periods under specific management, without permanent damage*". Land that is used beyond its capability ultimately loses its production value through exhaustion of soil nutrient levels or land degradation of some description.

Over the approved Stage 3 extraction area, the NSW Agriculture agricultural land classification atlas classifies the land as Class 3 agricultural land. Class 3 land is suitable as grazing land or for pasture improvement, cultivation or cropping in rotation with pasture. This classification complements the previous and existing land uses of the surrounding area which includes a horse-riding facility, orchards, grazing and other agricultural activities.

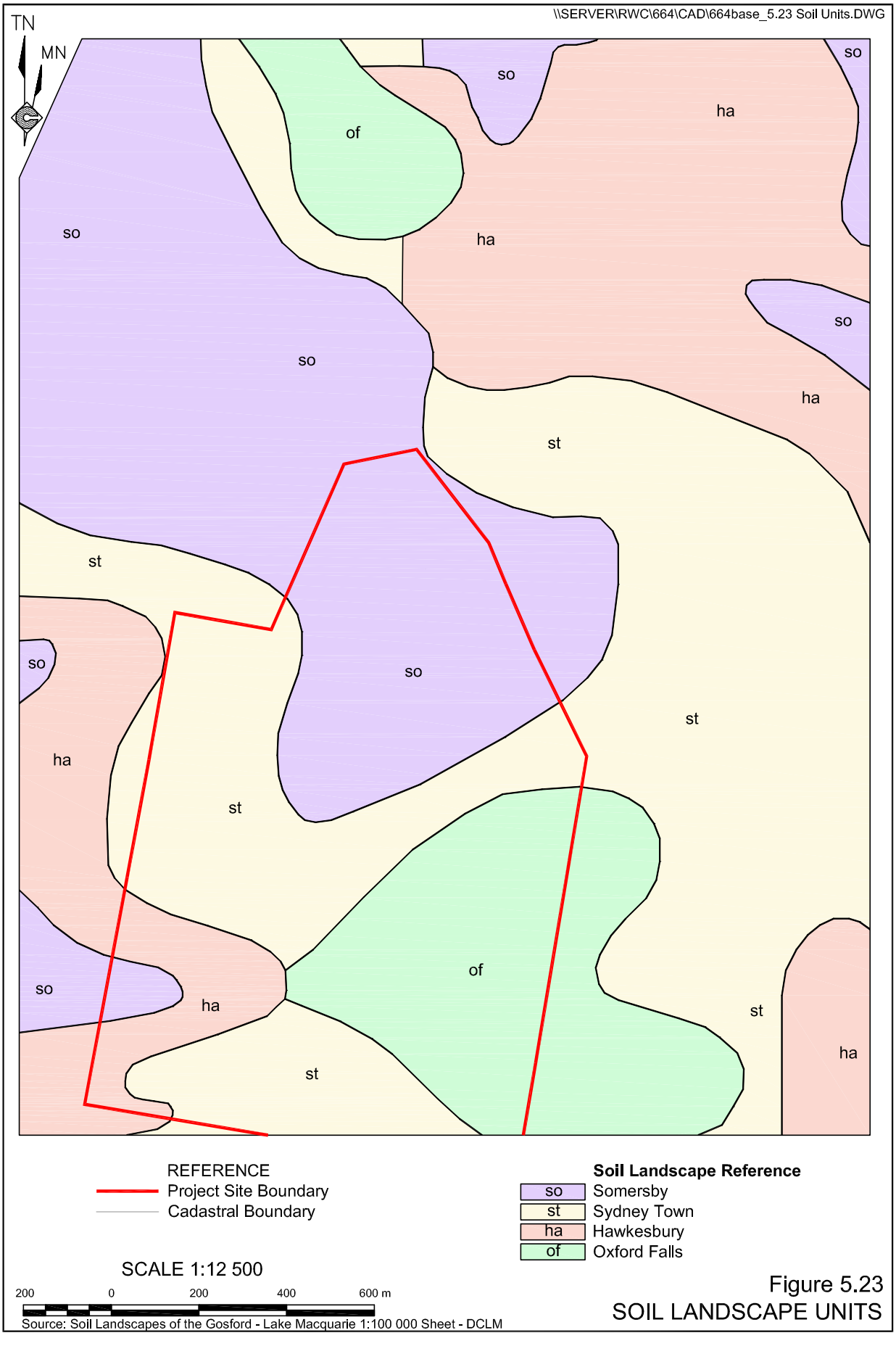


Figure 5.23
SOIL LANDSCAPE UNITS

The land classification of the proposed Southern Extension, however, is considered to approximate Class 6 or worse, ie. land not capable of being cultivated but suitable for grazing with the application of soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin.

5.9.3 Management Issues

The main soil-related issues to be managed throughout the life of the Project are as follows.

i) To ensure that the available soil resources are removed and managed such that they can be used to rehabilitate the final landform as described in Section 2.13.3 allowing for the final land uses as described in Section 2.13.4.

ii) To ensure that the soil is managed to minimize erosion and sedimentation from the Project Site.

iii) To ensure that the soil profile of the final landform is adequate to support the final land uses proposed in Section 5.9.1.

iv) To maximise the capability of the land in the final landform.

5.9.4 Environmental Controls and Management

5.9.4.1 Topsoil and Subsoil Management

Rocla is conscious of the need to conserve the topsoil resources on the Project Site and their importance in assisting with successful long-term rehabilitation. The main features of the topsoil management program, which are generally consistent with current management practices are as follows.

i) All available topsoil to a depth of approximately 0.15m to 0.3m would be stripped from the surface of each extraction stage.

ii) Wherever practicable, stripped topsoil would be placed directly onto an area prepared and awaiting rehabilitation.

iii) If no areas are available, topsoil would be stockpiled in predetermined areas for later reclamation. Topsoil stockpiles would be limited to no more than 2.0m in height to minimise adverse impacts upon the biological activity of the topsoil. The location of topsoil stockpiles would reflect operational constraints at the time, however, it is anticipated they would be placed as ‘wind row’ type structures around the perimeter of the active extraction stages, or otherwise located on the floor of the extraction area.

iv) Subsoil to a depth of approximately 0.5m would also be removed and if not able to be immediately placed directly onto an area prepared and awaiting rehabilitation, would also be stockpiled in predetermined areas for later reclamation. Subsoil stockpiles, when required, would generally not exceed 3m in height and may be used to form the acoustic bund walls required to reduce the noise level received by locations surrounding the Project Site (see Section 5.5.4).

v) The formed stockpile surfaces would be left with a generally even surface that is as 'rough' as possible, in a micro-sense, to assist in runoff control and seed retention and germination.

vi) If topsoil stockpiles are likely to remain for extended periods, a native seed mix would be broadcast to assist with temporary stabilisation.

vii) Where the subsoil stockpiles are likely to remain for extended periods, eg. when constructed as an acoustic bund wall, they would be covered with a layer of topsoil to assist with revegetation and erosion control.

viii) Excessive handling of the materials during the stripping and stockpiling operation and handling when the soils are wet would be avoided to protect any structure that may have developed. This would be accomplished, where possible, through the preferential direct transfer of the soils from stripping location to the rehabilitation area.

ix) Driving of machinery on the topsoil and subsoil stockpiles, as well as the respread soil, would be kept to an absolute minimum to maximise soil aggregation and prevent compaction, particularly when the stockpiles are moist.

x) Silt-stop fencing or similar would be placed immediately down-slope of stockpiles where required, until a stable vegetation cover is established.

It is noted that topsoil would be placed on areas requiring revegetation at a depth not exceeding 0.15m. This judicious use of topsoil would ensure there would be sufficient topsoil for the rehabilitation of the entire area disturbed by the extended quarry.

Subsoil which is surplus to bund and/or rehabilitation requirements would be mixed with oversize and used in the construction of silt cell walls, as capping for filled silt cells and, where practical, blended with the main product feed to maximise the available resource or to develop alternative product streams.

5.9.4.2 Contaminated Soil Management

The main source of potential soil contamination associated with the Project would be a result of fuel or lubricant spills. The potential for soil contamination would be minimised by:

- restricting the storage of all hydrocarbon materials to appropriately bunded areas of the Project Site;
- restricting all refuelling and vehicle maintenance activities to designated areas which are either sealed, bunded or located with access to spill control kits; and
- regular house keeping and maintenance of the hydrocarbon storage and vehicle maintenance areas.

In the event of a spill or leak outside the nominated storage/maintenance areas leading to the contamination of soils, Rocla would implement the following controls.

i) The source of the spill or leak would be isolated and either stopped or removed to an appropriate location, eg. fuel storage or vehicle maintenance area.

ii) If required, temporary bunding would be pushed up around the spill site to prevent the spread of the contamination.

iii) The contaminated soil would be excavated and, if only a small quantity, eg. several FEL bucket loads or $1m^3$ to $2m^3$, spread over a cleared and bunded area of the Project Site which is isolated from natural or created drainage for natural remediation.

iv) If the contamination is greater than $1m^3$ to $2m^3$, the contaminated material would be removed from the Project Site and delivered to a site licensed to accept hydrocarbon waste.

5.9.4.3 Final Landform Design and Rehabilitation

The final landform has been designed such that the bulk of Stages 3 and 4 may potentially be used for future agricultural or horticultural activities. To achieve this final land use, the slope of the majority of the landform has been kept as shallow as possible. Topsoil would be spread over the profiled land surface and vegetation would be sown to reflect the final intended land use. The retention of the water storage on the Project Site would further advantage any future agricultural use of the landform.

5.9.5 Assessment of Residual Impacts

5.9.5.1 Soil Management

The management procedures for the topsoil and subsoil resource as set out in Section 5.9.4 have been designed to ensure their proper handling and to provide the maximum opportunity for its re-use in the successful rehabilitation of the Project Site. These practices have been developed based on the operating experience gained to date on the Project Site, and have been shown to be successful. 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 be conducted as part 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.

5.9.5.2 Land Capability

Assuming the final landform is created as presented on Figure 2.13, with shallow slopes, a cover of topsoil, retained water storages and vegetation to suit the final land use, it is considered likely that the capability of the final landform would approximate, or be improved upon that of the pre-quarry environment.

5.10 LAND USE

5.10.1 Introduction

This section considers the impact of the Project on existing and probable future land use of the Project Site and surrounding area. Impacts are considered with reference to several NSW Planning Instruments, as originally identified in Section 3.2.4.3.

- **Sydney Regional Environmental Plan No. 8 (SREP 8) – Central Coast Plateau Areas**. Planning on the Central Coast Plateau Areas, within which the Project Site is located, is controlled principally by SREP 8. The objective of SREP 8 is to provide for the environmental protection of the Central Coast plateau and to evaluate competing land uses.
- **Sydney Regional Environment Plan No. 9 (SREP 9) – Extractive Industry (No. 2 – 1995)**. The Gosford Local Government Area is identified in Schedule 4 of this plan, as containing extractive material of regional significance in proximity to the population of the Sydney Metropolitan Area. The objective of SREP 9(2) is to facilitate the development of extractive resources in proximity to the population of the Sydney Metropolitan Area, whilst promoting the development in an environmentally acceptable manner.

  Notably, Gosford/Wyong LEP 2001 has confirmed the designated preferential use of land on which the Project Site is located as "*location of extractive industry*".
- **Sydney Regional Environment Plan No. 20 (SREP 20) – Hawkesbury-Nepean River (No 2—1997)**. The aim of SREP 20, which includes the Gosford Local Government Area as part of the Greater Metropolitan Region of Sydney, is to protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context.

5.10.2 Existing Land Uses

Section 4.3.1 provides a detailed description of the land uses surrounding the Project Site. Notably, the bulk of the land immediately to the south and southwest of the Project Site is native bushland with Popran National Park bordering the Project Site to the southwest. To the north, land is generally cleared land containing former and existing orchards, vineyards and market gardens. Areas to the east of Peats Ridge Road have been cleared for grazing, however, these areas quickly grade to native bushland again and Brisbane Water National Park located approximately 1km to the northeast.

Apart from the native vegetation and rural/agricultural land discussed above the principal existing land uses within 2km to 3km of the Project Site are as follows.

1. Groundwater is extracted for commercial purposes from bores immediately north of the Project Site on other land owned by the Gazzana family.
2. Poultry sheds are located approximately 40m to 60m north of the Project Site.
3. A horse riding centre is located on "Glenworth Valley" to the north and west of the Project Site. The centre, which caters for approximately 25 000 persons each year operates with approximately 200 horses. Other horse stabling and agistment blocks are located to the north of the Project Site.
4. The Australia Wildlife Walkabout Park, which markets itself as an "authentic Australian nature experience", is located to the immediate south of the Project Site. The property includes a visitor's centre and land owner residence with a veterinary clinic proposed to be operational near the entrance to the Wildlife Park.

   The property is surrounded by an electrified, feral proof fence. Visitors to the Wildlife Park include school children, overseas tourists on packaged tours and local drop-in tourists.
5. A number of residential and rural-residential life-style blocks.

5.10.3 Future Land Uses

No major change to the surrounding land uses is envisaged during the life of the proposed extension to the Calga Sand Quarry and as such, the Project Site has been designed with a final landform to cater for medium intensity agriculture or grazing and re-establishment of native vegetation.

It is noted that Lot 2, DP229889 is identified under SREP 8 as Prime Agricultural Land as well as a location of extractive industry under SREP 9(2) and the Gosford/Wyong LEP 2001. While the Gosford/Wyong LEP 2001 is recognised as taking precedence over SREP 8, agricultural activity on this property and those to the immediate north (also within the identified area of Prime Agricultural Land under SREP 8) has been limited in recent times, Rocla has recognised the potential value of this land for future agricultural activities. This is illustrated by the proposed final landform of Stages 3 and 4 of the Project Site which would provide a gently sloping and free draining landform, with access to significant water storages (retained Dams 7a, 7b/c, 14, 15 and W1 to W4). This landform would be an ideal setting for some form of high intensity agricultural or horticultural activity.

5.10.4 Assessment of Impacts

The viability of the existing uses of land surrounding the Project Site rely to varying degrees on the management of impacts on the following previously discussed aspects.

i) Reduced ***groundwater*** availability – has the potential to impact on the operations of a commercial water facility to the immediate north of the Project Site, those land uses that rely on a consistent supply of water to water stock and/or orchards, crops etc, as well as groundwater dependent ecosystems (GDEs) on the Project

Site or within the Cabbage Tree Creek catchment which depend on groundwater base flows initiated by recharge and/or flow through the Project Site.

It has been demonstrated in Section 5.1.2.3.2 that the groundwater level of the sandstone aquifer from which these surrounding land users draw their groundwater resources, is highly dependent on recharge from rainfall, with the Project likely to have a limited influence on a very small number of bores within a 1km radius of the Project Site. While a reduction in yield is considered unlikely as a result, Rocla has committed to compensating any affected groundwater user whose supply is demonstrated to have been adversely affected by Rocla's extraction activities.

Most notably, the proposed activities would not result in any detrimental impact in the yield of the bores of the commercial water operation, which are likely to be supplied by fracture flows below the elevation of impact from the Project. Any adverse impact on the viability of a surrounding land use is therefore assessed to be unlikely with appropriate contingency mitigation measures provided for by Rocla.

The predicted decrease in groundwater flows to the creeks of the Project Site and Cabbage Tree Creek which support GDEs may have some temporary adverse affect on the small areas of GDEs on the Project Site itself. However, given the minor areas affected by the proposed extraction activities in comparison to the total catchment area providing surface and base flows to Cabbage Tree Creek, any impact on GDEs off the Project Site would be minimal.

In relation to the proposed future use of Stages 3 and 4 of the Project Site for activities such as high intensity agriculture or horticulture, which are likely to require access to groundwater resources, the groundwater modelling completed indicates that local groundwater levels would return to pre-extraction levels following the cessation of the Project and rehabilitation of the Project Site. As such there would be no long term reduction in the availability of groundwater to any future owner/user of the Project Site

ii) Increased *noise* levels – may impact visitor experiences to the Australia Wildlife Walkabout Park through possible impacts on the fauna which reside within the park or as a result of a reduction in the overall aesthetic value of the park.

Any significant increase in local noise levels may also have a detrimental impact on local land uses which revolve around the bushland setting, eg. the horse riding operations of the "Glenworth Valley" property, or reduce the amenity and therefore perceived value of local residential properties. The day time noise levels would remain at least 7dB(A) below the relevant intrusiveness criterion (of 46dB(A)). Notably, the park is already subject to significant traffic noise from Peats Ridge Road and the F3 Freeway with minor contributions from the Calga Sand Quarry, with these noise sources not affecting activities at the Australia Wildlife Walkabout Park such as guided tours or bush tucker demonstrations. There is no reason to believe therefore that the small increase in noise levels attributable to the Project would reduce the aesthetic value of the Australia Wildlife Walkabout Park such that it would deter visitors. Notwithstanding this, it is recognised that the western side of the park is noticeably quieter than the

eastern and northern sides of the park as it is better shielded from traffic noise from the F3 Freeway and Peats Ridge Road. Noise levels from F3 traffic are considerably higher than those predicted from operations in either Stage 4 or Stage 5 on the Project Site.

Recognising the potential impact of noise levels on the surrounding local land uses, Rocla would implement a number of noise controls, most significantly acoustic bund walls around relevant sides of each extraction stage. Noise modelling predicts that no residence would be subject to noise levels which exceed the most stringent of noise criteria, either "intrusiveness", "amenity", "traffic" or "sleep disturbance" (see Section 5.5.6). Noise levels complying with these criteria are unlikely to affect native fauna or livestock such that the viability of the relevant land use which relies on these is affected.

iii) Elevated ***dust*** levels – could potentially exacerbate health conditions of local residents who have chosen the location for its 'clean air' values.

Modelling undertaken by PAEHolmes (2009) indicates that any increase in the concentration of airborne or deposited particulate matter (including crystalline silica) on land surrounding the Project Site would be well within the DECCW or other relevant health and nuisance related criteria. These concentrations would be far lower than is likely to impact on the health and/or condition of livestock or crops, orchards etc.

iv) *Soil resources* and land capability – of the final landform would directly affect the type of land use which could be undertaken on the Project Site following the cessation of extraction and rehabilitation of the Project Site.

As described in Section 5.9.4, Rocla has committed to appropriately managing the soil resources of the Project Site such that the soil profile of the free draining final landform of the Project Site replicates or improves the current profile and provides land of capability class III or better. To complement the re-instatement of the soil profile, water management structures such as Dams 7a, 7b/c, 14, 15 and W1 to W4 would be retained to provide a nearby and secure source of water for these activities.

v) The *conservation of biodiversity* on the Project Site and "Glenworth Valley" – would increase the area of native vegetation and fauna habitat protected within the Central Coast area. The biodiversity offset area would provide for extended habitat corridors between national parks in the region and an important buffer to the Popran National Park, thereby increasing value of these parks due to habitat connectivity and protection against invasion of weed and pest species.

vi) *Erosion and sedimentation* – may impact adversely on the vegetation and habitat of Cabbage Tree Creek, as well as that within Popran National Park.

Notably, Rocla has committed to constructing pollution control structures at the discharge points from the Project Site, as well as implementing the erosion and sediment controls listed in Section 5.2.5. Assuming these controls are implemented and maintained, the potential for downstream contamination and detrimental impacts on the vegetation, habitat and aesthetic value of Popran National Park would be minimal.

The above notwithstanding, Rocla is committed to maintaining a dialogue with surrounding landowners and residents to ensure that its ongoing activities within the Project Site do not adversely affect the surrounding existing or future land uses.

5.11 BUSHFIRE HAZARD

5.11.1 Introduction

Located within, and surrounded to the south and east, remnant native vegetation (both on private and Crown lands), the Project Site remains at risk of impacts from bushfires. This section reviews the existing bushfire hazard of the Project Site (Section 5.11.2), considers the safeguards, controls and management procedures to be followed to reduce the risk of fire initiation on the Project Site (Section 5.11.3.1) and respond to bushfire on lands external to the Project Site (Section 5.11.3.2), and assesses the environmental (and safety) risk posed by local bushfire hazard.

5.11.2 Existing Bushfire Hazard

As determined in Section 4.4, a review of the three critical parameters for assessing the category of bushfire attack for a site suggest that the proposed Southern Extension displays a high hazard rating. NSW RFS/Planning NSW (2001) define the 'high' hazard category as follows.

> *"significant ember attack, possible flame contact, radiation heat greater than 16kWm^{-2} and no greater than 21kWm^{-2}."*

On the basis of the high hazard category, appropriate precautions and controls should be implemented to ensure the risk of asset damage or harm to individuals is minimised.

5.11.3 Operational Safeguards, Controls and Management Measures

5.11.3.1 On-site Control of Fire Hazard

The activities of the Project that may increase the risk of fire on the Project Site and transport route, and the controls proposed to limit the risk posed by these are presented in **Table 5.48**.

Table 5.48
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 areas 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.
Vegetation Clearing	• Spark from machinery igniting leaf litter or broken vegetation.	• Clearing during high or extreme bushfire hazard conditions (as defined by the NSW Rural Fire Service) would be avoided. • No smoking policy to be enforced within the vegetated areas of the Project Site.
General Activities	• Smoking • Rubbish, eg. glass, metal. • Other general activities	• No smoking policy to be enforced in designated areas of the Project Site. • Focus on housekeeping to be maintained by site management. • Clearing to extend approximately 5m beyond active working area. • Water cart available to assist in extinguishing any fire ignited. • Site vehicles to carry a fire extinguisher.

5.11.3.2 Management Procedures On-site Control of Fire Hazard

Rocla would liaise with the DECCW (NPWS) to determine when back-burning or fire control activities are planned.

In the event of a bushfire event on surrounding lands, Rocla would provide access to on-site water storages for the NSW RFS to assist in fire control. Rocla would follow the instructions of the NSW RFS at all times when fire threatens the Project Site operations. If in any doubt, all personnel would be evacuated from the Project Site to ensure no personnel is placed in any danger as a result of the bushfire.

5.11.4 Assessment of Impacts

Assuming the implementation of the safeguards and/or controls identified in **Table 5.48** the risk of fire initiating on the Project Site would be significantly reduced.

Assuming the management measures identified in Section 5.11.3.2 are implemented, the risk to the safety of quarry personnel would be minimised while the abilities of the NSW RFS to combat the bushfires assisted through access to the quarry water storages.

5.12 HAZARDS, PUBLIC SAFETY AND SITE SECURITY

5.12.1 Introduction

The Director-General's Requirements issued by the Department of Planning identify "hazards and risk", including "public safety and site security" as key issues for assessment within the *Environmental Assessment*.

5.12.2 Potential Hazards and Risks

The risk analysis undertaken to identify and prioritize the issues to be assessed in the *Environmental Assessment* identified several hazards and risks to public safety associated with the Project. The management of potential risks was considered within Section 3 of the *Environmental Assessment*. The potential hazards and risks identified by the risk analysis are as follows (with the relevant section where each was assessed provided in brackets):

- airborne particulate matter (in particular respirable crystalline silica) impacts on health (Section 5.7.7.2);
- contamination of drinking water supplies (groundwater or surface water) (Section 5.1.5.5);
- road safety (Section 5.8.5.4); and
- fire or bushfire hazard (Section 5.11.3).

Consideration of the above hazards notwithstanding, Rocla recognises that its proximity and visibility from the Peats Ridge Road, Popran National Park and adjacent landholdings (which include commercial ventures) necessitate the implementation of procedures and controls to protect the safety of the public in general, as well as that of local landowners/land users. Measures would also be required to ensure the security of the Project Site facilities and equipment, and to protect the safety of Rocla's own and contracted employees, as well as that of visitors to the Project Site.

5.12.3 Operational Safeguards, Controls and Management Measures

It is Rocla's policy that each person employed on, or visiting the, Project Site is provided with a safe and healthy working environment and, to achieve this, Rocla would continue to implement its recruitment, induction and training program to achieve the following objectives.

- To ensure compliance with statutory regulations and maintain constant awareness of new and changing regulations.
- To eliminate or control safety and health hazards in the working environment in order to achieve the highest possible standards for occupational safety.
- To ensure the suitability of prospective employees through a structured recruitment procedure.
- To provide relevant occupational health and safety information and training to all personnel.

- To develop and constantly review safe working practices and job training.
- To conduct regular safety meetings and provide an open forum for input from all employees.
- To provide effective emergency arrangements for all employees, and general public protection.
- To maintain good morale and safety awareness through regular employee assessment and counselling (if required).
- To ensure all contractors adopt Rocla's policy objectives and maintain safety standards at all times while working on its premises.
- To develop public awareness of the safety standards and objectives at the Calga Sand Quarry.

Central to all aspects of site security and safety at the Calga Sand Quarry is and would continue to be:

- the adoption of a pro-active approach to employee and public safety;
- strict compliance at all times with the requirements of the:
  - Dangerous Goods Act 1975
  - Occupational Health and Safety Act 2000
  - Occupational Health and Safety Regulations 2001
  - All other relevant legislation and Australian Standards
  - WorkCover Authority; and
- an Occupational Health and Safety Policy covering all component activities at the quarry.

Rocla would implement the following measures in association with the development of Stages 4 and 5, most of which are already in place for operations in Stage 3.

- Maintenance of lockable gates at both entrances to the Project Site. The gates would be locked whenever sand extraction and associated activities are not being undertaken on the Project Site.
- Positioning security/warning signs at strategic locations around or within the Project Site. The signs would identify the presence of earthmoving equipment, deep excavations and steep slopes.
- Employee induction in safe working practices and regular follow-up safety meetings and reviews.
- Regular employee training on hazard identification and risk management.

- Installation of bunds along the margins of all internal haul roads where those roads are positioned adjacent to steep slopes, adjacent to the boundary of the extraction areas(s) and adjacent to all other steep slopes.
- Ensure all earthmoving equipment is fitted with appropriate safety equipment, eg. rollover protection structures and seatbelts, an operating broadband reversing alarm (or other approved warning device) and an approved location and method of operation for the fire suppression system, all of which would be maintained in a good condition and operated safely at all times.
- Ensuring all crushing equipment at all times complies with all relevant requirements, including:
  - AS 1657-1992 (fixed platforms, walkway, stairway and ladder design, construction and installation; and
  - AS 1755-1986 (conveyor – design, construction, installation and operation safety equipment).
- Strictly complying with all project approval and licence conditions.
- Erection of advisory signage, such as "Trucks Entering 200m", on Peats Ridge Road prior to the intersection with the Southern Entrance.
- Ensuring all trucks transporting quarry products from the Project Site are roadworthy and well maintained, are driven in a safe and courteous manner and strictly comply with Rocla's Driver Code of Conduct.

5.12.4 Assessment of Impacts

The assessments of Sections 5.1.5.5, 5.7.7.2, 5.8.5.4 and 5.11.3 determined that the Project would not result in any increase in, or unreasonable risk to, the safety and/or security of the Project personnel or the general public associated with water quality, airborne particulate matter (especially crystalline silica), road safety and bushfire.

The additional safeguards and management measures identified in Section 5.12.3 would further safeguard Rocla personnel, contractors and members of the general public from injury or impact on Proponent or private property.

5.13 SOCIO-ECONOMIC SETTING

5.13.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential air quality impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Reduced quality of life (moderate risk).
- Reduced property values (temporary to long term) (moderate to high risk).

The Director-General's Requirements issued by the Department of Planning identify "social and economic" as key issues for assessment within the *Environmental Assessment*.

5.13.2 The Existing Socio-economic Setting

5.13.2.1 Local Setting and Community Structure

The Calga Sand Quarry, and proposed Southern Extension, is located on the western side of Peats Ridge Road, approximately 1km northwest of the Calga Interchange of the F3 Freeway, within the Local Government Area of Gosford. Section 4.3 provided a summary of land ownership and land use between the Calga Interchange to the south, and Polins Road to the north of the Project Site. The residents of these properties, identified on **Figure 4.4**, collectively make-up the immediate local community and are collectively referred to as the Calga North Community. The village of Calga is actually located on the southern side of the F3 Freeway and comprises 11 residences, principally on rural-residential life-style blocks.

Land ownership within the Calga North Community is restricted to the south by the F3 Freeway and to the east and west by the steep topography off the Somersby Plateau (although several residential developments have been completed to the east of Jones Road in recent years). Land use (as discussed in Section 4.3.1) is diverse, ranging from residential, agricultural, tourism and commercial water extraction. Several land owners of the Calga North Community's sole income is derived through these land uses (eg. the commercial water extraction on Lot 121, DP755221), while others supplement their income through the land use, and the remaining are either employed elsewhere on the Central Coast or Sydney, retired, or not employed. Discussions held with many (17) of the local land owners within the Calga North Community as part of the community consultation outlined in Section 3.2.2.1, identified that the majority are long time residents of their current address, or the Calga area in general.

Many of the residents in the Calga North Community are known to Rocla although interaction between Rocla and most members of the Calga North Community is limited often to visits relating to principal periodic monitoring activities undertaken on some properties. As discussed in Section 3.2.2.1, representatives have visited most residents within the local community on at least one occasion, with a follow-up visit to the owners of Australia Wildlife Walkabout Park also undertaken at their request. While interaction is limited, the Calga North Community is represented by a Community Consultative Committee (of which several local land owners are members), which meets on a biannual basis to discuss the ongoing performance of the existing quarry operations. To Rocla's knowledge, while the majority of the local residents have resided in their current address or the general area for many years, no formal community group has been established amongst these residents (although it is noted that in other similarly diverse communities on the Somersby Plateau, proposed extractive industries have been the catalyst for the formation of such community groups).

Attitudes of those within the Calga North Community vary to the operation of the Calga Sand Quarry (a feature of the local area since the early 1990's) and the proposed extension. Several members of the local community have been vocal in their opposition to the Calga Sand Quarry, while others have indicated their concerns over extractive industry in general on the Somersby Plateau. Some members of the local community have expressed ambivalence to the operations of the quarry, however, the majority appear to be satisfied with the current operations as well as the proposed extension subject to their specific concerns being addressed.

Rocla has had little contact with the residents of the Calga Village to date, however, Rocla welcomed the opportunity in August 2009 to meet with most of the community to discuss the proposed quarry extension and to open dialogue with the community regarding issues of interest relating to the quarry extension and truck traffic past the edge of the village. It is recognised that there is considerable social cohesion amongst the residents of Calga Village given the close proximity of most residents.

5.13.2.2 Community Values

While there is significant diversity in the use of the land within the Calga North Community, several socio-economic values are common to those consulted. Based on the results of the community consultation undertaken by Rocla, as well as through a review of submissions made on the previous application for extension (to the north) of the Calga Sand Quarry, the dominant socio-economic values are as follows.

Maintenance of Existing Land Use/Economic Activity

While a proportion of the local residents of the Calga North Community do not obtain any financial return from their use of the land, ie. the land use is solely residential, a significant number of local land owners either derive their entire income, or a proportion of this from their land use. The economic activities include:

- tourism facilities;
- agriculture/horticulture;
- animal management, eg. horse stabling, dog kennelling, veterinary facilities; and
- water extraction.

Accordingly, concerns over the impact the proposed quarry extension might have on the ongoing viability of these land uses, ie. increased noise, reduced water availability and/or quality, clearing of vegetation reducing the visual appeal of the local area, have been raised.

Access to Water Resources to Support Existing Land Use

Building on the community values above, a significant number of local land owners in the Calga North Community and Calga Village maintain and/or operate one or more groundwater bores on their property. Some of these land owners have indicated the viability of their land use depends on ongoing access to this groundwater, while others have simply expressed concern that their access to this resource which is fundamental given the absence of mains water or the preference to use tank water.

Amenity of the Semi-rural Setting

As noted in Section 5.11.2.1, many of the local land owners around the Project Site have resided on this land for many years (in excess of 50 years in some cases), a period when as a predominantly agricultural area, the Somersby Plateau provided a significant proportion of food to Sydney and Central Coast. Many of these land owners view favourably this period in the history of the Somersby Plateau, which predates the rapid expansion of development on the Central Coast and inevitably increase in non-agricultural activity (including extractive industry) on the Somersby Plateau, and place significant value on the remaining agricultural areas of the

area. It is also acknowledged that a number of the residents of both the Calga North Community and Calga Village have only recently moved to the area given the attraction of living on a life-style block, albeit with considerable volumes of traffic in close proximity.

'Fresh Air'

Through a common expression of concern over what detrimental impact the proposed quarry extension might have on local air quality, the Calga North Community has illustrated the value it places on the 'fresh air' of the local setting. Several local residents consulted went further and identified the health issues associated with increase air pollution, in particular respirable crystalline silica which has been documented as causing the degenerative lung condition known as silicosis.

Somersby Plateau Native Vegetation

A number of residents have commented on their appreciation of the vegetated plateau and slopes, and the native fauna which inhabits this vegetation, within the local setting. The owner/operators of the Australia Wildlife Walkabout Park have been particularly vocal in outlining the value of the remnant native vegetation on the Somersby Plateau, which provides important habitat corridors between the established conservation areas of Popran and Brisbane Waters National Parks.

Somersby Plateau Indigenous Heritage

Numerous archaeological investigations have been undertaken on the Somersby Plateau, with the area providing an important repository of Aboriginal artefacts, sites and places. The link provided by these artefacts, sites and places to the pre-European settlement Aboriginal occupation of the area are valued not only by local Aboriginal stakeholders, eg. Darkinjung LALC, but several local land owners.

Peace and Quiet of the Local Setting

A number of those choosing to live within the Calga North Community do so because of the relative peace and quiet afforded by the setting particularly for those residents set back from Peats Ridge Road. While the existing Calga Sand Quarry is a largely accepted feature of the local setting, concerns have been raised over how the extension may increase local noise levels and reduce the general peace and quiet of the local area. In addition, while traffic, and the noise generated by it, is an accepted part of living in close proximity to the F3 Freeway, some residents have also raised concerns as to the impact of the Project on local traffic levels which in turn may further reduce the general peace and quiet of the local area.

Community Amenity and Lifestyle

Associated with the relative peace and quiet offered by the existing setting, many landowners and residents have chosen the area to maintain a quiet lifestyle, away from major urban centres, and enjoy the small community amenity value provided in such settings. There is concern that this lifestyle would be negatively affected by the extension of the Calga Sand Quarry and the resulting increased traffic.

5.13.3 Environmental Controls and Management

The majority of controls to be implemented by Rocla that would limit the impact of the Project on the socio-economic values of the local community have been previously described and discussed in the preceding sections of the *Environmental Assessment*. Reference to the appropriate sections are as follows.

- Access to Water Resources – Sections 5.1.3 and 5.2.3.
- Increased Noise levels – 5.5.4.
- Reduced Air Quality – 5.7.5.
- Impacts on Visual Appeal through Clearing – 5.9.4.
- Impacts on local Flora and Fauna – 5.2.6.
- Impacts on local Indigenous Heritage – 5.4.6.

In addition, Rocla intends to maintain ongoing dialogue with the local community, through the Community Consultative Committee process and one-on-one discussions as required, to continually assess the nature of surrounding landholders and the attributes of the local community and environment they value.

5.13.4 Assessment of Residual Impacts

5.13.4.1 Socio-economic Benefits of the Project

A planning report commissioned by the Department of Planning has predicted that unless a significant increase in the supply of fine aggregates (sand) is identified and secured for extraction in the immediate future, there is likely to be a deficit of these resources, which are critical to the construction industry by 2012 or 2013 (Geos Mining, 2006).

The major socio-economic benefit of the Project would be to provide for an increased supply of fine aggregate for the Sydney construction market, particularly when the building industry resumes normal to above normal levels of activity. Through easing the supply shortage, the potential flow on impacts associated with a shortage of the critical construction material, illustrated as **Figure 5.24**, could be avoided.

This socio-economic benefit would impact on a large number of people, in particular those in Sydney and the Central Coast where housing affordability has reduced significantly in recent years.

Other benefits would include the following.

- An increase in direct full-time employment from 8 up to 19 people. The Project would also provide continued employment for local contractors and service companies providing mechanical, technical and cleaning type services. It is likely that the majority of the new workforce would be sourced from the Somersby

Plateau, wider Central Coast and northern Sydney. Increased employment opportunities would have additional flow-on benefits including:

  - the provision of new and/or continued employment would provide an impetus to other local businesses;
  - quarry expenditure on fuel, parts and consumables; and
  - support of local community services and projects.

- The Calga Sand Quarry would continue to provide for locally produced sand and hard rock products which, due to the reduced travel distance, would be likely to be significantly less expensive for customers on the Central Coast than materials sourced from Sydney or Newcastle.
- The proposed final landform would provide opportunity for the continuation of employment generating activities. The Project Site is ideally located for the development of a product distribution centre, with the proposed slightly sloping landscape further increasing its value for this purpose. The presence of the water storages in the final landform would also be of value to future use of the site for intensive agriculture (eg. poultry farming) or horticulture.
- The continued diversification of development/industry in the LGA would lead to increased training opportunities for the residents of the LGA.

5.13.4.2 Socio-economic Costs of the Project

Ultimately, the degree of impact on the values of the local community would reflect Rocla's adherence to the operational safeguards and management measures proposed. The environmental assessments of impact included in Section 5 indicate that the Project would be unlikely to have a significant impact on noise, air quality, water resources, flora and fauna, heritage, or land use. In relation to the issue of greatest common concern to the local community, access to water resources, Rocla has committed to ongoing monitoring and the provision of compensatory supply should it be demonstrated the Project has an adverse impact on the water resources of the local area.

Impacts on aesthetic values of the local setting would be accounted for through the progressive rehabilitation, native vegetation re-establishment and general maintenance of the Project Site. Rocla has also committed to continuing its management of a complaints register and Community Consultative Committee, such that concerns of the local community can be swiftly identified and effectively dealt with.

It is often claimed that the development of extractive industry leads to a significant reduction in the value of surrounding properties. Notwithstanding the fact that the Calga Sand Quarry is an established element of the local setting, a report prepared by Mr Brian Nicholson, National Director of Extractive Industries & Waste Management of Colliers International (Real Estate Consultants) on the impact of extractive industry on property values has been reviewed with reference to the Project. In Nicholson's report entitled "*The Effect of Extractive Industry – Quarries – on Property Values*" (Nicholson, in press), it is noted that advances in environmental management are such that the management of many of the issues that may once have resulted in reduced property values, eg. noise, dust, blasting, clearing, have reduced these impacts to acceptable levels. It follows therefore that there would be no diminution in property values.

Nicholson (in press) presents three examples of where there has been urban intrusion into areas surrounding operating quarries.

1. Boral's Bombo Quarry. Residential development has been established to the immediate north (Kiama Downs Estate).
2. Hanson's Bass Point Quarry. Shell Cove Estate has been developed to the immediate west.
3. Cemex's Albion Park Quarry. Residential development to the north has become established to the immediate north.

In all three cases, there has been no evidence that the property value has been diminished as a consequence of the extractive industry (when compared to property values of neighbouring estates or developments). Nicholson goes further to state that contrary to the assertion that extractive industry diminishes property values, while ever the environmental, geographic and/or demographic factors which drive the value of property in the area remain, the value of the property would not change, regardless of the presence or absence of extractive industry.

With respect to the Calga Sand Quarry, the environmental, geographic and/or demographic factors which drive the value of property in the area could be considered to be the access to quality groundwater, access to quality of the agricultural land and the natural setting and landscape of the local area. Through effective control of noise, air quality, water resources and visibility (among other environmental parameters), the proposed Southern Extension to the Calga Sand Quarry would not alter these factors significantly. Therefore, as noted by Nicholson (in press), as the environmental, geographic and/or demographic factors would remain relatively unchanged, so would the property values.

5.13.4.3 Conclusion

The proposed Southern Extension of the Calga Sand Quarry has, to the extent feasible, been designed to minimise the social and economic cost of the Project on the local community. The Project provides for the removal, processing and despatch of sand products recognised to be in short and diminishing supply within the Sydney/Central Coast hinterland. The Project would be significant in generating local employment opportunities and boosting the local economy of Calga and other communities on the Somersby Plateau. The final landform would provide for the future use of the Project Site for employment generating facilities which could include, product distribution facilities, intensive agriculture, horticulture or others.

The overall environmental impact assessment process has assisted Rocla to design a Project that would have a range of acceptable residual impacts on the local environment and provide for the long term enhancement of native bushland to the benefit of local and regional fauna/flora and the overall environment.

Acknowledging these residual impacts, it is concluded that the Project would have an acceptable impact on the socio-economic setting as it would:

- contribute towards alleviating the diminishing supply of fine to medium-grained sand in the Sydney/Central Coast construction market;

- provide ongoing employment opportunities and contribute to the continued economic activity of the Calga area and the Gosford LGA;
- satisfy sustainable development principles; and
- have manageable impacts on the biophysical and socio-economic environment.

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