Boral Concrete
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Peppertree Quarry Modification 5

ENVIRONMENTAL ASSESSMENT

Prepared for Boral Quarries | October 2018



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EXECUTIVE SUMMARY

Introduction

Boral Resources (NSW) Pty Ltd (Boral) is seeking to modify Peppertree Quarry's (the Quarry) Project Approval (PA 06_0074) (the Approval) under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), to provide for the following (the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the Approval. The Minister for Planning is the consent authority for the Project.

This environmental assessment (EA) has been prepared on behalf of Boral to assess the potential environmental and community impacts associated with the Project.

Project summary

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Marulan South Limestone Mine (the Mine). This new overburden emplacement area will be needed in late 2018 and will take approximately four years to establish. The emplacement will cover approximately 44 ha and will be RL650 m at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

The powerline, which supplies electricity to the Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 25 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Mine, and will be a component of the Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

Two sediment dams will be constructed either end of the WOE to catch and treat dirty water until the batters are rehabilitated. Sediment dam P1 will be approximately 2.1 ML in volume and sediment dam P2 will be approximately 5.8 ML in volume.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the Project.

The only ground disturbance associated with the modification will be for the SWOE, sediment dams P1 and P2, powerline relocation and new haul road.

Environmental impact assessment

Technical specialists assessed key environmental issues associated with the Project, which were identified in the *Background Scoping Document* (November 2017). Key issues were identified in consultation with government agencies and the community. Environmental issues identified as low risk were not further assessed as the Project will not result in any additional impacts on these issues than the impacts described in the *Marulan South Quarry Environmental Assessment Report* (ERM 2006) and subsequent modifications.

A broad overview of the key outcomes of the environmental impact assessment is provided below.

Noise and Vibration

Potential noise impacts from construction and operation of the Project on nearby sensitive residential, commercial and industrial receivers were assessed in accordance with the NSW Environment Protection Authority's (EPA) (2017) *Noise Policy for Industry* (NPI). Application of the NPI required the determination of new 'trigger levels' (criteria) for the Project.

Noise generation during the daytime (7 am to 7 pm) and evening/night (7 pm to 7 am) operating periods were estimated for two worst case scenarios, assuming equipment was operating at the south-western end of the SWOE:

- approved operations plus the start of overburden emplacement activities at the SWOE, when equipment are at natural ground level; and
- approved operations plus overburden emplacement activities near the completion of the SWOE, where haul trucks would sometimes be shielded by the top of the emplacement.

The assessment did not incorporate worst case weather conditions as the incidence of temperature inversions in the project area is less than 30% of the winter night time.

The predicted noise levels for proposed daytime and night time operations comply with the operational noise trigger levels and Approval criteria at all locations. The highest noise level event which could interrupt sleep at the nearest receiver was estimated to be less than the maximum noise event screening criterion.

As the land acquisition criteria in the Approval are equal to or higher than the operational trigger noise levels, the predicted daytime and night time noise levels associated with the Project do not exceed the land acquisition criteria at any residence.

The NPI states "Where the project amenity noise level applies, and it can be met, no additional consideration of cumulative industrial noise is required." The predicted noise levels comply with the amenity level and no further assessment of cumulative noise was required.

The assessment of low frequency noise indicated compliance with the EPA criterion at the most-affected receiver.

The *Peppertree Quarry Noise and Blast Management Plan* will be amended with the new trigger levels determined under the NPI, once the Project is approved.

Air Quality

Potential air quality impacts from construction and operation of the Project on nearby sensitive residential, commercial and industrial receivers were assessed in accordance with the EPA's (2017) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. Total suspended particulates, PM_{10} and $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 10µm and 2.5µm or less) will be the primary emissions from the Project.

The assessment assumed a worst case scenario where maximum production was occurring at the Quarry during the approved hours with equipment at the closest locations to the receivers. Operations at the SWOE were assumed to occur between 7 am and 7 pm.

Dust emissions were predicted for the operation of the Quarry (incremental) and operation of the Quarry with local dust sources and background levels (cumulative) at the sensitive receivers and reported in:

- maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- annual average $PM_{2.5}$ and PM_{10} concentrations;
- annual average TSP concentrations; and
- annual average dust (insoluble solids) deposition rates.

No exceedances of the criteria were predicted at any assessed privately owned sensitive receiver due to emissions from the Quarry incorporating the Project, or the Quarry and Project plus other sources and background levels.

The cumulative annual average PM_{10} criterion of 25µg/m³ is predicted to be exceeded at a Boral owned receiver (B4). The tenancy agreement at this receiver incorporates negotiated agreement of noise and dust levels.

Dust impacts on more than 25% of privately owned land were also predicted to determine if Boral will be required to purchase any affected properties. The assessment showed that the Project would not result in any impact on more than 25% of any privately-owned land.

Management measures in Boral's (2017) *Air Quality Management Plan* will continue to be implemented at the Quarry, including in the Project area when the Project is approved.

Biodiversity

Potential biodiversity impacts from construction and operation of the Project were assessed in accordance with the Office of Environment and Heritage's (OEH) (2017) *Biodiversity Assessment Method* (BAM). Ecosystem and species credits were calculated for proposed vegetation clearing in accordance with the BAM.

Public databases, vegetation mapping and the BAM Calculator were used to predict the threatened flora and fauna species, and threatened ecological communities, which could exist in or frequent the Project area. Results of these searches were:

- according to the databases 22 threatened flora species could occur in the Project area, though the likelihood was low;
- the BAM Calculator predicted that 28 threatened fauna species could occur in the Project area; and
- mapping indicated two vegetation communities in the Project area:
    - Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands; and
    - Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin.

The Yellow Box - Blakely's Red Gum woodland is listed as an endangered ecological community (EEC) under the NSW *Biodiversity Conservation Act 2017* and a critically endangered ecological community (CEEC) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Field surveys confirmed the existence of the vegetation communities. No threatened flora species were observed and the Large-eared Pied Bat (*Chalinolobus dwyeri*) and Eastern Bentwing Bat (*Miniopterus schreibersii*) were recorded during the survey.

The following direct impacts would result from the Project:

- clearing of vegetation conservatively estimated to be 39.69 ha, including 27.68 ha of EEC/CEEC;
- clearing of associated threatened species habitat;
- clearing of Koala habitat estimated to be 27.1 ha; and
- clearing of Large-eared Pied Bat habitat estimated to be 27.1 ha.

The vegetation clearing protocol in Boral (2017) *Biodiversity and Rehabilitation Management Plan* will be implemented to reduce vegetation clearing impacts on biodiversity. Additionally, a strategy will be developed to offset the vegetation clearing impacts on biodiversity, which will be based on the following credit requirements:

- Ecosystem credit requirements:
  - Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands – 335 credits for the medium condition vegetation and 89 credits for the poor condition vegetation.
  - Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin – 134 credits for the medium condition vegetation and 23 credits for the poor condition vegetation.
- Species credit requirements:
  - Koala – 514 credits.
  - Large-eared Pied Bat – 772 credits.

Aboriginal heritage

Potential impacts on Aboriginal cultural heritage from the Project were assessed in accordance with OEH's:

- *Draft guidelines for Aboriginal cultural heritage impact assessment and community consultation* (2005);
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (2010);
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (2011); and
- *Code of practice for archaeological investigation of Aboriginal objects in NSW* (2010).

The Aboriginal cultural values of the Project area were determined in consultation with the Quarry's Aboriginal Management Committee and the Mine's registered Aboriginal parties.

The Project area was surveyed, which focussed on the areas predicted to contain evidence of previous Aboriginal occupation. Ground surface visibility was generally low, however, three sites were discovered which contained nine artefacts between them.

Five 3 m by 1 m test pits were excavated in the SWOE area on broad spurs and a ridge to characterise the sub-surface archaeology and test predictions and the survey results. A large amount of artefacts (40 – relative to the general artefact frequency in the area) were discovered in one test pit, which was on a large spur overlooking two drainage lines and has moderate research, rarity and integrity significance. Most of the artefacts were flakes or broken flakes.

All the Aboriginal sites and the area of moderate sensitivity in the Project area will be lost as creation of an overburden emplacement involves potential topsoil disturbance, truck movements, deposition of large amounts of soil, landscaping and landform rehabilitation. Artefacts below the surface will not be retrievable once the overburden emplacement is created.

All surface artefact sites (artefact scatters and isolated finds) in the study area will be collected by an archaeologist and members of the Aboriginal community. The site of medium significance will be subject to salvage excavation, which will aim to retrieve the most significant portions of the site.

Management measures in Boral's (2017) *Aboriginal Heritage Management Plan* will continue to be implemented at the Quarry, including in the Project area when the Project is approved.

Surface Water Management

Surface water is managed in accordance with Boral's (2017) *Peppertree Quarry Water Management Plan* and is based on segregating 'clean' and 'dirty' water and capturing and reusing stormwater runoff for use in the Quarry processes, dust suppression and environmental controls.

Exposed surfaces on the SWOE, WOE and haul road could erode during rainfall, which could generate sediments that could flow into local waterways then the Shoalhaven River.

The SWOE comprises three catchments which will drain to three sediment basins. Two of the sediment basins will be new and one existing basin will be enlarged. The sediment basins have been sized in accordance with the criteria for fine and dispersive sediments in OEH's (2008) *Managing Urban Stormwater: Soils & Construction – Volume 2E: Mines and Quarries* to capture the 95th percentile five day rainfall, including a 50% allowance for sediment storage.

The WOE comprises six catchments, with most of the clean water catchments diverted around the proposed sediment basins. Some remaining clean water and the dirty water will drain to two proposed sediment basins, with one basin pumped to the Quarry pit sump as required and the other draining into the Quarry's dam on Tangarang Creek (Dam 1).

One sediment basin has been sized for the 90th percentile five day rainfall as it drains to the Quarry pit and the other basin has been sized for the 95th percentile five day rainfall as it discharges to the 'sensitive' environment of Dam 1.

The proposed design and operating standard for the sediment basins is consistent with the objective of achieving a neutral or beneficial effect on the drinking water catchment as required under State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011.

Visual Amenity

The SWOE will be a new area of disturbance at the Quarry and has potential to be visible from publicly accessible areas and private properties. The other Project components will only require minor disturbance or minor rearrangement of existing Quarry components.

The likely visual exposure of the SWOE was analysed using topographic, cadastral and aerial images. Several viewpoints were selected from the total potential viewpoints for further assessment. The key viewpoints were public domain locations including on roads, recreational areas and lookouts, as well as several residential receivers.

Terrain was modelled in two and three dimensions and photomontages were prepared to confirm the visibility of the SWOE. The SWOE will have a low overall visual exposure to its visual catchment. Despite there being several rural properties and commercial operations within 3 km of the closest part of the Project, there is low visual exposure to those receivers and most have no views of it. Two receivers will have minor exposure to the SWOE. The existing eastern and southern overburden emplacements will significantly screen views of the Project.

The WOE is already approved and is of lower visual exposure. It is a small structure and its visual effects are confined to a short section of Marulan South Road. The SWOE and WOE will be progressively rehabilitated/vegetated in accordance with Boral's (2017) *Biodiversity and Rehabilitation Management Plan*.

The visual assessment found that there will be some minor residual visual impacts. The residual visual impacts were considered in relation to the changes to the visual environment that have been approved and occurred in the past and were found to be compatible with both the quarrying/industrial and the rural/natural visual environment.

Traffic and Transport

Potential impacts on traffic and road safety along Marulan South Road from the Project were assessed in accordance with NSW Roads and Maritime Service's (2002) *Guide to Traffic Generating Developments*.

Boral are negotiating with Goulburn Mulwaree Council regarding the purchase and deregistration of the section of Marulan South Road between the Quarry and the Aglime Fertiliser facility's access road, and propose to build an intersection along this section of road.

Two designs are proposed based on the following haulage scenarios from the Quarry pit:

- Marulan South Road to a left turn at the intersection into the SWOE/right turn out of the SWOE onto Marulan South Road; and
- the proposed haul road parallel to Marulan South Road and across Marulan South Road at the intersection into the SWOE.

The intersection will have single lane approaches which will be widened to cater for oversize vehicles. Stop signs were provided on the haul road approaches to Marulan South Road.

Boral may install traffic signals at the intersection should the section of Marulan South Road east of the Aglime facility be deregistered. The signals would suit either scenario and could be vehicle activated or timed, with pre-set phase times.

Peak hour traffic volumes at the intersection were predicted to determine its level of service (LoS). A LoS A was predicted for the proposed signalised and unsignalised intersections, which is the best possible intersection performance.

Conclusion

As outlined in this environmental assessment, the proposed modification is unlikely to result in any significant impacts on either the biophysical or social environment with the implementation of:

- environmental management and mitigation measures outlined in:
  - the Approval;
  - **Section 6** of this document;
- the biodiversity offset strategy; and
- requirements of EPL 13088.

The existing environmental management plans would be reviewed by Boral following approval of the Project and amended as necessary.

The Project is therefore considered to be in the public interest, and is recommended for approval.

Peppertree Quarry

MODIFICATION 5 – ENVIRONMENTAL ASSESSMENT

Prepared for Boral Resources (NSW) Pty Limited
August 2018

PR25

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Date	31 October 2018		31 October 2018

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1 INTRODUCTION

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry at Marulan South in the Goulburn-Mulwaree Local Government Area (LGA), New South Wales.

Boral is seeking to modify Project Approval (PA) 06_0074 (the Approval) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act), to provide for the following (Modification 5/the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

The Minister for Planning is the consent authority for the Project.

Element Environment has prepared this environmental assessment report (EA) on behalf of Boral to document the potential environmental and community impacts associated with the Project.

1.2 The applicant

Boral is a wholly owned subsidiary of Boral Limited and is the applicant for the Project.

Boral is an international building and construction materials group, headquartered in North Sydney, Australia. Boral's competitive position is underpinned by being a market leader in cement and construction materials in Australasia, the BORAL USG Joint Venture plasterboard business in Australia and Asia, and cladding and roof tiles in the USA.

Boral Australia employs over 5,000 people in its quarry, concrete, asphalt, concrete placing and cement operations. The business is a major supplier of products to the dwelling, commercial construction, and roads and engineering markets.

In NSW, Boral operates over 110 quarries, sand pits and gravel operations, producing products such as concrete aggregates, crushed rock, asphalt and sealing aggregates, road base materials, sand and gravels for the Australian construction materials industry.

2 EXISTING ENVIRONMENT AND QUARRY OPERATIONS

2.1 Site description and existing environment

The Quarry is at Marulan South, which is 10 kilometres (km) southeast of Marulan, 35 km east of Goulburn and approximately 175 km south-west of Sydney (**Figure 1**). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Mine) with the Hume Highway approximately 8 km to the northwest (**Figure 2**). Boral's private rail line connects the Quarry and the Mine with the Main Southern Railway approximately 5 km to the north (**Figure 2**).

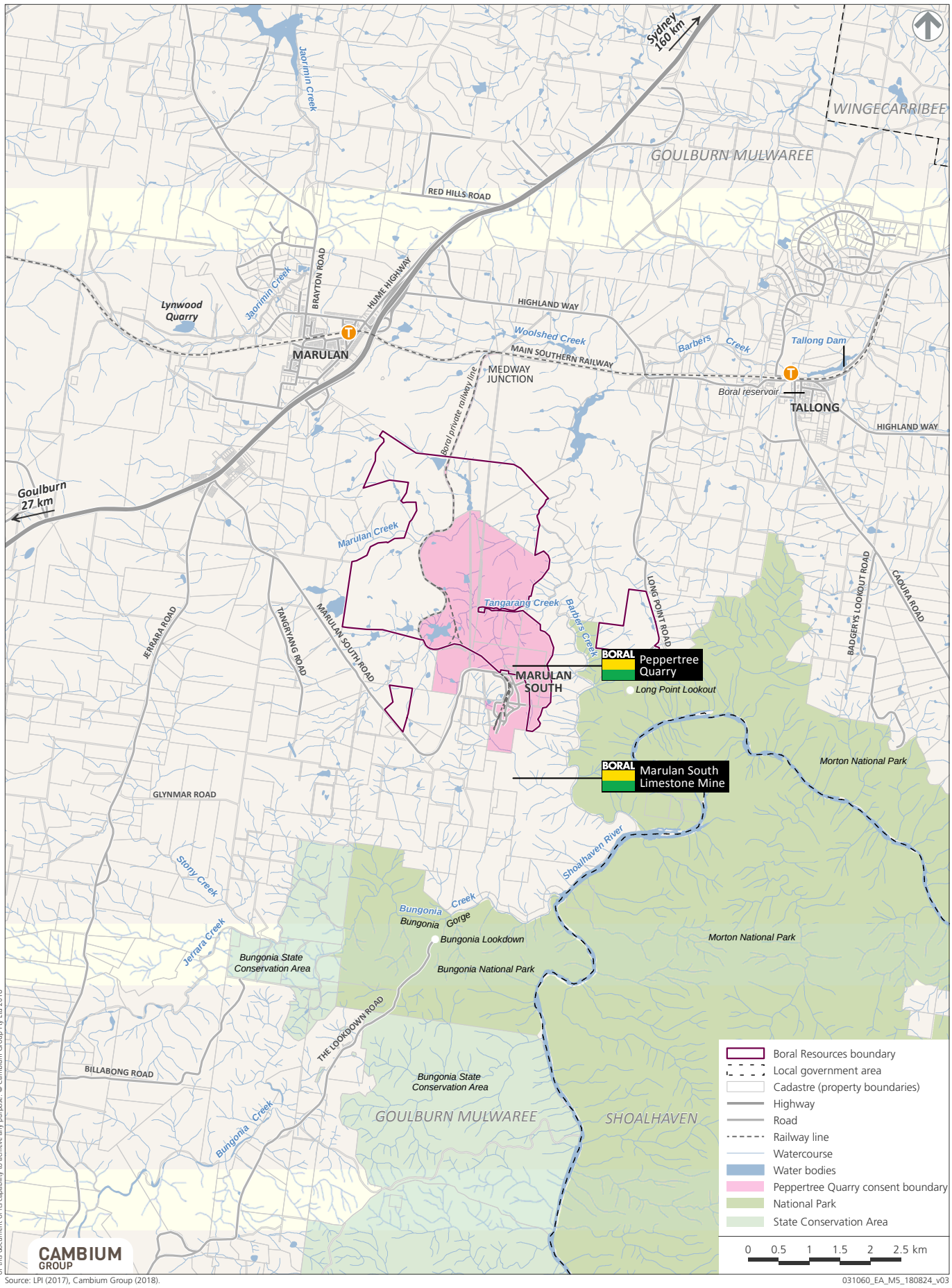
The Quarry (approximately 70 ha) is on Boral owned land, which has a total land holding of approximately 650 hectares (ha) around the Quarry, and includes additional granodiorite resources to the north and south and surrounding land (**Figures 3** and **4**). The land is zoned RU1 - Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 (**Figure 5**). Mining and extractive industries are permissible in this zone with consent.

The Quarry is bordered to the south by the Mine, to the east by Morton National Park and by rural properties to the north and west. Surrounding land uses include mining, grazing, rural properties including an agricultural lime manufacturing facility, fireworks storage facility and a turkey farm. The main access for these properties is via Marulan South Road. Rural residential properties are also to the northeast of the Quarry along Long Point Road. These properties are separated from the Quarry by the deep Barbers Creek gorge. The potentially impacted sensitive receivers are shown on **Figure 2**.

The site of the former village of Marulan South is located between the Quarry and the Mine on Boral owned land. The village was established principally to service the Mine but has been uninhabited since the late 1990s. The majority of the village's infrastructure has been removed and only a village hall and former bowling club remains. The bowling club has been converted into administration offices for the Mine.

Figure 1
Regional context

PEPPERTREE QUARRY MODIFICATION 5
ENVIRONMENTAL ASSESSMENT

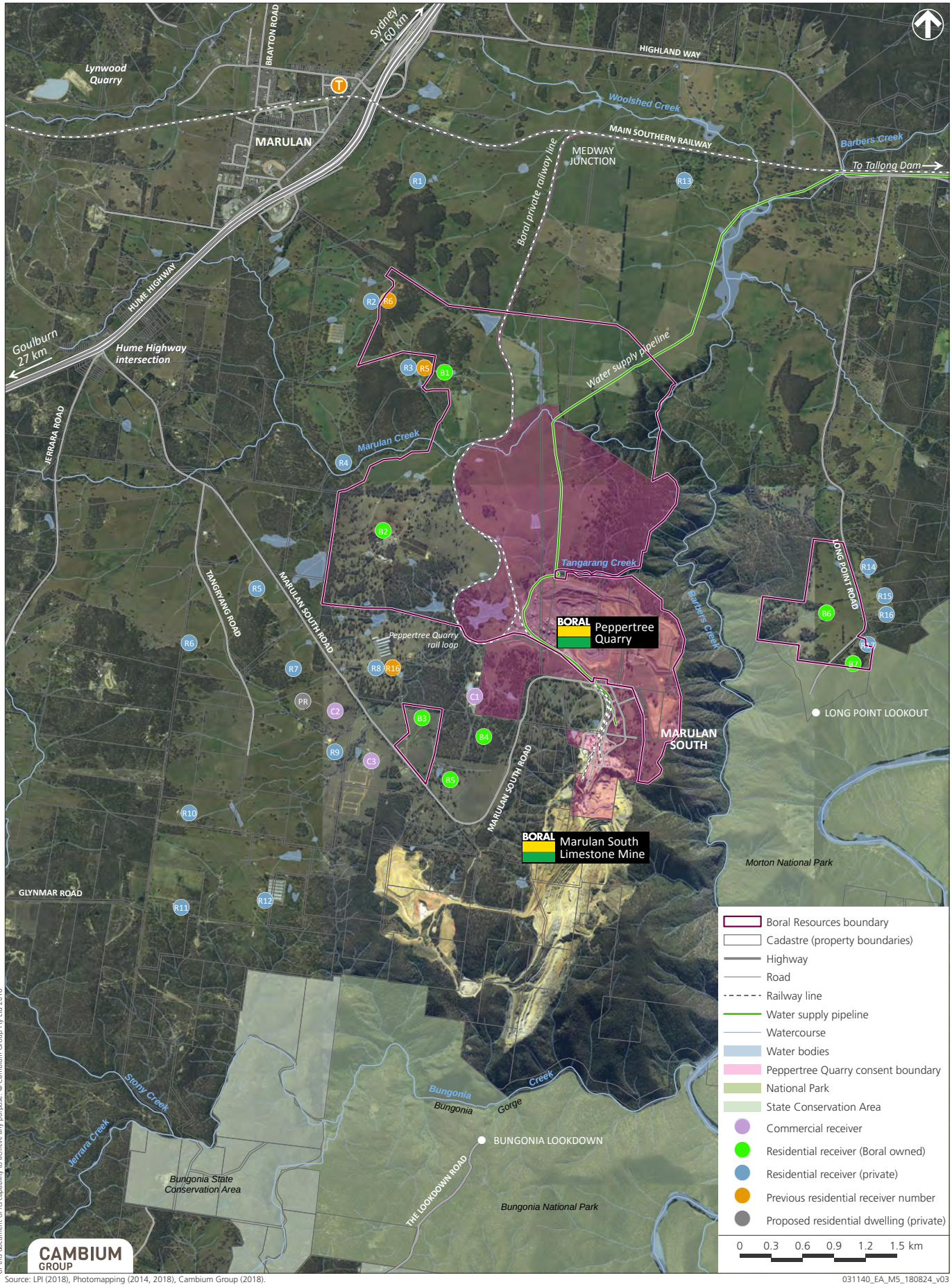


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Figure 2
Local context

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ENVIRONMENTAL ASSESSMENT

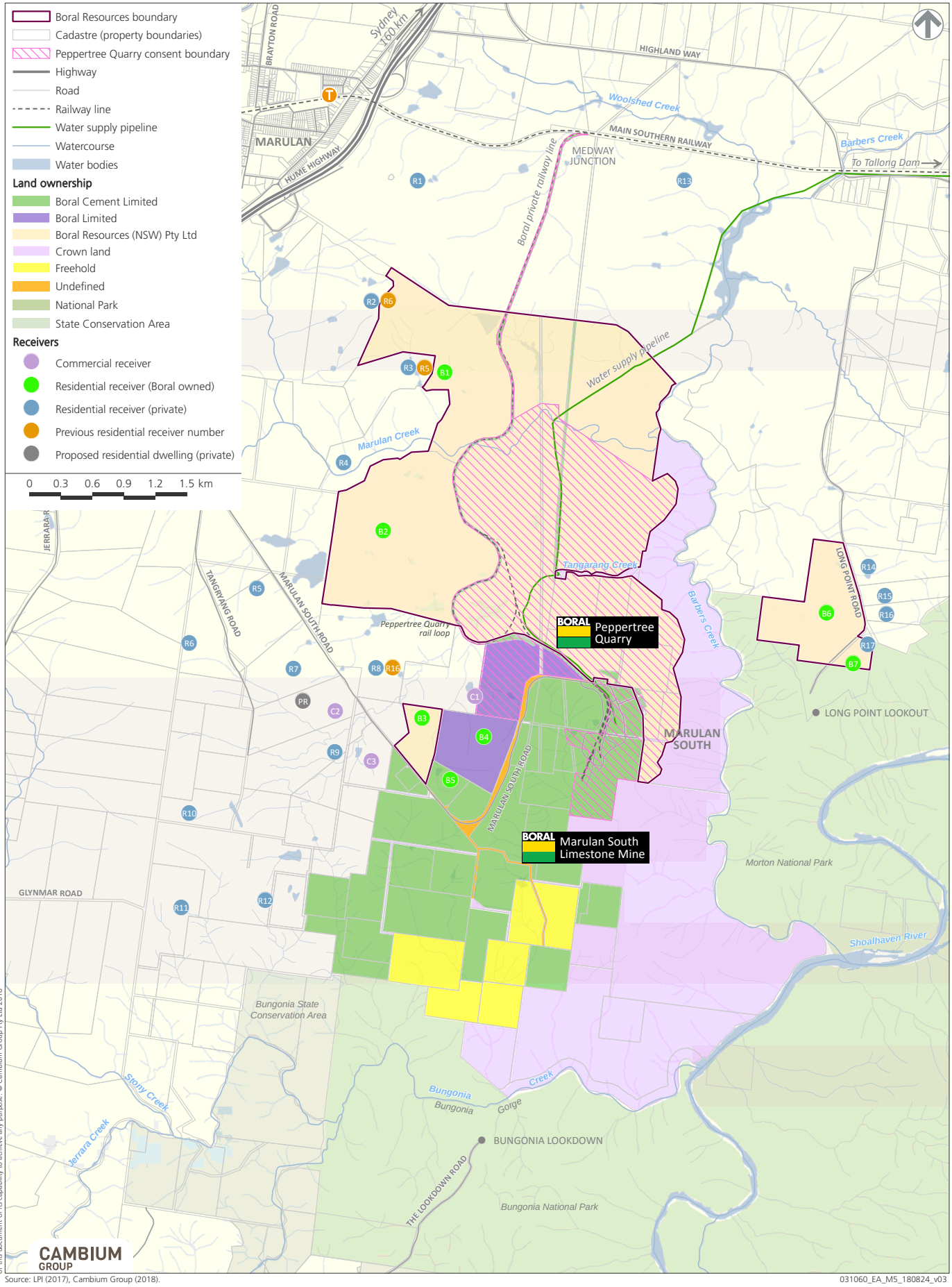


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Figure 3
Land ownership

PEPPERTREE QUARRY MODIFICATION 5
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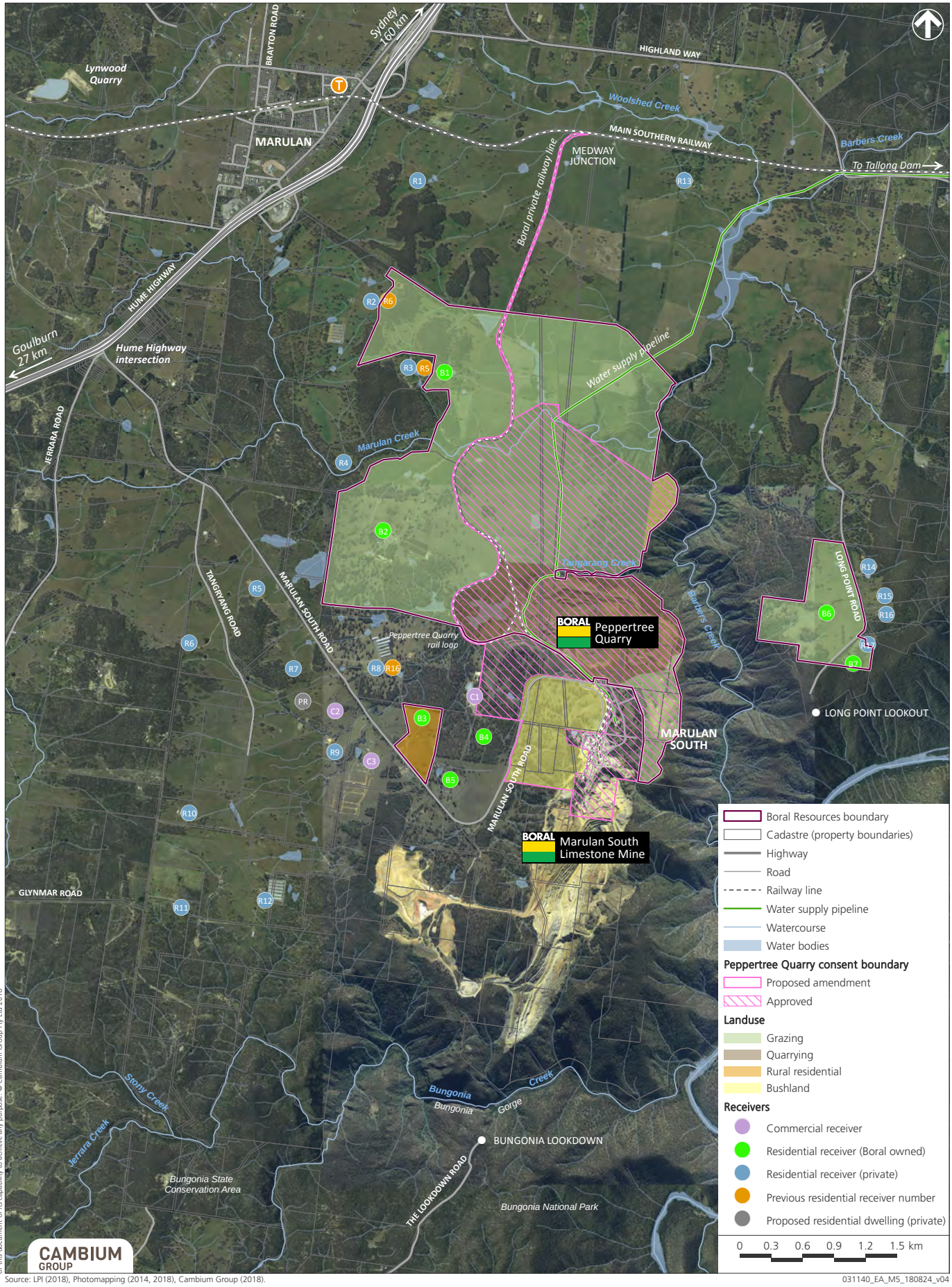
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Figure 4
Landuse

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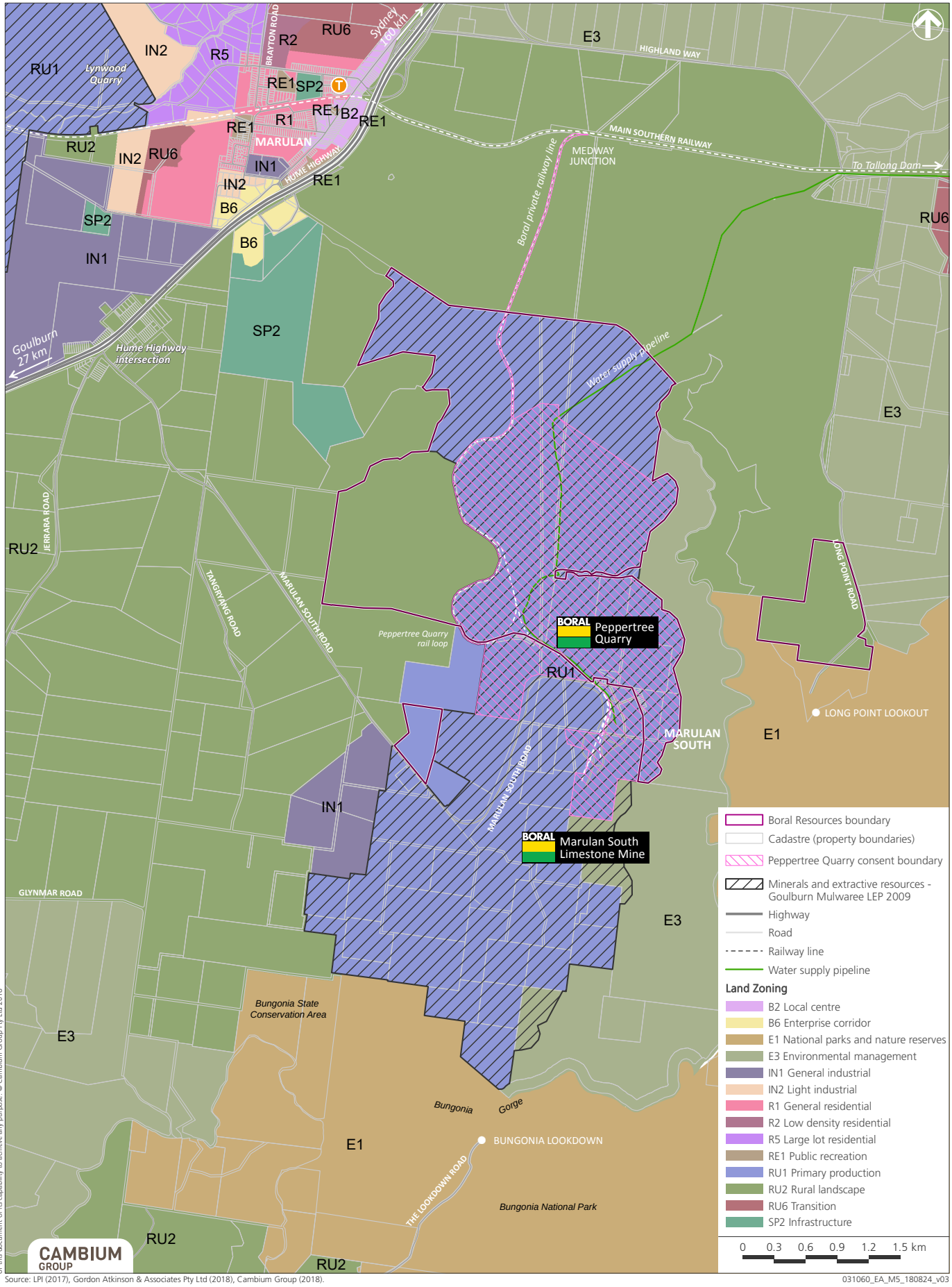
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Figure 5
Land zoning

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2.2 Operational history

The greater Sydney metropolitan area has traditionally been the Australian building and construction sector's major market.

Boral is a leading producer and supplier of building and construction materials in the country. Accordingly, a significant amount of development in Sydney, including many of the city's best known structures, are underpinned by Boral-supplied cement, concrete, and asphalt.

Concrete and asphalt are generated using course and fine hard rock aggregates. Since the 1800s, the majority of Sydney's aggregate and sand demand has been supplied from quarries extracting sand and gravel from the Nepean River flood plain near Penrith in Western Sydney.

These quarries, including the Boral Emu Plains site, are now exhausted of their sand and gravel (hard rock) resources.

Boral commenced planning for alternative sources of aggregate in the early 2000s to secure supply to its concrete, asphalt and other operations in Sydney.

This planning led to the establishment of the Quarry, as well as the construction of a new rail-to-road transfer terminal at Maldon, near Picton, to complement Boral's other rail terminals at St Peters and Enfield.

2.3 Planning approval history

The Quarry obtained Project approval from the Minister for Planning in 2007 under Part 3A of the EP&A Act. Project approval PA 06_0074 has since been modified four times as outlined in **Table 1.**

Table 1 Planning approval history

Date of Planning Approval	DA/MOD Number	Details
28 February 2007	PA06_0074	The "Marulan South hard rock quarry and associated infrastructure" project was granted approval by the Minster for Planning under Part 3A of the EP&A Act.
17 March 2009	Modification 1 PA06_0074	Approved under Section 75W of the EP&A Act for the construction of an exploratory test pit to extract a suitable amount of granodiorite to test and model rock behaviour and to assist with the design of plant and equipment for the Quarry.
3 November 2011	Modification 2 PA06_0074	Approved under Section 75W of the EP&A Act for infrastructure and site layout changes including the: ▪ Construction of a new rail loop embankment and overburden emplacement; ▪ Reduction in the water storage dam size; and ▪ Relocation of loading facilities,

Date of Planning Approval	DA/MOD Number	Details
		processing plant and stockpiling.
2 November 2012	Modification 3 PA06_0074	Approved under Section 75W of the EP&A Act for power and rail infrastructure changes including the: ▪ Construction of a High Voltage (HV) line approximately 1km in length; and ▪ Construction of an extension to the existing passing line on Boral's private rail line at Medway Junction.
24 August 2016	Modification 4 PA06_0074	Approved under Section 75W of the EP&A Act for the: ▪ construction of a new overburden emplacement area; and ▪ extension of in-pit operating hours.

The consolidated modified Approval for the Quarry is attached to this document as **Appendix A**.

2.4 Environment protection licence

The NSW *Protection of the Environment Operations Act 1997* (PoEO Act) provides for an integrated system of licensing and contains a core list of activities requiring environment protection licences (EPL) from the NSW Environment Protection Authority (EPA). The activities are called 'scheduled activities' and are listed in Schedule 1 of the Act.

The Quarry operates under EPL No. 13088. The existing EPL would be reviewed by Boral following a notice of approval regarding the Project. If variations to the EPL are required as a result of the Project, an application to vary the EPL would be submitted to the EPA.

2.5 Land ownership

Part of the land associated with the Project is owned by Boral Resources (NSW) Pty Limited and part is owned by Boral Limited and Boral Cement Limited (refer to **Figure 3**). Landowner consent will be sought from Boral Limited and Boral Cement Limited.

2.6 Approved project

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1 - 2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for producing a range of quarry products. The hard rock aggregates produced at the site range in size and shape for different purposes. Primarily, production is of concrete and asphalt aggregates, however, road bases, railway ballast, armour rock and gabion can also be produced. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, a water storage dam, an in-pit mobile crushing plant, overburden emplacement areas, noise

and visual bunding, product stockpiles, and staff facilities. The location of infrastructure at the Quarry is shown on **Figure 7**.

Work to establish the Quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

2.6.1 Quarry activities

Typical quarrying operations involve the stripping of overburden and the extraction of hard rock using open-cut drill and blast techniques.

Overburden is stripped by dozer, loaded onto trucks using excavators and/or front end loaders and transported to the overburden emplacement areas, where it is spread and shaped by dozer.

Traditional drill and blast methods are then used to break up the hard rock. A drill rig stationed on top of each production bench drills a series of holes that are later charged with explosives before detonation. Boral apply standard practice of limiting the maximum instantaneous charge as well using electronic detonators to stay within the relevant noise and vibration criteria.

Blasted rock is then processed on-site using crushers and screens to obtain the desired product. Material is initially crushed in a primary mobile crusher in the pit, which is fed by an excavator, front end loaders and trucks. In the future in-pit works will avoid the use of trucks, with blasted rock fed directly into the primary mobile crusher by excavator. After passing through the primary crusher, the crushed material is taken from the pit along a series of conveyors to the first set of screens located to the northwest of the pit. From there the processed material is stockpiled in a surge pile. Material in the surge pile is reclaimed and conveyed to the main processing area where it undergoes further crushing, screening and shaping. Product material is stored in the various covered storage bins prior to being dispatched off-site by train.

2.6.2 Transport of product

Product from the Quarry is transported entirely by rail with the exception of transportation of donated materials and in an emergency where it would be transported by road with the written approval of the Secretary of the NSW Department of Planning and Environment (DP&E). The Quarry has approval to transport up to 3.5 Mtpa of product from the site. At full production the Quarry will operate up to four trains per day which will transport product north to the Sydney market and other customers. In addition, the Mine operates up to six trains per day transporting product north to Berrima and Maldon and east to Port Kembla.

Trains to the Quarry and the Mine access Boral's private rail line from the Main Southern Railway at Medway Junction (**Figure 2**). A rail loop has been constructed at the Quarry for separation of rail movements on the rail line between the two Boral sites. Rail loading facilities were also established on the rail loop adjacent to the Quarry's processing plant.

Loading of product from the Quarry onto trains and train movements occur 24 hours, seven days a week. This enables train trips on the Main Southern Railway to be scheduled away from peak commuter times.

2.6.3 Operating hours and workforce

The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5 am to 11 pm. Approved operating hours are outlined in detail in **Table 2**.

Table 2 Approved operating hours

Activity	Day	Time
Construction works	Monday-Friday Saturday Sunday and Public Holidays	7.00am to 6.00pm 8.00am to 1.00pm None
Topsoil/overburden removal/emplacement	Any day	7.00am to 7.00pm
Blasting	Monday-Saturday Sunday and Public Holidays	9.00am to 5.00pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00am to 11.00pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

Employment at the Quarry includes 41 full time persons distributed over 2 to 3 shifts.

2.7 Environmental management and monitoring

Boral has prepared and implemented the following environmental management plans at the Quarry in accordance with PA06_0074:

- Boral (2017) Environmental Management Strategy;
- Boral (2017) Noise and Blast Management Plan;
- Boral (2017) Air Quality Management Plan;
- Boral (2017) Water Management Plan which includes:
  - site water balance;
  - erosion and sediment control measures;
  - surface and ground water monitoring program; and
  - surface and ground water response plans;
- Boral (2016) Pollution Incident Response Management Plan;
- Boral (2017) Aboriginal Heritage Management Plan; and
- Boral (2017) Biodiversity and Rehabilitation Management Plan.

Boral also maintains a comprehensive environmental monitoring network at and surrounding the Quarry (**Figure 6**). Data captured from these environmental monitors is used by Quarry management to monitor compliance with their Approval, EPL, and other regulatory requirements.

In accordance with PA06_0074, Boral has also prepared and implemented an environmental management strategy, which is an overarching strategy for implementation of environmental management measures at the Quarry, and an environmental monitoring program, which consolidates all the various monitoring requirements at the Quarry.

The existing environmental management plans would be reviewed by Boral following a notice of approval regarding the Project. If amendments to the above documents are required as a result of the Project they will be undertaken within three months of the notice of approval and submitted to DP&E for endorsement in accordance with Schedule 5, Condition 3 of PA06_0074 (**Appendix A**).

2.8 Environmental performance

The environmental management and monitoring regime as outlined in **Section 2.7** has been in effect for a number of years and has facilitated the operation of the Quarry in an environmentally responsible manner.

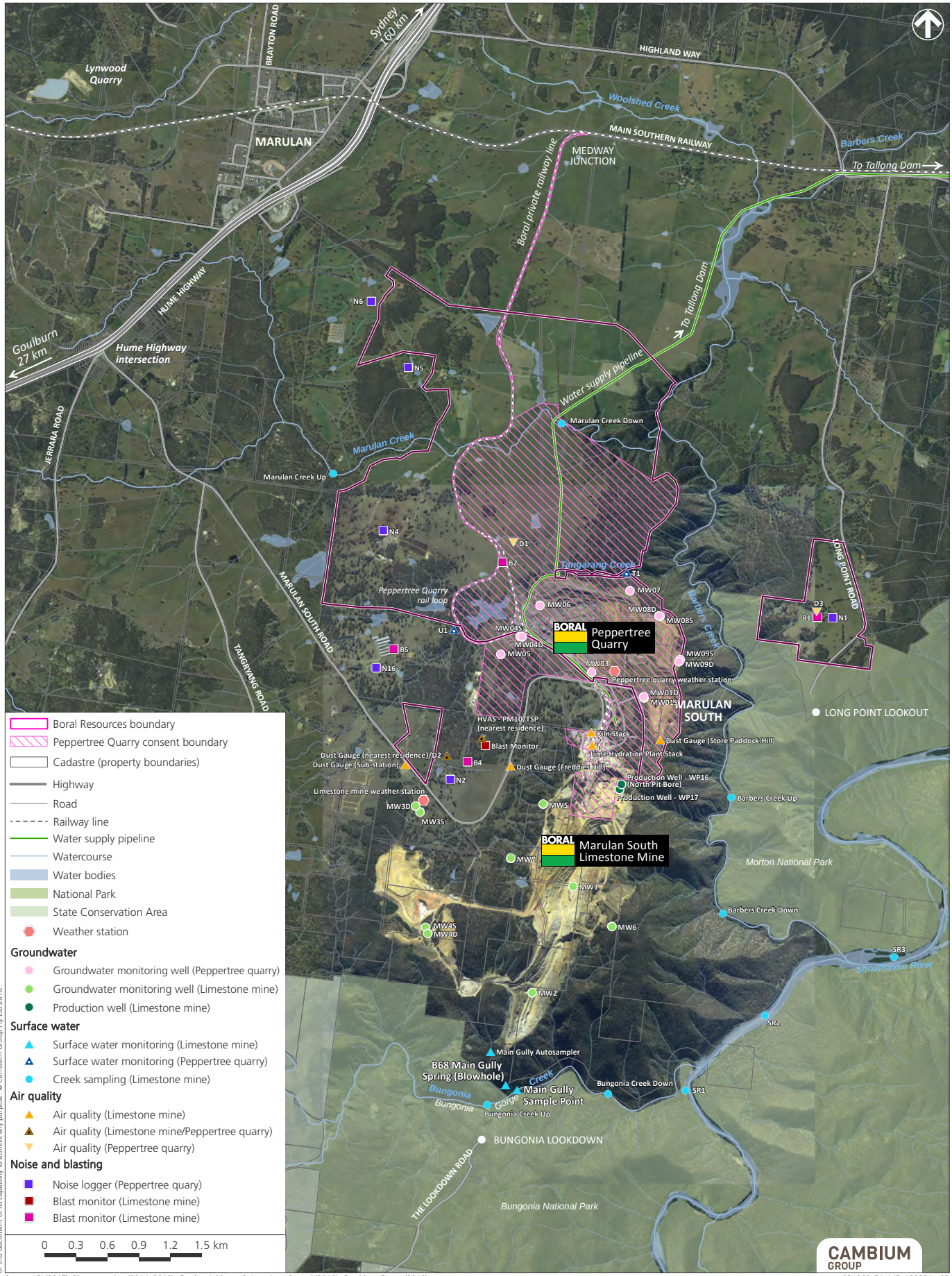
The most recent independent environmental audit was concluded by Arcadis in October 2016 as required by Schedule 5 Condition 6 of PA 06_0074. The audit found that 11 of 60 conditions were not complied with, or were partially complied with. The discrepancies mostly related to inadequacies in record keeping and management of correspondence, document control and equipment failure. None of the discrepancies posed a direct environmental risk, however, those related to monitoring posed a non-direct risk as the purpose of monitoring is to enable early detection of issues.

- The most recent annual environmental management report (AEMR) was prepared in March 2018 for the 2017 calendar year, as required by Schedule 5 Condition 10 of PA 06_0074 (ECS 2017). The following trends and outcomes were reported:
- Air quality –
    - Deposited dust results at one gauge were below criteria and results at the other two gauges were just on the criteria, due to a high content of organic matter (which is not associated with quarrying activities).
    - 24 hour average PM10 criterion was marginally exceeded five times, with investigations showing these to not be associated with the previous 24 hours of quarry operations.
    - Total suspended solids results were below the annual average criterion.
- Noise – noise levels caused concern to the occupants of one receiver (R3) and Boral has commenced a voluntary undertaking with DPE for measures to reduce noise at the residence.
- Blasting – the 43 blasts during the reporting period all complied with criteria.
- Surface water – the surface water quality results were consistent with historic trends.
- Groundwater – the monitoring network had only recently been installed and as such a long term dataset was not available for comparison. Notwithstanding, initial data indicate high fluctuations in pH across bores at and outside the Quarry; concentrations of nutrients exceeded Australia and New Zealand Environment Conservation Council (ANZECC) threshold values, which indicates high background levels; and organic analytes were not detected at the majority of bores.

An official caution was issued by DPE on 21 December 2017 regarding an exceedance of operational noise criteria on 12 July 2017. The caution notice required Boral to comply with the voluntary undertaking dated 6 November 2017.

Figure 6
Environmental monitoring locations

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3 PROPOSED MODIFICATIONS

3.1 Description of modifications

Boral is seeking to modify the Approval to:

- develop a new overburden area (SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the WOE;
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

3.2 Justification for the proposed modifications

Overburden emplacement at the Quarry is approved in (refer to **Figure 7**):

- noise bunds along the northern and eastern boundaries of the site;
- Western Overburden Emplacement;
- Southern Overburden Emplacement;
- Eastern Overburden Emplacement; and
- noise bund to the west of the Quarry that crosses Marulan South Road between Boral's private railway line and the entrance to the Quarry.

Remaining overburden was proposed to be emplaced within the south pit of Boral's adjoining Mine.

The noise bunds were completed during construction of the Quarry, the Eastern Overburden Emplacement reached capacity in 2017 and the Western Overburden Emplacement and Southern Overburden Emplacement will be completed by late 2018.

Mine planning for the Mine has ruled out emplacement of the Quarry's remaining overburden in the south pit. There is some limestone remaining in the south pit and extraction of this will continue beyond the Quarry's need for additional overburden emplacement space. Additionally, as much in-pit space as possible needs to be created in the south pit to minimise the need for future out of pit emplacements at the Mine.

The Mine, under its forthcoming development application, was seeking to hold 5 million m^3 (approximately 13 Mt) of overburden for the Quarry. However, the Mine's SSD application is unlikely to be determined until 2019. As the Quarry will run out of overburden emplacement space in 2018, Boral is seeking approval to incorporate this approximately 13 Mt overburden emplacement into the Approval.

The proposed location for the SWOE does not overlie any limestone or granodiorite resources, which means it will not sterilise future access to limestone or granodiorite resources.

Alternative locations for the SWOE on Boral owned land were considered and discounted on noise or logistical grounds. These alternatives included:

- An area of Boral owned land outside the Peppertree Quarry consent to the north of Tangarang Dam and north-west of the rail loop (Figure 8). This site was discounted for the following reasons:
  - Noise – potential noise impacts from this site were subject to a high level modelling exercise. The alternate location would be closer to receivers than other options (for example approximately 700 m from R4 versus 1,600 m from the SWOE to its nearest receiver). The modelling showed receivers R3 (37 dBA), R4 (35 dBA) and R7 (35 dBA) would be at or in exceedance of the Approval's daytime noise criteria of 35 dBA. Additionally, the difference in noise levels for R3 and R4 between the SWOE and this option would be 6 dBA, which would be a significant perceived change.
  - Visual amenity – when complete, the top of the emplacement would have been 650 m RL, which would have been approximately 36 m higher than the residence at R6. Therefore, the emplacement activities and the unrehabilitated, and eventually rehabilitated, landform would be visible from that receiver.
  - Aboriginal heritage – previous investigations of similar landscapes (relatively flat and broad spurs near a water course) have indicated such areas have medium archaeological sensitivity. In this case, the emplacement would have been on such a landform between two major waterways for the area; Marulan Creek and Tangarang Creek, suggesting it would be likely that items would be encountered.
  - Biodiversity – the area contains degraded Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands, which is listed as an endangered ecological community under the NSW *Biodiversity Conservation Act 2016* and a critically endangered ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
  - requires a longer haulage distance resulting in greater dust and greenhouse gas emissions.
- A patch of Boral owned land (within the Peppertree Quarry consent boundary) bordered by the Western Overburden Emplacement to the north-east, Boral's private railway line to the north, the agricultural lime manufacturing facility to the west, the agricultural lime manufacturing facility's driveway to the south and Marulan South Road to the east. This site was discounted as it:
  - is located significantly closer to sensitive receivers than the proposed SWOE site, with associated noise implications;
  - would be near Tangarang Creek, an area with likely high archaeological sensitivity;
  - would be in an area of Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands; and
  - requires a longer haulage distance resulting in greater dust and greenhouse gas emissions.
- An area of Boral owned land (within the Peppertree Quarry consent boundary) located immediately north of Tangarang Creek. This site was discounted as it is:
  - located closer to sensitive receivers than the proposed site, with associated noise implications;
  - likely to be of higher aboriginal heritage significance due to its proximity to a prominent creek – Tangarang Creek;

- logistically more complex as trucks need to drive through the processing plant and cross the Tangarang Dam wall to access the site; and
- the location of an additional approved water supply dam for the Quarry.

The location for the proposed SWOE was therefore selected as the preferred location due to the following:

- it is located the furthest from noise sensitive receivers;
- trucks don't need to drive through the processing plant and cross the Tangarang Dam wall; and
- the site has limited Aboriginal heritage values.

3.3 Description of the proposed modifications

3.3.1 South-western Overburden Emplacement

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Mine (refer to **Figure 7**). This new overburden emplacement area will be needed in late 2018 and will involve emplacement campaigns spread over approximately eight years.

The emplacement will cover approximately 44 ha and will require the clearing of approximately 28 ha of EEC **(Figure 8**). The highest point of the SWOE will be RL650 m at completion.

Prior to the emplacement of overburden, the toe of the emplacement will be identified on site, stormwater management and erosion control infrastructure installed and trees and shrubs removed.

Overburden stripped from the pit will be transported by trucks along the most direct haul route possible (refer to **Figure 7**), to the proposed emplacement where it will be spread and shaped by dozer.

The SWOE will be landscaped and rehabilitated in accordance with the *Biodiversity and Rehabilitation Management Plan* (2017) as outlined in **Section 6.9**.

Overburden removal and emplacement will continue within the current approved hours of 7am to 7pm Monday to Sunday.

The SWOE will impact on matters of national environmental significance (MNES), as described in Section 4.1.

3.3.2 Haul routes

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. The haul road will be two-lane and will be approximately 420 m long and 20 m wide. It will run west from the pit, adjacent to Marulan South Road to a proposed intersection, then south to the SWOE.

Prior to construction, erosion and sedimentation controls will be installed, approximately two additional trees removed (which are not already approved for removal associated with the Quarry pit) and topsoil stripped along the road route. Road base will then be laid and compacted.

An alternative haul route would involve trucks joining Marulan South Road at its eastern end (where it terminates at the old Marulan South township), travelling west along Marulan South Road and turning left into the SWOE at the proposed intersection. This haul route will

only be used once the section of Marulan South Road east of the agricultural lime manufacturing facility driveway, has been deregistered.

3.3.3 Intersection

A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE or to travel west and east along Marulan South Road turning left in and right out of the SWOE. The intersection may eventually be signalised when the section of Marulan South Road in the vicinity of the Quarry and Mine is de-registered and transferred to Boral ownership (this process is subject to ongoing negotiations with Council).

3.3.4 Powerline relocation

The powerline which supplies electricity to the Mine passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent (immediately west of the railway line), where it will connect to an existing overhead powerline that diverts south into the Mine's infrastructure area (refer to **Figure 7**).

The powerline will be approximately 1,300 m long and will require an approximately 25 m wide easement along its length for short spans and 25 m for longer spans. Vegetation including EEC will need to be cleared along its route, which has been taken into account in the total Project disturbance footprint and associated biodiversity offsetting calculations.

Boral proposes an amendment to the Quarry's consent boundary to the south as shown on **Figure 7** to encompass the SWOE. The amended boundary would be entirely contained on land owned by Boral Resources (NSW) Pty Limited, Boral Limited and Boral Cement Limited.

3.3.5 Western Overburden Emplacement

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Mine. Although approval for the shared road sales stockpile area will be sought by the Mine, under its forthcoming development application, the Quarry needs to seek an amendment to the approved WOE to accommodate the future shared road sales stockpile area.

The approved WOE comprises:

- a 10 m high elongated section (bund), located to the south of the railway line, extending the length of the processing plant; and
- a 30 m high triangular emplacement, extending south-east from the 20 m high elongated bund.

The WOE had a dual purpose of storing overburden and increasing noise attenuation from quarrying operations.

The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

3.3.6 Western Earth Bund

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the approved project. Doing this will not result in increased noise impacts to receivers in the west and south-west as the raised western section of the WOE will be retained and the proposed SWOE will be constructed between the pit and receivers in the south-west.

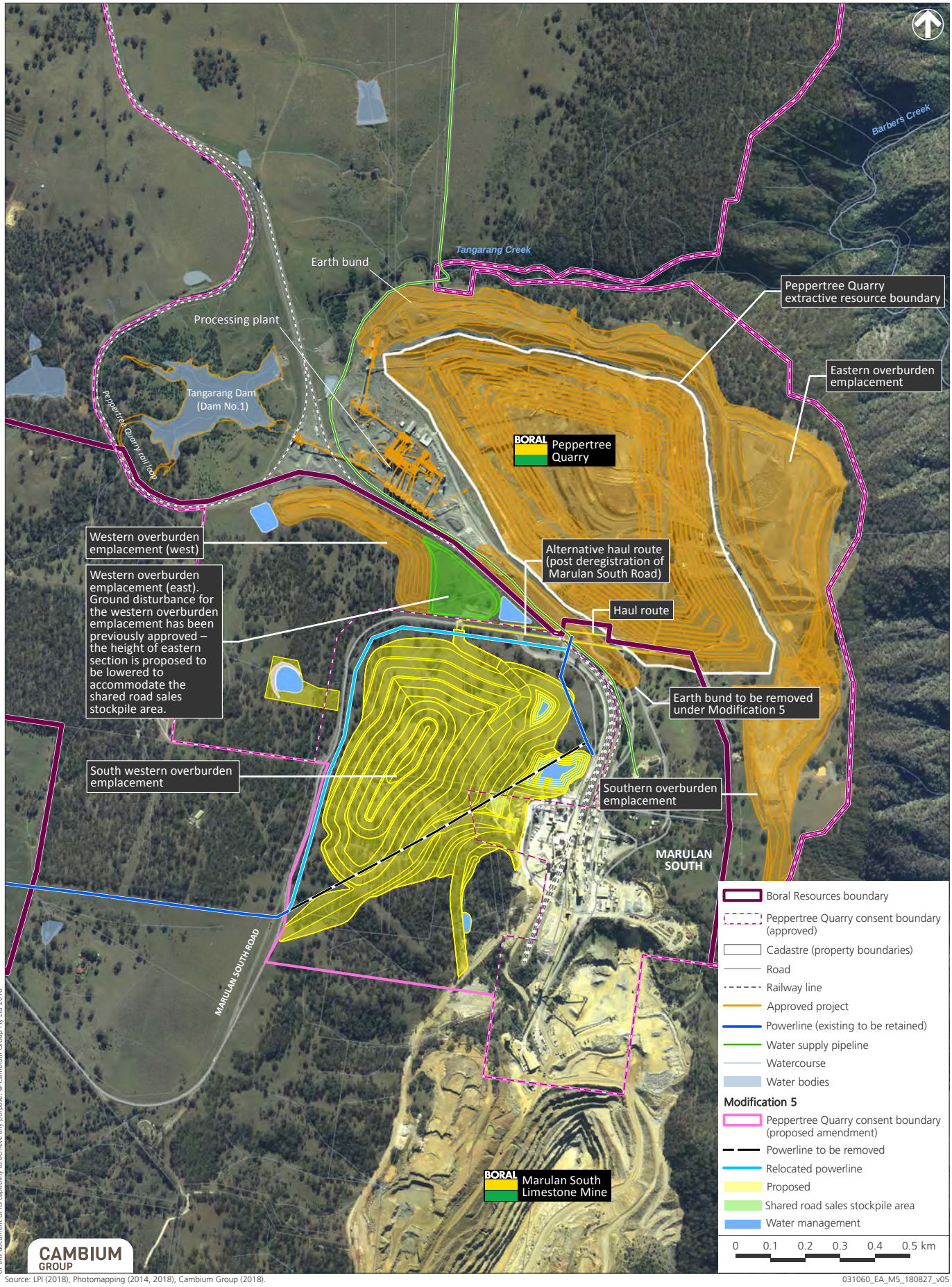
3.4 Comparison against approved project

Other than the proposed modifications outlined in **Section 3.3**, there will be no changes to any other aspects of the approved project.

The changes in approved environmental impacts resulting from the Project are discussed in **Section 6** of this report.

Figure 7
The Project

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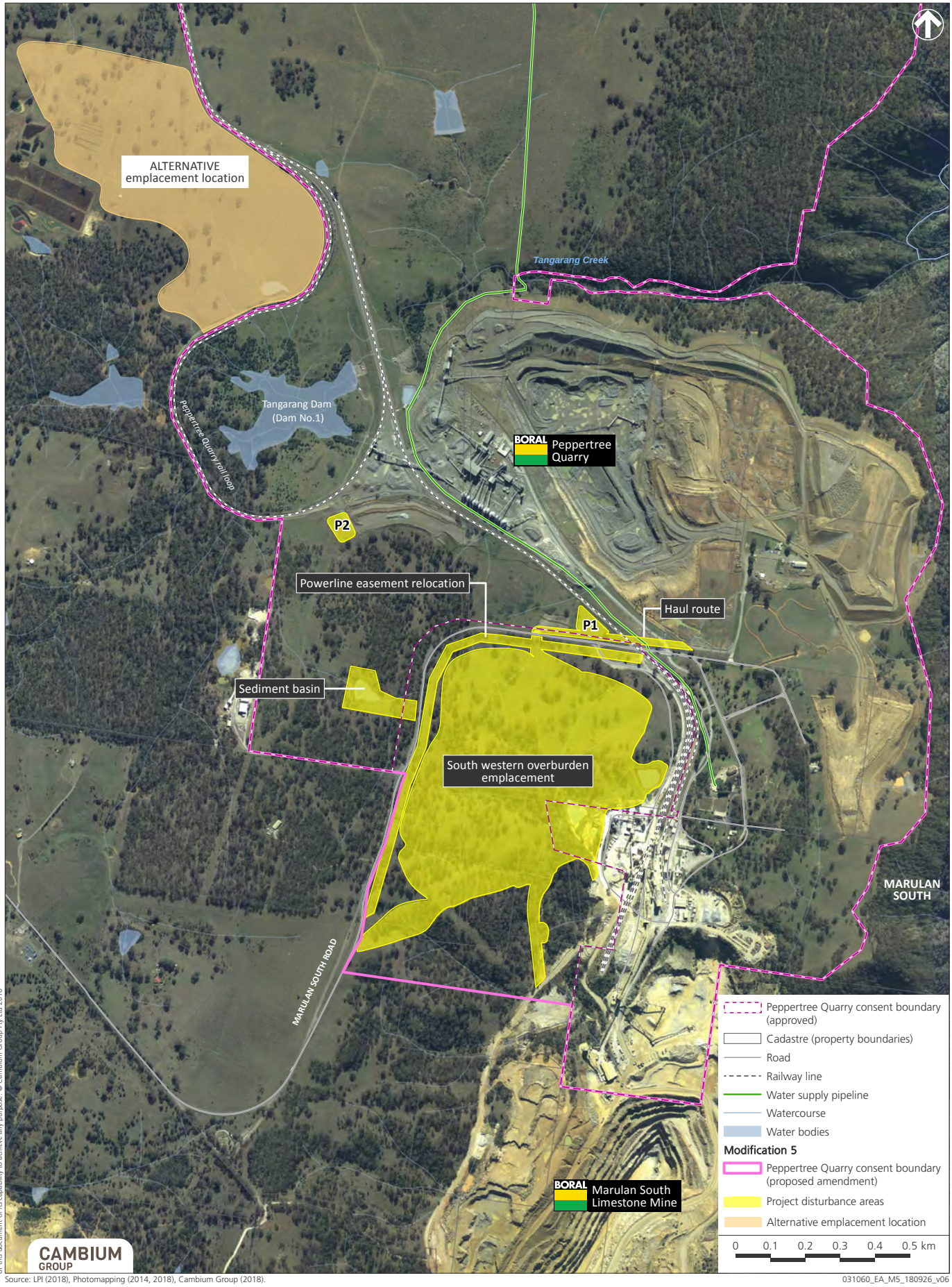
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Figure 8
Project disturbance areas

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4 LEGISLATIVE PLANNING CONSIDERATIONS

Boral seeks to modify PA06_0074, as described in **Section 3**, under Section 75W of the EP&A Act.

The following section identifies the applicable Commonwealth and State environment and planning legislation, local planning instruments, and discusses the relevant planning approval process applicable to the Project.

4.1 Commonwealth legislation

A review of the current Commonwealth legislation that is relevant to the Project is provided in **Table 3**.

Table 3 Summary of Commonwealth legislation and relevance to the Project

Planning Provision	Comments	Further Approvals and Requirements
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Under the EPBC Act, approval from the Minister for the Environment is required for any action that would result in a significant impact on MNES. The nine MNES are: ▪ world heritage properties; ▪ national heritage places; ▪ wetlands of international importance (Ramsar wetlands); ▪ nationally threatened species and ecological communities; ▪ migratory species; ▪ Commonwealth marine areas; ▪ the Great Barrier Reef Marine Park; ▪ nuclear actions (including uranium mining); ▪ a water resource, in relation to coal seam gas development and large coal mining development. A biodiversity assessment has been undertaken for the new areas proposed to be disturbed for the SWOE, powerline and haul road, which identified that one endangered ecological community (EEC) would be impacted by the Project, namely 'White Box Yellow Box Blakely's Red Gum Grassy Woodland', which is listed as an EEC under the *NSW Biodiversity Conservation Act 2017* (BC Act) and critically endangered ecological community (CEEC) under the EPBC Act. In total, the Project would result in the disturbance of approximately 28 ha of the EEC/CEEC. To satisfy the EPBC Act requirements, a MNES assessment of significance was conducted and concluded that the Project is unlikely to significantly impact the CEEC. Additionally, seven threatened and migratory fauna listed on the TSC Act and/or EPBC Act could be impacted by the Project. A MNES assessment of significance was completed for each of these species. The assessments concluded that the Project is unlikely to result in a significant impact on any EPBC Act listed threatened or migratory fauna species. A search of the EPBC Protected Matters Search Tool in February	Yes

Planning Provision	Comments	Further Approvals and Requirements
	2017 did not identify any additional MNES which may be impacted by the Project. The Project has been referred to the Commonwealth Department of Environment and Energy (DoEE) due the potential impacts on the CEEC. DoEE advised that the impacts can be assessed under the bilateral agreement between the Commonwealth and NSW and, therefore, a public environment report does not need to be prepared under the EPBC Act. Boral's adjacent Mine was declared a controlled action on 10 September 2015, and relates to the Project in the way described in Section 3.2.	
Native Title Act 1993 (NT Act)	The NT Act is administered by the National Native Title Tribunal. The Tribunal is responsible for maintaining a register of native title claimants and bodies to whom native title rights have been granted. The NT Act prescribes that native title can be extinguished under certain circumstances, including the granting of freehold land.	No
National Greenhouse & Energy Reporting Act 2007 (NGER Act)	The NGER Act provides a single national framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas projects, and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds. Boral triggers the threshold for reporting under the NGER Act, and reports energy use and greenhouse gas emissions from its operations, including the Quarry. Boral would continue to monitor and report energy use and greenhouse gas emissions associated with the modified Quarry operation in accordance with its obligations under the NGER Act.	No

DoEE declared the Project a controlled action on 15 October 2018 and DPE issued supplementary SEARs containing the Commonwealth's assessment requirements on 17 October 2018. The supplementary SEARs are in **Table 4** Supplementary SEARs, including the EA and appendix locations they are addressed.

Table 4 Supplementary SEARs

No.	Supplementary SEAR	EA reference/comment
Introduction		
3	The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in paragraph 1. A list of protected matters the Department of the Environment and Energy considered likely to be significantly impacted is provided in **Attachment A** to these Guidelines. Note that this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under this controlling provision, likely to be significantly impacted, are assessed for the Commonwealth decision-maker's consideration.	**EA** Section 6.4 **Appendix D** Section 4.7.2, Appendix 8
General requirements		

No.	Supplementary SEAR	EA reference/comment
4	The EA must, in addition to providing sufficient information for a decision, address the matters outlined in Schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000 (*Cth). The following includes requirements that have been identified as additional to the requirements prescribed in Schedule 2 of the NSW *Environmental Planning and Assessment Regulations 2000*. Proponents are advised to check that requirements in Schedule 4 of the EPBC Regulations have been appropriately addressed.	See following table sections and Appendix D.
Project description		
5	The title of the action, background to the action of the action and current status.	**EA** Section 1.1, Section 2.2, Section 2.3
6	The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	**EA** Section 2.1, Figure 3, Figure 7
7	How the action relates to any other actions that have been, or are being taken in the region affected by the action.	**EA** Section 3.2, Section 3.3.1
8	How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	**EA** Section 3.2, Section 3.3.1
9	A justification for the proposal including consideration of any less detrimental sites for the emplacement area, for example other cleared sites within the property boundary.	**EA** Section 3.2 **Appendix D** Section 5.1.1
Impacts		
10	The EA must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including:	
i	a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts;	**EA** Section 6.4.2 **Appendix D** Table 9
ii	a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;	**Appendix D** Table 9
iii	analysis of the significance of the relevant impacts; and	**Appendix D** Table 9
iv	any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	**Appendix D** Table 9
Avoidance, mitigation and offsetting		
11	For each of the relevant matters protected that are likely to be significantly impacted by the action, the EA must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including:	**EA** Section 6.4.3
i	a description, and an assessment of the expected or predicted effectiveness of the mitigation measures;	**Appendix D** Table 10, Section 5.1
ii	any statutory policy basis for the mitigation measures;	**Appendix D** Section 5.1
iii	the cost of the mitigation measures;	**Appendix D** Section 5.3.2
iv	an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing; and	**Appendix D** Appendix 9

No.	Supplementary SEAR	EA reference/comment
v	the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Secretary of DPE (refer to Boral 2017 *Peppertree Quarry: Biodiversity and Rehabilitation Management Plan*
12	Where a significant residual adverse impact to a relevant protected matter is considered likely, the EA must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	**EA** Section 6.4.3, Section 6.4.4 **Appendix D** Section 6
13	For each of the relevant matters likely to be impacted by the action the EA must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any:	
i	conservation advice or recovery plan for the species or community;	**Appendix D** Appendix 8
ii	relevant threat abatement plan for a process that threatens the species or community;	**Appendix D** Appendix 8
iii	wildlife conservation plan for the species; and	**Appendix D** Appendix 8
iv	any strategic assessment.	**Appendix D** Appendix 8
Key issues **Biodiversity (threatened species and communities)**		
14	The EA must identify each EPBC Act listed threatened species and community likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.	**EA** Section 6.4.2 **Appendix D** Section 5.2,
15	For each of the EPBC Act listed threatened species and communities and likely to be impacted by the action the EA must provide a separate:	
a	description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans;	**Appendix D** Section 4.7.2, Section 5.3.3, Section 5.3.4, Appendix 8
b	details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements;	**EA** Section 6.4.1 **Appendix D** Section 3.2.3, Section 4.2
c	description of the relevant impacts of the action having regard to the full national extent of the species or community's range;	**Appendix D** Section 5.3.2, Appendix 8
d	description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action;	**EA** Section 6.4.3 **Appendix D** Section 5.1
e	identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account;	**EA** Section 6.4.3, Section 6.4.4 **Appendix D** Section 5.2
f	a description of any offsets proposed to address residual adverse significant impacts and how these offsets will be	**EA**

No.	Supplementary SEAR	EA reference/comment
	established;	Section 6.4.3, Section 6.4.4 **Appendix D** Section 6
g	details of how the current published NSW Biodiversity Assessment Method (BAM) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; and	**Appendix D** Section 6
h	details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the BAM and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites.	**Appendix D** Section 6 – no figures provided for confidentiality; available separately in confidence if required.
16	Any significant residual impacts not addressed by the BAM may need to be addressed in accordance with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy.	**EA** Section 6.4.3, Section 6.4.4 **Appendix D** Section 6
Other approvals and conditions		
17	Information in relation to any other approvals or conditions required must include the information prescribed in Schedule 4 Clause 5 (a) (b) (c) and (d) of the EPBC Regulations 2000.	**EA** Section 2.3, Section 4
Environmental record of the person proposing to take the action		
18	Information in relation to the environmental record of a person proposing to take the action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.	**EA** Section 2.7, Section 2.8
Information sources		
19	For information given in an EA, the EA must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	**Appendix D** References

4.2 Key NSW legislation

4.2.1 Environmental Planning and Assessment Act 1979

Part 3A was repealed by the NSW *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* (Part 3A Repeal Act), which commenced on 1 October 2011. Under the Part 3A Repeal Act, projects deemed to be 'transitional Part 3A projects' will continue to be subject to Part 3A of the EP&A Act (as in force immediately before the repeal and as modified by the Part 3A Repeal Act). Transitional Part 3A projects include certain projects that were the subject of an existing approval under Part 3A.

As the Quarry has a Project Approval that was granted under Part 3A of the EP&A Act, it is a transitional Part 3A project. The provisions of Part 3A (as in force immediately prior to its repeal) continue to be applicable to the Project. Therefore, the project is proposed to be assessed under s75W of the repealed Part 3A.

The transitional arrangements in the EP&A Act were repealed by the Environmental Planning and assessment Bill 2017. This moved transitional Part 3A projects to the current State significant development and State significant infrastructure pathways, and applications to modify such projects will no longer be made under Section 75W. This modification application has been made within the transitional timeframe and is not affected by the above arrangements.

4.3 Other NSW legislation and policies

A summary of the other State environment and planning legislation potentially relevant to the Project is provided in **Table 5**.

Table 5 Summary of State legislation and relevance to the Project

Planning Provision	Comments	Further Approvals and Requirements
Protection of the Environment Operations Act 1997 (POEO Act)	The POEO Act is administered by the EPA and requires licences for environmental protection including waste, air, water and noise pollution control. The Peppertree Quarry Environment Protection Licence (EPL) No. 13088 provides for extractive activities with a production rate of greater than 2 million tonnes extracted, processed, or stored per annum. The Project will not trigger additional scheduled activities under the POEO Act. However, variation/s to the EPL may be required as a result of the Project. The requirement to vary the EPL would be confirmed by Boral via liaison with the EPA following the receipt of the notice of approval.	Possible Yes
Crown Lands Act 1989 (Crown Lands Act)	The Crown Lands Act provides for the administration and management of Crown land in the eastern and central divisions of NSW. Crown land may not be occupied, used, sold, leased, dedicated, reserved, or otherwise dealt with unless authorised by this Act or the *Crown Land (Continued Tenured) Act 1989*. The Project will not be on any Crown land (refer to **Figure 3**). Therefore, landowner consent is not required from the NSW Department of Industry – Crown Lands.	No
Water Management Act 2000 (WM Act)	The WM Act is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. Water sharing plans (WSP) prepared in accordance with the WM Act include rules for protecting the environment and administrating water licencing and trading. The Quarry is in the Barbers Creek Management Zone of the Greater Metropolitan Region Unregulated Area WSP and has a Water Access Licence issued under the WM Act to extract up to 145 megalitres of surface water from Tangarang Creek per year (Licence Number 10SL056926).	No

Planning Provision	Comments	Further Approvals and Requirements
	The Surface Water Assessment has determined that no amendment to the existing Water Access Licence would be required to support the Project.	
National Parks and Wildlife Act 1974 (NPW Act)	The NPW Act is the primary piece of legislation for the protection of Aboriginal cultural heritage in New South Wales. The Office of Environment and Heritage (OEH) administer the NPW Act. The NPW Act provides statutory protection for Aboriginal objects by making it illegal to harm Aboriginal objects and Aboriginal places. Under Section 86 of the NPW Act, a person must not harm or desecrate an Aboriginal object or place. In cases where harm to Aboriginal objects or places cannot be avoided, an Aboriginal heritage impact permit (AHIP) may be sought under Section 90 of the Act. An AHIP is not required for Part 3A approvals in accordance with the repealed Section 75U of the EP&A Act and therefore no further approvals are required for the Project under the NPW Act. Potential impacts to Aboriginal heritage were assessed (refer to **Section 6.5**).	No
Biodiversity Conservation Act 2016 (BC Act)	The BC Act aims to protect biological diversity of NSW and lists threatened or endangered flora and fauna species and ecological communities. Under the EP&A Act, impacts on threatened species listed under the BC Act are required to be assessed. The Project will result in an increase in the approved project disturbance area. Potential impacts to biodiversity were assessed, which identified that approximately 28 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland EEC would be impacted by the Project. Additionally, 29 threatened fauna listed under the BC Act could be impacted by the Project. A Biodiversity Offset Strategy will be formulated in accordance with the requirements of the *Biodiversity Assessment Method* (2017) (BAM). The strategy is outlined in the Biodiversity Assessment Report and is required to offset unavoidable impacts to the EEC and potential habitat of threatened fauna species. The offset package would be implemented following approval of the Project and within 12 months of the commencement of construction of the SWOE, in accordance with Schedule 3, Condition 34(b) of the project approval.	Yes
Heritage Act 1977 (Heritage Act)	This Act includes provisions relating to the protection and management of heritage items (historic heritage). Potential impacts to historic heritage were assessed and reported in the Aboriginal heritage report. No historic heritage sites were identified and therefore no further approvals are required under the Heritage Act.	No

Planning Provision	Comments	Further Approvals and Requirements
Roads Act 1993 (Roads Act)	Under Section 138 of the Road Act, consent is required to erect a structure or carry out work in, on or over a public road. It is proposed to construct an intersection on Marulan South Road so that overburden can be hauled from the pit to the SWOE. As such, consent will be sought from Council under Section 138 of the Act to construct the intersection.	Yes
Contaminated Lands Management Act, 1997 (CLM Act)	This Act establishes a process for investigating, and where required remediating contaminated lands, that pose a risk to human health and the environment. The EPA Contaminated Land Record was searched in February 2018. There are no contaminated sites in Marulan or Marulan South. The site of the proposed SWOE was investigated for potential contamination during preparation of the Mine SSD application (ZOIC 2018). The investigation did not identify any potential contamination at the site. The nearest potential contamination (Area of Environmental Concern 15) is at wash down bays and a waste oil tank site associated with the Mine's processing infrastructure, adjacent to the eastern boundary of the MOD 5 application area. The sites of the proposed surface disturbance are currently unused and were historically used for grazing livestock and Boral is unaware of any historical potentially contaminating activities that could have occurred in these areas. In the event that previously unidentified contaminated land is located during construction or operation, requirements of this Act would need to be complied with. No further assessment of contaminated land is therefore required.	No

4.3.1 State environmental planning policies

The relevant State environmental planning policies (SEPP) which need to be considered in relation to the Project are outlined below.

State Environmental Planning Policy No. 44 - Koala Habitat Protection

SEPP No. 44 restricts the granting of development consent for proposals on land identified as core koala habitat without preparation of a plan of management.

The Project will result in an increase in the approved project disturbance area, which requires the clearing of approximately 28 ha of native vegetation. The biodiversity assessment concluded that despite removal of potential Koala foraging habitat, the impact on the species would not be significant, as the Project would not remove core koala habitat and there is an abundance of quality habitat to the east of the Quarry in national parks and state conservation areas. A koala plan of management is therefore not required.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

This SEPP regulates the permissibility of mining, extractive industries and related development and specifies matters that must be considered in assessing extractive industry developments requiring consent under the EP&A Act.

The Project is not considered exempt or complying development under the SEPP and therefore requires consent. Accordingly, the Minister for Planning is the consent authority for the Project under Section 75W of the Act.

Part 3 of the SEPP identifies matters for consideration by the consent authority in determining an application for consent for the purposes of mining, petroleum production or extractive industries.

The following sections outline the compatibility of activities associated with the Project with Clauses 12 to 17 of Part 3 of the SEPP.

Clause 12

Clause 12 of the SEPP requires consideration of the compatibility of the development with other land uses in the vicinity. Potential impacts of the Quarry on surrounding land uses have been considered in previous environmental assessments for the Quarry and this EA. The EA has demonstrated that the Project would not result in a significant impact on existing land uses within the vicinity of the Quarry. Environmental control measures have been proposed to avoid or minimise identified impacts. As highlighted in **Section 5**, a community engagement program has been undertaken by Boral to inform the neighbouring landowners of the Project to Quarry operations and identify any potential impacts on existing uses. Boral also holds regular Community Consultative Committee meetings which provides an avenue for the community to raise any incompatibility issues between the approved Quarry operations and the existing land uses in the vicinity and allows Boral to work with the community to resolve these issues.

Clause 12A of the SEPP requires consent authorities to consider any applicable provisions of the *Voluntary Land Acquisition and Mitigation Policy*, published by the NSW Government in December 2014, before determining an application for consent for the purposes of mining, petroleum production or extractive industry.

The provisions of the *Voluntary Land Acquisition and Mitigation Policy* have been considered in the noise and air quality impact assessments (refer to **appendices B** and **C**).

Clause 13

Clause 13 of the SEPP requires a consent authority, prior to determining a development application, to consider whether the proposed development is likely to:

- have a significant impact on current or future extraction or recovery of extractive materials (including by limiting access to those resources); and
- be incompatible with any existing or approved mine or extractive industry in the vicinity.

As outlined in **Section 3.3**, the proposed SWOE will not result in the long term sterilisation of hard rock resources associated with the Quarry. The Project will also not sterilise any mineral resources or result in any negative impacts on the operations of the adjacent Mine.

Clause 14

Clause 14 of the SEPP requires that before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:

- that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable;
- that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable; and
- that greenhouse gas emissions are minimised to the greatest extent practicable.

The potential impacts of the Project on surface water and groundwater resources are discussed in **Section 6.6** and **6.9** respectively, including management and mitigation measures that would be implemented in order to minimise potential impacts.

The potential impacts of the Project on threatened species and biodiversity are described in **Section 6.4**, and include management and mitigation measures to be implemented in order to minimise potential impacts.

The potential for impacts associated with greenhouse gas emissions is considered in **Section 6.9**.

Clause 15

Clause 15 of the SEPP requires the consent authority, before granting consent, to consider the efficiency of the development in terms of resource recovery and the minimisation of waste associated with the extraction, recovery or processing of extractive materials.

The proposed SWOE located close to the Quarry pit, will facilitate the efficiency of resource recovery as it eliminates the long haulage distances associated with the previously proposed transport of overburden to the Mine's south pit.

As outlined in **Section 6.9**, the principles of the waste hierarchy set out by the *Waste Avoidance and Resource Recovery Act 2001* would continue to be upheld during continued operations of the Quarry, following implementation of the Project.

Clause 16

Clause 16 of the SEPP requires the consent authority to consider the implications of transporting extractive materials associated with the development on public roads.

As outlined in **Section 6.8**, the haulage of overburden material to the proposed SWOE would only include a minor section of Marulan South Road, which is only used for Boral's Marulan South operations.

Clause 17

Clause 17 of the SEPP requires that before granting development consent that the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development.

The proposed SWOE will be landscaped and rehabilitated in accordance with the existing *Peppertree Quarry Biodiversity and Rehabilitation Management Plan*, which was prepared as a condition of the Approval and updated after obtaining the Modification 4 approval.

State Environmental Planning Policy (Sydney Water Drinking Catchment) 2011

This SEPP aims to provide for healthy water catchments that will deliver high quality water while permitting development that is compatible with that goal.

Prior to granting consent to a proposed development, the SEPP requires that a consent authority must be satisfied that the proposed development will have a neutral or beneficial effect on water quality. It is submitted that the Project can be managed to provide a neutral effect on water quality within the Shoalhaven catchment as discussed further in **Section 6.6**.

4.4 Local environmental planning instruments

4.4.1 Goulburn Mulwaree Local Environmental Plan 2009

Local environmental plans (LEP) are environmental planning instruments that guide planning decisions for local government areas and allow councils to manage the way in which land is used through zoning and development consents.

Under the provisions of the Goulburn Mulwaree Local Environmental Plan 2009 (Goulburn Mulwaree LEP), the Quarry site is zoned RU1 Primary Production. Extractive industries are permissible in this zone with development consent.

The RU1 zone objectives are:

- to encourage sustainable primary industry production by maintaining and enhancing the natural resource base;
- to encourage diversity in primary industry enterprises and systems appropriate for the area;
- to minimise the fragmentation and alienation of resource lands;
- to minimise conflict between land uses within the zone and with adjoining zones;
- to promote the use of agricultural land for efficient and effective agricultural production;
- to avoid or minimise impacts on the natural environment and protection of environmentally sensitive land;
- to allow the development of non-agricultural land uses which are compatible with the character of the zone;
- to allow the development of processing, service and value-adding industries related to agriculture and primary industry production;
- to protect and enhance the water quality of receiving watercourses and groundwater systems to reduce land degradation; and
- to minimise the visual impact of development on the rural landscape.

This EA demonstrates that the Project, if implemented in accordance with the additional environmental controls, mitigation and monitoring measures and the biodiversity offset strategy outlined in **Section 6.4**, can be carried out in a manner which upholds the objectives of the zone and is consistent with other objectives of the Goulburn Mulwaree LEP.

5 CONSULTATION AND STAKEHOLDER ENGAGEMENT

Preparation of the EA involved consultation with DPE), Goulburn Mulwaree Council, a number of key government agencies, the Aboriginal Management Committee (AMC) and the local community.

Comments obtained through the consultation process assisted in identifying all environmental and social issues associated with the Project and have been considered in:

- the assessment of impacts associated with the proposed Project;
- selecting the location of and preparing the concept design for the proposed SWOE; and
- developing appropriate safeguards and environmental management measures.

Table 6 provides a summary of the issues that have been raised during stakeholder and community consultation and provides reference to the section of the EA in which these issues have been addressed.

All relevant government stakeholders, Aboriginal stakeholders and the local community will be advised of the public exhibition of the EA. A copy of the EA will be made available for review on DPE's website, and at the Goulburn Mulwaree Council office.

Table 6 Summary of stakeholder consultation

Stakeholder	Consultation Details	Comments	Response/EA Section Reference
Department of Planning and Environment (DPE)	Modification application and background scoping document (BSD) submitted to DPE on 21 December 2017. Teleconference on 28 November 2017.	Email correspondence received from DPE on 21 December 2017 and 27 February 2018 confirming that the Department was satisfied that it was not necessary to issue Secretary's environmental assessment requirements (SEARs) for the Project, subject to implementation of commitments outlined in the BSD as well as: ▪ submit a referral to DoEE under the EPBC Act; ▪ consult with relevant agencies and the community; and ▪ submit the EA before 1 September 2018.	EPBC Act: **Table 3.** Consultation: **Table 5.**
Goulburn Mulwaree Council (GMC)	Boral emailed BSD to GMC on 13 March 2018. GMC replied to BSD email on 3 April 2018.	GMC did not raise any issues with the Project and noted the proposed assessment method for the new intersection on Marulan South Road was satisfactory.	N/A
WaterNSW	Boral emailed the BSD to WaterNSW on 13 March 2018. WaterNSW replied to BSD email on 27 March 2018.	WaterNSW required the EA to consider: ▪ the current recommended practices under clause 9 of State Environmental Planning Policy (Sydney Water Drinking Catchment) 2011; ▪ the NorBE under State Environmental Planning Policy (Sydney Water Drinking Catchment) 2011; and ▪ whether or not the SWOE will drain to the west.	Surface water assessment: **Appendix F** and **Section 6.6**.
Office of Environment and Heritage/National Parks and Wildlife Service	Boral emailed the BSD to Office of Environment and Heritage on 13 March 2018. Teleconference with OEH on 9 February 2018 regarding Aboriginal heritage assessment method.	No response received to the BSD. OEH agreed in principle to the assessment methods for the Aboriginal heritage assessment during the teleconference.	Aboriginal heritage assessment: **Appendix E** and **Section 6.5**.
Environment Protection Authority (EPA)	Boral emailed the BSD to EPA on 13 March 2018.	EPA advised that the EA should consider cumulative air quality impacts associated with the Mine SSD project and that the noise assessment	Air quality assessment: **Appendix C** and **Section 6.3**. Noise impact assessment:

Stakeholder	Consultation Details	Comments	Response/EA Section Reference
	EPA replied to the BSD email on 28 March 2018.	should be in accordance with the Noise Policy for Industry (2017).	**Appendix B** and **Section 6.2**.
Aboriginal Management Committee (AMC) and Mine representative parties (RAP)	An introductory letter was sent to all AMC and RAP members on 27 February 2018. It provided details of the proposed assessment and survey method and invited the AMC and RAP members to provide cultural heritage values for the site. The Project area was surveyed with RAPs from 13 to 17 April 2015. The draft Heritage Impact Assessment report was provided to AMC members on 7 June 2018 for review and comment.	One response was received from the Gulgunya Ngunawal Heritage Corporation on 27 February 2018 regarding the proposed Aboriginal heritage assessment and survey method. The Corporation believed that new fieldwork was required in the Project area as the original assessment was for the Mine, not the Quarry; and that both the AMC and RAPs should be involved in consultation. The technical specialist replied on 28 March 2018 that the original fieldwork for the Mine covered the area subject to this modification, and that both the AMC and RAPs will be consulted on the Project. One response from the Murra Bidgee Mullangari endorsing the recommendations in the Aboriginal Cultural Heritage Impact Assessment Report.	Aboriginal heritage assessment: **Appendix E** and **Section 6.5**.
Neighbouring residences and community	A pre-notification letter was sent to private premises on Marulan South Road, Long Point Road and Glynmar Road on 22 June 2018. Visits to private premises on 29 June 2018. Emails on 16 July 2018 to residents requesting feedback on the Project. Community drop-in sessions held at Marulan Community Hall at 2:30pm-5.30pm on 8 August 2018, 9:30am-1pm on 9 August 2018. Overview of MOD 5 provided to the Peppertree	Feedback during visit to private premises included potential air quality impacts from the construction of overburden emplacements on neighbouring properties. Total of 14 visitors for both drop-in sessions. Comments specific to the Peppertree operation included: ▪ One claim was made that crushing operations at Peppertree could be heard at times. ▪ One neighbour restated uncertainty raised during 2015-16 original consultation on the Marulan South Limestone SSD / MOD 4 about aesthetics of overburden emplacements,	Air quality assessment: **Appendix C** and **Section 6.3**. Noise impact assessment: **Appendix B** and **Section 6.2**. Visual impact assessment: **Appendix G** and **Section 6.7**.

Stakeholder	Consultation Details	Comments	Response/EA Section Reference
	Quarry Community Consultative Committee regular meeting on 15 August 2018. Overview of SSD / MOD 5 applications given to the Marulan Chamber of Commerce on 15 August 2018. Three page information sheet emailed to neighbours, Marulan South Operations mailing list, and the Peppertree Quarry Community Consultative Committee in August 2018.	potential for the aesthetics to effect property values in the long-term, and dust management during construction.	
Media	Regular monthly column focussing on both SSD / MOD 5 published in Discover Marulan e-newsletter in July 2018. Article published in the Goulburn Post focussed on the SSD but mentioning staging of the community drop in sessions on 6 August 2018. Advertisements re community drop in sessions published in the Goulburn Post on 6 and 8 August. Regular monthly column focussing on both SSD / MOD 5 published in Discover Marulan e-newsletter in August 2018. Monthly column for Discover Marulan e-newsletter has been drafted and includes reminder about MOD 5 and further request for feedback.	No responses were received from the various media releases.	N/A

6 ENVIRONMENTAL ASSESSMENT

6.1 Identification of potential environmental impact

Potential environmental risks associated with the Project were analysed during preparation of the background scoping document, which was submitted to DP&E in December 2017. The environmental aspects potentially at risk of impact from the Project were the subject of specialist technical investigations (refer to **Sections 6.2 to 6.9** and **appendices B** to **H**).

Further specialist technical investigations were not considered necessary for environmental aspects with no or low risk of impact from the Project. For these issues, the Project would not result in any additional impacts other than what has been assessed in the *Marulan South Quarry Environmental Assessment Report* (ERM, October 2006) and subsequent approved modifications. As such, it is considered that these non-key issues could largely be addressed using existing environmental safeguards and management measures.

This chapter examines the change in the potential impacts of Modification 5 as compared to the approved Quarry components. It recommends, where required, mitigation and monitoring measures to manage potential impacts.

6.2 Noise

Potential noise impacts associated with the Project on sensitive receivers were assessed. The noise assessment report is in **Appendix B**, which is summarised in this chapter.

6.2.1 Existing environment

Noise sources

The Quarry is in a rural area which has low background noise levels. Noise sources in the local area include:

- natural (e.g. birdsong, insects, road noise and livestock);
- commercial (fireworks manufacturing and turkey farming);
- industrial (agricultural lime manufacturing, Mine and the Quarry); and
- Marulan South Road.

The sensitive receivers are identified on **Figure 2**.

Meteorology

The EPA's (2017) *Noise Policy for Industry* (NPI) regards a potential project area as being affected by temperature inversions if they occur for more than 30% of the total night time in winter. Temperature inversions can result in adverse noise impacts and are regarded as 'worst case' meteorological conditions. Analysis of five years of meteorological data from the Quarry's weather station indicates that temperature inversions occur less than 30% of total winter night time in the project area and therefore, temperature inversions were not included in the assessment.

Noise criteria

Noise was assessed in accordance with the NPI, which has resulted in new 'project noise trigger levels' for the Project. These trigger levels are proposed to replace the noise impact assessment criteria in Schedule 3 of the Approval. The trigger levels and how they apply to the sensitive receivers are summarised in the following sections.

Operational noise impact assessment criteria

The operational noise impact criteria from the Approval are compared to the new Project noise triggers in **Table 7**. The Project noise triggers were used for the assessment.

Table 7 Operational noise impact assessment criteria, $L_{Aeq,\ 15min}$ dBA

Receiver	Approval			Project noise trigger (NPI)		
	Day shift	Night shift		Day shift	Night shift	
	Day	Evening	Night	Day	Evening	Night
R1	35	35	35	40	39	38
R2	35	35	35	40	39	38
R3	35	35	35	40	39	38
R4	35	35	35	40	38	38
R5	35	35	35	40	38	38
R6	35	35	35	40	38	38
R7	35	35	35	40	38	38
R8	41	35	35	40	39	38
R9	35	35	35	40	39	38
R10	35	35	35	40	39	38
R11	35	35	35	40	39	38
R12	35	35	35	40	39	38
R13	35	35	35	40	36	35
R14	35	35	35	40	36	35
R15	35	35	35	40	36	35
R16	35	35	35	40	36	35
R17	35	35	35	40	36	35

Notes:

- The identified "Day" noise criteria apply throughout the period of the site's Day Shift (i.e. 7am to 7pm) on all days, despite the general definitions of Evening and Night otherwise applying to the Approval.
- The identified "Evening" and "Night" criteria apply only during the period of the site's Night Shift (i.e. 7pm to 7am).

Sleep disturbance criteria

The sleep disturbance criterion from the Approval is compared to the new maximum operational noise impact assessment criteria (for sleep disturbance) in **Table 8**.

Table 8 Maximum operational noise impact assessment criteria, $L_{A1,\ 1\ min}$ dBA

Receiver	NPI	
	$L_{Aeq,\ 15min}$	L_{AFMax}
R1	40	52
R2	40	52
R3	40	52
R4	40	52
R5	40	52
R6	40	52
R7	40	52
R8	40	52
R9	40	52
R10	40	52
R11	40	52
R12	40	52
R13	40	52
R14	40	52
R15	40	52
R16	40	52
R17	40	52

Land acquisition criteria and residual noise impacts

If the noise generated by the Quarry exceeds the criteria in **Table 9**, Boral is required, upon receiving a written request for acquisition from the landowner, to acquire the land in accordance with the procedures in Conditions 6-8 of Schedule 4 of the Approval.

Table 9 Land acquisition criteria, $L_{Aeq,\ 15min}$ dBA

Sensitive Receiver	Day $L_{Aeq,15min}$	Evening / Night $L_{Aeq,15min}$
R2	40	40
R3	40	40
R8	44	44

The NPI approach is to consider the residual impacts, which are described in **Table 10**.

Table 10 Significance of residual noise impacts

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of residual noise level is:
<=2 dBA	Not applicable	Negligible
>= 3 but <=5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1 dB	Marginal
>=3 dBA but <=5 dBA	> than recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate
>5 dBA	=< recommended amenity noise level	Moderate
>5 dBA	> recommended amenity noise level	Significant

Examples of receiver based treatments from the NPI are summarised in **Table 11**.

Table 11 examples of receiver based treatment to mitigate residual noise impacts

Significance of residual noise level	Example of potential treatment
Negligible	The exceedance would not be discernible by the average listener and therefore would not warrant receiver-based treatment or controls.
Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
Moderate	As for 'marginal', but also upgraded façade elements, such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Significant	May include suitable commercial agreement where considered feasible and reasonable.

The treatment options for noise affected privately owned properties from the NPI are summarised in **Table 12**.

Table 12 Privately owned property treatment options

Noise management zone		Noise affectation zone
1-2 dB above project noise trigger levels	**3-5 dB above project noise trigger levels**	**>5 dB project noise trigger levels**
No treatment controls required	Voluntary mitigation rights applicable	Voluntary mitigation rights applicable
	Architectural treatment required if requested (including ventilation and upgrade façade elements)	Architectural treatment required if requested
		Voluntary land acquisition rights applicable

Noise monitoring

Noise is monitored at the Quarry to determine compliance with the Approval. The monitoring results demonstrate that:

- daytime noise levels from the Quarry comply with the relevant Approval $L_{Aeq,15minute}$ operational noise impact assessment criteria;
- night time noise levels from the Quarry comply with the relevant Approval $L_{Aeq,15minute}$ and $L_{A1,\ 1minute}$ operational noise impact assessment criteria; and
- daytime, evening and night time noise level contributions ($L_{Aeq,period}$) are below the cumulative amenity criteria applicable to the area.

6.2.2 Assessment

Operational noise

The Environmental Noise Model was used to calculate noise levels at the sensitive receivers during the day and night operation of the Quarry. The predicted noise levels were compared to the Project noise trigger levels to determine if additional mitigation will be required and if there will be residual noise impacts.

The assessment was based on the Quarry's equipment and vehicles carrying out the activities described in **sections 2.6** and **3.3** during the timeframes in **Table 13**.

Table 13 Operating periods

Operation	Daytime 7am-7pm	Evening & night time 7pm-7am
In-pit extraction and processing operations	✓	✓*
Overburden operations (including SWOE)	✓	×
Secondary & Tertiary processing	✓	✓
Rail loading & product transportation	✓	✓

*In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)" are approved any day from 5am – 11pm which overlaps the day, evening and night assessment periods, therefore, this activity/operation has been included in the evening and night operational noise assessment.

The noise model included the following mitigation measures:

- noise mitigation of the in-pit primary crusher;
- enclosure of the secondary and tertiary processing plant;
- enclosure of the rail loading facility;
- enclosure of overhead bins for rail loading;
- haul truck noise reduction; and
- dozer noise reduction.

The following scenarios were assessed:

1. approved operations plus the start of overburden emplacement activities at the SWOE, when equipment are at natural ground level; and
2. approved operations plus overburden emplacement activities near the completion of the SWOE, where haul trucks would sometimes be shielded by the emplacement.

It was assumed that equipment was operating at the most south western end of the SWOE, representing a typical worst-case scenario for noise emissions likely to be experienced by the closest receivers 8 and 9. Use of 40 tonne trucks or 100 tonne trucks was also modelled as Boral is yet to determine which truck type to use for the Project. The 100 tonne trucks are slightly noisier than the 40 tonne trucks.

Model results for the above scenarios are in **tables 14** and **15** (which do not include the night time period as emplacement activities do not occur during the night). Model results for the night shift are in **Table 16**, when secondary and tertiary processing, rail loading and product transportation continue to operate.

Table 14 Daytime predictions – day shift beginning of Project

Receiver	Predicted noise levels, $L_{Aeq,15min}$		NPI operational noise trigger level $L_{Aeq,15min}$
	8 * 100t trucks	12 * 40t trucks	
R1	19	18	40
R2	28	27	40
R3	31	31	40
R4	29	27	40
R5	30	29	40
R6	26	25	40
R7	32	31	40
R8	37	36	40
R9	31	30	40
R10	27	26	40
R11	24	23	40
R12	25	24	40
R13	23	22	40
R14	29	28	40
R15	30	28	40

Receiver	Predicted noise levels, $L_{Aeq,15min}$		NPI operational noise trigger level $L_{Aeq,15min}$
	8 * 100t trucks	12 * 40t trucks	
R16	29	27	40
R17	30	28	40

Table 15 Daytime predictions – day shift end of Project

Receiver	Predicted noise levels, $L_{Aeq,15min}$		NPI operational noise trigger level $L_{Aeq,15min}$
	8 * 100t trucks	12 * 40t trucks	
R1	19	18	40
R2	28	27	40
R3	31	30	40
R4	29	28	40
R5	30	29	40
R6	28	27	40
R7	33	32	40
R8	38	37	40
R9	35	34	40
R10	30	29	40
R11	24	23	40
R12	24	23	40
R13	23	21	40
R14	30	29	40
R15	31	30	40
R16	30	29	40
R17	31	29	40

Table 16 Night time predictions – night shift

Sensitive Receiver	Predicted noise levels, $L_{Aeq,15min}$	NPI operational noise trigger level $L_{Aeq,15min}$
R1	16	38
R2	24	38
R3	28	38
R4	23	38
R5	28	38

Sensitive Receiver	Predicted noise levels, $L_{Aeq,15min}$	NPI operational noise trigger level $L_{Aeq,15min}$
R6	20	38
R7	28	38
R8	32	38
R9	26	38
R10	22	38
R11	16	38
R12	17	38
R13	18	35
R14	24	35
R15	23	35
R16	21	35
R17	20	35

The predicted noise levels for proposed daytime and night time operations comply with the operational noise trigger levels and Approval criteria at all locations (**Figure 9** and **Figure 10**).

Forty six noise measurements were made at receivers R2, R3, R4, R8 and R9 in February 2019. The Quarry noise level contributions were between 30 and 35 $dBA_{LAeq, 15minutes}$. The key noise generating activities were the primary crusher in the pit and the primary bin/ surge stockpile out of the pit. Noise mitigation to reduce the equipment's noise contributions were assumed to be in place for the noise predictions. The above predicted noise levels are lower than those measured in February and, therefore, are generally consistent with the measured noise levels.

Sleep disturbance

The potential for noise to disturb sleep was determined by calculating the mean difference between the intrusive $L_{Aeq, 15min}$ and the corresponding L_{AFmax} noise levels collected during night time noise monitoring in 2014 and 2017. The difference was between 0 dB and 10 dBA. The difference in ERM's 2018 monitoring was 2 dB to 8 dB.

The higher difference was used to be conservative, which results in a worst case $L_{A1, 1min}$ of 42 dBA at any receiver, which is less than the maximum noise event screening criteria (52L_{AFmax} dBA).

Land acquisition

As the land acquisition criteria in the Approval are equal to or higher than the operational trigger noise levels, the predicted daytime and night time noise levels associated with the Project do not exceed the land acquisition criteria at any residence.

The noise contours representing the daytime (55 $dBA_{LAeq,period}$), evening (50 $dBA_{LAeq,period}$) and night (45 $dBA_{LAeq,period}$) voluntary land acquisition criteria are all on Boral owned land.

Further, the noise levels do not require any receivers to be regarded as being in the 'noise affectation zone' as described in **Section 6.2.1**.

Cumulative impacts

The NPI states “Where the project amenity noise level applies, and it can be met, no additional consideration of cumulative industrial noise is required.” The Project trigger noise levels were based on the more stringent of the intrusive noise levels and the amenity level. As the predicted levels comply with the intrusive noise levels, they also comply with the amenity level. Therefore, no further assessment of cumulative noise is required.

Low frequency noise

Where a noise source contains certain characteristics, such as dominant low-frequency content, there is evidence that it can cause greater annoyance than other noise at the same noise level.

The NPI recommends application of correction factors to the source noise level at the receiver before comparison with the criteria to account for the additional annoyance caused by these modifying factors.

The assessment of low frequency noise indicated compliance with the EPA criterion at the most-affected receiver (R8).

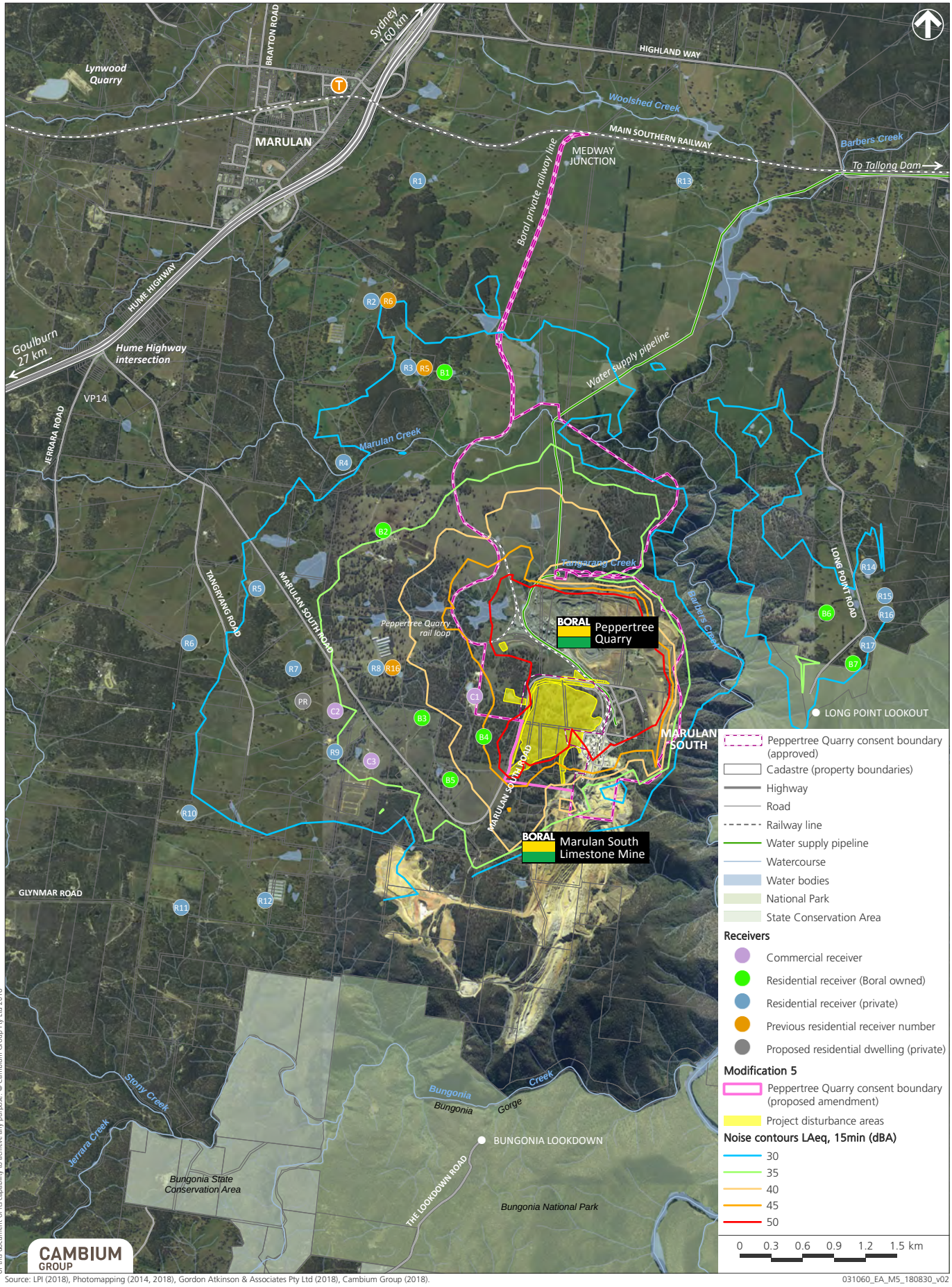
6.2.3 Residual impacts and management measures

The residual noise impact is the exceedance of the Project noise trigger level after all feasible and reasonable mitigation measures have been considered. No residual impacts are predicted at any privately owned receivers and, therefore, receiver-based treatments or controls are not required. Notwithstanding, Boral will continue its noise compliance monitoring and community consultation activities, and will implement measures if an exceedance is detected or a complaint is received from a member of the community.

As new Project noise trigger levels have been developed for the Project, it will be necessary to incorporate these into the Approval and EPL. The *Peppertree Quarry Noise and Blast Management Plan* will be amended with the new trigger levels once the Project is approved.

Figure 9
Daytime noise levels at end of Mod 5 with eight model 777 trucks

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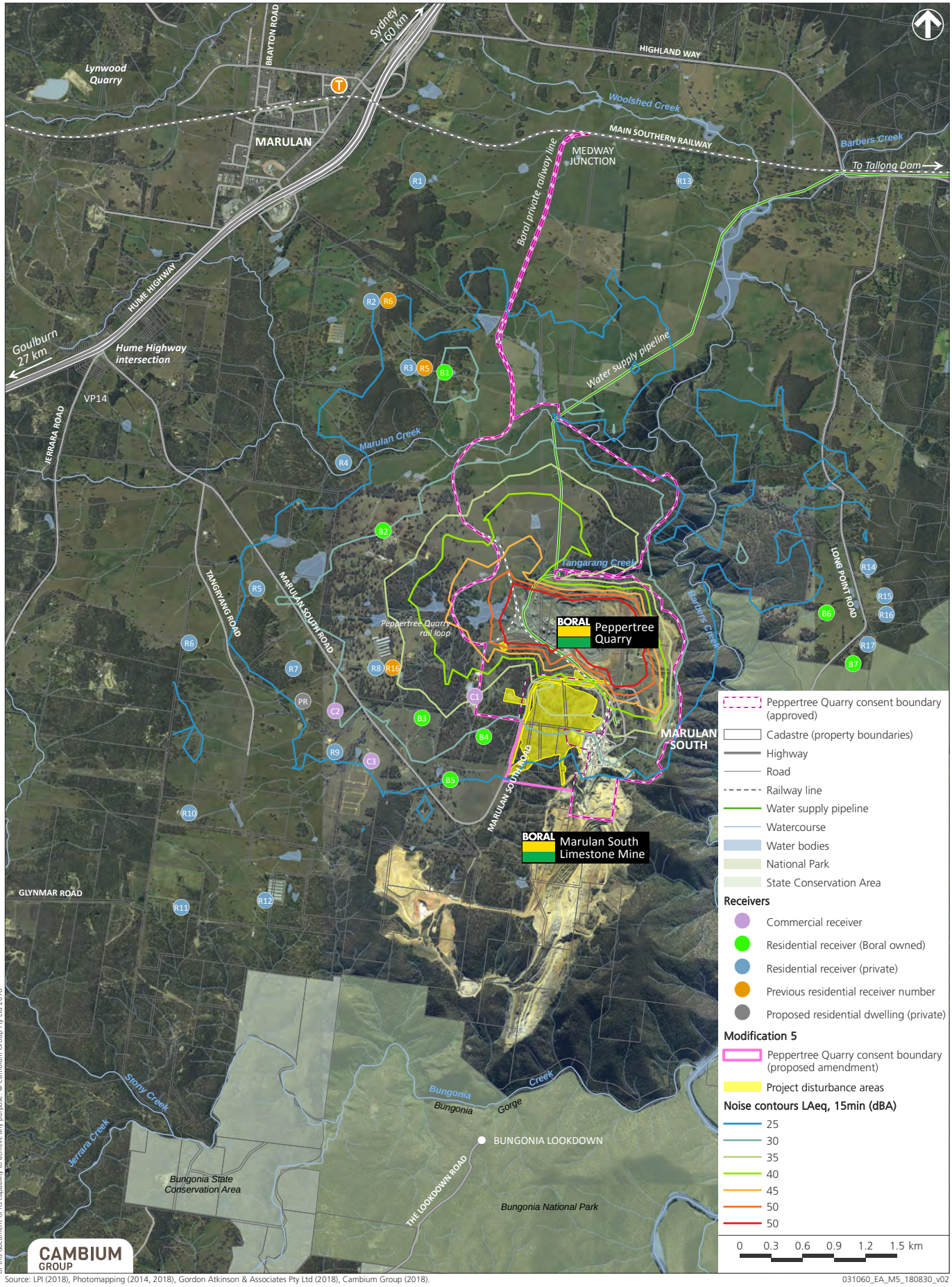
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Figure 10
Night time noise levels

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6.3 Air quality

Potential air quality impacts associated with the Project on sensitive receivers were assessed. The air quality assessment (AQIA) report is in **Appendix C**, which is summarised in this chapter.

6.3.1 Existing environment

Local climate

Long term climatic data from the Bureau of Meteorology weather station at Goulburn Airport Automatic Weather Station (Site No. 070330) the nearest weather station to the Quarry, are summarised in **Table 17**.

Goulburn has a subtropical highland climate with warm summers and cold winters, and a high diurnal temperature variation. Its climate is variable, though generally dry.

Table 17 Goulburn Airport climate data

Statistic	Month	
	Maximum	Minimum
Mean temperature	January – 27.9ºC	July – 0.3 ºC
Humidity – 9am	June – 88%	October/December – 65%
Humidity – 3pm	June – 63%	December – 39%
Rainfall	June – 60.9 mm	April – 25.6 mm
Windspeed – 9am	September – 19.8 km/h	March – 12.2 km/h
Windspeed – 3pm	August – 26.5 km/h	April – 19.8 km/h

Predominant 3pm winds are from the west, and to a lesser extent from the north-west and east.

Local air quality

Air emission sources around the Quarry are mining and extractive industries, commercial and industrial operations, agricultural activities, anthropogenic activities (such as motor vehicle exhaust, dust from unsealed roads, and domestic wood heaters) and rural activities.

Air quality monitoring stations are operated at the Quarry and Mine and comprise two high volume air samplers (HVAS), which measure either total suspended particulates (TSP) or PM_{10} (particulate matter with an aerodynamic diameter of 10µm or less), and six dust deposition gauges (refer to **Figure 6)**.

Regional air quality was characterised based on data from these stations plus Lynwood Quarry (approximately 10 km north-west of the Quarry) and EPA monitors at Bargo and Wollongong (approximately 73 km north-east and 87 km north-east of the Quarry, respectively).

Exceedances of PM_{10} and TSP at the Quarry, Mine and Lynwood Quarry between 2011 and 2017 are summarised in **Table 18**. Exceedances of PM_{10} and $PM_{2.5}$ at the Bargo and Wollongong monitors between 2011 and 2017 are summarised in **Table 19**.

Table 18 Air quality statistics for the Quarry, Mine and Lynwood Quarry

Statistic	Criterion	Measurement	Year	Location
PM_{10} (HVAS)				
Annual average	25µg/m^3	–	–	–
Max. 24hr ave.	50µg/m^3	70.4	2012	Mine
		50.5	2014	Mine
		158.3	2015	Mine
		58.2	2016	Mine
		64.7	2017	Mine
No. days >50µg/m^3	–	3	2012	Mine
		1	2014	Mine
		5	2015	Mine
		2	2016	Mine
		4	2017	Mine
TSP (HVAS)				
Annual average	90µg/m^3	–	–	–
Dust deposition (insoluble solids)				
Annual average	4g/m^2/month	7	2012	Mine
		6.8	2012	Quarry
		4.2	2013	Quarry
		4.5	2013	Lynwood
		4.5	2014	Quarry
		7.5	2016	Mine

Table 19 Air quality statistics for Bargo and Wollongong monitors

Statistic	Criterion	Measurement	Year	Location
PM_{10}				
Annual average	25µg/m^3	–	–	–
Max. 24hr ave.	50µg/m^3	89.7	2011	Bargo
		93.8	2013	Wollongong
		208.9	2013	Bargo
		50.8	2014	Bargo
		52.2	2015	Bargo
		52.9	2016	Wollongong

Statistic	Criterion	Measurement	Year	Location
		58.4	2016	Bargo
		55.2	2017	Wollongong
		53.5	2017	Bargo
No. days >50µg/m^3	–	1	2011	Bargo
		6	2013	Bargo
		2	2013	Wollongong
		1	2014	Bargo
		2	2015	Bargo
		2	2016	Wollongong
		3	2016	Bargo
		1	2017	Wollongong
		1	2017	Bargo
$PM_{2.5}$				
Annual average	8µg/m^3	–	–	–
Max. 24hr ave.	25µg/m^3	88.4	2013	Wollongong
		31.6	2015	Wollongong
		33.7	2016	Wollongong
No. days >25µg/m^3	–	2	2013	Wollongong

The exceedances of PM_{10} at the Mine may be due to the monitor's location close to mining activities. Generally, emissions follow a seasonal trend and are highest in spring and summer when the ground is drier with higher risk of wind blown dust.

The dust deposition gauges are located close to mining and quarrying activities, which may account for exceedances of the dust deposition criterion. Additionally, samples are often contaminated with bird droppings and insects, which can increase the insoluble solid content.

In a regional context, the worst PM_{10} and $PM_{2.5}$ exceedances at the EPA monitors are likely due to large bushfires.

6.3.2 Assessment

Total suspended particulates, PM_{10} and $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm or less) will be the primary emissions from the modified operations.

Potential emissions from a single worst case scenario were modelled using the California Meteorological Model (CALMET) and California Puff Model (CALPUFF). The scenario assumed maximum production at the Quarry, including the Project, with equipment at the closest locations to the sensitive receivers.

Operating hours for the existing activities were assumed to be in accordance with the Approval and emplacement at the SWOE will be from 7:00am to 7:00pm.

Dust emissions were estimated by analysing the types of dust generating activities at the Quarry and using emission factors developed by the United States EPA (Table 6.1 in the AQIA). The emission factors assumed implementation of all reasonable and feasible dust mitigation measures.

Dust emissions were predicted for the operation of the Quarry (incremental) and operation of the Quarry with local dust sources and background levels (cumulative) at the sensitive receivers and reported in:

- maximum 24 hour average PM2.5 and PM10 concentrations;
- annual average PM2.5 and PM10 concentrations;
- annual average TSP concentrations; and
- annual average dust (insoluble solids) deposition rates.

The unaccounted fractions of background dust levels (which arise from other non-modelled sources) were added to the annual average model predictions. The contribution of background dust levels was estimated by modelling the 2014 quarrying and mining activities and comparing predictions with the measured data from the corresponding monitoring stations. The average difference between the measured and predicted PM_{10}, TSP and deposited dust levels from each of the monitoring points was considered to be the contribution from other non-modelled dust sources.

In the absence of available $PM_{2.5}$ monitoring data for the area, background levels were estimated based on the assumption that an annual average $PM_{2.5}$ concentration of 8 µg/m³ is equivalent to an annual average PM_{10} concentration of 25 µg/m³. Therefore considering that the existing PM_{10} level is 11 µg/m3, the calculated $PM_{2.5}$ level to account for non-modelled sources as applied in this assessment is 3.5 µg/m³.

Estimated dust emissions from other local sources (including the Mine) used in the cumulative assessment are summarised in **Table 20**.

Table 20 Estimated annual average contribution from other dust sources

Pollutant	Background level	Unit
TSP	27.0	µg/m³
PM_{10}	11.0	µg/m³
$PM_{2.5}$	3.5	µg/m³
Dust deposition	2.8	g/m²/month

The results of the incremental assessment are compared to the NSW air quality criteria in **Table 21** and results of the cumulative assessment are compared to the criteria in **Table 22** (**Figure 11**).

No exceedances of the criteria are predicted at any assessed privately owned sensitive receiver due to emissions from the Quarry incorporating the Project, or the Quarry and Project plus other sources and background levels.

Dust impacts on more than 25% of privately owned land were also predicted to determine if Boral will be required to purchase any affected properties.

The assessment showed that the Project would not result in any impact on more than 25% of any privately-owned land.

Table 21 Incremental emission predictions

Sensitive Receiver	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)

	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Criteria					
	25[a]	8[b]	50[a]	30[a]	90[a]	2[a]
R1	0.5	0.0	3.2	0.1	0.2	0.00
R2	0.9	0.0	6.1	0.3	0.5	0.01
R3	1.2	0.1	7.7	0.4	0.7	0.01
R4	1.2	0.1	7.4	0.6	1.1	0.02
R5	1.3	0.2	7.9	1.0	1.8	0.04
R6	1.0	0.1	6.4	0.9	1.7	0.03
R7	1.6	0.3	9.6	1.6	3.1	0.06
R8	2.2	0.4	13.5	2.6	5.3	0.11
R9	1.8	0.3	10.2	1.5	3.0	0.06
R10	0.9	0.1	5.6	0.6	1.2	0.02
R11	0.7	0.1	3.9	0.4	0.6	0.01
R12	0.9	0.1	5.5	0.5	0.8	0.01
R13	0.2	0.0	1.1	0.1	0.1	0.00
R14	1.3	0.2	8.0	1.0	1.8	0.09
R15	1.4	0.2	8.6	1.2	2.3	0.13
R16	1.7	0.2	10.6	1.3	2.5	0.15
R17	2.1	0.3	12.4	1.7	3.2	0.18

Source: (a) NEPM 2003, (b) NSW DEC 2005.
(1) Dust is assessed as insoluble solids as defined by AS 3580.10.1-1991;
(2) Note that 2 g/m^2/month relates to the incremental contribution to dust deposition from the proposal. Cumulative levels are not to exceed 4 g/m^2/month.
(3) Note that the NEPM permits five days annually above the 24-hour average PM_{10} criterion to allow for bush fires and similar events.
µg/m³ = micrograms per cubic metre; g/m²/month = grams per square metre per month.

Table 22 Cumulative emission predictions

Sensitive Receiver	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	TSP (µg/m^3)	DD (g/m^2/month)
	Annual average			
	Criteria			
	8[a]	25[b]	90[b]	4[b]
R1	3.6	11.4	27.6	2.8
R2	3.6	11.7	28.1	2.8
R3	3.7	12.0	28.6	2.8
R4	3.7	12.4	29.3	2.8
R5	3.9	13.0	30.5	2.9
R6	3.9	13.0	30.5	2.9

Sensitive Receiver	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	TSP (µg/m^3)	DD (g/m^2/month)
	Annual average			
	Criteria			
	8[a]	25[b]	90[b]	4[b]
R7	4.1	14.5	33.2	2.9
R8	4.4	16.3	36.8	3.0
R9	4.5	16.1	36.2	3.0
R10	4.1	13.9	31.9	2.9
R11	4.1	14.1	32.2	2.9
R12	4.5	13.0	35.9	2.9
R13	3.5	11.2	27.3	2.8
R14	3.7	12.4	29.5	2.9
R15	3.8	12.7	30.1	2.9
R16	3.8	12.9	30.5	3.0
R17	3.9	13.4	31.6	3.0

Source: (a) NEPM 2003, (b) NSW DEC 2005.

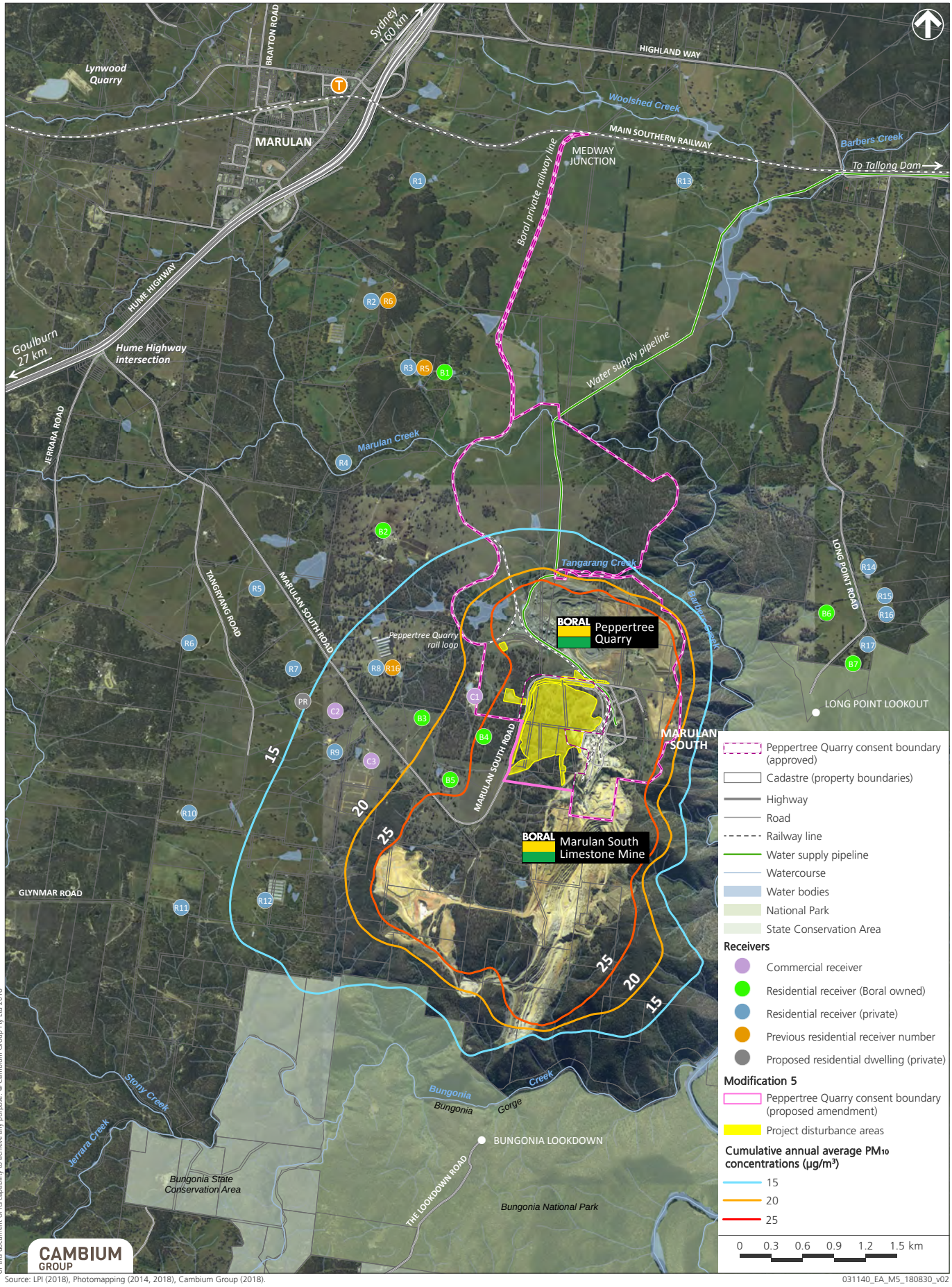
6.3.3 Residual impacts and management measures

The assessment demonstrated that, with implementation of existing dust management measures, the Project will not impact the air quality at sensitive receivers. Therefore, the existing air quality management plan will continue to be implemented at the Quarry and for the Project.

The cumulative annual average PM_{10} criterion of 25µg/m³ is predicted to be exceeded at a Boral owned receiver (B4). The tenancy agreement at this receiver incorporates negotiated agreement of noise and dust levels.

Figure 11
Cumulative annual average PM_{10} concentrations (µg/m³)

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6.4 Biodiversity

Potential impacts from the Project on flora and fauna were assessed in accordance with OEH's (2017) *Biodiversity Assessment Method* (BAM), which was implemented in August 2017. The biodiversity development assessment report (BDAR) report is in **Appendix D**, and is summarised in this chapter.

Ecosystem and species credits were calculated for proposed vegetation clearing in accordance with the BAM.

6.4.1 Existing Environment

The Project area is approximately 47.5 ha and consists of a mix of native woodland and gully forest vegetation and areas of exotic pasture grasses. Several small farm dams also occur. Much of the Project area has been historically impacted by vegetation clearing and grazing.

The Project area is in the South Eastern Highlands Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion.

Database and mapping searches

The Atlas of NSW Wildlife Database and the EPBC Act Protected Matters Search Tool were searched for threatened species records in a 10 km radius around the Project area. Results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey.

Mapping by Tozer et al carried out in 2006 was searched to identify vegetation communities that could occur in the Project area. The Tozer communities and corresponding plant community types (PCT) under the BAM, and their threatened ecological community (TEC) status, are summarised in **Table 23** (**Figure 12**).

Table 23 Vegetation communities in Project area

Tozer et al	PCT	TEC	Condition	Area (ha)
Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland	PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	EEC* under BC Act CEEC** under EPBC Act	Medium	18.64
			Poor	9.04
Bungonia Slates Woodland	PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	Not listed	Medium	8.46
			Poor	3.55
Exotic pasture/ infrastructure	-		-	7.84
Total				47.53
Total native vegetation				39.69

Notes: *endangered ecological community, **critically endangered ecological community.

According to the databases there is a likelihood that there are 22 threatened flora species occur in the Project area, with the list provided in Appendix 1 of the BDAR. However, according to the databases the likelihood of them occurring is low.

The BAM calculator was used to predict threatened fauna species which could occur in the Project area based on the outputs of the database searches, vegetation types and their condition and habitat features. The calculator predicted 28 threatened species could occur in the Project area, with the list provided in Table 7 of the BDAR.

Previous assessments

Reports on previous biodiversity surveys of the Quarry and Limestone Mine were reviewed and ecological information potentially relevant to the study area included:

- Identification of White Box Yellow Box Blakely's Red Gum Grassy Woodland at the Quarry and Mine sites.
- Records of *Solanum celatum* to the direct east of the Southern Overburden Emplacement on the steep slopes towards Barbers Creek.
- Identification of three threatened fauna including the Koala (*Phascolarctos cinereus*), Diamond Firetail (*Stagonopleura guttata*) and Varied Sittella (*Daphoenositta chrysoptera*) near the Quarry and Mine sites.

Fauna and flora surveys

The Project area was surveyed for fauna between 3 and 6 February 2015, 11 October 2015 and 5 February 2018. The Project area was surveyed for flora between 3 and 6 February 2015, 5 February 2018 and between 31 July to 1 August 2018. These dates were scheduled for the periods these species would be most visible.

Fauna were targeted using techniques such as harp trapping and remote cameras and field-based habitat assessment. The habitat assessment recorded:

- slope, aspect and landscape position;
- geology and soil type;
- dominant vegetation communities including their composition, structure and condition;
- form, quality and location of water sources;
- presence, size, number and condition of habitat features such as tree hollows; and
- level of disturbance.

The Large-eared Pied Bat (*Chalinolobus dwyeri*) and Eastern Bentwing Bat (*Miniopterus schreibersii*) were recorded during the survey. The BAM calculator predicted that the species listed in Table 7 of the BDAR could occur in the Project area based on the habitat assessment.

The flora survey comprised 11 plots and transects in the Project area, and walking meanders between the plots. Communities identified during the survey are summarised in **Table 22**. No threatened flora species were observed during the survey.

6.4.2 Assessment

The Project will directly and indirectly impact biodiversity during construction and operation. The majority of impacts on biodiversity will occur during construction from clearing of native vegetation and removal of habitat.

The following direct impacts would result from the Project:

- clearing of vegetation conservatively estimated to be 39.69 ha, including 27.68 ha of EEC/CEEC;
- clearing of associated threatened species habitat;
- clearing of Koala (which is listed as vulnerable under the BC Act and EPBC Act) habitat estimated to be 27.1 ha; and
- clearing of Large-eared Pied Bat (which is listed as vulnerable under the BC Act and EPBC Act) habitat estimated to be 27.1 ha.

The majority of vegetation likely to be affected by the Project has been subject to historic clearing and other agricultural activities such as grazing and is therefore thinned, fragmented and dominated in areas by Serrated Tussock.

Assessments of significance have been undertaken for potential impacts to foraging habitat associated with the following EPBC Act listed threatened species: Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Large-eared Pied Bat, and Grey-headed Flying Fox (Appendix 8 of the BDAR). The assessments of significance concluded that a significant impact to threatened fauna listed under the EPBC Act is unlikely.

Indirect impacts will mostly occur during the construction phase and will be short term and confined to the Project area. The primary potential indirect impacts and management measures will be:

- Increased noise, which could mask contact calls of birds.
- Increased dust, which could impact the health of plants.
- Erosion and sedimentation, which could impact soils and subsequently impact plant health; and deposit silt on plants.
- Spread of weed propagules, which could lead to invasion of native vegetation by weeds.

The potential extent of indirect impacts and their mitigation measures with a description of expected success of the measures are described in Table 10 of the BDAR.

6.4.3 Management measures and residual impacts

As described in Section 3.2, a number of alternative locations for the new overburden emplacement were considered. One of these (to the north-west of the proposed SWOE) would have had slightly worse biodiversity outcomes as it would have required the clearing of higher quality Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland.

The alternative location north of the Quarry was discounted as, even though the area is relatively clear of native vegetation, it is likely to have comparatively higher archaeological sensitivities given it is an elevated area between two prominent water courses in the locality (Tangarang and Marulan creeks). It also would have been closer to receivers than the SWOE and could have had increased noise, visual and air quality impacts compared to other locations. A section of this location is also subject to a proposed dam under the Mine SSD application, which has limited opportunities for relocation as it must be on a reliable water source.

The alternative location to the north-west of the Quarry (Figure 8) was considered in greater detail as it has less biodiversity constraints compared to the SWOE and is not subject to a separate development application. Notwithstanding that it is relatively clear of native vegetation, it contains component species of Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland and has been assessed as a degraded area of this EEC.

A high level noise assessment determined receivers near this alternative location would experience noise levels up to 6 dBA greater than levels from the SWOE. Additionally, the

emplacement would be more visible to receivers given its proximity to them, and it is likely the area has medium archaeological sensitivity given it is a relatively broad and flat spur between two prominent water courses in the locality (Tangarang and Marulan creeks).

The current design minimises the impact potential to surrounding resources while still making use of the available space within some of the deep gullies (i.e. main valley) to minimise the overall surface area (and consequent clearing) required from emplacement of materials.

The vegetation clearing protocol in Boral (2017) *Biodiversity and Rehabilitation Management Plan* will be implemented, including:

- Prior to clearing of grassland, ecologists will survey for ground dwelling fauna and will remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed.
- Prior to clearing of remnant hollow-bearing trees, ecologists will be engaged to supervise felling. All hollow-bearing trees that are accessible safely from the ground will be checked and identified fauna relocated. Hollows higher up and not accessible from the ground will be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate.
- Any fauna displaced during clearing will be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so).
- If fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service will be contacted to handle and collect for appropriate care and rehabilitation.

The disturbance would be progressively rehabilitated in accordance with Boral (2017) *Biodiversity and Rehabilitation Management Plan* to create a stable landform that does not result in sediment laden runoff or fugitive dust emissions, blends well with the adjacent natural landscapes of the Morton National Park and re-establishes a native bushland dominated by White Box Yellow Box Blakely's Red Gum Grassy Woodland species, which outcompetes invasive weed species.

The indirect impacts described above will be managed by implementation of relevant measures in the following management plans:

- Noise – Boral (2017) *Noise* and *Blasting Management Plan*.
- Dust – Boral (2017) *Air Quality Management Plan*.
- Erosion and sedimentation – Boral (2017) *Water Management Plan*.
- Weeds – Boral (2017) *Biodiversity and Rehabilitation Management Plan*.

Ecosystem and species credits required to offset the impacts to the vegetation, EEC/CEEC and threatened fauna species were determined using the BAM calculator and are summarised in **Table 24** and **Table 25**.

Table 24 Ecosystem credit requirements

PCT	Cleared area (ha)	Condition	Credits required
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	18.64	Medium	335
	9.04	Poor	89
PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	8.46	Medium	134
	3.55	Poor	23

Table 25 Species credit species requirements

Species credit species	Cleared habitat area (ha)	Credits required
Koala	27.1	514
Large-eared Pied Bat	27.1	772

6.4.4 Residual impacts

Under the BAM, an offset strategy is not required to be submitted with the BDAR, as the credits are to be formally retired with the establishment of a stewardship site, or payment into the Biodiversity Conservation Trust (BCT) Fund.

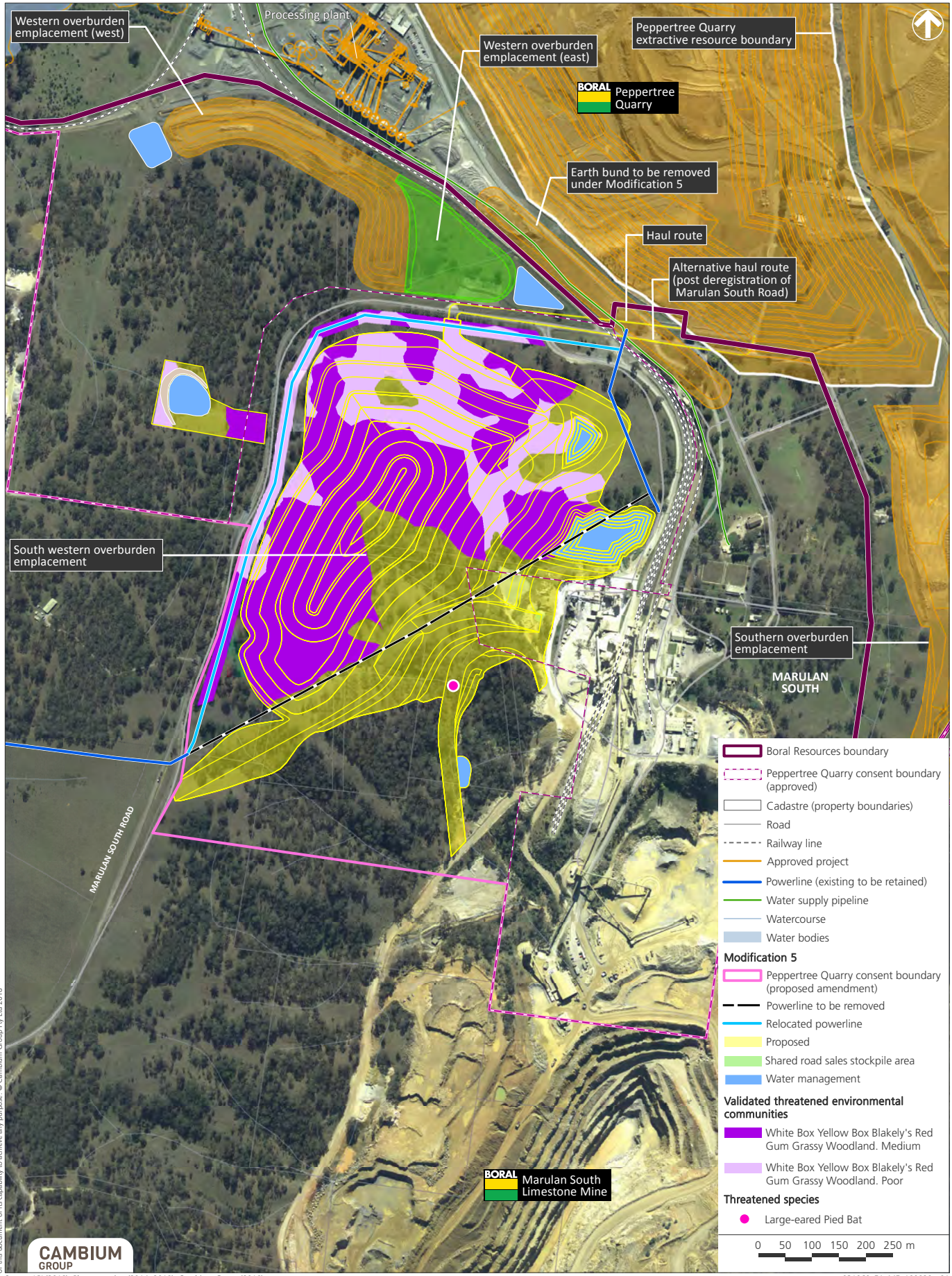
To date, a biodiversity stewardship site cannot be formally established as the BCT has not provided a public management action plan template to complete the Biodiversity Stewardship Site Assessment Report.

Boral has purchased a 1,000 ha property in the Bungonia IBRA subregion for the purposes of offsetting the Koala, Large-eared Pied Bat and PCT 778 liability. Similarly, negotiations are underway for the purchase of BAM credits from a 360 ha property for the Box Gum Woodland offset liability. However, the proposed stewardship sites are also waiting on the BCT to provide a management action plan template to formalise.

Given these delays due to the current agency processes, Boral requests additional time be given to formalise the biodiversity offset sites which would not impede on the commencement of clearing associated with the Project.

Figure 12
Vegetation communities and threatened biodiversity

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6.5 Aboriginal heritage

Potential impacts from the Project on the Aboriginal sensitivity of the Project area were assessed. The Aboriginal cultural heritage assessment (ACHA) report is in **Appendix E**, and is summarised in this chapter.

The ACHA is focussed on the proposed SWOE as the other areas subject to the Project were assessed for Aboriginal sensitivities and approved under the original application and subsequent modifications. The ACHA is based on previous investigations of the SWOE under the yet to be submitted Marulan South Limestone Mine SSD application as this area was originally proposed to be developed under that project.

6.5.1 Existing environment

The temperate climate in the area was suitable for historic Aboriginal occupation. The environment of the Project area would have provided a variety of resources for exploitation by Aboriginal people including plants and animals for food and adequate water supplies in the nearby creeks and rivers. Vegetation in the Project area would also have provided wood to make implements and shelters.

The surface geology provides stone for use in the manufacture of tools including quartz, feldspar and tuff.

The results from regional and local studies on Aboriginal occupation indicate that the most common Aboriginal site types are open artefact scatters and isolated finds. These sites are usually found near water with the majority of large sites along major creeks or at the confluences of minor creeks and drainage lines. Sites decrease in size and frequency as the distance from water increases. Sparse sites may exist on ridgelines and may represent evidence of the travelling routes used across the wider Southern Tablelands landscape.

There are no perennial watercourses in the Project area. However, there are numerous first and second order streams that converge into a third order stream at the base of the hilly terrain in the SWOE. These features are likely to have supported intermittent periods of camping focused near the third order stream, but only on suitably level to gently inclined terrain.

Post artefact deposition factors such as land clearing, cattle grazing and mining activities are likely to have disturbed stone artefacts. Disturbance would have resulted in the displacement of Aboriginal objects within the soil but would not fully diminish their archaeological and cultural value. Erosion also has the potential to more significantly displace Aboriginal objects through sheet wash and gully erosion, particularly on the slopes and narrow, cleared crests near incised drainage lines that characterise most of the Project area south of Marulan South Road.

6.5.2 Assessment

Predictions

The following predictions of the occurrence of sites in the Project area are based on analysis of the existing environment and previous studies on Aboriginal occupation of the region:

- Open camp sites evidenced by stone artefacts are likely to occur on prominent or elevated, level to gently inclined terrain overlooking watercourses. Moderate to steeply inclined slopes are far less likely to have archaeological evidence.
- Historical vegetation clearance and mining associated disturbance has occurred in the Project area and this indicates that modified trees will be rare or non-existent.

- Rock shelters are not predicted to occur as the landscape does not have suitable rock outcrops or overhangs.
- The likelihood of grinding groove sites is low as rock outcrops are rare. The outcropping granite is generally too coarse to have been used for stone tool manufacture or food preparation.
- Aboriginal quarries are unlikely to occur. Although silcrete has been identified eroding from the banks of Marulan Creek to the north, similar conditions are not expected in the Project area due to a difference in geology.
- Stone arrangements are unlikely to occur due to their general rarity and disturbance from historic clearing and mining activities.

Survey

The SWOE was surveyed between 13 to 17 April 2015 to identify Aboriginal sites or potential Aboriginal places and characterise the landscape to aid prediction of surface and sub-surface archaeological potential (**Figure 13**). The survey was focussed on the areas predicted to contain evidence of previous Aboriginal occupation.

Ground surface visibility conditions were generally low. Notwithstanding, the landscape of the study area was effectively characterised during the survey. Most of the SWOE has moderate to steep sloping ground. The spur lines leading east-west of the main ridge start gently at higher elevations, but transition into steep slopes towards the watercourses below. This was also observed at the hill slopes at the northern end of the SWOE. This means that most of the suitably level ground for Aboriginal camping is set back beyond 200 m of watercourses (with some discrete exceptions) and that most of the spur lines would have been more useful for transit between higher and lower elevation than for camping activities.

The Aboriginal sites described in **Table 26** and shown on **Figure 13** were discovered during the survey.

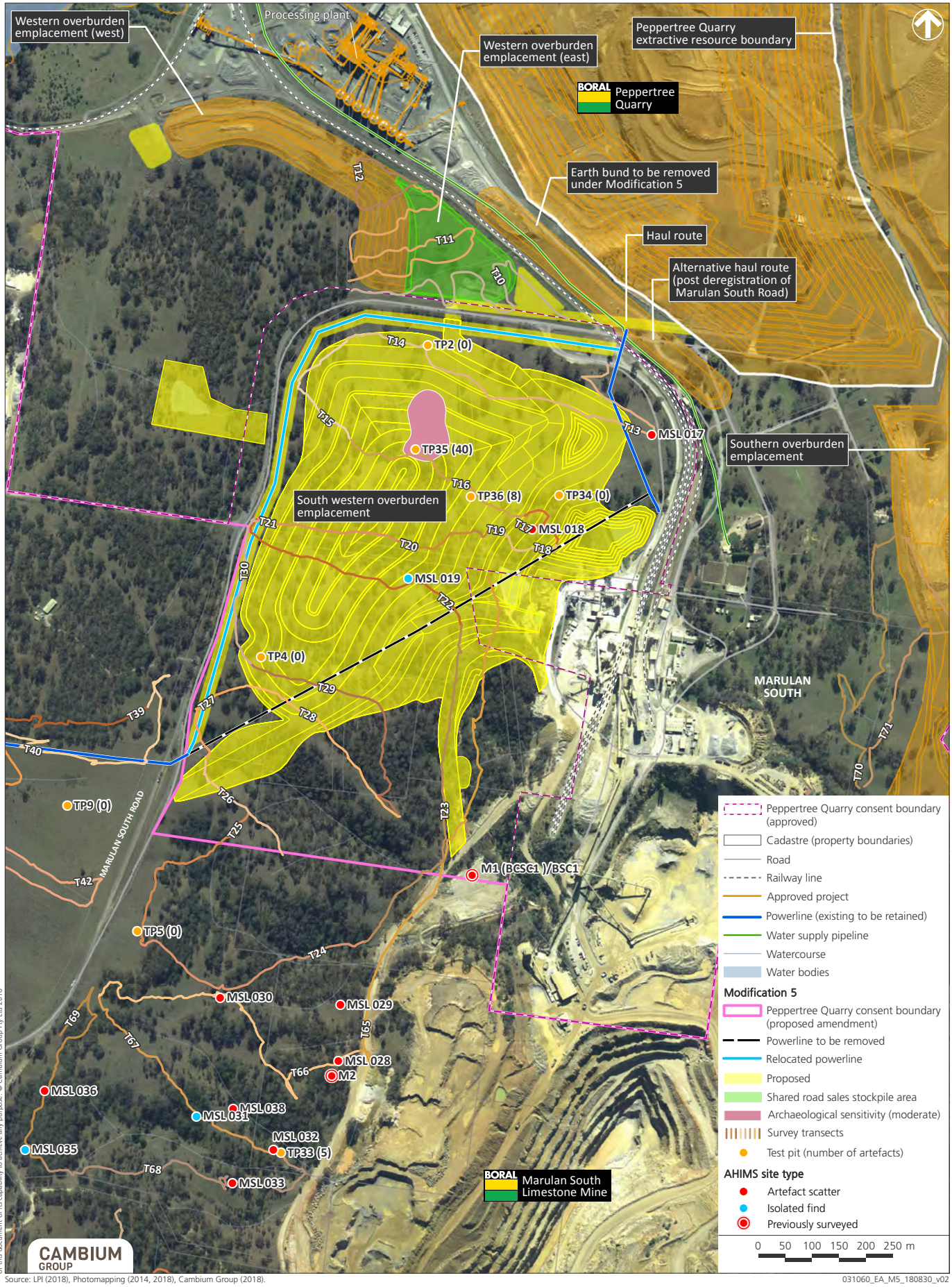
Table 26 Survey results

Site name	Easting	Northing	Site type	Landform	Distance to waterway	Description
MSL 017	228378	6149319	Artefact scatter	Hill slope	10 m	One silcrete and one quartz flake in ground exposed by the falling of a large eucalyptus tree.
MSL 018	228156	6149143	Artefact scatter	Spur	50 m	Six artefacts comprising five flakes and one core*. Exposure is approximately 20m^2 on a spur crest with a south-west aspect. Materials include quartz, silcrete, chert and quartzite.
MSL 019	227926	6149051	Isolated find	Hill slope	10 m	One mudstone core* eroding located on a steep hill slope on heavily disturbed context near the creek and incised drainage line. Artefact is unlikely to be in situ.

* Main piece of rock from which the flake was removed.

Figure 13
Aboriginal heritage survey coverage, results, test pits and area of sensitivity

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Test excavation

Five 3 m by 1 m test pits were excavated in the SWOE area to:

- characterise the subsurface archaeological deposit across sample landforms; and
- test the predictive model and survey results:
- particularly to understand if areas with frequent surface artefacts indicate extensive subsurface deposits; or
- if significant subsurface deposits are buried without surface artefact expressions; meaning that landscape analysis is a better guide to subsurface character than survey site results based on artefact expressions.

The test pits in the SWOE area (TP34, TP35 and TP36) (**Figure 13**) were on broad spurs featuring duplex soils with dark brown loams overlying silty clays of varying plasticity. TP2 and TP4 were on a ridge in the SWOE and displayed soil profiles of sandy loam topsoil overlaying olive brown clay deposits.

TP2, TP4 and TP34 contained no artefacts. The highest frequencies of artefacts were recovered from TP35 which contained 40 artefacts (subsequently labelled site MSL 055). This test pit was on a large flat spur overlooking two drainage lines. TP36 had eight artefacts (subsequently labelled site MSL 056) and was on a broad spur featuring duplex soils with dark brown loams overlying silty clays of varying plasticity. Further south, the landscape increases in gradient dramatically and the conditions for camping decrease in quality. Test pits in these steeper locations outside the Project area but on comparable landforms contained artefact counts of less than ten.

Most of the artefacts were flakes or broken flakes. The artefacts were predominantly silcrete (35) and quartz (12) with only one of chert. However, only two silcrete artefacts from TP35 showed evidence of retouch indicating tool manufacture. Six cores were found in TP35, and apart from one quartz core, all were silcrete. No cores were found in TP36.

The presence of mainly surface artefacts and minimal subsurface artefacts is likely due to a combination of:

- less intensive long term prehistoric Aboriginal camping activities in this area because of the steeper terrain and ephemeral drainage network, followed by;
- increased erosion and loss of surface artefacts because of steeper topography and skeletal soils; and
- minimal soil depth formation which would have prevented significant subsurface deposits from accumulating.

An exception was TP35 (MSL055) which contained 40 artefacts and was on a relatively flat spur in a prominent point in the landscape.

Significance

The Aboriginal community was consulted to determine if the Project area contains any specific socio-cultural heritage value. No information has been received that identifies specific heritage value unrelated to the Aboriginal sites. Aboriginal heritage sites are all of value to the Aboriginal community through the tangible connection that they represent to past Aboriginal land use.

Values of low, moderate or high were assigned to the scientific values of each site, as described in **Table 27**.

Table 27 Statements of significance

Site name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance
MSL 017	Artefact scatter	Low – sparse assemblage	Low – common type	Low – impact from erosion and clearing	Low – common types, sparse assemblage	Low – common types, sparse assemblage	Low
MSL 018	Artefact scatter	Low – surface artefacts on skeletal soil	Low – common type	Low – impact from erosion and clearing	Low – common types	Low – common types, sparse assemblage	Low
MSL 019	Isolated find	Low – sparse assemblage	Low – common type	Low – impact from erosion, cattle and flooding	Low – common types, sparse assemblage	Low – common types, sparse assemblage	Low
MSL 055	Subsurface artefact deposit	Moderate - further excavation in surrounding area of sensitivity could add to further information about the Aboriginal occupation in the landscape of Marulan South	Moderate unique artefact concentration in local landscape	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Low – common type	Moderate
MSL 056	Subsurface artefact deposit	Low – sparse assemblage	Low – common type	Low – impact from erosion, cattle and flooding	Low – common types, sparse assemblage	Low – common types, sparse assemblage	Low

Impacts

The proposed ground disturbance has potential to impact discovered and undiscovered Aboriginal objects by covering areas with overburden or breaking ground for construction of the haul road, powerline and water management structures.

Artefacts can be impacted to varying degrees from disturbance, where they are moved locally, removed or destroyed (lost). Loss entails complete removal of a site's elements and can include collection and relocation or complete burial.

All the sites and the area of moderate sensitivity in the Project area will be lost as creation of an overburden emplacement involves potential topsoil disturbance, truck movements, deposition of large amounts of soil, landscaping and landform rehabilitation. Artefacts below the surface will not be retrievable once the overburden emplacement is created.

The Project will not substantially add to the cumulative impact on Aboriginal items on a local or regional level due to the typically low scientific significance of the sites in the Project area.

6.5.3 Residual impacts and management measures

While the Aboriginal heritage sites within the Project disturbance footprint will be lost, impacts will be mitigated through collection and relocation of artefacts.

All surface artefact sites (artefact scatters and isolated finds) in the study area will be collected by an archaeologist and members of the Aboriginal community. Collected Aboriginal objects will be retained in accordance with the Boral (2017) *Aboriginal Heritage Management Plan* and will be under Boral management in a secured area prior to burial in designated locations.

Site MSL 055 and its surrounding area of moderate archaeological sensitivity will be subject to salvage excavation, which will aim to retrieve the most significant portions of the site and involve a two stage process of sampling followed by open area excavation. The salvaged artefacts will be subject to attribute analysis to understand manufacturing technology, site function and to compare the assemblage to studies completed in the wider region.

6.6 Surface water

Potential impacts from the Project on surface waters in and near the Project area were assessed. The surface water assessment report is in **Appendix F**, which is summarised in this chapter.

6.6.1 Existing environment

Surface water management

Surface water is managed in accordance with Boral's (2017) *Peppertree Quarry Water Management Plan* and is based on segregating 'clean' and 'dirty' water and capturing and reusing stormwater runoff for use in the Quarry processes, dust suppression and environmental controls. The Quarry is subdivided into sub catchment areas. Some sub-catchments are clean water catchments where water is diverted around disturbance areas and the remainder are dirty water catchments.

A number of catchments within the site drain to the Quarry pit and Dam 1 from where water is either used for dust suppression purposes, reused in operations or released to Tangarang Creek as environmental flows. Other catchments within the Quarry drain to a series of small sediment dams, mainly located on the outer edge of the northern noise bund or the eastern side of the Eastern Overburden Emplacement. In large storm events these dams drain directly to either Tangarang Creek or Barbers Creek.

Hydrology

The Quarry is in the Shoalhaven River catchment. Tangarang Creek is the main waterway in the vicinity of the Project, which flows along the northern boundary of the Quarry and drains to Barbers Creek in the north-east. Barbers Creek flows south into the Shoalhaven River. Tallowa Dam is on the Shoalhaven River approximately 30 km downstream of Barbers Creek, and is a source of drinking water to Sydney and the Illawarra.

The area of the SWOE drains in a south-east direction towards the Mine, with the exception of a small area in the extreme north-west adjacent to Marulan South Road, which drains in a westerly direction under the road and into a tributary of Tangarang Creek. Part of the area of the WOE drains to the north-west towards Tangarang Creek and Dam 1 and part drains north-east towards the Quarry pit.

Rainfall

Rainfall metrics important to assessment of surface water impacts are rainfall intensity, for designing water conveyance structures, and five day rainfall, for determining runoff storage capacity for sediment basins.

The average annual rain near the Project area is 696 mm, January, February and March are the wettest months of the year; and August is the driest. In wet years (90th percentile) annual rainfall can be 960 mm and dry years (10th percentile) rainfall can be 473 mm.

Rainfall depths used to design water conveyance structures are summarised in

Table 28, expressed as annual exceedance probability (AEP). AEP describes the probability of certain rainfall totals occurring. For example, the 1% AEP represents the highest likely rainfall for the Project area and could also be referred to as the 1 in 100 year event.

Table 28 Design rainfall depths for Marulan

Duration (min)	AEP					
	50%	20%	10%	5%	2%	1%
	Rainfall (mm)					
5	6.3	8.5	10.1	11.7	13.8	15.5
10	9.9	13.6	16.3	19.0	22.7	25.6
15	12.2	16.9	20.2	23.6	28.2	31.9
30	16.4	22.4	26.7	31.0	36.9	41.5
60	20.7	27.8	32.8	37.8	44.6	49.9
120	25.9	34.2	40.0	45.8	53.6	59.8
180	29.7	39.1	45.6	52.2	61.0	68.0

The 95th percentile rainfall depth over five consecutive days was used to size the sediment basins that flow into sensitive receiving environments in accordance with Table 6.1 of DEC's (2008) *Managing Urban Stormwater: Soils and Construction: Volume 2E Mines and Quarries* (**Table 29**).

Table 29 95th percentile five day rainfall depths

Rainfall percentile	Rainfall (mm)		
	Mittagong	Goulburn	Marulan South
90th	49.0	28.6	35.7
95th	75.2	40.8	52.8

Surface water quality

Surface water quality is monitored for the Quarry and Mine at the water monitoring sites below and with the frequencies summarised in **Table 30**:

- U1 – Tangarang Creek upstream of Dam 1.
- T1 – Tangarang Creek downstream of Dam 1.
- Marulan Up – Marulan Creek upstream of the Mine's proposed Marulan Creek Dam.
- Marulan Dn – Marulan Creek downstream of proposed Marulan Creek Dam.
- Barbers Up – Barbers Creek upstream.
- Barbers Dn – Barbers Creek downstream.
- SR1/2/3 – Shoalhaven River sites 1, 2 and 3.

The analytes are compared to the trigger values in the Australian and New Zealand Environment and Conservation Council's (2000) *Guidelines for fresh and marine water quality* (South East Australia, slightly disturbed ecosystems, upland river) and the site specific triggers in Boral's (2017) *Peppertree Quarry water management plan* in **Table 29**.

Table 30 Summary of surface water quality

Analyte/unit	Trigger value	Statistic	Monitoring site								
			U1	T1	Marulan Up	Marulan Dn	Barbers Up	Barbers Dn	SR1	SR2	SR3
Commenced			Feb 2012	Feb 2012	Nov 2014	Nov 2014	Sept 2014	Sept 2014	Jul 2014	Jul 2014	Jul 2014
Frequency			Monthly	Monthly	Quarterly during flow	Quarterly during flow	Monthly	Monthly	Monthly	Monthly	Monthly
pH	6.5-7.5[1]	Count	6.0	30.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0
		20%ile	7.2	7.7	7.6	7.8	7.8	7.9	7.3	7.2	7.2
	6.5-8.5[2]	Median	7.4	7.9	7.8	8.0	8.0	8.0	7.4	7.4	7.4
		80%ile	7.7	8.0	7.9	8.2	8.1	8.1	7.5	7.5	7.5
Electrical conductivity @ 25˚C (µS/cm)	350[1]	Count	6.0	30.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0
		20%ile	214.0	356.0	451.0	648.0	414.0	445.0	84.0	89.0	94.0
	1,500[2]	Median	249.0	654.0	1,160.0	1,000.0	541.0	553.0	103.0	105.0	110.0
		80%ile	288.0	813.0	1,556.0	1,248.0	853.0	933.0	139.0	143.0	146.0
Total dissolved solids (mg/L)	N/A	Count	3.0	24.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0
		20%ile	98.0	340.0	293.0	421.0	269.0	290.0	55.0	58.0	61.0
		Median	159.0	444.0	754.0	650.0	352.0	359.0	67.0	69.0	72.0
		80%ile	175.0	583.0	1,014.0	811.0	555.0	607.0	90.0	93.0	95.0
Suspended solids (mg/L)	N/A	Count	3.0	24.0	16.0	16.0	18.0	17.0	18.0	18.0	18.0
		20%ile	5.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
		Median	10.0	<5.0	7.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
		80%ile	21.0	41.0	10.0	6.0	<5.0	<5.0	8.0	6.0	8
Total nitrogen (mg/L)	0.25[1]	Count	5.0	29.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0
		20%ile	0.86	0.20	0.48	0.40	0.34	0.20	0.28	0.20	0.30
	1.1[2]	Median	1.2	0.25	0.80	0.60	0.40	0.50	0.45	0.40	0.45
		80%ile	1.24	0.58	1.02	0.80	0.66	0.60	0.60	0.50	0.62
Total phosphorus (mg/L)	0.02[1]	Count	6	30.0	25.0	25.0	28.0	27.0	30.0	30.0	30.0
		20%ile	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.09[2]	Median	0.12	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		80%ile	0.34	0.07	0.08	0.02	<0.01	0.02	0.02	0.02	0.02

Notes: 1. South East Australia, slightly disturbed ecosystems, upland river; 2. *Peppertree Quarry Water Management Plan.*

The 80th percentile water quality in the vicinity of the Project area does not exceed the site specific trigger values, with the exception of total nitrogen and total phosphorus at U1 and electrical conductivity at Marulan Up (upstream).

Water quality downstream from the Quarry (two sites in Barbers Creek) is generally better than the water quality upstream of the Quarry. Therefore, there is no evidence that the Quarry is adversely impacting the water quality in Barbers Creek.

6.6.2 Assessment

Exposed surfaces on the SWOE, WOE and haul road could erode during rainfall, which could generate sediments that could flow into local waterways then the Shoalhaven River.

6.6.3 Management measures

Boral's (2017) *Peppertree Quarry Water Management Plan* will be revised with the following management measures prior to overburden emplacement activities at the SWOE and proposed shared road sales stockpile area adjacent to the WOE.

Proposed sediment basins will be managed to ensure their runoff capture capacity is restored within five days of a rainfall event.

South-west Overburden Emplacement

The SWOE comprises three catchments, which will drain to three sediment basins as shown on **Figure 14**. The sediment basins will be emptied as follows:

- N1 will be a new sediment basin in the SWOE and will overflow or be pumped to the Kiln Dam, which is currently and will continued to be used as a water source for the Mine. The kiln dam will also be reconfigured and enlarged during the construction of the SWOE.
- N2 is an existing dam which will be enlarged and will overflow to Tangarang Creek or be pumped to the Kiln Dam.
- N3 will be a new sediment basin adjacent to the southern access to the SWOE and will overflow to the natural drainage line that drains to the Mine pit.

The sediment basins have been sized in accordance with the criteria for fine and dispersive sediments in DECC's (2008) *Managing Urban Stormwater: Soils & Construction – Volume 2E: Mines and Quarries* to capture the 95th percentile five day rainfall, including a 50% allowance for sediment storage (**Table 31**).

Table 31 SWOE sediment basin capacity requirements

Sediment basin	Catchment	Catchment area (ha)	Settlement zone (ML)	Sediment zone (ML)	Required volume (ML)
N1	B	25	8.5	4.2	12.7
N2	A	15	6.4	3.2	9.6
N3	C	8	1.7	0.9	2.6

Western Overburden Emplacement

The WOE comprises six catchments which will drain as described below, with some of the water draining into new sediment basins; P1 to the east of the proposed shared road sales stockpile area and P2 to the west of the WOE (**Figure 14**).

- Catchment 1 is upslope of the WOE and will be a clean water catchment, with flows diverted to the west.

- Catchment 2 is upslope of the WOE and will be a clean water catchment, with flows directed under the emplacement into a channel to the north which will flow into sediment basin P2.
- Catchment 3 comprises the north-west and western batters of the WOE and will drain into sediment basin P2.
- Catchment 4 comprises the southern batters of the WOE and will drain under the WOE into the channel to the north then to sediment basin P2.
- Catchment 5 comprises part of the northern batter of the WOE and will drain into the channel to the north then to sediment basin P2.
- Catchment 6 comprises the eastern batters of the WOE and the proposed shared road sales stockpile area and will drain to sediment basin P1.

Sediment basin P1 will be pumped into the Quarry pit sump as required and sediment basin P2 will drain to a bioswale then Dam 1 in the north-west.

Sediment basin P1 has been sized for the 90th percentile five day rainfall as it drains to the Quarry pit and sediment basin P2 has been sized for the 95th percentile five day rainfall as it discharges to the 'sensitive' environment of Dam 1. The sediment basin sizes are summarised in **Table 32**.

Table 32 WOE sediment basin capacity requirements

Sediment basin	Catchment	Catchment area (ha)	Settlement zone (ML)	Sediment zone (ML)	Required volume (ML)
P1	6	4.1	1.3	0.8	2.1
P2	2, 3, 4, 5	10.9	4.6	1.2	5.8

6.6.4 Residual impacts

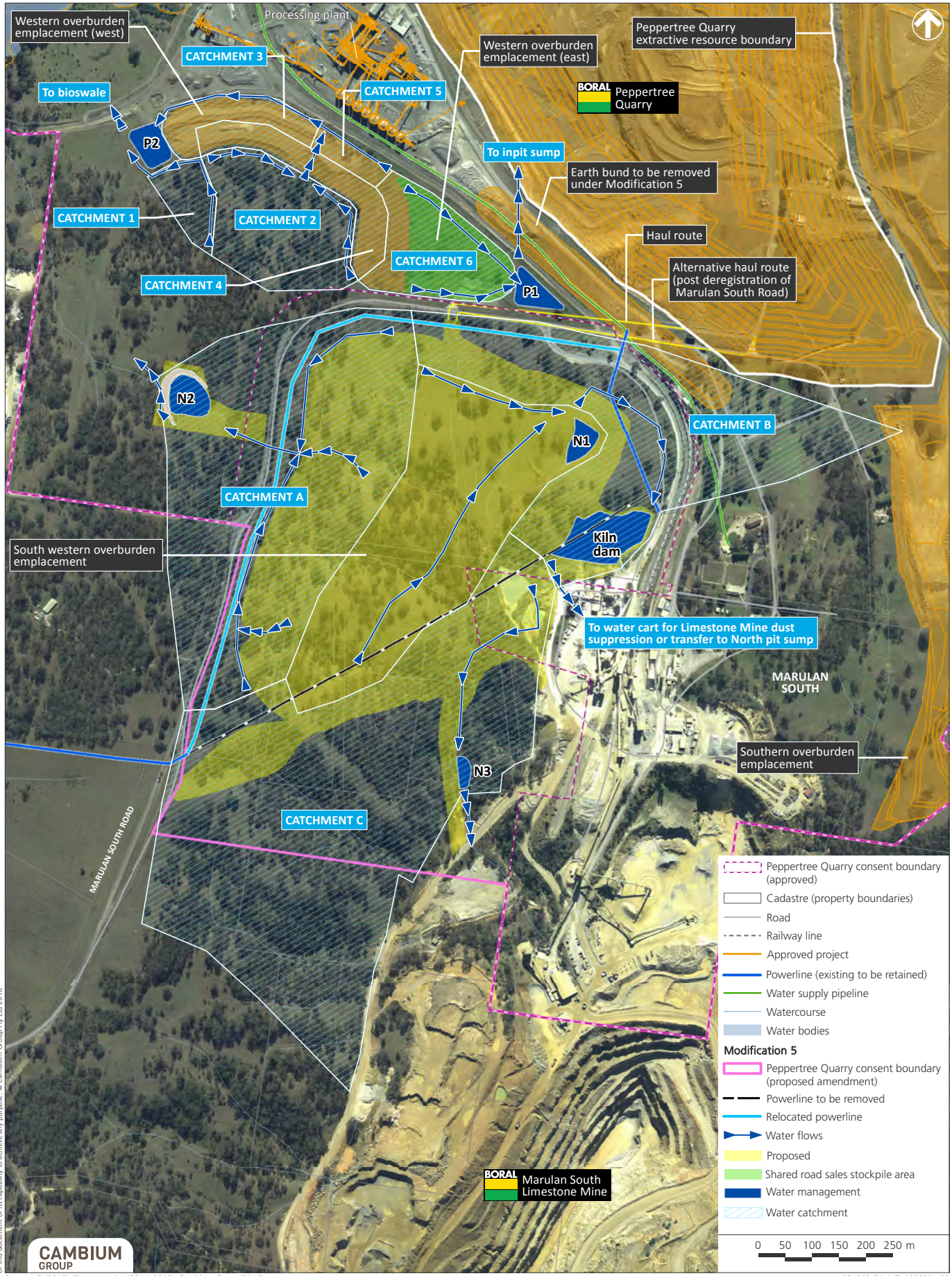
The sediment basins designed for the 95th percentile five day rain fall may overflow one to two times per year and those designed for the 90th percentile rain fall may overflow three to four times per year. During rain fall greater than the design event, sediment basins N2, N3 and P1 will overflow to either the Quarry or Mine water management systems. Sediment basin P2 will overflow to Dam 1 and sediment basin N1 will overflow to a tributary of Tangarang Creek, which will drain to Dam 1.

Therefore, the Project could contribute flows to Tangarang Creek once or twice a year. Tangarang Creek flows into Dam 1, which is a component of the Quarry water management system and no flooding or water quality impacts on downstream users are likely.

The proposed design and operating standard for the sediment basins is consistent with the objective of achieving a NorBE as required under State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011. In addition, given Dam 1 acts as a large clean water body, and that water quality downstream from the Quarry (two sites in Barbers Creek) is generally better than the water quality upstream of the Quarry, it is submitted that the Quarry water management system have a neutral or beneficial effect on the drinking water catchment.

Figure 14
Water management

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6.7 Visual amenity

Potential impacts from the Project on the visual amenity of sensitive receivers and public viewpoints were assessed. The visual impact assessment report is in **Appendix G**, which is summarised in this chapter.

6.7.1 Existing environment

Visual amenity in the area is characterised by rural and vegetated viewscapes, with some dispersed industrial, commercial and extractive land uses. Viewscapes to the east of the Quarry are characterised by vegetated and riverine environments with areas of high topographic relief in the Morton National Park and Bungonia State Conservation Area.

The area around the Quarry is publicly accessible via Marulan South Road, which provides access to a small number of private properties, the Quarry, Mine and agricultural lime manufacturing facility.

East of the Quarry and across the Barbers Creek gorge is Long Point Road, a minor rural road that terminates in the carpark of the Long Point Lookout. It provides access to a small number of rural properties. The Quarry is partly visible from a track at the Long Point Lookout that runs for a short distance south, then runs east to descend into the Shoalhaven River gorge.

Quarrying has resulted in construction of earth bunding to the north of the pit and emplacement of overburden to the north-east, east and south-east of the pit, which has changed the topography, form, line, colour and textures of the landscape. However, other than in the view from Marulan South Road, those visual effects are highly localised.

The existing scenic resources are minor. The visual quality and character of the land is common in the locality and of low accessibility to the public. That character is also widespread in the area and the Southern Tablelands generally, and is neither rare nor under threat.

6.7.2 Assessment

Method

The SWOE will be a new area of disturbance at the Quarry and has potential to be visible from publicly accessible areas and private properties. The other Project components will only require minor disturbance or minor rearrangement of existing Quarry components.

The likely visual exposure of the SWOE was analysed using topographic, cadastral and aerial images. The site and locality were also inspected to ground-truth potential viewing places. Several viewpoints were selected from the total potential viewpoints for further assessment. The key viewpoints were public domain locations including on roads, recreational areas and lookouts, as well as several residential receivers. The location of the receivers and viewpoints are shown on **Figure 15**.

Observations and assessments were made at each viewpoint (see photographs in Appendix 1 and assessment sheets in Appendix 4 of the VIA). A variety of other locations were also visited to ascertain the extent of the visual catchment and the characteristics of the views towards the Quarry.

Terrain was modelled in two and three dimensions and photomontages were prepared to confirm the visibility of the SWOE. **Figure 16** shows a 3D oblique aerial view of the proposed SWOE; **figures 17 to 23** show 3D rendered views with existing vegetation; and **figures 24 to 32** show photomontages of the final view after rehabilitation. The figures include Modification 4 (SOE) components to demonstrate cumulative impacts.

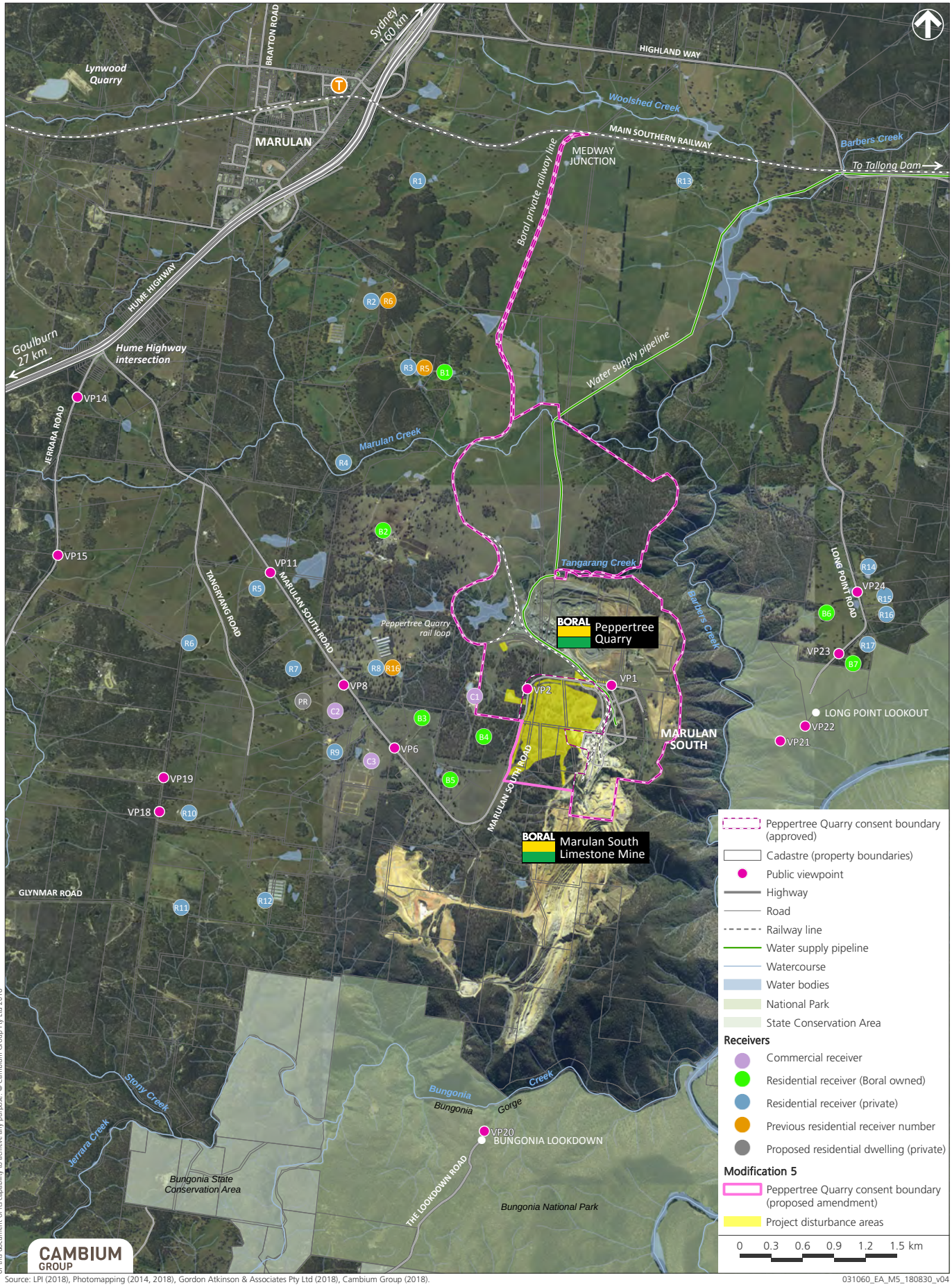
Terms relevant to the visual impact assessment are described in **Table 33**.

Table 33 Visual assessment terms

Term	Definition
Visual exposure	A measure of the extent to which a place in the landscape is seen from important public viewing locations (e.g. roads, recreation areas) and other fixed viewing locations such as private residences.
Visual catchment	An area within which there is sufficient detail, including view of the surrounding visual context, for the proposed changes to the environment to be perceived as either positive or negative impacts.
Viewing distance	Distance of the viewpoint from the Project component, with distances correlating to potential impacts (>3,000m – low, 500-3,000m – medium, <500m – high).
View place sensitivity	A measure of the public interest in the view which increases from low to high in the following order: publicly accessible or main roads, general lookouts, reserves.
Viewer sensitivity	A measure of the private interests in the effects of Project components on views. The private interest is reflected in the extent to which viewers, predominantly viewing from private residences, would perceive the effects on the existing view. Residences from which there would be close or medium distance range views affected, particularly those which are available over extended periods from places such as living rooms and outdoor recreational spaces, are places of medium and high viewer sensitivity, respectively.
Visual effects	The overall impact to a viewpoint taking account of view composition (e.g. expansive, restricted or panoramic views); relative viewing level (location of viewer in relative relief to the visible component); viewing period (time available to view the component); viewing distance; and view loss or blocking (how much a component will block views).

Figure 15
Viewpoint locations

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Figure 16
3D oblique view

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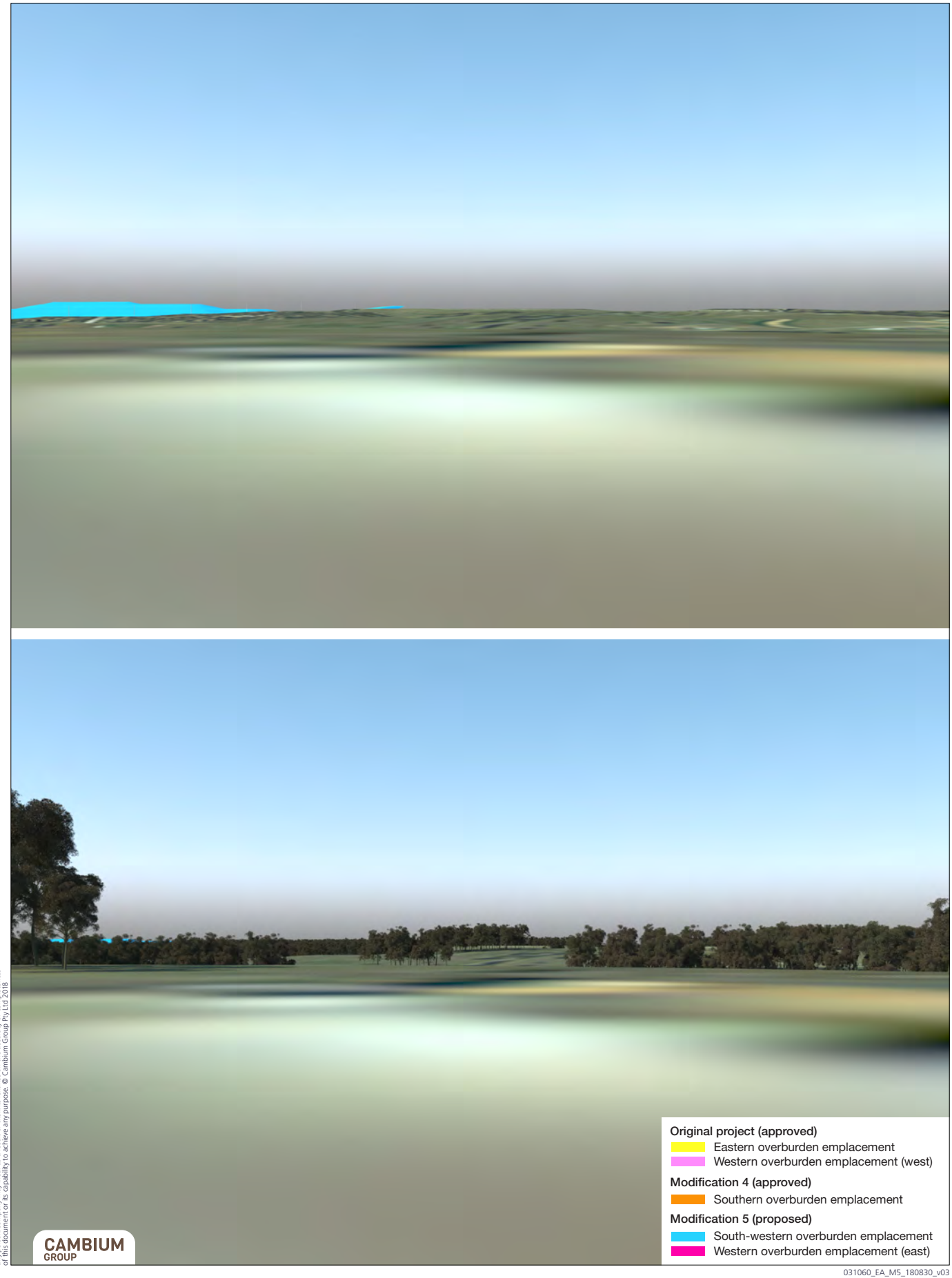


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Figure 17
Receiver C2 terrain and proposed landforms with vegetation

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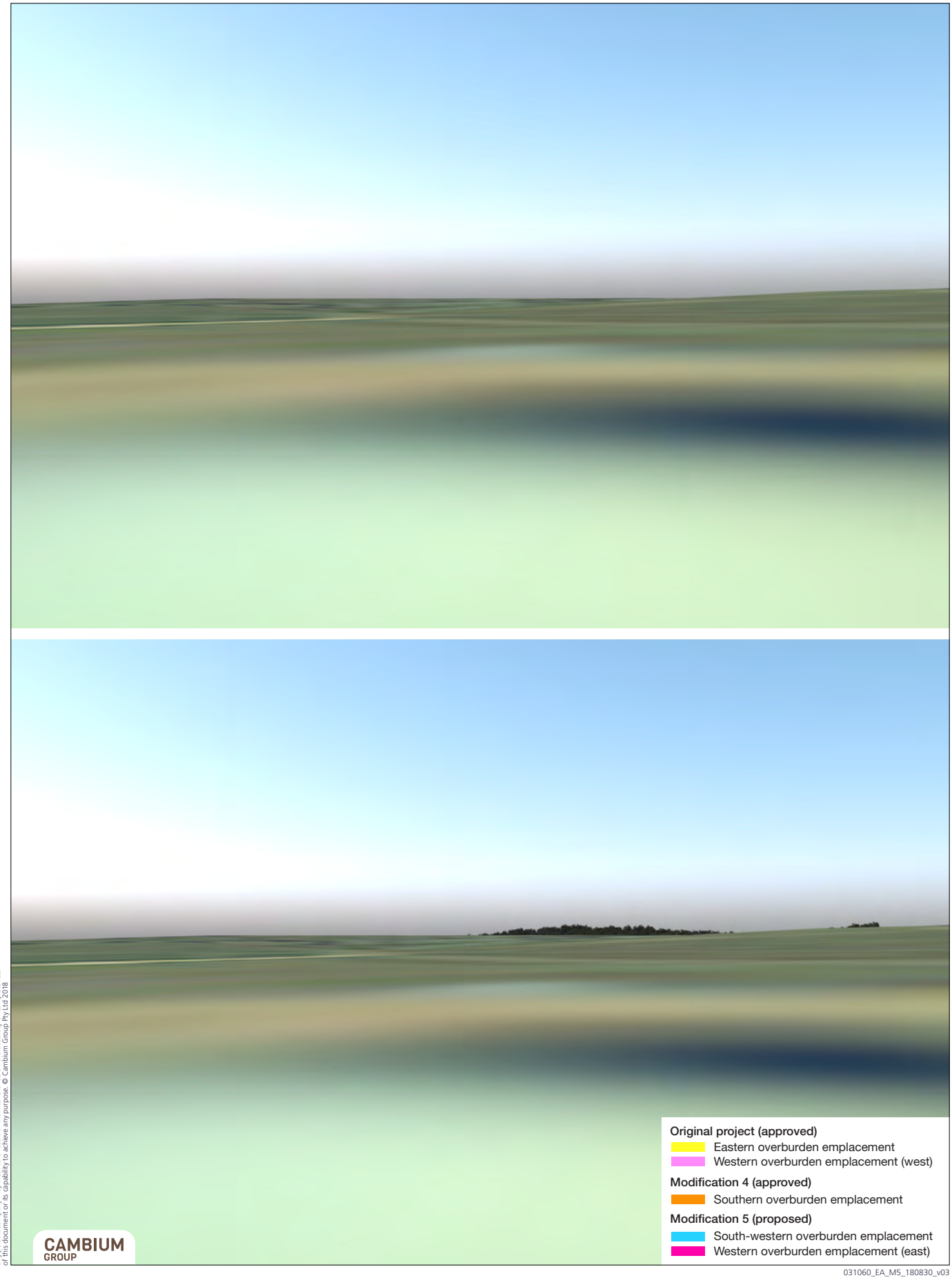


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Figure 18
Receiver C3 terrain and proposed landforms with vegetation

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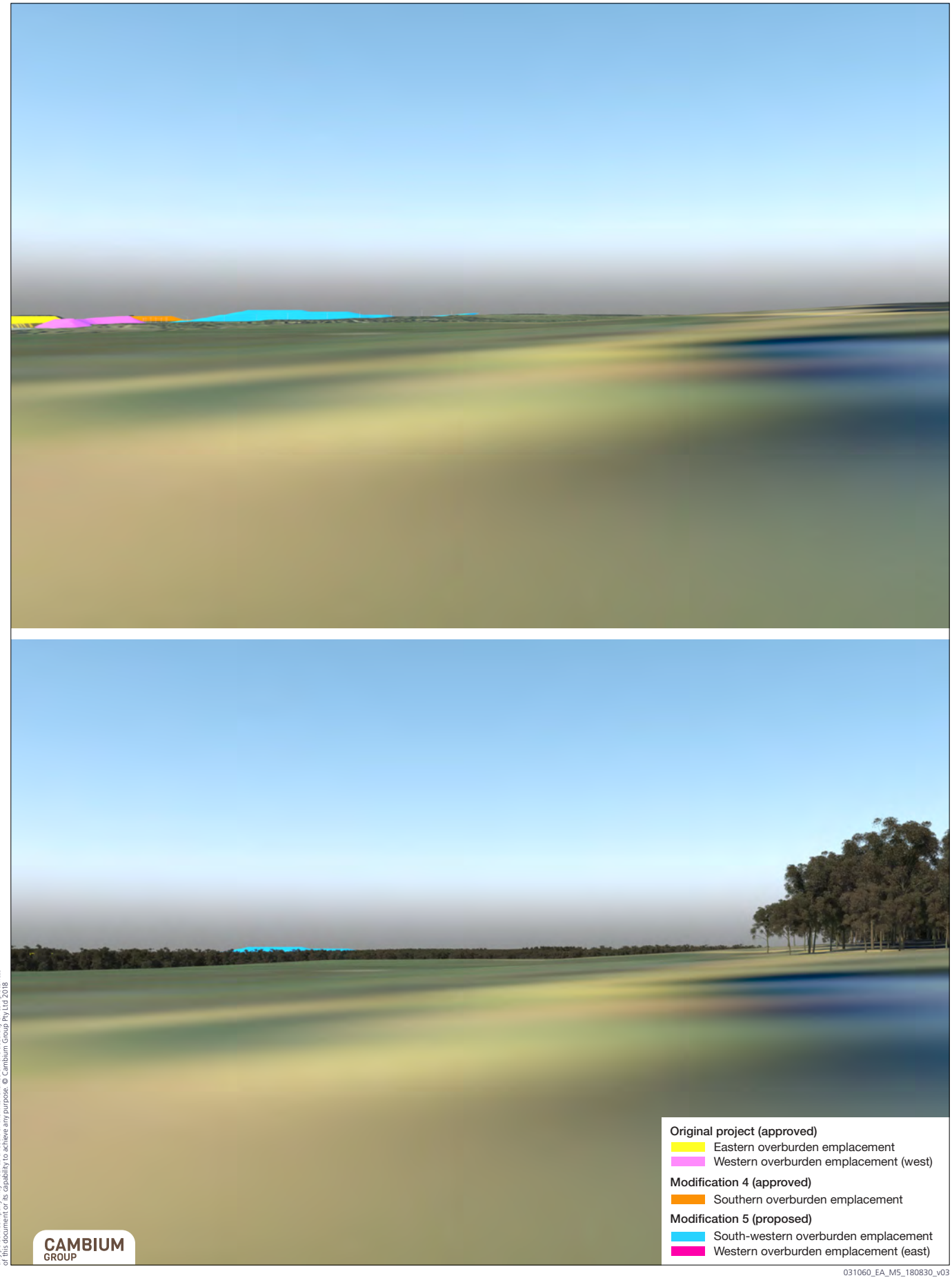


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Figure 19
Receiver R5 terrain and proposed landforms with vegetation

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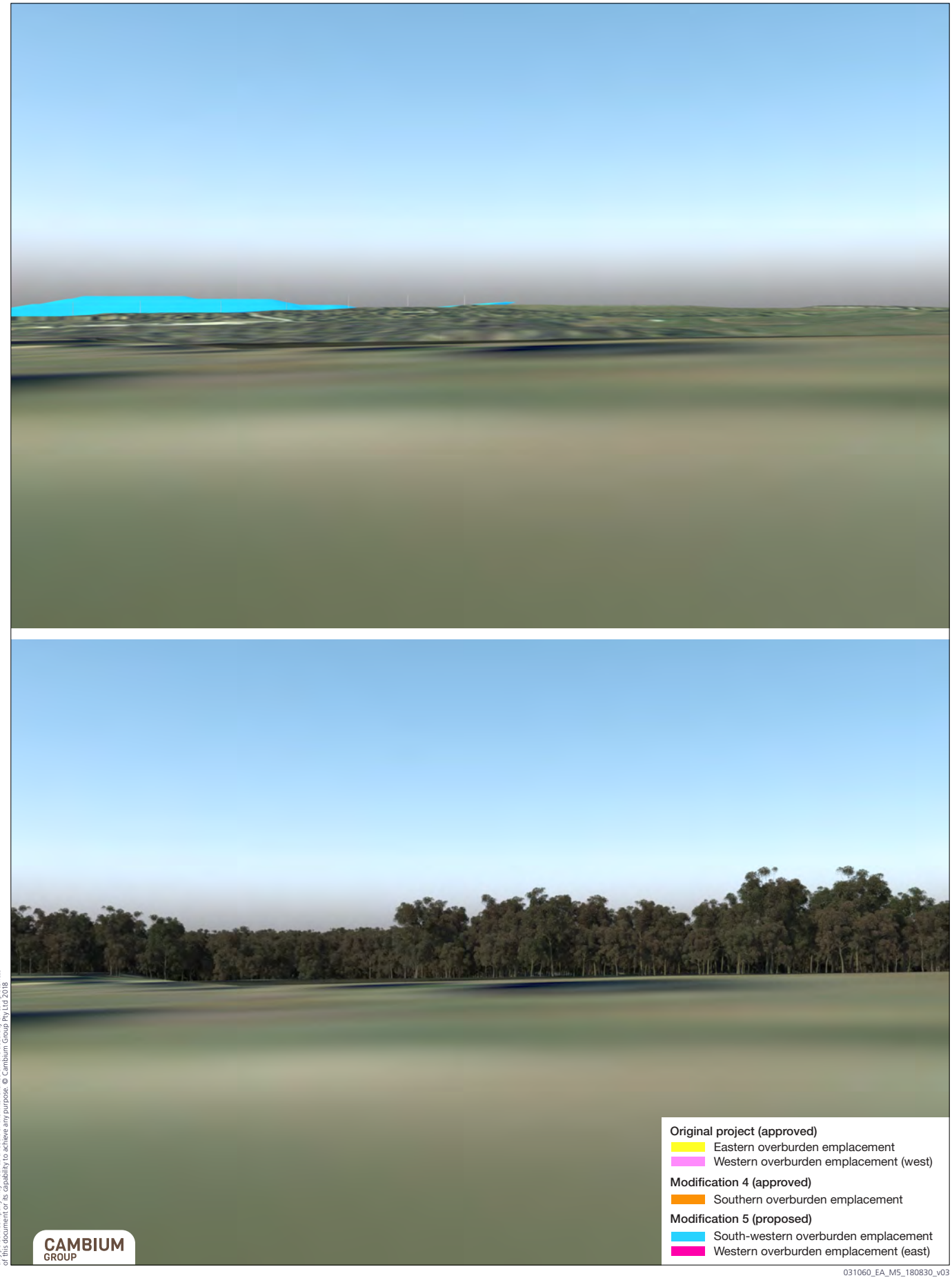


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Figure 20
Receiver R8 terrain and proposed landforms with vegetation

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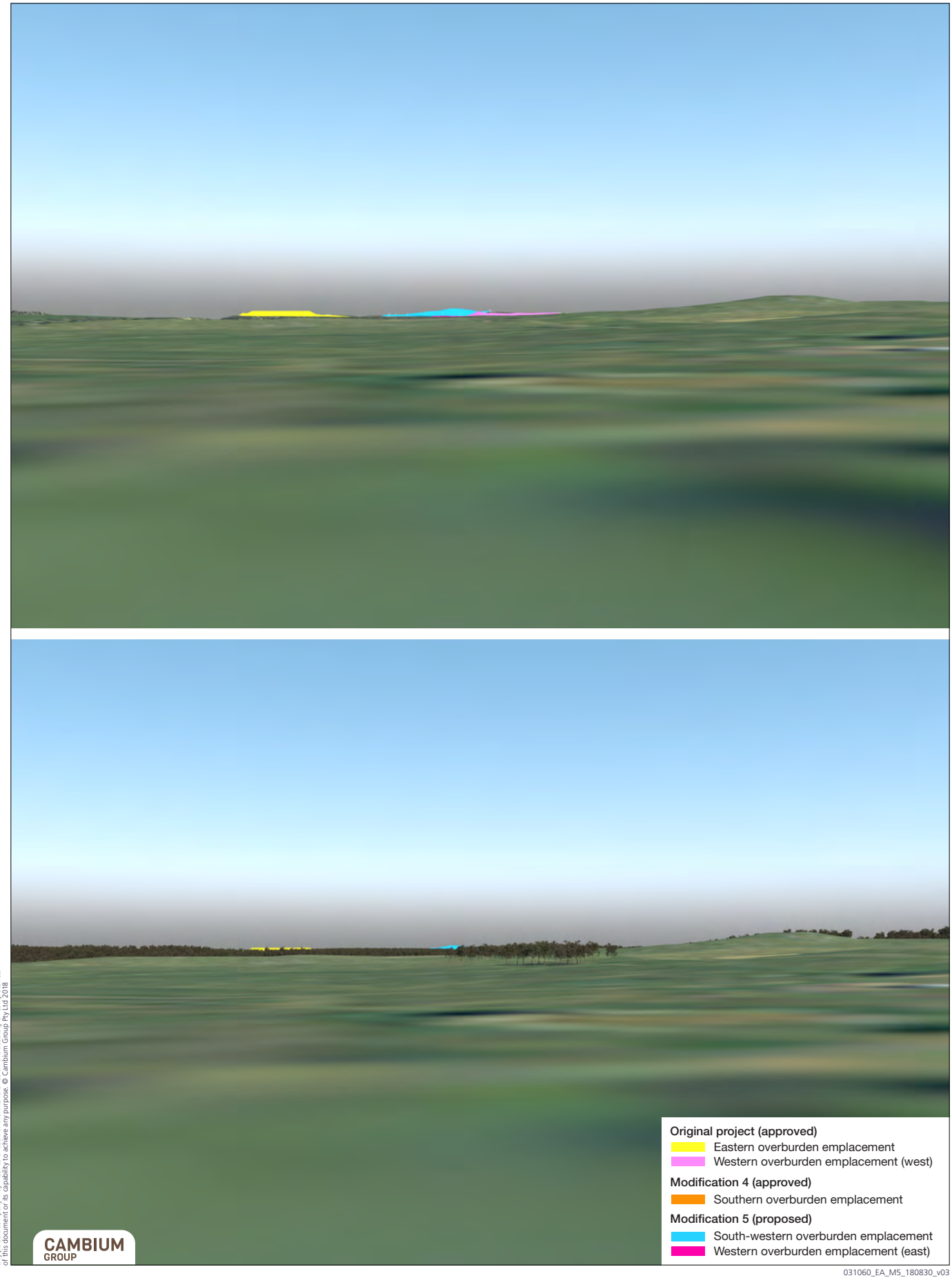


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Figure 21
Receiver R13 terrain and proposed landforms with vegetation

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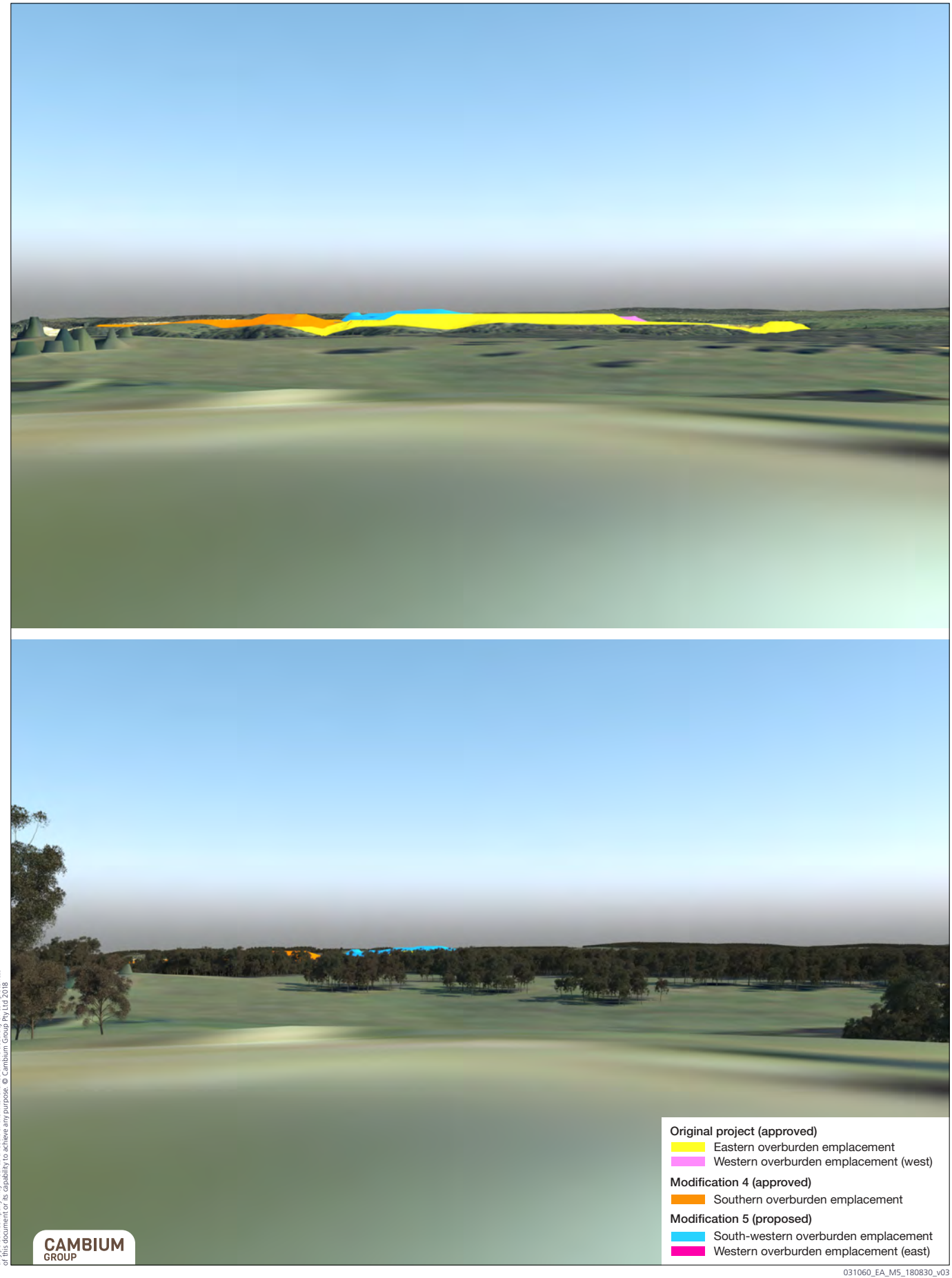


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Figure 22
Receiver R14 terrain and proposed landforms with vegetation

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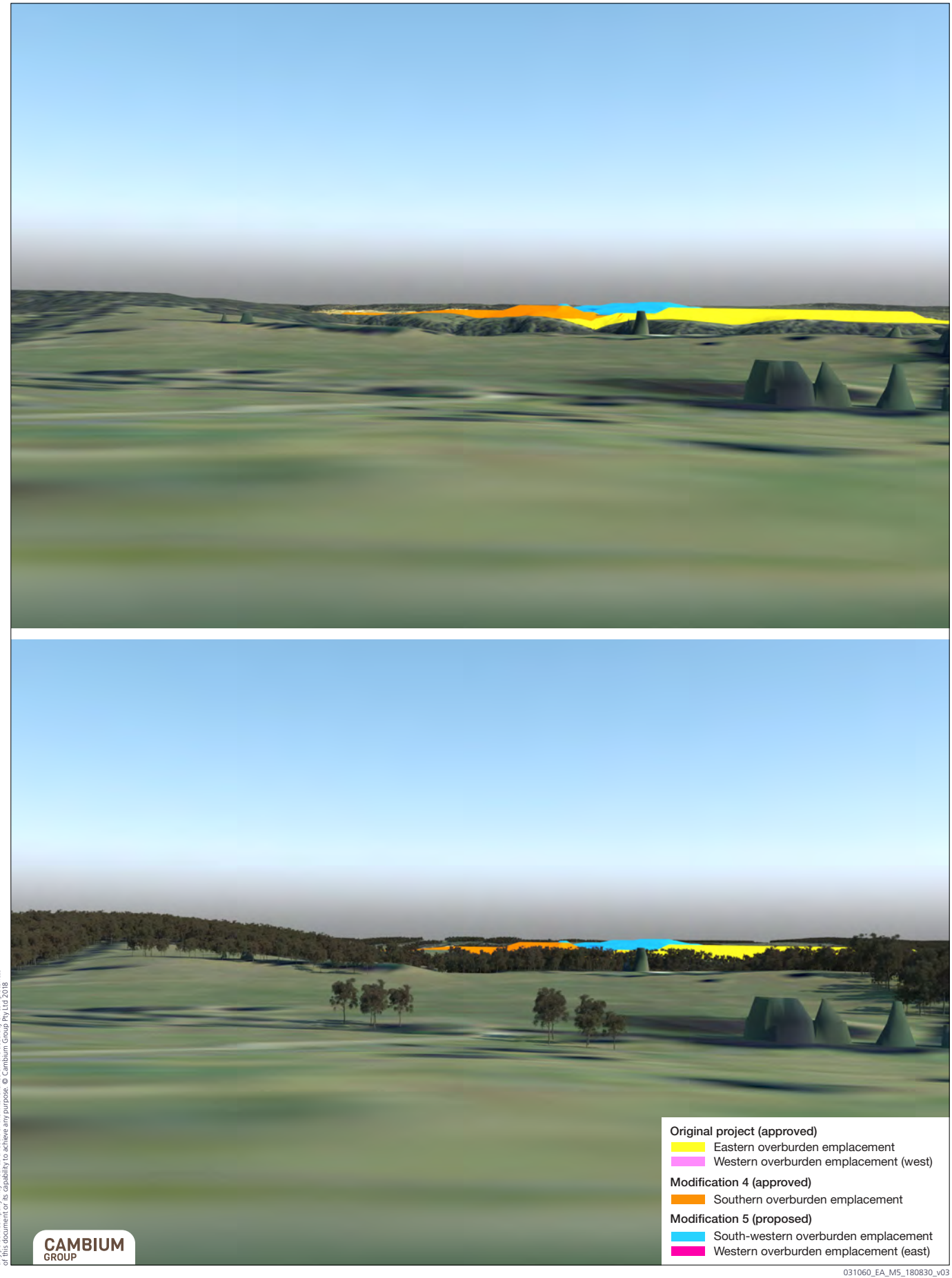


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Figure 23
Receiver R15 terrain and proposed landforms with vegetation

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Figure 24
Viewpoint 20 Look Down - Existing

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Figure 25
Viewpoint 20 Look Down - Analytical landform

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Figure 26
Viewpoint 20 Look Down - Photomontage of landform with mature vegetation

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Figure 27
Viewpoint R10 - Existing

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Figure 28
Viewpoint R10 - Analytical landform

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Figure 29
Viewpoint R10 - Photomontage of landform with mature vegetation

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Figure 30
Viewpoint 21 - Existing

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Figure 31
Viewpoint 21 - Analytical landform

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Figure 32
Viewpoint 21 - Photomontage of landform with mature vegetation

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Impacts

The proposed SWOE has a low overall visual exposure to its visual catchment. Despite there being several rural properties and commercial operations within 3 km of the closest part of the Project, (medium viewing distance and sensitivity classes) there is low visual exposure to those receivers and most have no views of it.

The WOE is already approved and is of lower visual exposure. It is a small structure and its visual effects are confined to a short section of Marulan South Road. The WOE would have a minor visual benefit in decreasing visibility of the Quarry's processing area and rail load-out facility from part of the road. The Project will not significantly change the height or layout of the WOE, with only the height of the proposed area of the future shared road sales stockpile area to be reduced.

The SWOE and WOE will have localised effects on views from an area of Marulan South Road that is highly modified and features minimal natural or scenic attributes. The road is a low sensitivity location. The re-aligned high voltage powerline would be of low visibility, largely confined to the Marulan South Road corridor over a short distance.

Viewpoint 21 is the only viewing location that will have a substantial view of the SWOE. Receivers R14 and R15 will have minor exposure to the SWOE. The existing eastern and southern overburden emplacements will significantly screen views of the Project.

The proposed SWOE will only be constructed during daytime hours and the Project will not change approved night time operations. Therefore, the Project will not change the extent, duration or intensity of the existing Quarry lighting.

6.7.3 Management measures and residual impacts

The SWOE and WOE will be progressively rehabilitated/vegetated in accordance with Boral's (2017) *Biodiversity and Rehabilitation Management Plan*. This rehabilitation is represented by the red and blue shading on the figures, which demonstrate that only vegetation will be visible from affected viewpoints at the end of rehabilitation.

The visual assessment found that there will be some minor residual visual impacts. The residual visual impacts were considered in relation to the changes to the visual environment that have been approved and occurred in the past and were found to be compatible with both the quarrying/industrial and the rural/natural visual environment.

6.8 Traffic and transport

Potential traffic and safety impacts associated with the Project on Marulan South Road were assessed. The traffic impact assessment report is in **Appendix H**, which is summarised in this chapter.

6.8.1 Background

The Quarry is accessed by road via Marulan South Road, which connects the Quarry and the Mine with the Hume Highway approximately 9 km to the northwest. The Quarry access intersection is on Cooper Crescent, at the end of Marulan South Road.

Boral is negotiating with Council to deregister the section of Marulan South Road east of the Aglime facility driveway, however, this process is unlikely to be complete during the timeframe of this assessment.

Boral proposes to construct a cross junction intersection, including road widening, on Marulan South Road approximately 350 m west of the truck access road to the Mine. This intersection will allow trucks hauling overburden material from the Quarry to cross Marulan South Road and enter/exit the SWOE area. Two designs are proposed based on the following haulage scenarios from the Quarry pit (**Figure 33**):

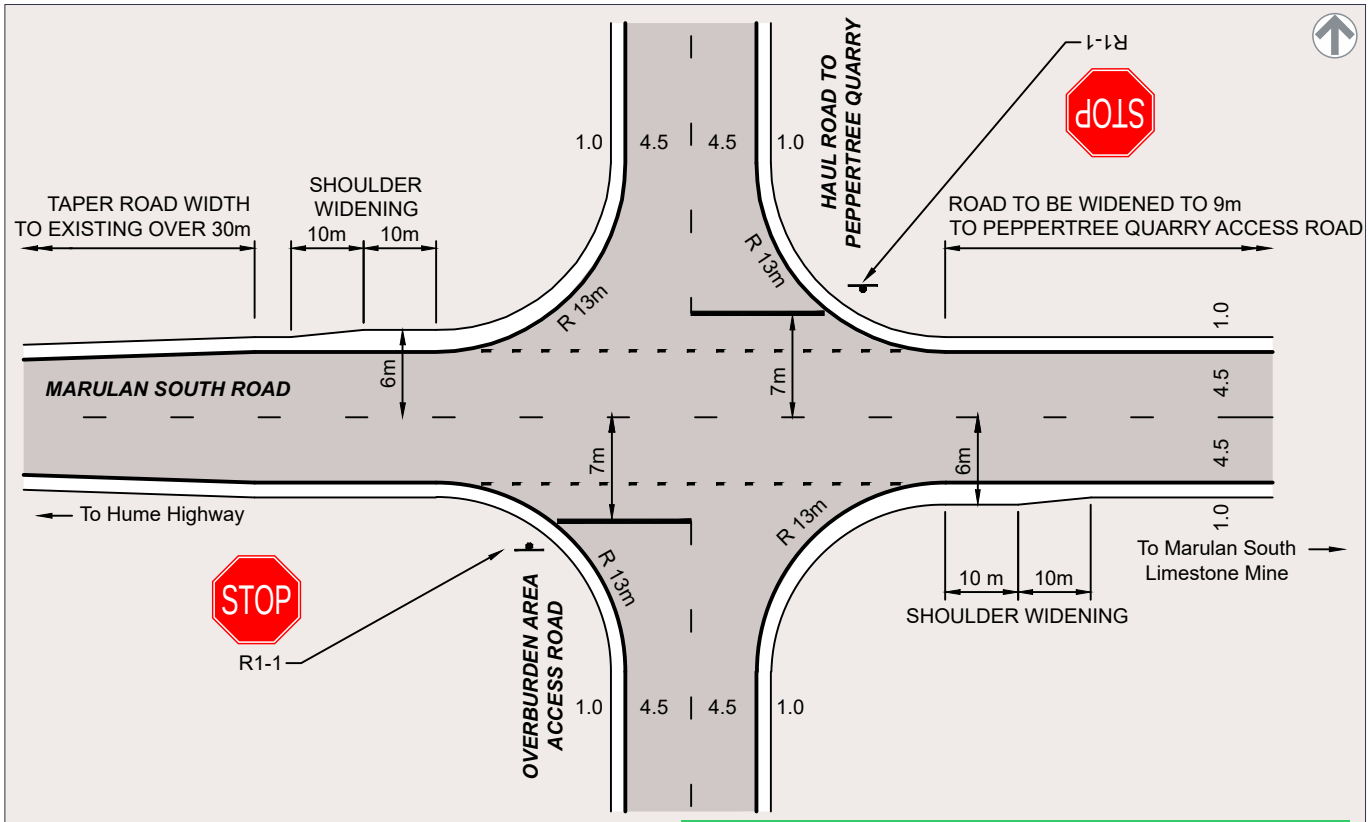
- Scenario 1 – Marulan South Road to a left turn at the intersection into the SWOE/right turn out of the SWOE onto Marulan South Road; and
- Scenario 2 – the proposed haul road parallel to Marulan South Road and across Marulan South Road at the intersection into the SWOE.

The intersection will have single lane approaches which will be widened to cater for oversize vehicles. Stop signs were provided on the haul road approaches to Marulan South Road.

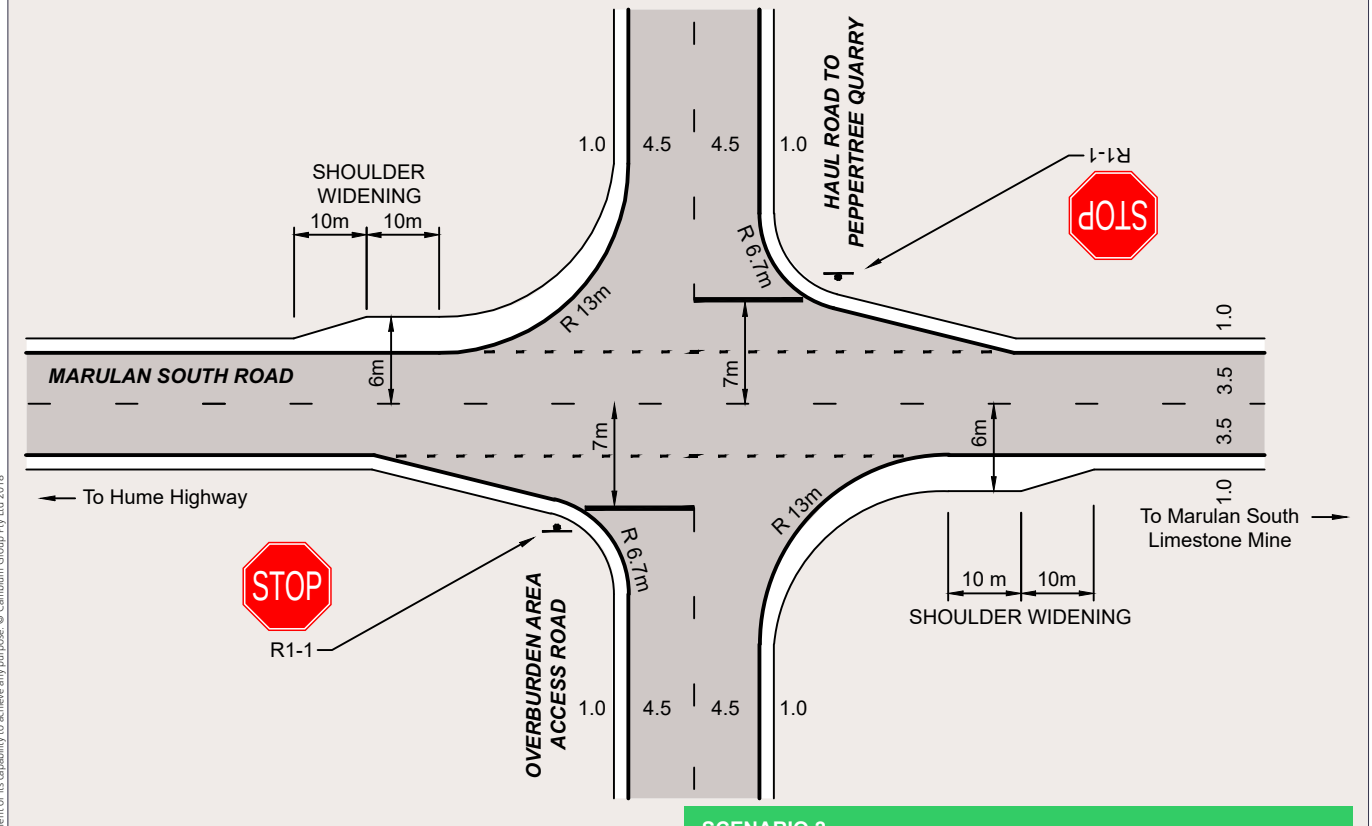
Boral may install traffic signals at the intersection should the section of Marulan South Road east of the Aglime facility be deregistered. The signals would suit either scenario and could be vehicle activated or timed, with preset phase times.

Figure 33
Conceptual intersection layouts

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SCENARIO 1
MARULAN SOUTH ROAD WIDENED TO 9m
FROM INTERSECTION TO PEPPERTREE QUARRY ACCESS ROAD



SCENARIO 2
MARULAN SOUTH ROAD TO REMAIN 7m WIDE

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Source: Transport and Urban Planning, 2018.

6.8.2 Assessment

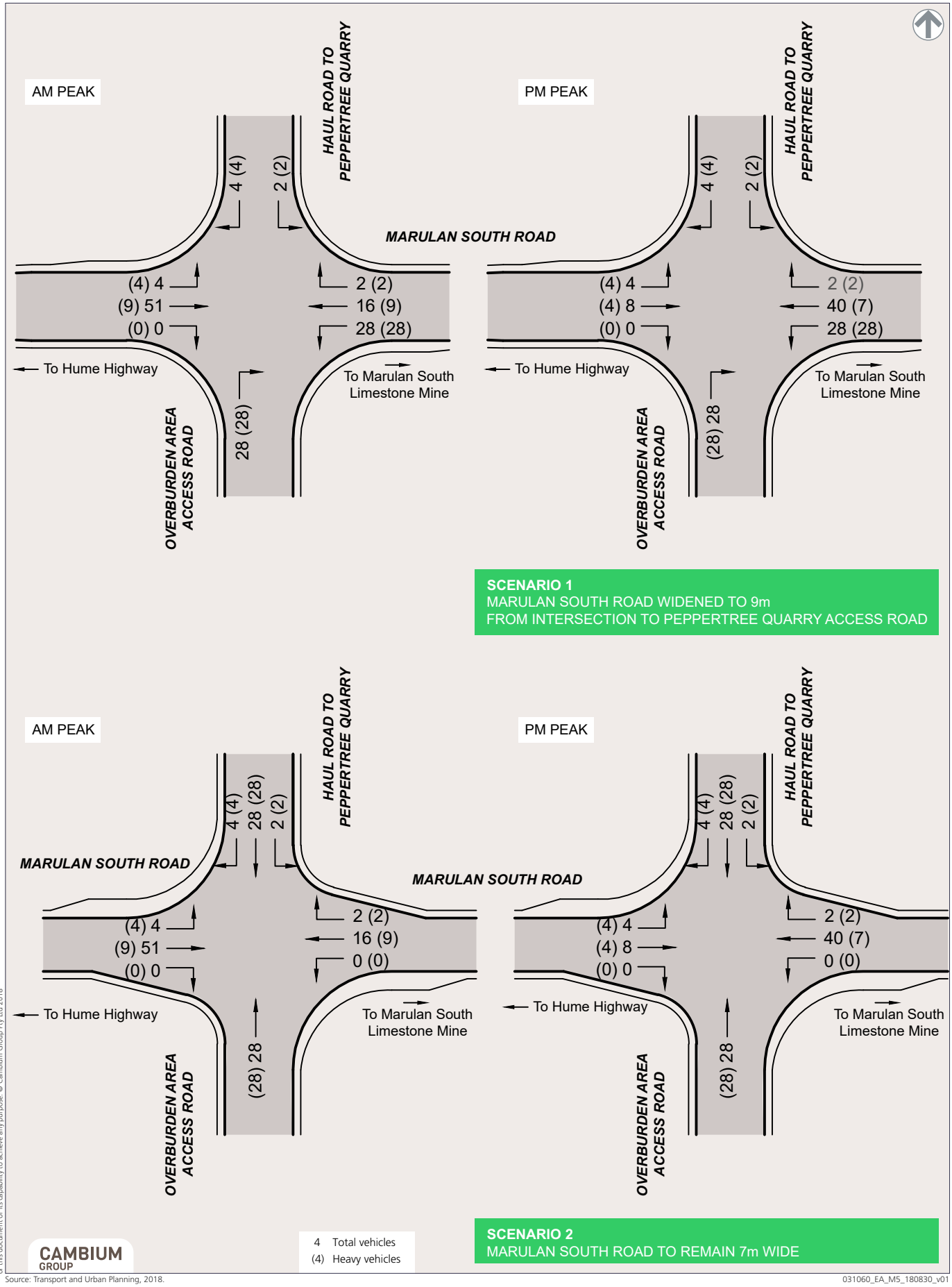
Operation of the intersection could slow and impede traffic flows along Marulan South Road. The location of the intersection could impact vehicle safety by being too close to the 90 degree curve in Marulan South Road between the Aglime facility driveway and the entrance to the Quarry. This could result in insufficient sight distance to the intersection and insufficient time for an east bound vehicle, emerging from the corner to see stopped traffic and safely slow down.

Peak hour traffic volumes at the intersection need to be predicted to assess level of service (LoS). Predicted peak hour traffic volumes at the intersection for the two haulage scenarios in Section 6.8.1 and shown on **Figure 34** comprise:

- existing Quarry and Mine vehicles travelling to and from the Hume Highway;
- 28 trucks per hour moving overburden from the Quarry pit to the SWOE and returning to the pit between 7:00am and 7:00pm seven days a week; and
- vehicles associated with the Mine's forthcoming development application including the proposed shared road sales stockpile area (to ensure the intersection is designed for the Quarry's overburden haul trucks plus future heavy vehicles associated with the Mine.

Figure 34
Future peak hour traffic volumes

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Source: Transport and Urban Planning, 2018.

The likely delays at the intersection were predicted for the two haulage scenarios using the Signalised and Unsignalised Intersection Design and Research Aid (SIDRA) program using the predicted peak hour traffic volumes.

SIDRA predicts intersection performance in terms of average vehicle delay (AVD), highest movement delay (HMD) and overall LoS. LoS is ranked from F to A, with A representing the best performance. According to the RMS, a LoS of D or better is desirable. The SIDRA results for the unsignalised intersection are summarised in **Table 34** and in **Table 35** for the signalised intersection.

SIDRA predicted a LoS A for signalised and unsignalised intersections under each haulage scenario, which is the best possible intersection performance.

Table 34 SIDRA results for unsignalized intersection

Performance measure	Scenario 1		Scenario 2	
	AM	PM	AM	PM
LoS	A	A	A	A
AVD (sec)	4.8	5.2	5.7	6.1
HMD (sec)	12.2	11.3	11.3/13.1*	10.5/12.5*

* HMD in seconds for cross movement and for right turn out of new haul road.

Table 35 SIDRA results for signalised intersection

Performance measure	Scenario 1		Scenario 2	
	AM	PM	AM	PM
LoS	A	A	A	A
AVD (sec)	12.9	13.5	11.6	11.9
HMD (sec)	0.104	0.125	0.104	0.104

Austroad's safe intersection sight distance for 60 km/h, assuming a 60 km/h speed limit in the vicinity of the intersection, is 113 m to 121 m, depending on a 2 second or 2.5 second reaction time. As sight distances from the intersection along Marulan South Road will be 200 m to the west and 250 m to the east, sight distances to and from the intersection will be in accordance with Austroad standards.

6.8.3 Residual impacts and management measures

The proposed intersection is not predicted to significantly impact traffic flow and safety along Marulan South Road. Sight distances will be sufficient provided the speed limit in the vicinity of the intersection is 60 km/h. Currently, the speed limit changes at the proposed location of the intersection from 80 km/h to 60 km/h. The change to 60 km/h will need to be moved 200 m west in order to achieve the safe sight distance from the western approach to the intersection.

Boral's previous (2012) *Peppertree Quarry Construction Management Plan* will be revised to incorporate management of road safety during construction of the proposed intersection.

6.9 Other environmental considerations

6.9.1 Land contamination

Proposed disturbance areas were investigated for potential contamination during preparation of the Mine SSD application (ZOIC 2018). The investigation did not identify any potential contamination at the site. The nearest potential contamination (Area of Environmental Concern 15) is at wash down bays and a waste oil tank site associated with the Mine's processing infrastructure, adjacent to the eastern boundary of the Project area.

The sites of the proposed surface disturbance are currently unused and were historically used for grazing livestock and Boral is unaware of any historical potentially contaminating activities that could have occurred in these areas.

In the event that previously unidentified contaminated land is located during construction or operation, requirements of the CLM Act would need to be complied with.

No further assessment of contaminated land is therefore required.

6.9.2 Land and rehabilitation

The proposed SWOE will be constructed out of the same material as the existing overburden emplacements on the Quarry site and will be designed to similar standards. As such, the SWOE will be landscaped and rehabilitated in accordance with the approved *Biodiversity and Rehabilitation Management Plan* (2017), in order to minimise the potential for visual, air quality, biodiversity and erosion and sedimentation impacts arising from unstabilised ground surfaces.

The *Biodiversity and Rehabilitation Management Plan* (2017) will be revised to incorporate the additional SWOE and any additional management strategies to ensure temporary stabilisation of exposed surfaces, permanent stabilisation strategies, progressive rehabilitation with groundcover vegetation during overburden emplacement and final rehabilitation as soon as practical after formation of the SWOE.

As required by Schedule 5, Condition 3 of the Approval, the *Biodiversity and Rehabilitation Management Plan* (2017) will be revised within three months of a notice of approval, and submitted to DPE for endorsement.

6.9.3 Groundwater

Groundwater resources in the Project area and potential impacts from development of the Quarry were assessed during preparation of the Marulan South Quarry Environmental Assessment Report (ERM, 2006) and during installation of monitoring bores in 2015. The assessment found that groundwater at the site occurs in discrete fractured zones, the most significant of which is the interface between the overburden and underlying granodiorite. There was no evidence of vertical or lateral movement of groundwater between these zones and the shallowest water was 15 m below ground level.

The establishment of the SWOE and changes to the WOE only require minor excavations and these activities will not impact groundwater. Construction of sediment dams P1 and P2 will not enter the water bearing zones and will not impact groundwater.

Additional impacts to groundwater are therefore unlikely to occur as a result of the Project and further assessment of potential groundwater impacts is not required.

6.9.4 Greenhouse gas

Greenhouse gas emission sources from the Quarry and potential impacts were assessed during preparation of the Marulan South Quarry Environmental Assessment Report (ERM, 2006). The assessment found that while extraction and processing of granodiorite consumes energy, the Quarry would implement strategies to minimise energy consumption and associated emissions. Such strategies included use of conveyors where possible in place of less efficient truck haulage and transport of aggregate by rail rather than road truck.

The hauling of overburden to the proposed SWOE instead of to the Mine's south pit will reduce the haulage distance for each truck by a minimum of 4 km per return trip. This reduction in haulage distance will significantly reduce both fuel consumption and greenhouse gas emissions associated with approved overburden emplacement activities.

The Project will not result in an increase in total production volumes at the Quarry or the means of finished product transportation by rail.

Boral will continue to monitor and report greenhouse gas emissions generated by Quarry operations in accordance with its commitments under the Commonwealth *National Greenhouse and Energy Reporting Act 2007*.

6.9.5 Socio-economic

The potential social impacts of the Project relate largely to impacts on general amenity such as noise, air quality (dust), surface water runoff and visual exposure. These potential social impacts have been thoroughly assessed in the EA and a range of mitigation measures (in addition to those presented in the Marulan South Quarry Environmental Assessment Report (ERM, 2006), Approval conditions, the EPL and approved *Peppertree Quarry Environmental Management Strategy* (2017) are recommended to minimise potential noise, air quality, surface water and visual impacts so they are not perceived as a nuisance to neighbouring residents and other sensitive receivers.

Some residents raised concern about the potential impact that visibility of overburden emplacements could have on their property values. The visual impact assessment concluded that there is low visual exposure to receivers and most will have no views of the SWOE. Receivers R14 and R15 will have minor exposure to the SWOE, which will be progressively rehabilitated with only vegetation visible from these receivers at the end of rehabilitation.

The building and construction industry in NSW and particularly Sydney has seen a great deal of growth in the last few years, with this growth forecast to continue. The NSW Government, together with Federal funding, has committed to significant infrastructure projects, including the Badgerys Creek Airport, new rail lines, and major road construction and upgrading. Boral is, and will be supplying a number of these projects with concrete and asphalt that includes aggregates and sand from the Quarry on rail through terminals at St Peter's and Enfield. Given the importance of these projects to the NSW economy, the additional overburden emplacement area is crucial to enable overburden emplacement prior to approval of the Mine SSD and to enable uninterrupted supply of concrete and asphalt to these and other projects, as well as future demand in the Sydney market.

6.9.6 Hazards

The Project will not result in any additional hazardous activities to those already undertaken at the Quarry eg blasting and storage of fuel.

Existing mitigation measures as previously required by the Approval conditions and approved *Peppertree Quarry Environmental Management Strategy* (2017) and subordinate plans, will continue to be implemented in order to minimise the potential for adverse impacts or environmental incidents associated with hazardous activities.

6.9.7 Waste

The Project is unlikely to generate any additional types of waste, not currently generated by the approved Quarry.

The main waste source which would result from the development of the SWOE is felled trees and shrubs. Cleared vegetation will be used for rehabilitation purposes on the final overburden emplacement embankments or elsewhere on site, where required.

All other waste created through development of the SWOE eg old livestock fencing, would be reused and/or recycled where possible or disposed of at an appropriately licensed facility.

7 Conclusion

Boral is seeking to modify the Peppertree Quarry Project Approval (PA 06_0074) under Section 75W of the EP&A Act, to provide for the following:

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

Mine planning for the Mine has ruled out emplacement of the Quarry's remaining overburden in the south pit. There is some limestone remaining in the south pit and extraction of this will continue beyond the Quarry's need for additional overburden emplacement space. Additionally, as much in-pit space as possible needs to be created in the south pit to minimise the need for future out of pit emplacements at the Mine.

The Mine, under its forthcoming development application, was seeking to hold 5 million m^3 (approximately 13 Mt) of overburden for the Quarry. However, the Mine's SSD application is unlikely to be determined until 2019. As the Quarry will run out of overburden emplacement space in 2018, Boral is seeking approval to incorporate this approximately 13 Mt overburden emplacement into the Approval.

The proposed location for the SWOE does not overlie any limestone or granodiorite, which means it will not sterilise future access to limestone or granodiorite resources.

Specialist technical investigations were undertaken to assess key environmental issues associated with the Project that were identified by the Project team and a thorough government agency and community consultation process. These investigations concluded that the Project is unlikely to result in any significant impacts on either the biophysical or social environment with the implementation of:

- environmental management and mitigation measures outlined in:
  - the Approval;
  - **Section 6** of this document;
- the biodiversity offset strategy; and
- requirements of EPL 13088.

The existing environmental management plans would be reviewed by Boral following approval of the Project and amended as necessary.

The Project is therefore considered to be in the public interest, and is recommended for approval.

APPENDIX A

Existing Project Approval 06_0074

Project Approval

Section 75J of the *Environmental Planning & Assessment Act 1979*

I, the Minister for Planning approve the project referred to in schedule 1, subject to the conditions set out in schedules 2 to 5.

The reason for these conditions is to:

- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the on-going environmental management of the project.

Frank Sartor MP
Minister for Planning

Sydney 2007 File No. 9040608

SCHEDULE 1

Project Application:	06_0074
Proponent:	Boral Resources (NSW) Pty Ltd
Approval Authority:	Minister for Planning
Land:	See Appendix 1
Project:	Marulan South hard rock quarry and associated infrastructure

Red type represents March 2009 Modification
Blue type represents November 2011 Modification
Green type represents October 2012 Modification
Purple type represents August 2016 Modification

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DEFINITIONS

Annual Review	The review required by condition 10 of Schedule 5
BCA	Building Code of Australia
CCC	Community Consultative Committee
Council	Goulburn Mulwaree Council
Department	Department of Planning and Environment
DPI Water	Department of Primary Industries - Water
DRE	Division of Resources and Energy, within the NSW Department of Industry
EA	Environmental Assessment for the project titled *Marulan South Quarry Environmental Assessment Report* Volumes 1 and 2 dated October 2006 and prepared by ERM, including the submissions report titled *Marulan South Quarry Submissions Report* dated December 2006
EA (MOD 1)	Modification Application 06_0074 MOD 1 and the accompanying Statement of Environmental Effects entitled *Marulan South Quarry Statement of Environmental for a Pre-commencement Exploratory Test Pit* dated 13 November 2008, and letter from Boral Resources Pty Ltd to the Department dated 13 February 2009
EA (MOD 2)	Modification Application 06_0074 MOD 2 and the accompanying EA titled *Boral Peppertree Quarry Section 75W Modification Report* dated June 2011 and prepared by ERM Australia, and the responses to issues raised in submissions, including those titled *Peppertree Quarry Submissions Report* dated 24 August 2011, *Response to OEH Submission* dated 12 October 2011, *and Response to Armitt Submission* dated 25 October 2011
EA (MOD 3)	Modification Application 06_0074 MOD 3 and the accompanying EA titled *Peppertree Quarry Modification 3 Environmental Assessment* dated August 2012 and prepared by EMGA Mitchell McLennan Pty Limited, and the responses to issues raised in submissions titled *Response to Submissions Peppertree Quarry Modification 3* dated 3 October 2012
EA (MOD 4)	Modification Application DA 06_0074 MOD 4 and the accompanying Environmental Assessment titled *Peppertree Quarry Modification 4 Environmental Assessment* dated April 2016 and prepared by Element Environment, including the Response to Submissions report dated July 2016 and prepared by Element Environment
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPL	Environment Protection Licence under the *Protection of the Environment Operations Act 1997*
Feasible	Feasible relates to engineering considerations and what is practical to build or carry out
Habitat Management Area	The area identified as such on the figure in Appendix 5
Incident	A set of circumstances that: • causes or threatens to cause material harm to the environment; and/or • breaches or exceeds the limits or performance measures/criteria in this approval
Land	As defined in the EP&A Act, except where the term is used in the noise and air quality conditions in Schedules 3 and 4 of this approval, where it is defined as the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this approval
Material harm to the environment	Actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial
Minister	Minister for Planning, or delegate
Mitigation	Activities associated with reducing the impacts of the project
Negligible	Small and unimportant, such as to be not worth considering
Noise Bund	Bunds built for noise and visual mitigation purposes and which do not exceed 10 metres in height
OEH	Office of Environment and Heritage
POEO Act	*Protection of the Environment Operations Act 1997*
Privately-owned land	Land that is not owned by a public agency, the Proponent or another quarrying or mining company
Project	Development to which the Project Approval applies
Proponent	Boral Resources (NSW) Pty Ltd or any other person or persons who rely on this approval to carry out the project that is subject to this approval
Public infrastructure	Linear and related infrastructure that provides services to the general public, such as roads, railways, water supply, drainage, sewerage, gas supply, electricity, telephone, telecommunications, etc.

Quarry operations	Extraction, processing, stockpiling and transportation of extractive materials carried out on the site and the associated removal of vegetation, topsoil and overburden
Quarry products	Includes all saleable quarry products, but excludes tailings and other wastes
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements
Rehabilitation	The restoration of land disturbed by the project to a good condition, and for the purpose of establishing a safe, stable and non-polluting environment
RL	Reduced level
RMS	Roads and Maritime Services
Secretary	Secretary of the Department, or nominee
Site	Land to which the Project Approval applies (see Appendix 1)

SCHEDULE 2
ADMINISTRATIVE CONDITIONS

Obligation to Minimise Harm to the Environment

1. The Proponent must implement all practicable measures to prevent or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

Terms of Approval

2. The Proponent must carry out the project:
   (a) generally in accordance with the EA, EA (Mod 1), EA (Mod 2), EA (Mod 3) and EA (Mod 4); and
   (b) in accordance with the Project Layout Plan and the conditions of this approval.

   Note: The Project Layout Plan is included in Appendix 2.

3. If there is any inconsistency between the documents in condition 2(a), the most recent document shall prevail to the extent of the inconsistency. The conditions of this approval shall prevail over the documents in condition 2(a) to the extent of any inconsistency.

4. The Proponent must comply with any reasonable requirement/s of the Secretary arising from the Department's assessment of:
   (a) any strategies, plans, programs, reviews, audits, reports or correspondence that are submitted in accordance with this approval (including any stages of these documents);
   (b) any reviews, reports or audits commissioned by the Department regarding compliance with this approval; and
   (c) the implementation of any actions or measures contained in these documents.

Limits on Approval

5. The Proponent may carry out quarrying operations on the site until 31 December 2038.

   Note: Under this approval, the Proponent is required to rehabilitate the site and carry out additional undertakings to the satisfaction of the Secretary. Consequently this approval will continue to apply in all other respects other than the right to conduct quarrying operations until the rehabilitation of the site and those additional undertakings have been carried out to a satisfactory standard.

6. The Proponent must not transport more than 3.5 million tonnes of quarry products from the site in any calendar year.

7. All quarry products must normally be transported from the site by rail. However, with the written approval of the Secretary, the Proponent may transport quarry products by road in an emergency or in other limited and exceptional circumstances.

Structural Adequacy

8. The Proponent must ensure that all new buildings and structures on the site are constructed in accordance with the relevant requirements of the BCA.

   Notes:
   - *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for any building works.*
   - *Part 8 of the EP&A Regulation sets out the detailed requirements for the certification of development.*

Demolition

9. The Proponent must ensure that all demolition work on site is carried out in accordance with *AS 2601-2001: The Demolition of Structures,* or its latest version.

Protection of Public Infrastructure

10. The Proponent must:
    (a) repair, or pay all reasonable costs associated with repairing any public infrastructure that is damaged by the project; and
    (b) relocate, or pay all reasonable costs associated with relocating any public infrastructure that needs to be relocated as a result of the project.

Operation of Plant and Equipment

11. The Proponent must ensure that all plant and equipment used at the site is:
    (a) maintained in a proper and efficient condition; and
    (b) operated in a proper and efficient condition.

12. *(deleted)*

SCHEDULE 3
ENVIRONMENTAL PERFORMANCE CONDITIONS

GENERAL EXTRACTION AND PROCESSING PROVISIONS

Identification of Boundaries

1. Prior to the commencement of construction, or as otherwise directed by the Secretary, the Proponent must:
   (a) engage an independent registered surveyor to survey the boundaries of the approved limit of extraction;
   (b) submit a survey plan of these boundaries to the Secretary; and
   (c) ensure that these boundaries are clearly marked at all times in a permanent manner that allows operating staff and inspecting officers to clearly identify those limits

   Note: The limit of extraction is shown conceptually on the plan in Appendix 2.

1A. The proponent must:
   (a) prior to the commencement of construction of the Southern Overburden Emplacement Area, or as otherwise agreed by the Secretary, engage an independent registered surveyor to survey the boundary of the emplacement area and submit a survey plan of this boundary to the Secretary; and
   (b) ensure that, during its construction and use, the boundary of the Southern Overburden Emplacement area is clearly marked in a manner that allows operating staff and inspecting officers to clearly identify its location.

   Note: The boundary of the Southern Overburden Emplacement Area is shown on the figure in Appendix 2.

NOISE

Construction of Bunds

2. In carrying out the construction of the noise bunds, the Proponent must:
   (a) comply with the construction noise criteria in the *Environmental Noise Control Manual 1994* for the first three months of the construction work; and
   (b) thereafter, comply with the daytime operational noise criteria in condition 4.

Construction Noise Management Plan

3. The Proponent must prepare and implement a Construction Noise Management Plan for the project to the satisfaction of the Secretary. This plan must be submitted to the Secretary for approval prior to the commencement of construction, and include:
   (a) a detailed description of the measures that would be implemented to achieve the construction noise limits in the *Environmental Noise Control Manual 1994* and the operational noise criteria in condition 4*;*
   (b) a community notification protocol for the proposed construction activities;
   (c) a description of the measures that would be implemented where the construction noise limits and/or operational noise limits are unlikely to be achieved or are not being achieved; and
   (d) details of who would be responsible for monitoring, reviewing and implementing the plan.

Operational Noise Impact Assessment Criteria

4. The Proponent must ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 1 at any residence on privately-owned land.

Table 1: Noise Impact Assessment Criteria dB(A)

Residential Receiver Location	***Day (7:00am to 7:00pm)*** $L_{Aeq(15\ minute)}$	***Evening (7:00pm to 10:00pm)*** $L_{Aeq(15\ minute)}$	***Night (10:00pm to 7:00am)***	
			$L_{Aeq(15\ minute)}$	$L_{A1(1\ minute)}$
R3 (5)	35	35	35	45
R2 (6)	35	35	35	45
R8 (16)	41	35	35	45

Any other residence on privately-owned land	35	35	35	45

Notes:
- *Residential receiver locations are shown on the plan in Appendix 3.*
- *Receiver numbers in parentheses are those identified in the approval prior to the notification of Modification 4 in 2016.*

Noise generated by the development is to be measured in accordance with the relevant requirements of the Industrial Noise Policy (as may be updated from time-to-time). Appendix 7 sets out the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

However, the noise criteria in Table 1 do not apply if the Proponent has an agreement with the owner/s of the relevant residence or land to exceed the noise criteria, and the Proponent has advised the Department in writing of the terms of this agreement.

Land Acquisition Criteria

5. If the noise generated by the project exceeds the criteria in Table 2, the Proponent must, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 6-8 of Schedule 4.

Table 2: Land Acquisition Criteria

Residential Receiver	***Day (7:00am – 7:00pm) $L_{Aeq(15\ minute)}$***	***Evening / Night (7:00pm – 7:00am) $L_{Aeq(15\ minute)}$***
R3 (5)	40	40
R2 (6)	40	40
R8 (16)	44	44

Notes:
- *Residential receiver locations are shown on the plan in Appendix 3.*
- *Receiver numbers in parentheses are those identified in the approval prior to the notification of Modification 4 in 2016.*

6. *(deleted)*

7. *(deleted)*

8. *(deleted)*

Operating Conditions

9. The Proponent must:
   (a) implement best practice noise management, including all reasonable and feasible noise mitigation measures to minimise the noise generated by the project;
   (b) investigate ways to minimise the noise generated by the project;
   (c) operate a comprehensive noise management system that uses a combination of predictive meteorological forecasting and noise monitoring data to guide the day to day planning of quarrying operations and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this approval;
   (d) minimise noise impacts during adverse weather conditions; and
   (e) report on these investigations and the implementation and effectiveness of these measures in the Annual Review,

   to the satisfaction of the Secretary.

Noise Management Plan

10. The Proponent must prepare a Noise Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA and submitted to the Secretary for approval by the end of March 2012, and must:
   (a) describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval;
   (b) describe the noise management system;
   (c) include a noise monitoring program that:
      - supports the noise management system;

- provides information to evaluate the performance of the project;
- includes a protocol for determining exceedances of relevant conditions of this approval;
- provides for the use of real-time and/or supplementary attended monitoring measures, if directed by the Secretary;
- includes regular attended and unattended monitoring at appropriate locations, including at receiver locations R4 and R17; and
- includes a program to characterise and measure low frequency noise (dB(C)) emissions.

(d) include a community notification protocol for the proposed construction activities; and
(e) detail who would be responsible for monitoring, reviewing and implementing the plan.

The Proponent must implement the approved management plan as approved from time to time by the Secretary.

Hours of Operation

11. The Proponent must comply with the hours of operation in Table 3.

Activity	*Day*	*Time*
Construction works	Monday-Friday	7.00am to 6.00pm
	Saturday	8.00am to 1.00pm
	Sunday and public holidays	None
Topsoil/overburden removal/emplacement	Any day	7.00am to 7.00pm
Blasting	Monday-Saturday	9.00am to 5.00pm
	Sunday and public holidays	None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00am to 11.00pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

Table 3 – Hours of Operation

11A. Between the hours of 5:00am to 7:00am and 7:00pm to 11:00pm the:
(a) in-pit crusher must not operate above RL 555; and
(b) mobile plant in the pit, including excavators, front-end loaders and trucks, must not operate above RL 570.

BLASTING AND VIBRATION

Airblast Overpressure Criteria

12. The Proponent must ensure that the airblast overpressure level from blasting at the project does not exceed the criteria in Table 4 at any residence on privately-owned land.

Airblast overpressure level (dB(Lin Peak))	*Allowable exceedance*
115	5% of the total number of blasts over a period of 12 months
120	0%

Table 4: Airblast Overpressure Impact Assessment Criteria

Ground Vibration Criteria

13. The Proponent must ensure that the ground vibration level from blasting at the project does not exceed the criteria in Table 5 at any residence or sensitive receiver on privately-owned land.

Peak particle velocity (mm/s)	*Allowable exceedance*
5	5% of the total number of blasts over a period of 12 months
10	0%

Table 5: Ground Vibration Impact Assessment Criteria for Residences on Privately-owned Land

Operating Conditions

14. The Proponent must implement best blasting practice to:
    (a) ensure that no flyrock leaves the site;
    (b) protect the safety of people, property, and livestock; and
    (c) minimise the dust and fume emissions from blasting on the site,
    to the satisfaction of the Secretary.

Public Notice

15. The Proponent must:
    (a) notify the landowner/occupier of any residence within 2 kilometres of the quarry pit who registers an interest in being notified about the blasting schedule on site;
    (b) operate a blasting hotline, or alternative system agreed to by the Secretary, to enable the public to get up-to-date information on blasting operations at the project; and
    (c) keep the public informed about this hotline (or any alternative system),
    to the satisfaction of the Secretary.

Monitoring

16. The Proponent must prepare a Blast Monitoring Program for the project to the satisfaction of the Secretary. This program must:
    (b) be submitted to the Secretary for approval prior to the commencement of construction;
    (c) be prepared in consultation with the EPA; and
    (d) monitor the performance of the project against the relevant blasting criteria.

    The Proponent must implement the approved monitoring program as approved from time to time by the Secretary.

AIR QUALITY

Air Quality Impact Assessment Criteria

17. The Proponent must ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the project do not exceed the criteria listed in Tables 6, 7 and 8 at any residence on privately owned land, or on more than 25 percent of any privately owned land.

Table 6: Long term impact assessment criteria for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Total suspended particulate (TSP) matter	Annual	[a] 90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 µg/m^3

Table 7: Short term impact assessment criterion for particulate matter

Pollutant	***Averaging period***	***[d]Criterion***
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 50 µg/m^3

Table 8: Long term impact assessment criteria for deposited dust

Pollutant	***Averaging period***	***Maximum increase[2] in deposited dust level***	***Maximum total[1] deposited dust level***
[c]Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 6-8

[a] Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources);

[b] Incremental impact (i.e. incremental increase in concentrations due to the project on its own);

[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and

[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

Land Acquisition Criteria

18. If particulate matter emissions generated by the project exceed the criteria in Tables 9, 10, and 11 at any residence on privately-owned land, or on more than 25 percent of any privately owned land, then upon

written request for acquisition from the landowner, the Proponent must acquire the land in accordance with the procedures in conditions 6-7 of schedule 4.

Table 9: Long term land acquisition criteria for particulate matter

Pollutant	Averaging period	[d] Criterion
Total suspended particulate (TSP) matter	Annual	[a] 90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 µg/m^3

Table 10: Short term land acquisition criteria for particulate matter

Pollutant	Averaging period	[da] Criterion
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 150 µg/m^3
Particulate matter < 10 µm (PM_{10})	24 hour	[b] 50 µg/m^3

Table 11: Long term land acquisition criteria for deposited dust

Pollutant	Averaging period	Maximum increase[2] in deposited dust level	Maximum total[1] deposited dust level
[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 9-11

[a] Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources);

[b] Incremental impact (i.e. incremental increase in concentrations due to the project on its own);

[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and

[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

Operating Conditions

19. The Proponent must:
    (a) implement best management practice on site, including all reasonable and feasible measures to minimise the off-site odour, fume and dust emissions generated by the project;
    (b) minimise any visible air pollution generated by the project;
    (c) minimise the surface disturbance of the site generated by the project; and
    (d) operate a comprehensive air quality management system that uses a combination of predictive meteorological forecasting and air quality monitoring data to guide the day to day planning of quarrying operations and the implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this approval;

    to the satisfaction of the Secretary.

Air Quality Management Plan

20. The Proponent must prepare a detailed Air Quality Management Plan for the project to the satisfaction of the Secretary. This plan must:
    (a) be prepared in consultation with EPA and submitted to the Secretary by the end of March 2012;
    (b) describe the measures that would need to be implemented to ensure compliance with the relevant conditions of this approval;
    (c) include a program for the implementation of the measures referred to in (b) above; and
    (d) include an air quality monitoring program that:
        - uses a combination of high volume samplers and dust deposition gauges to evaluate the performance of the project;
        - supports the air quality management system;
        - provides information to evaluate the performance of the project;
        - includes a protocol for determining exceedances of relevant conditions of this approval; and
        - provides for the use of real-time monitoring measures, if directed by the Secretary.

    The Proponent must implement the approved management plan as approved from time to time by the Secretary.

METEOROLOGICAL MONITORING

21. For the life of the project, the Proponent must ensure that there is a meteorological station in the vicinity of the site that:

(a) complies with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South Wales* guideline; and
(b) is capable of continuous real-time measurement of temperature lapse rate in accordance with the *NSW Industrial Noise Policy.*

SURFACE AND GROUND WATER

Water Supply

22. Prior to the commencement of construction, the Proponent must obtain the necessary approvals for the project under the *Water Act 1912*.

Note: The Water Management Act 2000 may apply to the project. The Proponent must consult with DPI Water on the relevant approvals at the time the application is made.

Discharges

23. Except as may be expressly provided for by an EPL, the Proponent must not discharge any dirty water from the quarry or ancillary operational areas.

23A. The Proponent must prepare an onsite wastewater report for the proposed effluent management system consistent with the requirements of *WaterNSW – "Developments in Sydney's Drinking Water Catchment" – Water Quality Information Requirements, 2011.* The effluent management system must be designed and constructed to be in accordance with this onsite wastewater report and its design must be approved by Council prior to construction.

Tangarang Creek Environmental Flow

24. The proponent must provide an environmental flow to Tangarang Creek equivalent to 10% of average daily flows. Details of the management of these environmental flows must be included in the Site Water Balance for the project (see below).

Sediment Dams

25. The Proponent must ensure that:
(e) critical structures such as "dirty water" dams are designed, constructed and maintained to a accommodate a 1 in 100 year ARI 24-hour event; and
(f) other dams and water management structures are designed, constructed and maintained to accommodate a 1 in 20 year ARI 24-hour event.

Water Management Plan

26. The Proponent must prepare a Water Management Plan for the project to the satisfaction of the Secretary. This plan must:
(a) be submitted to the Secretary for approval prior to the commencement of construction;
(b) be prepared in consultation with the DPI Water, EPA and WaterNSW; and
(c) include a:
- Site Water Balance;
- Erosion and Sediment Control Plan;
- Surface Water Monitoring Program;
- Ground Water Monitoring Program; and
- Surface and Ground Water Response Plan to address any potential adverse impacts associated with the project.

The Proponent must implement the approved management plan as approved from time to time by the Secretary.

Site Water Balance

27. The Site Water Balance must:
(a) include details of all water extracted (including make up water), dewatered, transferred, used and/or discharged by the project; and
(b) describe measures to minimise water use by the project.

Erosion and Sediment Control

28. The Erosion and Sediment Control Plan must:
(a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004* (Landcom);
(b) identify activities that could cause soil erosion and generate sediment;
(c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters;

(d) describe the location, function, and capacity of erosion and sediment control structures; and
(e) describe what measures would be implemented to maintain (and if necessary decommission) the structures over time.

Surface Water Monitoring

29. The Surface Water Monitoring Program must include:
(a) detailed baseline data on surface water flows and quality in Tangarang Creek and Barbers Creek;
(b) surface water impact assessment criteria;
(c) a program to monitor surface water flows and quality;
(d) a protocol for the investigation of identified exceedances of the surface water impact assessment criteria; and
(e) a program to monitor the effectiveness of the Erosion and Sediment Control Plan.

Ground Water Monitoring Program

30. The Ground Water Monitoring Program must include:
(a) detailed baseline data on ground water levels, flows, and quality, based on statistical analysis;
(b) groundwater impact assessment criteria for monitoring bores;
(c) a program to monitor regional ground water levels and quality; and
(d) a protocol for the investigation of identified exceedances of the ground water impact assessment criteria.

30A. In constructing and operating the Southern Overburden Emplacement Area, the Proponent must ensure that:
(a) the surface water management system is constructed in accordance with the plan shown on the figure in Appendix 4; and
(b) the surface water management system includes appropriate scour protection at discharge points to ensure the potential for erosion and transport of sediment to downstream waters is minimised.

30B. On completing of the construction of the surface water management system for the Southern Overburden Emplacement Area, the Proponent must commission an audit by a suitably qualified, experienced and independent person, approved by the Secretary, to determine whether the system has been constructed in accordance with this approval. A copy of the audit report and the Proponent's response to its recommendations must be provided to the Secretary and WaterNSW within 12 weeks of its commissioning.

TRAFFIC AND TRANSPORT

31. The Proponent must prepare and implement a construction traffic management plan for the project to the satisfaction of the RMS and Council.

ABORIGINAL HERITAGE

32. The Proponent must prepare an Aboriginal Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must:
(a) be submitted to the Secretary for approval prior to the commencement of construction;
(b) be prepared in consultation with the OEH and relevant Aboriginal communities; and
(c) include a:
- description of the measures that would be implemented for the mapping, and salvage or relocation of the archaeological relics in the Tangarang Creek Dam 1 area;
- description of the measures that would be implemented if any new Aboriginal objects or relics are discovered during the project; and
- protocol for the ongoing consultation and involvement of the Aboriginal communities in the conservation and management of Aboriginal cultural heritage on the site.

The Proponent must implement the approved management plan as approved from time to time by the Secretary.

32A If historical archaeological relics are unexpectedly discovered during works, all works must cease and a suitably qualified and experienced historical archaeologist be brought in to assess the find. Depending on the nature of the discovery, additional assessment and recording may be required prior to the recommencement of excavation in the affected area. The Heritage Council (or its Delegate) must be notified of this discovery in writing in accordance with section 146 of the *Heritage Act, 1977.*

BIODIVERSITY AND REHABILITATION

Rehabilitation and Habitat Management Area

33. The Proponent must:
    (a) rehabilitate the site in a manner that is generally consistent with the conceptual rehabilitation principles in Chapter 2.8 of the EA; and
    (b) implement the Habitat Management Area in a manner that is generally consistent with the documents listed in condition 2 of schedule 3 (and shown conceptually in Appendix 3), including the establishment, conservation and maintenance of at least 13.5 hectares of vegetation species characteristic of Box Gum Woodland,

    to the satisfaction of the Secretary.

Threatened Species Protection

33A. The Proponent must:
    (a) prior to clearing of vegetation and site preparation on the site of the Western Overburden Emplacement and extension, clearly and securely mark out the proposed boundary of the emplacement and extension;
    (b) avoid disturbance of *Box Gum Woodland* Endangered Ecological Community and other native vegetation adjacent to the site of the Western Overburden Emplacement and extension;
    (c) only undertake clearing of vegetation on the site of the Western Overburden Emplacement and extension following a recent fauna survey undertaken by a suitably qualified expert who has been approved by the Secretary; and
    (d) seek to avoid clearing of native vegetation on the site of the Western Overburden Emplacement and extension during the period August to November of any year.

Biodiversity Offset Strategy

34. The Proponent must:
    (a) implement the Biodiversity Offset Strategy described in EA (Mod 4);
    (b) within 12 months of the commencement of the construction of the Southern Overburden Emplacement Area, retire a total of 225 ecosystem credits in accordance with the *Framework for Biodiversity Assessment - NSW Biodiversity Offsets Policy for Major Projects*, to offset the removal of 8.1 hectares of White Box Yellow Box Blakely's Red Gum Grassy Woodland; and
    (c) provide long-term security and funding for the biodiversity offset area identified in the Biodiversity Offset Strategy through a Biobanking Agreement under the *Threatened Species Conservation Act 1995;*

    to the satisfaction of the Secretary.

    Note: The location and approximate area of the biodiversity offset area is shown on the figure in Appendix 6.

Biodiversity and Rehabilitation Management Plan

34A. The Proponent must prepare a Biodiversity and Rehabilitation Management Plan for the project to the satisfaction of the Secretary. This plan must:
    (a) be prepared in consultation with OEH and Council;
    (b) be submitted to the Secretary for approval by 28 February 2017, unless the Secretary agrees otherwise;
    (c) describe how the implementation of the Biodiversity Offset Strategy would be integrated with the management of the Habitat Management Area, and the overall rehabilitation of the site;
    (d) provide details of the conceptual final landform and associated land uses for the site;
    (e) include detailed performance and completion criteria for evaluating the performance of the Biodiversity Offset Strategy, the Habitat Management Area and the rehabilitation of the site, including triggers for any necessary remedial action;
    (f) describe the short, medium and long term measures that would be implemented to:
        - manage native vegetation on site, including within the Biodiversity Offset Area and the Habitat Management area; and
        - comply with the rehabilitation principles in Chapter 2.8 of the EA;
    (g) describe in detail the measures that would be implemented over the next 3 years (to be updated for each 3 year period following initial approval of the plan) including the procedures to be implemented for:
        - maximising the salvage of environmental resources within approved disturbance areas, including tree hollows, vegetation and soil resources, for beneficial reuse in the Biodiversity Offset Area, the Habitat Management Area or for rehabilitating other areas of the site;
        - restoring and enhancing the quality of native vegetation and fauna habitat in the Biodiversity Offset Area, the Habitat Management Area and other areas of the site through assisted natural regeneration, targeted vegetation establishment and the introduction of fauna habitat features;

- protecting native vegetation and fauna habitat outside the approved disturbance area;
- minimising the impacts of the project on native fauna, including the protocol for undertaking pre-clearance surveys;
- establishing vegetation screening and landscaping the site (including the bunds and overburden emplacement areas) to minimise the visual impacts of the project on surrounding receivers;
- ensuring minimal environmental consequences for threatened species, populations and habitats;
- collecting and propagating seed;
- controlling weeds and feral pests;
- controlling access; and
- bushfire management,

(h) include a program to monitor and report on the effectiveness of these measures;
(i) describe how the performance of these measures would be monitored over time; and
(j) set completion criteria for the rehabilitation of the site.

The Proponent must implement the approved management plan as approved from time to time by the Secretary.

Rehabilitation Bond

35. Within 3 months of the first Independent Environmental Audit the Proponent must lodge a rehabilitation bond for the project with the Secretary. The sum of the bond must be calculated at $2.50/m^2 for the total area to be disturbed in each 5 year period, or as otherwise directed by the Secretary.

Notes:
- *If the rehabilitation is completed to the satisfaction of the Secretary, the Secretary will release the rehabilitation bond.*
- *If the rehabilitation is not completed to the satisfaction of the Secretary, the Secretary will call in all or part of the rehabilitation bond, and arrange for the satisfactory completion of the relevant works.*

36. Within 3 months of subsequent audits, the Proponent must review, and if necessary revise, the sum of the bond to the satisfaction of the Secretary. This review must consider:
(a) the effects of inflation;
(b) any changes to the total area of disturbance; and
(c) the performance of the rehabilitation against the completion criteria of the Biodiversity and Rehabilitation Management Plan.

VISUAL IMPACT

Visual Amenity and Lighting

37. The Proponent must:
(a) *minimise the visual impacts, and particularly the off-site lighting impacts, of the project;*
(b) *revegetate overburden emplacements, emplacement extensions and bunds as soon as practicable;*
(c) *take all practicable measures to further mitigate off-site lighting impacts from the project; and*
(d) *ensure that all external lighting associated with the project complies with* Australian Standard AS4282 (INT) 1995 - Control of Obtrusive Effects of Outdoor Lighting,
to the satisfaction of the Secretary.

38. *(Deleted)*

39. *(Deleted)*

Advertising

40. The Proponent must not erect or display any advertising structure(s) or signs on the site without the written approval of the Secretary.

Note – This does not include business identification, traffic management and safety or environmental signs.

WASTE MANAGEMENT

41. The Proponent must:
(a) monitor the amount of waste generated by the project;
(b) investigate ways to minimise waste generated by the project;
(c) implement reasonable and feasible measures to minimise waste generated by the project; and
(d) report on waste management and minimisation in the Annual Review.
to the satisfaction of the Secretary.

42. The Proponent must ensure that all waste generated or stored on site is assessed, classified and managed in accordance with the EPA's *Environmental Guidelines: Assessment Classification and Management of Liquid and Non-Liquid Wastes*.

EMERGENCY AND HAZARDS MANAGEMENT

Dangerous Goods

43. The Proponent must ensure that the storage, handling, and transport of dangerous goods are conducted in accordance with the relevant *Australian Standards*, particularly AS1940 and AS1596, and the *Dangerous Goods Code*.

Safety

44. The Proponent must secure the project to ensure public safety to the satisfaction of the Secretary.

Bushfire Management

45. The Proponent must:
    (a) ensure that the project is suitably equipped to respond to any fires on-site; and
    (b) assist the rural fire service and emergency services as much as possible if there is a fire on-site.

PRODUCTION DATA

46. The Proponent must:
    (a) provide annual production data to the DRE using the standard form for that purpose; and
    (b) include a copy of this data in the Annual Review.

QUARRY EXIT STRATEGY

47. The Proponent must prepare and implement a Quarry Exit Strategy for the project to the satisfaction of the Secretary. This strategy must:
    (a) be submitted to the Secretary for approval at least 5 years prior to the cessation of the project;
    (b) be prepared in consultation with the relevant agencies;
    (c) define the objectives and criteria for quarry closure;
    (d) investigate options for the future use of the site, including any final void/s;
    (e) describe the measures that would be implemented to minimise or manage the ongoing environmental effects of the project; and
    (f) describe how the performance of these measures would be monitored over time.

SCHEDULE 4
ADDITIONAL PROCEDURES

NOTIFICATION OF LANDOWNERS

1. If the results of monitoring required in Schedule 3 identify that impacts generated by the project are greater than the relevant impact assessment criteria, then the Proponent must notify the Secretary and the affected landowners and/or existing or future tenants (including tenants of quarry owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the project is complying with the relevant criteria.

INDEPENDENT REVIEW

2. If a landowner (excluding quarry owned properties) considers that the operations of the quarry are exceeding the impact assessment criteria in Schedule 3, then he/she may ask the Proponent in writing for an independent review of the impacts of the project on his/her land.

   If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision, the Proponent must:

   (a) commission a suitably qualified, experienced and independent expert, whose appointment has been approved by the Secretary, to:
   - consult with the landowner to determine his/her concerns;
   - conduct monitoring to determine whether the project is complying with the relevant impact assessment criteria in schedule 3; and
   - if the project is not complying with these criteria then:
     - determine if the more than one quarry/mine is responsible for the exceedance, and if so the relative share of each quarry/mine regarding the impact on the land;
     - identify the measures that could be implemented to ensure compliance with the relevant criteria; and

   (b) give the Secretary and landowner a copy of the independent review.

3. If the independent review determines that the quarrying operations are complying with the relevant criteria in Schedule 3, then the Proponent may discontinue the independent review with the approval of the Secretary.

4. If the independent review determines that the quarrying operations are not complying with the relevant criteria in Schedule 3, and that the quarry is primarily responsible for this non-compliance, then the Proponent must:

   (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent expert, and conduct further monitoring until the project complies with the relevant criteria; or

   (b) secure a written agreement with the landowner to allow exceedances of the relevant impact assessment criteria,

   to the satisfaction of the Secretary.

   If the independent review determines that the project is not complying with the relevant acquisition criteria, and that the project is primarily responsible for this non-compliance, then upon receiving a written request from the landowner, the Proponent must acquire all or part of the landowner's land in accordance with the procedures in condition 6-7 below.

5. If the independent review determines that the relevant criteria are being exceeded, but that more than one quarry/mine is responsible for this exceedance, then together with the relevant quarry/mine/s, the Proponent must:

   (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent expert, and conduct further monitoring until there is compliance with the relevant criteria; or

   (b) secure a written agreement with the landowner and other relevant mine/s to allow exceedances of the relevant impact assessment criteria,

   to the satisfaction of the Secretary.

   If the independent review determines that the project is not complying with the relevant acquisition criteria in schedule 3, but that more than one mine is responsible for this non-compliance, then upon receiving a written request from the landowner, the Proponent must acquire all or part of the landowner's land on as equitable a basis as possible with the relevant quarries/mine/s, in accordance with the procedures in conditions 6-7 below.

LAND ACQUISITION

6. Within 3 months of receiving a written request from a landowner with acquisition rights, the Proponent must make a binding written offer to the landowner based on:

(a) the current market value of the landowner's interest in the property at the date of this written request, as if the land was unaffected by the project the subject of the project application, having regard to the:
- existing and permissible use of the land, in accordance with the applicable planning instruments at the date of the written request; and
- presence of improvements on the land and/or any approved building or structure which has been physically commenced at the date of the landowner's written request, and is due to be completed subsequent to that date, but excluding any improvements that have resulted from the implementation of the 'additional noise mitigation measures' in condition **Error! Reference source not found.** of Schedule 3;

(b) the reasonable costs associated with:
- relocating within the Goulburn Mulwaree local government area, or to any other local government area determined by the Secretary; and
- obtaining legal advice and expert advice for determining the acquisition price of the land, and the terms upon which it is required; and

(c) reasonable compensation for any disturbance caused by the land acquisition process.

However, if at the end of this period, the Proponent and landowner cannot agree on the acquisition price of the land, and/or the terms upon which the land is to be acquired, then either party may refer the matter to the Secretary for resolution.

Upon receiving such a request, the Secretary will request the President of the NSW Division of the Australian Property Institute to appoint a qualified independent valuer to:
- consider submissions from both parties;
- determine a fair and reasonable acquisition price for the land and/or the terms upon which the land is to be acquired, having regard to the matters referred to in paragraphs (a)-(c) above;
- prepare a detailed report setting out the reasons for any determination; and
- provide a copy of the report to both parties.

Within 14 days of receiving the independent valuer's report, the Proponent must make a binding written offer to the landowner to purchase the land at a price not less than the independent valuer's determination.

However, if either party disputes the independent valuer's determination, then within 14 days of receiving the independent valuer's report, they may refer the matter to the Secretary for review. Any request for a review must be accompanied by a detailed report setting out the reasons why the party disputes the independent valuer's determination. Following consultation with the independent valuer and both parties, the Secretary will determine a fair and reasonable acquisition price for the land, having regard to the matters referred to in paragraphs (a)-(c) above, the independent valuer's report, the detailed report of the party that disputes the independent valuer's determination and any other relevant submissions.

Within 14 days of this determination, the Proponent must make a binding written offer to the landowner to purchase the land at a price not less than the Secretary's determination.

If the landowner refuses to accept the Proponent's binding written offer under this condition within 6 months of the offer being made, then the Proponent's obligations to acquire the land must cease, unless the Secretary determines otherwise.

7. The Proponent must pay all reasonable costs associated with the land acquisition process described in condition 6 above, including the costs associated with obtaining Council approval for any plan of subdivision (where permissible), and registration of this plan at the Office of the Registrar-General.

8. *(deleted)*

SCHEDULE 5
ENVIRONMENTAL MANAGEMENT, REPORTING AND AUDITING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. If the Secretary requires, the Proponent must prepare an Environmental Management Strategy for the project to the satisfaction of the Secretary. This strategy must:
   (a) be submitted to the Secretary for approval within 6 months of the Secretary advising the Proponent that the strategy is required;
   (b) provide the strategic framework for the environmental management of the project;
   (c) identify the statutory approvals that apply to the project;
   (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project;
   (e) describe the procedures that would be implemented to:
      - keep the local community and relevant agencies informed about the operation and environmental performance of the project;
      - receive, handle, respond to and record complaints;
      - resolve any disputes that may arise during the course of the project;
      - respond to any non-compliance; and
      - respond to emergencies; and
   (f) include:
      - copies of any strategies, plans and programs approved under the conditions of this approval; and
      - a clear plan depicting all the monitoring to be carried out under the conditions of this approval.

   The Proponent must implement any approved Environmental Management Strategy as approved from time to time by the Secretary.

Management Plan Requirements

2. The Proponent must ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:
   (a) detailed baseline data;
   (b) a description of:
      - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
      - any relevant limits or performance measures/criteria; and
      - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;
   (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
   (d) a program to monitor and report on the:
      - impacts and environmental performance of the project; and
      - effectiveness of any management measures (see (c) above);
   (e) a contingency plan to manage any unpredicted impacts and their consequences, and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;
   (f) a program to investigate and implement ways to improve the environmental performance of the project over time;
   (g) a protocol for managing and reporting any:
      - incidents;
      - complaints;
      - non-compliances with statutory requirements; and
      - exceedances of the impact assessment criteria and/or performance criteria;
   (h) a protocol for periodic review of the plan; and
   (i) a document control table that includes version numbers, dates when the management plan was prepared and reviewed, names and positions of people who prepared and reviewed the management plan, a description of any revisions made and the date of the Secretary's approval.

   Note: The Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.

Revision of Strategies, Plans & Programs

3. Within 3 months of the submission of an:
   (a) Annual Review under condition 9 below;
   (b) incident report under condition 7 below;
   (c) audit report under condition 10 below; and
   (d) any modifications to this approval,

   the Proponent must review the strategies, plans and programs required under this approval, to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document must be submitted for the approval of the Secretary.

   Note: The purpose of this condition is to ensure that strategies, plans and programs are regularly updated to incorporate any measures recommended to improve environmental performance of the project.

4. Prior to approval of management plans required to be submitted by 30 November 2016, and the approval of the Biodiversity and Rehabilitation Management Plan required to be submitted by 28 February 2017, all management plans, monitoring programs, strategies, programs and protocols approved as at the date of approval of modification 4 to this approval will continue to have full force and effect, and may be revised under the requirements of condition 5 below as if subject to the conditions of this approval that applied prior to the approval of Modification 4, or otherwise with the approval of the Secretary.

Updating and Staging of Strategies, Plans or Programs

5. To ensure that strategies, plans or programs required under this approval are updated on a regular basis, and that they incorporate any appropriate additional measures to improve the environmental performance of the development, the Proponent may at any time submit revised strategies, plans or programs for the approval of the Secretary. With the agreement of the Secretary, the Proponent may also submit any strategy, plan or program required by this approval on a staged basis.

   With the agreement of the Secretary, the Proponent may prepare a revision of or a stage of a strategy, plan or program without undertaking consultation with all parties nominated under the applicable condition in this approval.

   Notes:
   - *While any strategy, plan or program may be submitted on a staged basis, the Proponent will need to ensure that the operations associated with the development are covered by suitable strategies, plans or programs at all times.*
   - *If the submission of any strategy, plan or program is to be staged; then the relevant strategy, plan or program must clearly describe the specific stage/s of the development to which the strategy, plan or program applies; the relationship of this stage/s to any future stages; and the trigger for updating the strategy, plan or program.*

Adaptive Management

6. The Proponent must assess and manage project-related risks to ensure that there are no exceedances of the criteria and/or performance measures in Schedule 3. Any exceedance of these criteria and/or performance measures constitutes a breach of this approval and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation.

   Where any exceedance of these criteria and/or performance measures has occurred, the Proponent must, at the earliest opportunity:
   (a) take all reasonable and feasible measures to ensure that the exceedance ceases and does not re-occur;
   (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and
   (c) implement remediation measures as directed by the Secretary,

   to the satisfaction of the Secretary.

Community Consultative Committee

7. The Proponent must operate a Community Consultative Committee (CCC) for the project, to the satisfaction of the Secretary. This CCC must be operated in general accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects* (Department of Planning, 2007, or its latest version)

   Notes:
   - *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval.*
   - *In accordance with the guideline, the committee should be comprised of an independent chair and appropriate representation from the Proponent, Council and the local community.*
   - *This condition may be fulfilled by the operation of a regional CCC for Boral's mining and quarrying activities in the Marulan area.*

REPORTING

Incident Reporting

8. The Proponent must immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident, the Proponent must provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

Regular Reporting

9. The Proponent must provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval.

Annual Review

10. By the end of March each year, or other timing as may be agreed by the Secretary, the Proponent must submit a report to the Department reviewing the environmental performance of the project to the satisfaction of the Secretary. This review must:
    (a) describe the works (including rehabilitation) that were carried out in the previous calendar year, and the works that are proposed to be carried out over the current calendar year;
    (b) include a comprehensive review of the monitoring results and complaints records of the project over the previous calendar year, which includes a comparison of these results against the:
        - relevant statutory requirements, limits or performance measures/criteria;
        - requirements of any plan or program required under this approval;
        - monitoring results of previous years; and
        - relevant predictions in the documents listed in condition 2(a) of Schedule 2;
    (c) identify any non-compliance over the past calendar year, and describe what actions were (or are being) taken to ensure compliance;
    (d) identify any trends in the monitoring data over the life of the project;
    (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and
    (f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the project.

INDEPENDENT ENVIRONMENTAL AUDIT

11. Within 3 years of the date of the commencement of construction and every 3 years thereafter, unless the Secretary directs otherwise, the Proponent must commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
    (a) be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary;
    (b) include consultation with the relevant agencies and the CCC;
    (c) assess the environmental performance of the project and whether it is complying with the relevant requirements in this approval and any relevant EPL or necessary water licence for the project (including any assessment, strategy, plan or program required under these approvals);
    (d) review the adequacy of strategies, plans or programs required under the abovementioned approvals;
    (e) recommend appropriate measures or actions to improve the environmental performance of the project, and/or any assessment, strategy, plan or program required under the abovementioned approvals; and
    (f) be conducted and reported to the satisfaction of the Secretary.

    Note: This audit team must be led by a suitably qualified auditor and include experts in any fields specified by the Secretary.

    Within 10 weeks of commissioning this audit, or as otherwise agreed by the Secretary, the Proponent must submit a copy of the audit report to the Secretary, together with its response to any recommendations contained in the audit report.

ACCESS TO INFORMATION

12. By 30 November 2016, unless otherwise agreed by the Secretary, the Proponent must:
    (a) make the following information publicly available on its website:
        - the documents listed in condition 2(a) of Schedule 2;
        - current statutory approvals for the project;
        - all approved strategies, plans or programs required under the conditions of this approval;
        - a comprehensive summary of the monitoring results of the project, reported in accordance with the specifications in any conditions of this approval, or any plans and programs required under the conditions of this approval;

- a complaints register, which is to be updated on a quarterly basis;
- the Annual Reviews (over the last 5 years);
- any independent environmental audit, and the Proponent's response to the recommendations in any audit; and
- any other matter required by the Secretary, and

(b) keep this information up-to-date,

to the satisfaction of the Secretary.

APPENDIX 1: SCHEDULE OF LAND

Lot	*DP*
23	867667
5	203290
95	750029
24	867667
109	750029
1	371167
1-6	261615
1	557562
143	750029
12	570616
2	557562
21	657523
100	1064794
4	106569
1-9	216767
11	570616
5	111641
22	867667
1	1124189
2	106569

APPENDIX 2: PROJECT LAYOUT

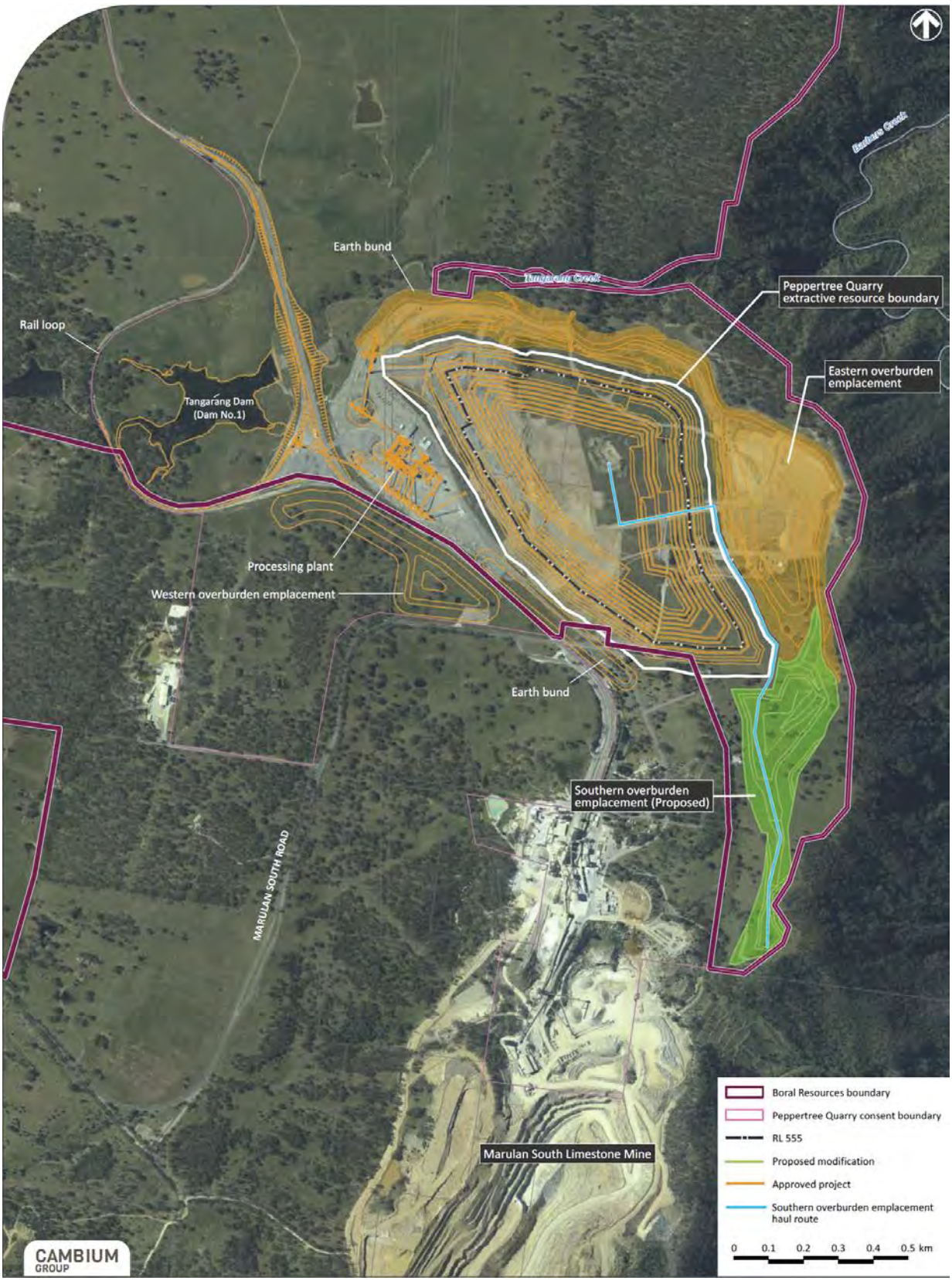


Figure showing the project layout

APPENDIX 3: NOISE RECEIVER LOCATIONS

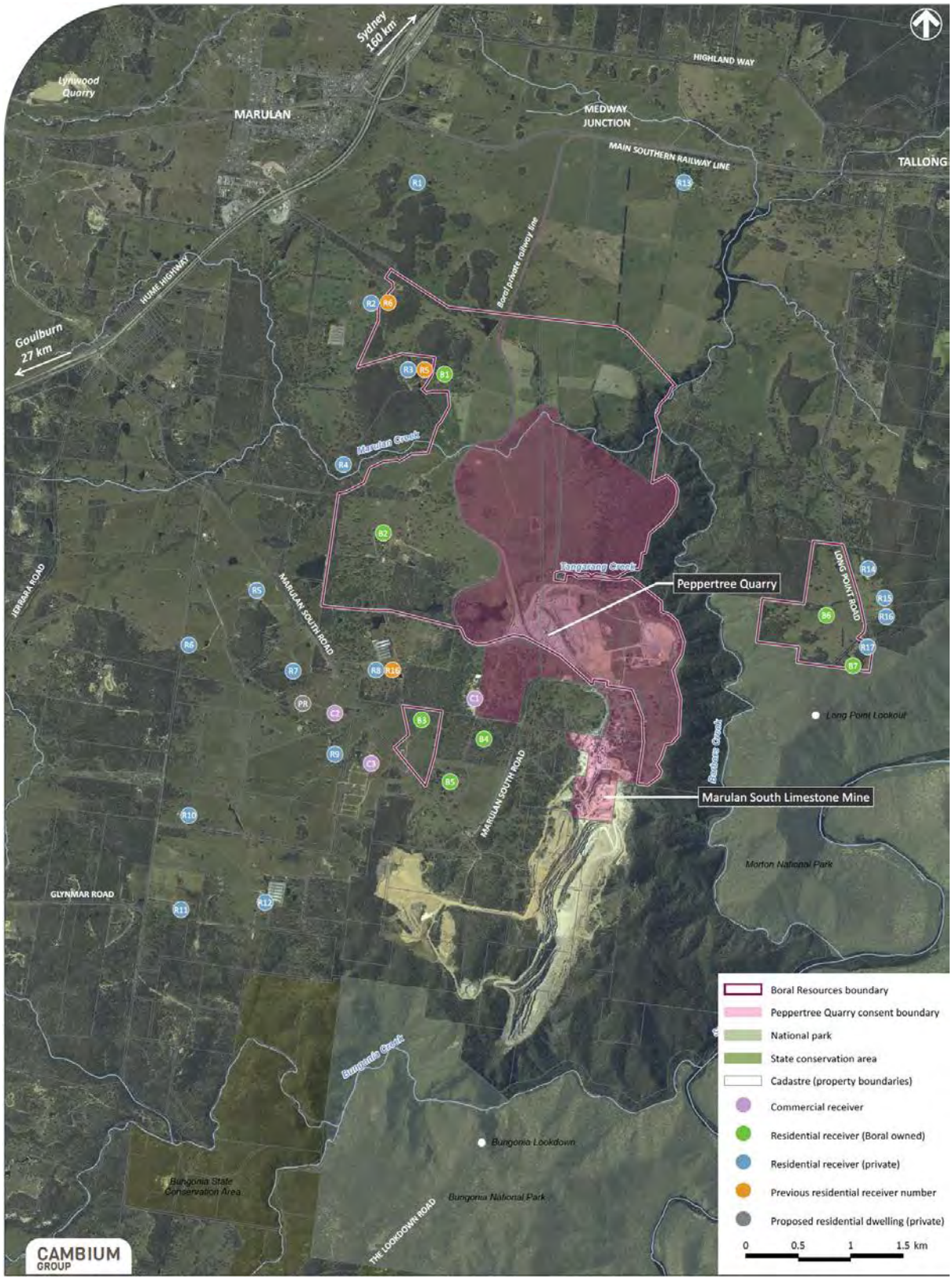


Figure showing the location of the residential receivers

APPENDIX 4: SURFACE WATER MANAGEMENT SYSTEM FOR THE SOUTHERN OVERBURDEN EMPLACMENT AREA

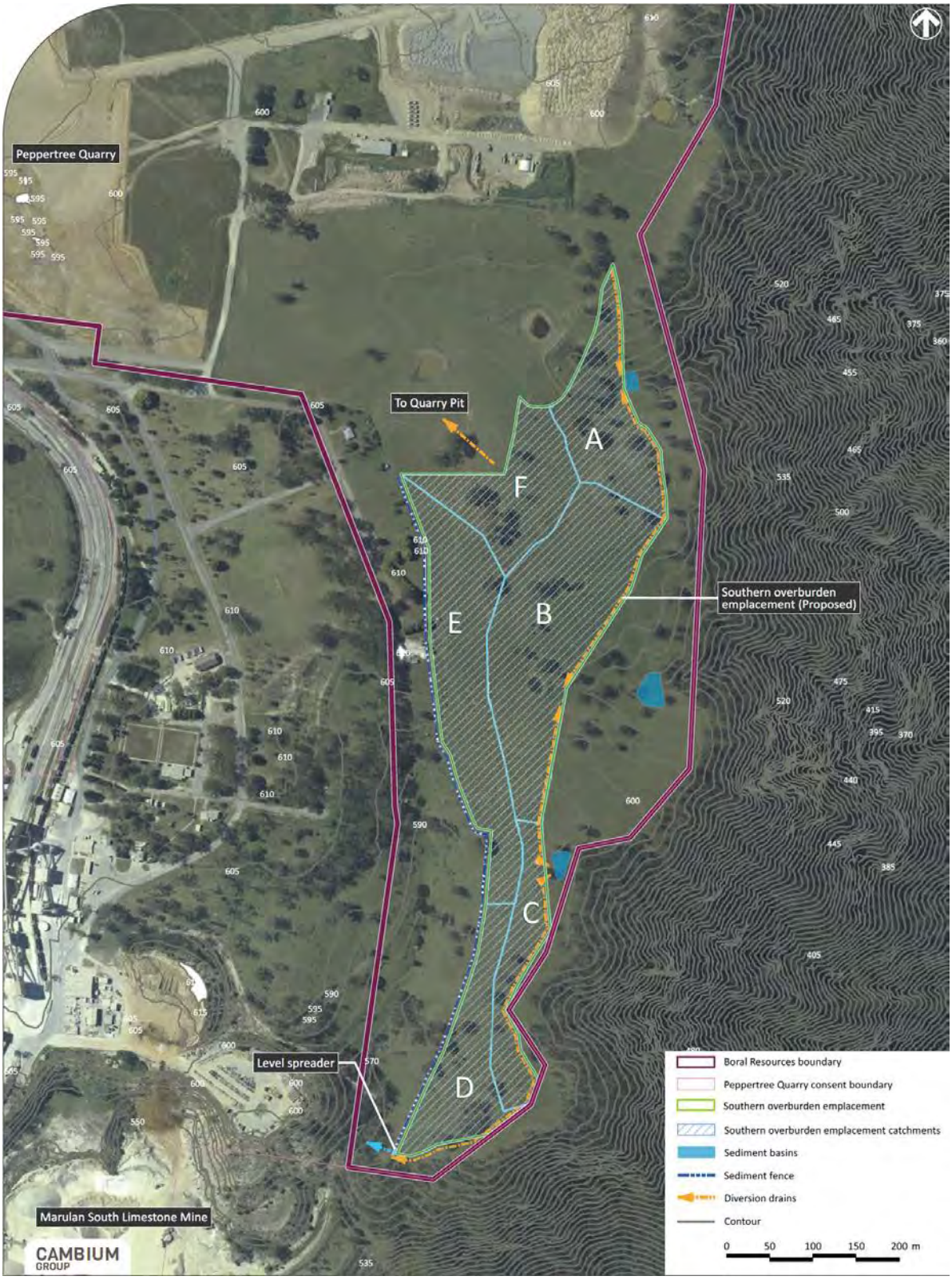


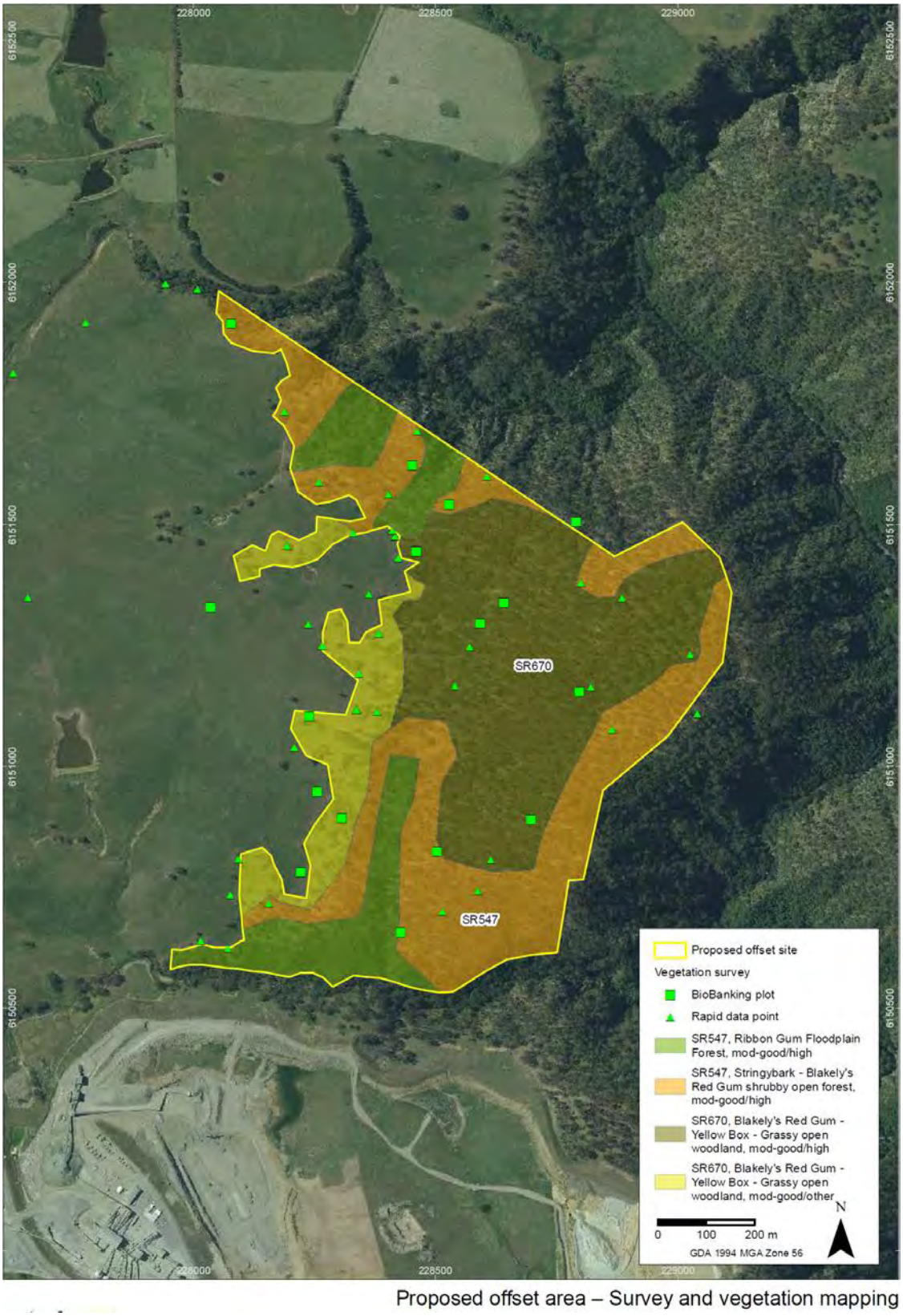
Figure showing the surface water management system for the southern overburden emplacement area

APPENDIX 5: HABITAT MANAGEMENT AREA



Figure showing the location of the Habitat Enhancement Area

APPENDIX 6: BIODIVERSITY OFFSET AREA



Proposed offset area – Survey and vegetation mapping

Figure showing the location and approximate area of the biodiversity offset area

APPENDIX 7: NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in Table 2 are to apply under all meteorological conditions except the following:
   a) wind speeds greater than 3 m/s at 10 m above ground level; or
   b) temperature inversion conditions between 1.5°C and 3°C/100 m and wind speed greater than 2 m/s at 10 m above ground level; or
   c) temperature inversion conditions greater than 3°C/100 m.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions must be that recorded by the meteorological station required under condition xx of Schedule 3.

Compliance Monitoring

3. Unless the Secretary agrees otherwise, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the *NSW Industrial Noise Policy* (as amended from time to time), in particular the requirements relating to:
   a) monitoring locations for the collection of representative noise data;
   b) equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment;
   c) modifications to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration; and
   d) the use of an appropriate modifying factor for low frequency noise to be applied during compliance testing at any individual residence if low frequency noise is present (in accordance with the INP) and before comparison with the specified noise levels in the approval.

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APPENDIX B

Noise Impact Assessment Report

ACOUSTICS AND AIR

NOISE IMPACT ASSESSMENT

PEPPERTREE QUARRY MOD 5

REPORT NO. 14250-A
VERSION B

SEPTEMBER 2018

PREPARED FOR

ELEMENT ENVIRONMENT
ON BEHALF OF BORAL RESOURCES (NSW) PTY LTD

WILKINSON MURRAY

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Draft	5 March 2018	George Jenner	John Wassermann
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B	Final	17 August 2018	John Wassermann	-
B	Final	21 September 2018	John Wassermann	-
B	Final	26 September 2018	John Wassermann	-

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AAAC

This firm is a member firm of the Association of Australasian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Celebrating 50 Years in 2012

Wilkinson Murray is an independent firm established in 1962, originally as Carr & Wilkinson. In 1976 Barry Murray joined founding partner Roger Wilkinson and the firm adopted the name which remains today. From a successful operation in Australia, Wilkinson Murray expanded its reach into Asia by opening a Hong Kong office early in 2006. Today, with offices in Sydney, Newcastle, Wollongong, Orange, Queensland and Hong Kong, Wilkinson Murray services the entire Asia-Pacific region.

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

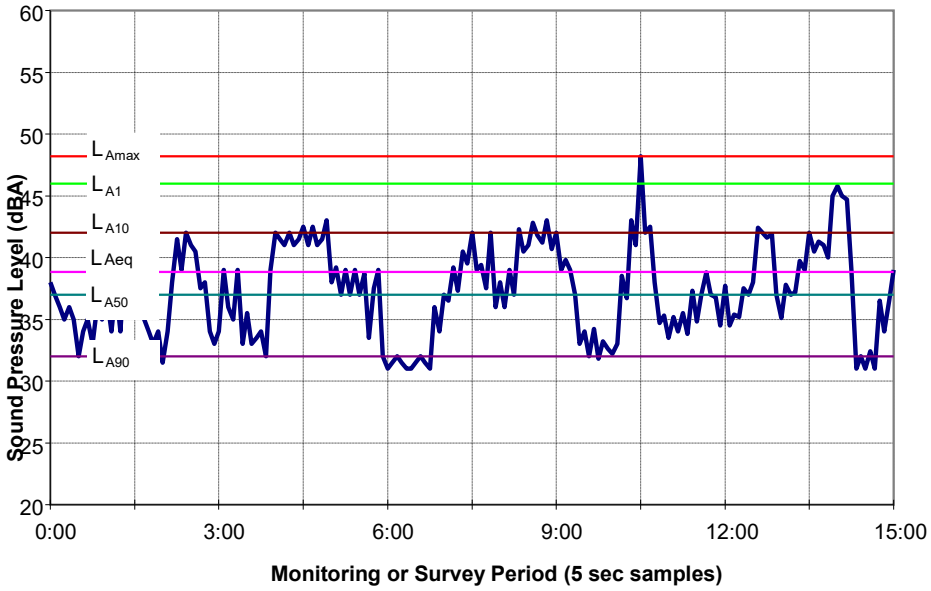
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level 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.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



EXECUTIVE SUMMARY

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) to provide for the following (hereafter referred to as the Project):

- Develop a new overburden area (South-west Overburden Emplacement – SWOE);
- Extend the consent boundary to the south to encompass the SWOE;
- Construct a new haul road from the pit to the SWOE;
- Construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- Amend the design of the Western Overburden Emplacement (WOE);
- Remove the Western Earth Bund (which has not been constructed); and
- Relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Project Approval. The Minister for Planning is the consent authority for the proposed modification.

Since the project was approved, the New South Wales Environment Protection Authority (EPA) has released the *Noise Policy for Industry* (*NPfI*). The *NPfI* proposes slightly different method for assessing noise and has implications for assessment during daytime and for cumulative noise assessment.

The assessment has found that:

- At all receivers the predicted noise level for day time operations associated with the proposed south western overburden emplacement comply with the *NPfI* noise trigger levels.
- The predicted noise level for proposed in-pit operations during the evening and night time comply with the operational *NPfI* noise impact assessment criteria.
- The predicted noise levels are below the land acquisition criteria at all residences.
- The predicted noise levels comply with the *NPfI* sleep disturbance noise trigger levels at all residences.
- Predicted noise levels comply with the *NPfI* amenity levels. Therefore, the cumulative industrial noise levels are predicted to be satisfactory.

1 INTRODUCTION

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) to provide for the following (hereafter referred to as the Project):

- Develop a new overburden area (South-west Overburden Emplacement – SWOE);
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- Remove the Western Earth Bund (which has not been constructed); and
- Relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Project Approval. The Minister for Planning is the consent authority for the proposed modification.

This report presents a noise assessment of the proposed modification. Noise modelling will consider the changed landform due to the modified WOE and construction of the SWOE, and any adverse acoustic consequences of not building the Western Earth Bund. The Project Approval includes noise assessment criteria. Since the project was approved, the New South Wales Environment Protection Authority (EPA) has released the *Noise Policy for Industry (NPfI)*. The *NPfI* proposes a slightly different method for assessing noise and has implications for assessment during daytime and for cumulative noise assessment.

To assess the potential noise impacts associated with the Project, this report compared the Project with noise criteria developed from the *NPfI* and limits in the Project Approval.

The noise assessment evaluates potential noise impacts associated with the Project in accordance with the *NPfI*.

Transportation noise (rail and traffic) and blasting has not been conducted in this report as no modification is being proposed to existing transportation of product off site or blasting regimes.

2 SITE DESCRIPTION

2.1 Existing Environment & Quarry Operations

2.1.1 Site Description

The Quarry is at Marulan South in the Goulburn Mulwaree Local Government Area (LGA) and is approximately 175 km south-west of Sydney (Figure 2-1Figure 2-1). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Limestone Mine) with the Hume Highway approximately 9 km to the north-west (Figure 2-2). Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6 km to the north (Error! Reference source not found.).

The Quarry is on approximately 650 ha of Boral owned land, which includes the Quarry (occupying approximately 70 ha), additional granodiorite resources to the south and surrounding land (Figure 2-3 and Figure 2-4). The site is zoned RU1 –- Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 (Figure 2-5). Mining and extractive industries are permissible in this zone with consent.

2.1.2 Approved Project

The current operations of the Quarry are approved under Project Approval PA06_0074 as modified.

Quarry Activities & Infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities. The location of infrastructure at the Quarry is shown on Figure 2-6.

Work to establish the quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E.

Operating Hours & Workforce

The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5 am to 11 pm. Approved operating hours are outlined in detail in Table 2-1.

Table 2-1 Approved operating hours.

Activity	Day	Time
Construction works	Monday to Friday Saturday Sunday and public holidays	7.00am to 6.00pm 8.00am to 1.00pm None
Topsoil/overburden removal/emplacement	Any day	7.00am to 7.00pm
Blasting	Monday to Saturday Sunday and public holidays	9.00am to 5.00pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00am to 11.00 pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

The Quarry employs 30 full time persons distributed over 2-3 shifts.

2.2 Proposed Modifications

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and will take approximately 4 years to establish. The emplacement will cover approximately 44 ha and will be RL650 at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

The powerline, which supplies electricity to the Limestone Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Limestone Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 20 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine and will be a component of the Limestone Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

Two sediment dams will be constructed either end of the WOE to catch and treat dirty water until the batters are rehabilitated. sediment dam P2 will also catch clean water from upslope of the WOE. Sediment dam P1 will be approximately 2.1 ML in volume and sediment dam P2 will be approximately 5.8 ML in volume.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the project.

The only ground disturbance associated with the modification will be for the SWOE, powerline relocation and new haul road (Figure 2-7).

Figure 2-1 Region context

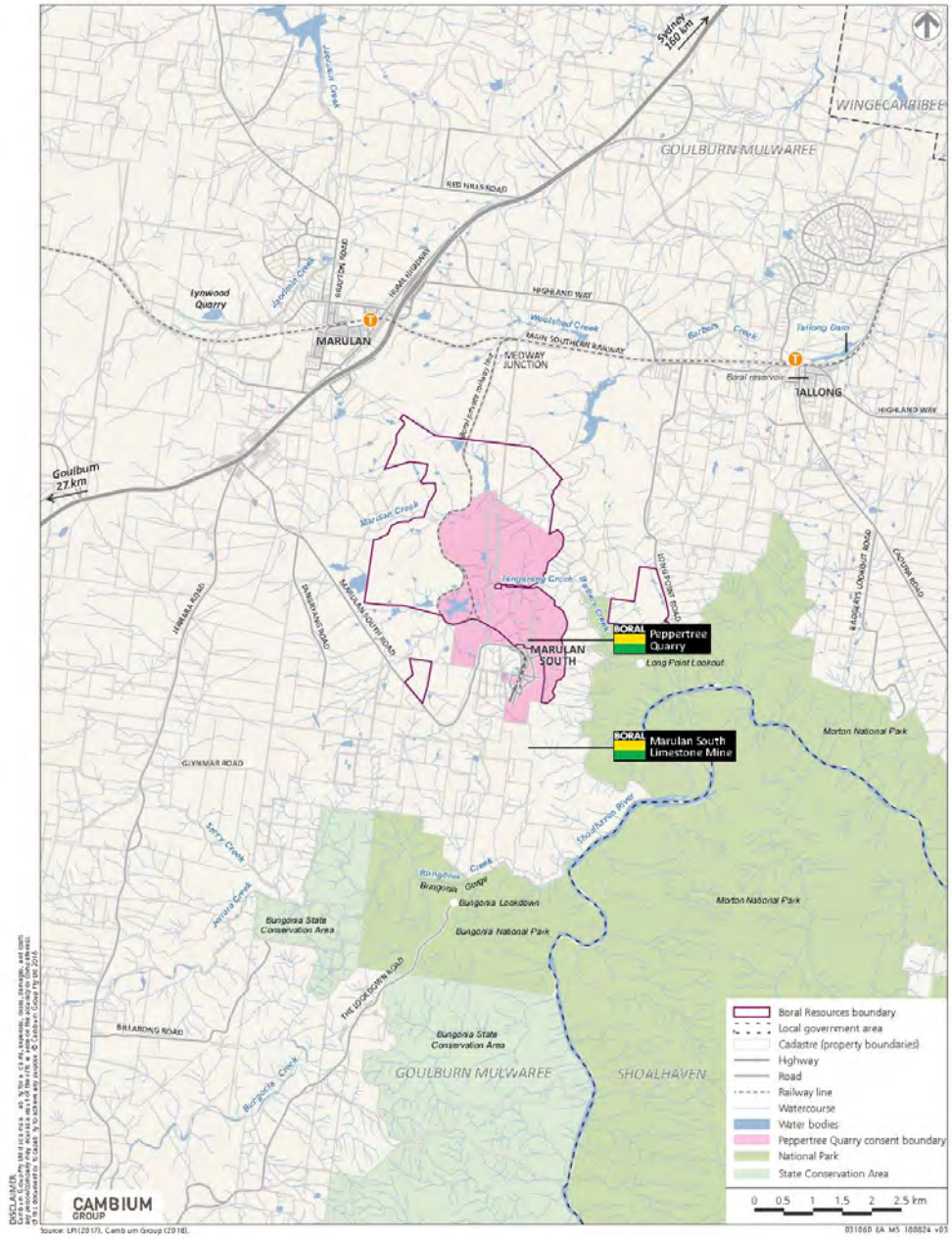


Figure 2-2 Local context

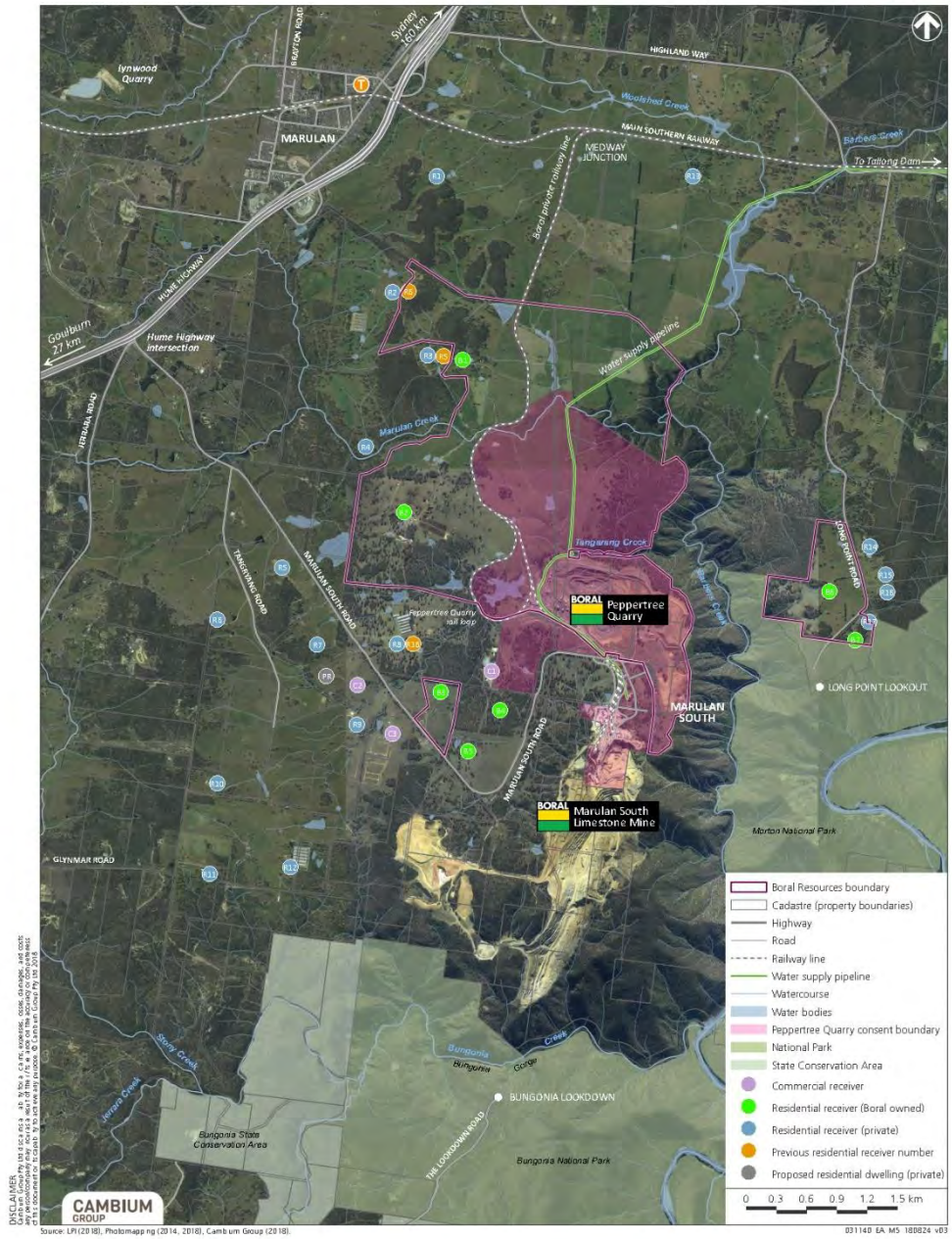


Figure 2-3 Land ownership

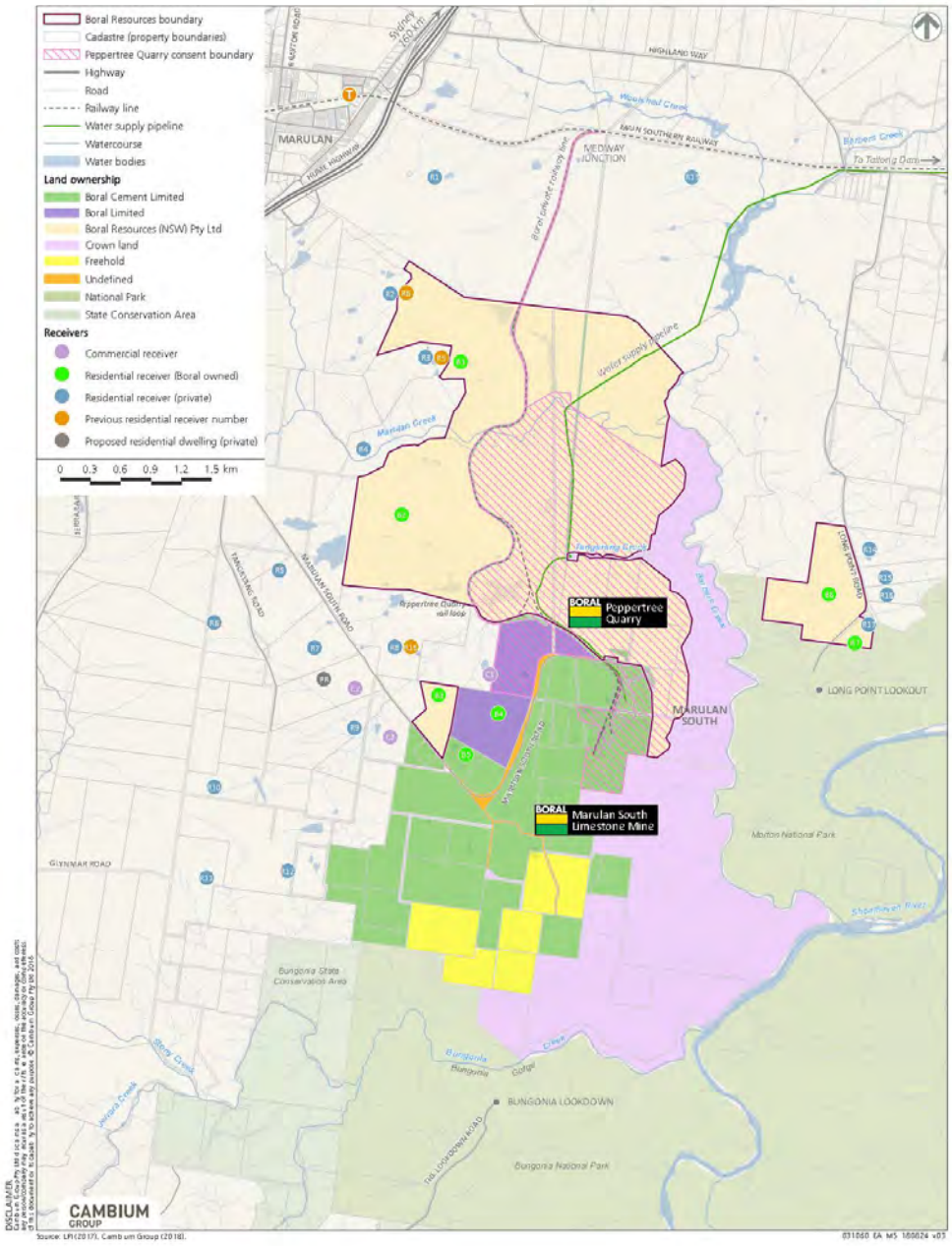


Figure 2-4 Land use

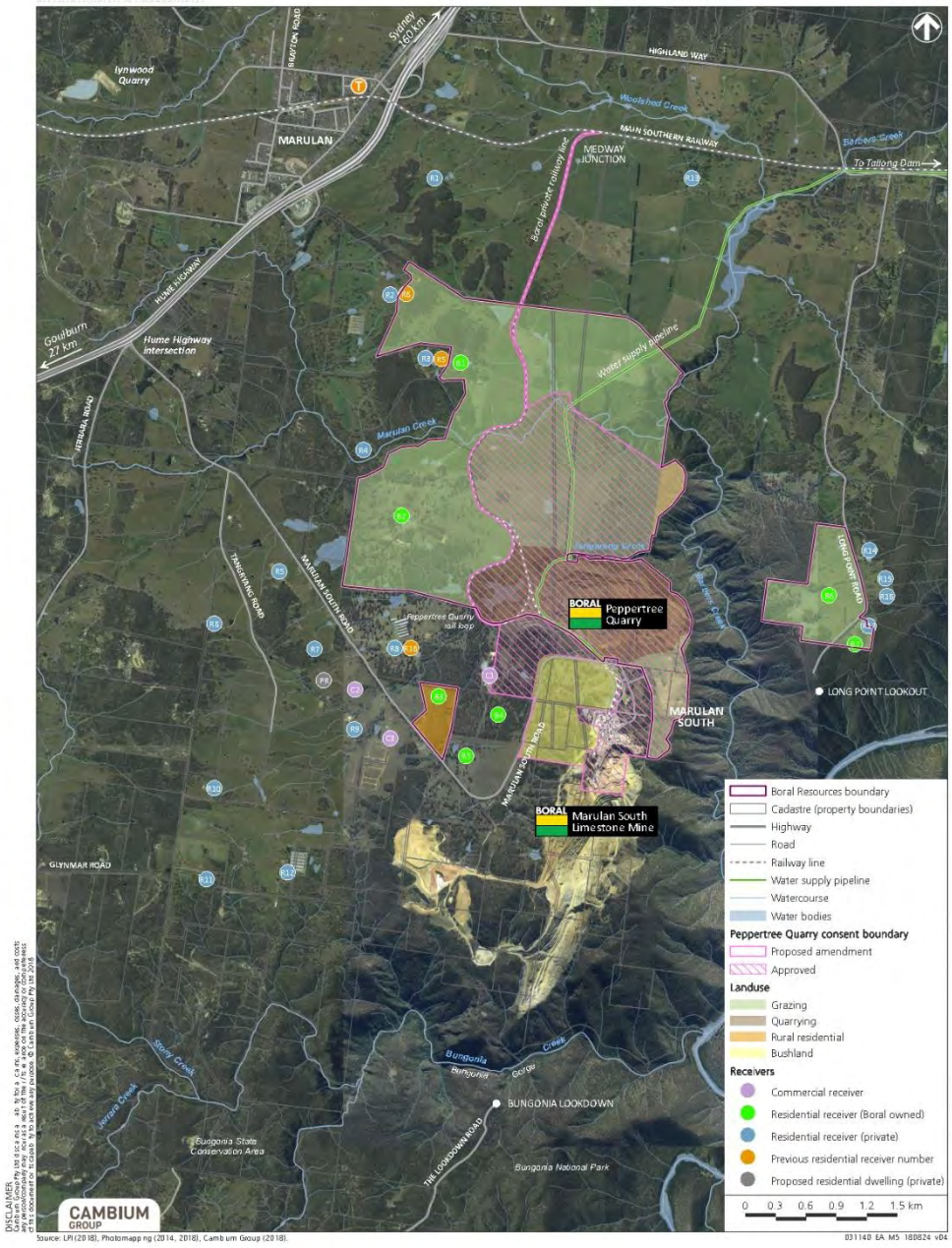


Figure 2-5 Local Zoning

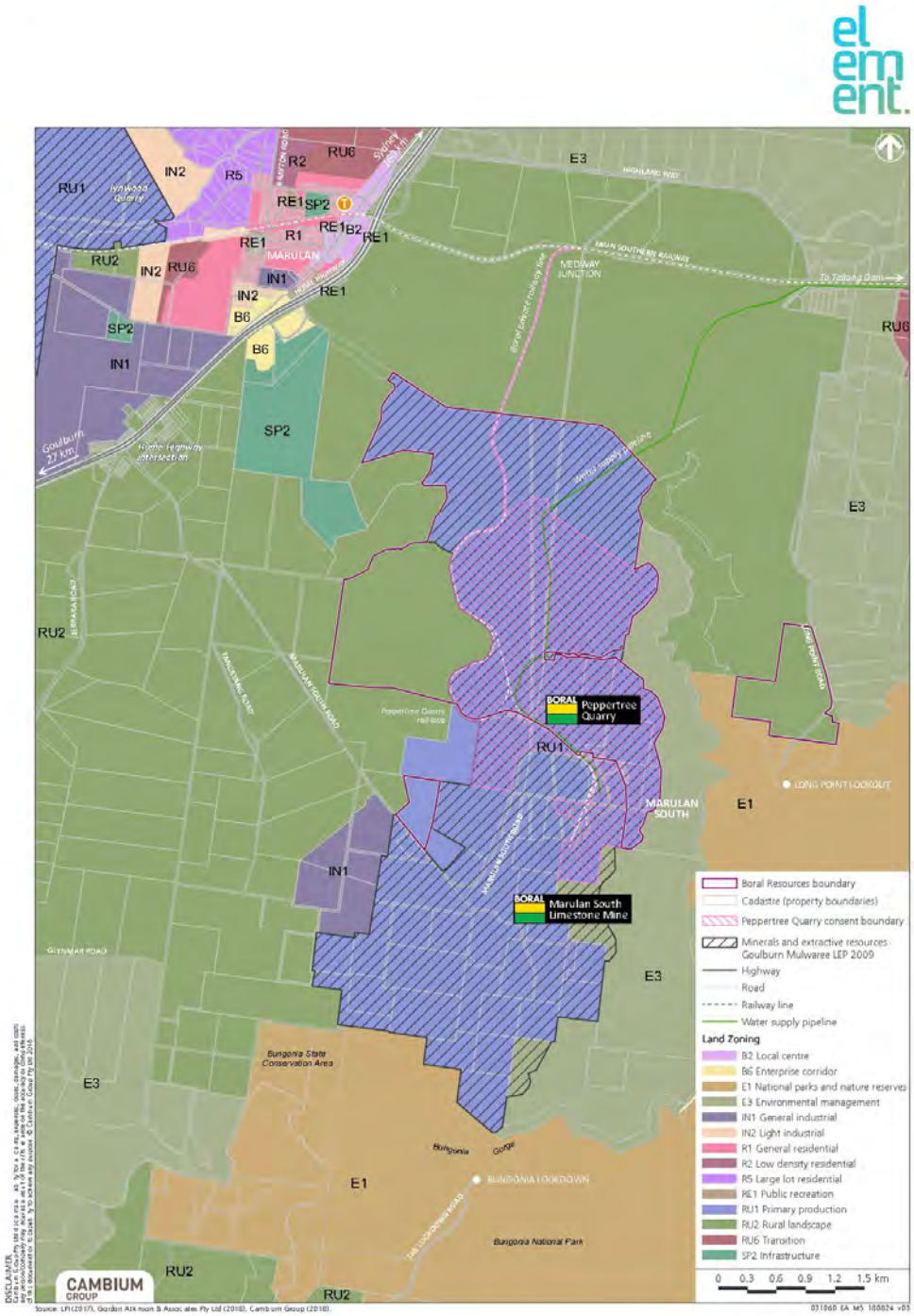


Figure 2-6 The Project

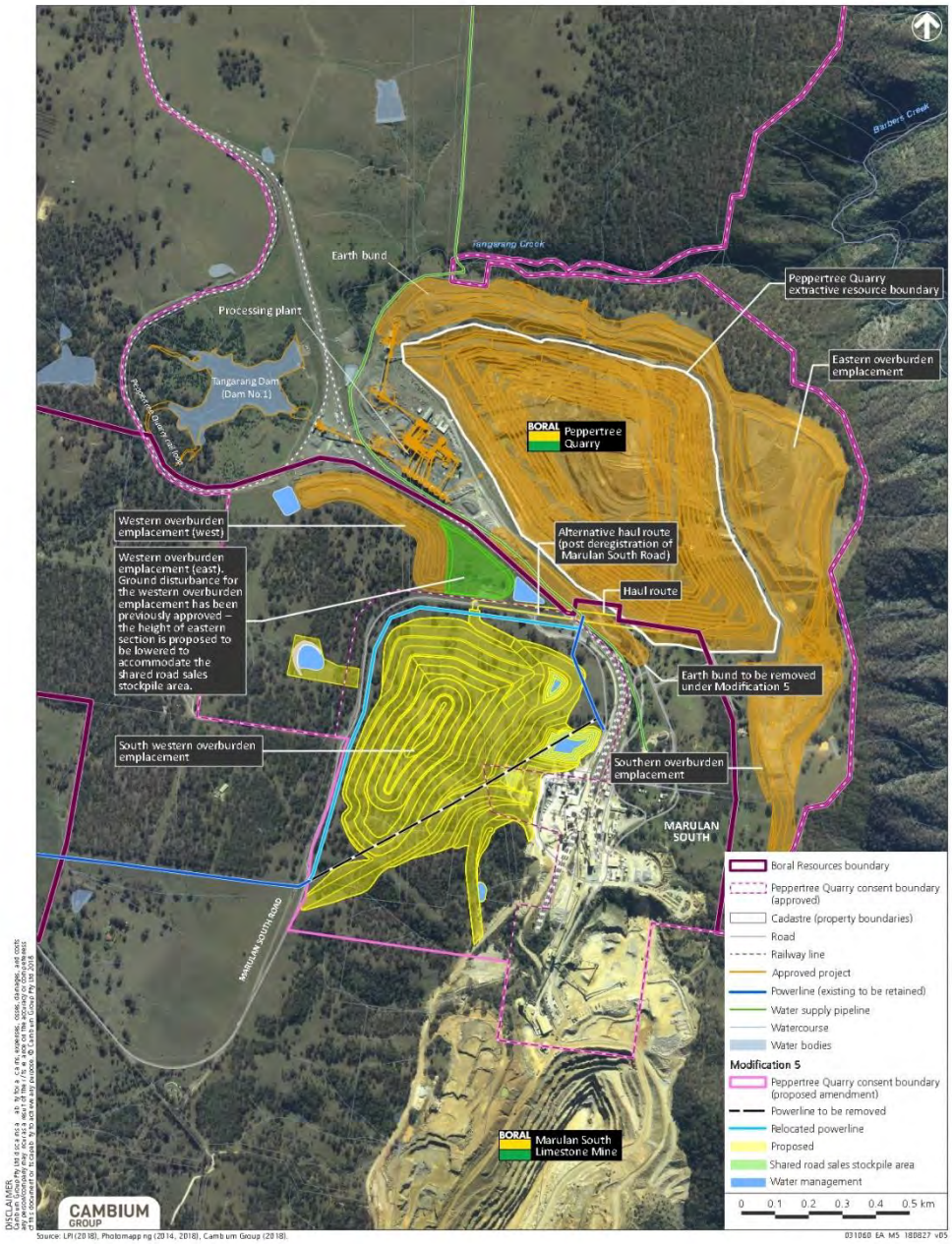
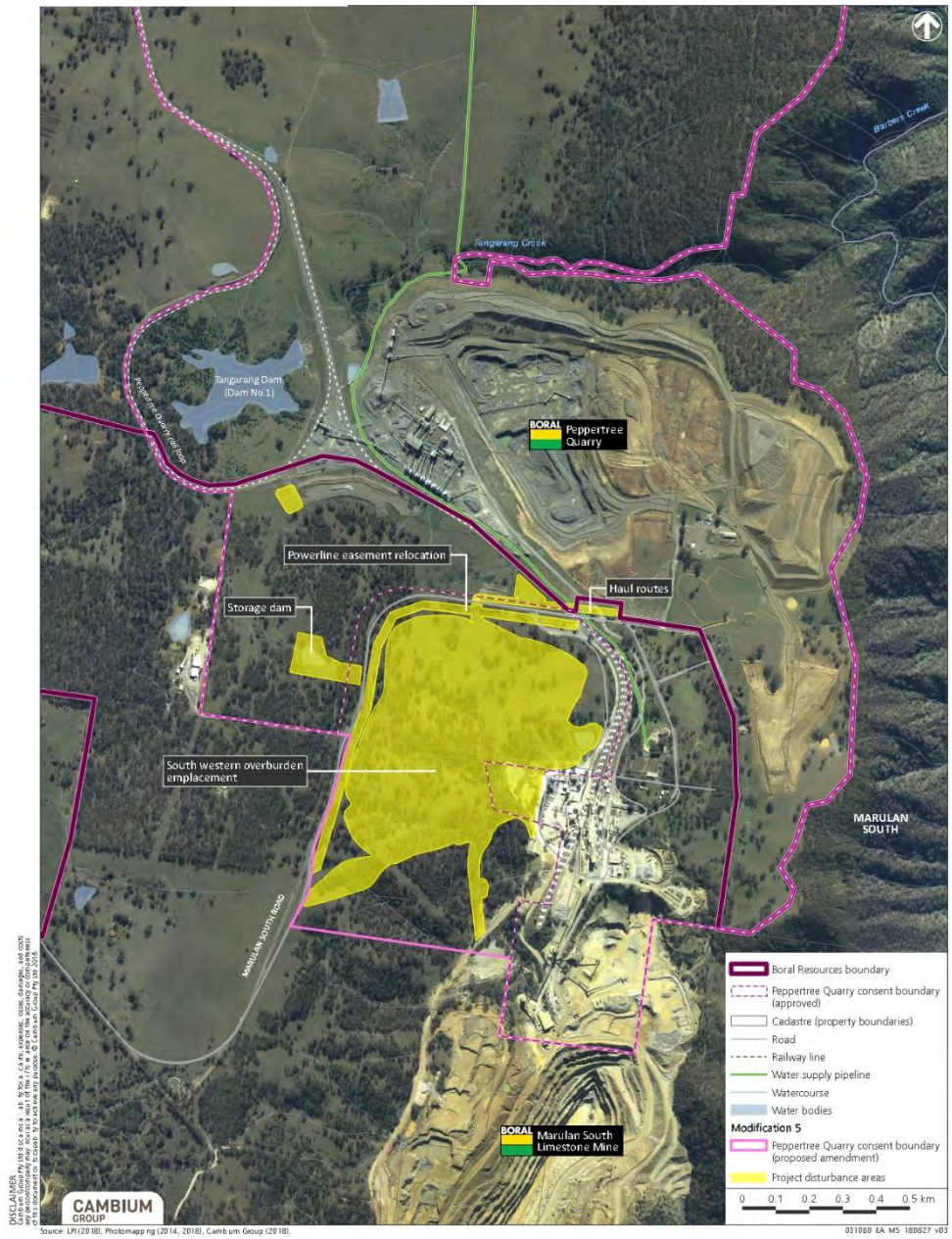


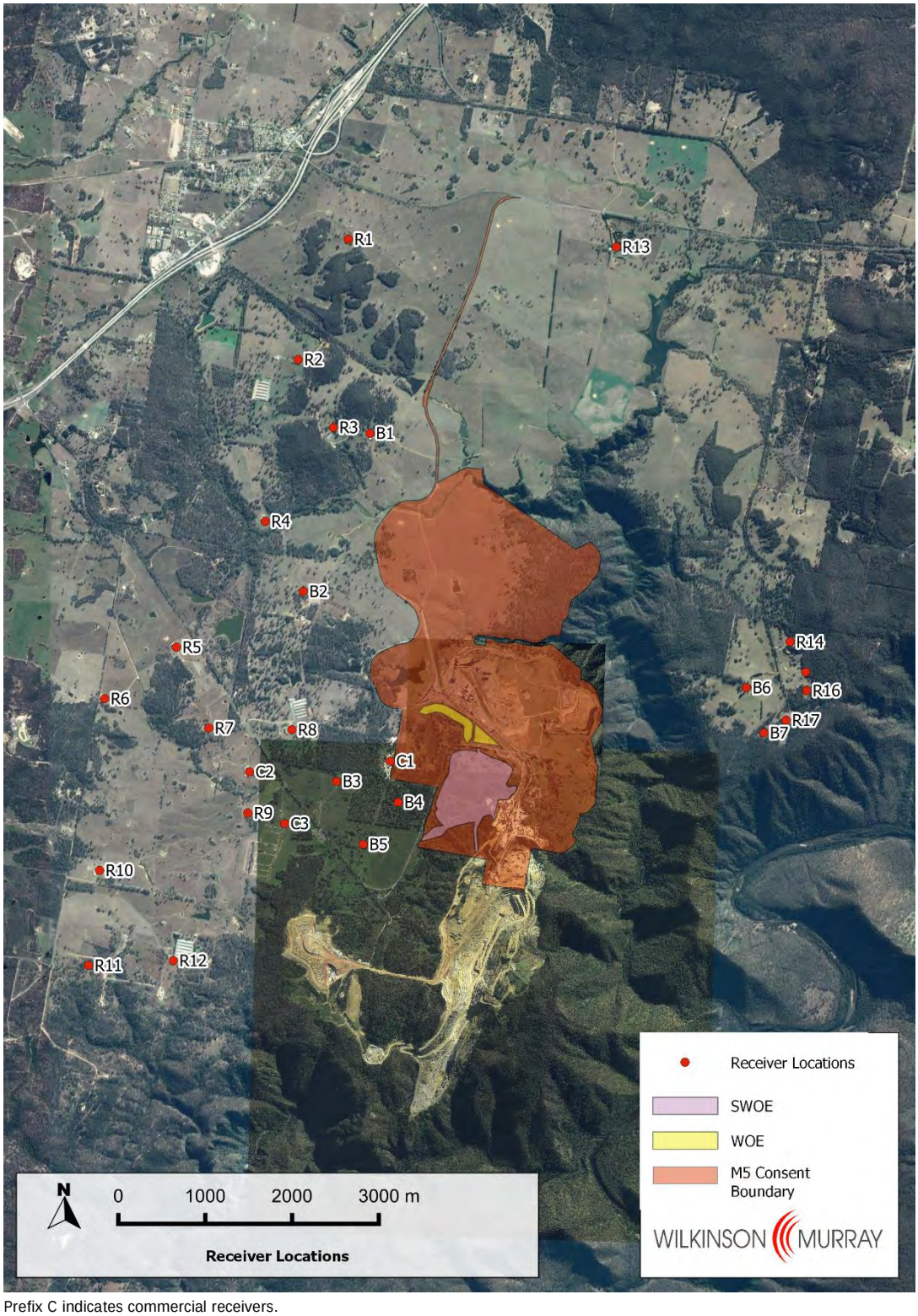
Figure 2-7 Project disturbance area



3 IDENTIFICATION OF SENSITIVE RECEIVERS

The Quarry is bordered to the south by the Limestone Mine, to the east by Morton National Park and by rural properties to the north and west. Surrounding land uses include mining, grazing, rural properties including an agricultural lime manufacturing facility, fireworks storage facility, turkey farm and rural residential. The main access for these properties is via Marulan South Road. Rural residential properties are also located to the northeast of the mine along Long Point Road. These properties are separated from the mine by the deep Barbers Creek gorge. Figure 3-1 presents the location of the quarry in relation to sensitive receivers of relevance to this assessment.

Figure 3-1 Sensitive Receivers



Prefix C indicates commercial receivers.
Prefix B indicates Boral owned receivers.
Prefix R indicates privately owned residential receiver.

3.1 Existing Project Approval

The noise-sensitive receptors identified in the Appendix 3 of the Project Approval are presented in Figure 3-1 and the noise conditions from Schedule 3 of the Project Approval are presented below:

Operational Noise Impact Assessment Criteria

4. *The Proponent must ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 1 at any residence on privately owned land.*

Table 1: Noise Impact Assessment Criteria

Residential Receiver Locations	Day (7:00am to 7:00pm) $L_{Aeq,15min}$	Evening (7:00pm to 10:00pm) $L_{Aeq,15min}$	Night (7:00pm to 10:00pm)	
			$L_{Aeq,15min}$	$L_{A1,1min}$
R3 (5)	35	35	35	45
R2 (6)	35	35	35	45
R8 (16)	41	35	35	45
Any other noise-sensitive location	35	35	35	45

Notes:

- *Residential receiver locations are shown on the plan in Appendix 3.*
- *Receiver numbers in parentheses are those identified in the approval prior to the notification of Modification 4 in 2016.*

Noise generated by the development is to be measured in accordance with the relevant requirements of the Industrial Noise Policy (as may be updated from time-to-time). Appendix 7 sets out the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

However, the noise criteria in Table 1 do not apply if the Proponent has an agreement with the owner/s of the relevant residence or land to exceed the noise criteria, and the Proponent has advised the Department in writing of the terms of this agreement.

Land Acquisition Criteria

5. *If the noise generated by the project exceeds the criteria in Table 2, the Proponent must upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in Conditions 6-8 of Schedule 4.*

Table 2: Land Acquisition Criteria

Residential Receiver	*Day (7:00am to 7:00pm)* $L_{Aeq,15min}$	*Evening / Night (7:00pm to 7:00am)* $L_{Aeq,15min}$
R3 (5)	*40*	*40*
R2 (6)	*40*	*40*
R8 (16)	*44*	*44*

Notes:

- *Residential receiver locations are shown on the plan in Appendix 3.*
- *Receiver numbers in parentheses are those identified in the approval prior to the notification of Modification 4 in 2016.*

It should be noted that the Project Approval does not have any conditions that require consideration of land acquisition for any privately-owned land where criteria are exceeded on more than 25 percent of the land.

3.2 Noise Compliance Monitoring

Noise compliance monitoring for Peppertree Quarry is undertaken quarterly in accordance with the Noise Management Plan. The conclusions from compliance monitoring are:

- Daytime site noise levels associated with the quarry comply with the relevant $L_{Aeq,15minute}$ operational noise impact assessment criteria contained in the Project Approval; and
- Night time site noise levels associated with the quarry comply with the relevant $L_{Aeq,15minute}$ and $L_{A1,\ 1minute}$ operational noise impact assessment criteria contained in the Project Approval.

Additional compliance monitoring was conducted at R3 using an unattended directional noise monitoring (BarnOwl®). The analysis of the data indicated that there were potential exceedances of the 35 dBA $L_{Aeq,15min}$ noise criteria from Peppertree Quarry and these levels could have been caused by unusual temperature inversion conditions during the daytime period.

ERM conducted noise monitoring for current quarry operations (ERM, February 2018 "Peppertree Quarry Site Inspection and Noise monitoring") (ERM report). The aim of the report was to determine sources of noise generated by the quarry and recommend reasonable and feasible mitigation measures to reduce noise levels and minimise impacts.

The ERM report presented measured noise levels at the following receivers:

- R2;
- R3;
- R4;
- R8; and
- R9.

A total of 46 operator attended noise measurements were completed by ERM. Background L_{A90} noise levels varied significantly between 22 dBA and 48dBA depending on the measurement location, on average the L_{A90} levels were approximately 37dBA. Ambient L_{Aeq} noise levels also varied significantly between 31dBA and 54dBA depending on the location, on average L_{Aeq} noise levels were approximately 43dBA.

Of the 46 operator attended noise measurements that were completed, quarry noise levels contributions, $L_{Aeq,\ 15minutes}$, were generally less than 30dBA. For a limited number of measurements, the quarry noise emissions were more easily detectable and contributed more to the overall acoustic environment, with noise levels contributions between 30 and 35dBA.

The potential for low frequency and tonal noise emissions were noted for each measurement by ERM. ERM stated that in general that quarry noise emissions may have an unbalances spectrum containing components within the low frequency range of the spectrum, but the overall low frequency levels are generally acceptable with due regard to the newly released EPA Policy for Industry.

The key noise generating items of equipment and activities were identified to be:

a) Primary crusher situated within the pit; and

b) the primary bin/ surge stockpile situated out of the pit but associated with the primary material processing activities.

The secondary, tertiary and quaternary material processing activities were observed to generate noise but this did not contribute significantly to the sites noise levels.

The ERM report recommended the following noise mitigation that have been adopted by Boral, namely:

- maintain and replace the "acoustic curtains" that are fitted to the primary crusher.
- maintain and replace the "acoustic pads" that are fitted to the primary crusher.
- enclose the primary bin.

The proposed noise mitigation has been installed and or is committed too by Boral. For example, Figure 3-2 shows the installed noise enclosure for the Primary bin.

Figure 3-2 Primary Bin noise mitigation



4 BACKGROUND NOISE LEVELS

This section discusses the Rating Background Levels (RBL) to be used in the assessment.

Determining ambient background levels in the absence of noise from the Limestone Mine or Peppertree Quarry is complicated by their continued operations, which only cease for a period of 3-days over the Christmas break.

The NPfI is encourages long-term background noise monitoring (with a minimum of one week of noise data) at a location to determine existing background noise levels that are indicative of levels during the entire year. To set appropriate RBLs for this assessment this report considers long term historical monitoring data for Peppertree, as well as monitoring carried out for the Marulan South Mine Continued Operations assessment. This will ensure that RBLs established would be indicative of levels during the entire year and considered yearly and seasonal variations.

4.1 Measurements during Christmas Shutdown, 2014

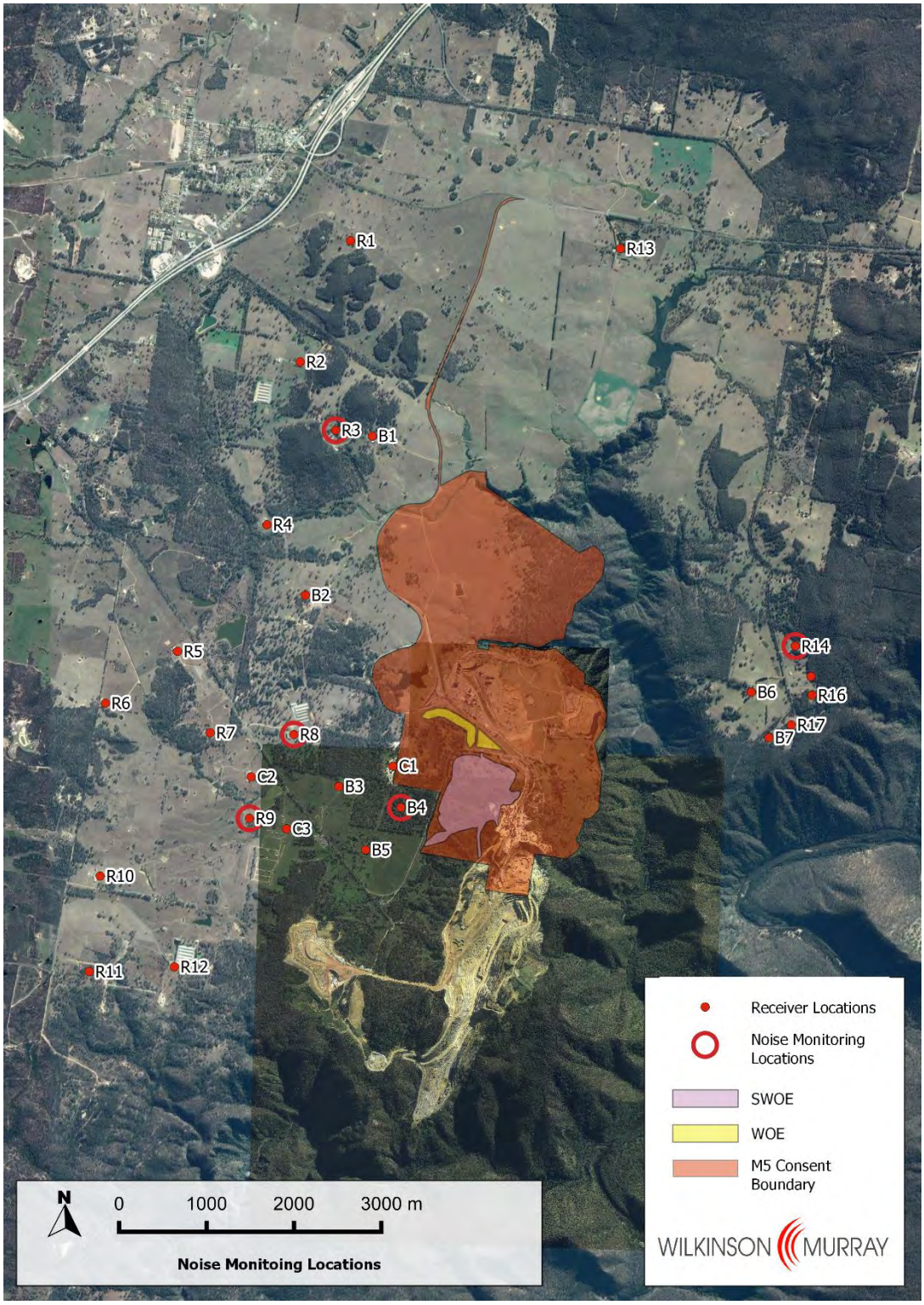
Background noise levels were measured by unattended noise loggers at five (5) locations during the Christmas break of 2014 for the Marulan South Mine Continued Operations assessment.

As the measurements were compromised by adverse weather, the background levels used in the assessment are determined from an analysis of the Christmas 2014 monitoring, ongoing quarterly monitoring for Peppertree Quarry, and other previously published RBLs in Peppertree Quarry environmental assessments.

4.1.1 Monitoring Locations

Noise monitoring locations are shown on Figure 4-1.

Figure 4-1 Noise Monitoring Locations



4.1.2 Equipment

The noise monitoring equipment used for background noise measurements consisted of environmental noise loggers set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary of Acoustic Terms for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. This is used for the assessment of sleep disturbance. The L_{A90} level is normally taken as the background noise level during the relevant period.

4.1.3 Measurement Results

Due to adverse weather conditions, no complete sets of daytime measurements were taken; however, there are two (2) complete evening and night time background noise measurements. As there were only two days of data, and some of it affected by meteorology, the RBLs for the daytime period were estimated from the measurement charts. The results of the background noise measurements are shown in Table 4-1, and the result charts in Appendix A. The charts show the measured noise level at 15-minute intervals throughout the monitoring period. RBLs are determined from the set of 15-minute L_{A90} levels for day, evening and night on any day. The charts also show other standard noise descriptors such as $L_{Aeq,15min}$ and the L_{Amax} for the 15-minute periods.

At the eastern noise monitoring location (on the eastern side of Barbers Creek gorge (R14), the evening period measurement is higher than the daytime period. In accordance with the *NPfI* recommendations, the evening RBL will be set to the daytime level.

Because the monitoring period was limited, and site observations indicated that the long-term RBL is not influenced by noise from Peppertree Quarry and Marulan South Mine, the results shown in Table 4-1 will be considered in the context of previous monitoring and ongoing compliance monitoring at Peppertree Quarry.

That analysis shows that while the measured levels during the Christmas shutdown are slightly lower than the adopted long-term RBL, they are within the range of RBLs measured over many years.

Table 4-1 Measured Rating Background Levels, December 2014

Location	RBL, dB(A)		
	Daytime	Evening	Night
(B4) Mine Manager Property	34	31	30
(R8) Turkey Farm	35	32	32
(R9) Western Location	35	32	32
(R3) Northern Location	35	31	31
(R14) Eastern Location	31	33	27

Notes:
1 Day: the period from 7.00am to 6.00pm.
2 Evening: the period from 6.00pm to 10.00pm.
3 Night: the period from 10.00pm to 7.00am.

4.2 Other RBL Data

Additional background noise levels have been measured around the Limestone Mine as part of the Peppertree Quarry noise compliance monitoring program. Daytime attended background ($L_{A90,15min}$) noise monitoring results from 2011 to 2014 are presented in Table 4-3. Unattended background ($L_{A90,period}$) noise monitoring results from 2011 to 2017 are presented in Table 4-4.

Background noise levels were measured for the environmental assessment of the Peppertree Quarry Modification 2 in 2011. The relevant measured levels are shown in Table 4-2 (only daytime and night time periods are reported in the Environmental Assessment).

Table 4-2 Background Noise Levels

Receiver	Period	RBL
R2	Daytime	30
	Night time	30
R8	Daytime	34
	Night time	34

To view the long-term trend in RBL, Table 4-4 includes:

- RBL from Peppertree Compliance Monitoring;
- RBL from Peppertree Environmental Assessment; and
- RBL from Wilkinson Murray Measurements, December 2014.

Table 4-3 Daytime Attended Background Levels Measured during Peppertree Quarry Compliance Monitoring , $L_{A90,15min}$ – dBA

ID		5 & 6 Oct 2011	L_{A90}	12 Oct 2012	L_{A90}	12 Jan 2012	L_{A90}	13 Jan 2012	L_{A90}	21 Nov 2012	L_{A90}	22 Nov 2012	L_{A90}	16 Jan 2013	L_{A90}	17 Jan 2013	L_{A90}	
R8	16	11.12am	34	12.51pm	38	3.20pm	42.5	9.18am	37.1	11.22am	35	12.31pm	39	10.50am	36	11.33am	35	
B2	4	2.31pm	38	12.39pm	40	12.46pm	35.4	12.45pm	34.3	4.26pm	38	8.26am	34	14.44pm	27	7.49am	35	
B3	3	3.27pm	37	12.50pm	38	2.08pm	33.0	8.10am	37.6	2.56pm	39	9.34am	42	15.18pm	39	7.20am	40	
B5	2	0.59pm	38	2.22pm	37	2.44pm	30.6	8.43pm	37.0	2.20pm	29	9.02am	41	10.07am	32	12.05pm	33	
B6	1	0.43pm	31	3.36pm	39	10.22am	32.3	10.12am	34.1	11.22am	35	10.30am	29	13.55pm	36	9.05am	37	
R3	5	10.11am	38	4.43pm	38	4.00pm	30.3	10.58am	32.9	1.20pm	40	11.51am	34	11.48am	32	10.12am	35	
R2	6	10.49am	37	4.16pm	35	11.21am	33.3	11.26am	39.2	12.34pm	41	11.17am	34	12.30pm	41	10.50am	44	
ID		8 Aug 2013	L_{A90}	9 Aug 2013	L_{A90}	22 Oct 2013	L_{A90}	24 Oct 2013	L_{A90}	22 Jan 2013	L_{A90}	22 Jan 2013	L_{A90}	22 Oct 2014	L_{A90}	23 Oct 2014	L_{A90}	Median
R8	16	12.25pm	40	11.20am	33	-	-	11.11am	52	3.03pm	43	1.13pm	42	12.30pm	32	9.45am	28	37
B2	4	1.53pm	39	10.16am	44	14.59pm	32	9.20am	48	12.53pm	38	11.26am	39	-	-	-	-	38
B3	3	1.22pm	40	-	-	-	-	-	-	12.15pm	42	11.55am	41	-	-	-	-	39
B5	2	12.55pm	39	10.54am	41	14.22pm	34	10.12am	51	11.22am	42	8.45am	38	12.00pm	36	9.15am	30	36
B6	1	12.42pm	37	9.11am	37	-	-	7.41am	45	1.46pm	32	9.38am	27	-	-	-	-	36
R3	5	11.31am	41	12.20pm	41	-	-	8.33am	47	4.14pm	36	10.34am	33	2.00pm	31	1.02pm	28	35
R2	6	10.56am	41	11.59am	45	-	-	8.58am	54	3.53pm	34	10.13am	39	1.15pm	40	12.30pm	35	37

Table 4-4 Combined Background Levels Measured during Various Studies from Peppertree Quarry and Marulan Mine, $L_{A90,period}$ – dBA

Date	R4			R2			R8			B6			B5		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
Peppertree EA	-	-	-	30	30	30	34	34	34	-	-	-	-	-	-
25 July 2012	36	37	46	-	-	-	32	32	32	33	33	33	-	-	-
22 November 2012	36	34	30	30	37	33	36	34	35	-	-	-	-	-	-
17 January 203	33	31	30	34	30	30	-	-	-	-	-	-	33	38	34
22 August 2013	34	38	40		38	40	35	35	38	-	-	-	40	36	35
October 2013	34	34	33	35	38	36	35	33	30	-	-	-	32	30	30
January 1014	30	30	30	31	30	30	35	34	32	-	-	-	38	36	34
August 2014	40	40	38				36	35	34	-	-	-	34	33	33
October 2014	34	32	32	34	32	32	32	32	32	-	-	-	30	31	30
December 2014 (WM)	34	31	31				35	32	32	-	-	-	-	-	-
April 2015	33	33	33	34	36	34	37	33	29	-	-	-	33	35	25
July 2015	36		38				34	38	36	-	-	-	-	-	-
February 2016	30	31	37	35	32	36	36	35	35	-	-	-	31	38	36
May 2016	-	-	-	-	-	-				-	-	-	-	39	-
August 2016	37	45	-	-	-	40	34	31	30	-	-	-	34	35	34
October 2016	37	38	-	-	-	40	35	34	31	-	-	-	-	-	-
February 2017	40	-	-	40	37	38	36	32	40	-	-	-	-	-	-
May 2017	30	31	30	37	37	39	31	30	33	-	-	-	-	-	-
July 2017	27	29	29	29	28	33	31	31	30	-	-	-	-	-	-
December 2017	32	34	38	38	38		38	35	37	-	-	-	-	-	-
Median	34	33	33	34	36	35	35	34	33	33	33	33	33	36	34

	Wind affected
-	No Data

4.3 Adopted RBL Values

Based on site observations and attended monitoring reports, it is considered that the long-term RBL at the receiver locations is not caused by noise emission from either Peppertree Quarry or the Limestone Mine. As the limited data collected during Christmas shutdown was not sufficient to set RBLs for the assessment, it has been considered with previously collected data.

The reported background noise levels measured around the Limestone Mine as part of the Peppertree Quarry noise compliance monitoring program were typically low and therefore it is unlikely that the L_{A90} levels would have been influenced by quarry or mine noise. This is confirmed by site noise levels measured when the Limestone Mine and quarry was shut down (Table 4-1) and noise levels measured for Peppertree Quarry compliance purposes (Table 4-3 and Table 4-4), which show similar trends with the daytime levels being higher than evening and night.

The NPfI suggests that for the long-term noise data, the rating background level is defined as the median value of:

- all the day assessment background levels over the monitoring period for the day;
- all the evening assessment background levels over the monitoring period for the evening; or
- all the night assessment background levels over the monitoring period for the night. 'Median' is the middle value in a number of values.

As stated above the RBL is usually the median of separate assessment periods, for a conservative assessment, measurements greater than RBL 40 dBA were excluded from this assessment. While there is no requirement to do this under the *NPfI*, those levels were judged atypically high for a rural setting and may have been impacted by extraneous noise, for example from insects. Combining these results, the RBL at each receiver are shown in Table 4-5.

Table 4-5 Rating Background Levels – L_{A90}

Receiver	Rating Background Level, L_{A90}		
	Daytime[1]	Evening[2]	Night[3]
R1	34	34	34
R2	34	34	34
R3	34	34	34
R4	34	33	33
R5	34	33	33
R6	34	33	33
R7	34	33	33
R8	35	34	33
R9	35	34	33
R10	35	34	33
R11	35	34	33
R12	35	34	33

Receiver	Rating Background Level, L_{A90}		
	Daytime[1]	Evening[2]	Night[3]
R13	31	31	30
R14	31	31	30
R15	31	31	30
R16	31	31	30
R17	31	31	30

5 NOISE POLICY FOR INDUSTRY

5.1.1 Overview

The NSW *NPfI* provides a framework and process for deriving noise criteria for consents and licences that enable the EPA and others to regulate premises that are scheduled under the *Protection of the Environment Operations Act 1997*.

The *NPfI* documents a procedure for assessment and management of industrial noise which involves the following steps:

- Determining the project noise trigger levels for a development. The project noise trigger level is a benchmark level above which noise management measures are required to be considered and is not intended as a mandatory requirement. They are derived by considering short-term intrusiveness due to changes in the existing noise environment (applicable to residential receivers only) and maintaining noise level amenity for particular land uses for residents and other sensitive receivers;
- Predicting or measuring noise produced by the development (having regard to any associated annoying characteristics and prevailing meteorological effects);
- Comparing the predicted or measured noise level with the project noise trigger level and assessing impacts and the need for noise mitigation and management measures;
- Considering any residual noise impacts following the application of feasible and reasonable noise mitigation measures;
- Setting statutory compliance levels that reflect the best achievable and agreed noise limits for development; and
- Monitoring and reporting environmental noise levels from the development.

For assessing intrusiveness, the background noise level (L_{A90}) is measured and the RBL determined (refer to Section 4). The *NPfI* states that where the daytime RBL was measured at less than 35 dBA, then a minimum daytime RBL of 35 dBA must be used. Therefore, the daytime RBL for all sensitive receivers has been adjusted to 35 dBA as the measured RBL at all receivers was 35 dBA or lower.

The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous noise level (L_{Aeq}) of the source (measured over a 15-minute period) does not exceed the background noise level (RBL) by more than 5 dBA. Therefore, the Project intrusiveness noise trigger levels are calculated by adding 5 dBA to the RBL.

Table 5-1 summarises the minimum assumed RBLs and the intrusiveness noise levels relevant to the Project.

Table 5-1 Project Intrusiveness Noise Trigger Levels, dBA

Receiver	RBL			Intrusiveness Noise Level		
	Daytime	Evening	Night	Daytime	Evening	Night
R1	35	34	34	40	39	39
R2	35	34	34	40	39	39
R3	35	34	34	40	39	39
R4	35	33	33	40	38	38
R5	35	33	33	40	38	38
R6	35	33	33	40	38	38
R7	35	33	33	40	38	38
R8	35	34	33	40	39	38
R9	35	34	33	40	39	38
R10	35	34	33	40	39	38
R11	35	34	33	40	39	38
R12	35	34	33	40	39	38
R13	35	31	30	40	36	35
R14	35	31	30	40	36	35
R15	35	31	30	40	36	35
R16	35	31	30	40	36	35
R17	35	31	30	40	36	35

Note 1: Daytime 7.00am–7.00pm; Evening 7.00pm–10.00pm; Night 10.00pm-7.00am.

5.1.2 Amenity Noise Level

The *NPfI* amenity noise level is specific to the type of land use and associated activities. The amenity noise levels relate only to industrial-type noise and do not include transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms and amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

The recommended amenity noise level represents the objective for total industrial noise at a receiver location. The project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To prevent increases in industrial noise due to the cumulative effect of several developments in an area, the project amenity noise level for each new source of industrial noise is set at 5 dBA below the recommended amenity noise level. For comparison to the intrusiveness level, the project amenity noise trigger level is converted from a period level (day, evening or night time periods) to a 15-minute level by adding 3 dBA.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

Derivation of *NPfI* amenity noise trigger levels is given in Section 5.1.3.

Table 5-2 Amenity Noise Levels, dBA

Receiver	Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level $L_{Aeq,period}$ (dBA)	Project Amenity Trigger Level $L_{Aeq,15min}$ dBA
Residence	Rural	Day	50	48
		Evening	45	43
		Night	40	38
Commercial	All	When in use	65	63

Note 1: Daytime 7.00am–7.00pm; Evening 7.00pm–10.00pm; Night 10.00pm-7.00am.

At commercial receivers, the $L_{Aeq,15min}$ project amenity noise level is 63 dBA.

5.1.3 Project Noise Trigger Levels

In determining the project noise trigger levels, a comparison needs to be made between the amenity and intrusiveness noise levels, and the lowest noise level needs to be selected for each period (day, evening and night). As outlined in Table 5-2, for 24 operations, the highest amenity noise level for a rural receiver at night time can be 38dBA. Therefore, for those residential receivers where the night time intrusiveness noise trigger level is 39 dBA (refer to Table 5-1) an adjusted project noise trigger level of 38 dBA needs to be adopted. The resulting project trigger levels are shown in Table 5-3.

Table 5-3 Project Noise Trigger Levels, $L_{Aeq,15min}$ dBA

Receiver	Project Noise Trigger Level (*NPfI*)		
	Daytime	Evening	Night
R1	40	39	38
R2	40	39	38
R3	40	39	38
R4	40	38	38
R5	40	38	38
R6	40	38	38
R7	40	38	38
R8	40	39	38
R9	40	39	38
R10	40	39	38
R11	40	39	38

Receiver	Project Noise Trigger Level (*NPfI*)		
	Daytime	Evening	Night
R12	40	39	38
R13	40	36	35
R14	40	36	35
R15	40	36	35
R16	40	36	35
R17	40	36	35
All commercial Receivers	63	63	63

Note 1: Daytime 7.00am–7.00pm; Evening 7.00pm–10.00pm; Night 10.00pm-7.00am.

5.2 Maximum Noise Level Events

Noise sources of short duration and high level that may cause disturbance to sleep if occurring during the night time need to be considered.

The most appropriate descriptors for a source relating to sleep disturbance is the $L_{A1\ (1\ minute)}$ (the level exceeded for 1% of the specified time period of 1 minute) or L_{AFmax} (the maximum level during the specified time). The NSW EPA accepts that these descriptors are interchangeable as they both describe maximum noise level.

The approach recommended by the *NPfI* is to apply the following initial screening noise levels:

- $L_{Aeq,15min}$ 40 dBA or the prevailing RBL + 5 dB, whichever is the greater; and/or
- L_{AFmax} 52 dBA or the prevailing RBL + 15 dB, whichever is the greater.

The sleep disturbance screening noise levels apply outside bedroom windows during the night time period (10:00pm to 7:00am).

Where the screening noise levels cannot be met, a detailed maximum noise level event assessment should be undertaken.

As highest night time RBL at any receiver is 34 dBA:

- The highest RBL+5 dB is 39 dBA; and
- The highest RBL + 15 dB is 49 dBA.

Therefore, the maximum event screening levels at all receivers are:

- $L_{Aeq,15min}$ 40 dBA; and
- L_{AFmax} 52 dBA.

The maximum noise level (sleep disturbance) criteria are presented in Table 5-4 for all receivers.

Table 5-4 Maximum Noise Event Screening criteria, dBA

Receiver	*NPfI*	
	$L_{Aeq,15min}$	L_{AFMax}
R1	40	52
R2	40	52
R3	40	52
R4	40	52
R5	40	52
R6	40	52
R7	40	52
R8	40	52
R9	40	52
R10	40	52
R11	40	52
R12	40	52
R13	40	52
R14	40	52
R15	40	52
R16	40	52
R17	40	52

5.3 Low Frequency Noise

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, the *NPfI* recommends correction factors to be applied to the source noise level at the receiver before comparison with the project noise trigger levels. The only relevant characteristic for noise from the Quarry is the potential for dominant low-frequency content.

The *NPfI* recommends investigating whether a modifying factor for low-frequency noise is applicable based on an analysis of third octave band levels where there is a difference between C- and A- weighting levels of more than 15dB. The factor to be applied depends on comparison of the third octave spectrum of the noise against the threshold spectrum in Table 5-5 (Table C2 from *NPfI*).

Table 5-5 Low Frequency Noise Thresholds (Table C2 from *NPfI*)

Threshold & Predicted Level	One-Third Octave Centre Frequency, Hz												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
$L_{Zeq,15min}$ threshold level	92	89	86	77	69	61	54	50	50	48	48	46	44

The following corrections apply where the measured dBC minus dBA level is 15 dB or more:

- where any of the one-third octave noise levels in *NPfI* Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2 dBA positive adjustment to measured / predicted A-weighted levels applies for the evening / night period.
- where any of the one-third octave noise levels in *NPfI* Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5 dBA positive adjustment to measured / predicted A-weighted levels applies for the evening / night period and a 2 dBA positive adjustment applies for the daytime period.

5.4 Residual Noise Impacts

The *NPfI* recognises that where all source and pathway feasible and reasonable noise mitigation measures have been applied a proposed development might give rise to residual noise impacts.

Table 4.1 of the *NPfI*, which interprets the significance of any potential noise exceedances, is reproduced below in Table 4-4. These significance categories (i.e. negligible, marginal, moderate and significant) are generally consistent with Table 1 of the *Voluntary Land Acquisition and Mitigation Policy* (*VLAMP*) (DP&E, 2014) which addresses noise and air quality impacts from State significant mining, petroleum and extractive industry developments. An updated draft version of this policy (DP&E, 2017) was released in November 2017. Given the policy is still in draft form, the revised policy has not been considered in this assessment.

Table 5-6 Significance of Residual Noise Impacts

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of residual noise level is:
<=2 dBA	Not applicable	Negligible
>= 3 but <=5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
>= 3 but <=5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1dB	Moderate
>5 dBA	=< recommended amenity noise level	Moderate
>5 dBA	> recommended amenity noise level	Significant

The *NPfI* also gives examples of noise mitigation measures addressing residual noise impacts in Table 4.2 of the policy. Table 4.2 of the *NPfI* is reproduced in Table 5-7.

Table 5-7 Examples of Receiver-Based Treatment to Mitigate Residual Noise Impacts

Significance of residual noise level	Example of potential treatment
Negligible	The exceedance would not be discernible by the average listener and therefore would not warrant receiver-based treatment or controls.
Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
Moderate	As for 'marginal', but also upgraded façade elements, such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Significant	May include suitable commercial agreement where considered feasible and reasonable.

Table 5-8 presents the methodology for assessing noise levels which may exceed the *NPfI* Project noise trigger levels at privately-owned residences.

Table 5-8 Project Noise Impact Assessment Methodology

Noise Management Zone		Noise Affectation Zone
1-2 dB above Project noise trigger levels	3-5 dB above Project noise trigger levels	> 5 dB Project noise trigger levels
No treatment/controls required	• Voluntary mitigation rights applicable. • Architectural treatment required if requested (incl. ventilation & upgraded façade elements).	• Voluntary mitigation rights applicable. • Architectural treatment required if requested (incl. ventilation & upgraded façade elements). • Voluntary land acquisition rights applicable.

6 NOISE MODELLING PROCEDURE

Operational noise levels at nearby receivers have been calculated using the Environmental Noise Model (ENM) a proprietary computer program from RTA Technology Pty Ltd. ENM accounts for the effects of distance, shielding, ground effects, air absorption and meteorological effects. This modelling has been previously accepted by the EPA for use in environmental noise assessments. The assessment models the total noise at each receiver from the operation of the Project. Total predicted operational noise levels are then compared with the operational noise trigger levels presented in Section 5.

Typical quarrying operations involve the stripping of overburden and the extraction of hard rock using open-cut drill and blast techniques. Overburden is transported by trucks to the overburden emplacement areas, where it is spread and shaped by dozer. Worst-case noise scenarios assume overburden emplacement in the new SWOE.

Quarried material is processed on-site using various crushers and screens to obtain the desired product. Material is initially crushed in a primary mobile crusher located within the pit which is currently fed by an excavator. The mobile crusher/ conveyor system can be positioned close to the extraction location, thereby facilitating in-pit crushing works to be "truck-less" most of the time. After passing through the primary crusher, the crushed material is taken from the pit along a series of conveyors to the first set of screens located to the northwest of the pit and material is stockpiled in a surge pile. Material in the surge pile is reclaimed and conveyed to the main processing area where it undergoes further crushing and screening. Product material is stored in the various storage bins prior to being dispatched off-site by trains.

Operational scenarios were developed to represent the potential worst-case impact from operations occurring on-site and the potential to generate noise at the surrounding sensitive receptors.

The typical approved daytime operations of the Peppertree Quarry (as presented in Table 6-1) with the following proposed overburden hauling and emplacement activities associated with the SWOE was modelled:

SWOE

- 1x Dozer;
- 1x Grader;
- 1x Watercart (30,000 litres Articulated); and
- 12x Cat 740 Trucks (40 tonnes articulated) or 8x Cat 777 Trucks (100 tonnes).

In-pit extraction and processing operations

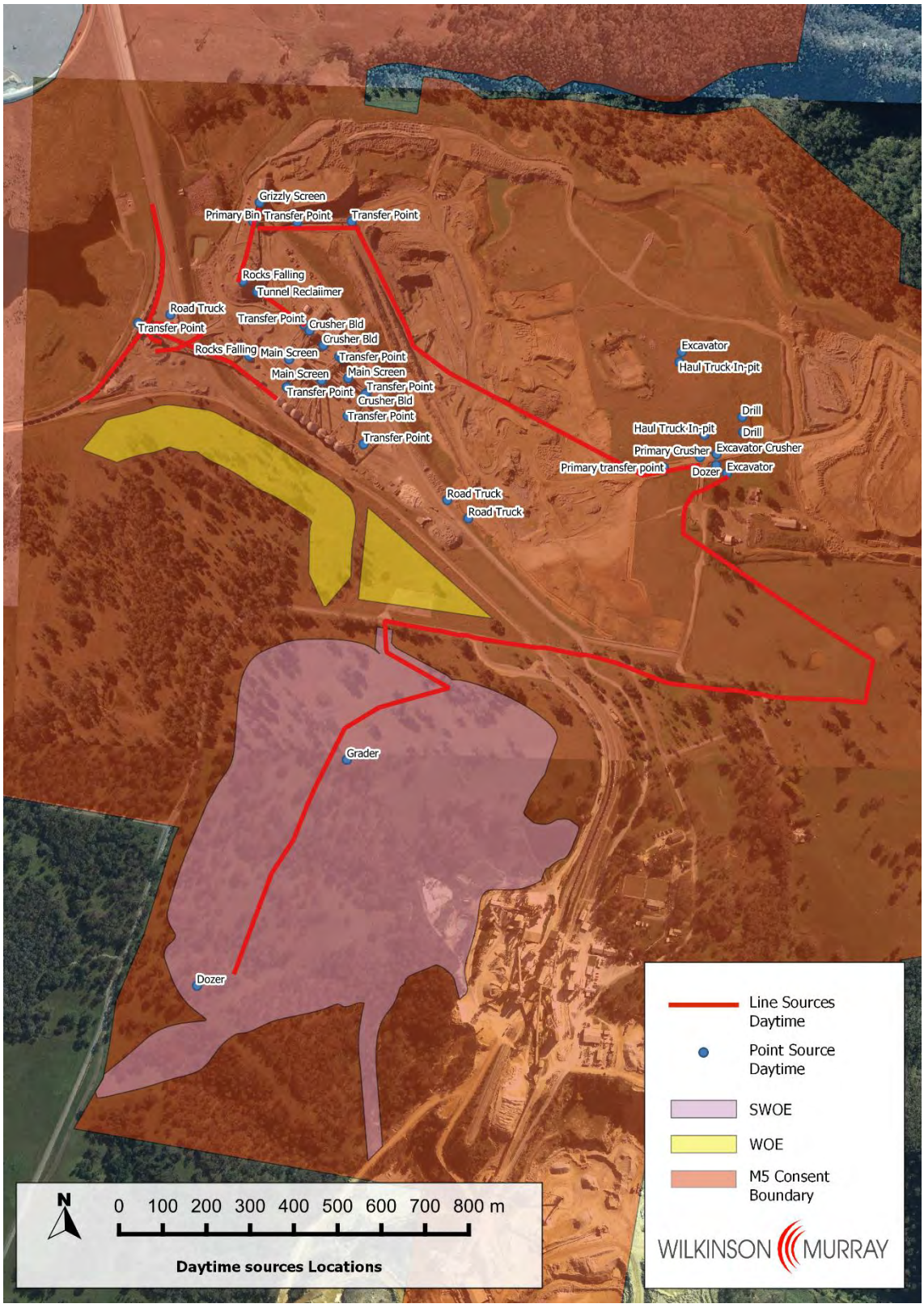
- 1x in-pit Mobile Crusher operating at RL 555;
- 2x Excavator (150 tonne);
- 2x Trucks (40 tonne Articulated) (Worst case operation when trucks are used to move material to the Primary crusher);
- 2x Drill Rigs at RL 570; and
- 1x Watercart (10,000 litre).

Secondary / Tertiary Processing, rail loading and product transportation

- Primary Screening Plant;
- Grizzly Screen;
- Secondary Crushing & Screening;
- Tertiary Crushing & Screening;
- Numerous conveyors and transfer points;
- Primary bin;
- Rocks falling on Stockpile (surge);
- Tunnel reclaim;
- Train moving slowly through loading facility;
- Loading Rail wagons;
- Enclosed Rail storage bins loading;
- 2x FELs; and
- 3x Road Trucks (delivery of limestone sand).

Figure 6-1 shows the locations of the noise sources for the typical approved daytime operations and the proposed overburden hauling and emplacement activities associated with the SWOE.

Figure 6-1 Indicative Modelling Scenario for the Modified Daytime Operations (7am-7pm)



Typical approved evening / night time operations of the Peppertree Quarry (as presented in Table 6-1) with the following proposed in-pit operations all operating at RL555 and between 5.00am and 11.00pm:

In-pit extraction and processing operations

- 1x in-pit Mobile Crusher operating at RL 555;
- 1x Excavator (65 tonne) + 2x Trucks (40 tonne Articulated) all operating at RL 570;
- 2x Drill Rigs at RL 570; and
- 1x Watercart (10,000 litre).

It should be noted that the secondary and tertiary processing, rail loading and product transportation also operates during the evening and night time period.

Presently two trucks are used in the pit to haul blast rock from the blast face to the crusher, as required. Once all overburden within the pit is removed, there will be no trucks and only an excavator or front end loader will replace the trucks. To assess worst-case noise impacts the two trucks hauling blast rock from the blast face to the crusher was modelled.

Figure 6-2 shows the locations of the noise sources for the typical approved evening / night time operations of the Peppertree Quarry with the in-pit operations.

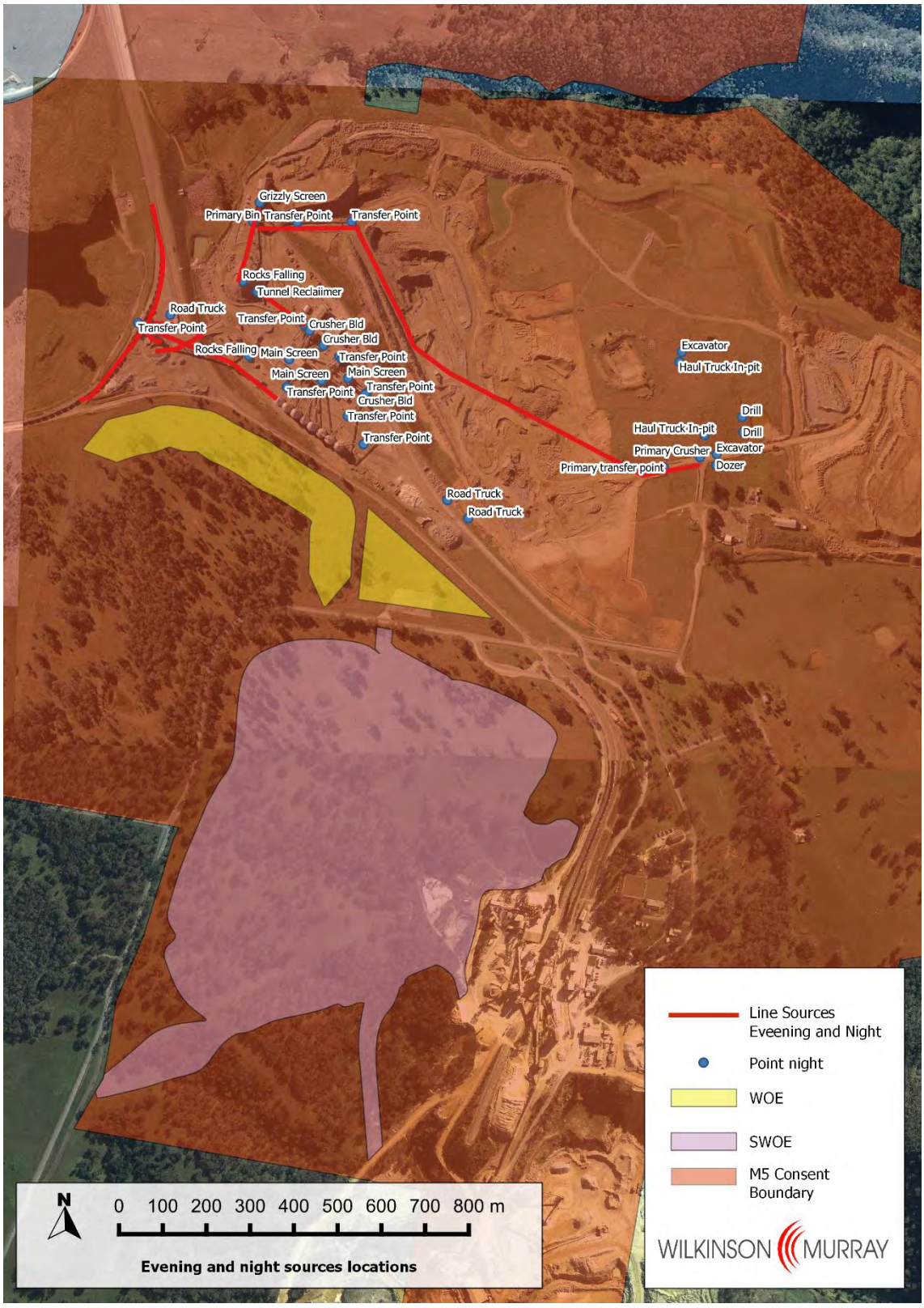
These scenarios were based on the assumption that all plant and equipment operate simultaneously. In practice, such an operating scenario would be unlikely to occur, and the results of the modelling are typically conservative.

The quarry operations included in the noise modelling scenarios are summarised in . While night time operations are unchanged, there is some change in overburden emplacements which could lead to a potential change in acoustic shielding to some receivers. Therefore, an assessment of night time noise emission is included.

Table 6-1 Operations Modelled

Operation	Daytime 7am-7pm	Evening & Night Time 7pm-7am
In-pit extraction and processing operations	✓	✓
Overburden operations (SWOE)	✓	✗
Secondary & Tertiary processing	✓	✓
Rail loading & product transportation	✓	✓

Figure 6-2 Indicative Modelling Scenario for the Modified Evening / Night Time Operations (7pm-7am)



An inventory of sound power levels of plant, equipment and operations are presented in Table 6-2. The sound power levels are based on a combination of measured noise levels, data from previous environmental assessments of the Peppertree Quarry and Wilkinson Murray's database.

Table 6-2 Equipment Sound Power Levels

Fleet Item	Typical Plant Description	Location	Sound Power Level L_{Aeq} (dBA)	Reference
Haul Trucks	Articulated Truck	In-pit	110	Site noise measurements
	Articulated Truck Cat 740 (40t)	Overburden emplacement	110	Site noise measurements
	Haul Truck Cat 777 (100t)	Overburden emplacement	114	Wilkinson Murray database
Primary Screening Plant		Processing area	104	Site noise measurements
Grizzly Screen		Processing area	104	Site noise measurements
Primary Bin		Processing area	108*	ERM
Secondary Crushing & Screening		Processing area	104	Site noise measurements
Tertiary Crushing & Screening		Processing area	104	Site noise measurements
Conveyor (Pit to Stockpile)		Processing area	80dBA per m	Peppertree Mod 2
Rocks falling on Stockpile		Processing area	103	Site noise measurements
Tunnel reclaim		Processing area	93	Site noise measurements
Train moving slowly through loading facility		Rail loading & product transportation	103	Site noise measurements
Conveyor (others)		Processing area	75dBA per m	Peppertree Mod 2
Conveyor transfer points		Processing area	92	Site noise measurements
Drill		In-pit	115	Wilkinson Murray database
In-pit Mobile Crusher		In-pit	115*	Site noise measurements

Fleet Item	Typical Plant Description	Location	Sound Power Level L_{Aeq} (dBA)	Reference
Primary transfer point		In-pit	108	ERM
Road Trucks		Processing area	102	Wilkinson Murray database
Dozer	D10 / D11	Overburden emplacement	112	Peppertree Mod 2
Enclosed Rail storage bins loading		Rail loading & product transportation	94	Peppertree Mod 2
Excavators	Komatsu 850	In-pit	106	Peppertree Mod 2
Loaders	Komatsu WA800	Processing Area	114	Peppertree Mod 2
	CAT 988	In-pit	111	Peppertree Mod 2
Grader	CAT 140H	Haul roads	108	Wilkinson Murray database
Watercarts		Haul roads	110	Wilkinson Murray database

* Mitigation Included

As noted, the hauling could be done using 12 x Cat 740 Trucks (40 tonnes articulated) or 8 x Cat 777 Trucks (100 tonnes). The total source sound power level of the use of the Cat 740 Trucks will be 2dBA lower than the use of 8 x Cat 777 Trucks. Therefore, both truck types were modelled as outlined in the noise modelling scenarios in Table 6-3.

At the beginning of Modification 5, the landform where the overburden is placed on the SWOE was assumed to be at the level of the existing land. For the scenario representing the end of Modification 5, it was assumed that the SWOE would be near its final configuration and haul trucks would sometimes be shielded by the top of the emplacement.

In all daytime scenarios, it was assumed that emplacement was taking place at the south western end of the SWOE, representing a typical worst-case scenario for noise to closest residential Receivers 8 and 9.

Table 6-3 Noise Modelling Scenarios

Scenario	Period	Haul Trucks	Phase of Modification
1	Day	8 x 777	Beginning of Mod 5
2	Day	12 x 740	Beginning of Mod 5
3	Day	8 x 777	End of Mod 5
4	Day	12 x 740	End of Mod 5
5	Night	N/A	Life of Modification

6.1 Environment for Noise Assessment Process

6.1.1 Accounting for Different Meteorological Conditions

Fact Sheet D of the *NPfI* defines standard meteorological conditions and noise-enhancing meteorological conditions to be considered for the assessment. The definition of those conditions is provided in Table D1 of Fact Sheet D which is reproduced in Table 6-4.

Table 6-4 *Standard and noise-enhancing meteorological conditions.*

Meteorological conditions	*Meteorological parameters*
Standard meteorological conditions	*Day/evening/night: stability categories A-D with wind speed up to 0.5m/s at 10m AGL*
Noise-enhancing meteorological conditions	*Day/evening: stability categories A-D with light winds (up to 3m/s at 10m AGL)* *Night: stability categories A-D with light winds (up to 3m/s at 10m AGL) and/or stability category F with winds up to 2m/s at 10m AGL*

Notes: m/s = metres per second; m = metres; AGL = above ground level; where a range of conditions is nominated, the meteorological condition delivering the highest predicted noise level should be adopted for assessment purposes. However, feasible and reasonable noise limits in consents and licences derived from this process would apply under the full range of meteorological conditions nominated under standard or noise-enhancing conditions as relevant. All wind speeds are referenced to 10m AGL. Stability categories are based on the Pasquill-Gifford stability classification scheme.

Fact Sheet D provides two options when considering meteorological effects:

- Conservatively adopt noise-enhancing meteorological conditions without processing meteorological data local to the site; or
- Determine the significance of noise-enhancing meteorological conditions based on meteorological data local to the site and:
    1) adopt significant noise-enhancing conditions for the assessment, where noise-enhancing meteorological conditions are deemed significant; or
    2) adopt standard meteorological conditions for the assessment where noise-enhancing meteorological conditions are not deemed significant.

As Boral maintains two weather stations (one on the Limestone Mine site and one at Peppertree Quarry), an analysis of the meteorological data was undertaken to determine the significance of noise-enhancing meteorological conditions at the site.

6.1.2 Analysis of Meteorology

Five years of meteorological data from the Peppertree Quarry weather station were provided by Boral. The data included the Pasquill-Gifford stability category. The *NPfI* states: "Where the sum total of F and G inversions occur for at least 30% of the total night time in winter, the project area is considered to be significantly affected by inversions warranting noise assessment."

Table 6-5 presents the results of the analysis of the occurrence of temperature inversions on winter nights and shows that temperature inversions occur for less than 30% of winter nights.

Table 6-5 Percent Occurrence of F & G Inversions on Winter Nights

Year	Winter
2012	
2013	25.6
2014	29.8
2015	28.7
2016	24.5
2012/2017	27.2
Average	27.2

Wind roses for each season are presented in Appendix C. Analysis of five years data showed that noise-enhancing conditions as defined in the *NPfI* are not a feature of the area.

6.1.3 Adopted Meteorological Parameters for Noise Assessment Model

Given these results, standard meteorological conditions as described above were used for assessment of noise emissions.

Temperature and humidity make small differences to prediction using ENM. The parameters used were:

- for daytime – 70% relative humidity, 20° degrees Celsius; and
- for evening and night time – 90% relative humidity, 10° degrees Celsius.

7 NOISE IMPACT ASSESSMENT

7.1 Operational Noise Assessment

Predicted noise levels for the identified operational scenarios have been calculated using the assumptions presented above. Predictions for the daytime scenarios are presented in Table 7-1 (beginning of Modification 5) and Table 7-2 (end of Modification 5).

Predictions for the evening and night time scenario is presented in Table 7-3.

Table 7-1 Daytime Predictions LAeq,15min dBA – At start of Modification 5 (Scenarios 1 and 2)

Receiver	Predicted Noise Levels, $L_{Aeq,15min}$		Trigger or Approval Levels	
	Scenario 1 8x Cat 777 Trucks	Scenario 2 12x Cat 740 Trucks	*NPfI* Trigger	Project Approval Criteria
R1	19	18	40	35
R2	28	27	40	35
R3	31	31	40	35
R4	29	27	40	35
R5	30	29	40	35
R6	26	25	40	35
R7	32	31	40	35
R8	37	36	40	41
R9	31	30	40	35
R10	27	26	40	35
R11	24	23	40	35
R12	25	24	40	35
R13	23	22	40	35
R14	29	28	40	35
R15	30	28	40	35
R16	29	27	40	35
R17	30	28	40	35

Table 7-2 Daytime Predictions $L_{Aeq,15min}$ dBA – End of Modification 5 (Scenarios 3 and 4)

Receiver	Predicted Noise Levels, $L_{Aeq,15min}$		Trigger or Approval Levels	
	Scenario 3 8x Cat 777 Trucks	Scenario 4 12x Cat 740 Trucks	*NPfI* Trigger	Project Approval Criteria
R1	19	18	40	35
R2	28	27	40	35
R3	31	30	40	35
R4	29	28	40	35
R5	30	29	40	35
R6	28	27	40	35
R7	33	32	40	35
R8	38	37	40	41
R9	35	34	40	35
R10	30	29	40	35
R11	24	23	40	35
R12	24	23	40	35
R13	23	21	40	35
R14	30	29	40	35
R15	31	30	40	35
R16	30	29	40	35
R17	31	29	40	35

Table 7-3 Evening and Night Time Predictions – $L_{Aeq,15min}$ dBA – (Scenarios 5)

Receiver	Predicted Noise Levels, $L_{Aeq,15min}$	Trigger or Approval Level	
		NPfI Trigger	Project Approval Criteria
R1	16	38	35
R2	24	38	35
R3	28	38	35
R4	23	38	35
R5	28	38	35
R6	20	38	35
R7	28	38	35
R8	32	38	35
R9	26	38	35
R10	22	38	35
R11	16	38	35
R12	17	38	35
R13	18	35	35
R14	24	35	35
R15	23	35	35
R16	21	35	35
R17	20	35	35

The predicted noise levels for proposed daytime, evening and night time operations, including the proposed SWOE, comply with the operational noise trigger level at all locations. The predicted levels comply with the Project Approval criteria at all locations.

Predicted noise contour for daytime scenarios 3 and night time scenario 5 are presented in Appendix B. Daytime scenarios 3 is presented as it presents the greatest impact.

7.2 Comparison of noise modelling with measured noise levels

The ERM report presented measured noise levels at the following receivers:

- R2;
- R3;
- R4;
- R8; and
- R9.

A total of 46 operator attended noise measurements were completed by ERM. Of the 46 operator attended noise measurements that were completed, quarry noise levels contributions, $L_{Aeq,15minutes}$, were generally less than 30dBA. For a limited number of measurements, the quarry noise emissions were more easily detectable and contributed more to the overall acoustic environment, with noise levels contributions between 30 and 35dBA.

From the results of the noise measurements, ERM identified the key noise generating activities were the Primary crusher situated within the pit and the primary bin/ surge stockpile situated out of the pit and recommended noise mitigation to reduce their noise contributions which have been assumed to be in place for the noise predictions presented in this report. The predicted noise levels presented in this report are therefore lower than those measured by ERM and considering this the predicted noise levels presented in this report are generally consistent with the measured noise levels from ERM.

7.3 Maximum Noise Level Assessment

At a distance from a quarry operation, instantaneous changes in noise level are typically small as the noise experienced by the receiver is due to many low-level noise sources.

Night time operator-attended noise measurement results have been examined to review the existing corresponding L_{AFmax} noise levels and determine the difference between the intrusive $L_{Aeq,15min}$ and the corresponding maximum L_{AFmaxn} noise levels.

The results of night time noise measurements for the compliance monitoring for Peppertree Quarry in 2014 and 2017 (ERM, 2014, 2105, 2016 and 2017) are summarised in Table 7-4, including the measured (quarry-contributed) intrusive $L_{Aeq,15min}$ and the L_{AFmax} noise levels.

Table 7-4 Measured Maximum Night Time $L_{Aeq,15min}$ and L_{AFmax} Noise Levels

Receiver	2014			2015			2016			2017		
	Measured $L_{Aeq,15min}$	Measured L_{AFmax}	Difference	Measured $L_{Aeq,15min}$	Measured L_{AFmax}	Difference	Measured $L_{Aeq,15min}$	Measured L_{AFmax}	Difference	Measured $L_{Aeq,15min}$	Measured L_{AFmax}	Difference
R2 (6)	25	33	8	27	35	8	29	31	2	25	32	7
R3	31	38	7	30	35	5	26	33	7	33	42	9
R8 (16)	23	33	10	-	-	-	24	34	10	27	32	5
R17	-	-	-	-	-	-	24	24	0	23	32	9
R4	-	-	-	-	-	-	26	26	0	27	34	7
Mean			8			6			4			7

The night time operator-attended noise measurement results show a difference of between 0 and 10 dBA between the (quarry-contributed) intrusive $L_{Aeq,15min}$ and the maximum L_{AFmax} noise levels.

ERM in their analysis of L_{AFmax} noise levels identified a difference of $L_{Aeq,15min}$ and the maximum L_{AFmax} noise levels of between 2 to 8dB which is consistent with the analysis above.

For a conservative sleep disturbance assessment, a 10dBA difference has been assumed between the calculated $L_{Aeq,15min}$ and the maximum L_{AFmax} noise levels. The predicted L_{AFmax} noise levels from the night time operations are presented in Table 7-5.

Table 7-5 Night Time Predictions – L_{AFmax} dBA – (Scenarios 5)

Receiver	Predicted Noise Levels L_{AFmax}	Maximum Noise Event Screening criteria L_{AFmax}
R1	26	
R2	34	
R3	38	
R4	33	
R5	38	
R6	30	
R7	38	
R8	42	
R9	36	52
R10	32	
R11	26	
R12	27	
R13	28	
R14	34	
R15	33	
R16	31	
R17	30	

The predicted L_{AFmax} night time noise levels comply with the sleep disturbance criteria of 52 dBA at all locations. The predicted L_{AFmax} noise levels are comparable to those measured for quarry compliance.

7.4 Land Acquisitions Noise Criteria

As the land acquisition criteria in the Project Approval are equal to or higher than the operational target noise levels, the predicted daytime, evening and night time noise levels associated with the proposed modifications, do not exceed the land acquisition criteria at any residence.

According to the *VLAMP*, the Project is subject to voluntary land acquisition when the recommended maximum noise levels in Table 2.1 of the INP is exceeded on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

The recommended voluntary land acquisition criteria are:

- Daytime – 55 $L_{Aeq,period}$;
- Evening – 50 $L_{Aeq,period}$; and
- Night time – 45 $L_{Aeq,period}$.

Wilkinson Murray has reviewed potential impacts on privately-owned land. Review of the noise contours in Appendix D established that the daytime 55 dBA $L_{Aeq,period}$, the evening 50 dBA $L_{Aeq,period}$ and night time 45 dBA $L_{Aeq,period}$ remain within lands owned by Boral. The noise contours used for this review are based on $L_{Aeq,15min}$ predictions and therefore should be considered conservative as the minus 3 dB conversion from a 15-minute to period level has not been considered.

8 LOW FREQUENCY NOISE IMPACTS

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level.

The *NPfI* recommends correction factors to be applied to the source noise level at the receiver before comparison with the criteria to account for the additional annoyance caused by these modifying factors.

It is a requirement of the Quarry's approval to "include a program to characterise and measure low frequency noise emissions" as such noise emissions have been reported by receivers in the past.

The *NPfI* recommends investigating whether modifying factors are applicable based on an analysis of third octave band levels where there is a difference between C- and A-weighting levels of more than 15 dB (See Section 5-3).

The noise modelling data used for the predictions was in octaves. Data below 63 Hz, and third octave source data, is generally not available. The uncertainty of the calculation of the difference between C- and A-weighting levels would appear to be quite large.

At the most-affected receiver (R8) a difference between C- and A-weighting levels of 18dB was calculated. shows the results of a low-frequency analysis calculated to Receiver 8 under noise-enhancing meteorological conditions during daytime and night time. Because third octave data at low frequencies is unavailable, the calculation is based on a spectrum measured by Wilkinson Murray at Receivers R17 and R3 when investigating low frequency noise emission from Marulan South Mine.

Table 8-1 Low Frequency Noise Analysis at Receiver 8

Threshold & Predicted Level	Overall		One-Third Octave Centre Frequency, Hz												
	A	C	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
$L_{Zeq,15min}$ threshold level	-	-	92	89	86	77	69	61	54	50	50	48	48	46	44
Predicted Level, Worst Case (Receiver 8)	38	56	47	52	51	44	44	44	43	44	41	42	40	37	32

The predicted level at Receiver 8 is below the threshold level in all frequency bands, so no modifying factor is indicated for low frequency noise. This will also hold for all other receivers and is consistent with the ERM report.

Boral is committed to ameliorating any low frequency noise issues if they arise for the Project consistent with the most recent low frequency noise assessment process from the *NPfI*.

9 RESIDUAL NOISE IMPACTS

The concept of "residual noise impact" was introduced in the *NPfI*. They describe the situation where best-achievable noise level from a development exceeds the project noise trigger level when assessed at a sensitive receiver location.

Residual noise impacts are identified after all source and pathway feasible and reasonable noise mitigation measures have been considered. The significance of the residual impact and the need to assess receiver-based treatment options may need to be considered as part of an authority's determination / approval process.

There are no predicted residual noise impacts at any receiver.

10 CONCLUSION

This report details predicted operational noise emissions from the proposed modifications to the Peppertree Quarry.

To assess the potential noise impacts associated with the proposed modifications to the Peppertree Quarry operations, this report compared the predicted noise emissions from the existing and proposed operations with the operational noise impact assessment criteria in the Project Approval, and with proposed revision to noise criteria based on noise "trigger" levels describe in the NSW *Noise Policy for Industry*.

The assessment has found that:

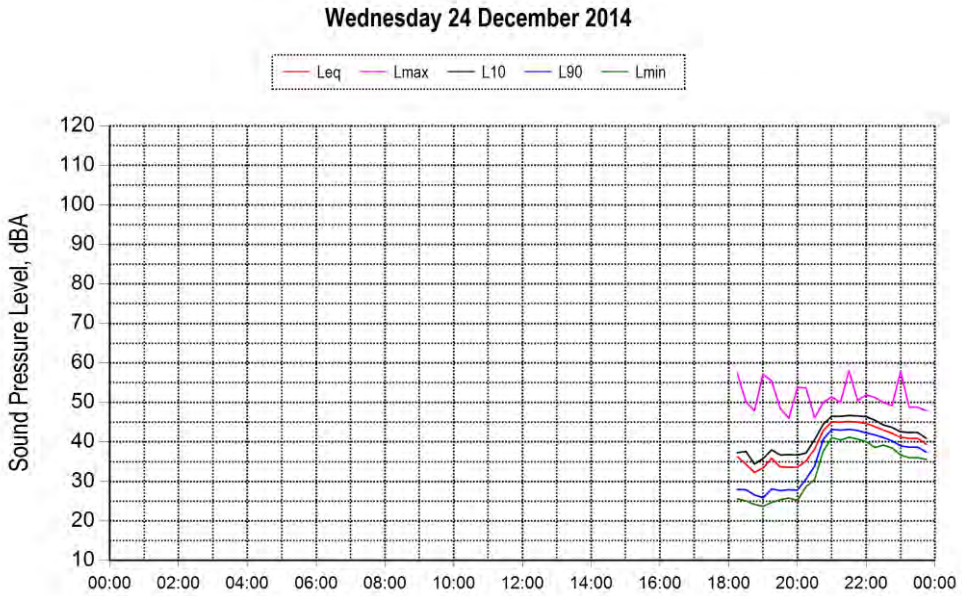
- At all receivers the predicted noise level for day time operations associated with the proposed SWOE comply with the *NPfI* noise trigger levels.
- The predicted noise level for proposed in-pit operations during the evening and night time comply with the noise trigger levels from the *NPfI*;
- As the land acquisition criteria in the Project Approval are higher than or equal to the operational noise trigger levels, the predicted daytime, evening and night time noise levels associated with the proposed modifications, do not exceed the land acquisition criteria at any residence;
- Maximum noise levels from the modified Peppertree Quarry operations have been analysed and it is expected that compliance with the sleep disturbance criteria in the Project Approval and trigger levels from the *NPfI*, would be achieved at all locations.

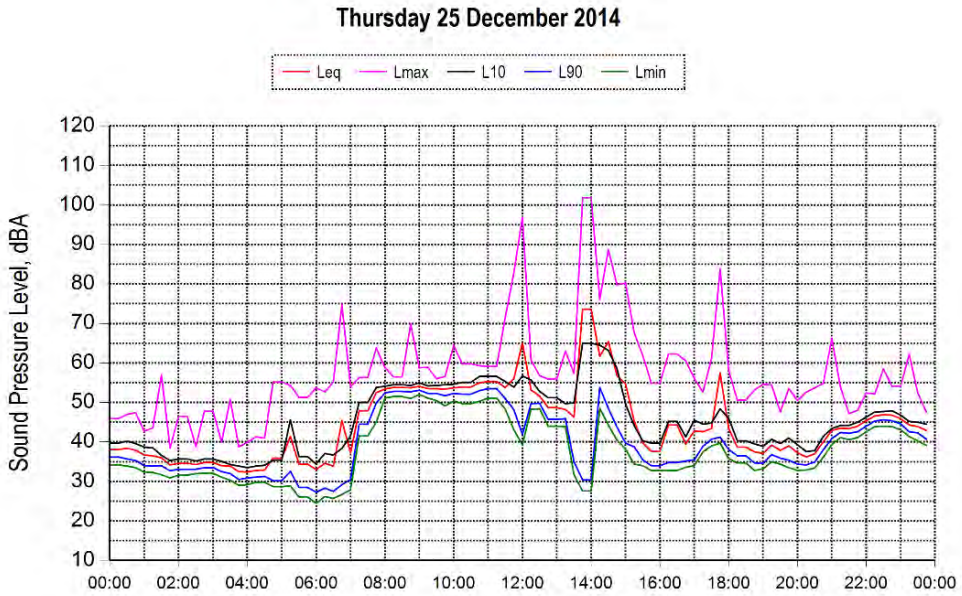
Given these conclusions, and the demonstrated performance of existing operations via the ongoing noise monitoring regime, it is considered that the continued implementation of the Noise Management Plan and associated management measures would be adequate to manage potential operational noise impacts which would arise from activities associated with the modified Peppertree Quarry operations.

APPENDIX A

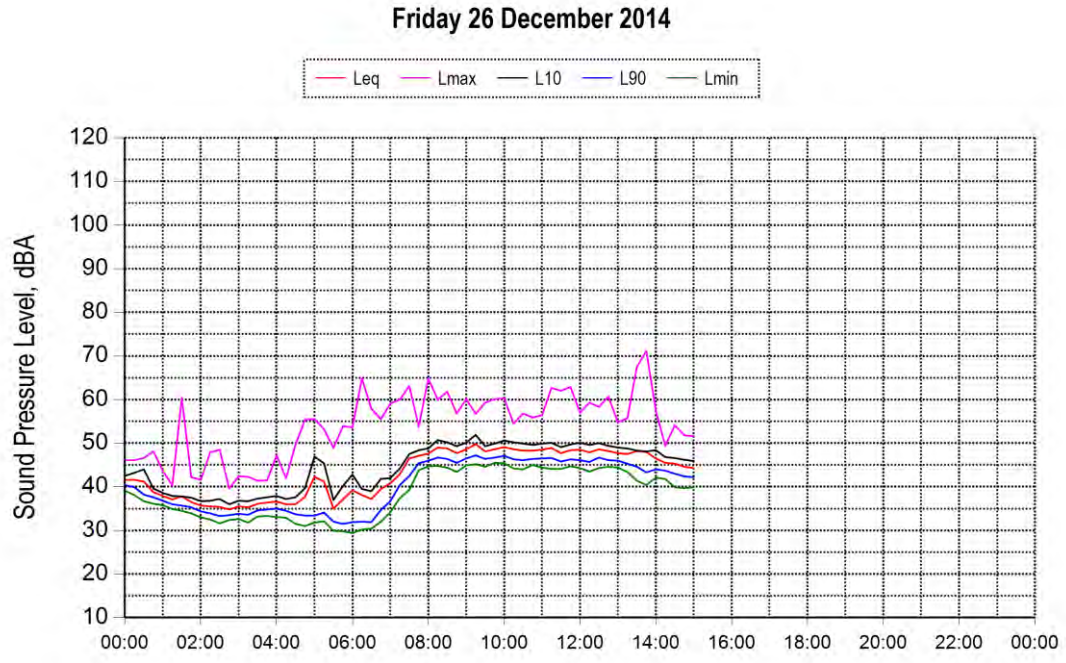
NOISE MONITORING RESULTS

B4) Mine Manager Property

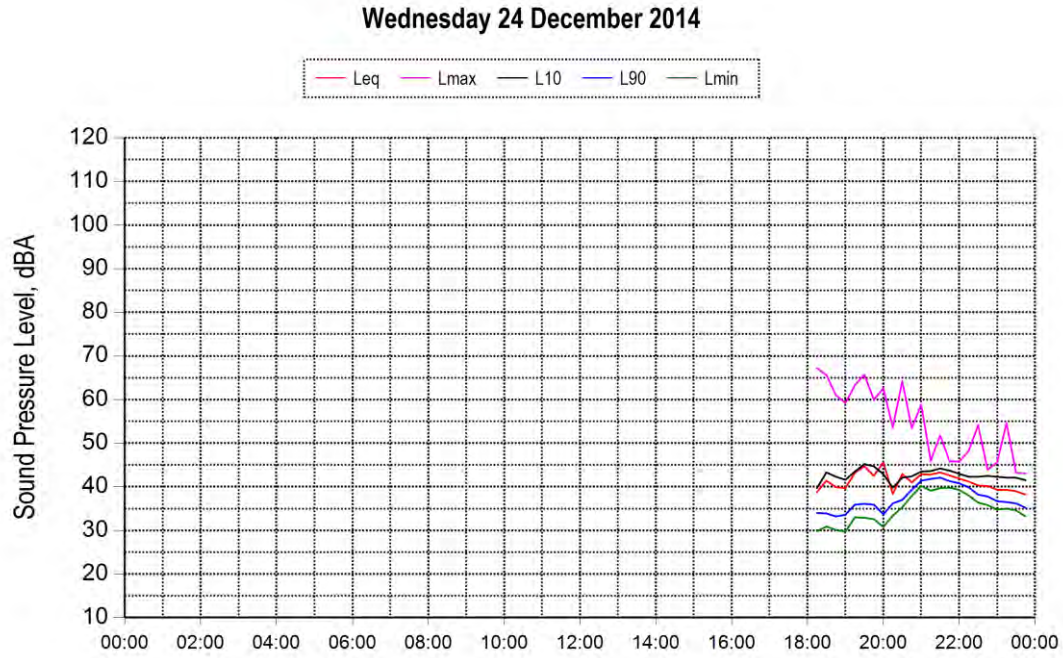


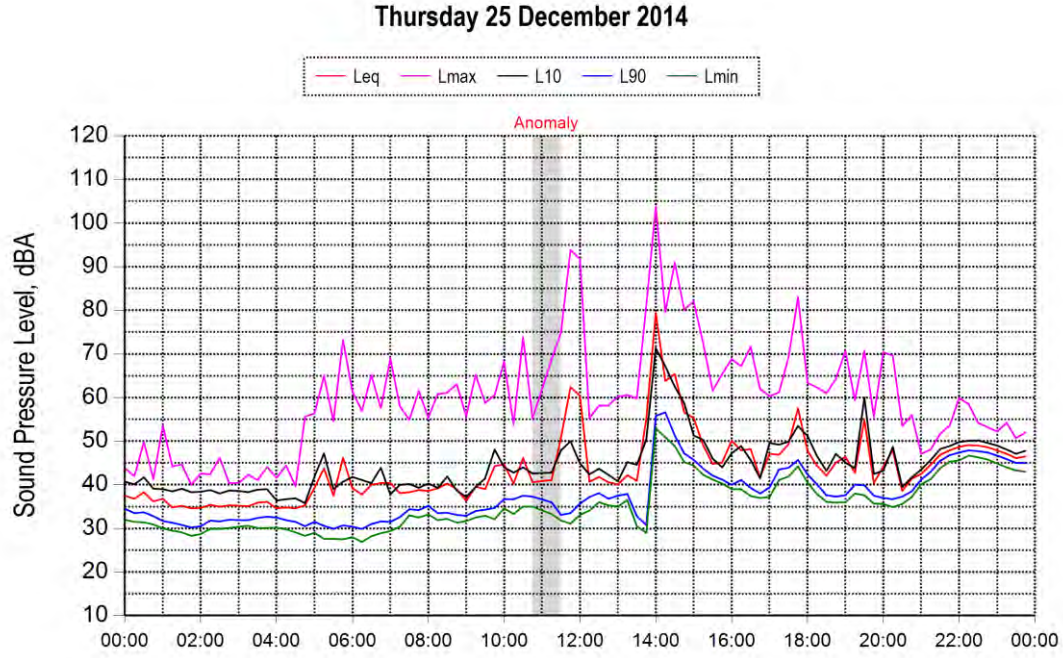


B4) Mine Manager Property

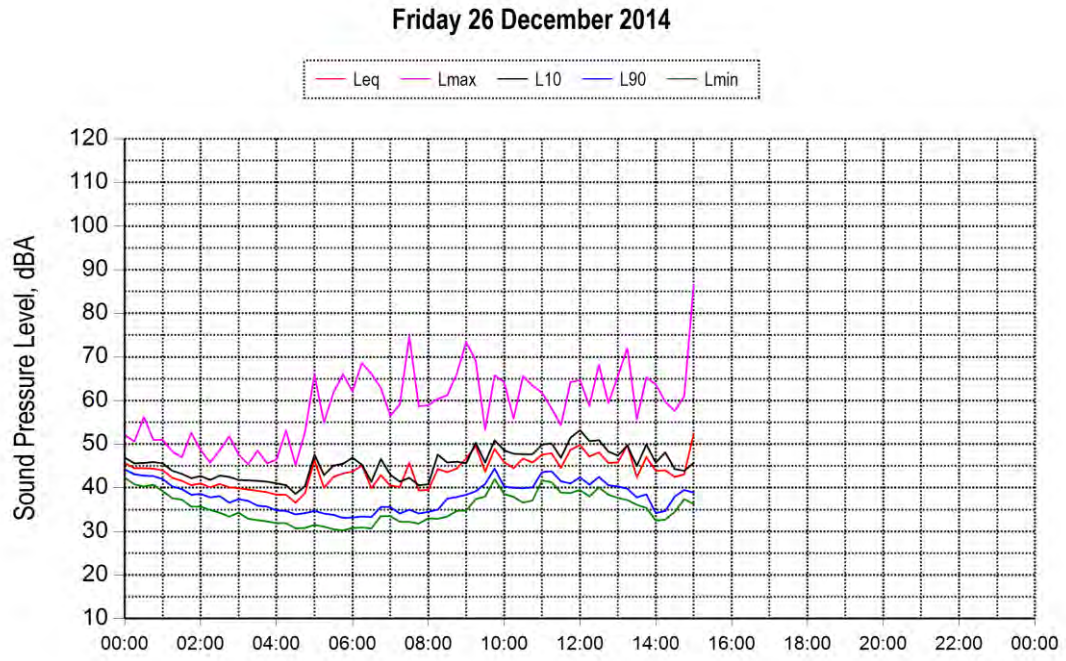


(R8) Turkey Farm

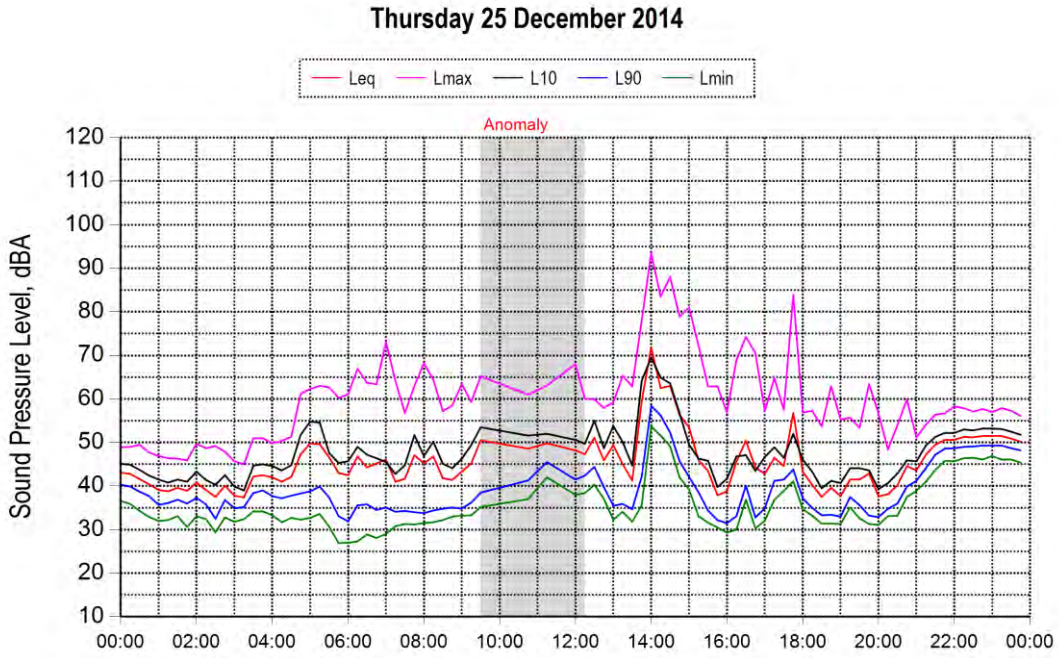


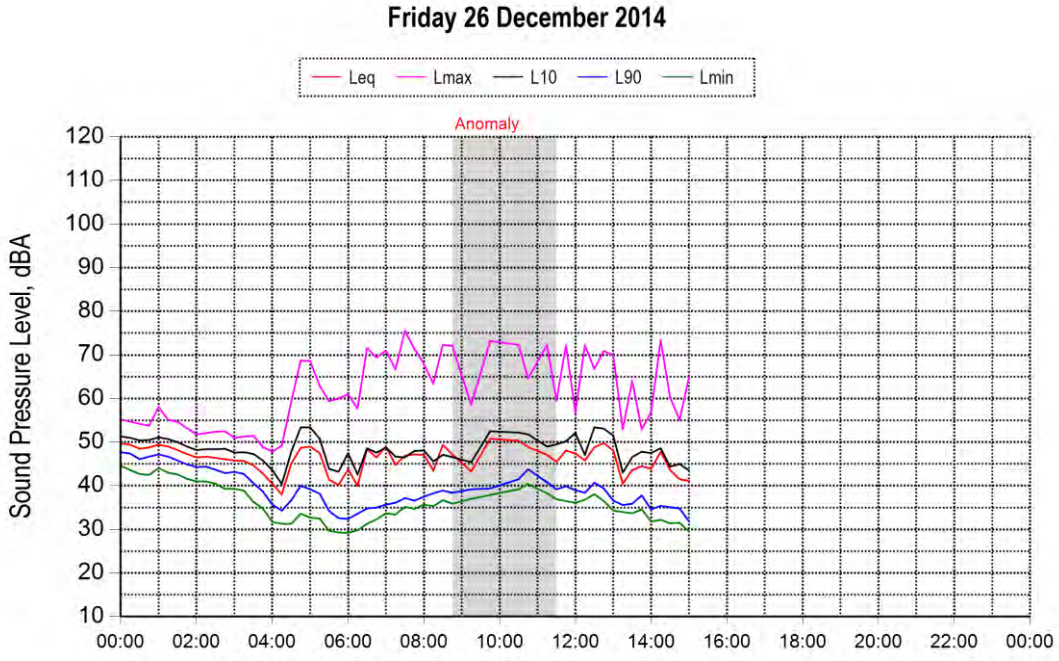


(R8) Turkey Farm

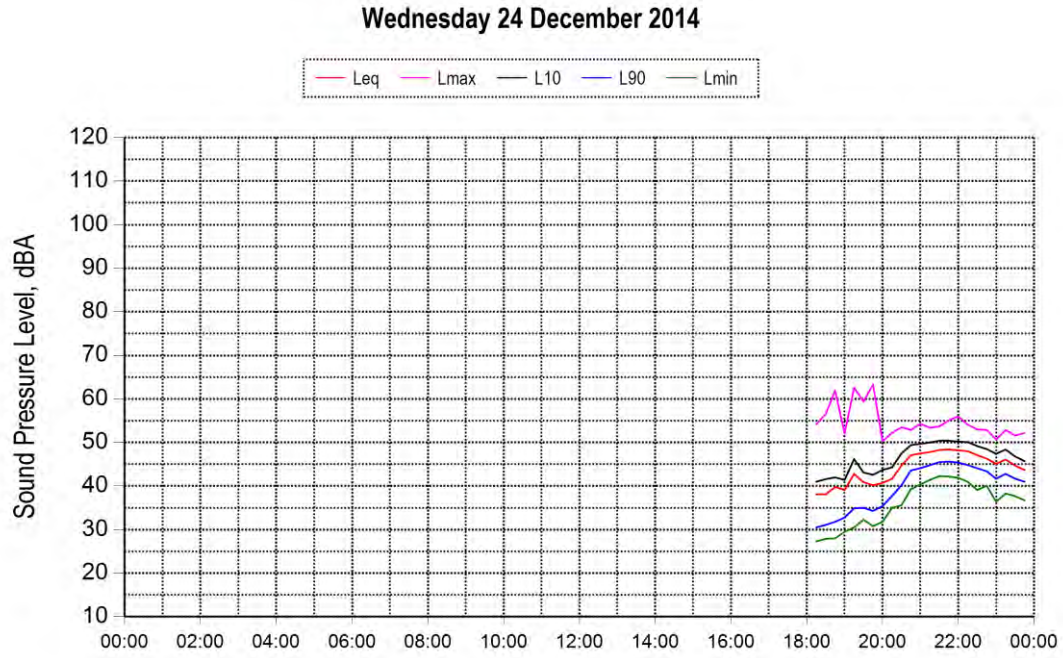


(R9) Western Location

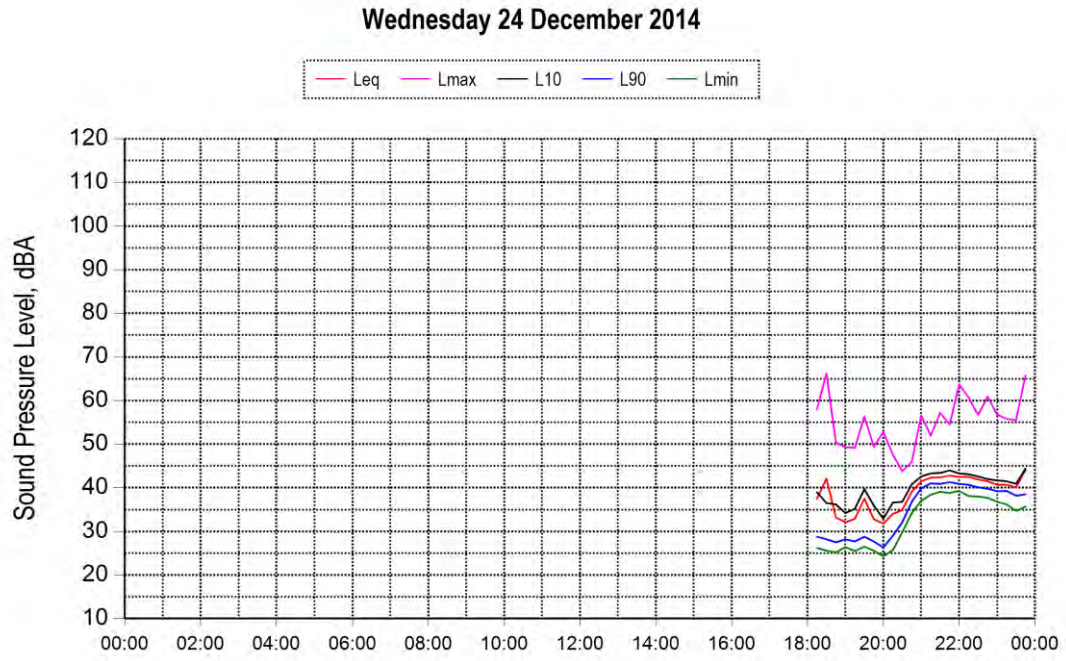


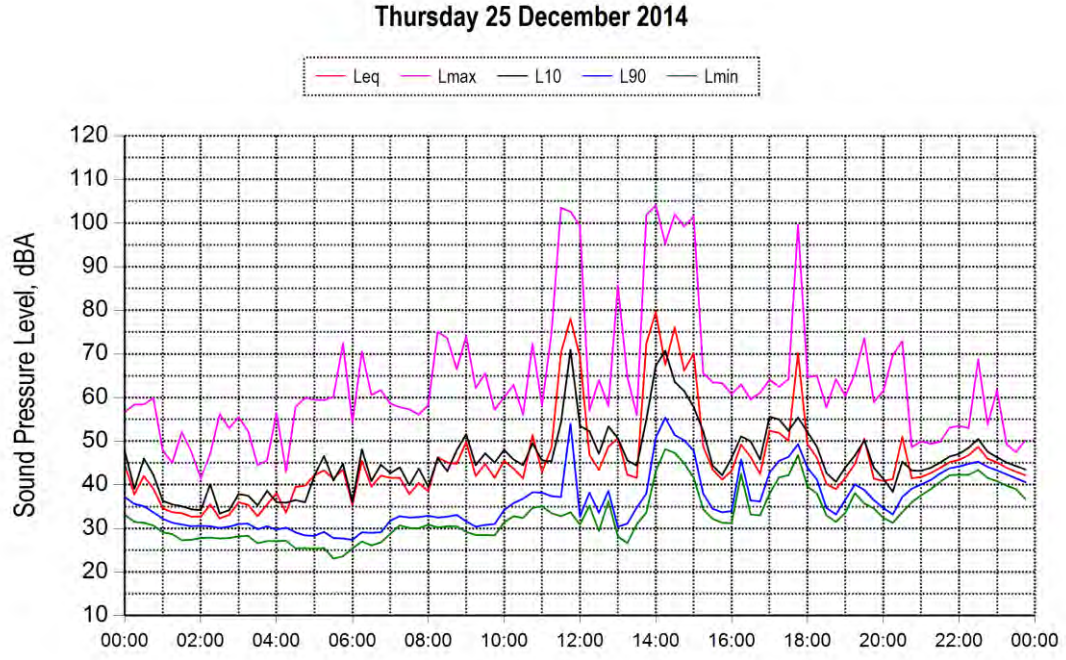


(R9) Western Location

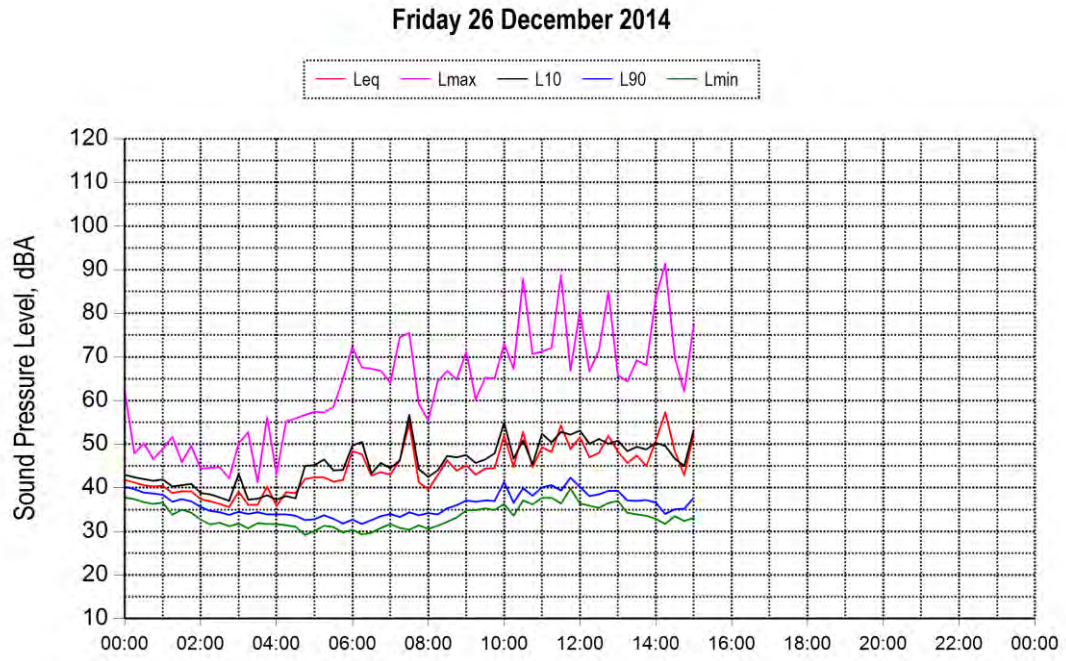


(R3) Northern Location

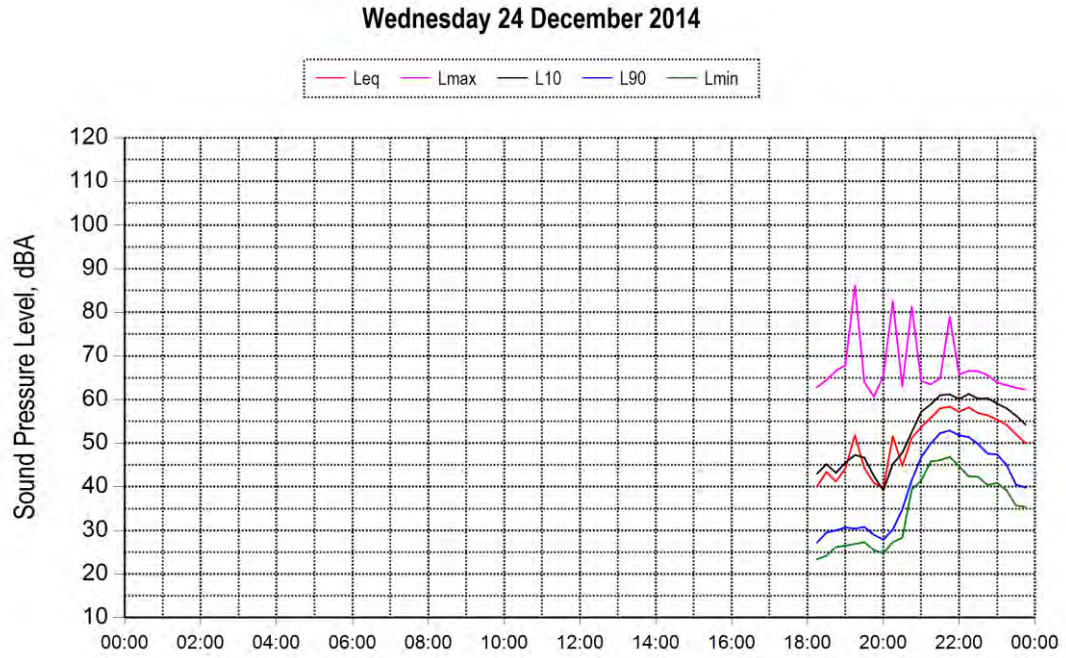


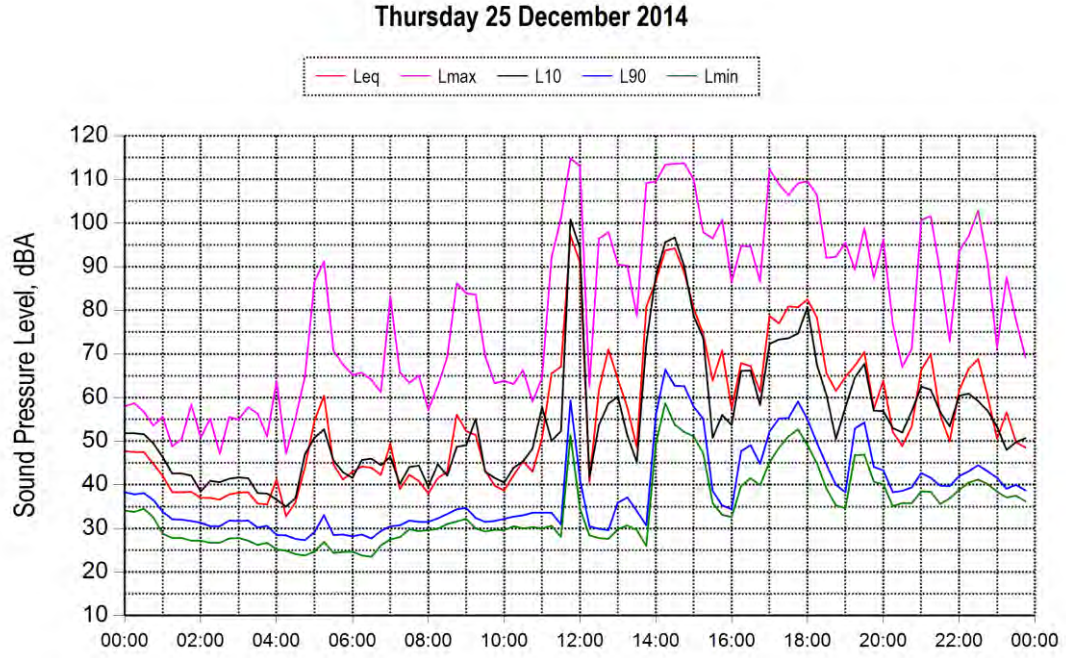


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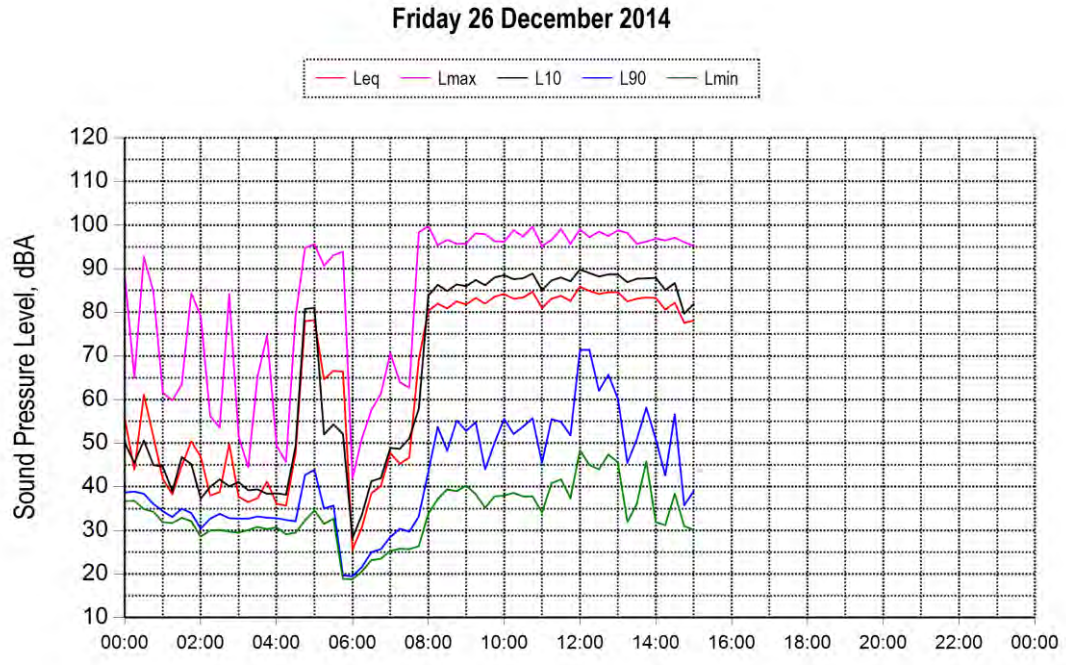


(R14) Eastern Location



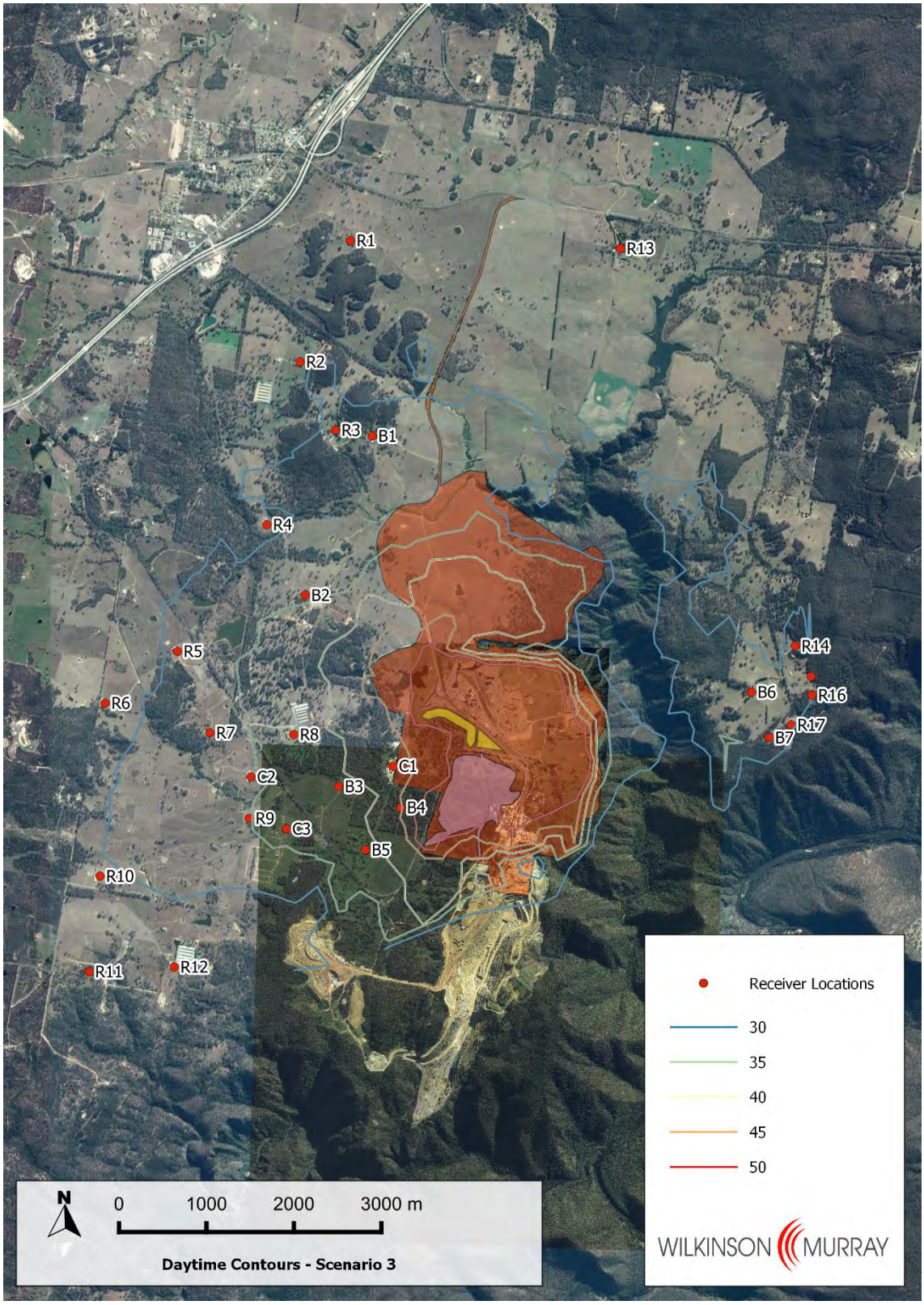


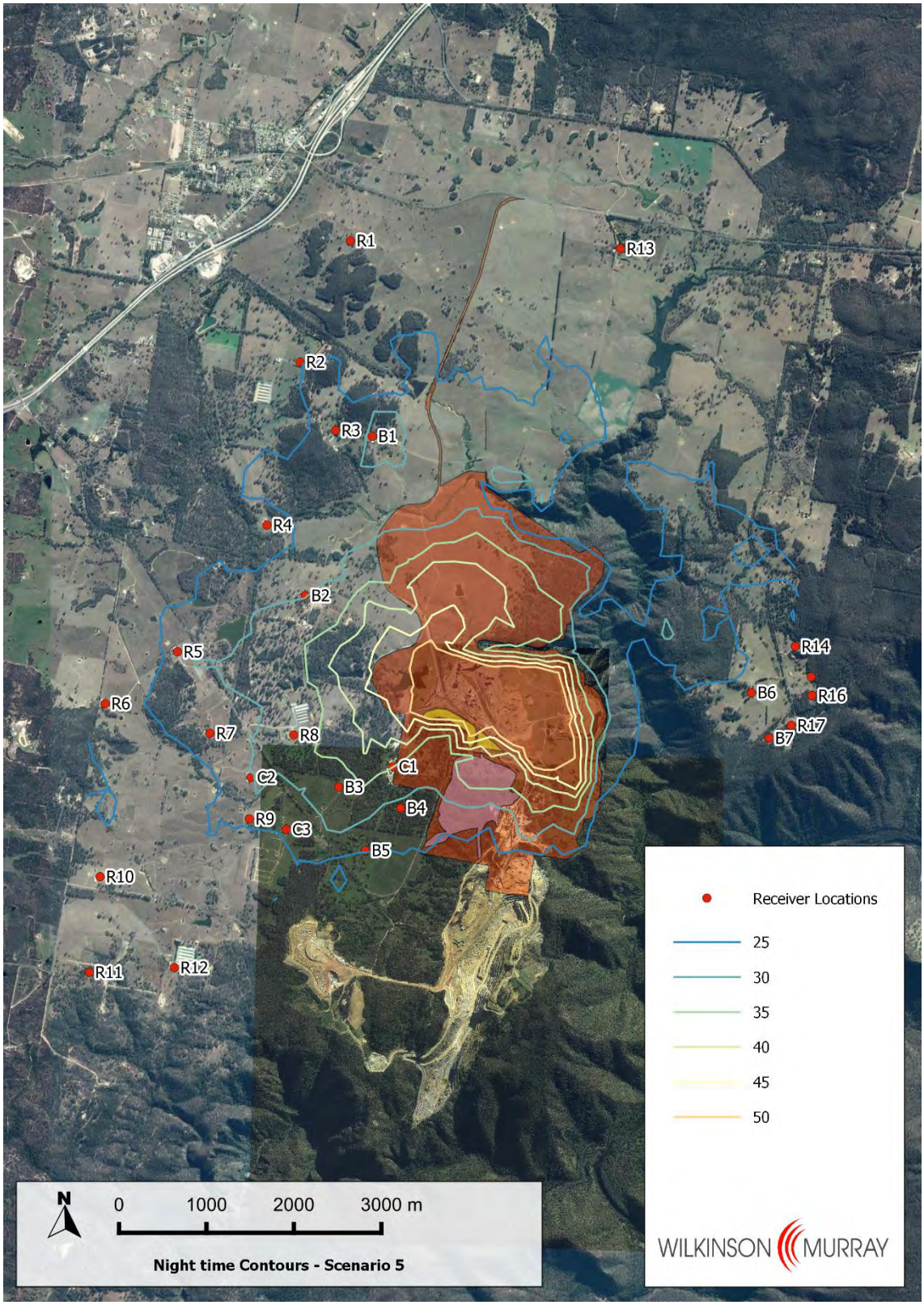
(R14) Eastern Location



APPENDIX B

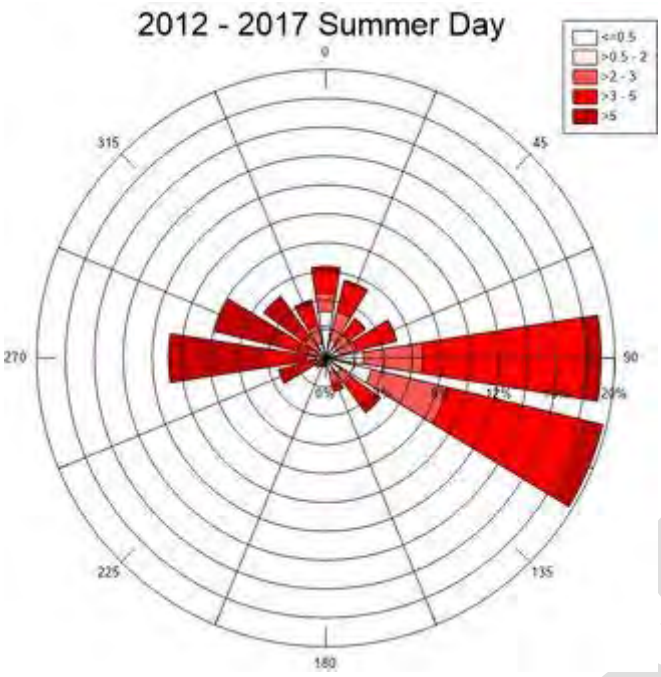
NOISE CONTOURS

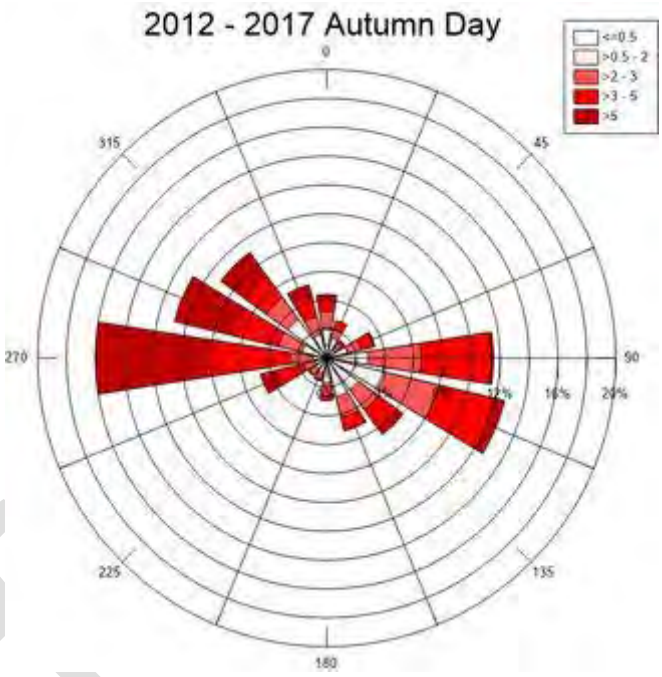

R1
R13
R2
R3
B1
R4
B2
R5
R14
R6
B6
R16
R7
R8
R17
B7
C1
C2
B3
B4
R9
C3
B5
R10
R11
R12
Receiver Locations
30
35
40
45
50
N
0
1000
2000
3000 m
Daytime Contours - Scenario 3
WILKINSON MURRAY

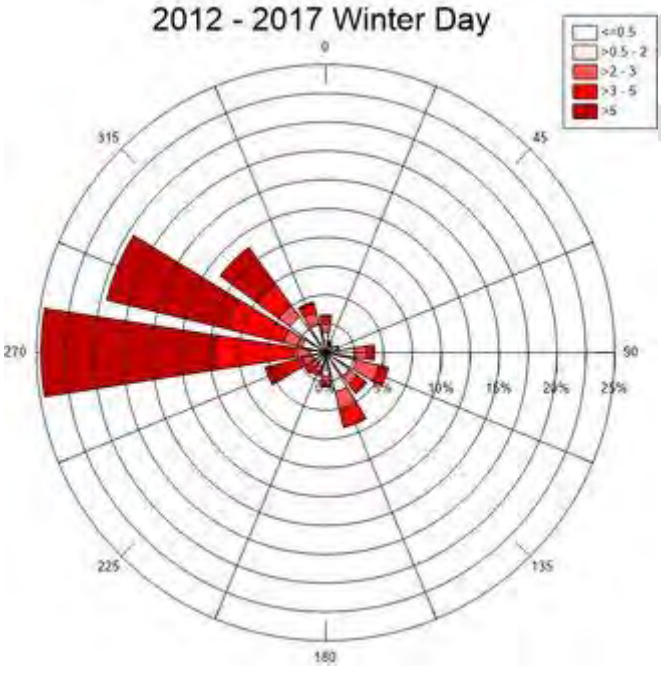

R1
R13
R2
R3
B1
R4
B2
R5
R14
R6
B6
R16
R7
R8
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B7
C1
C2
B3
B4
R9
C3
B5
R10
R11
R12
Receiver Locations
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3000 m
Night time Contours - Scenario 5
WILKINSON MURRAY

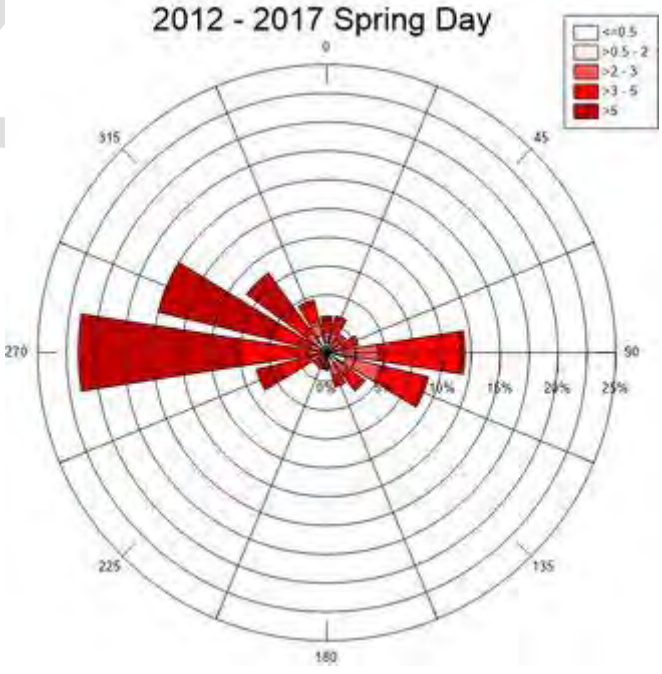
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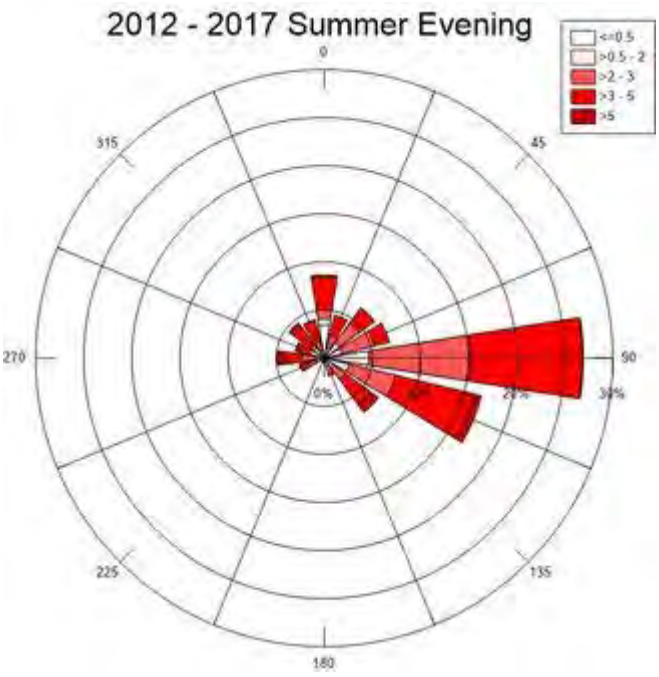
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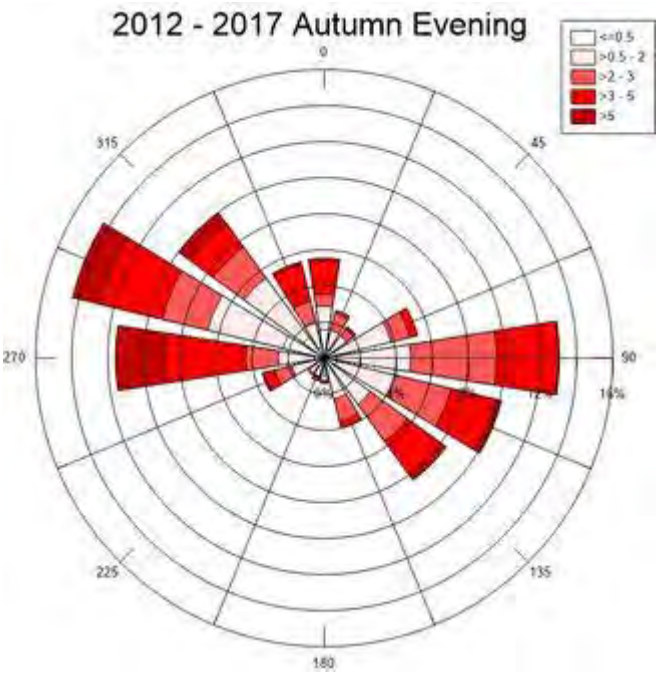

2012 - 2017 Summer Day
<=0.5
>0.5 - 2
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20%
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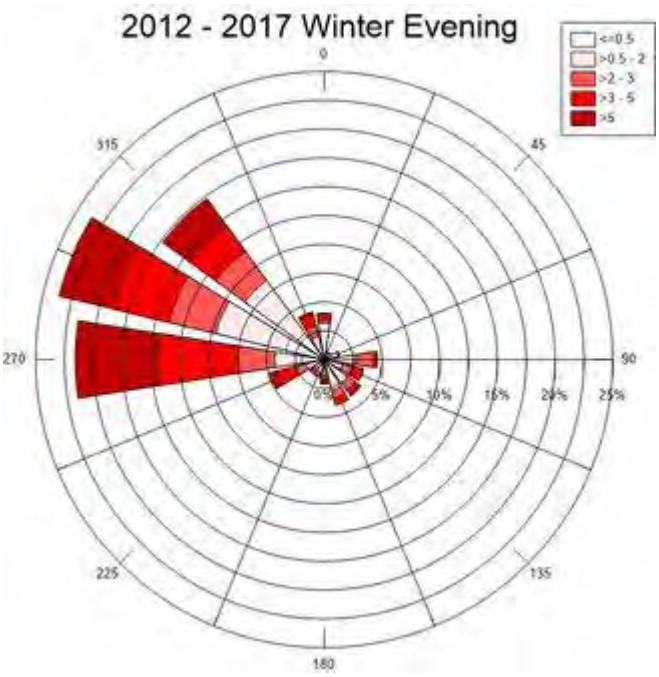

2012 - 2017 Autumn Day
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25%

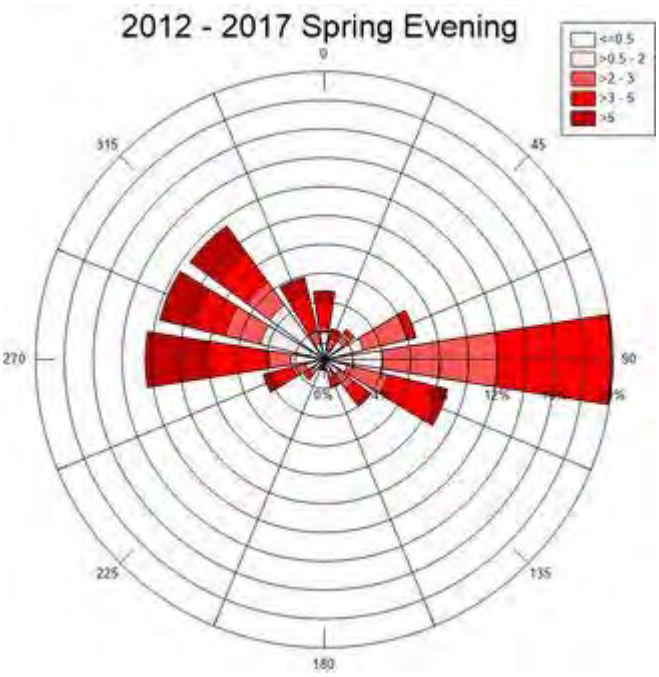

2012 - 2017 Winter Day
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15%
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25%

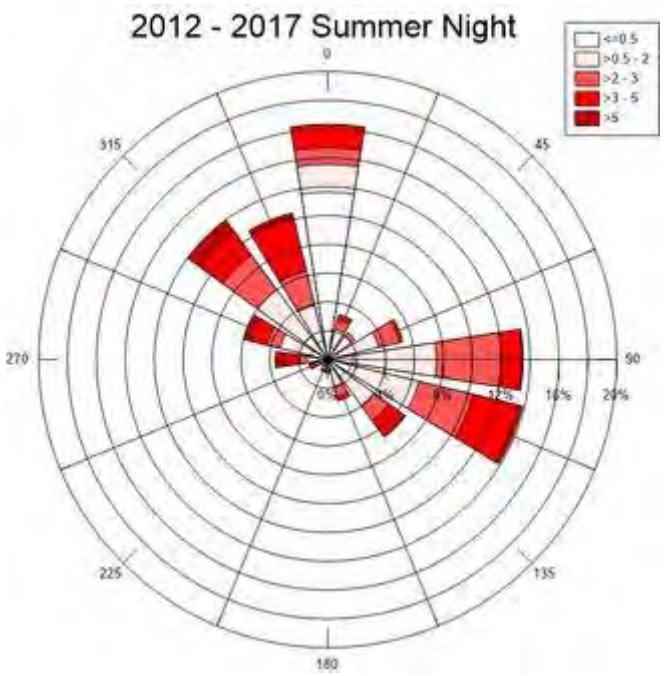

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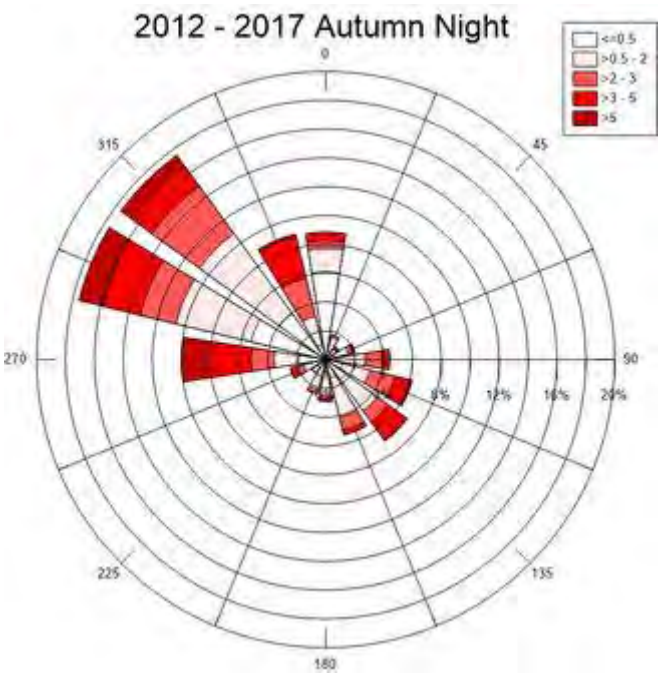

2012 - 2017 Summer Evening
<=0.5
>0.5 - 2
>2 - 3
>3 - 5
>5
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90
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225
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315
0%
20%
30%

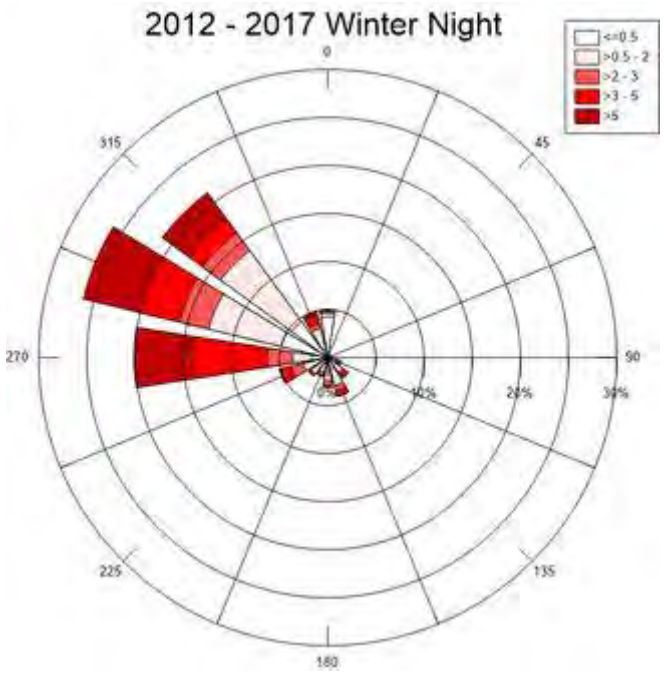

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>2 - 3
>3 - 5
>5
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270
315

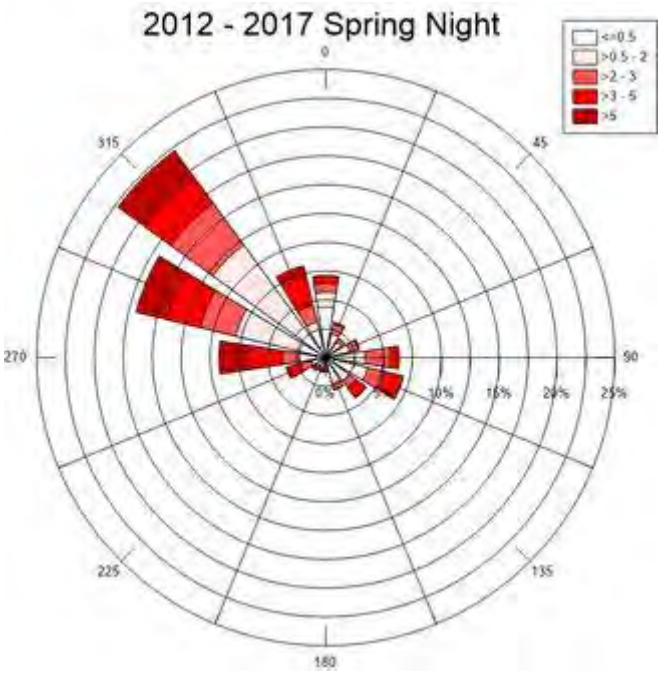

2012 - 2017 Winter Evening
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>2 - 3
>3 - 5
>5
0
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225
270
315
0%
5%
10%
15%
20%
25%

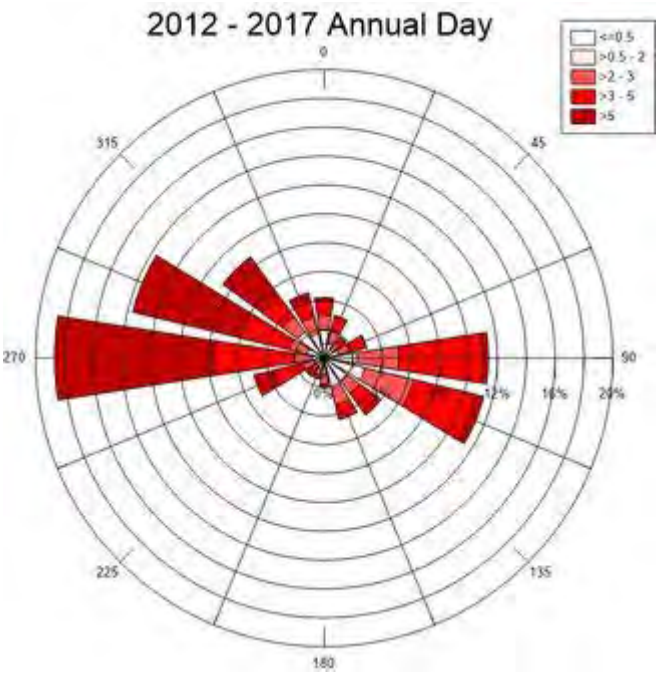

2012 - 2017 Spring Evening
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>0.5 - 2
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>3 - 5
>5
0
45
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270
315

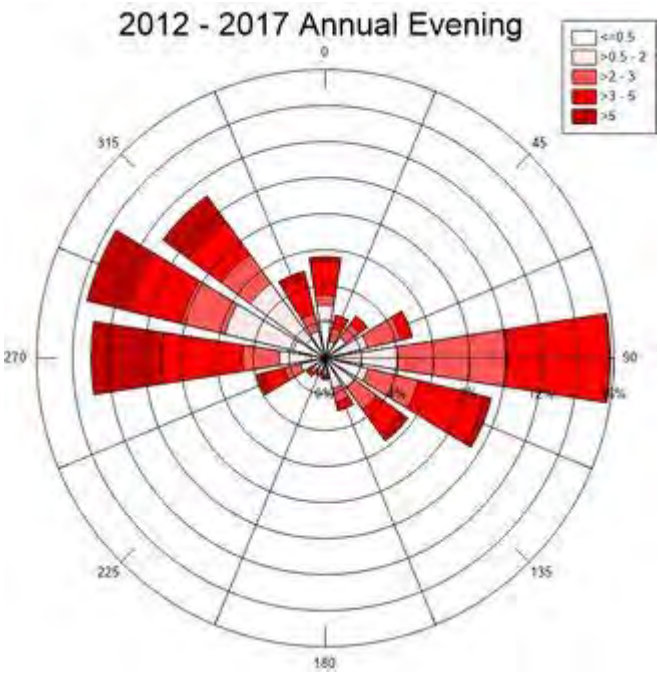

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>3 - 5
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315

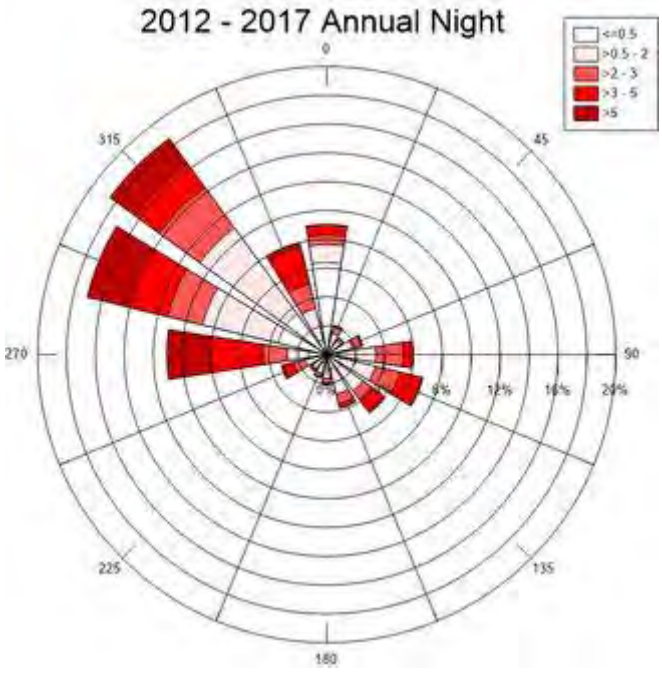

2012 - 2017 Autumn Night
<=0.5
>0.5 - 2
>2 - 3
>3 - 5
>5
0
45
90
135
180
225
270
315


2012 - 2017 Winter Night
<=0.5
>0.5 - 2
>2 - 3
>3 - 5
>5
0
45
90
135
180
225
270
315


2012 - 2017 Spring Night
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>0.5 - 2
>2 - 3
>3 - 5
>5
0
45
90
135
180
225
270
315

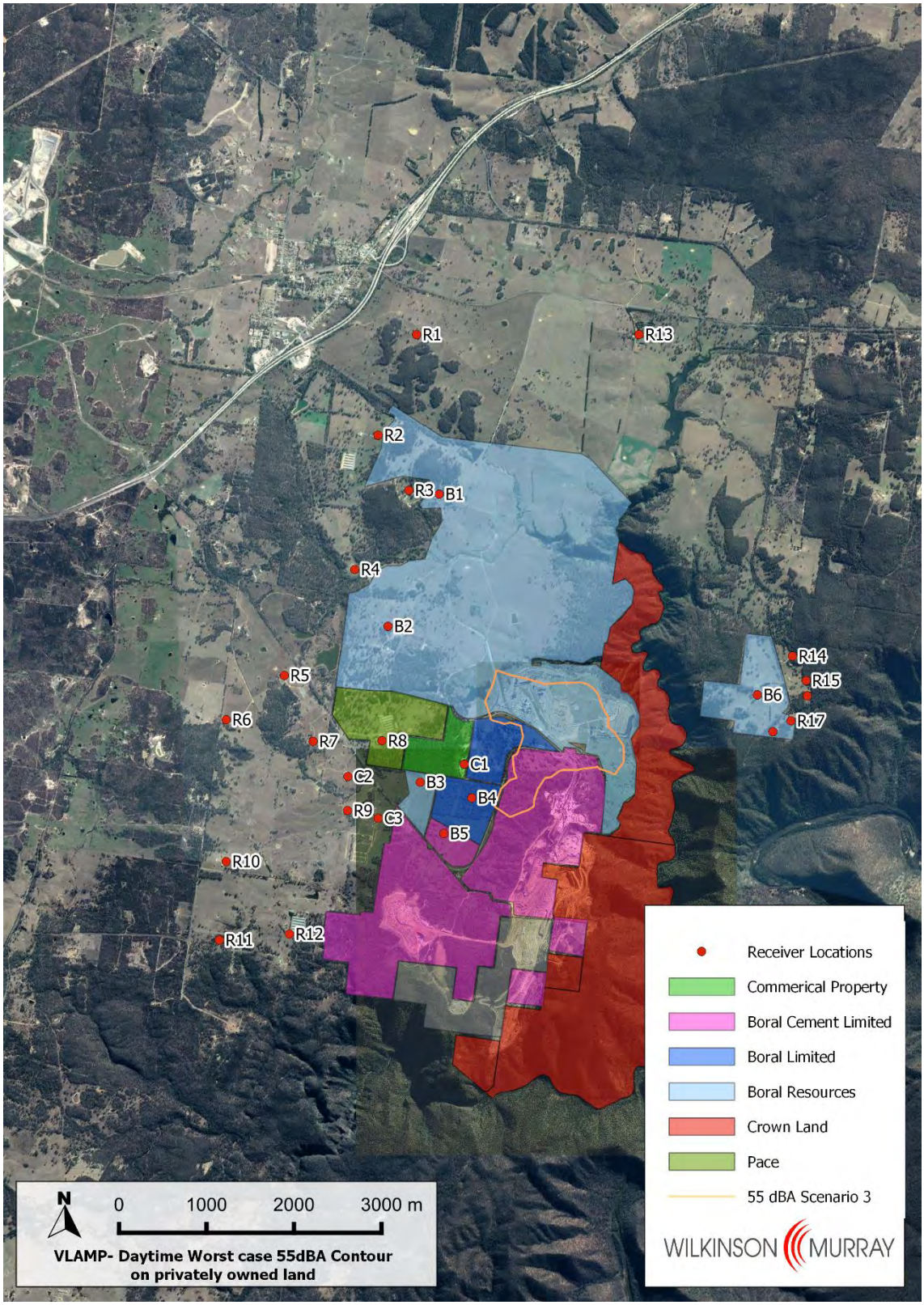

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>0.5 - 2
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>3 - 5
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0
45
90
135
180
225
270
315
8%
12%
16%
20%

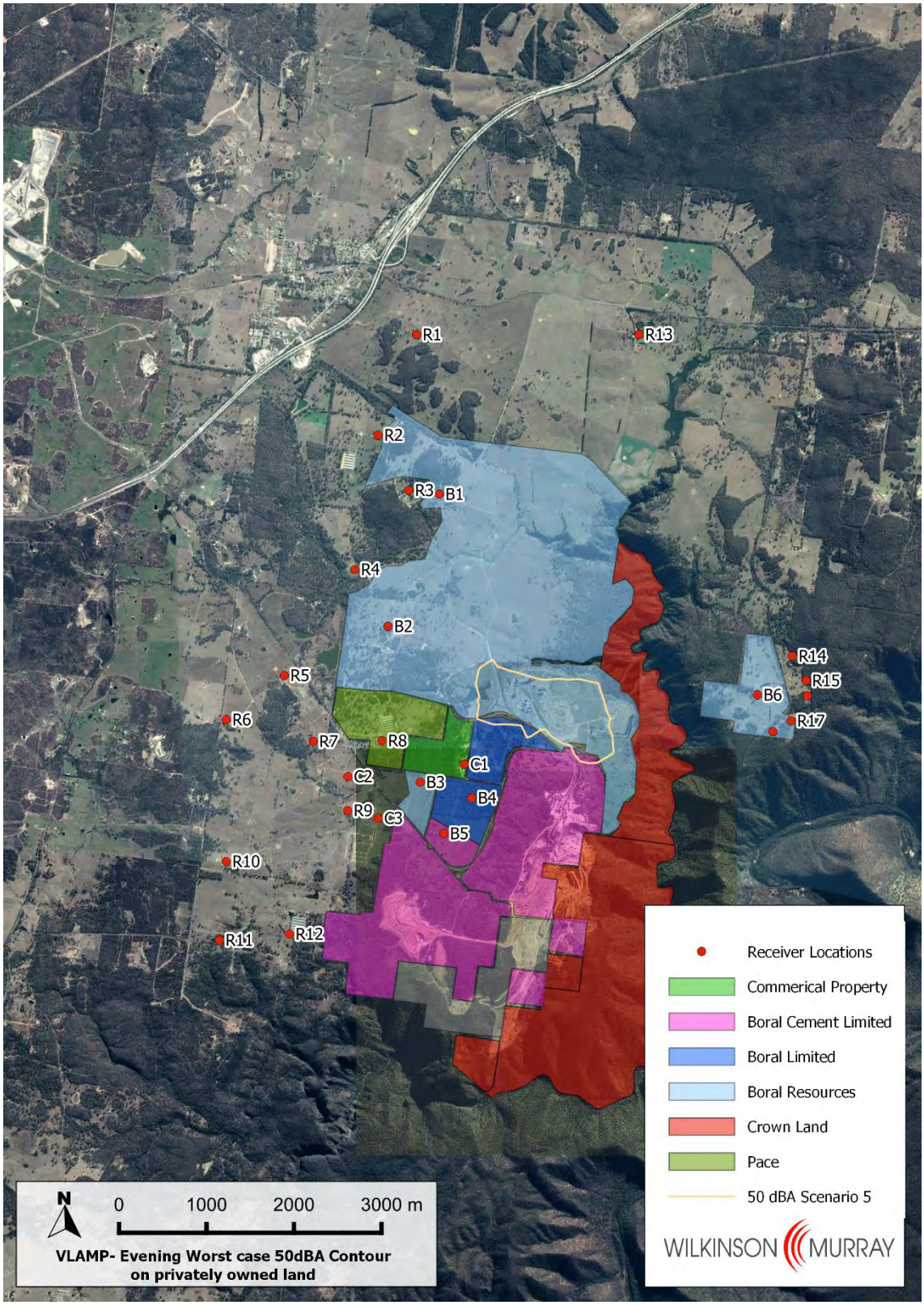

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>3 - 5
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225
270
315

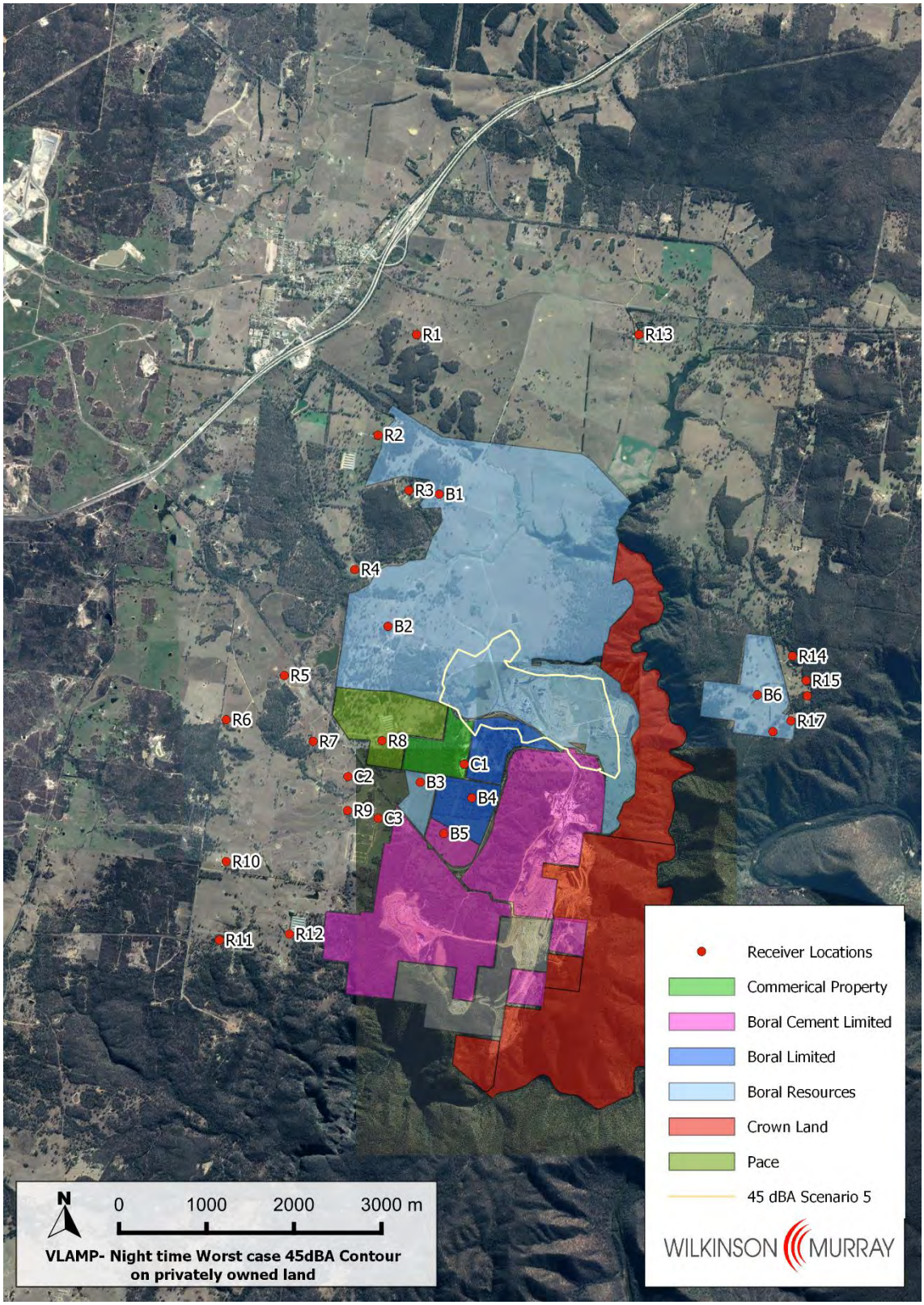

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>0.5 - 2
>2 - 3
>3 - 5
>5
0
45
90
135
180
225
270
315
8%
12%
16%
20%

APPENDIX D

VLAMP Assessment


R1
R13
R2
R3
B1
R4
B2
R14
R15
B6
R17
R5
R6
R7
R8
C1
C2
B3
B4
R9
C3
B5
R10
R11
R12
N
0
1000
2000
3000 m
VLAMP- Daytime Worst case 55dBA Contour
on privately owned land
Receiver Locations
Commerical Property
Boral Cement Limited
Boral Limited
Boral Resources
Crown Land
Pace
55 dBA Scenario 3
WILKINSON MURRAY


R1
R13
R2
R3
B1
R4
B2
R14
R15
B6
R17
R5
R6
R7
R8
C1
C2
B3
B4
R9
C3
B5
R10
R11
R12
N
0
1000
2000
3000 m
VLAMP- Evening Worst case 50dBA Contour
on privately owned land
Receiver Locations
Commerical Property
Boral Cement Limited
Boral Limited
Boral Resources
Crown Land
Pace
50 dBA Scenario 5
WILKINSON MURRAY


R1
R13
R2
R3
B1
R4
B2
R14
R15
B6
R17
R5
R6
R7
R8
C1
C2
B3
B4
R9
C3
B5
R10
R11
R12
N
0
1000
2000
3000 m
VLAMP- Night time Worst case 45dBA Contour
on privately owned land
Receiver Locations
Commerical Property
Boral Cement Limited
Boral Limited
Boral Resources
Crown Land
Pace
45 dBA Scenario 5
WILKINSON MURRAY

APPENDIX C

Air Quality Impact Assessment Report

AIR QUALITY IMPACT ASSESSMENT

PEPPERTREE QUARRY

MODIFICATION 5

Element Environment on behalf of
Boral Resources (NSW) Pty Ltd

28 August 2018

Job Number 15040430A

Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
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Air Quality Impact Assessment
Peppertree Quarry Modification 5

DOCUMENT CONTROL

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DRAFT - 002	09/04/2018	P Henschke	
FINAL - 001	21/08/2018	P Henschke	A Todoroski
FINAL - 002	28/08/2018	P Henschke	

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1 INTRODUCTION

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-West Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and,
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Approval. The Minister for Planning is the consent authority for the proposed modification.

The purpose of this report by Todoroski Air Sciences is to present an assessment of the potential air quality impacts associated with the Project. To assess potential air quality impacts associated with the Project, this report incorporates the following aspects:

- A background to the Quarry and description of the Project;
- A review of the existing meteorological and air quality environment surrounding the site;
- A description of the dispersion modelling approach used to assess potential air quality impacts; and,
- Presentation of the predicted results and discussion of the potential air quality impacts.

1.2 Existing environment and Quarry operations

1.2.1 Site description

The Quarry is at Marulan South in the Goulburn Mulwaree Local Government Area (LGA) and is approximately 175 kilometres (km) south-west of Sydney (**Figure 1-1**). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Limestone Mine) with the Hume Highway approximately 9 km to the north-west (**Figure 1-2**). Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6 km to the north (**Figure 1-2**).

The Quarry is on approximately 650 hectares (ha) of Boral owned land, which includes the Quarry (occupying approximately 70 ha), additional granodiorite resources to the south and surrounding land (**Figure 1-3** and **Figure 1-4**). The site is zoned RU1 – Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 (**Figure 1-5**). Mining and extractive industries are permissible in this zone with consent.

There is an extensive ground water, surface water and air quality monitoring network around the Quarry and Limestone Mine (**Figure 1-6**)

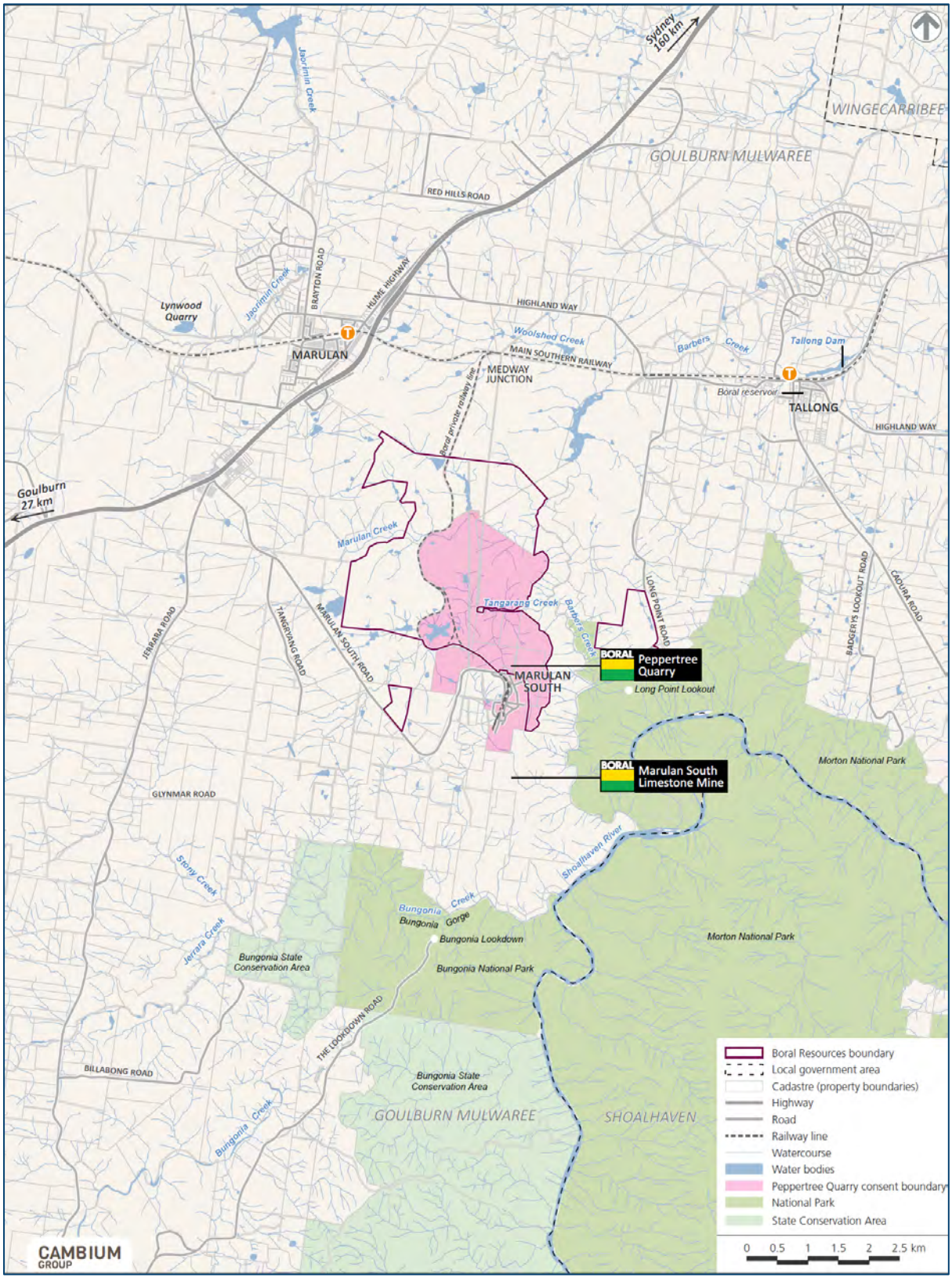


Figure 1-1: Regional context

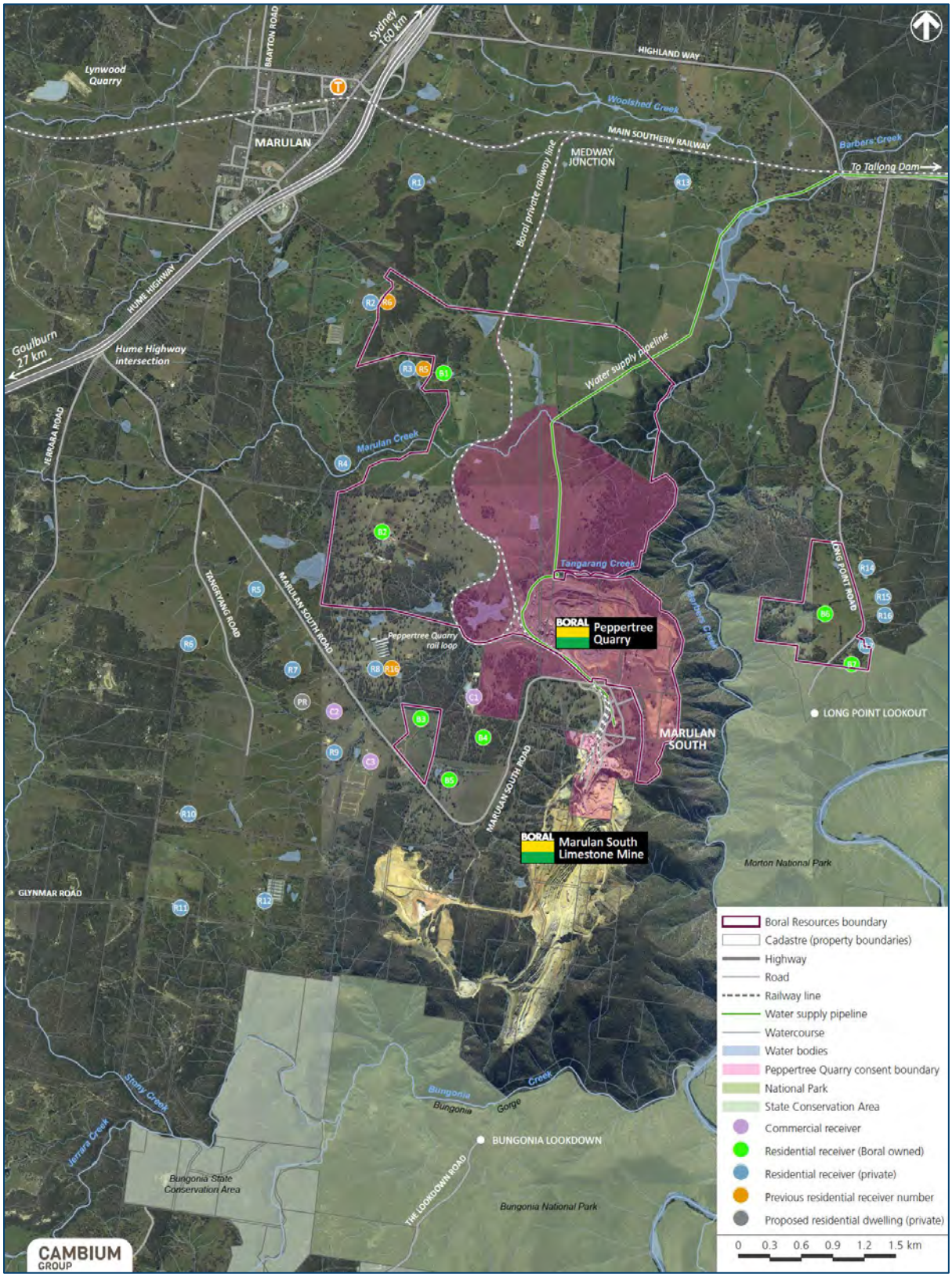


Figure 1-2: Local context

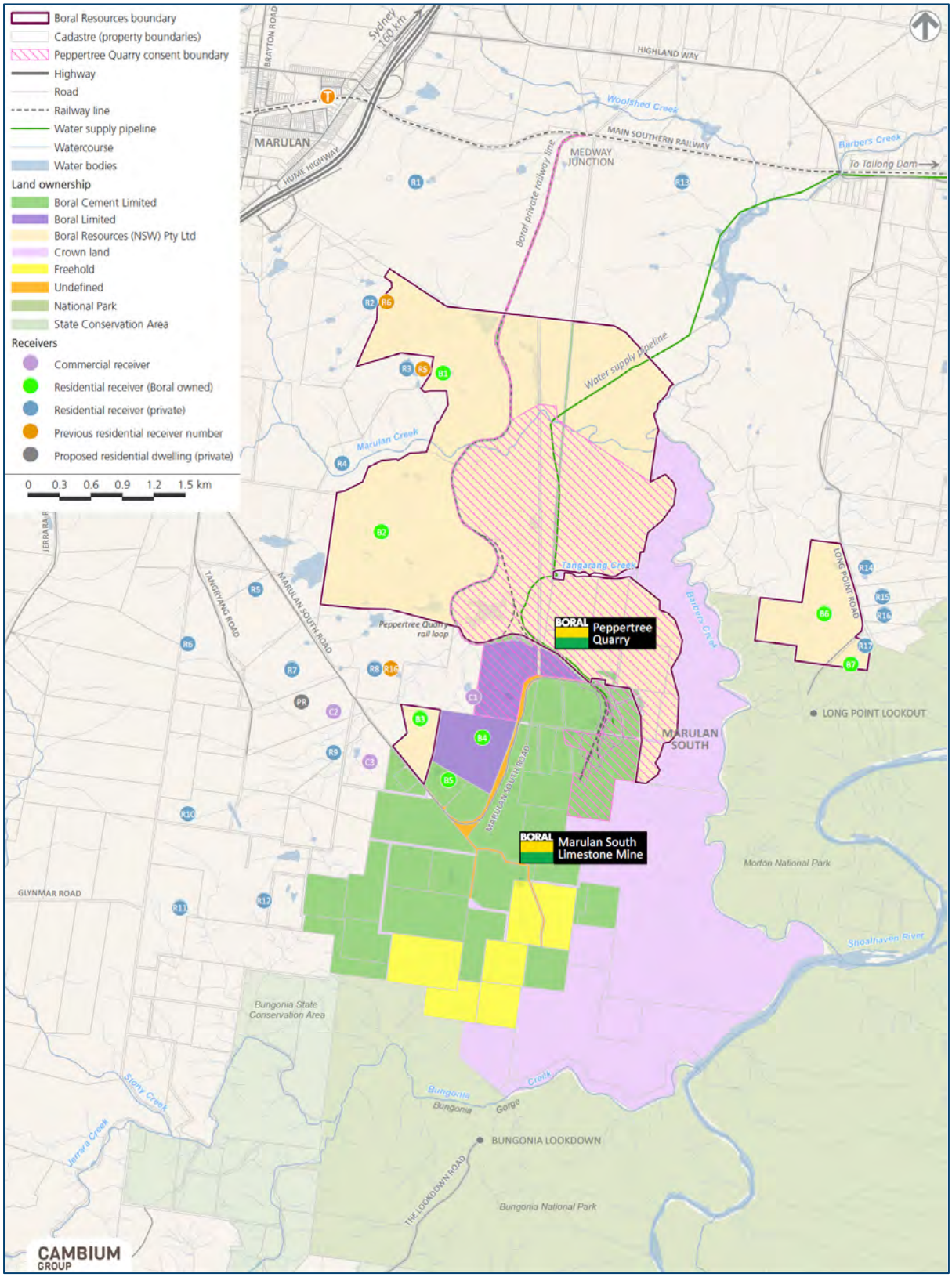


Figure 1-3: Land ownership

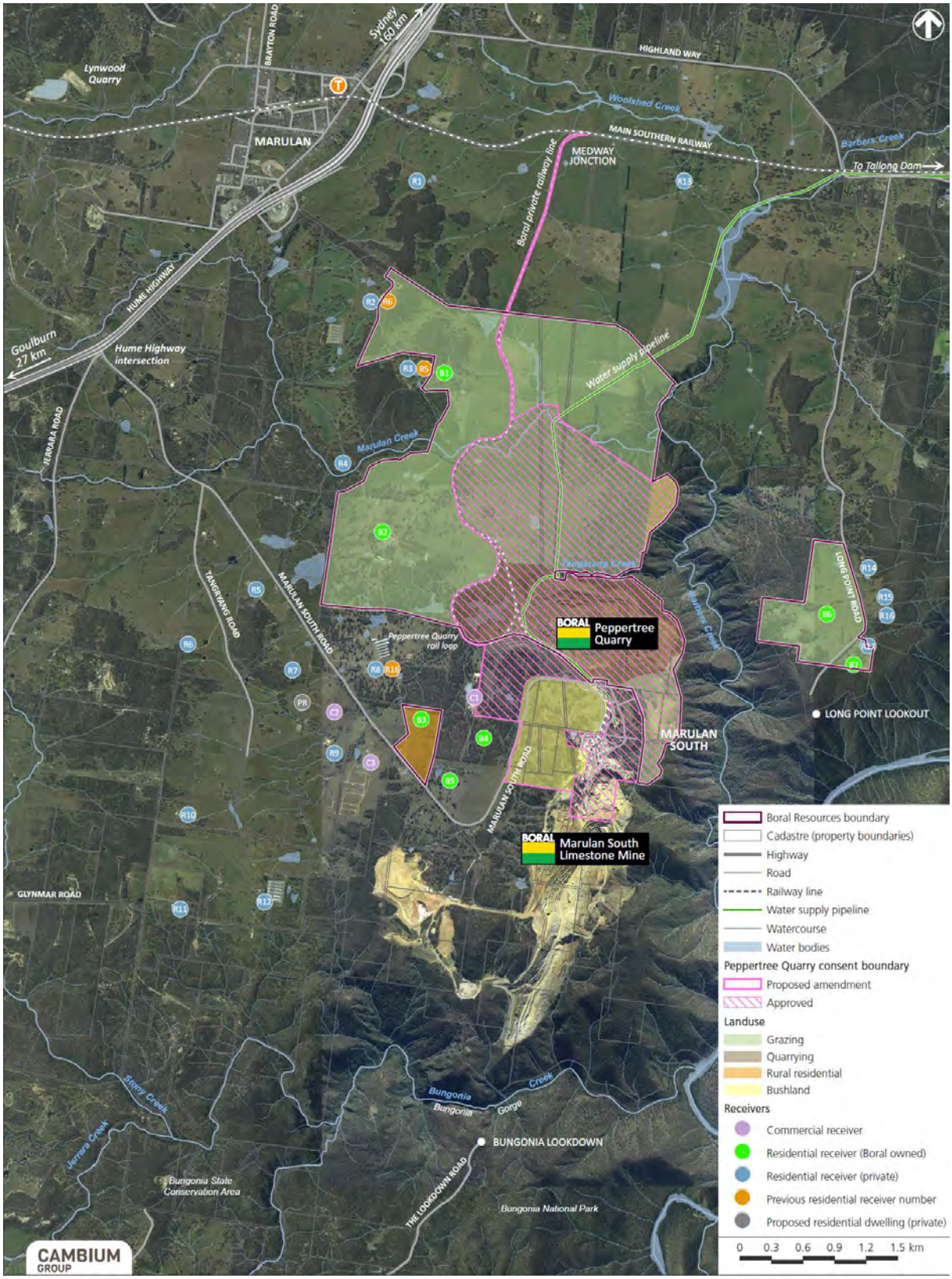


Figure 1-4: Land use

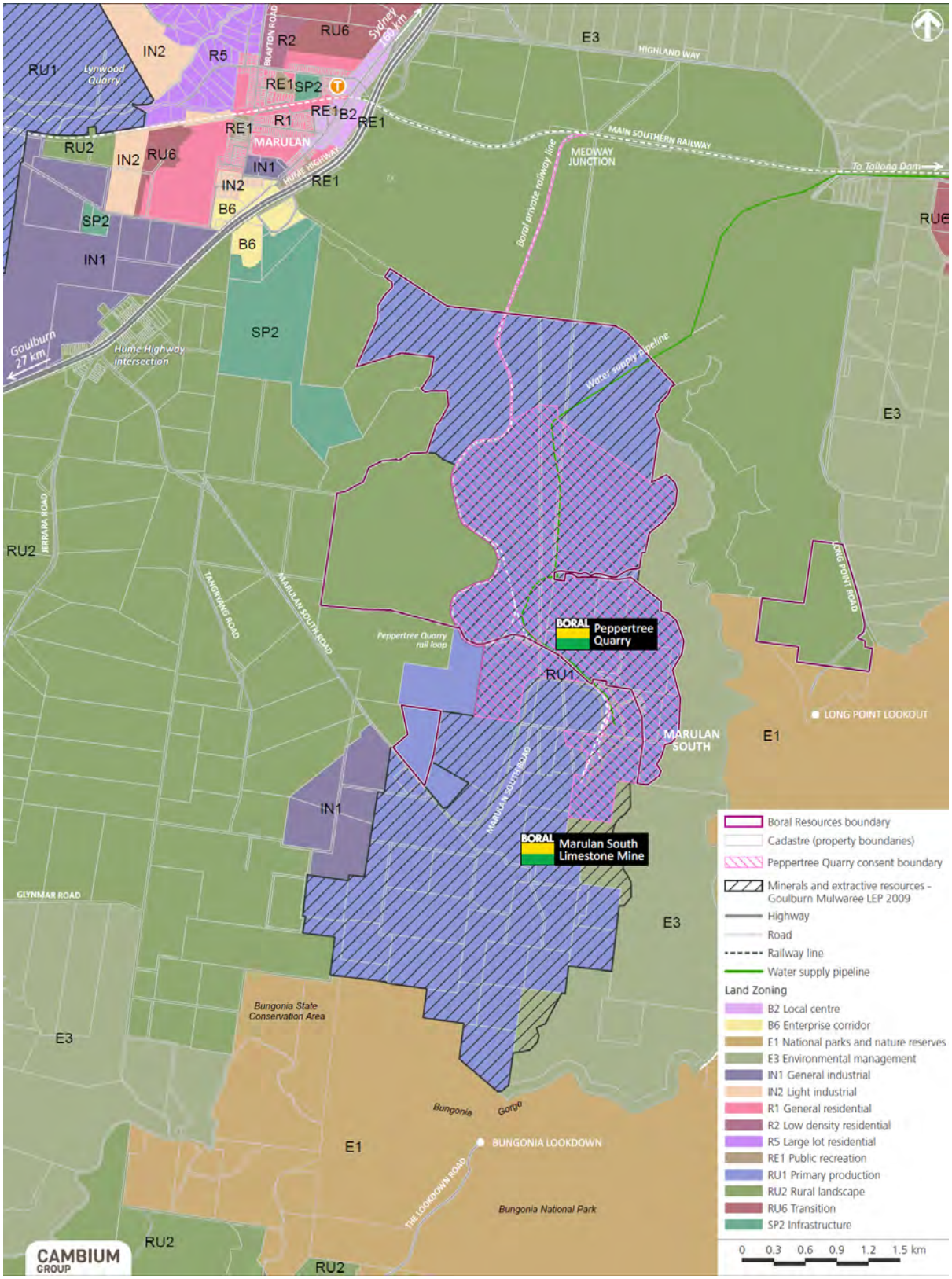


Figure 1-5: Land zoning

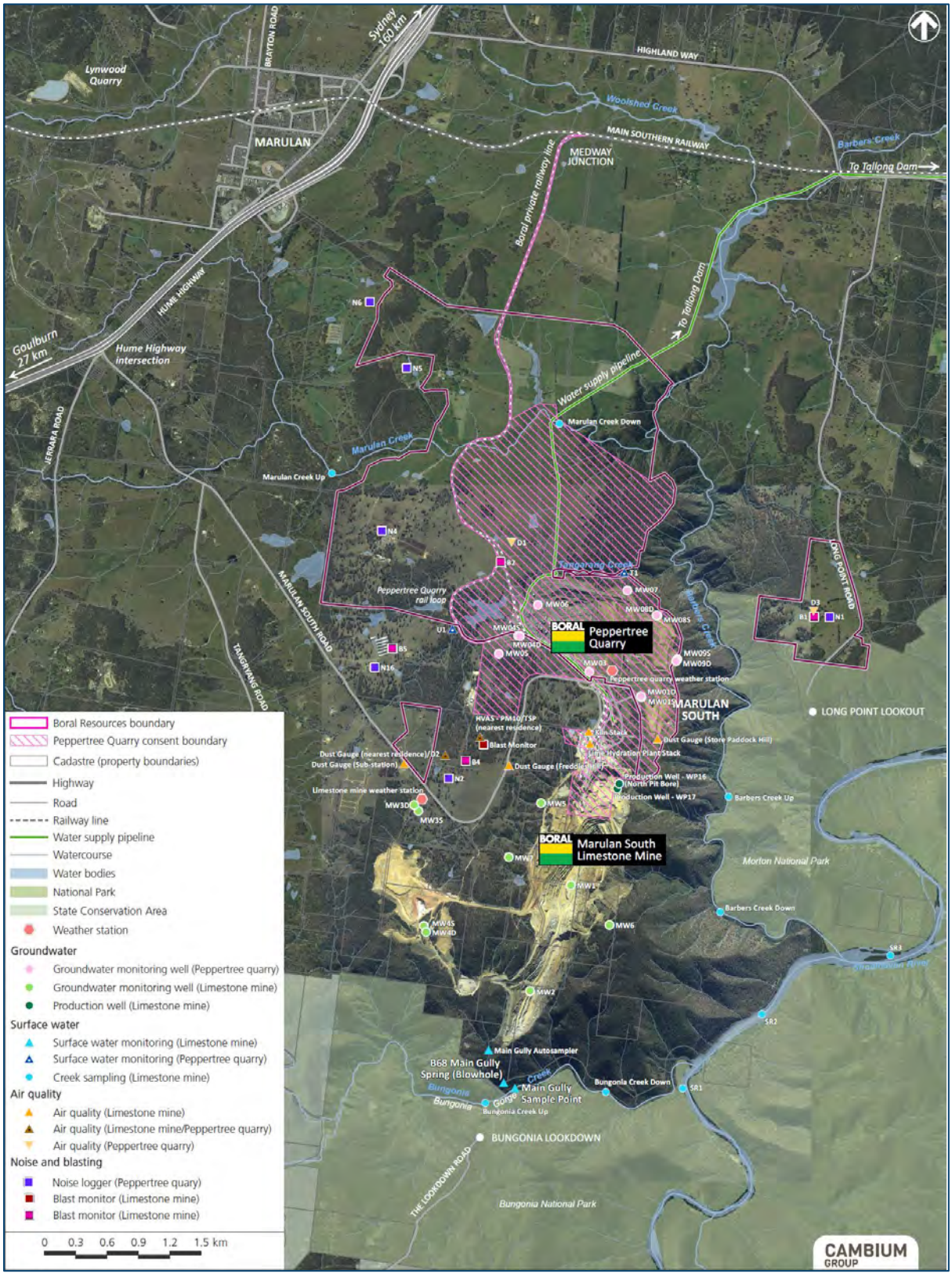


Figure 1-6: Environmental monitoring locations

1.2.2 Approved project

The current operations of the Quarry are approved under Project Approval PA06_0074 as modified.

1.2.2.1 Quarry Activities and Infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities. The location of infrastructure at the Quarry is shown on **Figure 1-7**.

Work to establish the quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E.

1.2.2.2 Operating hours and workforce

The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5 am to 11 pm. Approved operating hours are outlined in detail in **Table 1-1**.

Table 1-1: Approved operating hours

Activity	Day	Time
Construction works	Monday to Friday Saturday Sunday and public holidays	7.00 am to 6.00 pm 8.00 am to 1.00 pm None
Topsoil/overburden removal/emplacement	Any day	7.00 am to 7.00 pm
Blasting	Monday to Saturday Sunday and public holidays	9.00 am to 5.00 pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00 am to 11.00 pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

The Quarry employs 30 full time persons distributed over 2-3 shifts.

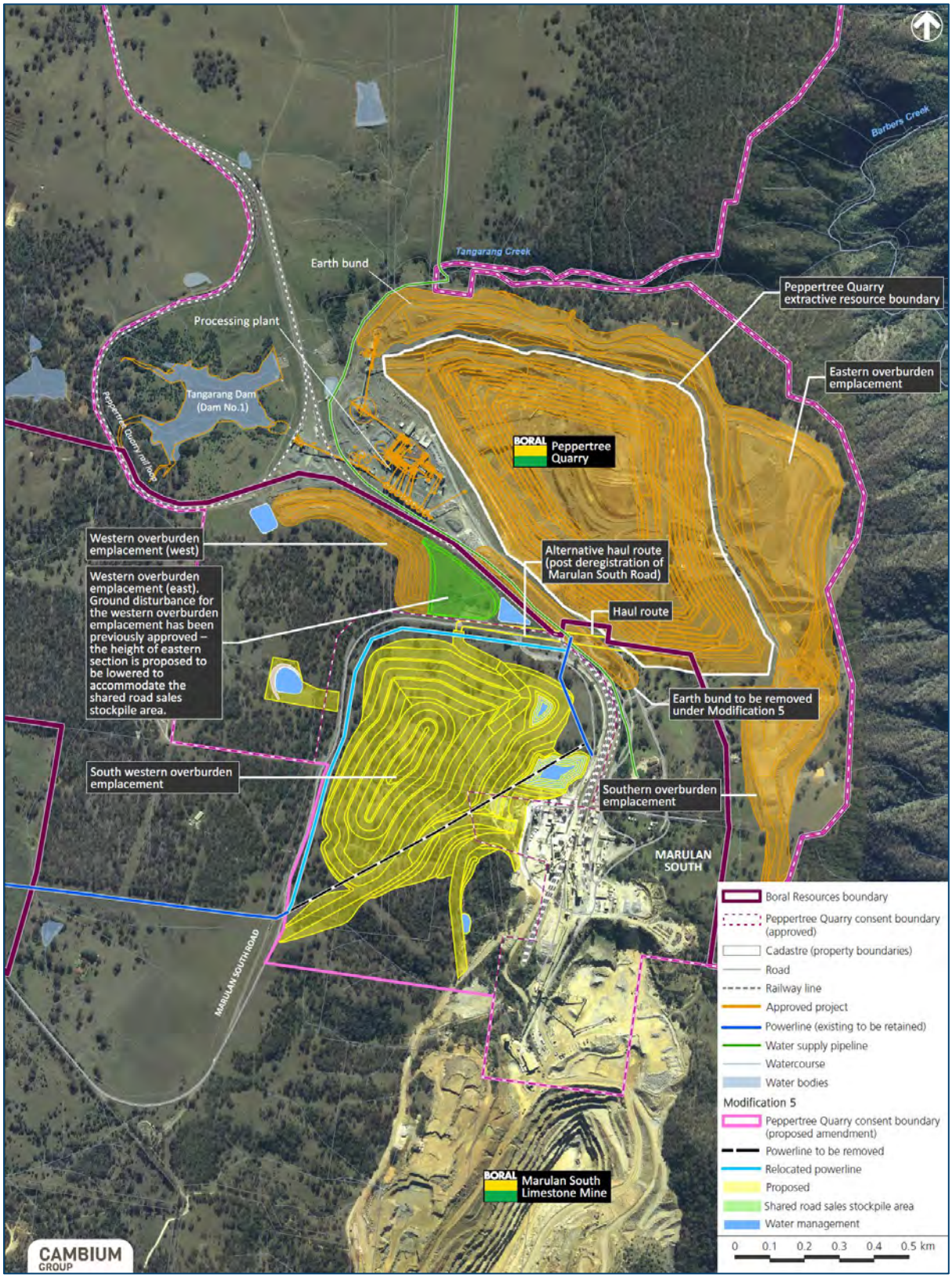


Figure 1-7: The Project

1.3 Proposed modifications

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and will take approximately four years to establish. The emplacement will cover approximately 44 ha and will be RL650 at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

The powerline, which supplies electricity to the Limestone Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Limestone Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 20 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine, and will be a component of the Limestone Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

Two sediment dams will be constructed either end of the WOE to catch and treat dirty water until the batters are rehabilitated. Sediment dam P2 will also catch clean water from upslope of the WOE. Sediment dam P1 will be approximately 2.1 mega litres (ML) in volume and sediment dam P2 will be approximately 5.8 ML in volume.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the project.

The only ground disturbance associated with the modification will be for the SWOE, sediment dams P1 and P2, powerline relocation and new haul road (see **Figure 1-8**).

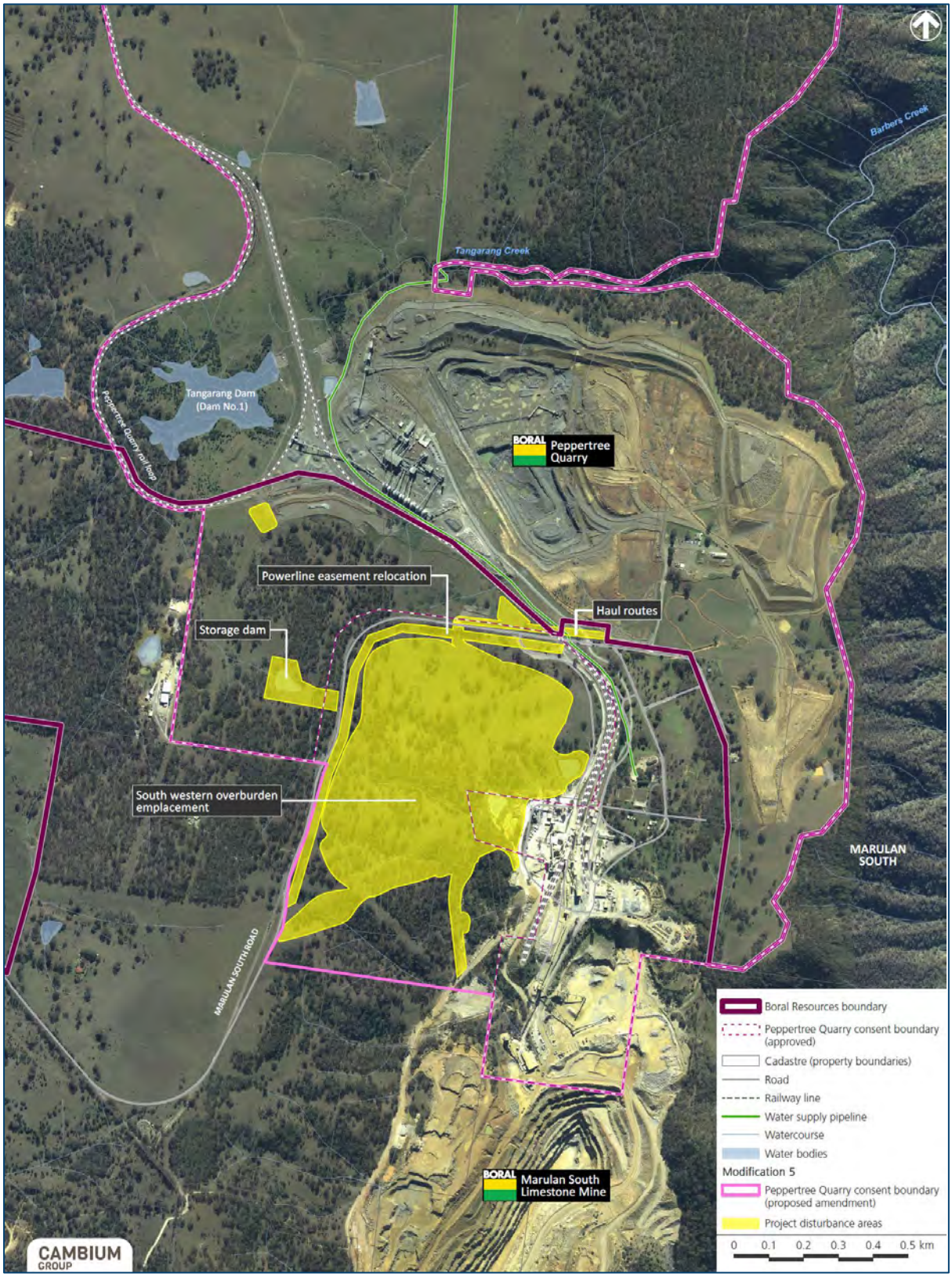


Figure 1-8: Project disturbance areas

2 PROJECT SETTING

Figure 2-1 also presents the location of the Project in relation to sensitive receivers of relevance to this assessment. **Appendix A** provides a detailed list of all the sensitive receivers assessed in this report. The sensitive receivers surrounding the Quarry are identified as privately-owned residences, Boral-owned residences, commercial receivers and a proposed privately-owned residential dwelling.

Figure 2-2 presents a three-dimensional visualisation of the topography in the general vicinity of the Quarry. The area can be characterised as complex to the southeast with the deep gorges and valleys associated with the Bungonia and Morton National Parks. To the west and northwest the terrain is generally more open and gently undulating. The complex local terrain in this area would have a significant effect on the wind patterns and dispersion of dust.

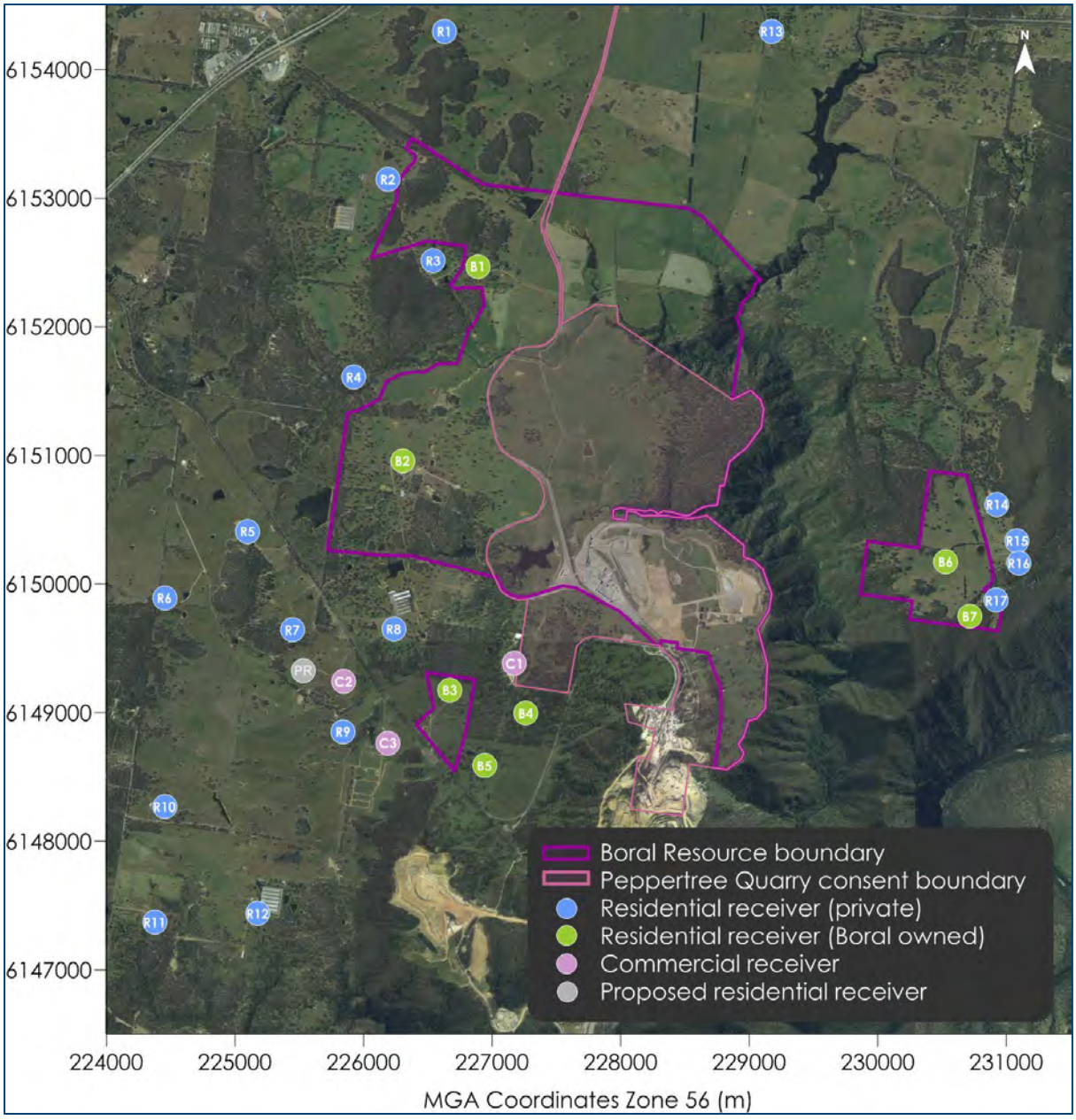


Figure 2-1: Project location

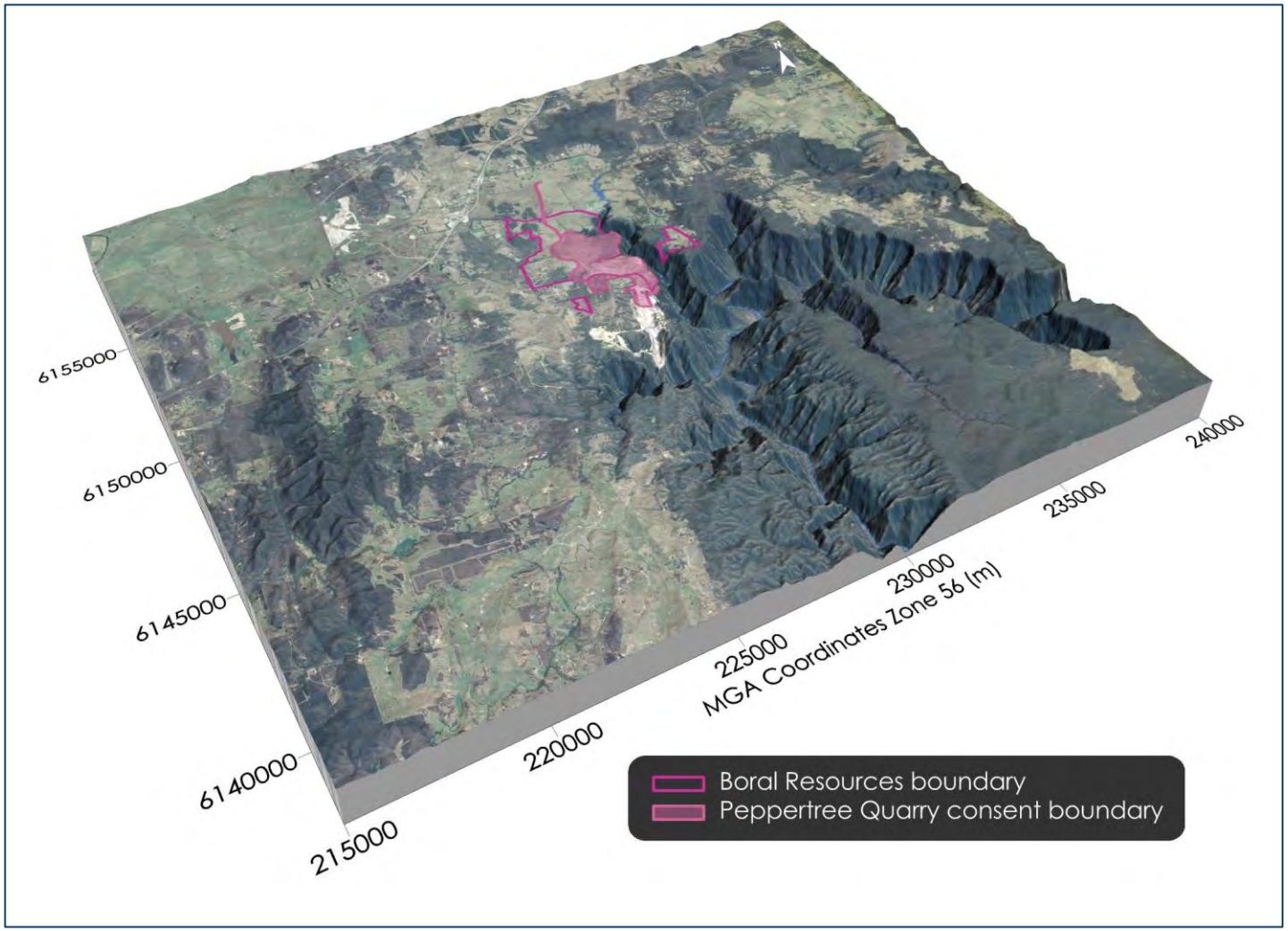


Figure 2-2: Topography surrounding the Quarry location

3 AIR QUALITY ASSESSMENT CRITERIA

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the Project and the applicable air quality criteria.

3.1 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the Project. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
Total suspended particulate (TSP) matter	Annual	Total	90µg/m^3
Particulate matter ≤ 10µm (PM_{10})	Annual	Total	25µg/m^3
	24 hour	Total	50µg/m^3
Particulate matter ≤ 2.5µm ($PM_{2.5}$)	Annual	Total	8µg/m^3
	24 hour	Total	25µg/m^3
Deposited dust	Annual	Incremental	2g/m^2/month
		Total	4g/m^2/month

Source: **NSW EPA (2017)**

µm = micrometre µg/m^3 = micrograms per cubic metre g/m^2/month = grams per square metre per month

3.2 NSW Voluntary Land Acquisition and Mitigation Policy

Part of the NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP) dated 15 December 2014 and gazetted on 19 December 2014 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-2** at any residence or workplace. [1]

Table 3-2: VLAMP Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation Criterion		Impact Type
PM_{10}	Annual	30µg/m^3*		Human health
	24 hour	50µg/m^3**		Human health
TSP	Annual	90µg/m^3*		Amenity
Deposited dust	Annual	2g/m^2/month**	4g/m^2/month*	Amenity

Source: **NSW Government (2014)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria.

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-3** at any residence, workplace or on more than

[1] Where any exceedance would be unreasonably detrimental to workers health or carrying out of the business.

25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 3-3: VLAMP Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition Criterion		Impact Type
PM_{10}	Annual	30µg/m³*		Human health
	24 hour	50µg/m³**		Human health
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: **NSW Government (2014)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.

3.3 Draft NSW VLAMP

To be consistent with the updated NSW EPA policies for air quality impacts, the NSW VLAMP is currently under review with a draft revised document issued in November 2017.

Voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-2** at any residence or workplace.

Table 3-4: Draft VLAMP Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation Criterion		Impact Type
$PM_{2.5}$	Annual	8µg/m³*		Human health
	24 hour	25µg/m³**		Human health
PM_{10}	Annual	25µg/m³*		Human health
	24 hour	50µg/m³**		Human health
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: **NSW Government (2017)**

*Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 3-3** at any residence, workplace or on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 3-5: Draft VLAMP Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition Criterion		Impact Type
$PM_{2.5}$	Annual	8µg/m³*		Human health
	24 hour	25µg/m³**		Human health
PM_{10}	Annual	20µg/m³*		Human health
	24 hour	50µg/m³**		Human health
TSP	Annual	90µg/m³*		Amenity
Deposited dust	Annual	2g/m²/month**	4g/m²/month*	Amenity

Source: **NSW Government (2017)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.

4 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Quarry.

4.1 Local climate

Long term climatic data collected at the Bureau of Meteorology (BoM) weather station at Goulburn Airport Automatic Weather Station (AWS) were analysed to characterise the local climate in the proximity of the Project. The Goulburn Airport AWS is located approximately 25km west-southwest of the Project site and is the nearest BoM weather station with available long-term climate statistics.

Table 5-1 and **Figure 5-1** show climatic parameters that have been collected from the Goulburn Airport AWS over an 18 to 26 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 27.9 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 0.3°C.

Rainfall peaks during the summer and the month of June. The data show June is the wettest month with an average rainfall of 60.9 millimetres (mm) over 7 days and April is the driest month with an average rainfall of 25.6mm over 4 days.

Relative humidity levels exhibit variability and seasonal flux across the year. Mean 9am relative humidity levels range from 65% in October and December to 88% in June. Mean 3pm relative humidity levels vary from 39% in December to 63% in June.

Wind speeds have a generally similar spread between the 9am and 3pm conditions. The mean 9am wind speeds range from 12.2 kilometres per hour (km/h) in March to 19.8km/h in September. The mean 3pm wind speeds vary from 19.8km/h in April to 26.5km/h in August.

Table 4-1: Monthly climate statistics summary – Goulburn Airport AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	27.9	26.4	23.8	19.9	15.9	12.4	11.7	13.4	16.5	19.8	23.0	25.8	19.7
Mean min. temp. (°C)	12.7	12.7	10.1	5.7	2.5	1.3	0.3	0.5	3.1	5.2	8.3	10.7	6.1
Rainfall													
Rainfall (mm)	48.9	52.7	40.0	25.6	32.8	60.9	33.5	39.9	45.8	50.2	54.9	57.2	551.9
No. of rain days	4.7	5.1	5.3	4.0	4.3	7.0	6.2	6.1	6.9	6.1	6.0	5.8	67.5
9am conditions													
Mean temp. (°C)	19.0	17.8	15.1	12.7	8.8	5.9	5.0	6.7	10.8	13.9	15.3	17.7	12.4
Mean R.H. (%)	69	78	81	78	85	88	87	81	72	65	69	65	76
Mean W.S. (km/h)	15.5	13.8	12.2	12.6	12.5	13.3	13.5	17.1	19.8	19.4	17.5	16.8	15.3
3pm conditions													
Mean temp. (°C)	26.1	24.9	22.5	18.9	14.8	11.3	10.5	12.2	15.1	18.2	21.1	24.2	18.3
Mean R.H. (%)	41	45	46	46	54	63	61	52	50	46	45	39	49
Mean W.S. (km/h)	22.2	21.4	20.5	19.8	20.7	22.2	23.2	26.5	26.4	25.3	23.7	23.0	22.9

Source: **Bureau of Meteorology (2017), accessed December 2017**

R.H. = relative humidity W.S. = wind speed

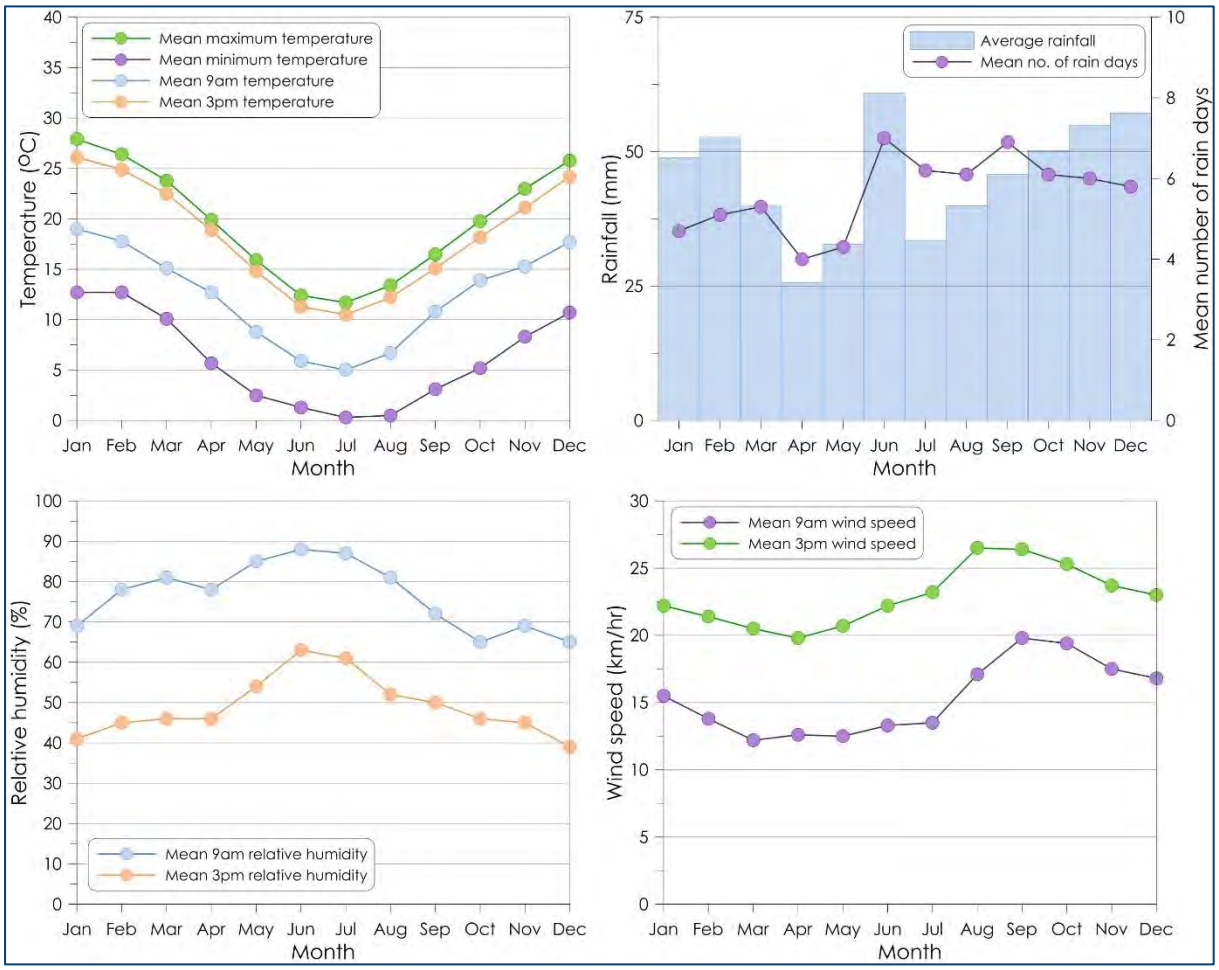


Figure 4-1: Monthly climate statistics summary – Goulburn Airport AWS

4.2 Local meteorological conditions

The Quarry and the neighbouring Limestone Mine both operate 10-metre (m) tall automatic weather stations to assist with the environmental management of site operations. The location of these stations is shown in **Figure 4-2**.

Annual and seasonal windroses prepared from data collected during the 2014 calendar period are presented in **Figure 4-3** and **Figure 4-4** for the Limestone Mine and Quarry weather stations respectively.

The 2014 meteorological year is applied in this assessment for consistency with the recent modelling for the Peppertree Quarry (**Todoroski Air Sciences, 2016**), and thus allows a direct comparison to be made. The year is representative of typical conditions, as outlined in more detail in **Appendix B**.

The annual windroses from both stations indicate that the typical wind flow of the area is on a west to east axis with the strongest winds originating from the west. The Limestone Mine station data show a greater spread of winds ranging from the west-southwest to the north-northwest relative to the Quarry station which only has limited winds from the northeast. This may be due to the different positioning of the stations, with the Limestone Mine weather station situated near a dense line of vegetation to the west of the station, whereas the Quarry site is less obstructed with cleared land to the west.

In summer the winds predominately occur from the east and east-southeast at both stations. The autumn and spring wind distributions share similarities with the annual distributions, with winds typically ranging from the west to the northwest and east. During winter, the Limestone Mine weather station records varied winds from the west and south and south-southeast. In comparison the Quarry weather station shows the dominant winds from the west with fewer winds from the other directions.

Overall, the wind distribution patterns of the stations are generally as expected of the local area considering the siting of the stations in relation to the local features such as terrain and vegetation.

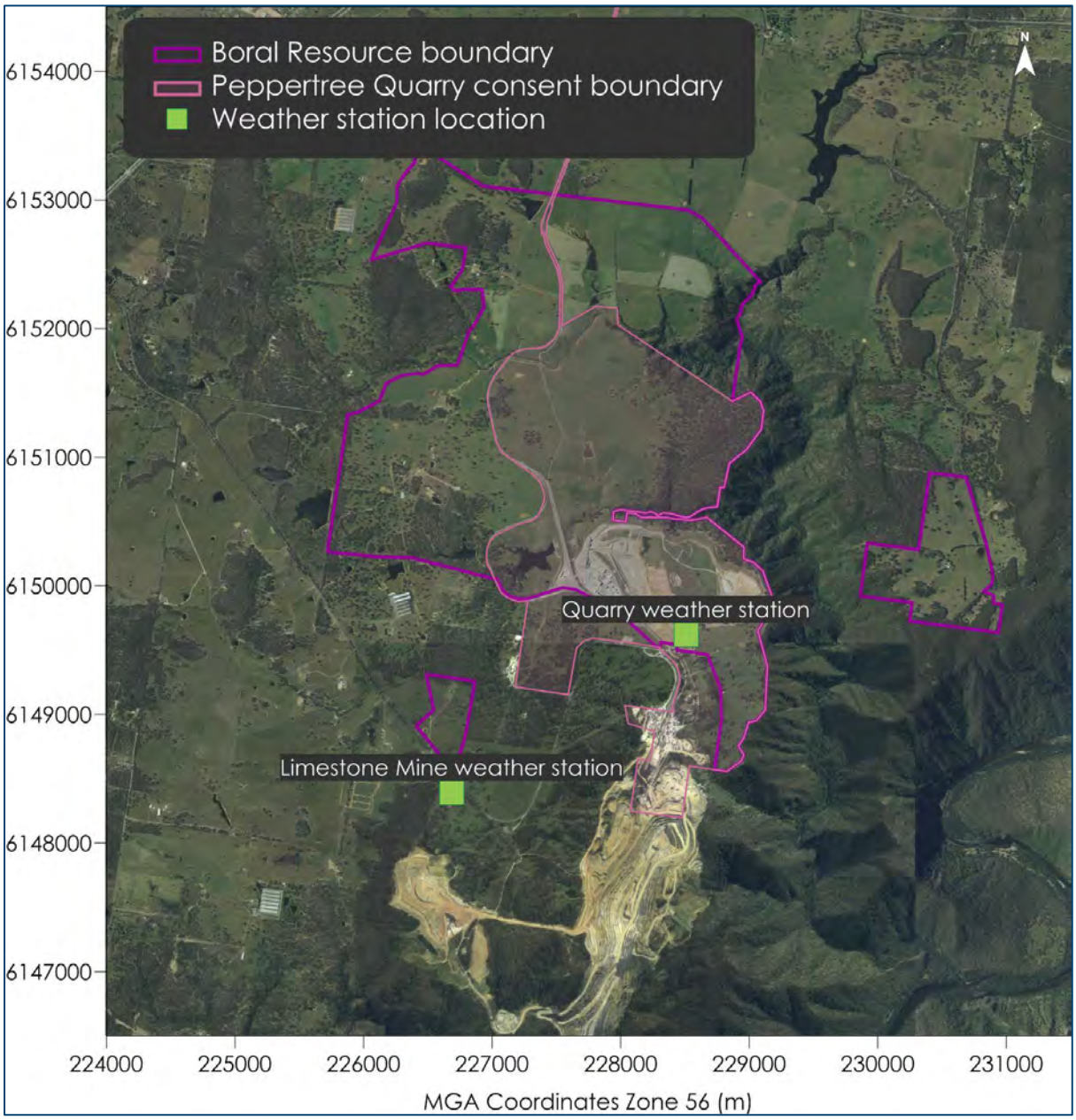


Figure 4-2: Weather station locations

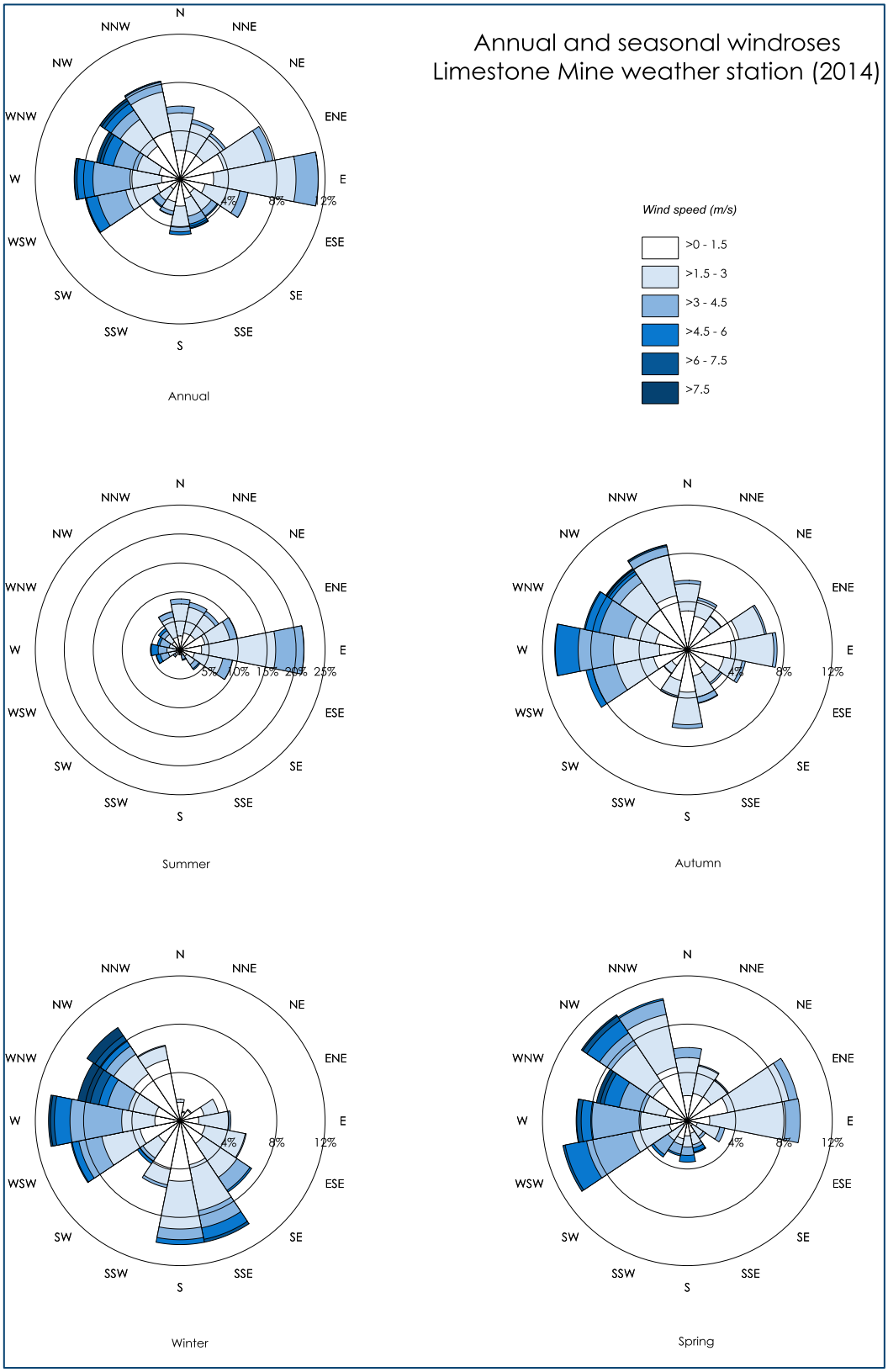


Figure 4-3: Annual and seasonal windroses for the Limestone Mine weather station (2014)

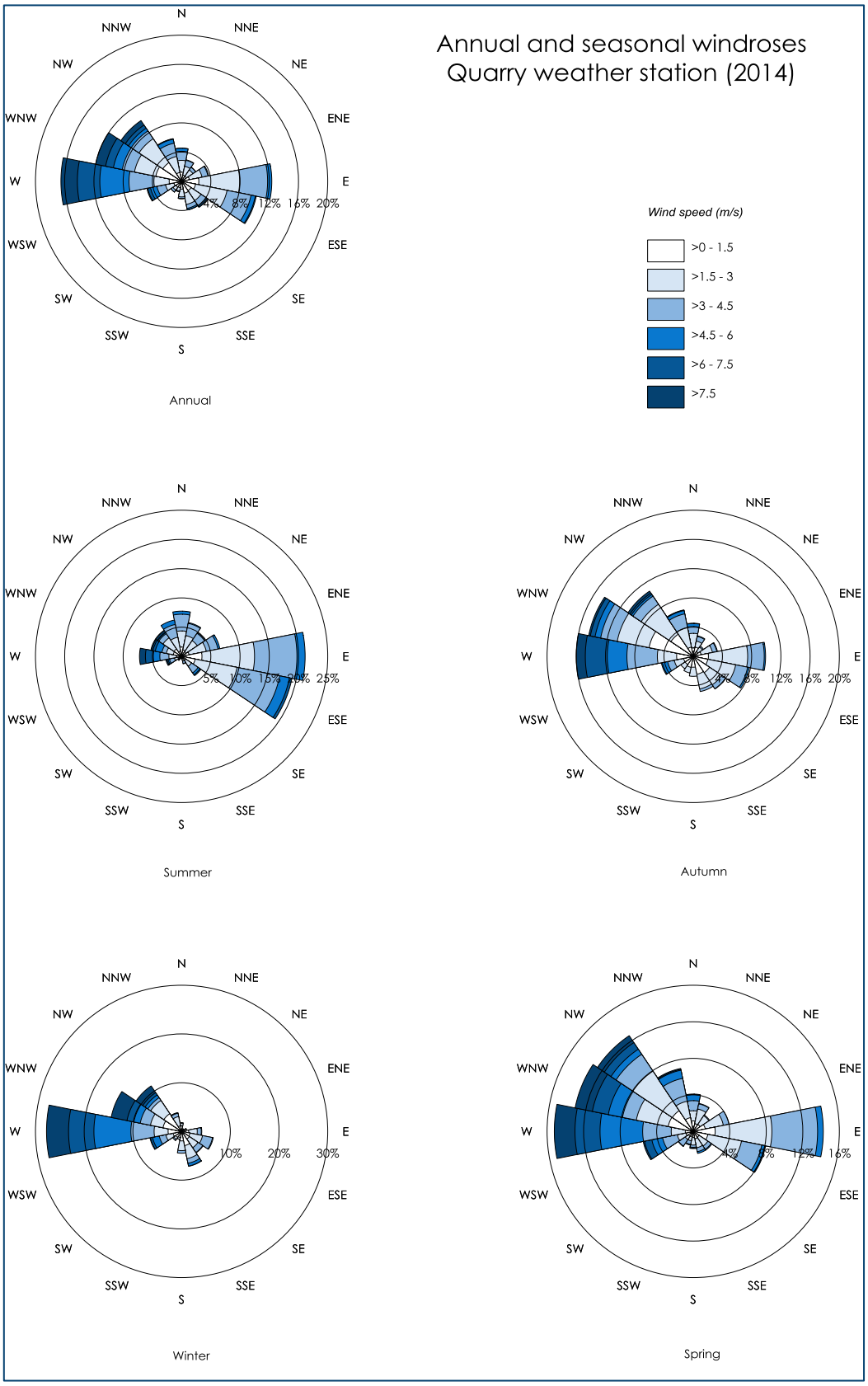


Figure 4-4: Annual and seasonal windroses for the Quarry weather station (2014)

4.3 Local air quality monitoring

The main sources of air emissions in the wider area of the Project include extractive industries, commercial and industrial operations, agricultural activities, emissions from local anthropogenic activities (such as motor vehicle exhaust, dust from dirt roads, and domestic wood heaters) and various other rural activities.

This section reviews the available ambient monitoring data collected as part of the Limestone Mine and Quarry ambient air quality monitoring program between July 2011 and June 2017 to characterise the existing background levels of the surrounding area.

In addition to these data, the results from air quality monitors operated by the Lynwood Quarry located approximately 10km north-west of the Project and the NSW Office of Environment and Heritage (OEH) monitors at Wollongong and Bargo located approximately 73km north-east and 87km east-northeast of the Project respectively, have also been reviewed.

4.3.1 Air quality monitoring network description

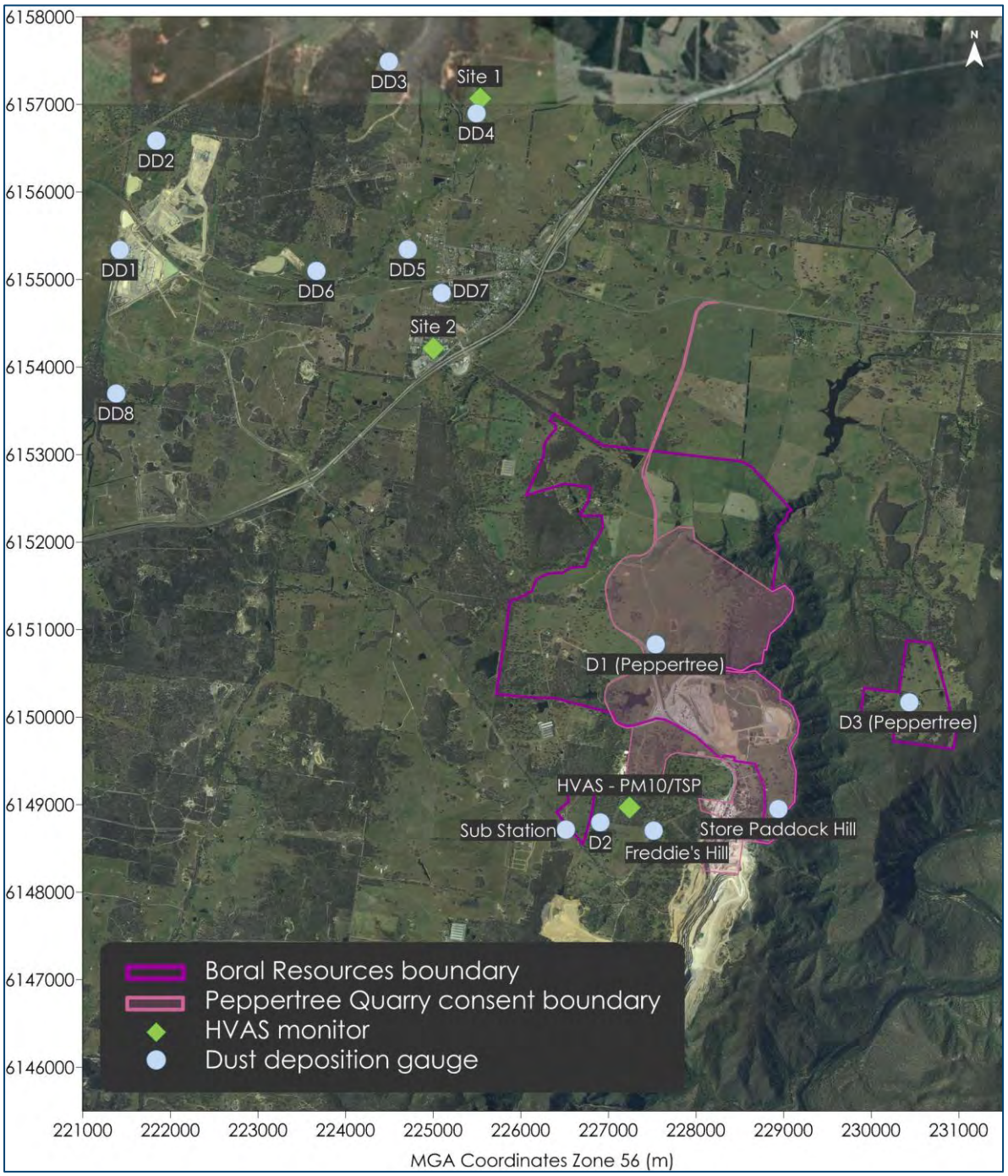
The air quality monitors operated as part of the Limestone Mine and the Quarry air quality monitoring network include two High Volume Air Samplers (HVAS) measuring either TSP or PM_{10} and six dust deposition gauges.

The Lynwood Quarry operates two HVAS stations measuring PM_{10} and eight dust deposition gauges. The NSW OEH monitors ambient levels of PM_{10} and $PM_{2.5}$ at Wollongong and Bargo.

Table 4-2 lists the monitoring stations reviewed in this section and **Figure 4-5** presents the approximate locations of these monitors.

Table 4-2: Summary of ambient monitoring stations

Monitoring site ID	Type
HVAS – PM_{10} (Marulan/Peppertree)	HVAS - PM_{10}
HVAS - TSP (Marulan/Peppertree)	HVAS - TSP
Sub Station (Marulan)	Dust Gauge
D2 (Marulan/Peppertree)	Dust Gauge
Freddie's Hill (Marulan)	Dust Gauge
Store Paddock (Marulan)	Dust Gauge
D1 (Peppertree)	Dust Gauge
D3 (Peppertree)	Dust Gauge
Site 1 (Lynwood)	HVAS - PM_{10}
Site 2 (Lynwood)	HVAS - PM_{10}
DD1 (Lynwood)	Dust Gauge
DD2 (Lynwood)	Dust Gauge
DD3 (Lynwood)	Dust Gauge
DD4 (Lynwood)	Dust Gauge
DD5 (Lynwood)	Dust Gauge
DD6 (Lynwood)	Dust Gauge
DD7 (Lynwood)	Dust Gauge
DD8 (Lynwood)	Dust Gauge
Wollongong (NSW OEH)	PM_{10}, & $PM_{2.5}$
Bargo (NSW OEH)	PM_{10}, & $PM_{2.5}$



Note: Wollongong and Bargo (NSW OEH) monitors not shown

Figure 4-5: Monitoring locations

4.3.2 PM_{10} monitoring

A summary of the results from the HVAS monitoring stations during 2011 to 2017 is presented in **Table 4-3** and **Figure 4-6**. The monitoring results in **Table 4-3** indicate that annual average PM_{10} levels at these monitors are below the NSW EPA impact assessment criterion of 25µg/m^3 at all sites, the maximum 24-hour average PM_{10} concentrations were on occasion above the criterion of 50µg/m^3 during the monitoring period at the Quarry HVAS monitor.

The monitoring data indicate that levels are typically higher at the Quarry HVAS monitor compared to the Lynwood monitors. This may be due to the location of the Quarry HVAS monitor close to the mining activities and near to a neighbouring lime processing facility which would influence the results. Due to its location, the monitor presents a conservative estimate of the actual conditions at the surrounding receiver locations.

It is noted that the Site 2 – Lynwood monitor was subject to some technical difficulties and as a result recorded low levels (i.e. annual average levels less than 10µg/m^3) (**Holcim, 2017**).

It can be seen from **Figure 4-6** that PM_{10} concentrations recorded at the monitoring stations follow a seasonal trend and are nominally highest in the spring and summer months with the warmer weather raising the potential for drier ground elevating the occurrence of windblown dust, bushfires and pollen levels.

Table 4-3: PM_{10} levels from HVAS monitoring (µg/m^3)

Year	HVAS – Quarry[2]	Site 1 - Lynwood[2]	Site 2 - Lynwood	Criterion
	Annual average			
2011[1]	-	-	-	25
2012	15.9	8.0	3.9	25
2013	13.8	10.0	-	25
2014	17.9	7.9	-	25
2015	23.7	12.1	-	25
2016	16.8	9.4	9.2	25
2017	-	-	-	25
	Maximum 24-hour average			
2011[1]	37.5	20.5	8.7	50
2012	**70.4**	38.1	11.8	50
2013	42.2	36.7	11.3	50
2014	**50.5**	20.6	18.2	50
2015	**158.3**	31.9	43.4	50
2016	**58.2**	23.2	21.9	50
2017	**64.7**	39.5	36.7	50
	Number of days >50µg/m^3			
2011[1]	0	0	0	-
2012	3	0	0	-
2013	0	0	0	-
2014	1	0	0	-
2015	5	0	0	-
2016	2	0	0	-
2017	4	0	0	-

[1]Data available from July 2011

[2]Data available till June 2017

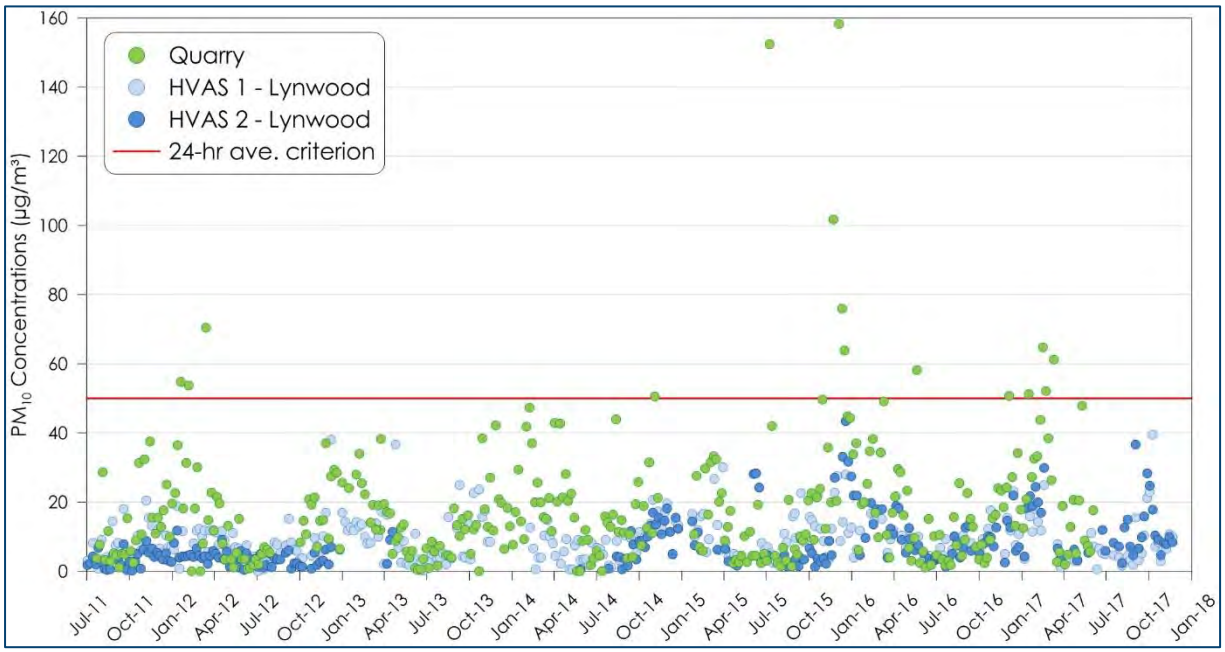


Figure 4-6: HVAS 24-hour average PM_{10} concentrations

A summary of the available PM_{10} data from January 2011 to December 2017 at the NSW OEH Wollongong and Bargo monitoring stations is presented in **Table 4-4**. Measured 24-hour average concentrations are presented graphically in **Figure 4-8**.

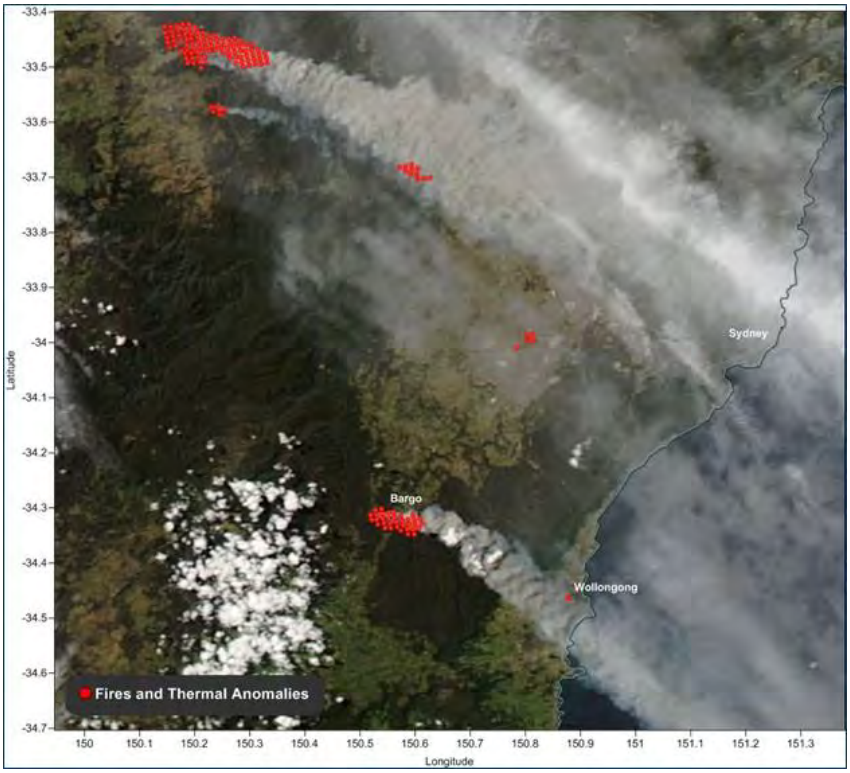
A review of the data in **Table 4-4** indicates that the annual average PM_{10} concentrations recorded at the Wollongong and Bargo monitoring stations were below the relevant criterion of 25µg/m³ for all years reviewed.

The recorded maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m³ at times during the review period. Most notable is the recorded maximum 24-hour average at the Bargo monitoring station on 17 October 2013 with a level of 208.9µg/m³. A large-scale bushfire was the likely main contributor to this reading.

Figure 4-7 presents satellite imagery which indicates the fire event and large smoke plumes affecting the area. The Wollongong monitor was also affected by this bushfire event which lasted for several days.

Table 4-4: Summary of PM_{10} levels from NSW OEH Wollongong and Bargo monitors (µg/m³)

Year	Wollongong	Bargo	Criterion
	Annual average		
2011	17.0	12.9	25
2012	18.0	14.3	25
2013	17.6	15.3	25
2014	17.7	14.5	25
2015	16.9	13.4	25
2016	17.3	14.4	25
2017	18.1	14.1	25
	Maximum 24-hour average		
2011	48.5	**89.7**	50
2012	47.5	45.2	50
2013	**93.8**	**208.9**	50
2014	45.3	**50.8**	50
2015	45.8	**52.2**	50
2016	**52.9**	**58.4**	50
2017	**55.2**	**53.5**	50
	Number of days >50µg/m³		
2011	0	1	-
2012	0	0	-
2013	6	2	-
2014	0	1	-
2015	0	2	-
2016	2	3	-
2017	1	1	-



Source: **NASA, 2015**

Figure 4-7: Satellite imagery of bushfires on 17 October 2013

Figure 4-8 shows a similar seasonal variation to the HVAS monitors, with higher levels during the warmer months recorded at the Wollongong and Bargo monitors.

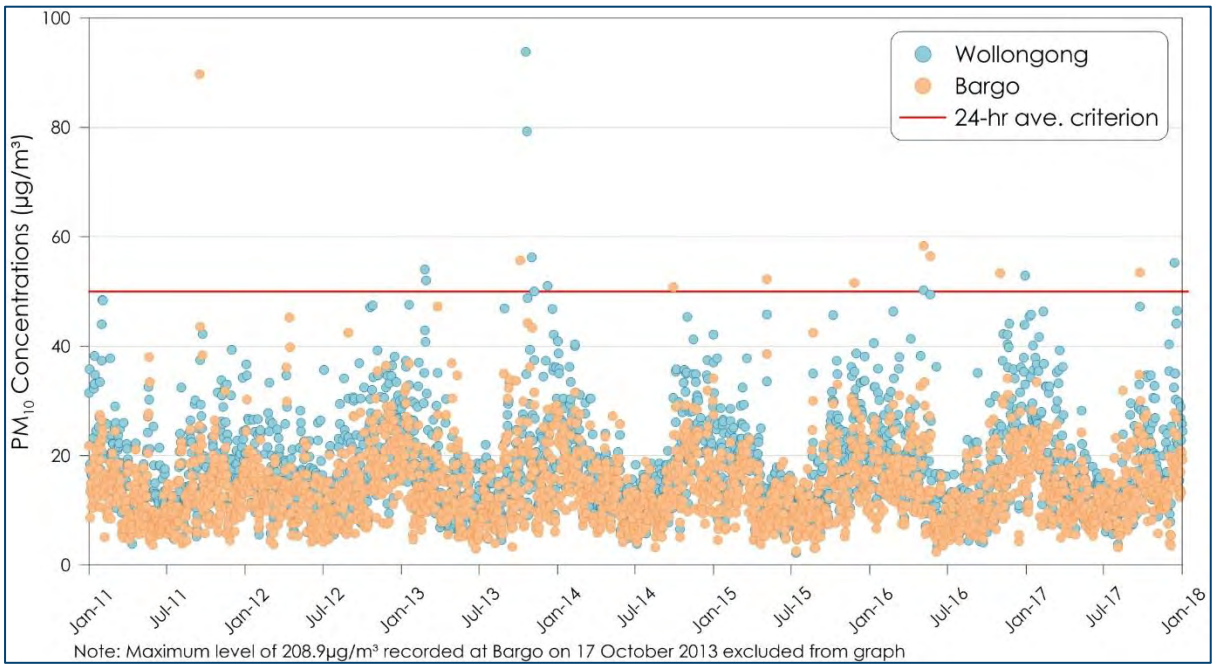


Figure 4-8: 24-hour average PM_{10} levels at Wollongong and Bargo

4.3.3 $PM_{2.5}$ monitoring

A summary of the available data from January 2011 to December 2017 at the NSW OEH Wollongong and Bargo monitoring stations is presented in **Table 4-5**. Measured 24-hour average concentrations are presented graphically in **Figure 4-9**.

A review of the data in **Table 4-5** indicates that the annual average $PM_{2.5}$ concentrations recorded at the Wollongong and Bargo monitoring stations were below the relevant criterion of 8µg/m^3 for all years reviewed.

The recorded maximum 24-hour average $PM_{2.5}$ concentrations were found to exceed the relevant criterion of 25µg/m^3 at times during the review period. Most notable is the recorded maximum 24-hour average at the Wollongong monitoring on 19 October 2013 with a level of 88.4µg/m^3, which is likely associated with a large-scale bushfire.

Table 4-5: Summary of $PM_{2.5}$ levels from NSW OEH Wollongong and Bargo monitors (µg/m³)

Year	Wollongong	Bargo	Criterion
	Annual average		
2011	4.6	-	8
2012	4.6	-	8
2013	7.7	-	8
2014	7.0	-	8
2015	7.6	-	8
2016	7.4	-	8
2017	7.1	6.3	8
	Maximum 24-hour average		
2011	17.7	-	25
2012	15.6	-	25
2013	**88.4**	-	25
2014	17.3	-	25
2015	**31.6**	-	25
2016	**33.7**	11.5	25
2017	24.7	20.9	25
	Number of days >25µg/m³		
2011	0	-	-
2012	0	-	-
2013	2	-	-
2014	0	-	-
2015	0	-	-
2016	0	0	-
2017	0	0	-

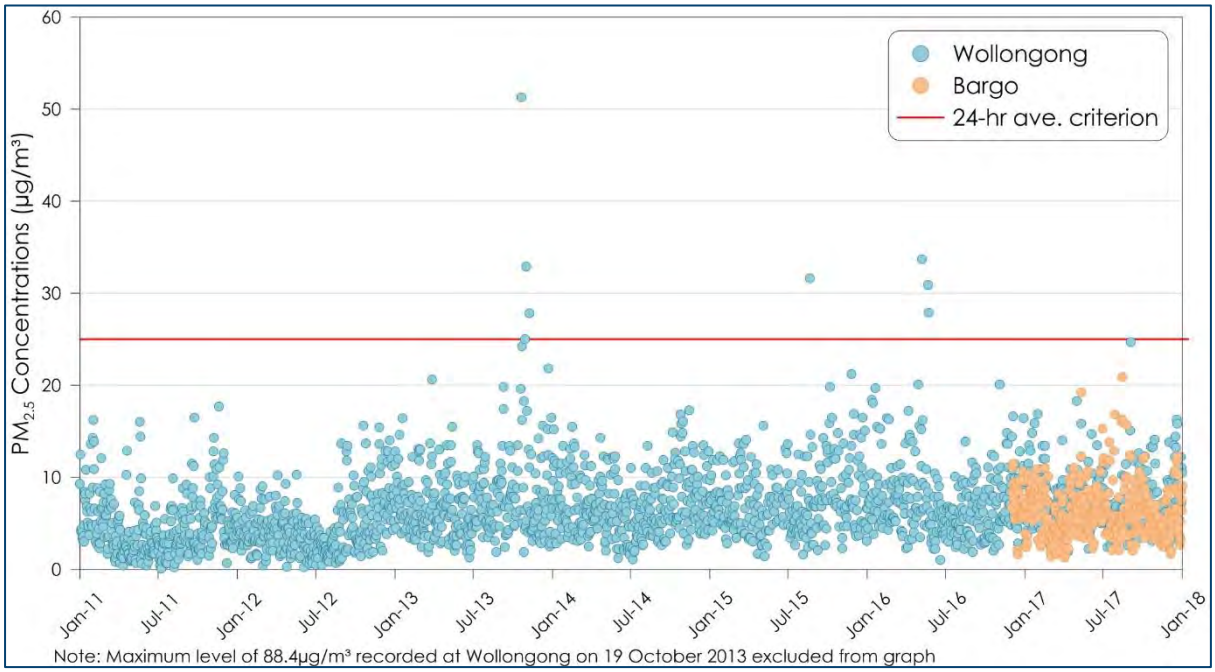


Figure 4-9: 24-hour average $PM_{2.5}$ levels at Wollongong and Bargo

4.3.4 TSP monitoring

The available TSP monitoring data collected between 2011 and 2017 are summarised in **Table 4-6** and presented in **Figure 4-10.**

The monitoring data summarised in **Table 4-6** indicate that the annual average TSP concentrations at the Quarry monitor were below the criterion of 90µg/m^3.

Figure 4-10 shows that the 24-hour average TSP concentrations follow a similar trend to the PM_{10} monitoring data as expected, with generally higher levels occurring during the spring and summer months. It should be noted that unlike PM_{10}, there is no applicable air quality criteria for 24-hour average TSP concentrations. The TSP dust metric is only assessed on an annual basis.

Table 4-6: TSP levels from HVAS monitoring (µg/m^3)

Year	HVAS - Quarry	Criterion
	Annual average	
2011[1]	32.1	**90**
2012	31.4	**90**
2013	28.3	**90**
2014	39.2	**90**
2015	46.6	**90**
2016	38.8	**90**
2017[2]	52.1	**90**

[1]Data available from July 2011

[2]Data available till June 2017

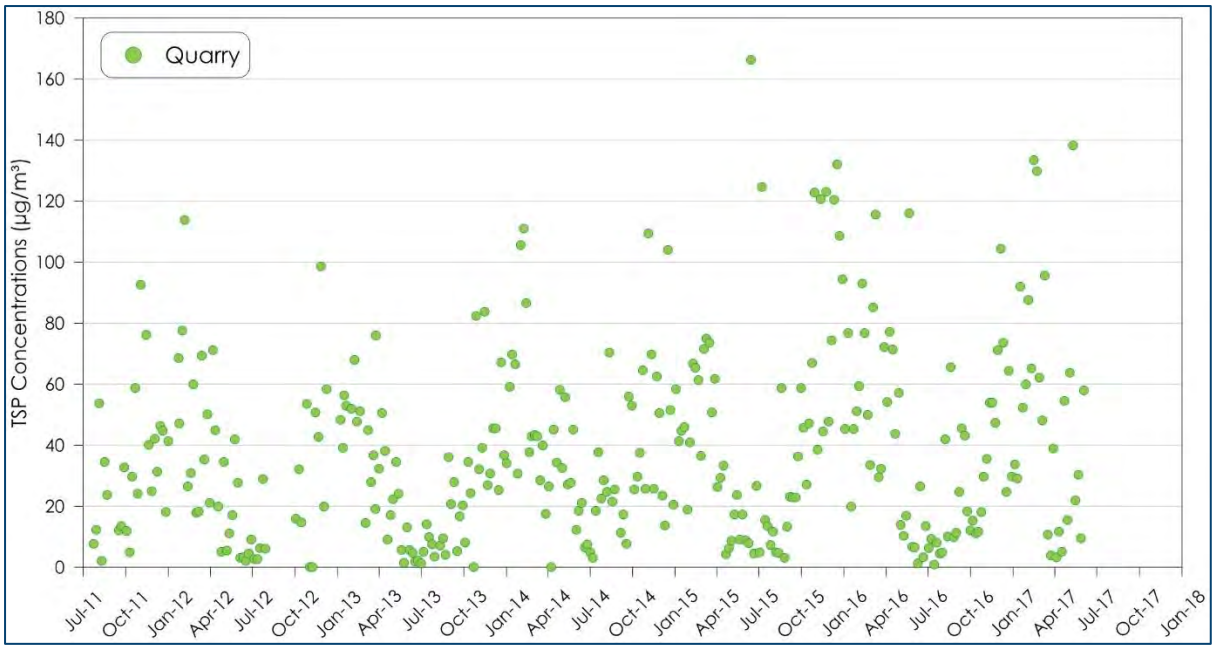


Figure 4-10: HVAS 24-hour average TSP concentrations

4.3.5 Dust deposition monitoring

The available annual average dust deposition levels recorded at the Limestone Mine/Quarry and Lynwood between 2012 and 2016 by are summarised in **Table 4-7** and **Table 4-8**, respectively.

Many of the gauges are generally located in close proximity to the mining and quarrying activities (refer to **Figure 4-5**). These locations are likely to show the highest levels of deposited dust in the area due to their close proximity to dust sources, other sources such as traffic on unsealed roads and driveways and animal grazing would also contribute to the measured deposited dust levels. In this case, the measured dust deposition levels at these locations would not be representative of the sensitive receiver locations.

The results in **Table 4-7** indicate the majority of dust gauges recorded annual average insoluble deposition levels below the criterion of 4g/m^2/month. As noted, the dust gauges that recorded generally higher levels are likely to be influenced by their location relative to the mining and quarrying activities (e.g. Freddie's Hill, Store Paddock and D1). Samples are also often contaminated with bird droppings and/or insects which can increase the insoluble solid content.

Table 4-7: Annual average dust deposition (insoluble solids) – Marulan / Peppertree (g/m²/month)

Year	Annual average						
	Sub Station	Freddie's Hill	Store Paddock	D1	D2	D3	Criteria
2012	3.7	3.4	**7.0**	**6.8**	1.9	2.3	**4**
2013	2.5	3.3	3.6	**4.2**	2.2	2.8	**4**
2014	2.5	3.4	3.5	**4.5**	1.8	2.8	**4**
2015	3.2	3.1	4.0	-	2.6	-	**4**
2016	2.6	3.3	**7.5**	-	2.5	-	**4**

Table 4-8: Annual average dust deposition - Lynwood (g/m²/month)

Year	Annual average								
	DD1	DD2	DD3	DD4	DD5	DD6	DD7	DD8	Criteria
2012	1.5	3.6	3.4	1.9	1.2	3.0	1.6	1.5	**4**
2013	0.6	1.0	**4.5**	0.6	0.6	2.1	0.7	0.6	**4**
2014	2.1	2.3	1.3	1.4	2.9	1.6	1.0	1.3	**4**
2015	1.5	**7.5**	2.9	2.0	2.9	2.5	0.9	1.1	**4**
2016	**5.9**	1.7	2.0	3.1	1.2	1.7	2.8	3.1	**4**

Source: **Holcim, 2017**

5 DISPERSION MODELLING APPROACH

5.1 Modelling methodology

The dispersion modelling methodology applied in this assessment is the same as that applied in the Peppertree Quarry Modification 4 (**Todoroski Air Sciences, 2016**) assessment using the CALPUFF modelling suite.

The CALMET meteorological modelling has been revised to incorporate the changes to the local terrain for the proposed modelling scenario which affect the local wind flows of the area. This assessment used the same meteorological conditions assessed in the Modification 4 assessment which were based on data for January 2014 to December 2014 from four surrounding monitoring sites. The 2014 meteorological year is considered representative of typical conditions, as outlined in more detail in **Appendix B**.

Dust emissions from each activity were represented by a series of volume sources and included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

As a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

5.2 Modelling scenario

This assessment considers a single scenario to represent the Project. The scenario chosen represents the potential worst-case impacts in regard to the quantity of material emplaced at the SWOE and the potential to generate dust impacts at the nearby sensitive receiver locations.

The quarrying operations involve the stripping of overburden and the extraction of hard rock using open-cut drill and blast techniques. Overburden is transported by trucks to the SWOE via the new haul road, where it is spread and shaped by dozer. The active quarrying areas and exposed areas are to be kept to a minimum for the efficiency of the operation and this also has a positive effect in minimising the potential amount of dust levels generated from the operations. Rehabilitation of overburden emplacement areas is undertaken in stages as the emplacements progress.

Quarried material is processed on-site using various crushers and screens to obtain the desired product. Material is initially crushed in a primary mobile crusher located within the pit which is currently fed by an excavator, front end loaders and trucks. The mobile crusher/ conveyor system can be positioned close to the extraction location, thereby facilitating in-pit works to be "truck-less". This eliminates the dust emissions from unnecessary material handling and hauling activity. Blasted rock is fed directly into the primary mobile crusher by excavator. After passing through the primary crusher, the crushed material is taken from the pit along a series of conveyors to the first set of screens located to the northwest of the pit and material is stockpiled in a surge pile. Material in the surge pile is reclaimed and conveyed to the main processing area where it undergoes further crushing and screening. Product material is stored in the various storage bins prior to being dispatched off-site by trains.

An indicative plan for the selected operational scenario is presented in **Figure 5-1**.

The modelled year represents a potential worst-case scenario with regard to dust generation with the proposed maximum approved amount of material handled, at the closest possible locations to the nearby receivers. For the modelled operational scenario, the existing approved eastern, southern and western overburden emplacement areas are assumed to have been completed and the new SWOE is in operation.

Operating hours for overburden stripping and emplacement at the SWOE will be the same as the approved operations from 7:00am to 7:00pm. All other operations at the Quarry will also continue to occur in accordance with the approved operating hours.

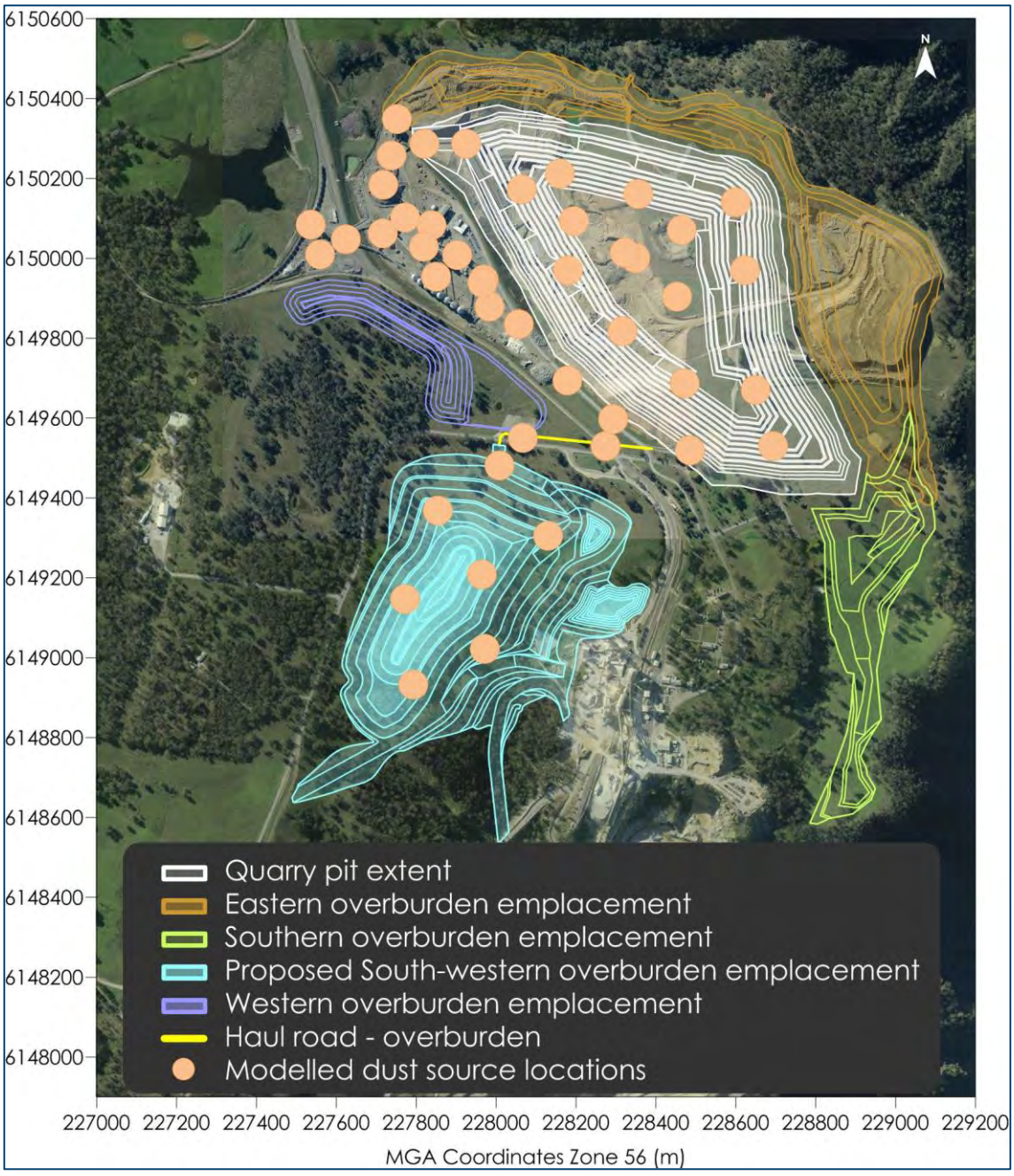


Figure 5-1: Indicative modelling scenario for the Project

5.3 Emissions estimation

For the modelled scenario, dust emission estimates have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emission factors.

The emission factors were sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation. Total dust emissions from all significant dust generating activities for the Project are presented in **Table 5-1**. Detailed emission inventories and emission estimation calculations are presented in **Appendix C**.

The estimated emissions presented in **Table 5-1** are commensurate with an operation utilising reasonable and feasible best practice dust mitigation applied where applicable.

Table 5-1: Estimated emission for the Project

Activity	TSP emissions (kg/year)	PM_{10} emissions (kg/year)	$PM_{2.5}$ emissions (kg/year)
Excavator loading overburden to haul truck	5,010	2,370	359
Hauling overburden to emplacement area	86,774	19,410	1,941
Unloading overburden at emplacement area	5,010	2,370	359
Dozer shaping overburden emplacement area	20,886	5,047	2,193
Drilling rock	3,068	1,595	92
Blasting rock	1,880	977	56
Excavator loading rock to haul truck	6,465	3,058	463
Hauling rock to hopper	35,772	8,002	800
Unloading rock at stockpile	6,465	3,058	463
Excavator loading rock to hopper	6,465	3,058	463
Primary crushing of material	2,400	1,080	200
Conveying material to screens (grizzly + scalp)	244	122	18
Conveyor transfer x5	9,697	917	139
Screening material	4,400	1,480	100
Conveying material to surge pile	34	17	3
Unloading material to surge pile	5,657	2,675	405
Unloading scalp material	1,293	612	93
Loading scalp material to haul truck	1,293	612	93
Hauling scalp material to stockpile (near train load out)	6,797	1,520	152
Unloading scalp material at stockpile	1,293	612	93
Loading scalp material to trains	1,293	612	93
Conveying material from surge pile to crusher	33	17	2
Crushing of material	2,100	945	175
Conveying material to screen	17	8	1
Conveying material to screen w/ transfer	22	11	2
Conveyor transfer x1	622	294	45
Screening material	4,235	1,425	96
Conveying material to train load out Silo 1	114	57	9
Conveying material to train load out Silo 2	34	17	3
Conveyor transfer x1	246	117	18
Conveying material to train load out Silo 3	37	18	3
Conveyor transfer x1	338	160	24
Conveying material to crusher (2)	36	18	3
Conveyor transfer x1	1,230	582	88
Crushing (2) of material	3,806	1,522	89
Conveying material to screen (2)	15	7	1
Screening (2) material	1,975	1,207	148
Conveying material to train load out Silo 4	27	13	2
Conveying material to train load out Silo 5	27	14	2
Conveying material to train load out Silo 6 + 7	75	38	6
Conveyor transfer x2	1,396	330	50

Activity	TSP emissions (kg/year)	PM_{10} emissions (kg/year)	$PM_{2.5}$ emissions (kg/year)
Screening (air sort) material	2,592	1,584	194
Unloading Limestone sand from Marulan	485	229	35
Conveying material to train load out Silo 8	33	17	3
Conveying material to train load out from all Bins	140	70	10
Loading product material to trains	1,697	803	122
Unloading overflow material from radial stacker	194	92	14
Excavator loading overflow material to haul truck	194	92	14
Hauling overflow material to stockpile (near train load out)	423	95	9
Unloading overflow material at stockpile	194	92	14
Loading overflow material to trains	194	92	14
Unloading test material from radial stacker	57	27	4
Excavator loading test material to hopper	57	27	4
Unloading rejects (weathered material) to haul truck	283	134	20
Excavator loading rejects (weathered material) to haul truck	283	134	20
Hauling rejects (weathered material) to emplacement area	5,271	1,179	118
Unloading rejects (weathered material) at emplacement area	283	134	20
Grading roads	1,418	495	44
Wind erosion - Overburden emplacement area	21,024	10,512	1,577
Wind erosion - Open pit	120,474	60,237	9,036
Wind erosion - Infrastructure stockpiles	18,828	9,414	1,412
Total emissions	**402,700**	**151,458**	**22,026**

5.3.1 Emissions from other mining operations

In addition to the estimated dust emissions from the Project, the adjacent Limestone Mine has been included in the modelling to assess potential for cumulative dust effects.

Other activities in the local area include an agricultural lime production facility. This is a relatively small operation, and the background data (HVAS) monitor is located within approximately 300m of the activity. This background data would capture any significant environmental emissions associated with this facility, hence it has not been explicitly modelled.

Table 5-2 summarises the emissions adopted in this assessment for the modelled scenario.

Table 5-2: Estimated emissions from nearby mining operation

Mining operation	TSP emission (kg/year)
The Limestone Mine	850,820

Additionally, there would be numerous smaller or very distant sources that contribute to the total background dust level. Modelling these non-mining sources explicitly is impractical, however the residual level of dust attributable to all other such non-modelled sources has been included in the cumulative results.

5.3.2 Cumulative assessment - accounting for other non-modelled sources

To account for sources not explicitly included in the model, and to fully account for all cumulative dust levels, the unaccounted fractions of background dust levels (which arise from the other non-modelled sources), were added to the annual average model predictions.

The contribution of background dust levels was estimated by modelling the past (known) quarrying and mining activities during 2014 and comparing model predictions with the actual measured data from the corresponding monitoring stations. The average difference between the measured and predicted PM_{10}, TSP and deposited dust levels from each of the monitoring points was considered to be the contribution from other non-modelled dust sources.

In this case, the estimated background levels for TSP, PM_{10} and deposited dust are identical to the levels applied in the Modification 4 assessment (**Todoroski Air Sciences, 2016**).

In the absence of available $PM_{2.5}$ monitoring data for the area, an estimate of background levels was calculated based on the assumption that an annual average $PM_{2.5}$ concentration of 8µg/m^3 is equivalent to an annual average PM_{10} concentration of 25µg/m^3. Thus considering that the existing PM_{10} level is 11µg/m^3, the calculated $PM_{2.5}$ level to account for non-modelled sources as applied in this assessment is 3.5µg/m^3.

Table 5-3 outlines the estimated annual average contribution from other non-modelled dust sources for the area surrounding the Quarry.

Table 5-3: Estimated annual average contribution from other non-modelled dust sources

Pollutant	Background level	Unit
TSP	27.0	µg/m^3
PM_{10}	11.0	µg/m^3
$PM_{2.5}$	3.5	µg/m^3
Dust deposition	2.8	g/m^2/month

6 BEST PRACTICE OPERATIONAL DUST MITIGATION MEASURES

The Quarry has carefully considered the possible range of air quality mitigation measures that are feasible and can be applied to achieve a standard of operation consistent with current best practice for the control of dust emissions from coal mines in NSW, as outlined in the recent NSW EPA document, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone Environmental, 2010**).

A summary of the key current dust controls applied to the Quarry operations and as outlined in the *Peppertree Quarry Air Quality Management Plan* (**Boral, 2017**), is shown in **Table 6-1**. Where applicable these controls have been applied in the dust emission estimates shown in **Table 5-1**. Further detail on the level of control applied is set out in **Appendix C**.

Table 6-1: Best practice dust mitigation measures

Activity	Dust Control
Hauling on unsealed roads	✦ Avoided via use of conveyor from quarry pit to processing plant ✦ Watering roads ✦ Use the largest practical truck size ✦ Road edges to be clearly defined with marker post or equivalent to control locations ✦ Obsolete roads will be ripped and re-vegetated as soon as practical ✦ Impose speed restrictions
Hauling on sealed roads	✦ Keep roads maintained ✦ Regular cleaning with road sweeper ✦ Covering of loads ✦ Impose speed restrictions
Drilling	✦ Dust suppression systems ✦ Cease operations if systems are not operating properly resulting in excessive visible dust ✦ Take care not to disturb drill cuttings
Blasting	✦ Meteorological conditions assessed prior to blasting ✦ Adequate stemming
Bulldozer activity	✦ Modify activities during periods of high visible dust
Loading/unloading material	✦ Avoided via use of conveyor from quarry pit to processing plant ✦ Minimise drop heights

Activity	Dust Control
	✦ Modify activities during periods of high visible dust
Crushing / Screening	✦ Dust suppression sprays on the primary crusher ✦ Enclosure with dust extraction system ✦ Regular housekeeping in and around buildings ✦ Regular servicing and inspection of dust cyclone
Conveyor and transfers	✦ Used to reduce hauling, loading and unloading emissions that would otherwise occur ✦ Water sprays ✦ Belt cleaning and spillage minimisation ✦ Enclosures ✦ Adjusting belt speed at the optimum level ✦ Daily cleaning of areas
Wind erosion on stockpiles and exposed surfaces	✦ Profiling of surfaces to reduce surface speed ✦ Contouring of overburden emplacement shape where practical to avoid strong wind flows and smooth gradients to reduce turbulence at surface ✦ Rehabilitation as soon as practical ✦ Topsoil stockpiles not regularly used, to be re-vegetated ✦ Review weather conditions and modify activities to minimise stockpile disturbance during adverse conditions ✦ Water sprays ✦ Containment of aggregate materials within silos limiting the need to stockpile materials
Train loading	✦ Enclosed ✦ Regular cleaning of any spillage ✦ 2 to 3% water added to each wagon as loaded

7 DISPERSION MODELLING RESULTS

The dispersion model predictions for the assessed scenario are presented in this section. The results presented include those for the operation in isolation (incremental impact) and cumulative impacts with the operation of other sources and background levels. The results show the estimated:

- Maximum 24 hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average $PM_{2.5}$ and PM_{10} criteria, the predictions show the highest predicted 24-hour average concentrations that were modelled at each point within the modelling domain for the worst day (a 24-hour period) in the one year long modelling period. When assessing the total (cumulative) 24-hour average impacts based on model predictions, challenges arise with identification and quantification of emissions from non-modelled sources over the 24-hour period. Due to these factors, the 24-hour average impacts need to be calculated differently to annual averages and as such, the predicted total (cumulative) impacts for maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations have been addressed specifically in **Section 7.2**.

Each of the sensitive receivers shown in **Figure 2-1** and detailed in **Appendix A** were assessed individually as discrete receptors with the predicted results presented in tabular form for the assessed scenario.

In the tables of results, receptors are labelled according to the type of receptor, as follows:

- R - Residential receiver (private);
- C - Commercial receiver;
- B - Residential receiver (Boral owned); and,
- PR - Proposed residential dwelling (private)

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-1 presents the predicted particulate dispersion modelling results for the incremental impact at each of the assessed sensitive receiver locations. The results show minimal incremental effects would arise at the privately-owned sensitive receiver locations (Receiver 1 to 17) due to the Project. No exceedances of the criteria for dust deposition are predicted at any assessed sensitive receiver due to emissions from the Quarry incorporating the Project.

Note the proposed residential dwelling (see **Table 7-1**) does not actually exist at this time. As a conservative measure potential impacts at this potential future dwelling have been considered on the basis of the modelled levels at the existing receivers located substantially closer to the Project where impacts would be higher.

Table 7-1: Modelling predictions for the Quarry including the Project – incremental impact

Receiver ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Air quality impact criteria					
	-	-	-	-	-	2
R1	0.5	0.0	3.24	0.13	0.23	0.00
R2	0.9	0.0	6.07	0.27	0.48	0.01
R3	1.2	0.1	7.7	0.4	0.7	0.01
R4	1.2	0.1	7.4	0.6	1.1	0.02
R5	1.3	0.2	7.9	1.0	1.8	0.04
R6	1.0	0.1	6.4	0.9	1.7	0.03
R7	1.6	0.3	9.6	1.6	3.1	0.06
R8	2.2	0.4	13.5	2.6	5.3	0.11
R9	1.8	0.3	10.2	1.5	3.0	0.06
R10	0.9	0.1	5.6	0.6	1.2	0.02
R11	0.7	0.1	3.9	0.4	0.6	0.01
R12	0.9	0.1	5.5	0.5	0.8	0.01
R13	0.2	0.0	1.1	0.1	0.1	0.00
R14	1.3	0.2	8.0	1.0	1.8	0.09
R15	1.4	0.2	8.6	1.2	2.3	0.13
R16	1.7	0.2	10.6	1.3	2.5	0.15
R17	2.1	0.3	12.4	1.7	3.2	0.18
B1	1.4	0.1	9.3	0.4	0.8	0.02
B2	1.9	0.2	11.8	1.4	2.6	0.06
B3	2.7	0.5	15.4	3.0	6.6	0.14
B4	4.3	1.0	22.0	5.1	12.9	0.28
B5	2.6	0.4	13.2	2.1	4.6	0.08
B6	2.1	0.3	13.2	1.8	3.5	0.20
B7	2.4	0.3	13.9	1.9	3.8	0.20
C1	3.4	0.9	19.4	5.1	12.0	0.28
C2	1.8	0.3	10.9	1.8	3.8	0.07
C3	2.0	0.3	11.0	1.7	3.5	0.06
PR*	1.8	0.3	10.9	1.8	3.8	0.07

*Impact is conservatively assumed to be the same as that at Receiver C2.

7.1 Modelling predictions - cumulative impacts

The predicted cumulative annual average $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project and other sources, including the estimated background, are presented in **Table 7-2**.

The results indicate the predicted levels would be below the relevant criteria at the privately-owned sensitive receiver locations (Receiver 1 to 17) for each of the assessed dust metrics.

Boral owned receiver, B4, is predicted to exceed the annual average PM_{10} criteria of 25µg/m³. All other Boral owned and commercial receivers are predicted to experience dust levels below the relevant criteria for each of the assessed dust metrics.

Table 7-2: Modelling predictions for the Quarry including the Project – cumulative impacts

Receiver ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Annual average			
	Air quality impact criteria			
	8	25	90	4
R1	3.6	11.4	27.6	2.8
R2	3.6	11.7	28.1	2.8
R3	3.7	12.0	28.6	2.8
R4	3.7	12.4	29.3	2.8
R5	3.9	13.0	30.5	2.9
R6	3.9	13.0	30.5	2.9
R7	4.1	14.5	33.2	2.9
R8	4.4	16.3	36.8	3.0
R9	4.5	16.1	36.2	3.0
R10	4.1	13.9	31.9	2.9
R11	4.1	14.1	32.2	2.9
R12	4.5	16.0	35.9	2.9
R13	3.5	11.2	27.3	2.8
R14	3.7	12.4	29.5	2.9
R15	3.8	12.7	30.1	2.9
R16	3.8	12.9	30.5	3.0
R17	3.9	13.4	31.6	3.0
B1	3.7	12.0	28.7	2.8
B2	3.9	13.5	31.3	2.9
B3	5.0	19.0	42.2	3.1
B4	6.4	**26.4**	58.3	3.4
B5	5.9	23.4	50.4	3.2
B6	3.9	13.5	31.6	3.0
B7	4.0	13.9	32.5	3.0
C1	5.5	21.9	48.9	3.3
C2	4.4	15.7	35.6	2.9
C3	4.8	17.7	39.2	3.0
PR*	4.4	15.7	35.6	2.9

*Impact is conservatively assumed to be the same as that at Receiver C2.

7.2 Assessment of total (cumulative) 24-hour average $PM_{2.5}$ and PM_{10} concentrations

Cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts at the closest and most potentially impacted privately-owned receiver locations are of most interest in this assessment.

This analysis has focused on the nearest privately-owned sensitive receiver locations surrounding the Quarry that would be most likely to experience maximum cumulative impacts due to the Project. All other receivers would be expected to experience levels lower than those assessed.

Figure 7-1 shows the locations at which the contemporaneous impact assessment was made.

As there are no readily available ambient $PM_{2.5}$ monitoring data collected near to the Quarry, monitoring data from the HVAS monitoring station and the NSW OEH monitoring station at Wollongong have been applied in the assessment.

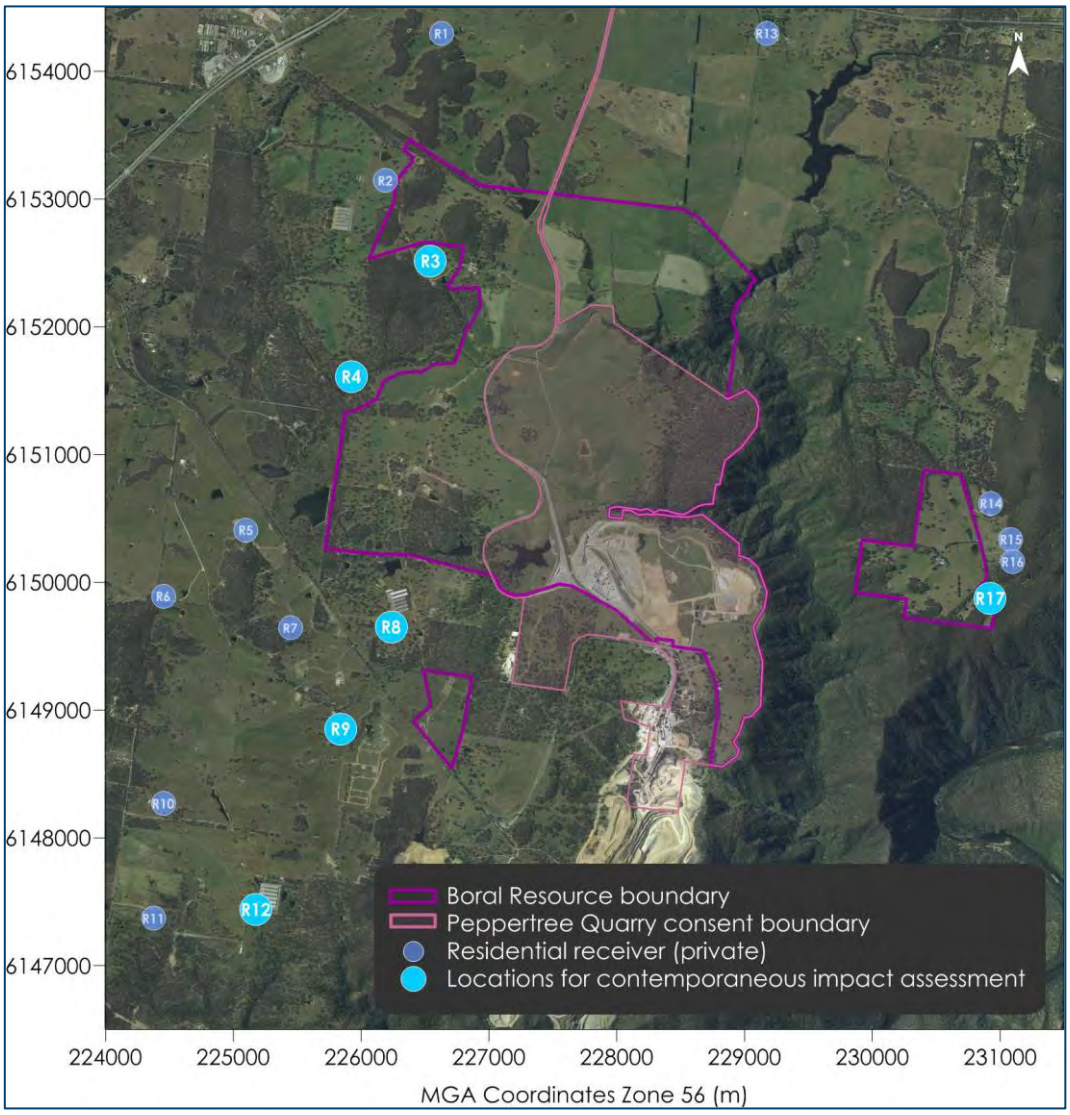


Figure 7-1: Locations for contemporaneous cumulative impact assessment

7.2.1 Assessment of cumulative $PM_{2.5}$ impacts

To assess the potential cumulative 24-hour average $PM_{2.5}$ impacts due to the Project, a Level 1 approach (i.e. adding the maximum background and maximum incremental level together) is applied per two different approaches to establish the background level, as follows:

- Assuming maximum ambient $PM_{2.5}$ level is 32% (i.e. 8/25 per the criteria ratio) of the maximum ambient PM_{10} levels – the criteria ratio approach; and
- Applying the Victorian EPA approach[2] with the available ambient $PM_{2.5}$ monitoring data from the NSW OEH monitoring station at Wollongong during 2014.

[2] The Victorian Government's State Environment Protection Policy (Air Quality Management), **SEPP (2001)** states at Part B, 3(b) "Proponents required to include background data where no appropriate hourly background data exists must add the 70th percentile of one year's observed hourly concentrations as a constant value to the predicted maximum concentration from the

This has been done as there is no available ambient $PM_{2.5}$ monitoring data, which means the NSW EPA contemporaneous approach cannot be applied, and thus the approaches applied are considered to be the next most suitable alternative to use.

7.2.1.1 Criteria ratio approach

The PM_{10} HVAS monitoring data from the Limestone Mine monitor were applied per the criteria ratio approach. The HVAS monitoring data already include a dust contribution from the existing Quarry and Limestone Mine during this period. The double counting in this case has not been accounted for and therefore the approach is likely to provide a relatively conservative assessment of potential cumulative impacts.

Per this approach, the maximum measured PM_{10} concentration during the 2014 assessment year is 50.5µg/m^3 (refer to **Table 4-3**) and 32% of this level, representing the maximum $PM_{2.5}$ level, is 16.1µg/m^3. This value was added with the maximum predicted $PM_{2.5}$ level and the results of the cumulative assessment are presented in **Table 7-3** for each of the assessed receivers. The results indicate that the predicted maximum cumulative impact would not exceed the relevant criterion of 25µg/m^3 for the receiver locations.

Table 7-3: Cumulative 24-hour average $PM_{2.5}$ assessment – criteria ratio approach – maximum number of additional days above 24-hour average $PM_{2.5}$ criterion

Receiver ID	Number of additional days above 24-hour average $PM_{2.5}$ criterion
R3	0
R4	0
R8	0
R9	0
R12	0
R17	0

7.2.1.2 Victorian EPA approach

The monitoring data from the Wollongong monitoring station are representative of a more densely populated area with greater influences of anthropogenic sources compared to the area surrounding the Quarry. The monitoring data therefore would provide a conservative assessment of potential cumulative impacts for the area surrounding the Quarry.

The 70th percentile of the measured Wollongong $PM_{2.5}$ monitoring data during 2014 is 8.2µg/m^3 and is considered for the cumulative assessment.

The results of the cumulative assessment are presented in **Table 7-4** for each of the assessed receivers. The results indicate that the predicted maximum cumulative impact would not exceed the relevant criterion of 25µg/m^3 for the receiver locations.

model simulation. In cases where a 24-hour averaging time is used in the model, the background data must be based on 24-hour averages.

Table 7-4: Cumulative 24-hour average $PM_{2.5}$ assessment – Victorian EPA approach – maximum number of additional days above 24-hour average $PM_{2.5}$ criterion

Receiver ID	Number of additional days above 24-hour average $PM_{2.5}$ criterion
R3	0
R4	0
R8	0
R9	0
R12	0
R17	0

7.2.2 Assessment of cumulative PM_{10} impacts

An assessment of cumulative 24-hour average PM_{10} impacts was undertaken in accordance with the methods outlined in Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA**, **2017**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts.

As shown in **Section 5.3**, maximum background levels have in the past reached levels near to the 24-hour average PM_{10} criterion level (depending on the monitoring location and time). As a result, the screening Level 1 NSW EPA approach of adding maximum background levels to maximum predicted modified Quarry only levels would show levels above the criterion.

In such situations, (where a Level 1 assessment indicates that an impact may be possible due to elevated background levels) the NSW EPA approach requires a more thorough Level 2 assessment whereby the measured background level on a given day is added contemporaneously with the corresponding modified Quarry only level predicted using the same day's weather data. This method factors into the assessment the spatial and temporal variation in background levels affected by the weather and existing sources of dust in the area on a given day. However, even with a detailed Level 2 approach, any air dispersion modelling has limitations in predicting short term impacts which may arise many years into the future, and these limitations need to be understood when interpreting the results.

Ambient (background) dust concentration data for January 2014 to December 2014 from the HVAS monitoring station have been applied in the Level 2 contemporaneous 24-hour average PM_{10} assessment and represent the prevailing measured background levels at the monitoring location which is near to the Quarry.

As the Quarry and other nearby operations (the Limestone Mine) were operational during 2014, they would have contributed to the measured levels of dust at the monitor, making the levels higher than the likely background levels further away at residential receivers. Due to this it is important to account for these existing activities in the cumulative assessment.

To consider the Quarry's influence on prevailing dust levels, modelling of the actual operating scenario for the 2014 period (in which the weather and background dust data were collected) was conducted to estimate the existing contribution to the measured levels of dust. The results were applied in the cumulative assessment to minimise potential double counting of existing emissions (otherwise the contribution would occur in the measured data and in the modelled levels), and thus to make a more reliable prediction of the likely cumulative total dust level.

Specifically, to calculate the background levels at receivers, the predicted air quality concentrations from the Quarry and the Limestone Mine during 2014 at the HVAS monitoring station location were subtracted from the measured levels at the HVAS. However, for conservatism, and as models tend to over predict source contributions, no level lower than the 25th percentile of the measured HVAS results for the 2014 period was applied to represent the underlying background level on any day.

As the HVAS monitoring data are only available on every sixth day in 2014 (per the EPA run cycle) and on a few occasions no result was recorded, the 70th percentile of the HVAS data for the period from July 2011 to June 2017 (20.7µg/m^3) was applied to substitute for these gaps.

This approach was tested by applying the complete set of 24-hour average PM_{10} monitoring data from Bargo in a contemporaneous 24-hour average PM_{10} assessment. The application of the Bargo data resulted in lower levels than calculated with the above approach, providing a reasonable indication that the assessment is likely to be conservative and thus to overestimate the actual background level and cumulative 24-hour average PM_{10} impacts.

Table 7-5 provides a summary of the findings of the contemporaneous assessment at each assessed sensitive receiver location. The results in **Table 7-5** indicate that it is unlikely that systemic (i.e. greater than five days) cumulative impacts would arise at assessed receiver locations during the assessed years.

Detailed tables of the full assessment results are provided in **Appendix E**.

Table 7-5: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average PM_{10} criterion

Receiver ID	Number of additional days above 24-hour average PM_{10} criterion
R3	0
R4	0
R8	0
R9	0
R12	0
R17	0

The contemporaneous assessment indicates no potential for any cumulative 24-hour average PM_{10} impacts to occur at the assessed sensitive receiver locations. The sensitive receiver locations are considered to represent areas where the highest cumulative impacts are most likely to occur. Given that these locations have no potential for any significant impact to occur, it can be inferred that there would also be no prospect of any significant impact to occur at all other sensitive receiver locations.

Time series plots of the predicted cumulative 24-hour average PM_{10} concentrations for R4 and R8 are presented in **Figure 7-3**. R4 and R8 are located closest to the SWOE and most likely to be affected based on the prevailing weather conditions.

The yellow bars in the figure represent the contribution from the Quarry and the Limestone Mine and the black bars represent the background levels at the HVAS monitor. Note that on the days on which there is no HVAS data, the 70th percentile level of the HVAS data is used to elevate the total cumulative level. It is clear from the figures that the Quarry (and Limestone Mine combined) would have a relatively small influence at these receiver locations and the cumulative levels would remain within criteria.



Figure 7-2: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R4 and R8

7.3 Dust impacts on more than 25 per cent of privately-owned land

An assessment was made to ascertain where the potential impacts due to the Project may extend over more than 25 per cent of any privately-owned land. Such an assessment can only be conducted approximately, based on the predicted pollutant dispersion contours.

For the Project, the maximum extent of the 24-hour average PM_{10} impact due to the operation of the Quarry was greater than the extent of any of the other assessed dust metrics and hence represents the most impacting parameter.

The contour presented in **Figure 7-3** defines the likely maximum 24-hour average PM_{10} level assessed over the life of the Project. The contour indicates that the Project would not result in any impact on more than 25 per cent of any privately-owned land.

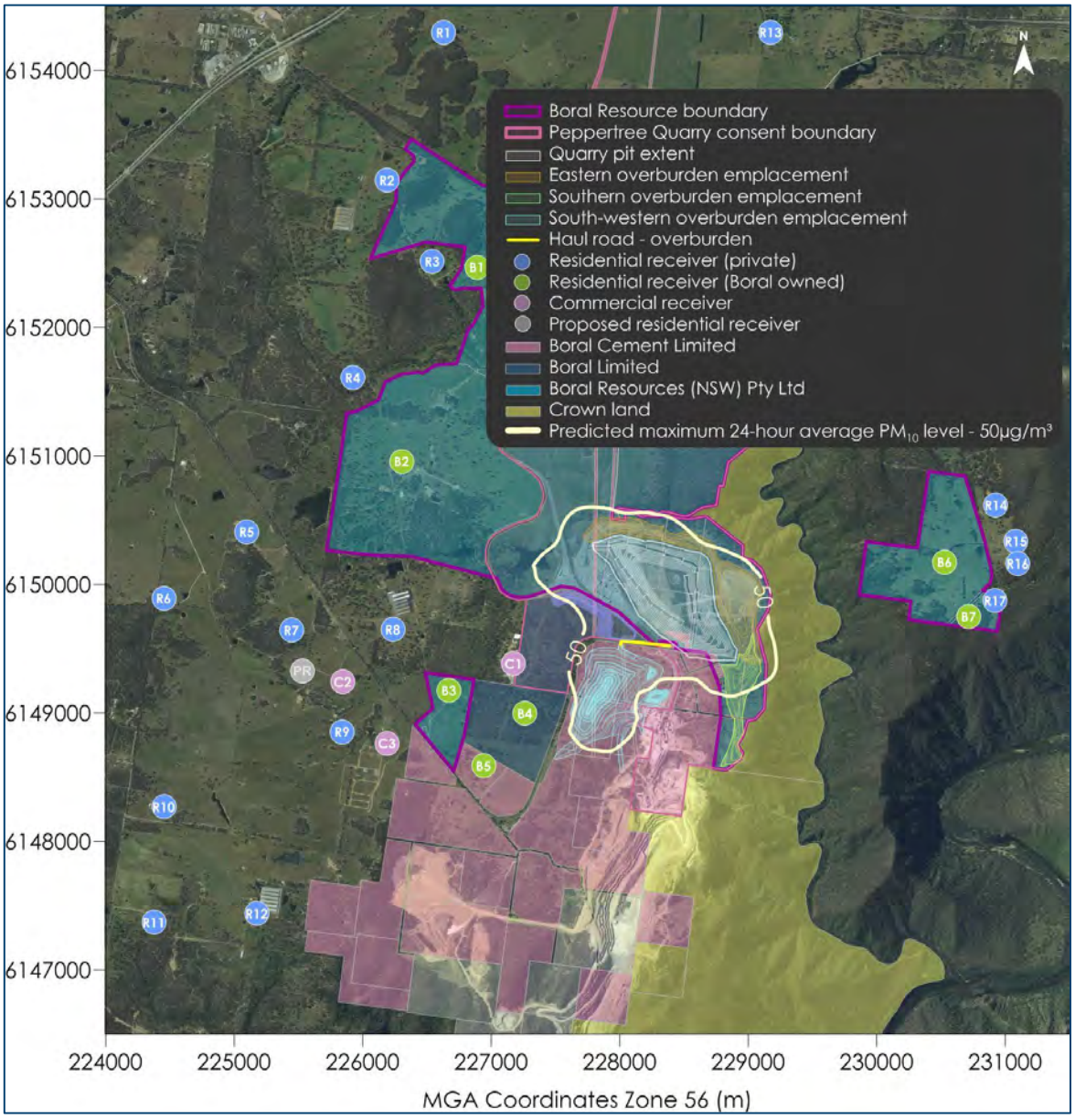


Figure 7-3: Predicted maximum 24-hour average PM_{10} level

8 DUST MITIGATION AND MANAGEMENT

The existing operations at the Quarry implement various dust mitigation and management measures, in accordance with the existing Peppertree Quarry Air Quality Management Plan to minimise the potential for air quality impacts in the surrounding environment.

Relative to the existing operations, the proposed modifications to the Quarry are unlikely to lead to any significant change in dust levels at receivers. This is supported by the air quality assessment for the modified Quarry operations which predicts that there would be no exceedances of NSW EPA air quality criteria at any privately-owned receivers due to the modified Quarry operations and background sources (including the Limestone Mine).

Given this situation and the demonstrated performance of existing operations, it is considered that the continued implementation of the Air Quality Management Plan management measures would be suitable to manage potential air quality impacts from the modified Quarry operations.

9 SUMMARY AND CONCLUSIONS

This study has examined potential air quality impacts that may arise from the proposed modifications to the Peppertree Quarry.

The assessment also incorporates the proposed continued operations at the neighbouring Limestone Mine.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the modified Quarry operations. The results indicate that the assessed air pollutants generated by the modified Quarry operations would comply with the applicable assessment criteria at all locations assessed except for one Boral owned property, B4.

The assessment indicates that the proposed modifications would not lead to any unacceptable level of environmental impact at any receptors in the surrounding area not owned by Boral.

The Peppertree Quarry would continue to apply appropriate dust mitigation and management measures to ensure it minimises the potential occurrence of excessive dust emissions from the site.

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Appendix A

Sensitive Receivers

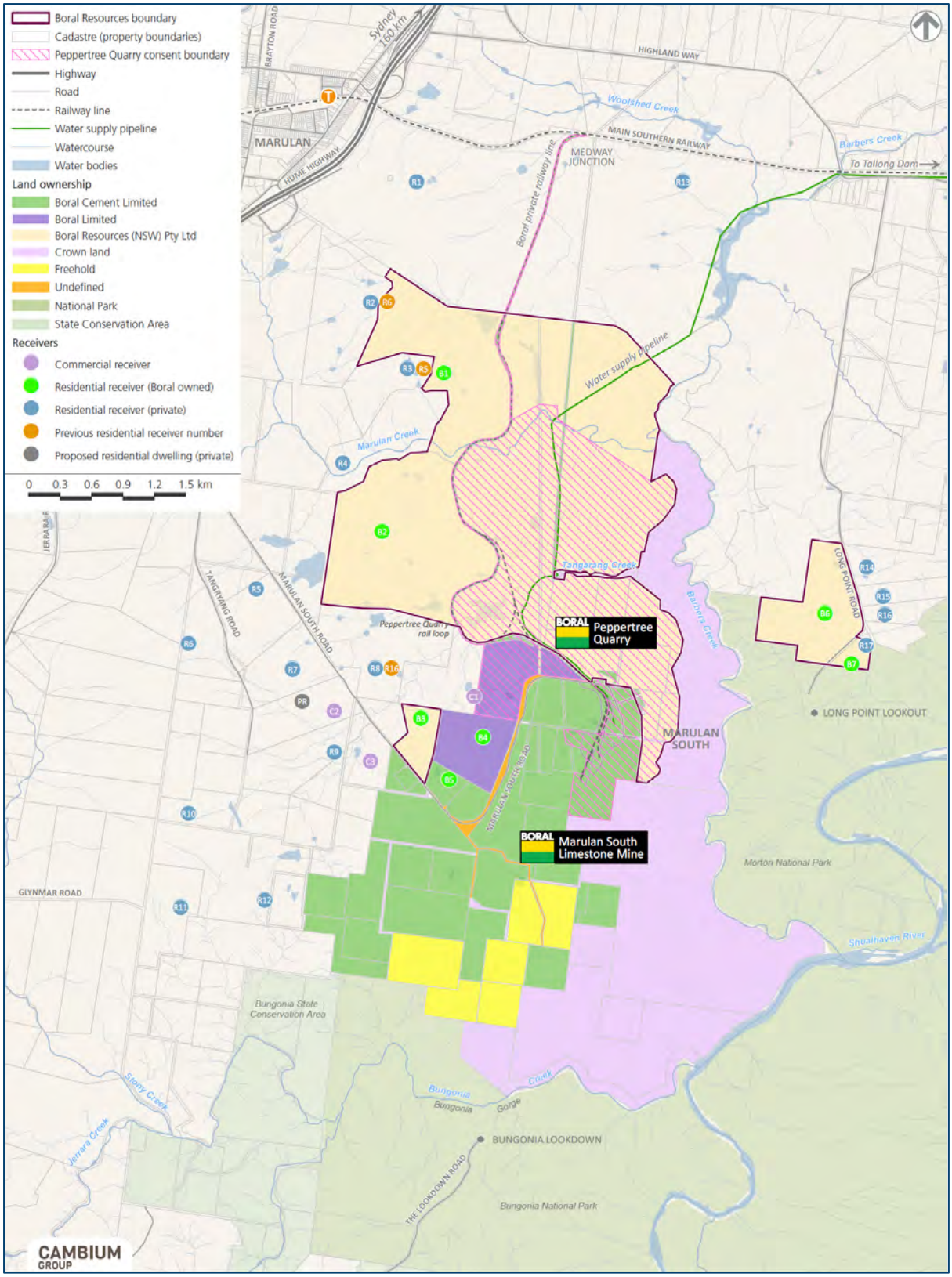


Figure A-1: Sensitive receiver locations

Table A-1: List of sensitive receivers considered in the study

Receiver ID	Easting (m)	Northing (m)
R1	226630	6154295
R2	226189	6153145
R3	226542	6152514
R4	225923	6151609
R5	225098	6150410
R6	224452	6149891
R7	225446	6149643
R8	226234	6149650
R9	225840	6148852
R10	224452	6148269
R11	224375	6147370
R12	225176	6147439
R13	229173	6154296
R14	230928	6150618
R15	231084	6150338
R16	231098	6150163
R17	230921	6149873
C1	227175	6149382
C2	225844	6149241
C3	226190	6148764
B1	226889	6152469
B2	226302	6150958
B3	226671	6149175
B4	227261	6148995
B5	226941	6148589
B6	230527	6150174
B7	230715	6149749
PR	225532	6149325

R - residential receiver (private)

C - commercial receiver

B - residential receiver (Boral owned)

PR - proposed residential dwelling (private)

Appendix B

Selection of Meteorological Year

Selection of meteorological year

The 2014 calendar year has been selected as the meteorological year for the dispersion modelling based on an analysis of the latest five years of meteorological data and wind patterns which reflect those patterns experienced in latest five years.

A statistical analysis of the latest five years of meteorological data from the nearest BoM weather station with suitable available data, Goulburn Airport AWS, is presented in **Table B-1**. The standard deviation of five years of meteorological data spanning 2012 to 2016 was analysed against the mean measured wind speed, temperature and relative humidity.

The analysis indicates that 2014 is closest to the average for wind speed and temperature and 2012 and 2015 is closest for relative humidity.

Figure B-1 shows the frequency distributions for wind speed, temperature and relative humidity of the 2014 year compared with the mean of the 2012 to 2016 data set. The 2014 year data appears to be well aligned with the mean data.

Therefore, based on this analysis it was determined that 2014 is generally representative of the long-term trends compared to other years and is thus suitable for the purpose of modelling.

Table B-1: Statistical analysis results of standard deviation from mean five year meteorological data at Goulburn Airport AWS

Year	Wind speed	Temperature	Relative humidity
2012	0.41	0.70	4.21
2013	0.41	1.02	4.47
2014	0.40	0.9	4.69
2015	0.51	1.13	4.21
2016	0.58	1.05	4.55

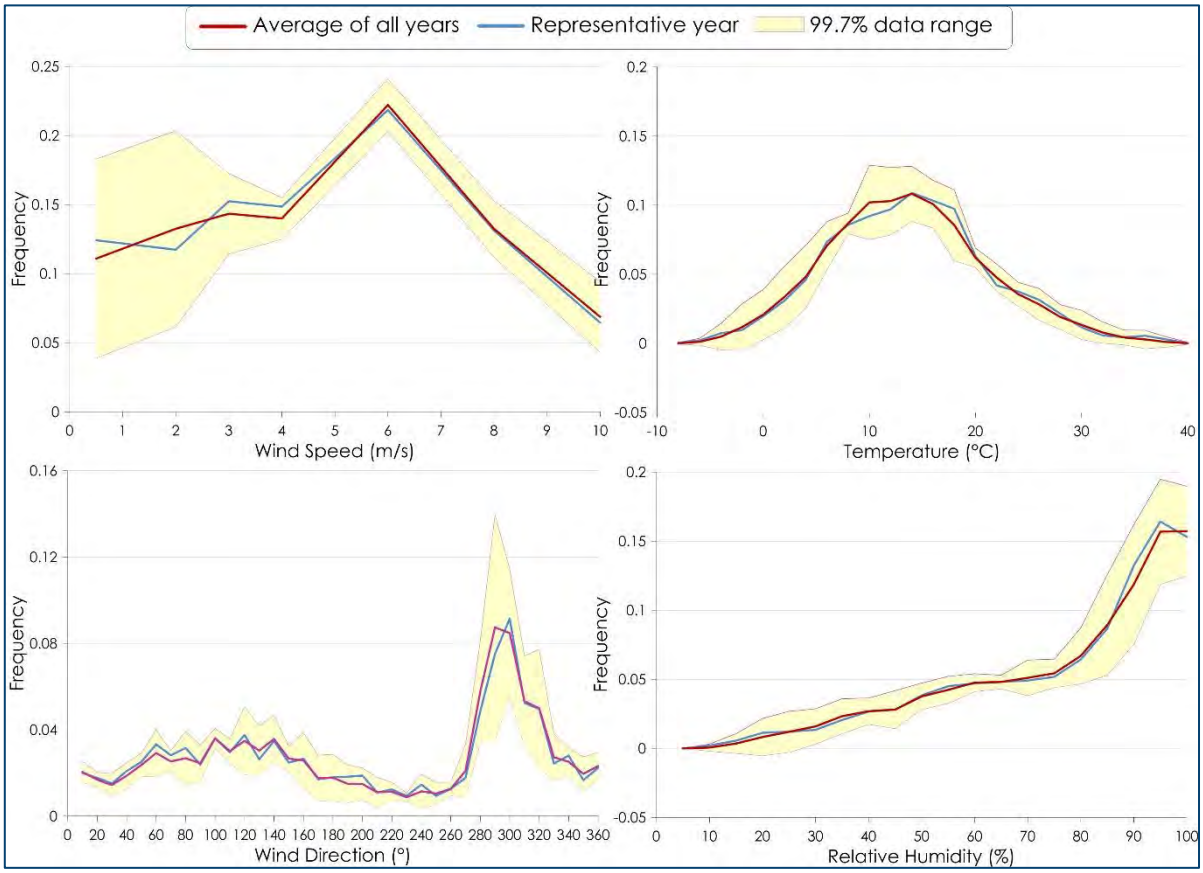


Figure B-1: Frequency distribution of meteorological parameters

Appendix C

Emission Calculation

Emission Calculation

The quarry production schedule and quarry plan designs provided by Boral have been combined with emissions factor equations that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- National Pollutant Inventory (NPI) documents "Emission Estimation Technique Manual for Mining, Version 3.1" (**NPI, 2012**);
- State Pollution Control Commission document "Air Pollution from Coal Mining and Related Developments" (**SPCC, 1983**); and,
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: International Best Practise Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining", prepared by Katestone Environmental (**Katestone Environmental, 2010**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. Detailed emission inventory for the modelled year is presented in **Table C-2**

Control factors include the following:

- Hauling on unpaved surfaces – 80% control for watering of trafficked areas. Note the control factor is only applied to the mechanically generated emissions and not the contributions from the diesel exhaust emissions.
- Drilling – 70% control for use of dust suppression.
- Conveyor – 70% control for enclosed conveyors.

Table C-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Drilling (overburden)	$EF = 0.59\ kg/hole$	$0.52 \times TSP$	$0.03 \times TSP$
Blasting (overburden)	$EF = 0.00022 \times A^{1.5}\ kg/blast$	$0.52 \times TSP$	$0.03 \times TSP$
Loading / emplacing material & conveyor transfer	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$
Dozers on overburden	$EF = 2.6 \times \frac{s^{1.2}}{M^{1.3}}\ kg/hour$	$EF = 0.45 \times \frac{s^{1.5}}{M^{1.4}} \times 0.75\ kg/hour$	$EF = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \times 0.105\ kg/hour$
Crushing (tertiary)	$EF = 0.0006\ kg/$tonne	$EF = 0.00027\ kg/$tonne	$EF = 0.00005\ kg/$tonne
Screening	$EF = 0.0011\ kg/$tonne	$EF = 0.00037\ kg/$tonne	$EF = 0.000025\ kg/$tonne
Crushing (fines)	$EF = 0.0015\ kg/$tonne	$EF = 0.0006\ kg/$tonne	$EF = 0.000035\ kg/$tonne
Fines screening	$EF = 0.0018\ kg/$tonne	$EF = 0.0011\ kg/$tonne	$0.075 \times TSP$
Wind erosion on exposed areas, stockpiles & conveyors	$EF = 3{,}504\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$
Grading roads	$EF = 0.0034 \times sp^{2.5}\ kg/VKT$	$EF = 0.0056 \times sp^{2.0} \times 0.6\ kg/VKT$	$EF = 0.0034 \times sp^{2.0} \times 0.031\ kg/VKT$

EF = emission factor, A = area of blast (m^2), U = wind speed (m/s), M = moisture content (%), s = silt content (%), VKT = vehicle kilometres travelled (km), sp = speed of grader (km/h).

Table C-2: Emissions inventory

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	TSP Emission Factor	PM10 Emission Factor	PM2.5 Emission Factor	Units	Var.1	Units	Var.2	Units	Var.3 - TSP/ PM10/ PM2.5	Units	Var.4	Units
Excavator loading overburden to haul truck	5,010	2,370	359	3,100,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Hauling overburden to emplacement area	86,774	19,410	1,941	3,100,000	t/yr	0.140	0.031	0.003	kg/t	40	tonnes/load	3.1	km/return trip	1.8/ 0.4/ 0.0	kg/VKT	80	%
Unloading overburden at emplacement area	5,010	2,370	359	3,100,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Dozer shaping overburden emplacement area	20,886	5,047	2,193	1,248	hr/yr	16.7	4.0	1.8	kg/h	10	S.C. (%)	2	M.C. (%)				
Drilling rock	3,068	1,595	92	17,333	holes/y	0.59	0.307	0.018	kg/hole							70	%
Blasting rock	1,880	977	56	52	blasts/y	36	18.80	1.08	kg/blast	3,000	Area of blast (m^2)						
Excavator loading rock to haul truck	6,465	3,058	463	4,000,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Hauling rock to hopper	35,772	8,002	800	4,000,000	t/yr	0.045	0.010	0.001	kg/t	40	tonnes/load	1.0	km/return trip	1.8/ 0.4/ 0.0	kg/VKT	80	%
Unloading rock at stockpile	6,465	3,058	463	4,000,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Excavator loading rock to hopper	6,465	3,058	463	4,000,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Primary crushing of material	2,400	1,080	200	4,000,000	t/yr	0.0006	0.0003	0.0001	kg/t								
Conveying material to screens (grizzly + scalp)	244	122	18	0.2	ha	3,504	1,752	263	kg/ha/yr							70	%
Conveyor transfer x5	9,697	917	139	4,000,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)			70	%
Screening material	4,400	1,480	100	4,000,000	t/yr	0.0011	0.0004	0.000025	kg/t								
Conveying material to surge pile	34	17	3	0.03	ha	3,504	1,752	263	kg/ha/yr							70	%
Unloading material to surge pile	5,657	2,675	405	3,500,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Unloading scalp material	1,293	612	93	800,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Loading scalp material to haul truck	1,293	612	93	800,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Hauling scalp material to stockpile (near train load o	6,797	1,520	152	800,000	t/yr	0.042	0.010	0.001	kg/t	40	tonnes/load	1.0	km/trip	1.8/ 0.4/ 0.0	kg/VKT	80	%
Unloading scalp material at stockpile	1,293	612	93	800,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Loading scalp material to trains	1,293	612	93	800,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Conveying material from surge pile to crusher	33	17	2	0.03	ha	3,504	1,752	263	kg/ha/yr							70	%
Crushing of material	2,100	945	175	3,500,000	t/yr	0.0006	0.0003	0.0001	kg/t								
Conveying material to screen	17	8	1	0.01	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveying material to screen w/ transfer	22	11	2	0.02	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveyor transfer x1	622	294	45	1,165,500	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)	1.1	Rehandle	70	%
Screening material	4,235	1,425	96	3,500,000	t/yr	0.0011	0.0004	0.000025	kg/t					1.1	Rehandle		
Conveying material to train load out Silo 1	114	57	9	0.10	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveying material to train load out Silo 2	34	17	3	0.03	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveyor transfer x1	246	117	18	462,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)	1.1	Rehandle	70	%
Conveying material to train load out Silo 3	37	18	3	0.03	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	TSP Emission Factor	PM10 Emission Factor	PM2.5 Emission Factor	Units	Var.1	Units	Var.2	Units	Var.3 - TSP / PM10 / PM2.5	Units	Var.4	Units
Conveyor transfer x1	338	160	24	633,500	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)	1.1	Rehandle	70	%
Conveying material to crusher (2)	36	18	3	0.03	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveyor transfer x1	1,230	582	88	2,306,500	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)	1.1	Rehandle	70	%
Crushing (2) of material	3,806	1,522	89	2,306,500	t/yr	0.0015	0.0006	0.0000	kg/t					1.1	Rehandle		
Conveying material to screen (2)	15	7	1	0.01	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Screening (2) material	1,975	1,207	148	997,500	t/yr	0.0018	0.0011	0.0001	kg/t					1.1	Rehandle		
Conveying material to train load out Silo 4	27	13	2	0.02	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveying material to train load out Silo 5	27	14	2	0.02	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveying material to train load out Silo 6 + 7	75	38	6	0.07	ha	3,504	1,752	263	kg/ha/yr					1.1	Rehandle	70	%
Conveyor transfer x2	1,396	330	50	1,309,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)	1.1	Rehandle	70	%
Screening (air sort) material	2,592	1,584	194	1,309,000	t/yr	0.0018	0.0011	0.0001	kg/t					1.1	Rehandle		
Unloading Limestone sand from Marulan	485	229	35	1,000,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)			70	%
Conveying material to train load out Silo 8	33	17	3	0.03	ha	3,504	1,752	263	kg/ha/yr							70	%
Conveying material to train load out from all Bins	140	70	10	0.13	ha	3,504	1,752	263	kg/ha/yr							70	%
Loading product material to trains	1,697	803	122	3,500,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)			70	%
Unloading overflow material from radial stacker	194	92	14	120,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Excavator loading overflow material to haul truck	194	92	14	120,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Hauling overflow material to stockpile (near train loa	423	95	9	120,000	t/yr	0.018	0.004	0.000	kg/t	40	tonnes/load	0.4	km/trip	1.8/ 0.4/ 0.0	kg/VKT	80	%
Unloading overflow material at stockpile	194	92	14	120,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Loading overflow material to trains	194	92	14	120,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Unloading test material from radial stacker	57	27	4	35,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Excavator loading test material to hopper	57	27	4	35,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Unloading rejects (weathered material) to haul truck	283	134	20	175,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Excavator loading rejects (weathered material) to ha	283	134	20	175,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Hauling rejects (weathered material) to emplacemer	5,271	1,179	118	175,000	t/yr	0.151	0.034	0.003	kg/t	40	tonnes/load	3.4	km/trip	1.8/ 0.4/ 0.0	kg/VKT	80	% Cont
Unloading rejects (weathered material) at emplacem	283	134	20	175,000	t/yr	0.00161	0.00076	0.00012	kg/t	1.365	$(W.S./2.2)^{1.3}$ (m/s)	2	M.C. (%)				
Grading roads	1,418	495	44	2,304	km	0.62	0.22	0.02	kg/VKT	8	speed (km/h)						
Wind erosion - Overburden emplacement area	21,024	10,512	1,577	6.0	ha	3,504	1,752	263	kg/ha/yr								
Wind erosion - Open pit	120,474	60,237	9,036	34.4	ha	3,504	1,752	263	kg/ha/yr								
Wind erosion - Infrastructure stockpiles	18,828	9,414	1,412	5.4	ha	3,504	1,752	263	kg/ha/yr								
Total emissions (kg/yr)	402,700	151,458	22,026														

Appendix D

Isopleth Diagrams

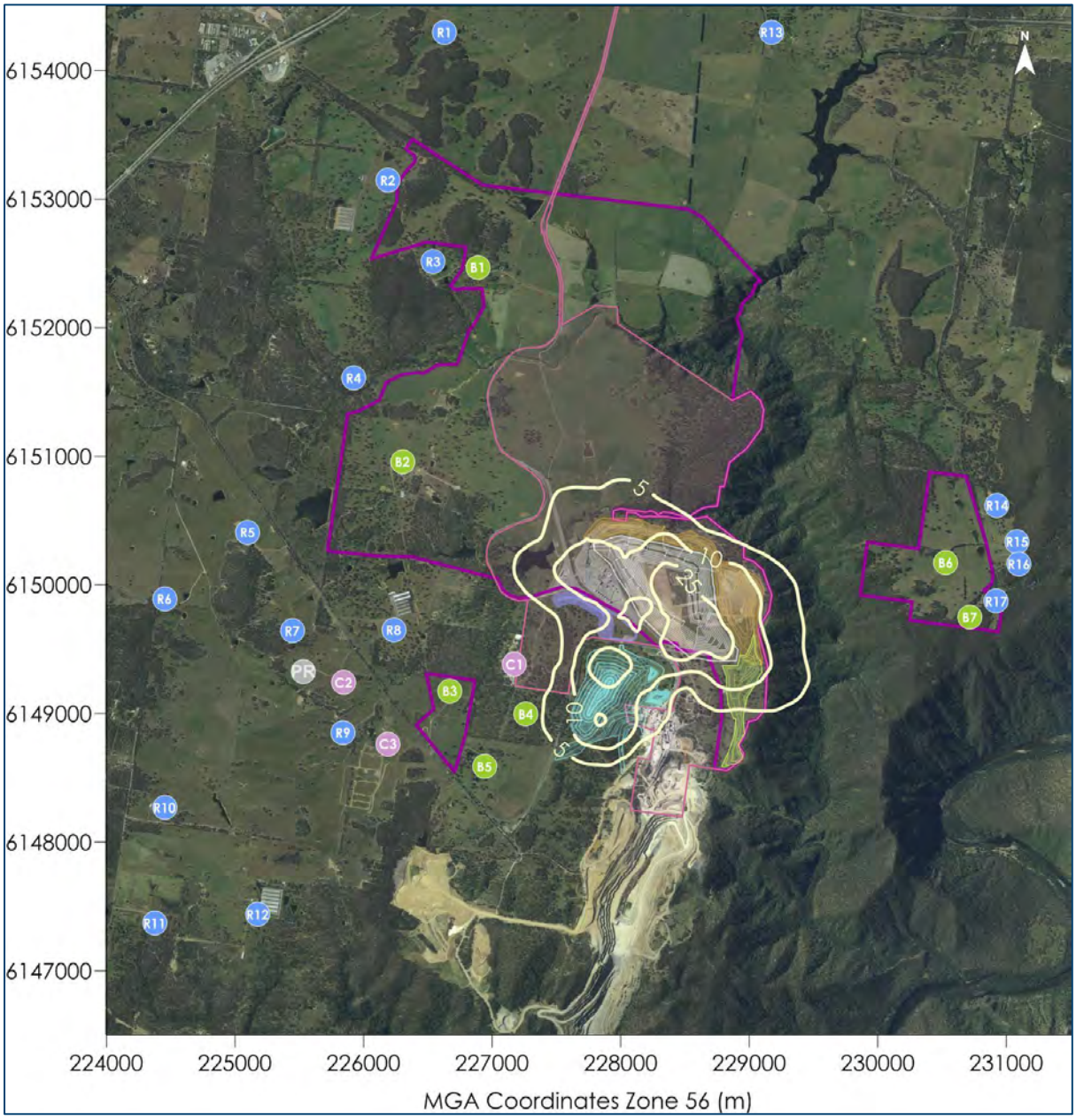


Figure D-1: Predicted maximum incremental 24-hour average $PM_{2.5}$ concentrations (µg/m³)

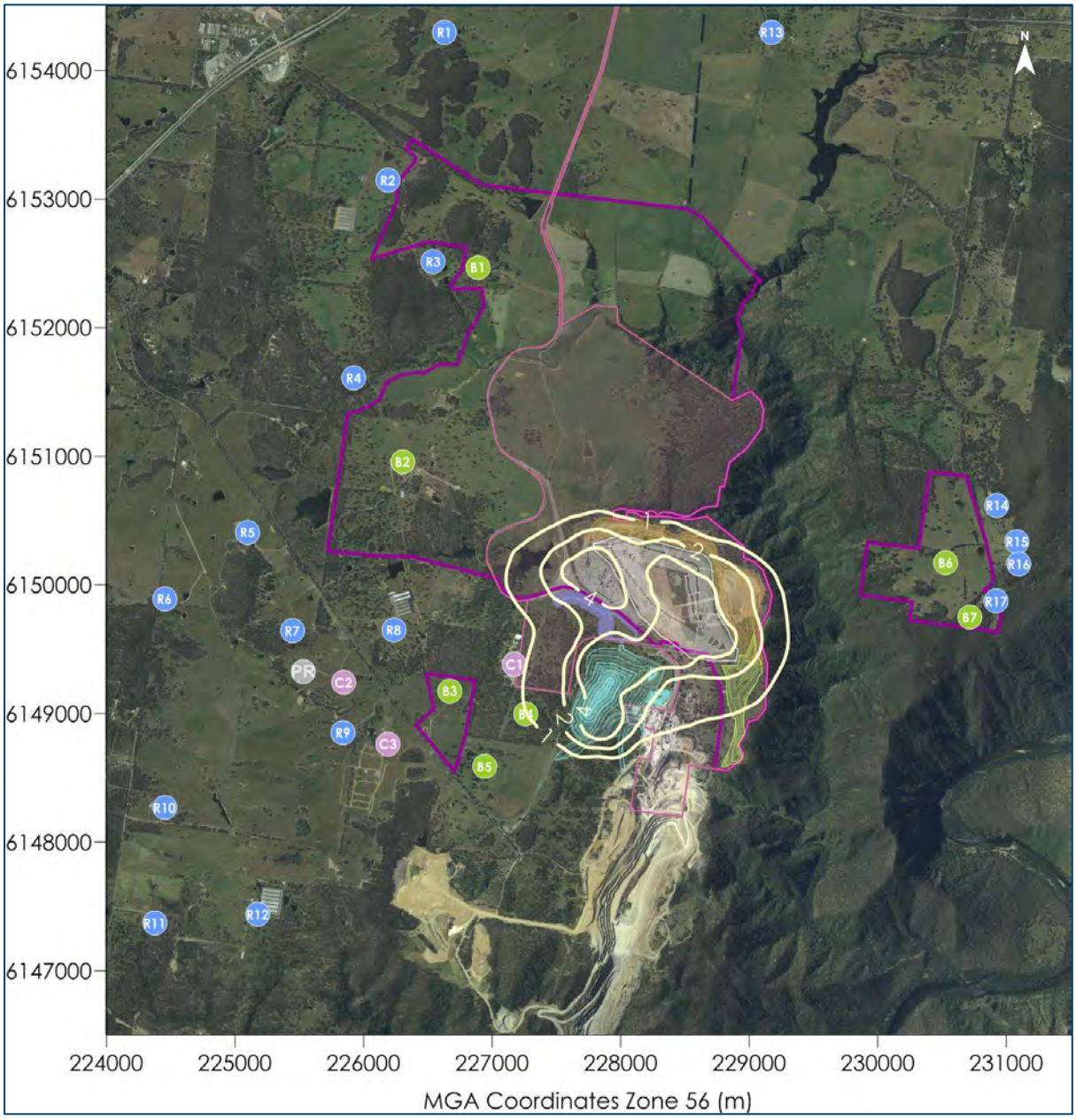


Figure D-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

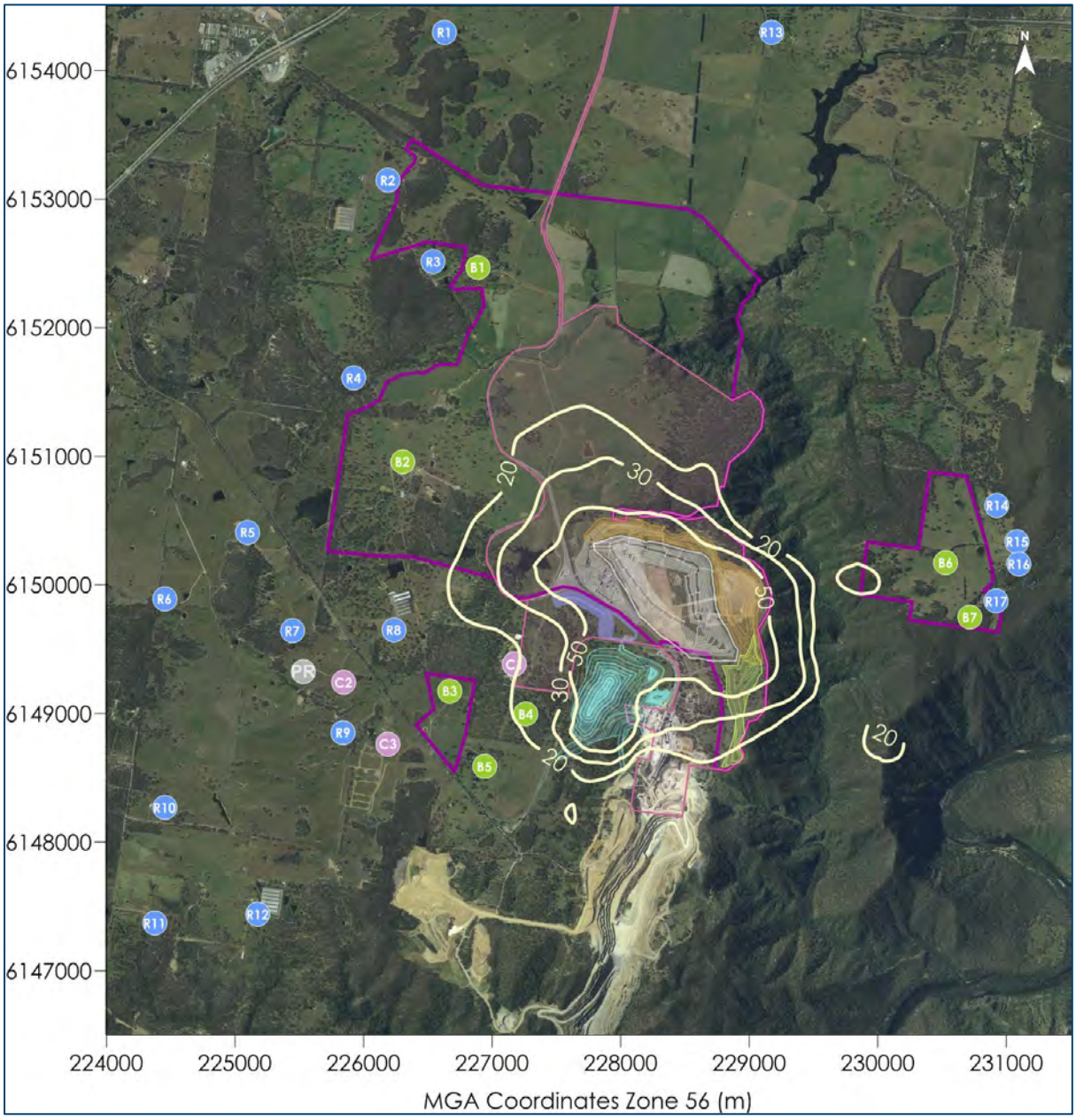


Figure D-3: Predicted maximum incremental 24-hour average PM_{10} concentrations (µg/m³)

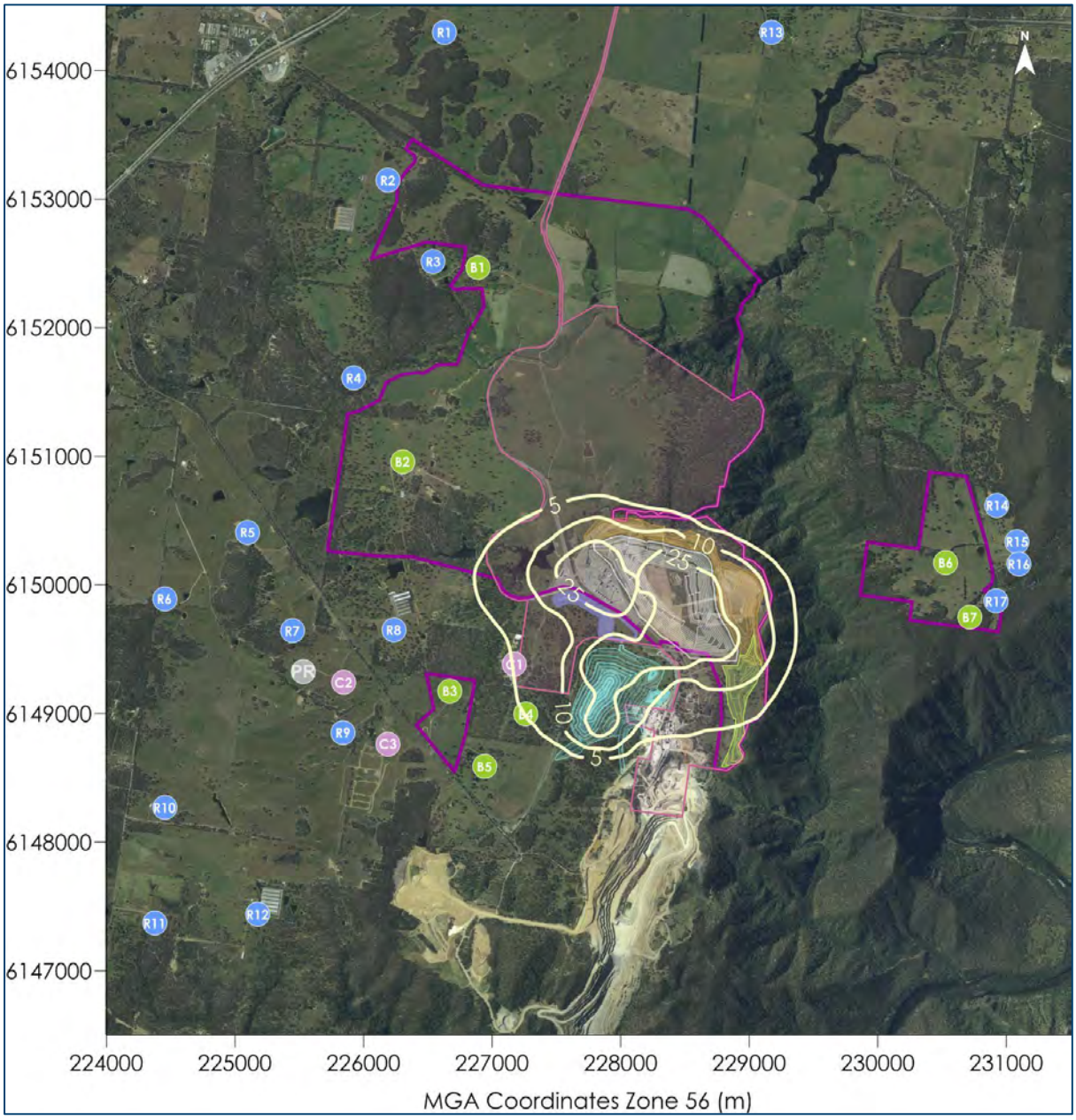


Figure D-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

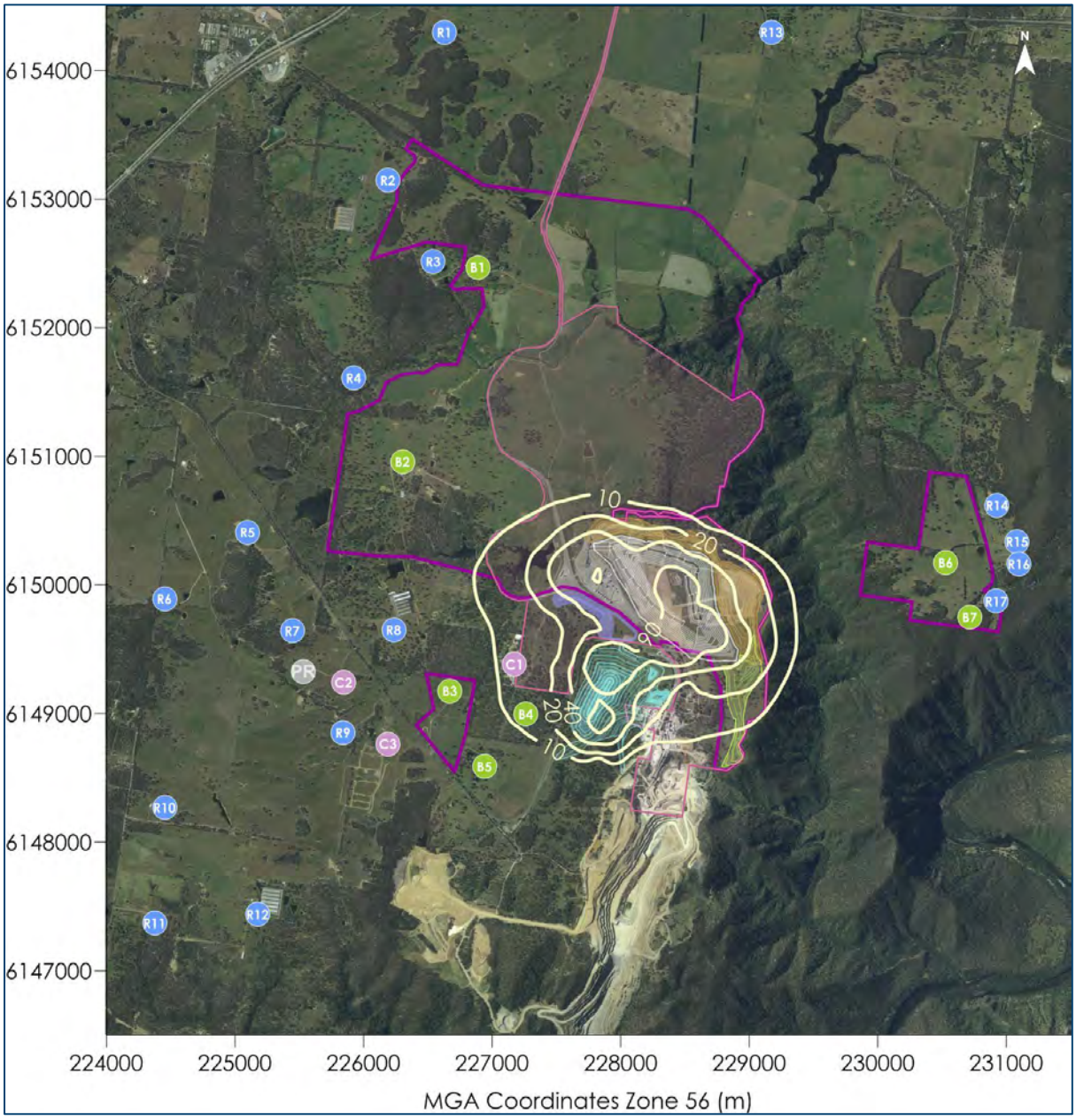


Figure D-5: Predicted incremental annual average TSP concentrations (µg/m³)

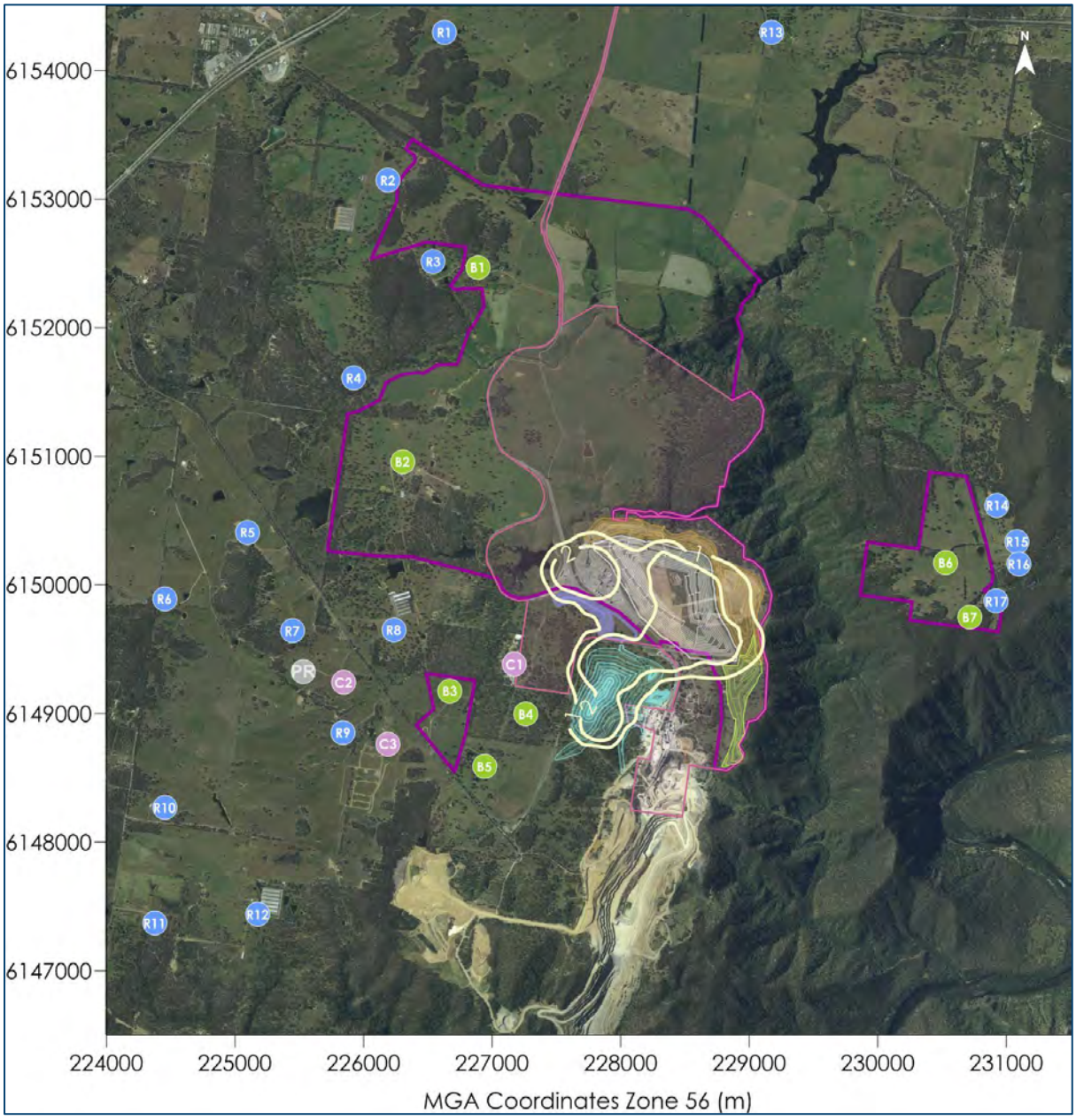


Figure D-6: Predicted annual average dust deposition levels (g/m²/month)

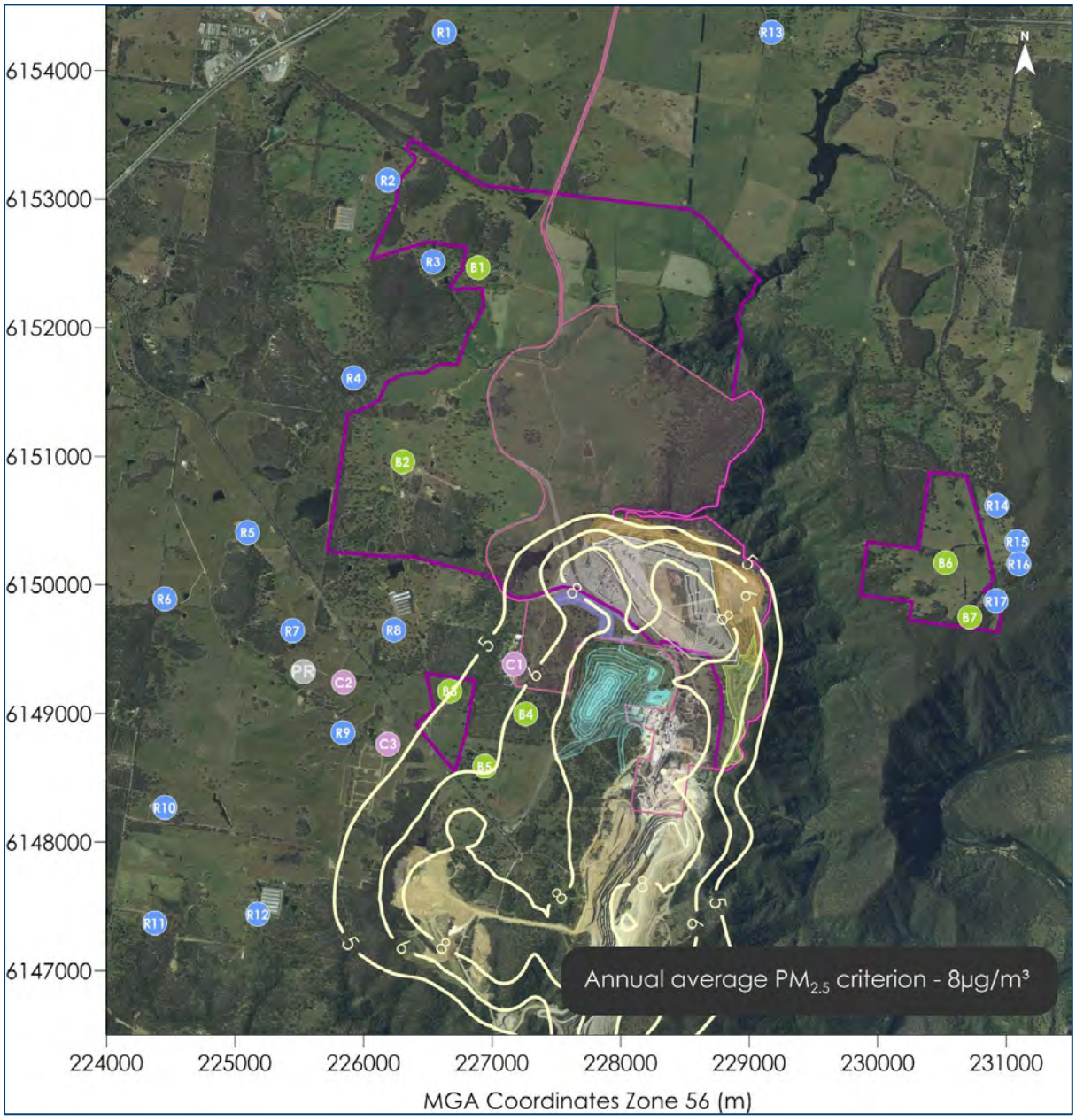


Figure D-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

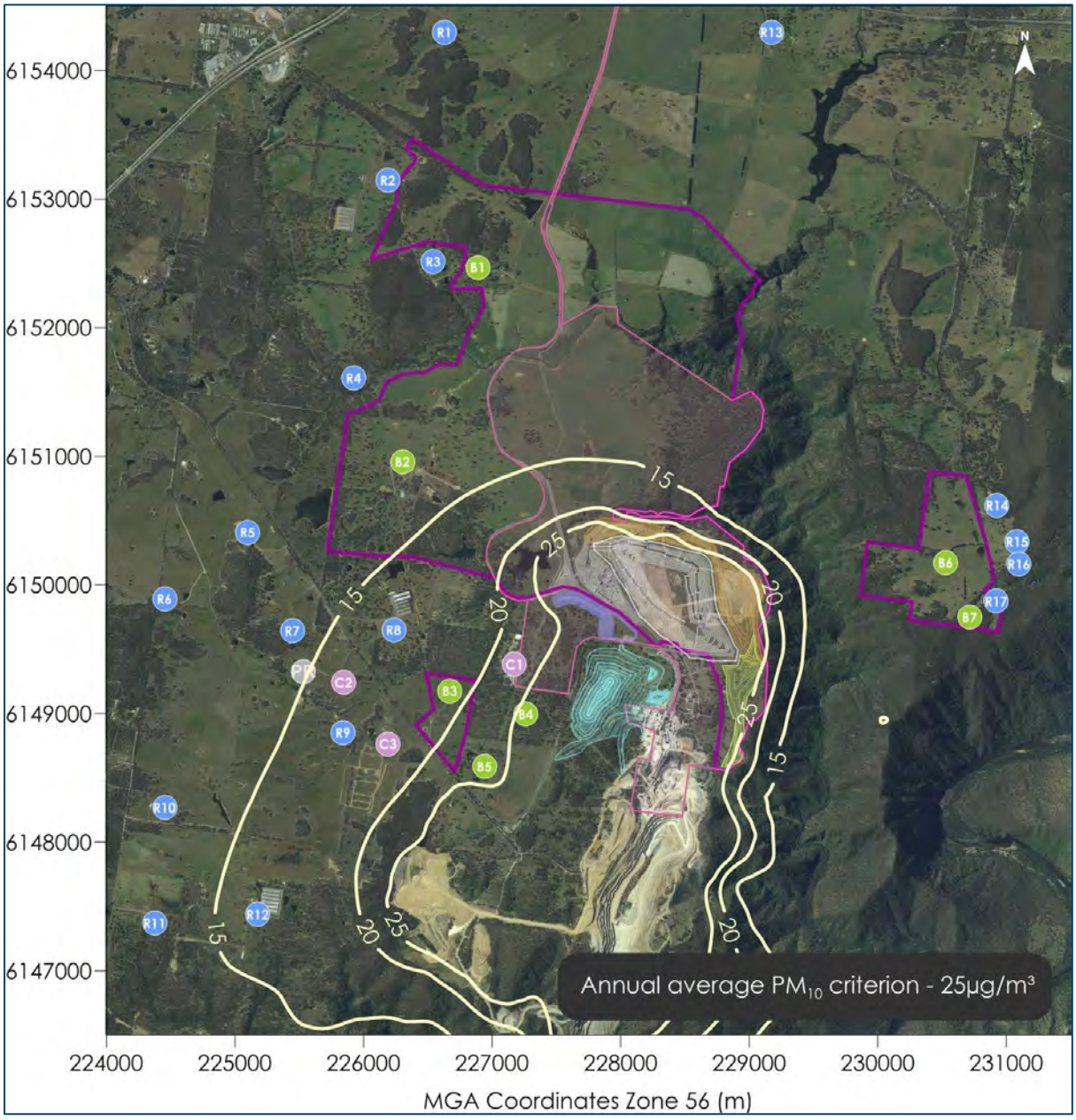


Figure D-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

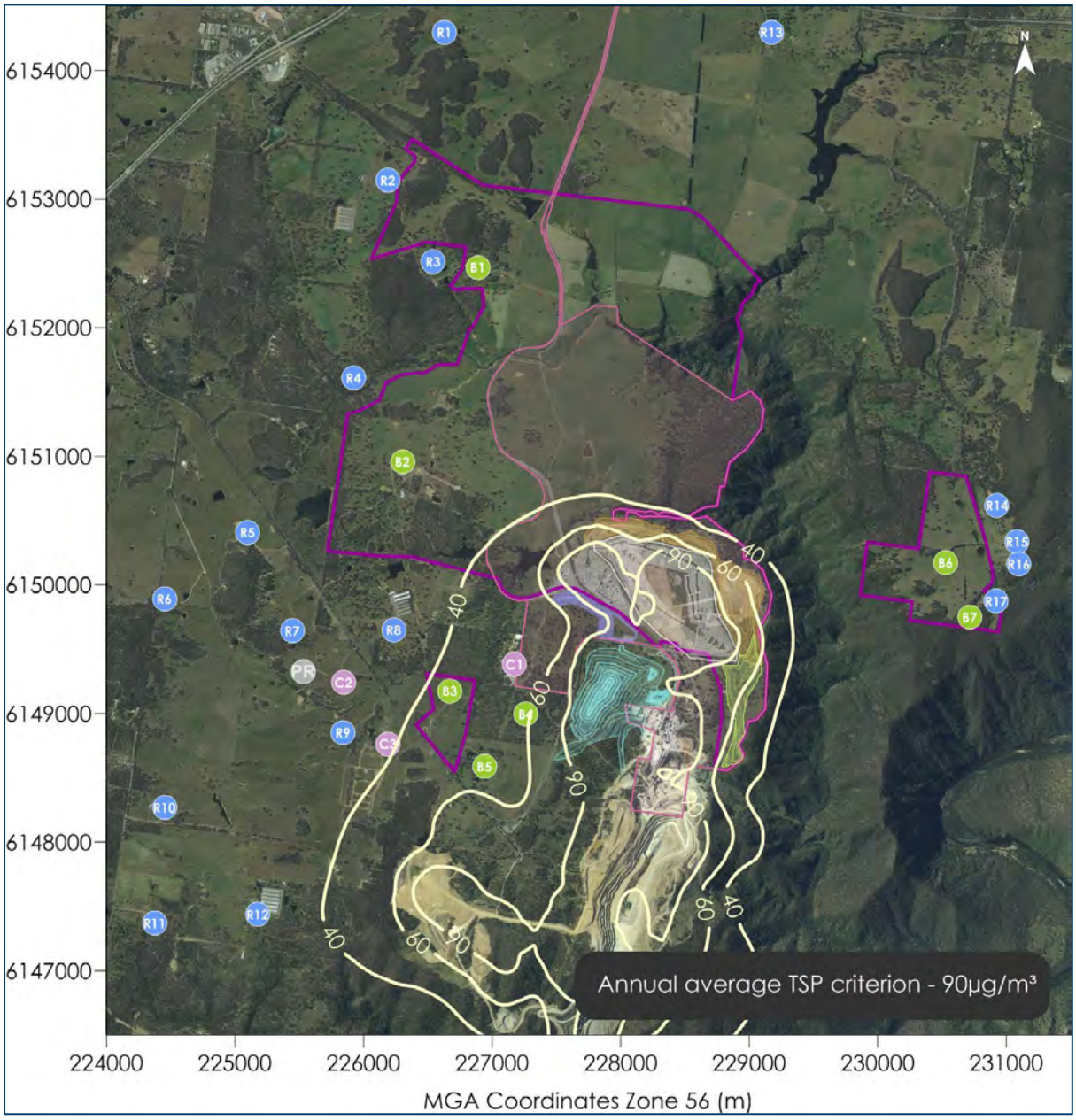


Figure D-9: Predicted cumulative annual average TSP concentrations (µg/m³)

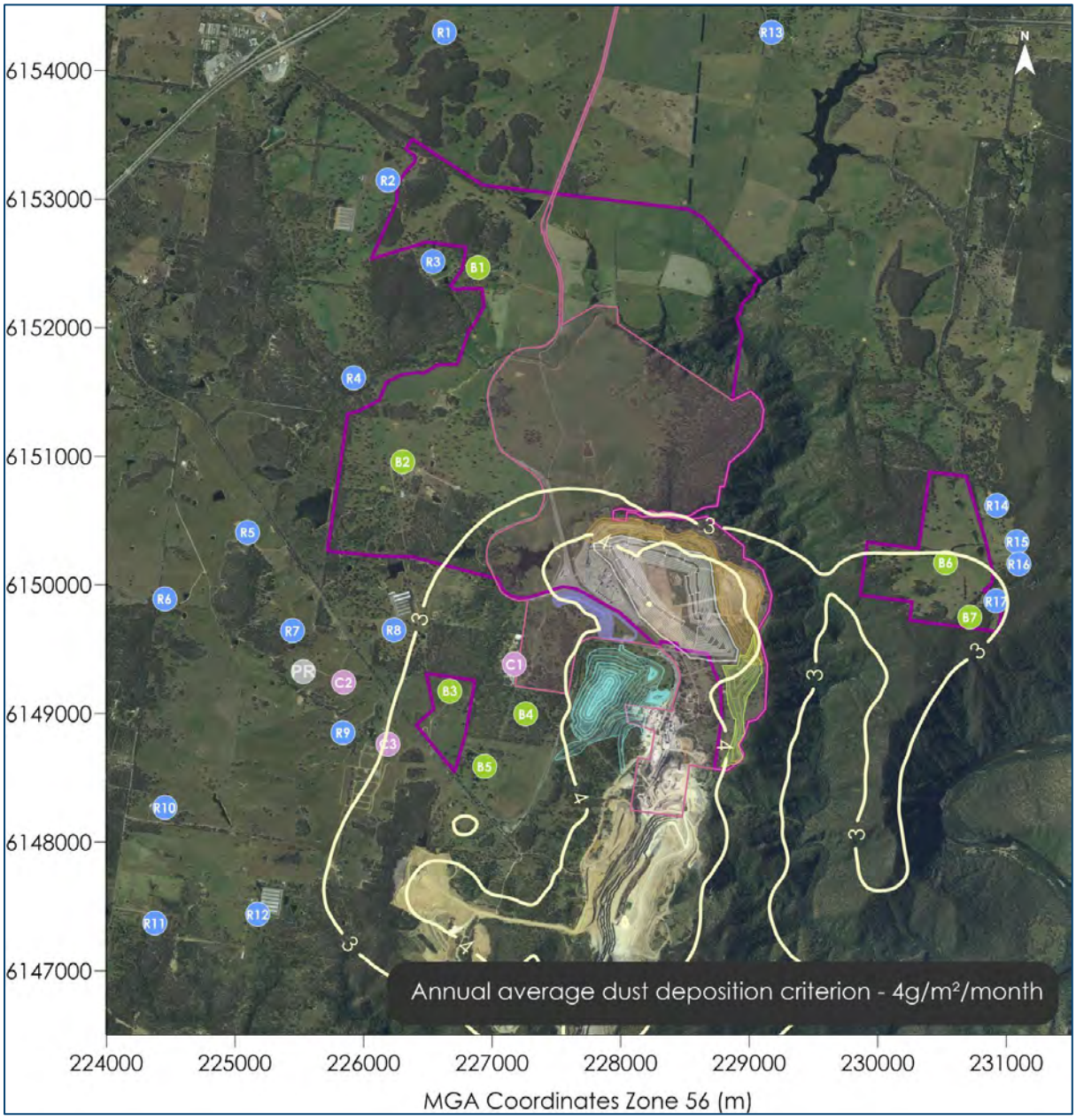


Figure D-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

Appendix E

Further detail regarding 24-hour PM_{10} analysis

Further detail regarding 24-hour PM_{10} analysis

The analysis below provides a cumulative 24-hour PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 46 to 47 of the Approved Methods.

The background level is the estimated ambient level at the nearest monitoring station (HVAS) excluding the contribution from the Quarry and the Limestone Mine.

The predicted increment is the predicted level to occur at the receiver due to the modified Quarry operations and incorporating the Limestone Mine.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Each table assesses one receiver. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the modified Quarry operations and continued operation of the Limestone Mine.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

Any value above the criterion of 50µg/m^3 are in **bold red**

Tables E-1 to **E-6** show the predicted maximum cumulative levels at each receiver surrounding the Quarry.

Please note that the 70th percentile of the measured HVAS level (20.7µg/m^3) is used on days when there is no monitoring data, hence this number appears frequently in the background levels in the tables.

Table E-1: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receiver R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
4/11/2014	42.8	0.0	42.8	19/08/2014	20.7	18.5	39.2
2/04/2014	41.9	0.1	42.0	24/03/2014	20.7	15.9	36.6
7/02/2014	41.5	0.1	41.6	6/06/2014	20.7	13.3	34.0
26/04/2014	28.1	0.0	28.1	9/06/2014	20.7	10.8	31.5
13/02/2014	25.5	0.3	25.8	5/04/2014	20.7	10.6	31.3
29/09/2014	25.0	0.0	25.0	30/08/2014	11.0	10.2	21.3
23/10/2014	25.0	0.1	25.1	4/09/2014	20.7	9.0	29.7
1/02/2014	24.9	0.4	25.3	29/08/2014	20.7	8.9	29.6
20/04/2014	21.1	0.0	21.1	14/04/2014	18.4	8.5	26.9
25/02/2014	20.7	0.0	20.7	28/08/2014	20.7	8.1	28.8

Table E-2: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receiver R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
4/11/2014	42.8	0.0	42.8	6/06/2014	20.7	15.0	35.7
2/04/2014	41.9	0.1	42.0	5/06/2014	20.7	12.0	32.7
7/02/2014	41.5	0.2	41.7	25/03/2014	20.7	11.5	32.2
26/04/2014	28.1	0.0	28.1	24/03/2014	20.7	11.2	31.9
13/02/2014	25.5	0.5	26.0	9/06/2014	20.7	11.0	31.7
29/09/2014	25.0	0.0	25.0	22/08/2014	20.7	10.4	31.1
23/10/2014	25.0	1.3	26.3	21/08/2014	20.7	10.1	30.8
1/02/2014	24.9	1.0	25.9	19/08/2014	20.7	9.7	30.4
20/04/2014	21.1	0.0	21.1	13/04/2014	20.7	9.5	30.2
25/02/2014	20.7	0.0	20.7	14/04/2014	18.4	9.5	27.9

Table E-3: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receiver R8

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
4/11/2014	42.8	1.2	44.0	28/02/2014	20.7	25.2	45.9
2/04/2014	41.9	0.2	42.1	1/03/2014	20.7	24.7	45.4
7/02/2014	41.5	4.0	45.5	22/08/2014	20.7	23.1	43.8
26/04/2014	28.1	0.0	28.1	7/04/2014	20.7	22.7	43.4
13/02/2014	25.5	7.7	33.2	25/03/2014	20.7	21.1	41.8
29/09/2014	25.0	0.1	25.2	5/06/2014	20.7	19.7	40.4
23/10/2014	25.0	6.8	31.8	13/03/2014	20.7	18.4	39.1
1/02/2014	24.9	13.1	37.9	2/03/2014	20.7	18.1	38.8
20/04/2014	21.1	0.1	21.2	30/05/2014	20.7	17.9	38.6
25/02/2014	20.7	0.4	21.1	9/03/2014	11.0	17.6	28.7

Table E-4: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receiver R9

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
4/11/2014	42.8	1.5	44.3	13/03/2014	20.7	22.0	42.7
2/04/2014	41.9	0.2	42.2	28/02/2014	20.7	22.0	42.7
7/02/2014	41.5	4.9	46.5	7/04/2014	20.7	21.5	42.2
26/04/2014	28.1	0.0	28.1	25/03/2014	20.7	19.2	39.9
13/02/2014	25.5	8.9	34.4	10/11/2014	6.1	19.2	25.3
29/09/2014	25.0	0.1	25.2	22/01/2014	20.7	18.8	39.5
23/10/2014	25.0	8.1	33.1	30/05/2014	20.7	18.5	39.2
1/02/2014	24.9	15.4	40.2	20/01/2014	11.0	18.4	29.5
20/04/2014	21.1	0.1	21.2	1/03/2014	20.7	17.7	38.4
25/02/2014	20.7	1.0	21.6	9/03/2014	11.0	17.6	28.7

Table E-5: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receiver R12

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
4/11/2014	42.8	3.2	46.0	10/11/2014	6.1	25.9	32.0
2/04/2014	41.9	0.2	42.2	27/12/2014	20.7	25.0	45.7
7/02/2014	41.5	6.0	47.5	12/09/2014	20.7	24.9	45.6
26/04/2014	28.1	0.0	28.1	13/01/2014	20.7	23.9	44.6
13/02/2014	25.5	9.1	34.5	23/02/2014	20.7	23.4	44.1
29/09/2014	25.0	0.1	25.1	27/04/2014	20.7	22.6	43.3
23/10/2014	25.0	6.8	31.8	11/02/2014	20.7	22.5	43.2
1/02/2014	24.9	15.0	39.8	20/12/2014	20.7	22.3	43.0
20/04/2014	21.1	0.0	21.1	12/02/2014	20.7	22.1	42.8
25/02/2014	20.7	1.5	22.2	9/12/2014	20.7	21.5	42.2

Table E-6: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receiver R17

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
4/11/2014	42.8	0.3	43.1	25/06/2014	3.8	13.6	17.4
2/04/2014	41.9	3.3	45.3	16/06/2014	20.7	12.6	33.3
7/02/2014	41.5	0.1	41.6	26/06/2014	20.7	12.4	33.1
26/04/2014	28.1	6.3	34.4	4/05/2014	20.7	12.4	33.1
13/02/2014	25.5	0.4	25.9	10/07/2014	20.7	11.9	32.6
29/09/2014	25.0	1.0	26.0	30/06/2014	20.7	11.2	31.9
23/10/2014	25.0	0.4	25.3	1/08/2014	20.7	11.1	31.8
1/02/2014	24.9	0.1	24.9	18/07/2014	20.7	11.0	31.7
20/04/2014	21.1	3.7	24.9	17/07/2014	20.7	10.8	31.5
25/02/2014	20.7	0.0	20.7	17/06/2014	20.7	10.5	31.2

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APPENDIX D

Biodiversity Development Assessment Report

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Environment and Heritage



Peppertree Modification 5

Biodiversity Development Assessment Report

Prepared for Boral Resources (NSW) Pty Ltd

October 2018

Document control

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Cover photograph: Location photo for the Peppertree Quarry Modification 5 site

Executive summary

Context

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE)
- extend the consent boundary to the south to encompass the SWOE
- construct a new haul road from the pit to the SWOE
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE
- amend the design of the Western Overburden Emplacement (WOE)
- remove the Western Earth Bund (which has not been constructed)
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Project Approval. The Minister for Planning is the consent authority for the proposed modification.

Aims

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to assess the ecological values and impacts associated with the Peppertree Quarry Modification 5 Project, and provide a Biodiversity Development Assessment Report (BDAR). This BDAR has applied the OEH (2017) Biodiversity Assessment Methodology (BAM) to describe and assess the ecological values within the study area and surrounds, and determine how the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). This report also has assessed the potential impacts of the Project on Matters of National Environmental Significance (MNES) under the Commonwealth Environment *Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Study area

The study area is approximately 48.33 ha, consisting of a mix of native woodland and gully forest vegetation and areas of exotic pasture grasses. A number of small farm dams also occur. Much of the site has been historically impacted by vegetation clearing and grazing.

Survey overview

Numerous surveys have been completed by Niche since 2015 within the study area. Surveys have included the following:

- Field survey using the OEH (2014) Framework for Biodiversity Assessment (FBA) completed by a botanist and ecologist from the 3rd to the 6th of February 2015, and 5th February 2018. The survey involved the collection of flora plot and transect data in accordance with the FBA and random meanders for threatened flora
- Fauna survey completed by two ecologists on 3rd to the 6th of February 2015, 11 October 2015, and 5th February 2018. Fauna survey included: Ultrasonic call recording for bats, camera trapping, diurnal bird surveys, spotlighting, call playback and listening, stag watching, Koala Spot assessments and opportunistic survey.

- Flora plots and transects and additional Koala survey as per the BAM completed on 31 July to 1 August 2018.

Native vegetation Assessment

Vegetation validation was undertaken as per the BAM which confirmed that the study area contained the following Plant Community Types (PCTs):

1. PCT778: Coast Grey Box – stringybarky dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin
2. PCT1334: Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands.

One non-native vegetation type that does not align to any PCT was also recorded within the study area. Different condition classes were given to the PCTs where obvious differences in structure and quality existed.

Vegetation alignment was confirmed and discussed on-site during consultation with OEH on the 16th June 2015.

Threatened flora

During the field survey, no threatened flora were recorded within the area proposed to be developed.

It is known based on previous field assessment for Boral, that the threatened *Solanum celatum* occurs within the locality, however this plant was not recorded during the targeted surveys.

Threatened flora

Fifty-five threatened fauna have been recorded or are predicted to occur within 10 km of the study area according to database searches and the BAM Credit Calculator. However, only one 'species credit fauna' - Large-eared Pied Bat was recorded on an Anabat device positioned towards the south of the study area.

Whilst not detected, the Koala was also determined to have habitat within the study area given the presence of feed trees, and known records within the locality.

As such, the assessment concludes that two 'species credit fauna', the Koala and Large-eared Pied Bat, have habitat within the study area.

A total of eight EPBC Act listed threatened fauna were also regarded to have potential habitat within the study area. Species include: Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Large-eared Pied Bat, Koala and Grey-headed Flying Fox.

Impacts – Native vegetation

The main impact on biodiversity associated with the Project is clearing of native vegetation and removal of habitat within the study area. The extent of clearing of native vegetation communities is conservatively estimated at 39.7 hectares.

One Threatened Ecological Community will be impacted by the Project – White Box Yellow Box Blakely's Red Gum Grassy Woodland, which is listed as an Endangered Ecological Community (EEC) under the BC Act and Critically Endangered Ecological Community (CEEC) under the EPBC Act. Approximately 27.68 hectares of the TEC would be impacted. An offset for the impact has been provided for this community as per the requirements of the FBA. An Assessment of Significance under the EPBC Act has also been conducted for the impact on the TEC. The Assessment concluded the Project is likely to significantly impact the CEEC.

Impacts – Threatened flora

No threatened flora are likely to be impacted by the Project given the lack of suitable habitat and results of the field survey. It is therefore unlikely that the Project will result in a significant impact to any threatened flora.

Impacts – Threatened fauna

Two species credit fauna, and eight EPBC listed threatened and migratory fauna are considered to be affected by the Project. Most of these species are likely to utilise the foraging habitat of the study area on an intermittent basis.

Both the Koala and Large-eared Pied Bat would be offset according to the requirements of the BAM.

Assessments of Significance completed for the EPBC Act listed fauna, has indicated that a significant impact toward the Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Large-eared Pied Bat, and Grey-headed Flying Fox is unlikely. The Assessment of Significance concluded that the Project would result in habitat fragmentation and loss of Koala habitat within the local area.

Avoidance and minimisation

The Project design process has demonstrated avoidance to biodiversity impacts as far as practical. Alternative locations were considered, however were dismissed based on noise, Aboriginal heritage values and logistics in transportation. The site selection for the Project has been largely dictated by:

- The availability of Boral owned land within the development consent boundary, that is not required for other quarry operations. The site is also located as far as possible from neighbouring residences.
- The proposed emplacement has been designed to avoid/minimise impacts to an adjacent area of good quality native vegetation that occurs to the west of Marulan South Road.
- Progressive and final revegetation and rehabilitation to create a stable landform that does not result in the sediment laden runoff, fugitive dust emissions, blends well with the adjacent natural landscapes of the Morton National Park and re-establishes a native bushland dominated by White Box Yellow Box Blakely's Red Gum Grassy Woodland species.

Mitigation and management

The Project will reduce impacts to biodiversity through:

- Undertaking vegetation clearing in accordance with the Vegetation Clearance Protocol described in section 4.1 (impacts arising from the construction will primarily relate to vegetation clearing).
- Fencing and signposting erected as close as possible to the edge of the proposed overburden emplacement disturbance footprint as described in section 4.1.
- Educating employees and/or contractors involved in the construction of the overburden emplacement.
- Update and implementation of the existing Peppertree Quarry Landscape and Rehabilitation Management Plan as described in section 6.4.9.
- Dust suppression.
- Procedures for the management of spills throughout the study area including the requirements for vehicles to carry spill kits.
- Management and removal of all rubbish from the study area.

Credit calculations

The ecosystem credits required to offset the Project equate to the following:

- Total of 157 credits for PCT 774 Coast Grey Box - stringybark dry woodland on slopes of the Shoalhaven Gorges, southern Sydney Basin Bioregion (SR534)
- Total of 424 credits for PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670).

The species credit required for the Project include:

- A total of 514 credits for the removal of 27.1 hectares of Koala habitat
- A total of 772 credits for the removal of 27.1 hectares of Large-eared Pied Bat habitat.

Offset strategy

In order to satisfy the biodiversity offset requirement for the Project, Boral propose to establish Stewardship sites on two parcels of land which would ensure in perpetuity management and protection native vegetation, White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, known Koala habitat and known Large-eared Pied Bat habitat. Both properties would satisfy the State and Commonwealth offset liability of the Project, with excess BAM credits that could be used for future Projects.

Glossary

Term	Definition
Clearing area	Means the area directly impacted by the site either by clearing of vegetation or trimming of vegetation.
Development envelope	The location of the proposed development including overburden emplacement area, Western Overburden Emplacement (WOE), powerline, dam and haul road. Direct impacts occur wholly within this area.
Indirect impacts	Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas.
Locality	The site and surrounds, nominally a 10 km radius from the Site.
Subject site (Site)	Means the area directly affected by the Peppertree Quarry Modification 5 Project.
Study area	The area of direct and indirect impact

Abbreviations

Acronym	Term/Definition
BAM	Biodiversity Assessment Methodology
BDAR	Biodiversity Development Assessment Report
BAM Calculator	Biodiversity Credit Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BMP	Biodiversity Management Plan
BOS	*NSW Biodiversity Offsets Scheme*
CEEC	Critically Endangered Ecological Community
DP&E	NSW Department of Planning and Environment
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ha	Hectare/s
IBRA	Interim Biogeographic Regionalisation for Australia
MNES	Matters of National Environmental Significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*).
OEH	Office of Environment and Heritage (formerly DECCW, DECC, DEC)
PEA	Preliminary Environmental Assessment
PCT	Plant Community Type
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
SSD	State Significant Development
TEC	Threatened Ecological Community

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1. Introduction to Biodiversity Development Assessment

1.1 Introduction

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry located in Marulan South, New South Wales.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE)
- extend the consent boundary to the south to encompass the SWOE
- construct a new haul road from the pit to the SWOE
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE
- amend the design of the Western Overburden Emplacement (WOE)
- remove the Western Earth Bund (which has not been constructed)
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Project Approval. The Minister for Planning is the consent authority for the proposed modification.

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to assess the ecological values and impacts associated with the Peppertree Quarry Modification 5 Project, and provide a Biodiversity Development Assessment Report (BDAR). This BDAR has applied the OEH (2017) Biodiversity Assessment Methodology (BAM) to describe and assess the ecological values within the study area and surrounds, and determine how the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). This report also has assessed the potential impacts of the Project on Matters of National Environmental Significance (MNES) under the Commonwealth Environment *Protection and Biodiversity Conservation Act 1999* (EPBC Act). This report also identifies avoidance, mitigation and offsets for the Project.

1.2 The project

1.2.1 General description of Site

The Quarry is located in Marulan South, 10 kilometres (km) southeast of Marulan, 35 km east of Goulburn and approximately 175 km south-west of Sydney, within the Goulburn Mulwaree Local Government Area (LGA) in the Southern Tablelands of NSW (Figure 1 and Figure 2).

Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine with the Hume Highway approximately 8 km to the north-west. Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 5 km to the north.

The Quarry is on approximately 650 ha of Boral owned land, which includes the Quarry site (occupying approximately 70 ha), additional granodiorite resources to the south and surrounding land.

1.3 Approved Project

1.3.1 Quarry Activities and Infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1 - 2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28 - 50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from Boral's adjacent Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities.

Work to establish the Quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

1.3.2 Transport of Product

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of Department of Planning and Environment (DP&E). The Quarry has approval to transport up to 3.5 Mtpa of product from the site. At full production the Quarry will operate up to four trains per day which will transport product north to the Sydney market and other customers. In addition, the Limestone Mine currently operates up to six trains per day transporting product north to Berrima and Maldon and east to Port Kembla.

Trains to the Quarry and the Limestone Mine access Boral's private rail line from the Main Southern Railway at the Medway Junction. The rail line is mostly single track with a 1 km length of triple line track used for shunting and train loading and a 1.2 km passing loop at Medway Junction. A rail loop has been constructed at the Quarry for separation of rail movements on the rail line between the two Boral sites. Rail loading facilities were also established on the rail loop adjacent to the Quarry's processing plant.

Loading of product from the Quarry onto trains and train movements occur 24 hours, seven days a week. This enables train trips on the Main Southern Railway to be scheduled away from peak commuter times.

1.3.3 Operating Hours and Workforce

The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5am to 11pm. Approved operating hours are outlined in detail in Table 1.

Table 1. Approved operating hours

Activity	Day	Time
Construction works	Monday to Friday Saturday Sunday and public holidays	7.00 am to 6.00 pm 8.00 am to 1.00 pm None
Topsoil/overburden removal/emplacement	Any day	7.00 am to 7.00 pm
Blasting	Monday to Saturday Sunday and public holidays	9.00 am to 5.00 pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00 am to 11.00 pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

1.4 Proposed modifications

1.4.1 Description of the Proposed Modifications

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE)
- extend the consent boundary to the south to encompass the SWOE
- construct a new haul road from the pit to the SWOE
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE
- amend the design of the Western Overburden Emplacement (WOE)
- remove the Western Earth Bund (which has not been constructed)
- relocate a powerline which runs through the proposed SWOE site.

1.4.2 New Overburden Emplacement

Overburden emplacement at the Quarry is currently approved within noise bunds located along the northern and eastern boundaries of the site, an emplacement area to the east of the approved quarry pit (Eastern Overburden Emplacement), an emplacement area to the south of the approved quarry pit (Southern Overburden Emplacement) and an emplacement area (Western Overburden Emplacement) and noise bund (Western Earth Bund) to the west of the Quarry. Remaining overburden is approved to be emplaced in the south pit of the Limestone Mine.

The noise bunds were completed during construction of the Quarry, the Eastern Overburden Emplacement reached capacity in 2017 and the Southern Overburden Emplacement is likely to be completed by late 2018. Part of the Western Overburden Emplacement is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine.

Mine planning for the Limestone Mine has ruled out emplacement of the Quarry's remaining overburden in the south pit. There is substantial limestone remaining in the south pit and extraction of this will continue beyond the Quarry's need for additional overburden emplacement space. Additionally, as much in-pit space as possible needs to be created in the south pit to minimise the need for future out of pit emplacements at the Limestone Mine.

The Limestone Mine, under its forthcoming development application (Limestone Mine Project), was seeking to hold 5 million m3 (approximately 13 Mt) of overburden for the Quarry, however, this is unlikely

to be approved until 2019. As the Quarry will run out of overburden emplacement space in 2018, Boral is seeking approval for this approximately 13 Mt overburden emplacement.

The proposed new South-western Overburden Emplacement will be located to the south of the Western Overburden Emplacement, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and will take approximately 4 years to establish.

An existing high voltage powerline that supplies power to the Limestone Mine traverses the proposed location of the new South-western Overburden Emplacement. This section of powerline will need to be relocated along the toe of the emplacement, adjacent to Marulan South Road.

As the proposed new South-western Overburden Emplacement is located outside Peppertree Quarry's consent boundary, an amendment to the consent boundary is part of this modification application.

The proposed emplacement will therefore be landscaped and rehabilitated in accordance with the existing Peppertree Quarry Landscape and Rehabilitation Management Plan.

1.5 Study area

The study area occurs within the Southern Rivers Catchment Management Area (CMA), South Eastern Highlands IBRA Bioregion (Interim Biogeographic Regionalisation for Australia), and, Bungonia Tableland and Gorge Mitchell Landscape (Figure 3). The study area is approximately 48.33 hectares.

Within the study area, the land directly disturbed by the Project is referred to as the subject site. The area of direct and indirect impact is referred to as the study area.

1.6 State approval and assessment process

1.6.1 Application of the BAM

This BDAR has applied the BAM in order to assess impacts on biodiversity. The BAM is a new framework for assessment of biodiversity impacts and determination of offsetting requirements for major projects under the NSW Biodiversity Offsets Scheme (BOS).

This assessment has used the BAM Calculator (version 1.2.1.00).

1.7 Commonwealth approval and assessment process

Matters of National Environmental Significance (MNES) are protected under the EPBC Act. The BAM requires proponents to identify and assess the impacts on all nationally listed threatened species and threatened ecological communities that may be present on or near the study area. Therefore, the BAM has partly been used to perform assessment of impacts under the EPBC Act. Further assessment of impacts under the EPBC Act has been undertaken via assessments of significance for EPBC Act listed species with the potential to be affected by the proposed project (Appendix 8).

In addition, a Commonwealth Referral, was prepared and submitted to the Department of the Environment and Energy (DoEE) in June 2018 (EPBC 2018/8243).

On the 15 October 2018, the Project was considered a Controlled Action by DoEE, and Supplementary SEARs provided to be addressed in the Biodiversity Impact Assessment. The key matters raised in the SEARs that are applicable to this Biodiversity Impact Assessment, and the section within this report, is outlined in Table 2.

Table 2. Supplementary SEARs from DoEE

SEARS	Addressed in report
The project will be assessed under an accreditable process under Part 4, Division 4.7 of the Environmental Planning and Assessment Act 1979 (EP&A Act), addressing the matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulation 2000 (Cth). These requirements do not stand alone but are a supplement to any assessment requirements provided by the New South Wales Department of Planning and Environment and must be addressed in conjunction with those requirements. The requirements are intended such that there is sufficient information in the assessment report relevant to MNES such that the Commonwealth decision-maker may make a determination whether or not to approve the action.	MNES addressed throughout this BDAR. The BDAR has followed the BAM.
3. The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in paragraph 1. A list of protected matters the Department of the Environment and Energy considered likely to be significantly impacted is provided in Attachment A to these Guidelines. Note that this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under this controlling provision, likely to be significantly impacted, are assessed for the Commonwealth decision-maker's consideration. The Department of the Environment and Energy considers that there are likely to be significant impacts to: • White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – critically endangered; • Regent Honeyeater (Xanthomyza phrygia) – critically endangered; • Large-eared Pied Bat (Chalinolobus dwyeri) – vulnerable; and • Koala (Phascolarctos cinereus) (combined populations of QLD, NSW and the ACT) – vulnerable.	EPBC Act Assessments of Significance have been completed for all EPBC Act listed threatened species that may be impact by the Project (Appendix 8) and discussed in section 4.7.2.
The EA must provide the following details: 5. The title of the action, background to the action of the action and current status.	Section 1.2
6. The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Section 1.4
7. How the action relates to any other actions that have been, or are being taken in the region affected by the action.	Section 5.3.3
8. How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	See discussion on avoidance and mitigation – section 5.1.
9. A justification for the proposal including consideration of any less detrimental sites for the emplacement area, for example other cleared sites within the property boundary.	See discussion on avoidance and mitigation – section 5.1.

SEARS	Addressed in report
10. The EA must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including: i. a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts; ii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; iii. analysis of the significance of the relevant impacts; and iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	See Table 10 in regards to direct and indirect impacts.
Avoidance, mitigation and offsetting 11. For each of the relevant matters protected that are likely to be significantly impacted by the action, the EA must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: i. a description, and an assessment of the expected or predicted effectiveness of the mitigation measures, ii. any statutory policy basis for the mitigation measures; iii. the cost of the mitigation measures; iv. an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing; v. the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Effectiveness of mitigation measures provided in Table 10. Cost of mitigation measures have been incorporated into the pre-feasibility assessment of the Project and discussed in section 5.1.3 An outline the Environmental Management Plan is provided in Appendix 10. The details of the agency responsible for endorsing or approving the mitigation measures is provided in the Environmental Management Plan.
12. Where a significant residual adverse impact to a relevant protected matter is considered likely, the EA must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	Offset strategy provided in section 6.
13. For each of the relevant matters likely to be impacted by the action the EA must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any: i. conservation advice or recovery plan for the species or community, ii. relevant threat abatement plan for a process that threatens the species or community iii. wildlife conservation plan for the species iv. any strategic assessment.	Incorporated into the EPBC Act Assessments of Significance.

SEARS	Addressed in report
14. The EA must identify each EPBC Act listed threatened species and community likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.	See section 5.2.
15. For each of the EPBC Act listed threatened species and communities and likely to be impacted by the action the EA must provide a separate: a. description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans; b. details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements; c. description of the relevant impacts of the action having regard to the full national extent of the species or community's range; and d. description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action; e. identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account; f. a description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established. g. details of how the current published NSW Biodiversity Assessment Method (BAM) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; and h. details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the BAM and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites;	a) EPBC Act listed biodiversity impacted discussed in section 5.3, section 5.3.1, and Appendix 8. b) surveys detailed in section 3.2.3 and section 4.2 c) impacts in relation to Box Gum Woodland discussed in section 5.3.2 and Appendix 8. d) avoidance and mitigation detailed in section 5.1 e) impacts after mitigation provided in section 5.2 f) offsets provided in section 6 g) Detailed regarding BAM and EPBC Offset Policy provided in section 6. h) details of the area and credits from the offset sites provided in section 6, however no figures have been provided due to confidentiality reasons – Boral can provide separately in confidence as required.
16. Any significant residual impacts not addressed by the BAM may need to be addressed in accordance with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy. http://www.environment.gov.au/epbc/publications/epbc-actenvironmental-offsets-policy.	g) Detailed regarding BAM and EPBC Offset Policy provided in section 6.
19. For information given in an EA, the EA must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	All text has been appropriately referenced where required. EPBC Act Protected Matters Search was completed in September 2018.

1.8 Assessment objectives and format

The primary objective of this assessment is to use the guidelines and methodology provided in the BAM to determine the impact the project would have on biodiversity, avoid and mitigate these impacts and then calculate the project's biodiversity offset requirement. In addition, impacts on Commonwealth MNES are addressed through the process of the BAM and by assessments of significance for potentially impacted species.

This BDAR has two broad stages consistent with the BAM methodology:

Stage 1 – Biodiversity Assessment

- assessment of landscape features
- assessment of native vegetation
- assessment of threatened species and populations.

Stage 2 – Impact Assessment

- avoid and minimise impacts on biodiversity values
- consider impact and offset thresholds
- determine and calculate offset requirements.

1.9 Assessment resources and assessor qualifications

This BDAR has been prepared by the following accredited assessors or experts:

- Luke Baker – Senior Ecologist/Ecology Team Leader/Accredited Biodiversity Assessor: flora and fauna field survey, data management, data entry, credit calculations, review of credit calculations, report preparation
- Simon Tweed – Field survey
- Amanda Griffiths – Field survey.

Other specialist staff involved in preparing the assessment include:

- Alex Christie – Ecologist: field survey, reporting
- Lucy Porter – Ecologist: field survey
- Dr Ross Jenkins and Greg Tobin: mapping.

1.10 Consultation

Consultation with the Office of Environment and Heritage (OEH) was undertaken in relation the Limestone Mine Project, however the area that was investigated during the inspection was the study area. Table 2 below summarises they key issues covered during correspondence associated with the Limestone Mine Project which overlaps with this BDAR.

Table 3. Relevant consultation with OEH

Dates of consultation	Relevant key issues/discussion points	How are the issues addressed in this report?
17/04/2015	17th of April 2015 Phone call with Catherine Ellis of OEH to discuss approval pathways and suggested approach to biodiversity assessment for Peppertree Modification 4 and Marulan South Project – the current Project is part of the initial Marulan South Project footprint.	Report has been undertaken using methods consistent with the FBA.

Dates of consultation	Relevant key issues/discussion points	How are the issues addressed in this report?
09/06/2015 11/06/2015	Phone call with Stewart Lloyd (GM Council). Enquired as to any Council mapping of vegetation with emphasis on EEC/CEECs. Council's mapping is limited – there is some collaboration between Council and the recent mapping project by OEH led by John Briggs with a focus on identification of White Box Yellow Box Blakely's Red Gum Woodland.	Consultation with OEH on latest mapping project. Ensures vegetation mapping used for wider locality is the best available and that corridors are identified. Enabled Council's input regarding any concerns or issues for addressing.
9/6/2016	Meeting on-site with Miles Beok, and John Briggs regards the difficulty with aligning the vegetation units recorded on-site with an appropriate Plant Community Type (PCT). This consultation overlaps with the Marulan South Project as both Projects utilise the same study area. Key conclusions from the meeting and site inspection include the following: Agreed that vegetation on-site was likely to align to the following best fit BVTs and their associated Tozer (2006) mapping unit: SR624 Silvertop Ash - Blue-leaved Stringybark shrubby open forest on ridges, north east South Eastern Highlands Bioregion (this is equivalent to P10. Eastern Tablelands Dry Forest). SR534 Coast Grey Box - stringybark dry woodland on slopes of the Shoalhaven Gorges, southern Sydney Basin Bioregion (this is equivalent to P27. Bungonia Slates Woodland). SR670 Yellow Box grassy woodland of the northern Monaro and Upper Shoalhaven area, South Eastern Highlands Bioregion (this is equivalent to P24. Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland). SR534 Coast Grey Box - stringybark dry woodland has an estimated cleared percentage of 15% within the CMA. Most of this vegetation community is within Bungonia State Conservation Area and Morton National Parks or Crown Land. Very restricted. It will therefore be difficult to find an offset for this BVT. Likely have Eucalyptus bosistoana predominantly within the gullies/slopes with some E. melliodora amongst them. Very difficult to distinguish between the two species as both are occurring together. The gullies/slopes also have a mix or hybrids of Red Gums (Eucalyptus tereticornis, E. blakelyi and E. amplifolia) which presents difficulties with identification. SR534 Coast Grey Box - stringybark dry woodland has an estimated cleared percentage of 15% within the CMA. Most of this vegetation community is within Bungonia State Conservation Area and Morton National Parks or Crown Land. Very restricted. It will therefore be difficult to find an offset for this BVT. Variation rule is likely to be accepted for this BVT. SR624 Silvertop Ash - Blue-leaved Stringybark shrubby open forest is Dry Sclerophyll Forest Formation with 40% cleared within the CMA. All efforts to directly offset this BVT would be made. If unlikely to offset directly a BVT of Dry Sclerophyll Forest Formation that has an equal of greater than 40% cleared would be proposed.	The conclusions from this meeting have assisted in aligning the vegetation to appropriate PCTs. The site inspection with OEH was vital in providing confidence in the PCT alignment. The variation criteria for SR534 and SR634 have been discussed in the offset strategy.

2. Landscape assessment

2.1 Landscape assessment - methods

As detailed in section 4 of the BAM (OEH 2017), a landscape assessment for the proposal is required, which was conducted within the BAM Calculator. Landscape value is an assessment of a number of factors including:

- native vegetation cover
- rivers, streams and estuaries
- areas of geological significance
- habitat connectivity

For each factor the current state of the landscape is assessed then compared with the state of the landscape if the proposal were to proceed.

2.1.1 Landscape features and scoring

Table 4 below provides details of the landscape settings and scored landscape features for the proposed project.

Table 4: Landscape features and scoring under the NSW BAM

Landscape features	Description	Figure reference
IBRA bioregion/subregion	South Eastern Highlands IBRA region, and within the Bungonia IBRA subregion.	Figure 3
Mitchell Landscapes	One Mitchell landscape occurs across the study area: Bungonia Tableland and Gorge.	Figure 3
Rivers, streams and estuaries and Strahler stream order	No rivers, streams of estuaries occur within the study area. An ephemeral drainage channel occurs through the middle of the study area, which would only provide very limited flow during high rainfall events. There are a number of small farm dams which occur throughout the study area. These dams were empty during the warmer months of field survey.	Figure 3
Wetlands within and adjacent to development	None	
Cleared areas	The native vegetation present within the study area has been subject to historic clearing. Much of the vegetation to the north, has been extensively cleared, leaving a combination of native pasture/introduced pasture with scattered eucalypts. Cleared areas are more prominent to the east were existing Marulan South Mine Pit, and rail loop occurs.	Figure 4
Connectivity features	The study area adjoins native vegetation to the immediate west of Marulan South Road. The development would reduce the size of this width only leaving scattered trees that would occur between the emplacement and the proposed powerline.	Figure 4
Buffer area (percent	A 1,500m buffer was applied to the Site resulting in an overall buffer area of	Figure 4

Landscape features	Description	Figure reference
native vegetation cover)	1,299 ha. Aerial interpretation coupled with the results of the current field survey and additional surveys completed by Niche as part of the Marulan South Project, offsetting investigations and Peppertree Modification 4 Biodiversity Assessment, was used to map the area of native vegetation, and introduced vegetation. In total, 561.2 ha is non-native vegetation (consisting of mine pit, existing emplacement and infrastructure, residential and roads/rail links etc.), and 738.1 ha is native vegetation. ***Woody vegetation cover*** The native vegetation extent and cover of woody vegetation was determined via aerial photography interpretation based on canopy cover. For woody vegetation 49.8% of the buffer area was determined to support native woody vegetation with benchmark cover (647.5 ha). ***Non-woody vegetation cover*** For non-woody vegetation, experience of the study area was drawn upon in addition to aerial photography interpretation to estimate cover of native grassland vegetation. Areas that were naturally grassland correspond with high fertility depressions situated away from core infrastructure. Native grassland was conservatively estimated that 6.8 % of the buffer area contains native grassland (88.1 ha). ***Total native vegetation cover*** Combining the estimated woody and non-woody vegetation cover resulted in 56.81% of the buffer area supporting native vegetation. This falls into the 30-70% category within the BAM Calculator.	
Site context	Site based assessment.	
Geological significance and soils	There are no karst, caves, crevices, cliffs or other areas of geological significance within the Site. There are no high hazard soil areas.	

3. Native vegetation and flora assessment

3.1 Data review

3.1.1 Atlas of NSW Wildlife Database

A review of spatial records of threatened flora within a 10 km radius of the study area was undertaken using data obtained from the Atlas of NSW Wildlife. Records were obtained prior to field survey. Results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey.

3.1.2 EPBC Act Protected Matters Search

A Protected Matters Search (EPBC Act) was carried out for a 10 km radius of the Site. Results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey. The results of the search are provided in Appendix 1.

3.2 Plant community delineation and mapping

Vegetation within the study area has been mapped previously as part of the Native vegetation of South Eastern NSW (Tozer et al. 2006). The mapping units of the Tozer et al. 2006 mapping have been aligned to an associated PCT in the OEH Vegetation Information System (VIS) database. This mapping project aided the initial vegetation mapping of the study area and surrounds.

The initial flora survey which was conducted from the 3rd to the 6th of February 2015, and 12th February 2018, followed the methodology specified in the OEH (2014) Framework for Biodiversity Assessment. An update of the flora survey was completed in July 31st to the 1st of August 2018 which followed the BAM.

The most recent flora survey effort consisted of 11 BAM plots/transects within the study area.

Walking meanders were undertaken between plot locations. At a minimum, the combined foot traverses complied with the recommended number and length of traverses per area of stratification unit (vegetation community) according to DEC (2004) survey guidelines. The walking meanders were also used to survey for threatened flora species across the study area, in particular the presence of *Solanum celatum* which occurs widely across the locality.

The number of plots undertaken, along with the required survey effort as specified in the BAM is provided in Table 6 and shown in Figure 5.

The plot data and species list obtained during the field assessment is provided in Appendix 3.

The field survey presented a number of difficulties with eucalyptus identification, due to the historic clearing of the site, and the overlap of *Eucalyptus bosistoana* and *E. melliodora,* which are quite similar in appearance. Similarly, the presence of *Eucalyptus tereticornis, E. Blakelyi* and *A. amplifolia* were in combination, thus also presenting identification difficulties. To assist in identification of the eucalypts and alignment to relevant PCTs and Tozer et al 2006 mapping units, a site visit with John Briggs (OEH) was undertaken on 6th of June 2016 with Niche. The consultation was undertaken as part of the Marulan South Project, which comprised of the current Peppertree Mod 5. The site visit and subsequent consultation (Table 3) assisted in aligning the PCTs within the study area.

3.2.3 Plant community delineation and mapping

As detailed above, the vegetation of the study area was validated using methods consistent with the BAM.

Within the study area two native vegetation types and one non-native vegetation type were identified. These vegetation communities were aligned to the relevant Tozer et al. (2006) vegetation unit, and Plant Community Types (PCTs) required for use with the BAM.

Different condition classes were assigned to vegetation where obvious differences in structure and quality occurred, resulting in two PCTs and four vegetation categories as shown in Table 5.

Descriptions for those communities which occur within the study area are provided in Appendix 2. Vegetation community mapping is shown in Figure 6.

Table 5. Vegetation mapping and alignment for vegetation types within the study area

Plant Community Type (PCT)	Equivalent Tozer et al. (2006) mapping unit	Vegetation formation	Vegetation class	Threatened Ecological Community (TEC)*	PCT % cleared	Condition identifier input used in Calculator	Total (ha)
PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	P24. Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland	Grassy Woodlands	Southern Tableland Grassy Woodlands	EEC under BC Act. CEEC under EPBC Act.	92	Medium	18.64
						Poor	9.04
PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin (SR534)	P27. Bungonia Slates Woodland	Dry Sclerophyll Forests (Shrub/grass subformation)	Central Gorge Dry Sclerophyll Forests	Not listed	15	Medium	8.46
						Poor	3.55
Exotic pasture/ Infrastructure	-	-	-	-	-		8.64
Total							48.33
Total native vegetation							39.69

Table 6: Vegetation zones within the proposed development envelope and associated plot/transect survey requirement

Vegetation Zone Number	Plant Community Type (PCT)	Equivalent Tozer et al. (2006) mapping unit	PCT % cleared	Condition identifier input used in BBCC	Total (ha)	Plots required (BAM)	Plots completed
1	PCT1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	P24. Tableland Grassy White Box Yellow Box Blakely's Red Gum Woodland	92	Moderate	18.64	3	3
2				Poor	9.04	3	3
3	PCT778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin (SR534)	P27. Bungonia Slates Woodland	15	Moderate	8.46	3	3
4				Poor	3.55	2	2
5	Exotic pasture/ Infrastructure	-	-	-	8.64	None (however several plots and transects were conducted to test cover values and species richness)	0
	Total				48.33	11	11
	Total native vegetation				39.69		

3.2.4 Plant community descriptions

Refer to Appendix 2 for plant community descriptions and diagnostic species for each plant community.

3.2.5 Site values

Flora

Floristic data recorded from floristic plots performed throughout the identified vegetation zones (Figure 6) is included within Appendix 3.

Plot and transect values

The results of the plot data and species list obtained during the field assessment is provided in Appendix 4.

Site value scores

The Site value assessment was carried out by entering plot data into the BAM Calculator. The data provides quantitative measures of composition, structure and function for each vegetation zone (Appendix 4). The BAM Calculator compares the values recorded with the benchmark for the vegetation class to provide the Site value score. This score represents the overall condition of the vegetation compared against the benchmark (out of 100).

The score from these inputs, coupled with data in the following section of this report, is used to determine the number of ecosystem credits that are required for development.

All vegetation zones within the development envelope scored within the threshold for offsetting (15 out of 100 for threatened ecological communities and 17 out of 100 for non-threatened ecological communities). Ecosystem credit offsets are required for impacts to any vegetation within the development envelope.

3.2.6 High threat and priority weeds

During the field surveys two high threat weeds were recorded as listed under the NSW *Biosecurity Act 2015*.

High threat weed species include: *Nassella trichotoma* (Serrated Tussock) and *Paspalum dilatatum* (Dallas Grass). The abundance and cover of *Nassella trichotoma* (Serrated Tussock) was quite high across most of the flora plots, in particular those completed within the open paddock areas where PCT1334 Yellow Box - Blakely's Red Gum grassy woodland occurred.

3.2.7 Threatened ecological communities

A list of Threatened Ecological Communities (TECs) occurring or potentially occurring within the locality as generated from the database searches detailed in section 3.1, is provided in Appendix 1. The database searches identified seven TECs that have been identified as potentially occurring within the locality.

Based on the results of the detailed vegetation validation, an analysis of existing vegetation mapping by Tozer et al (2006), and review of the Conservation Advice of the TECs, one TEC was identified as being present within the Site:

- Yellow Box Blakely's Red Gum Woodland and Derived Native Grassland (Endangered Ecological Community (EEC) under the BC Act and Critically Endangered Ecological Community (CEEC) EPBC Act)

The Yellow Box Blakely's Red Gum Woodland community was identified as aligning to PCT1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670).

Based on the plot surveys within and surrounding the development envelope, two vegetation condition classes were attributed to TEC:

Moderate condition: Consisting of clumps of scattered trees with a mix of native and introduced ground cover.

Poor condition: consisting of few scattered *Eucalyptus melliodora, E. bosistoana,* and *E. blakelyi.*

3.3 Threatened flora

Threatened flora with the potential to occur, as generated by the BAM Calculator, are presented in Table 7 and Appendix 1.

All are assumed to be absent from the study area based on non-detection of the species during targeted searches.

The walking meanders were used to survey for threatened flora species across the study area, in particular the presence of *Solanum celatum*, given the species has been previously recorded throughout the locality.

In total, approximately 14 hours of threatened flora random meanders were conducted between the 3rd to the 6th of February 2015, and 5th February 2018. And a further 5 hours completed 31st July to the 1st of August 2018.

During the field survey, no BC Act or EPBC Act listed threatened flora were recorded. Many of the threatened flora that have potential to occur are relatively conspicuous and are unlikely to remain undetected during the survey. Given the field survey was completed during the recommended survey times for those species identified in the BAM (Table 7), the flora habitat requirements, and the conspicuous nature of the species, it is highly unlikely that threatened flora occur within the study area.

Table 7. Recommended threatened flora survey time matrix as specified in BAM

Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Consideration
Eucalyptus macarthurii	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Pimelea axiflora subsp. pubescens									Yes	Yes	Yes	Yes	Survey was not completed during known flowering time however quite conspicuous, particularly given the ground cover within the study area was not dense – not detected during targeted flora survey. Unlikely to remain undetected during the survey.
Pomaderris cotoneaster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time – not detected during targeted flora survey. Unlikely to remain undetected during the survey.
Pultenaea pedunculata									Yes	Yes	Yes		Survey was not completed during the recommended survey time, however, the species is conspicuous. It is unlikely to remain undetected during the survey.
Solanum celatum									Yes	Yes	Yes		The survey was not completed during the recommended survey time However, the species has been recorded extensively throughout the locality by Niche during all times of the year. There is also a large population within Bungonia National Park and Morton National Park. Unlikely to remain undetected during the survey.
Swainsona sericea	Yess	Yes							Yes	Yes	Yes	Yes	Survey completed during recommended survey time – not detected during targeted flora survey. Unlikely to remain undetected during the survey.

4. Assessment of fauna and habitat

4.1 Bionet Atlas & EPBC Act Protected Matters Search

Similar to that in section 4.1, a review of spatial records of threatened fauna within a 10 km radius of the study area was undertaken using data obtained from the Bionet Atlas, and predicted threatened biodiversity were generated from an EPBC Act Protected Matters Search.

Thirty-five threatened fauna have been previously recorded or have modelled habitat within a 10 km radius of the study area (Appendix 1) according to the database searches. The potential for these species to occur within the study area is discussed in section 4.7 and Appendix 1. The results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey.

4.2 Methods – field survey

The fauna field surveys incorporated both targeted survey using established survey techniques (as described in Table 8) and habitat-based assessment.

Habitat assessment considered the type and condition of habitats for fauna species. Habitat features recorded within the survey area included:

- Topographic features (such as slope, aspect and landscape position)
- Geology/soil type
- Dominant vegetation community composition, structure and condition of strata levels
- Form, quality and location of water sources
- The presence, number, size and condition of unique habitat features (such as tree hollows and crevices, loose tree bark, fallen timber mistletoe and any rock outcropping or scattered surface rock)
- The level of disturbance.

The fauna survey design effort had an emphasis on detection of species credit fauna where available habitat was present for such species. Since ecosystem credit species (see Appendix 1) have a high likelihood of being present on the site (based on the presence of habitat surrogates) specific targeted survey was not always performed for these species. However, the design attempted to detect the range of fauna using the study area in order to assist with evaluating its importance to fauna more generally.

Table 8. Fauna survey details and effort

Method	Effort and Timing	Details	Targeted species (NSW listed)	Targeted species (Commonwealth listed)
Ultrasonic call recording for bats	1 x night 04/02/2015 1 x night 05/02/2015	One Wildlife Acoustics SM2BAT ultrasonic recorders was deployed over one night along potential flyways or watercourses.	Large-eared Pied Bat, Eastern False Pipistrelle, Golden-tipped Bat, Eastern Bent-wing-bat, Eastern Freetail-bat, Southern Myotis, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat.	Large-eared Pied Bat
Harp Trapping	1 x night; 05/02/2015	A Harp traps was deployed overnight along identified flyways along tracks.		
Reptile survey	20 mins 05/02/2015 25 mins 05/02/2018	Random meander turning over surface rocks. Note that such habitat were very restricted and sparse.	Pink-tailed Legless Lizard Striped Legless Lizard Broad-headed Snake Little Whip Snake Rosenberg's Goanna	Pink-tailed Legless Lizard Striped Legless Lizard Broad-headed Snake
Diurnal bird surveys (2 hectare)	1 hour 04/02/2015 0.75 hours 05/02/2015 0.75 hours 05/02/2015 0.75 hours 11/10/2015 1 hours 01/08/2018	20 minute, 2 hectare bird surveys were extended in time due to relatively low bird activity in most areas and additional species being recorded after or at the end of the typical standard 20 min period. Incidental bird sightings were made throughout surveys activities with species of note being recorded spatially. Birds were identified with the use of 10 X 42 binoculars or from their calls.	All birds	All birds
Remote Cameras	27 nights x 3 cameras (41,78,74) 06/02/2015	Moultrie 990i infrared cameras were deployed. Half of the cameras were baited with a mix of peanut-butter/oats/honey while the other half were baited with sardines. Cameras were placed along animal tracks near water points or other features.	Spotted-tail Quoll, Long-nosed Potoroo, Brush-tail Rock Wallaby, Rosenbergs Goanna.	Spotted-tail Quoll, Brush-tail Rock Wallaby, Long-nosed Potoroo, New Holland Mouse.
Spotlighting	30 mins 03/02/2015 45 mins 05/02/2015 60 mins 05/02/2018 30 mins 31/08/2018	Spotlighting surveys targeting arboreal mammals and nocturnal birds were performed, primarily on foot but also from a slow moving vehicle throughout parts of the study area.	Powerful Owl, Masked Owl, Sooty Owl, Koala, Yellow-bellied Glider, Greater Glider, Grey-headed Flying Fox and Sugar Glider.	Greater Glider, Grey-headed Flying Fox
Call playback and Owl Listening	3 x 45 minute surveys: 03/02/2015, 05/02/2015	Call-playback (Powerful Owl, Masked Owl, Sooty Owl, Koala, Yellow-bellied Glider and Sugar Glider) was undertaken within the study area over three nights. After an initial listening period of five minutes, calls of the target species were broadcast through a 10 watt megaphone for five minutes followed by a five minute listening period and a period of spotlighting.	Powerful Owl, Masked Owl, Sooty Owl, Koala, Yellow-bellied Glider and Sugar Glider.	Koala
Frog survey and aquatic habitat surveys.	30 mins 05/02/2015	Frogs were listened for at dams and ephemeral drainage lines throughout the study area. Active searching for frogs using spotlights was also conducted around dams, and watercourses witihin Peppertree landholds.	Littlejohn's Tree Frog, Green and Golden Bell Frog, Giant Burrowing Frog.	Littlejohn's Tree Frog, Green and Golden Bell Frog, Giant Burrowing Frog.

Method	Effort and Timing	Details	Targeted species (NSW listed)	Targeted species (Commonwealth listed)
Stag watching	2 x 30 mins: 05/02/2015	Trees with hollows or cracks were watched immediately prior to sunset.	Yellow-bellied Glider, Squirrel Glider, Sooty Owl, Powerful Owl, Masked Owl, Barking Owl.	
Koala SAT	1 x survey 05/02/2015 1 x survey 05/02/2018 1 x survey 02/08/2018	SAT (Koala scat) surveys were conducted across the study area. In addition to SAT surveys random tree inspections were carried out during traverses of the study area at selected feed trees searching for scats and characteristic bark scratches.	Koala	Koala
Opportunistic survey	During all activities	Opportunistic observations were made of fauna aided with binoculars and photography as appropriate. Opportunistic survey included searches of habitat such as under logs, rocks or waste piles (where limited areas of such habitat existed) or within heaped leaf litter, casual bird or mammal observations or observations of their calls.	All species	All species

4.3 Recommended fauna survey effort in BAM

Threatened fauna predicted or potentially occurring within the IBRA subregion were reviewed. This list was refined post field survey for the development envelope within the BAM Calculator on the basis of the vegetation types, condition and habitat features as well as the results of field survey. The list of predicted and candidate species generated via the BAM Calculator is in Table 9. A status for each species is provided which represents the basis for deciding whether a species was present or absent from the development envelope. No ecosystem credit species were omitted from the BAM Calculator, despite there being very limited or no habitat present within the study area for many of the predicted species.

Table 9: List of candidate and predicted threatened fauna for the proposed project

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Consideration
Candidate threatened species														
Regent Honeyeater (Breeding)	*Anthochaera phrygia*									Yes	Yes	Yes	Yes	No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Surveys completed during recommended survey period in October.
Pink-tailed Legless Lizard	*Aprasia parapulchella*									Yes	Yes	Yes		No – lack of rocky habitat. Targeted reptile surveys did not record the species.
Gang-gang Cockatoo (Breeding)	*Callocephalon fimbriatum*	Yes									Yes	Yes	Yes	No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey.
Glossy Black-Cockatoo (Breeding)	*Calyptorhynchus lathami*			Yes	Yes	Yes	Yes	Yes	Yes					No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey.
Eastern Pygmy-possum	*Cercartetus nanus*	Yes	Yes	Yes						Yes	Yes	Yes	Yes	No – species not recorded during targeted survey. Unlikely to be present. Survey completed during recommended survey time.
Large-eared Pied Bat	*Chalinolobus dwyeri*	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes – recorded during the field survey.
Giant Burrowing Frog	*Heleioporus australiacus*	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Yes	No – no habitat present within the study area.
Little Eagle (Breeding)	*Hieraaetus morphnoides*								Yes	Yes	Yes			No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Surveys completed during recommended survey period in October.
Swift Parrot (Breeding)	*Lathamus discolor*					Yes	Yes	Yes	Yes					No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Surveys completed during recommended survey period in August.
Little Bentwing-bat (Breeding)	*Miniopterus australis*	Yes	Yes										Yes	No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Surveys completed during recommended survey time in February.
	Miniopterus schreibersii	Yes	Yes									Yes	Yes	No – no breeding habitat identified within the study area. The species was also not recorded foraging during the

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Consideration
Eastern Bentwing-bat (Breeding)	*oceanensis*													survey.
Barking Owl (Breeding)	*Ninox connivens*					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Survey completed during recommended survey time in August.
Powerful Owl (Breeding)	*Ninox strenua*					Yes	Yes	Yes	Yes					No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Survey completed during recommended survey time in August.
Squirrel Glider	*Petaurus norfolcensis*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during survey. Survey undertaken during recommended survey time.
Brush-tailed Rock-wallaby	*Petrogale penicillata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during survey. No records within locality. Unlikely to be present.
Koala	*Phascolarctos cinereus*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not recorded during the field survey, however is known to occur within the locality. It may use the habitat features of the study area. The Koala is therefore considered further in the impact assessment.
Masked Owl (Breeding)	*Tyto novaehollandiae*					Yes	Yes	Yes	Yes					No – no breeding habitat identified within the study area. The species was also not recorded foraging during the survey. Survey completed during recommended survey time in August.
Predicted threatened species														
Regent Honeyeater	*Anthochaera phrygia*	No requirement to survey as assumed to be present based on habitat present												
Gang-gang Cockatoo	*Callocephalon fimbriatum*													
Glossy Black-Cockatoo	*Calyptorhynchus lathami*													
Speckled Warbler	*Chthonicola sagittata*													
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*													

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Consideration
Varied Sittella	*Daphoenositta chrysoptera*													
Spotted-tailed Quoll	*Dasyurus maculatus*													
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*													
Little Lorikeet	*Glossopsitta pusilla*													
Painted Honeyeater	*Grantiella picta*													
Little Eagle	*Hieraaetus morphnoides*													
Swift Parrot	*Lathamus discolor*													
Hooded Robin (south-eastern form)	*Melanodryas cucullata*													
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*													
Little Bentwing-bat	*Miniopterus australis*													
Eastern Freetail-bat	*Mormopterus norfolkensis*													
Turquoise Parrot	*Neophema pulchella*													
Barking Owl	*Ninox connivens*													
Powerful Owl	*Ninox strenua*													
Yellow-bellied Glider	*Petaurus australis*													
Scarlet Robin	*Petroica boodang*													
Flame Robin	*Petroica phoenicea*													
Koala	*Phascolarctos cinereus*													
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*													
Diamond Firetail	*Stagonopleura guttata*													

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Consideration
Little Whip Snake	*Suta flagellum*													
Masked Owl	*Tyto novaehollandiae*													
Rosenberg's Goannna	*Varanus rosenbergi*													
Regent Honeyeater	*Anthochaera phrygia*													

4.4 Fauna habitat

Numerous sources of disturbance operate throughout most of the study area, which have impacted upon the condition of fauna habitat. Disturbances include:

- Selective clearing - which has occurred throughout all accessible areas of the study area, with timber being used historically to fuel furnaces in the Marulan area (pers. comm. Rod Wallace – Boral). As a result, all trees were of similar ages, and the understorey had been extensively cleared. Large hollow-bearing logs were very sparse due to the prior clearing events.
- Weed invasion - weeds range in their density across the study area from moderately sparse in the dry sclerophyll shrubby vegetation types to common throughout the study area within grassland habitat. The weed spread is in response to levels of grazing or other disturbance factors. Infestations of Serrated Tussock (*Nassella trichotoma*) were common throughout the entire study area, with higher concentrations in the open grassy paddocks.
- Historic cattle grazing - as such, the ground cover is a mix of native and introduced pasture species.
- Macropod grazing - a high level of macropod grazing was observed in open grassy areas. As such, much of the native ground cover within these areas were sparse in composition and richness.
- Feral animals - feral animals were common throughout the entire study area. Rabbits and Brown Hares are moderately common throughout most of the study area. Feral goats have also been sighted in the study area (pers. comm. Grant Thompson – Boral). These introduced predators, coupled with the low abundance of available sheltering habitat (such as hollow logs) may have led to a decreased abundance and diversity of small and medium sized ground dwelling mammals.

Available fauna habitat within the study area was relatively limited consisting of:

- Grassy Woodlands (mostly scattered trees with a mix of native and exotic grasses)
- Forest gullies and
- Farm dams.

Grassy Woodland

Grassy Woodland habitat within the study area consisted predominantly of sparse scattered trees mainly *E. bosistoana, E. melliodora, E. eugenioides* and red gums (*E. tereticornis* and *E. blakelyi*) with areas of more consolidated woodland patches occasionally present (Photo 1). Habitat features had been subject to historic clearing and grazing.

Forest gullies

Forest gully habitat within the study area consisted predominantly of sparse scattered trees mainly *Eucalyptus bosistoana* and red gums (*E. tereticornis* and *E. blakelyi*) with some stringybarks (E. eugenioides, E. globoidea) (Photo 2). Log density in these areas was greater than that of the grassy woodlands.

Farm dams

A number of small dams from 0.05 – 0.15 hectares in size occurred within the study area. The dams differ in their shape and depth. At the times of the field surveys, less than 30 cms of water was present during the wetter periods. In February and July 2018, the dams did not contain any water. During rainfall events, the dams may supply water supply for vertebrate fauna and may act as foraging habitat for bats, birds and common frogs.



Photo 1. Grassy woodland habitat with a mix of *Eucalyptus bosistoana, E. melliodora, E. blakelyi* and *E. eugenioides*.



Photo 2. Gully forest habitat dominated by a mix of *Eucalyptus bosistoana* and Red Gums (*E.tereticornis/E.blakelyi X)*

4.5 Connectivity of fauna habitat

The study area has limited connectivity to the east and north due to the Marulan South Mine Pit and Peppertree Quarry. To the east, there is connectivity to a patch of native vegetation to the east of Marulan South Road, which provide scattered woodland habitat connectivity throughout the general locality.

To the south of the site, connectivity existing within woodland habitat within similar disturbance and condition to that of the study area. Due to the location of the Marulan South Mine Pit, connectivity to Bungonia State Conservation Area and Morton National Park is somewhat impeded.

The land to the west, being part of the more fertile tablelands, is predominantly cleared for agriculture. However, scattered patches of native vegetation occur across the tableland areas, some of which is connected to the study area.

The study area does not form part of any national landscape corridors (SEWPaC, 2012a) and no identified OEH wildlife corridors occur within the vicinity of the site.

Connectivity losses would occur for the life of the mine with connectivity being progressively reinstated during mine rehabilitation. However, the landforms reinstated during rehabilitation are likely to be a less favourable linkage for some fauna species due to their topography, heterogeneity and reduced quality in some areas. More mobile species, such as birds and bats, without highly specific habitat requirements (at least for certain lifecycle aspects) are likely to be most effective at using reinstated linkages.

4.6 Fauna recorded during field surveys

Fauna field surveys using the methods described in section 4.2 were undertaken in each of the identified habitats, with the suite of methods employed in each habitat type dependant on the potential presence of subject threatened fauna within that habitat type. Notable opportunistic sightings whilst travelling within the study area were also recorded. A complete species list is provided in Appendix 4.

A total of 45 fauna were recorded during field surveys within or adjacent to the study area. The results comprised of one reptile, 22 mammals, and 22 birds. A complete fauna list is provided in Appendix 4.

The suite of fauna recorded were predominantly locally common species tolerant of at least moderate disturbance and lower condition vegetation or degraded habitats.

Some mobile species recorded would primarily be dependent on the adjacent woodland areas but would take advantage of parts of the study area to forage (e.g. common Wallaroo, Large-eared Pied Bat).

A high number of goats were recorded across the study area during the July 2018 field survey. Approximately 35 goats were recorded within the study area. According to Grant Thompson (Boral – Environmental officer), the goats have been in the area most days since the start of 2018.

Hares and foxes were also frequently recorded in the study area during the field surveys.

4.7 Threatened fauna

Two threatened fauna were recorded with the study area: Large-eared Pied Bat and Eastern Bentwing Bat.

A number of additional threatened fauna have the potential to occur within the study area but were not recorded, most likely due to their potential use of the study area or wider locality being limited to sporadic occurrences (e.g. nomadic birds) (Appendix 1). Of these threatened fauna, only the Koala and Large-eared Pied Bat are regarded as species credit fauna that would require offsetting under the BC Act.

The Eastern Bentwing Bat is regarded as both an ecosystem and species credit species, with the species credit component triggered by the presence of breeding habitat. The Eastern Bentwing Bat has breeding habitat within caves and artificial tunnels, neither of which occur within the study area. As such, the Eastern Bentwing has been regarded as an ecosystem credit species for this assessment.

4.7.1 Species credit fauna

As discussed in section 4.7, the survey resulted in only one species credit fauna being recorded within the study area: the Large-eared Pied Bat. The Koala, due to the presence of feed trees and proximity to the Koala population of Bungonia Gorge, has also been considered further as a species credit fauna as discussed below.

Large-eared Pied Bat habitat in the study area

The Large-eared Pied Bat was recorded at anabat survey locations within, and adjacent to the study area. As such, portions of native vegetation within the study area have been considered foraging habitat for the species.

Not a significant amount of information is known about the Large-eared Pied Bat, however, as indicated on the BioNet Atlas, the species is regarded as a 'species credit' species as it cannot be reliably predicted to occur on a site based on vegetation and other landscape features.

Breeding habitat, which as described on the BioNet Atlas as including PCTs associated with the species within 100m of rocky areas containing caves, overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings. As the site, does not occur within 100 metres of any of these features known to contain the species, breeding habitat is unlikely to be present within the study area.

Two caves are known to occur within over 2 kilometres of the study area, known as Main Gully Spring and Main Gully Spring Two (Bauer and Bauer 1998). Both caves are spring caves described as follows:

- Main Valley Spring; located beneath the quarry – in periods of high discharge this cave acts as an overflow, draining limestone to the north. A number of chambers and tunnels are described including a chamber 1 m x 2.7 m wide.
- Main Valley Spring Two; A spring at the base of the cliffline 50 m to the east of Main Valley Spring this spring flows during low flow conditions with the Main Valley Spring being an overflow for this spring.

The two caves described are connected, with the Main Valley Spring being the only candidate for bat roosting (it is likely that Main Valley Spring Two is too frequently inundated to act as a roost site). It is assumed unlikely that long-term maternity roosts would be established in Main Valley Spring due to its limited size and occasional inundation of most if not all parts of the cave in times of high flow. However, given the lack of previous survey of this cave, it is not possible to state with certainty that a maternal roost could not be established for Large-eared Pied Bat.

Regardless of whether bat roosting or breeding occurs within either of the above caves, both are located away from the study area and would not experience any impact associated with the Project. The current proposal is not forecast to increase noise or vibration to the subject caves or any other known caves in the locality.

The Large-eared Pied Bat is known to forage in a range of vegetation types, including dry and wet sclerophyll forest, grassy woodland, Callitris dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country (Hoye & Dwyer 1995; Pennay 2002; DECC 2007). Foraging habitat on fertile soils (or within fertile valleys) is also considered an important overall

requirement for the Large-eared Pied Bat (Pennay 2008), however the species has been recorded extensively within sandstone associated vegetation, indicating that whilst foraging habitat on fertile soils is likely to be important, foraging would by no means be confined to such areas.

As such, the area of foraging habitat within the study area includes PCTs with a 'medium condition' class. Approximately 27.1 ha of habitat for the Large-eared Pied Bat has therefore been mapped within the study area. This area has been regarded in this assessment as the Species polygon for the Large-eared Pied Bat, which has been addressed later in the report to generate the species credit required for the Project.

The impacts to foraging habitat for the Large-eared Pied Bat are discussed further in section 5.3.

Koala habitat in the study area

Surveys and collection of anecdotal evidence of Koala sightings conducted within the study area and surrounds as part of this assessment revealed that Koalas have been sighted sporadically within the locality of the Project site over the past decade, with a Koala observed every 2- 3 years around the South Marulan Mine (pers. comm. Grant Thompson – Boral).

Scat surveys, spotlighting, call-playback and tree surveys did not identify repeated or on-going use of trees within any of the proposed development area.

There are 137 Koala records from the Bionet Atlas within a 10 km radius of the study area. The majority of these records (105) are from the Bungonia National Park and Bungonia State Conservation Area (SCA) which occur approximately 1 - 4 km south of the Project site. The large number of records from the Park can largely be attributed to establishment of a monitoring program based on park visitors and staff reporting Koala sightings. However, the program has not allowed for a reliable estimate of Koala numbers in the area (pers. comm. Audrey Kutzner NSW NPWS). Nonetheless the area where the majority of Koala records occur is considered one of the primary known active sites for a Koala population centred along the Shoalhaven Gorge and extending approximately 40 km to the south of the study area towards Nerrigan and approximately 30 km east towards Tallowa Dam (Allen 2002). The population area encompasses large areas of Morton National Park. Within the Shoalhaven Gorge population area, it has been estimated that some 7,500 ha of secondary koala habitat exists, supporting between 80 and 150 Koalas (Allen 2002). The Shoalhaven Gorge Koala population was described as a low-density population utilising secondary habitat, spread at least in patches and consisting of breeding associations linked by the movements of dispersing young (Allen 2002).

North and west of the protected areas around the Bungonia and Shoalhaven gorges Koala records within the Bionet Atlas are very limited, with sporadic observations from private land and along roadsides, one being from the Marulan Quarry and two additional records (including road-kill) each from around the townships of Marulan and Tallong. These areas are more disturbed predominantly private tenure. They generally consist of more fertile areas that have been developed traditionally for agriculture. It is clear that Koalas are able to travel through such areas and feed trees, including primary feed trees, are available to them throughout such areas. Targeted Koala survey in these areas (private land on the tablelands) is likely to have been minimal and therefore actual Koala distribution and abundance within such areas is poorly known. Therefore, whilst it is acknowledged that limits exist regarding predictions of Koala distribution and abundance within the locality, given previous disturbance resulting in fragmented vegetation, and the lack of Koala records within the higher elevation areas away from the protected areas around the Bungonia and Shoalhaven gorges, it is considered unlikely that active Koala areas (with permanent and moderate to high

densities of Koalas) such as those within the Bungonia National Park/SCA would extend into the Project site.

Whilst the Koala was not recorded within the study area during the targeted surveys, it is recognised given previous sightings throughout the locality, that the Koala may use the habitat features of the study area on occasion. In order to determine the area of habitat within the study area that the Koala may utilise, the area of occupancy has been determined by considering the density and composition of preferred feed trees listed as primary, secondary and tertiary feed species under the National recovery plan for the Koala (DEC 2008). Occupiable habitat was considered as areas where either two or more known feed tree species occurred, or a single feed species occurred and occupied more than 50% of the canopy cover within a 400 m2 floristic quadrat. Highly disturbed and substantially cleared areas were excluded as habitat.

The area of habitat has been split into areas deemed poor/unsuitable (very limited use/if any), moderate (contains Koala feed trees however is limited in movement due to steepness of terrain), and good (containing Koala feed trees with relatively limited obstacles in regards to movement). The Koala has therefore been attributed to an area of 27.1 ha of occupiable habitat within the study area (Figure 8). This area has been regarded in this assessment as the Species polygon for the Koala, which has been addressed later in the report to generate the species credits required for the Project.

4.7.2 EPBC Act listed fauna

A total of 35 EPBC Act listed fauna were considered in the assessment based on the database reviews detailed in section 4.1. Of these species, eight were considered to have a moderate to high likelihood to utilise the habitat features of the study area for foraging.

Three EPBC Act Vulnerable listed fauna that have foraging habitat within the study area include the Koala, Large-eared Pied Bat and Grey-headed Flying Fox. Both the Koala and large-eared Pied Bat have been discussed in detail in sections above. The Grey-headed Flying Fox is only likely to utilise the study area on occasion for foraging. No roosting camp sites were observed in the study area, nor known to occur within close proximity to the study area.

Threatened amphibians generated in the database searches include the Giant Burrowing Frog, Green and Golden Bell Frog and Littlejohn's Tree Frog. After considering the habitat requirements for these species, all have been regarded as unlikely to occur in the study area given the lack of suitable habitat (Appendix 1). It should be noted that none of these species have been previously recorded within the locality. Based on the habitat requirement, none detection during surveys, coupled with the absence of records within the locality, all three threatened amphibians are regarded as being absent from the study area and therefore have not been considered further.

Threatened birds with limited potential to occur in the study area listed as Vulnerable under the EPBC Act include the Regent Honeyeater, Australasian Bittern, Curlew Sandpiper, Painted Honeyeater, Swift Parrot, Eastern Curlew and Australian Painted Snipe. None of these species were detected during the bird surveys completed as part of this assessment, and with the exception of the Australasian Bittern, none have been recorded previously within the locality. Only one record provided on the BioNet Atlas for the Australasian Bittern occurs approximately 2.5 kilometres to the south-east of the study area within native vegetation of the Bungonia State Conservation Area. Unlike the study area, the site of this record contains relatively intact native vegetation and is part of an extensive native vegetation corridor. Based on the specific habitat requirements of each of the species (Appendix 1), and the lack detection during targeted surveys, it is likely that the habitat features within the study area would only be used on an intermittent basis for foraging. The extensive native vegetation that occurs throughout the land to the south and east within Morton

National Park and Bungonia State Conservation Area are likely to offer greater habitat availability for each of the species. As such, the species have been given a low likelihood of occurrence within the study area (Appendix 1).

During the field survey, no migratory species listed under the EPBC Act were recorded. However, a number of listed migratory species have been recorded from the locality and in some cases have the potential to fly over the study area (see Appendix 1). Species include: Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, and Rufous Fantail. The Vulnerable EPBC Act species – the Large-eared Pied Bat, and Grey-headed Flying Fox also have potential foraging habitat throughout the study area. Impacts of the Project on these EPBC Act listed species are considered further in section 5.

5. Impact Assessment

The Impact Assessment below forms Stage 2 of the BDAR as detailed in the BAM.

5.1 Avoid and minimise impacts

In accordance with the BAM, proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a project on biodiversity values. This section of the report outlines the avoidance, management and mitigation measures that Renew Estate has incorporated into the project design or will employ during construction, operation or completion of the project to reduce impacts on biodiversity values.

5.1.1 Avoidance measures (site selection)

Boral Resources has aimed to avoid and minimise environmental impacts from the project during the design process.

Site selection for the Project has been largely dictated by the availability of Boral owned land, within the development consent boundary, that is not required for other quarry operations, is located as far as possible from neighbouring residences.

Alternatives locations for the proposed development footprint on Boral owned land were considered and discounted on biodiversity, noise or logistical grounds. The location of the alternative locations are described further in the Environmental Impact Assessment (Element Environment 2018) for the Project.

These alternatives included:

- An area of Boral owned land outside the Peppertree Quarry consent to the north of Tangarang Dam and north-west of the rail loop. This site was discounted for the following reasons:
    - Noise – potential noise impacts from this site were subject to a high level modelling exercise. The alternate location would be closer to receivers than other options (for example approximately 700 m from R4 versus 1,600m from the SWOE to its nearest receiver). The modelling showed receivers R3 (37 dBA), R4 (35 dBA) and R7 (35 dBA) would be at or in exceedance of the Approval's daytime noise criteria of 35 dBA. Additionally, the difference in noise levels for R3 and R4 between the SWOE and this option would be 6 dBA, which would be a significant perceived change.
    - Visual amenity – when complete, the top of the emplacement would have been 650 m RL, which would have been approximately 36 m higher than the residence at R6. Therefore, the emplacement activities and the unrehabilitated, and eventually rehabilitated, landform would be visible from that receiver.
    - Aboriginal heritage – previous investigations of similar landscapes (relatively flat and broad spurs near a water course) have indicated such areas have medium archaeological sensitivity. In this case, the emplacement would have been on such a landform between two major waterways for the area; Marulan Creek and Tangarang Creek, suggesting it would be likely that items would be encountered.
    - Biodiversity – the area contains degraded Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands, which is listed as an endangered ecological community under the NSW Biodiversity Conservation Act 2016 and a critically endangered ecological community under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.
    - requires a longer haulage distance resulting in greater dust and greenhouse gas emissions.

- A patch of Boral owned land (within the Peppertree Quarry consent boundary) bordered by the Western Overburden Emplacement to the north-east, Boral's private railway line to the north, the agricultural lime manufacturing facility to the west, the agricultural lime manufacturing facility's driveway to the south and Marulan South Road to the east. This site was discounted as it:
    - is located significantly closer to sensitive receivers than the proposed SWOE site, with associated noise implications;
    - would be near Tangarang Creek, an area with likely high archaeological sensitivity;
    - would be in an area of Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands; and
    - requires a longer haulage distance resulting in greater dust and greenhouse gas emissions.
- An area of Boral owned land (within the Peppertree Quarry consent boundary) located immediately north of Tangarang Creek. This site was discounted as it is:
    - located closer to sensitive receivers than the proposed site, with associated noise implications;
    - likely to be of higher aboriginal heritage significance due to its proximity to a prominent creek – Tangarang Creek;
    - logistically more complex as trucks need to drive through the processing plant and cross the Tangarang Dam wall to access the site; and
    - the location of an additional approved water supply dam for the Quarry.

The location for the proposed SWOE was therefore selected as the preferred location due to the following:

- it is located the furthest from noise sensitive receivers;
- trucks don't need to drive through the processing plant and cross the Tangarang Dam wall; and
- the site has limited Aboriginal heritage values.

5.1.2 Avoidance measures (pre-construction)

Boral has investigated measures to avoid and minimise environmental impacts from the Project during the design process. Generally, this process has involved:

- Overlay and consideration of the preliminary project footprint on aerial photography together with information on constraints such as available vegetation mapping, NSW Wildlife Atlas database information, cadastral information, property boundaries including conservation reserve boundaries, existing roads and utility corridors etc.
- Review of the location of specific project infrastructure and emplacement areas relative to vegetation on aerial photography and regional vegetation mapping
- Minimisation of the overall emplacement area extent, and to allow for an area that was as consolidated as possible without sterilising future potential limestone mine areas
- Avoidance of direct impacts to certain areas of identified constraints during design, for example through relocation of infrastructure (such as roads, stockpiles, ancillary infrastructure etc.) where reasonable and feasible
- Where significant features could not be avoided, identification of mitigation measures to minimise impacts, or commitment to compensation (i.e. offset measures) if impacts are not able to be sufficiently mitigated.

Specific principles adopted to avoid or minimise impacts on biodiversity are discussed below for the emplacement area and access roads.

Emplacement area

Key drivers for the design of the emplacement area were economics, future resource availability, management of overburden materials and avoidance of impacts to surrounding conservation areas. A range of options for emplacement areas were considered after prefeasibility and constraints assessment conducted by Niche in 2012 identified biodiversity constraints including areas of White Box Yellow Box Blakely's Red Gum CEEC and Koala habitat. Consideration was given to avoidance of areas of the CEEC, however the alternatives were not economically feasible for the Project (e.g. transportation of overburden away from the Project site). As emplacement of the overburden has the potential to influence surface and subsurface water quality in surrounding areas (through percolation of water through emplacement materials or erosion and transportation of emplacement materials to lower areas) a major emphasis of the emplacement area design was to ensure that the resultant landforms did not cause such impacts to surrounding reserves.

The current design minimises the impact potential to surrounding reserves while still making use of the available space within some of the deep gullies (i.e. main valley) to minimise the overall surface area (and consequent clearing) required from emplacement of materials.

Access roads

Several access road options were considered for the proposed haul road. During the options analysis, minimisation of environmental impacts occurred through consideration of vegetated areas, existing roads were proposed in already disturbed areas as much as practical to reduce impacts on habitat.

5.1.3 Mitigation measures (construction and post-construction)

Impacts arising from the construction will primarily relate to vegetation clearing. Boral proposes to undertake the following mitigation and management actions during construction.

Fencing and signposting

Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the study area.

Signposting will be used to inform Project personnel and site visitors of areas of conservation value to restrict entry or inform behaviour that will reduce incidental interactions with threatened species - e.g. speed limits along access roads to reduce potential for fauna vehicle strikes.

Employee Education and General Environmental Controls

Employees and contractors would be educated on and required to implement the following controls, to avoid or at least minimise potential environmental impacts associated with the construction of the southern overburden emplacement.

- minimise dust generation by minimising the extent and time that bare soil is exposed and by appropriate dust suppression.
- procedures for the management of hydrocarbon and/or chemical spills throughout the study area including the requirements for vehicles to carry spill kits.
- ensuring vehicles remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process and in on-going Project discussions.
- management and removal of all rubbish from the study area.

Vegetation Clearance Protocol

The vegetation clearing protocol provided in Boral's Peppertree Quarry Landscape and Rehabilitation Management Plan should be adhered to. This Plan includes the following:

- Prior to clearing of grassland, ecologists are to survey for ground dwelling fauna and to remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed.
- Prior to clearing of remnant hollow-bearing trees, ecologists are to be engaged to supervise felling. All hollow-bearing trees that are accessible safely from the ground are to be checked and identified fauna relocated. Hollows higher up and not accessible from the ground are to be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate.
- Any fauna displaced during clearing are to be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so).
- In an event that fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service (WIRES) will be contacted to handle and collect for appropriate care and rehabilitation.

5.1.4 Rehabilitation

The disturbance would be progressively rehabilitated in accordance with the Peppertree Quarry Landscape and Rehabilitation Management Plan, to create a stable landform that does not result in sediment laden runoff or fugitive dust emissions, blends well with the adjacent natural landscapes of the Morton National Park and re-establishes a native bushland dominated by White Box Yellow Box Blakely's Red Gum Grassy Woodland species, which outcompetes invasive weed species.

Update of Peppertree Quarry Landscape and Rehabilitation Management Plan

Boral's Peppertree Quarry Landscape and Rehabilitation Management Plan will need to be updated to reflect biodiversity management measures associated with the proposed overburden emplacement in order to protect and manage important biodiversity values. Currently, the existing Plan discusses key commitments relating to threatened species management, pest and weed management, fire management and site hygiene practices. The contents of the existing Landscape and Rehabilitation Management Plan has been provided in Appendix 9.

5.1.5 Pest and weed management

The existing Plan would include a section relating to pest and weed management activities of the Project and will include:

- Management protocols for feral animals such as foxes, goats, rabbits and cats within the rehabilitation area.
- Management protocols for the identification of noxious or important environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the site).

5.1.6 Fire management

Boral currently have a Bushfire Management Plan (Boral 2015) for the South Marulan Operations. Fire prevention and suppression are detailed within the Plan including emergency protocols should a fire occur. This Plan would be updated where required to reflect the Project.

5.2 Impact Summary

The project would affect biodiversity, including threatened biodiversity through both direct and indirect impacts during construction and operation. The majority of impacts on biodiversity would occur during construction from clearing of native vegetation and removal of habitat.

The direct and indirect impacts associated with project and measures to offset and manage biodiversity in the long term are outlined the following sections.

5.3 Direct Impacts

The following residual direct impacts would result from the project:

- Clearing of native vegetation and associated habitat, conservatively estimated to be 39.7 ha.
- The area of clearing includes impacts to 27.7 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland, which is listed as a TEC.
- Clearing of species credit fauna habitat for the following:
    - Koala habitat estimated to be 27.1 ha
    - Large-eared Pied Bat estimated to be 27.1 ha.

The majority of vegetation likely to be affected by the Project has been subject to historic clearing and other agricultural activities such as grazing and is therefore thinned, fragmented and dominated in areas by Serrated Tussock.

5.3.1 Direct impact to native vegetation and habitat

The Project would result in the clearing of 39.7 ha of vegetation regarded as 'native vegetation,' as defined in the BAM. The majority of vegetation likely to be affected by the Project has been subject to historic logging, grazing, and other agricultural activities, and is therefore thinned in areas, and dominated in areas by Serrated Tussock. This is clearing evident in all condition classes of PCT1334 Yellow Box - Blakely's Red Gum grassy woodland given it occurs on the flatter and gentle slopes which has been subjected it to greater grazing and clearing pressures.

In total, the area attributed in this assessment as a moderate condition class (canopy present) is 27.1 ha, and the area attributed to a poor condition class is 12.6 ha.

5.3.2 Direct impact to White Box Yellow Box Blakely's Red Gum Grassy Woodland

The Project would result in a direct impact to 27.7 ha of the TEC White Box Yellow Box Blakely's Red Gum Grassy Woodland. As discussed in section 3.2, the TEC has been attributed to two different condition classes that make up PCT1334 Yellow Box - Blakely's Red Gum grassy woodland.

The TEC is located within the areas proposed study area on the gentle slopes and relatively flat terrain.

The TEC to be impacted is in a modified state, due to previous land clearing, grazing, feral pest grazing, over abundant herbivore grazing, and due to the abundance and spread of Serrated Tussock. This is a common theme for the TEC, as throughout its range, the TEC has been reduced in area and highly fragmented because of clearance for cropping and grazing and pasture improvement due to the ecological community's occurrence on fertile soils. Very few high quality remnants remain anywhere across its former range. The EPBC Policy Guidelines (DoE 2014) state that over 90% of the original extent of this ecological community

has been cleared. This is supported by OEH (2014) who regarded the equivalent Biometric Vegetation Type to be 90% cleared, and Thomas et al. (2000) estimate that within South-Eastern NSW 59,468 ha remain from the pre-1750 extent of 1,012,052 ha (approximately 94% cleared).

The areas of the TEC within the study area are already fragmented by Marulan South Road and areas of cleared land to the east of the study area. This is a common theme for the TEC which is already highly fragmented in the locality. The Project will lead to increased fragmentation of the ecological community in the local context through the combination of the emplacement areas, however connectivity will be retained within contiguous habitat around the periphery of the study area.

As the TEC is regarded as a Serious and Irreversible Impact (SAII) candidate entry under the BAM, further consideration of the impacts on the TEC have been provided in section 5.3.4.

An Assessment of Significance under the EPBC Act has also been completed for impacts on the TEC (Appendix 8). The Assessment concluded that a significant impact was likely, and thus triggering the need to offset the impacts under the EPBC Act (section 6).

5.3.3 Direct impact to Koala habitat

A discussed in section 4.6, the Koala is expected to use portions of the study area on a limited basis.

Impacts from the Project largely relate to the removal of foraging and dispersal habitat that has been defined as being critical to the survival of the Koala under the EPBC Act (DoE 2014; Appendix 8). Habitat mapped as good and moderate habitat potential, totalling 27.1 (Figure 8), contained either two or more known feed trees (listed as primary, secondary or tertiary species under the species Recovery Plan (DECC 2008)) or a single feed species that occupied more than 50% of a 400 m2 floristic quadrat.

Such habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The proposal includes the removal of 27.1 ha of such habitat, which through application of the guidelines is considered a significant impact under the EPBC Act (see Appendix 8 MNES Assessments of Significance).

Due to the apparent limited use of the study area and its extremely small extent in relation to similar habitat for the Shoalhaven Gorge Koala population (7,500 ha), it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven Gorge) such that a decline would occur or that the population is placed at risk of extinction. Active sites for this population are concentrated within protected areas and the study area is not thought to provide a link between active areas within the population's distribution or to any other Koala population.

As the Koala is regarded as a SAII candidate entry under the BAM, further consideration of the impacts on the Koala have been provided in section 5.3.4.

An Assessment of Significance under the EPBC Act has also been completed for impacts on the Koala (Appendix 8). The Assessment concluded that a significant impact was likely, and thus triggering the need to offset the impacts under the EPBC Act (section 6).

5.3.4 Direct impact to Large-eared Pied Bat habitat

As detailed in section 4.6, 27.1 ha of foraging habitat for the Large-eared Pied Bat would be impacted by the Project. No breeding habitat would be impacted by the Project.

Foraging habitat is locally common and the quantity of habitat to be removed is not considered critical to the overall species survival or the local occurrence of the species. Within a 10 km radius of the Project site it is estimated that 33, 837 ha of native vegetation exists within the locality of the study area.

As the Large-eared Pied Bat is regarded as a SAII candidate entry under the BAM, further consideration of the impacts on the Large-eared Pied Bat have been provided in section 5.3.4.

An Assessment of Significance under the EPBC Act has also been completed for impacts on the Large-eared Pied Bat (Appendix 8). The Assessment concluded that a significant impact was unlikely to occur. A biodiversity offset under the EPBC Act is therefore not proposed for the impacts toward the Large-eared Pied Bat, however the species would be subsequently be offset in accordance with the BAM to satisfy the BC Act offsetting requirement (section 6).

5.3.1 Direct impacts to EPBC Act listed fauna

As discussed above, the Project is likely to result in a significant impact to one EPBC Act listed fauna species: the Koala. Significant impacts to the Large-eared Pied Bat are considered unlikely.

As a precautionary and conservative approach, this assessment has also provided Assessments of Significance for impacts to threatened, migratory and relatively mobile EPBC Act listed fauna, which on occasion, may fly over the study area, or use it for foraging on an intermittent basis.

Assessments of Significance have been completed in Appendix 8 for the following EPBC Act listed threatened or migratory species: Fork-tailed Swift, Great Egret, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail and Grey-headed Flying Fox. The Assessments of Significance have concluded that a significant impact to these species is unlikely.

5.3.2 Indirect impacts

Indirect impacts associated with the Project will largely occur during the construction of the new overburden emplacement resulting in a short term impact (i.e. the construction and rehabilitation phases of the overburden emplacement) and will be minimised where possible through management procedures. A range of indirect impacts are likely to, or could, occur as a result of the Project including:

- Increased noise and dust.
- Erosion or sedimentation in the drainage lines downslope.
- Increased spreading of weed propagules.

The indirect impacts described above are variable in terms of the distance they may extend from the study area, and in many cases, due to mitigation measures, indirect impacts will be completely contained within the study area.

Indirect impacts on the biodiversity values of areas surrounding the study area, along with recommended mitigation measures to minimise identified impacts, are discussed in Table 10.

As required in the Commonwealth SEARs, the costs associated with the mitigation measures have been taken into account during the pre-feasibility assessment of the Project. Funds include (but not limited to):

- Improving Dam N2 to collect water from the western side of the SWOE (ie. mitigating sedimentation from adjacent areas) – approximately $35K.
- Weed management on SWOE (ie. preventing weed spread into adjacent areas) – approximately $15K/year.
- Dust management on SWOE (ie preventing impacts of dust settling on adjacent forest),truck maintenance, fuel and wages – approximately $250K/year.

Table 10. Indirect impacts and mitigation measures

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
Edge effects	The establishment of the new overburden emplacement would result in the creation of new edges adjacent to areas of existing native vegetation to the south. The new edges could facilitate the establishment and spread of introduced plant species, however appropriate monitoring and control measures would be implemented during and after construction, to counter act weed invasion. The overburden emplacement would be progressively rehabilitated and will eventually be entirely revegetated to a native, open woodland community, which will recreate fauna habitat and minimise the edge effect created during construction disturbance.	Varying distance from subject site. Potentially occurring within 50 metres from the disturbance area throughout the active life of the Project.	Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the emplacement. Signposting and education will be also be used to inform Project personnel of no-go areas. Weed management and monitoring to be updated in the existing Biodiversity & Rehabilitation Management Plan 2017 (Boral 2017).	Active weed, and pest management are anticipated to be successful at managing edge effects from the Project.
Weeds	Weeds have the opportunity to establish themselves in areas of disturbed vegetation. The greatest establishment of weeds are in areas already disturbed or subject to agricultural land use. This is mainly toward the north of the study area. However, it should be noted that weeds were common throughout the entire study area. The Project has the potential to increase or lead to the establishment of weed species where they do not currently exist through the operation of machinery during construction. New weed species can potentially be introduced as a result of the movement of construction vehicles and materials into the study area. Areas more likely to be exposed to weed increases are areas of native vegetation that occur to the south of the study area. However, weeds will be controlled during and after construction in accordance with the Landscape and Rehabilitation Management Plan and thus indirect impacts from weeds is likely to be minor within the adjacent woodland areas.	Variable depending on topography. However, typically would occur within close proximity to disturbance area.	Weed management and monitoring to be implemented in accordance with the Landscape and Rehabilitation Management Plan.	Active weed control methods are likely to be successful in managing the spread of weeds within adjacent areas.
Erosion and sedimentation	Erosion of soils and associated sedimentation associated with the proposed overburden emplacement may involve the following: • Alteration of soil structure beneath haul roads. • The increase of surface water flow from the study area during rain events into the woodland areas to the south may result in	Variable depending on topography and operation.	Stormwater management measures will be implemented in accordance with the recommendations in the Peppertree Quarry Modification 4 Surface Water Assessment (Advisian	Sedimentation control are known to reduce sedimentation spills.

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
	erosion. • The deposition of soil particulates in drainage lines and remnant vegetation along the toe of the emplacement.		2015) and in accordance with Peppertree Quarry Water Management Plan.	
Dust	Dust will be generated from the construction and operation of the overburden emplacement. The Peppertree Quarry Modification 5 Air Quality Impact Assessment (Todoroski Air Sciences 2018) concluded that the Project would comply with the applicable assessment criteria at all locations assessed except for one Boral owned property, and that the project would not lead to any unacceptable level of environmental impact. Through accumulation with existing dust generated from existing Quarry operations, dust generated during construction of the overburden emplacement has the potential to impact upon the health of plants and vegetation particularly in those areas of dense native woodland immediately adjacent to the site. Research shows that the impacts of dust on vegetation can have both positive and negative impacts, however the impacts of increased levels of dust on animals are unknown (Farmer 1993). Farmer (1993) anticipated that dust may increase the susceptibility of plants and vegetation to secondary stresses, such as drought, insects and pathogens, or allow penetration of toxic metals or phytotoxic gaseous pollutants.	Variable depending on wind conditions. Potential for dust emissions likely throughout life of mine.	Dust impacts will be mitigated through the onsite use of water suppression and the progressive rehabilitation of the subject site. Further, vegetation clearing protocols for the Project will seek to minimise exposed areas with the potential to generate dust by completing vegetation clearing as close to mining as practical.	Successful implementation of dust control would minimise dust. Current dust suppression mitigation works are on-going at the Marulan and Peppertree Quarry.
Noise	Noise will be generated from the construction and operation of the overburden emplacement. The Peppertree Quarry Modification 5 Noise Impact Assessment (Wilkinson Murray 2018) concluded that the Project is unlikely to result in exceedances of the relevant noise criteria during the day, evening or night time. Although relevant research is limited, studies have found that traffic noise can mask the important contact calls of certain birds such as the budgerigar, canary, and Zebra Finch, (Lohr et al. 2003). Parris and Schneider (2008) found that it was increased volumes of noise and not increased volumes of traffic that were important. Various studies have indicated that changes in bird calls in response to traffic noise are twofold, either the birds change the characteristics of their call to avoid interaction of the sound of the	Variable depending on wind conditions. Potential for noise impacts likely throughout life of mine.	It should be noted that noise emissions from the establishment and operation of the overburden emplacement would be managed and monitored in accordance the Peppertree Quarry Noise and Blast Management Plan, which includes all reasonable and feasible noise mitigation measures.	Details explored in Wilkinson and Murray (2018).

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
	call with the created sounds or they limit calling to periods when the levels of noise are reduced. As the construction of the southern overburden emplacement will be undertaken immediately south of and after the completion of the eastern overburden emplacement, fauna inhabiting the adjacent woodlands of Barbers Creek Gorge will not be exposed to any greater noise than they are currently exposed to. The noise assessment of both the extension of in-pit operating hours and the establishment of the southern overburden emplacement has predicted that the proposed modifications to the approved operations, will not result in any perceptible changes in noise levels in the surrounding area. The Project is therefore unlikely to result in any additional noise impacts on local fauna.			
Increased lighting	In relation to night-time lighting, there is no proposed change to the existing Quarry lighting. The light that is currently emitted from the existing operations is from the lighting associated with the out-of-pit works, primarily the processing plant and surrounds, which is the main light source from the Quarry.	Light spill into nearby woodland areas to the west may occur – these areas currently exposed to lighting from vehicle usage along Marulan South Road.	Boral to continue with their existing night-time lighting as proposed.	No mitigation measures proposed.
Fire	Historically, arid zone bushfires tend to be associated with a proficient growth of native grasses following large rain events. During summer, following rain events, dry swards of grasses pose a bushfire hazard when placed near a source of ignition. Vehicles driven through long grass with hot exhausts may cause a fire particularly during the hotter months of the year.	Potential to be widespread in locality, though unlikely.	The Biodiversity Management Plan will incorporate bushfire management protocols to prevent and deal with the potential for bushfire.	Given the existing quarry operations have not resulted in any significant fires, the implementation of the Biodiversity Management Plan would likely assist in fire prevention.

5.3.3 Cumulative impacts

Cumulative impacts are the successive, incremental and combined impacts (both positive and negative) of an activity on the environment (Franks et al., 2010). They can arise from the compounding activities of a single operation given the interaction of that operation with past, current and future activities that may or may not be related to the existing development. Cumulative impacts may also arise through the interaction of one development with other types of activities and industries, such as grazing and broad scale agriculture.

In relation to the Project, the cumulative impacts are considered to be the total impact on the environment that would result from the current proposal plus any additional impacts likely to occur due to subsequent projects that are of a similar nature or that are partly or wholly contingent on the Project.

Identifiable cumulative impacts to be considered in the locality include:

- Marulan South Project – currently in draft form with the Environmental Assessment to be submitted in the coming month. The Marulan South Project is for the approval of a 30 year mine plan, including associated overburden emplacement areas, mine water supply dam, and various associated infrastructure that occurs immediately adjacent to the study area. This Project would result in cumulative impacts immediately adjacent to the study area, including:
    - Removal of an additional 142.7 ha of native vegetation and fauna habitat.
    - Removal of an additional 60.9 ha of White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC.
    - Removal of additional Koala habitat estimated to be 105.3 ha.
    - Removal of additional Large-eared Pied Bat estimated to be 113.2 ha.
    - A biodiversity offset for all residual impacts as per the BAM.
    - Rehabilitation of the areas impacted.

At a regional scale, the Marulan South Project site occurs within the Tablelands landscape of the Southern Rivers Bioregion of which approximately 44 % is occupied by the Goulburn Mulwaree LGA (ELA 2007). Agriculture is the main land use within the LGA which makes up 56% of the total area. Clearing has occurred predominately in the more fertile lands and along riparian zones. This is consistent with the Marulan South Project with grazing land occurring along the Inundation area and WOE. Only a small portion of the LGA (8%) is part of formal reserves and the remaining native vegetation represents only a small proportion of the pre-European vegetation. The main threat to remaining vegetation and to important ecosystem functions carried out by riparian zones and wetlands has been attributed to further clearing associated with agricultural practises and rural residential development in agricultural areas (ELA 2007), rather than mine associated clearing or impacts.

Whilst the Marulan South Project will result in degradation to native vegetation within the Southern Rivers Bioregion, the Project will also involve an offset that will contribute to in-perpetuity managed conservation areas within the Bioregion. This will contribute to objectives within the CMA's catchment action plan (Southern Rivers CMA 2013); within the Southern Rivers Bioregion it is proposed that an increase of 11,000 hectares to at least 41,000 hectares of land managed for conservation is to be achieved.

5.3.4 Serious and irreversible impacts

Threatened species which have potential to experience Serious and Irreversible Impacts (SAII) as a result of the project include the impacts to White Box Yellow Box Blakely's Red Gum Woodland TEC, Koala habitat and Large-eared Pied Bat habitat.

No clearing limit thresholds have been set by OEH to any of the SAII entities that are impacted by the Project. As required in section 10.2 of the BAM, the BDAR must address the SAII assessment criteria for each SAII entity potentially impacted by the Project. The SAII assessment criteria in relation to White Box Yellow Box Blakely's Red Gum Woodland TEC, Koala habitat and Large-eared Pied Bat habitat has been provided in Appendix 6.

After considering the SAII assessment criteria (Appendix 6), the project does not have the potential to cause Serious and Irreversible Impacts (SAII) to any TEC or threatened species.

5.3.5 Quantifying offset requirements

The BAM identifies the BAM Calculator as the appropriate tool for quantifying the offsets required in both Ecosystem Credit and Species Credit terms. A calculation of the nature and extent of offset credits required due to biodiversity impacts associated with the project has been undertaken using the BAM Calculator.

5.3.1 Summary of ecosystem credits required

The ecosystem credits to be retired for the Project as determined by the Biodiversity Credit Calculator are shown in Table 11.

Table 11 : Ecosystem credit requirements

Vegetation zone	Plant Community Type (PCT)	Vegetation formation	Vegetation class	Condition identifier input used in Calculator	Total (ha)	Credits required
1	PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)	Grassy Woodlands	Southern Tableland Grassy Woodlands	Medium	18.64	335
2				Poor	9.04	89
3	PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)	Dry Sclerophyll Forests (Shrub/grass subformation)	Central Gorge Dry Sclerophyll Forests	Medium	8.46	134
4				Poor	3.55	23

5.3.2 Summary of species credits required

Offsets required for species credit species are shown in Table 12. Species credits are required for the Koala and Large-eared Pied Bat.

Table 12: Species credit species requirements

Species Credit Species	Cleared habitat area (ha)	Required credits
Koala - (*Phascolarctos cinereus*)	27.1	514
Large-eared Pied Bat - (*Chalinolobus dwyeri*)	27.1	772

6. Offset strategy

Under the BAM, an offset strategy is not required to be submitted with the BDAR, as the credits are to be formally retired with the establishment of a Biodiversity Stewardship Site, or payment into the Biodiversity Conservation Trust (BCT) Fund. However, as noted in the DoEE Supplementary SEARs, a biodiversity offset strategy is required to be included in the Biodiversity Assessment.

6.1 One offset package to satisfy the NSW and EPBC Offset Requirements

Under the BAM, the biodiversity offsets must provide benefits to biodiversity to compensate for the adverse impacts of an action. Biodiversity offsets assist in achieving long-term conservation outcomes while providing development proponents with the ability to undertake actions that have unavoidable impacts on biodiversity.

Unavoidable impacts to biodiversity are those impacts that are residual (i.e. impacts that remain after impact avoidance, management and mitigation measures are employed to reduce the type or magnitude of biodiversity impacts). Section 5.1.1 of this report outlines the design changes that Boral has implemented through the feasibility and pre-feasibility stages of the Project in order to avoid and reduce impacts to biodiversity values. Section 5.1.2 to Section 5.1.6 of this report outline the management and mitigation actions that Boral will employ to further reduce direct and indirect impacts to biodiversity values as a result of this Project.

This section of the report describes the approach to biodiversity offsetting proposed for the Project in order to satisfy the BAM and Commonwealth Offsetting requirements.

Based on the results of the MNES Assessments of Significance contained in this report, the Project would result in a significant impact to White Box Yellow Box Blakely's Red Gum Grassy Woodland and the Koala. As such, the biodiversity offset proposed would satisfy both the State and Commonwealth offsetting requirement for both threatened entities. It should be noted that whilst this assessment has not determined a significant impact to any other threatened biodiversity as listed under the EPBC Act, the proposed offsets discussed below would protect and enhance habitat for a range of threatened and migratory fauna listed on the EPBC Act.

6.2 Proposed offset strategy

Boral propose to offset the Project using two properties, which would be established as Stewardship Sites under the BAM to provide in-perpetuity protection and management of biodiversity values. The properties are listed in Table 13 and detailed below.

Table 13. Offset liability properties

Property	Size	Applicable biodiversity values present to offset the Project	Percentage of offset liability met (State and Commonwealth)
Property 1 – Boral owned	Approximately 1,000 ha	• PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534) • Koala • Large-eared Pied Bat.	100%
Property 2 – Private owned	Approximately 360 ha	• PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) – associated TEC as listed under the BC Act and EPBC Act.	100%

6.2.1 Property 1 (Boral owned)

Boral has purchased a 1,000 hectare property within the Bungonia subregion for the purposes of offsetting for the current Project. The details of the property have been withheld from this assessment for confidentiality reasons, however can be provided in a separate report to the Departments should it be required.

To date, Niche have completed field surveys on the property in accordance with the BAM, and fauna surveys (spotlighting and anabat recording) to determine the presence of Koala and Large-eared Pied Bat.

The field surveys confirmed the presence of a Koala population on the site (four individuals recorded), and Large-eared Pied Bat foraging habitat (captured using anabat devices located in all habitat features of the property).

The area of both Koala and Large-eared Pied Bat habitat available on the site that would be managed in perpetuity is approximately 936 hectares.

The Biodiversity values at the site would satisfy the following biodiversity offset liabilities:

- PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin (SR534)
- The BAM offset liability and the EPBC Act offset requirement for the Koala
- The BAM offset liability and the EPBC Act offset requirement for the Large-eared Pied Bat.

To date, reporting and Biodiversity credit calculations have been completed. A Stewardship Application has not yet been submitted given the BCT has not provided a management action plan template at the time of submission for this report.

6.2.2 Property 2 (private owned)

In order to satisfy the offset liability for PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670) and subsequent EPBC listed White Box Yellow Box Blakely's Red Gum Grassy Woodland, Boral are in the final stages of negotiation to secure credits within a 360 hectare property containing the TEC. Through the retirement of 424 credits, the offset liability for the Project would be met for both the State and Commonwealth TEC requirement.

Details of the negotiations can be provided in confidence to the Departments, however have been withheld from this assessment due to confidentiality reasons.

7. Conclusion

This report provides a BDAR in accordance with the BAM in order to address the potential impacts associated with the Peppertree Modification 5 Project.

The Project will result in the disturbance of 39.69 ha of native vegetation. Indirect impacts may include dust, noise, erosion and sedimentation which will be mitigated by measures provided in section 5.3.2 of this report.

During the field survey one TEC - White Box Yellow Box Blakely's Red Gum Woodland was found to occur within the study area. Two condition classes were attributed to the TEC to assist with offsetting the impacts. The Project will result in disturbance to approximately 27.68 ha of the TEC listed under the BC Act and EPBC Act. This TEC would be offset according to the requirements of the BAM.

A further 12.01 ha of native vegetation would also be offset in accordance with the BAM.

No threatened flora are likely to be impacted by the Project given the lack of habitat and absence of threatened flora during the field survey.

Seventeen threatened and migratory fauna species are considered to be affected by the Project. Most of these species are likely to utilise the foraging habitat of the study area on an intermittent basis. No further assessment of impact is required for the ecosystem credit species based on the requirements of the BAM and the offsetting of the associated PCTs Ecosystem Credit Species under the BAM which do not require further assessment of impact as they would be offset with their associated PCTs.

The Koala and Large-eared Pied Bat are the only listed Species Credit Species which require an offset for the Project given their detection within, or adjacent to the study area.

Those threatened fauna species which are listed under the EPBC Act that were attributed a moderate to high likelihood of occurrence within the study area include: Fork-tailed Swift, Cattle Egret, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Large-eared Pied Bat, and Grey-headed Flying Fox. An EPBC Act Assessment of Significance for each of these species has been completed and concluded that a significant impact to any EPBC Act listed threatened fauna is unlikely.

Mitigation measures associated with indirect impacts have been proposed through the revision and implementation of existing management plans.

A total of 581 Ecosystem Credits are required to offset PCT impacts and associated threatened fauna habitat surrogates; 514 Koala credits and 772 Large-eared Pied Bat credits.

In order to satisfy the biodiversity offset requirement for the Project, Boral propose two properties which would be established as Stewardship Sites. The two sites would ensure the in perpetuity management and protection native vegetation, White Box Yellow Box Blakely's Red Gum Grassy Woodland TEC, known Koala habitat and known Large-eared Pied Bat habitat.

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Figures

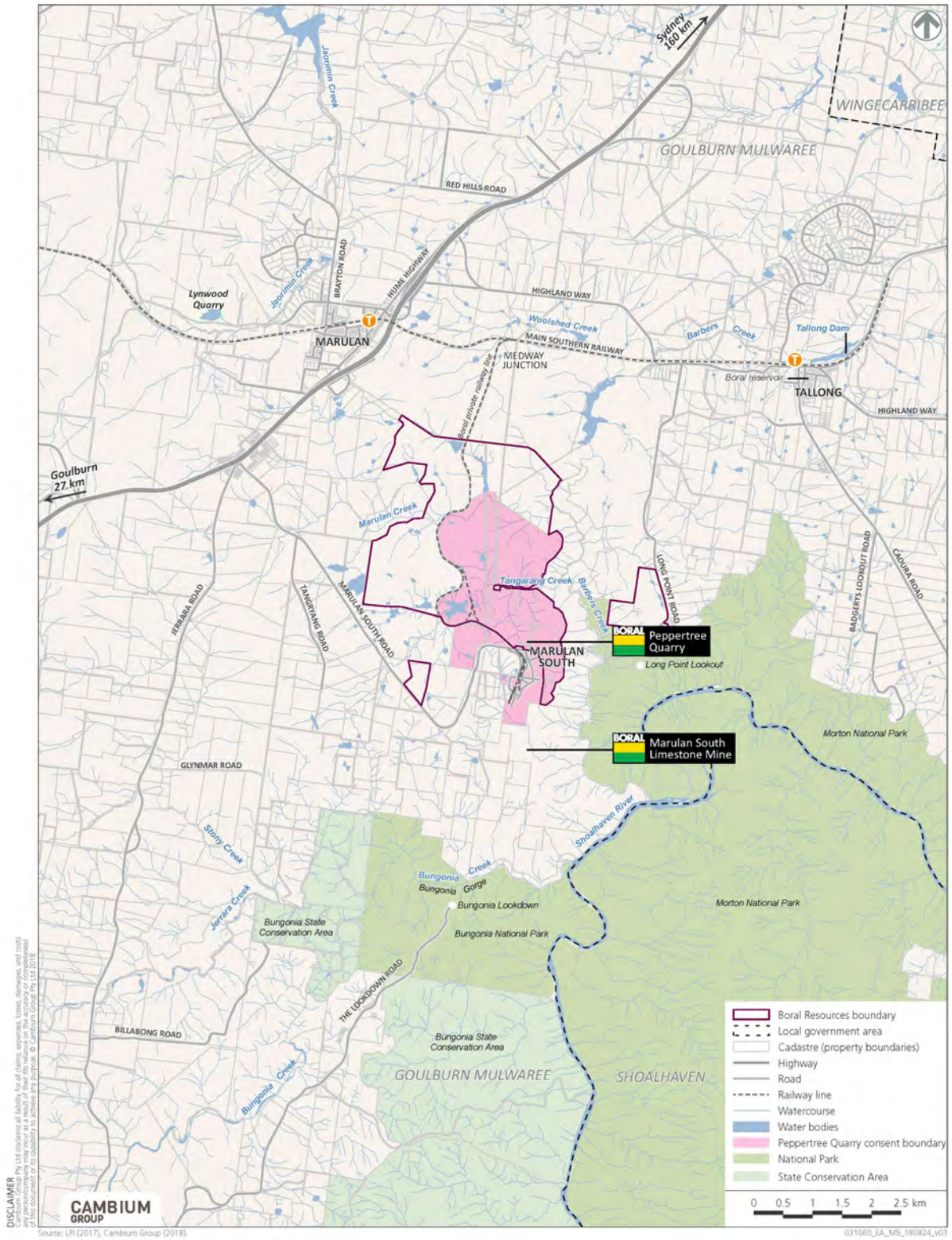
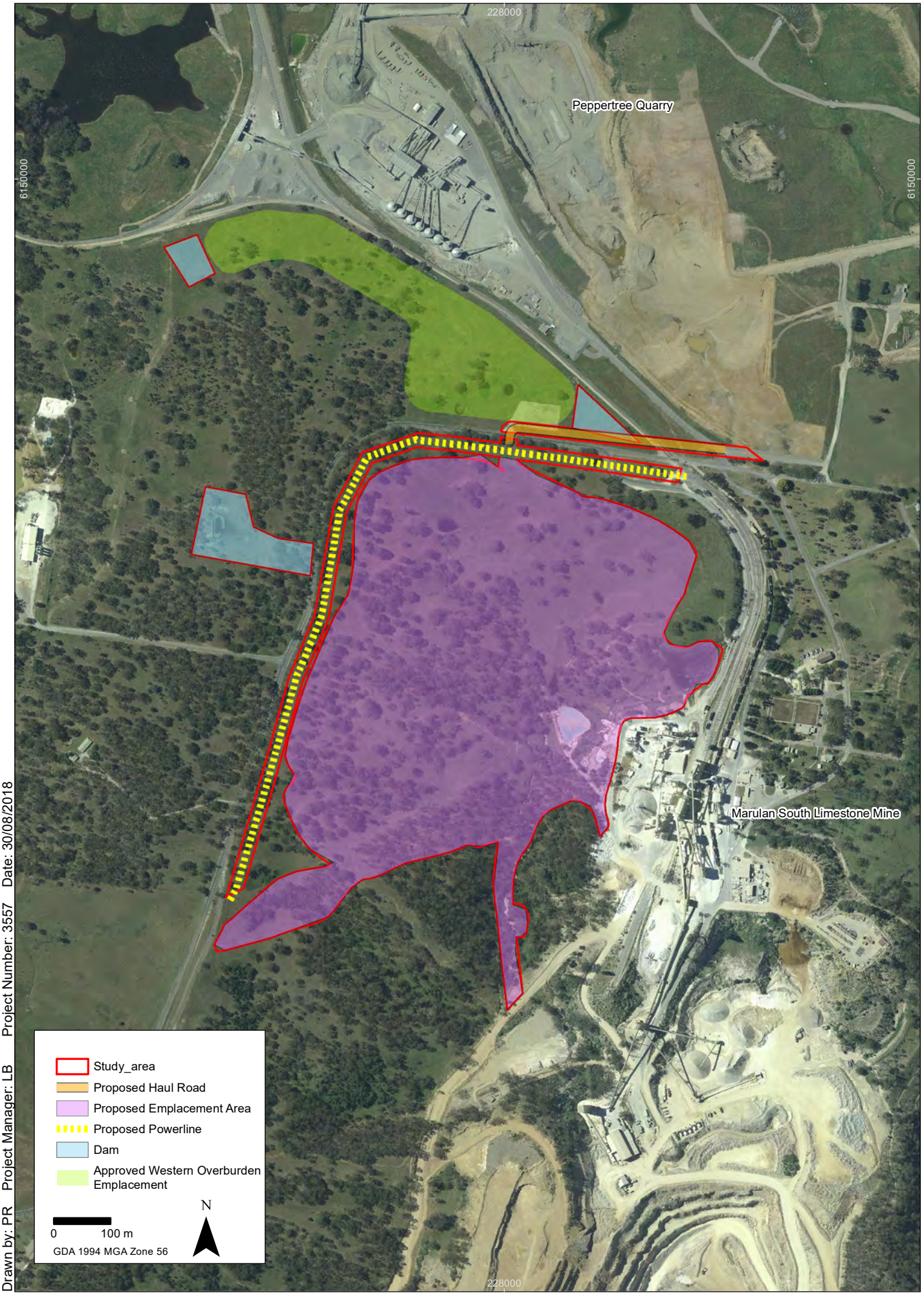


Figure 1. Local context



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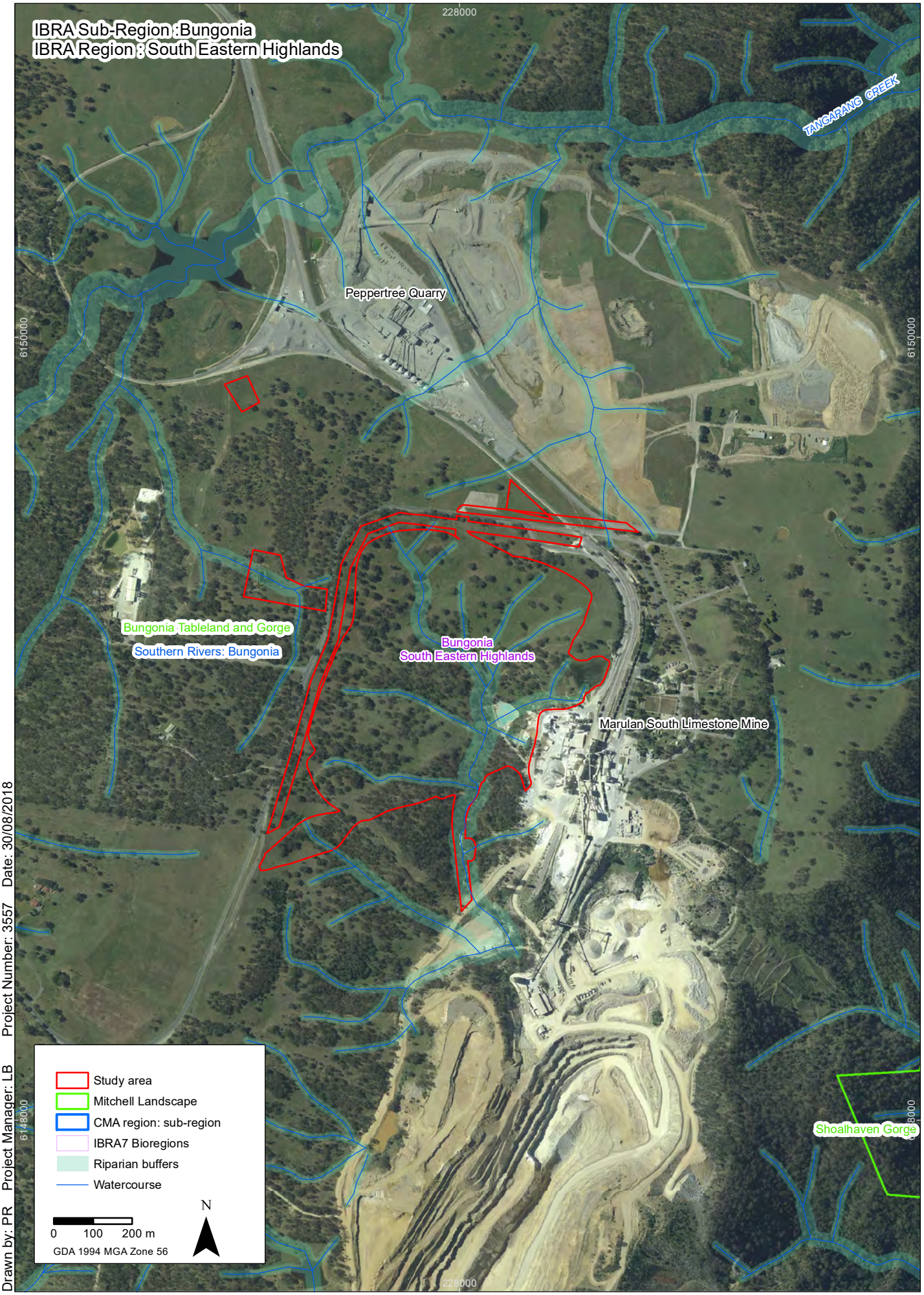
Site Map

Peppertree Modification 5 Biodiversity Assessment

FIGURE 2

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Imagery: (c) Boral 2014



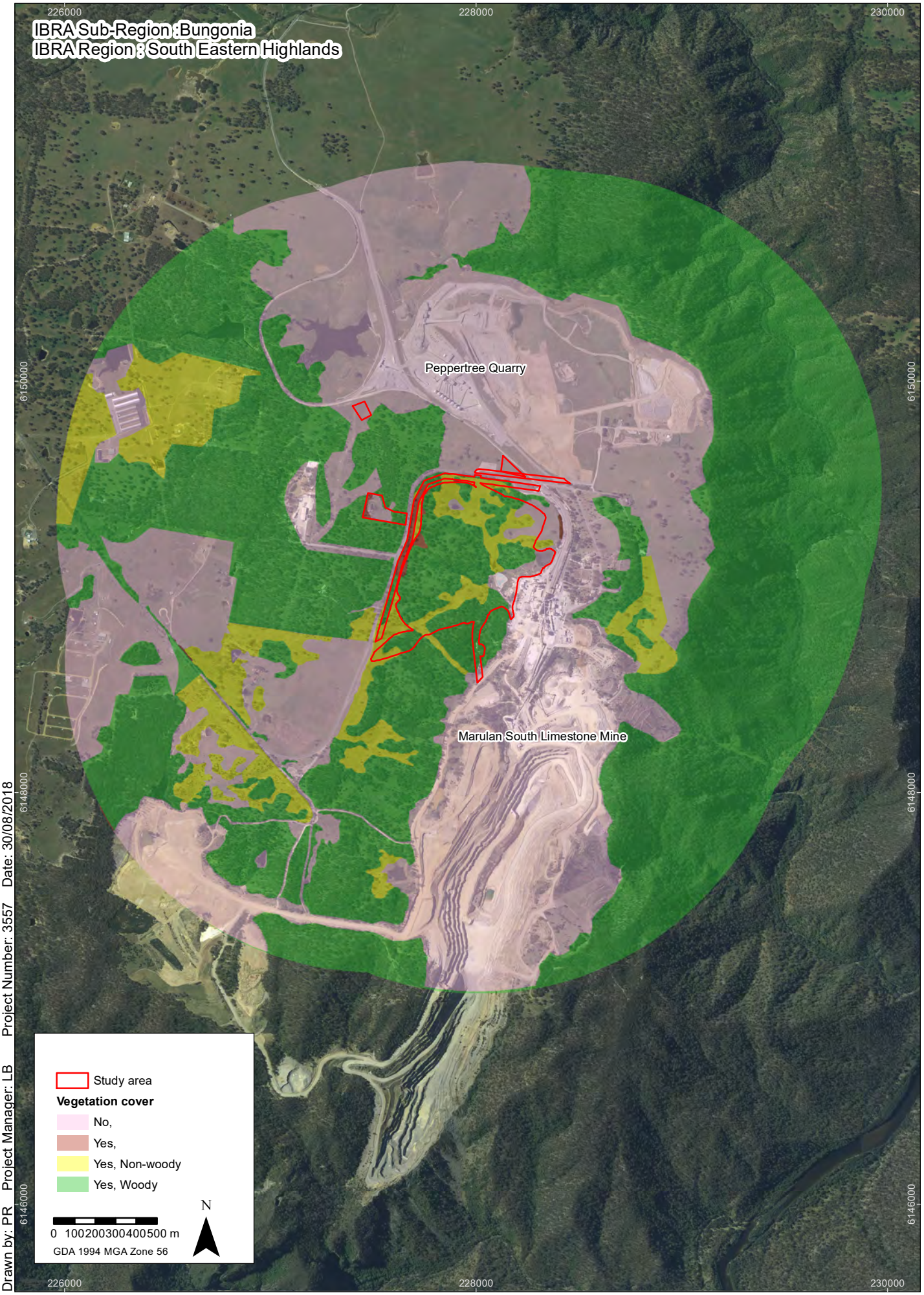
Location Map

Peppertree Modification 5 Biodiversity Assessment

FIGURE 3

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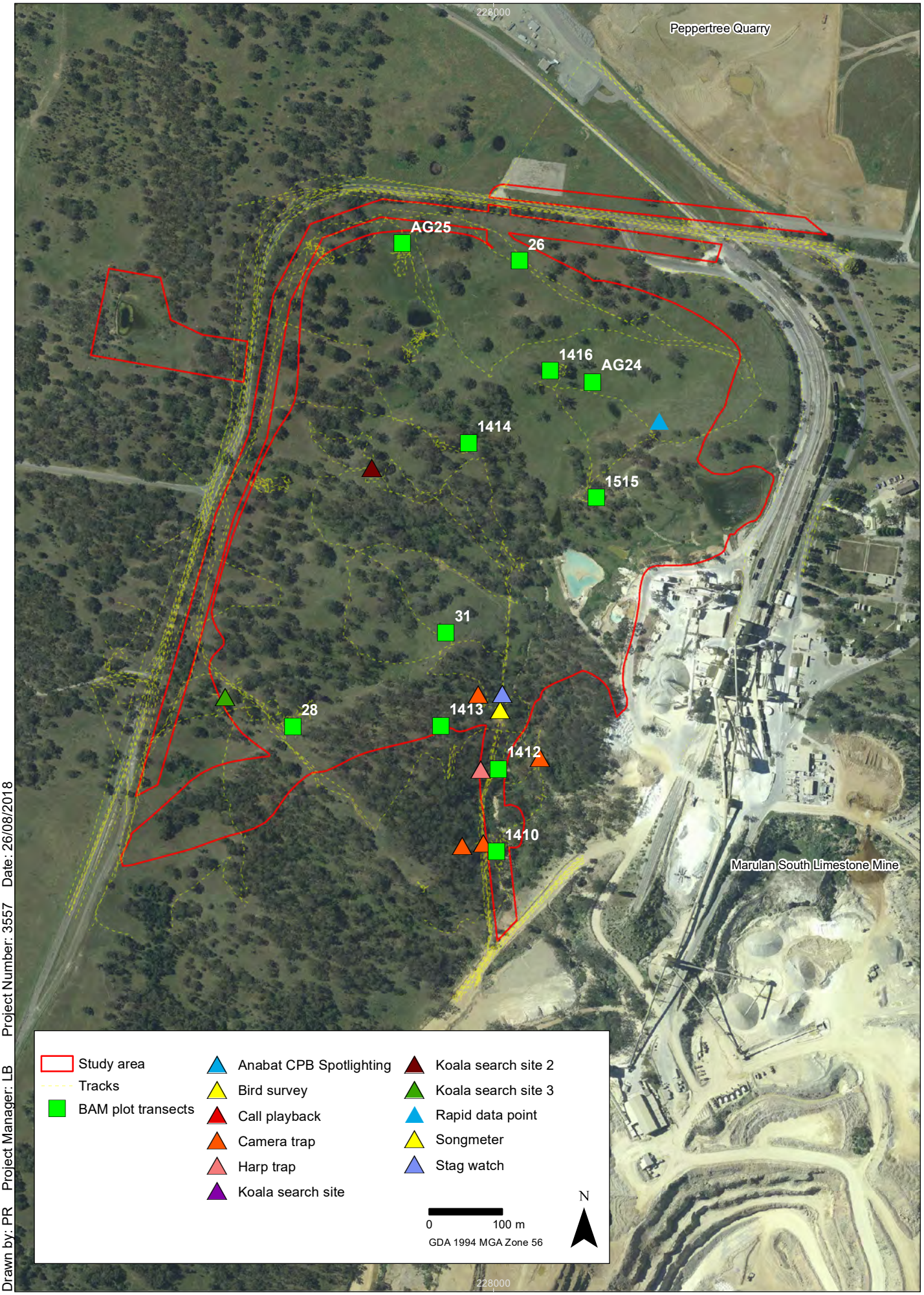
Location Map

Peppertree Modification 5 Biodiversity Assessment

FIGURE 4

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Drawn by: PR Project Manager: LB Project Number: 3557 Date: 26/08/2018

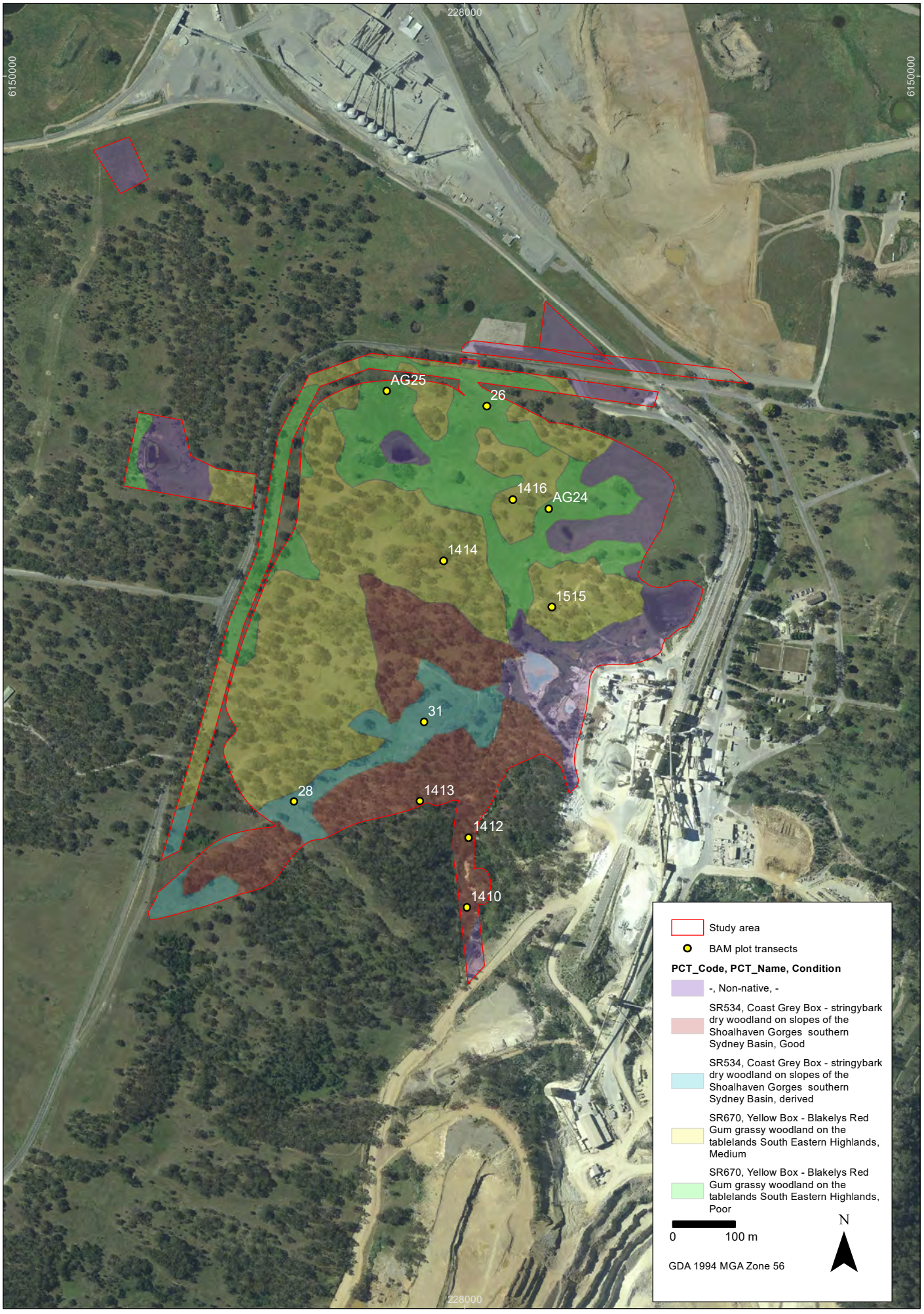
Survey Effort

Peppertree Modification 5 Biodiversity Assessment

FIGURE 5

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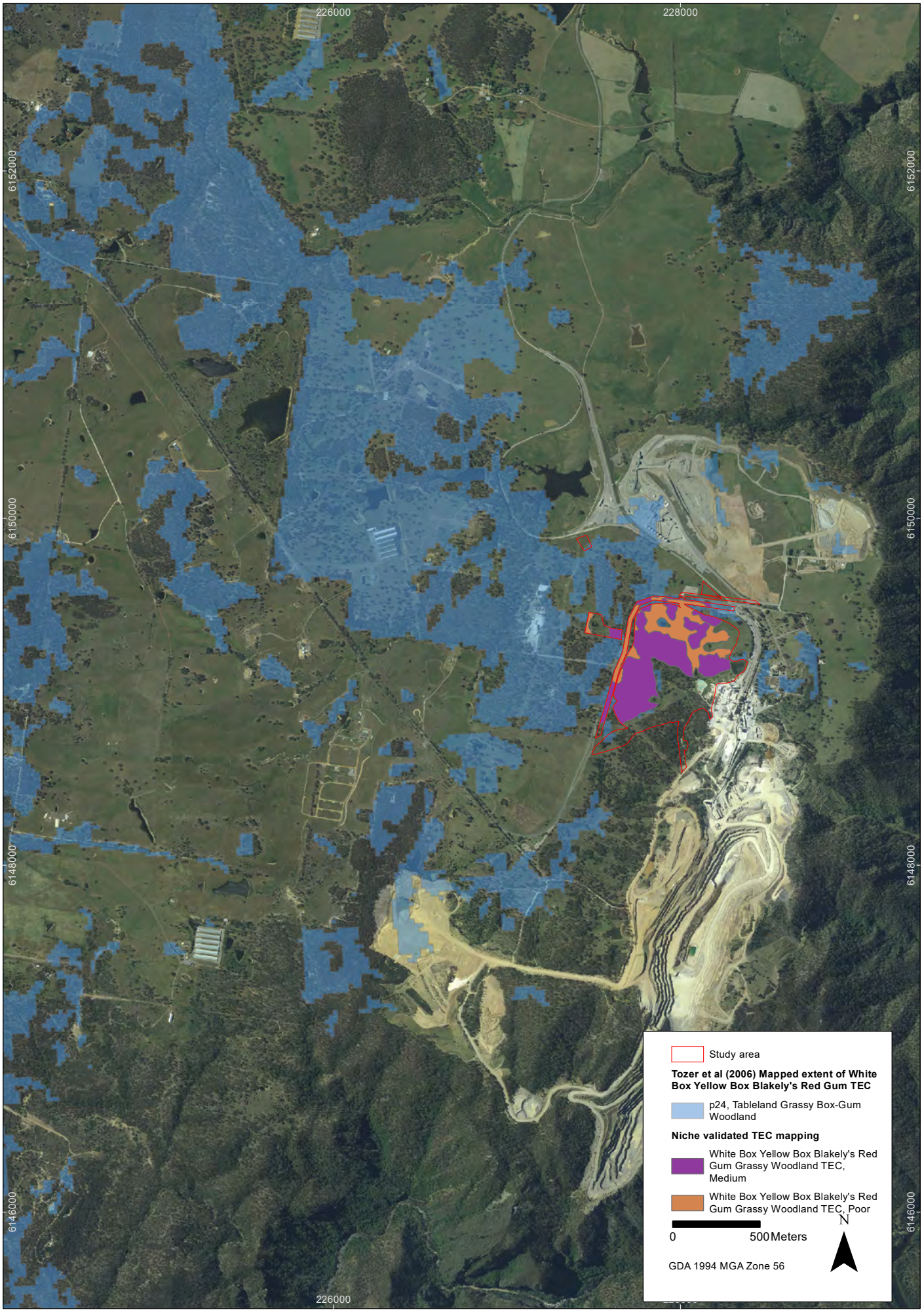
Drawn by: PR Project Manager: LB Project Number: 3557 Date: 30/08/2018

Niche Validated Vegetation Mapping
Peppertree Modification 5 Biodiversity Assessment

FIGURE 6

Path: T:\SpatialWorking\LB\3557 Peppertree Mod 5\3557_Figure_4_Veg_Niche.mxd

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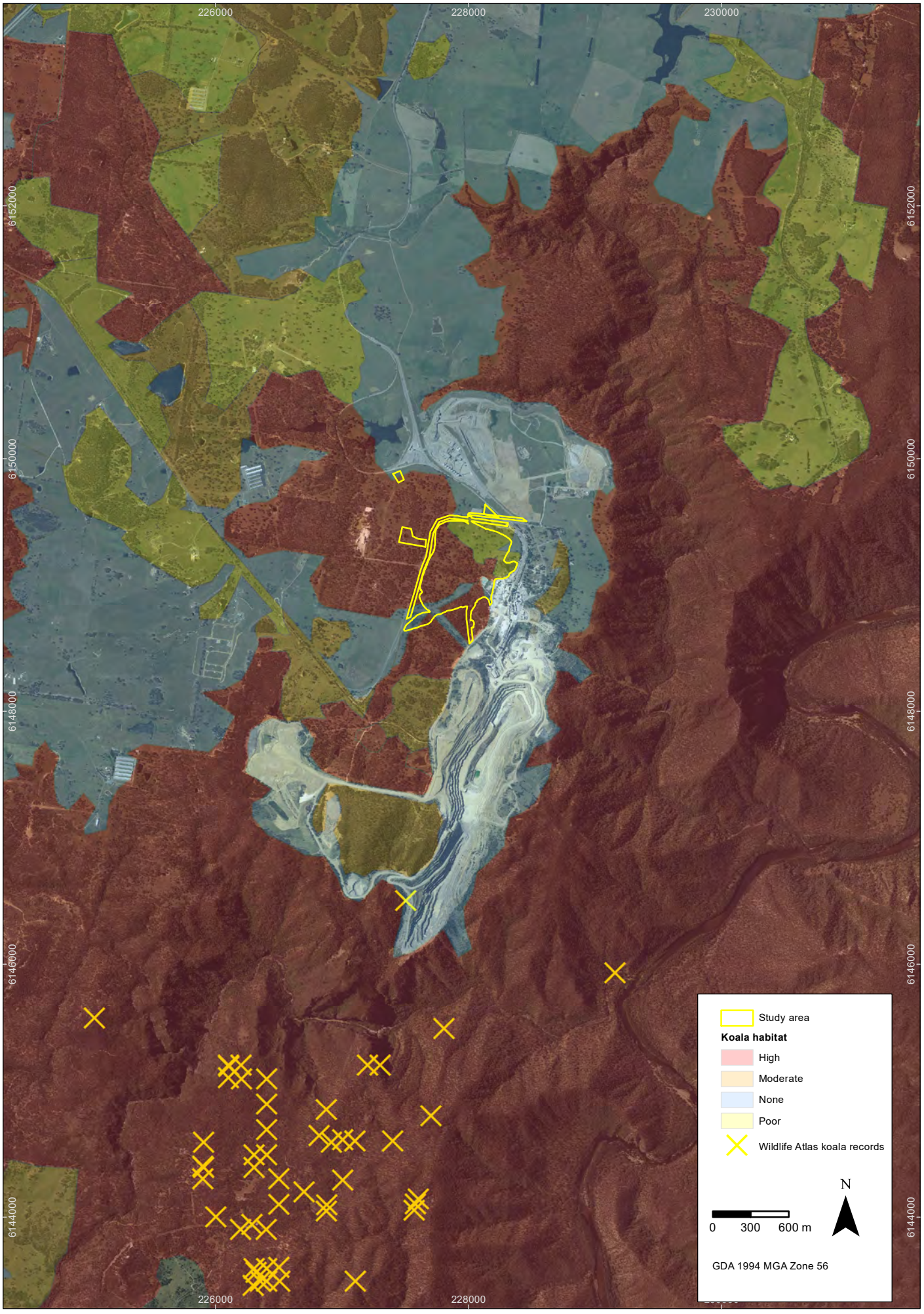
Threatened Ecological Communities mapped in study area

Peppertree Modification 5 Biodiversity Assessment

FIGURE 7

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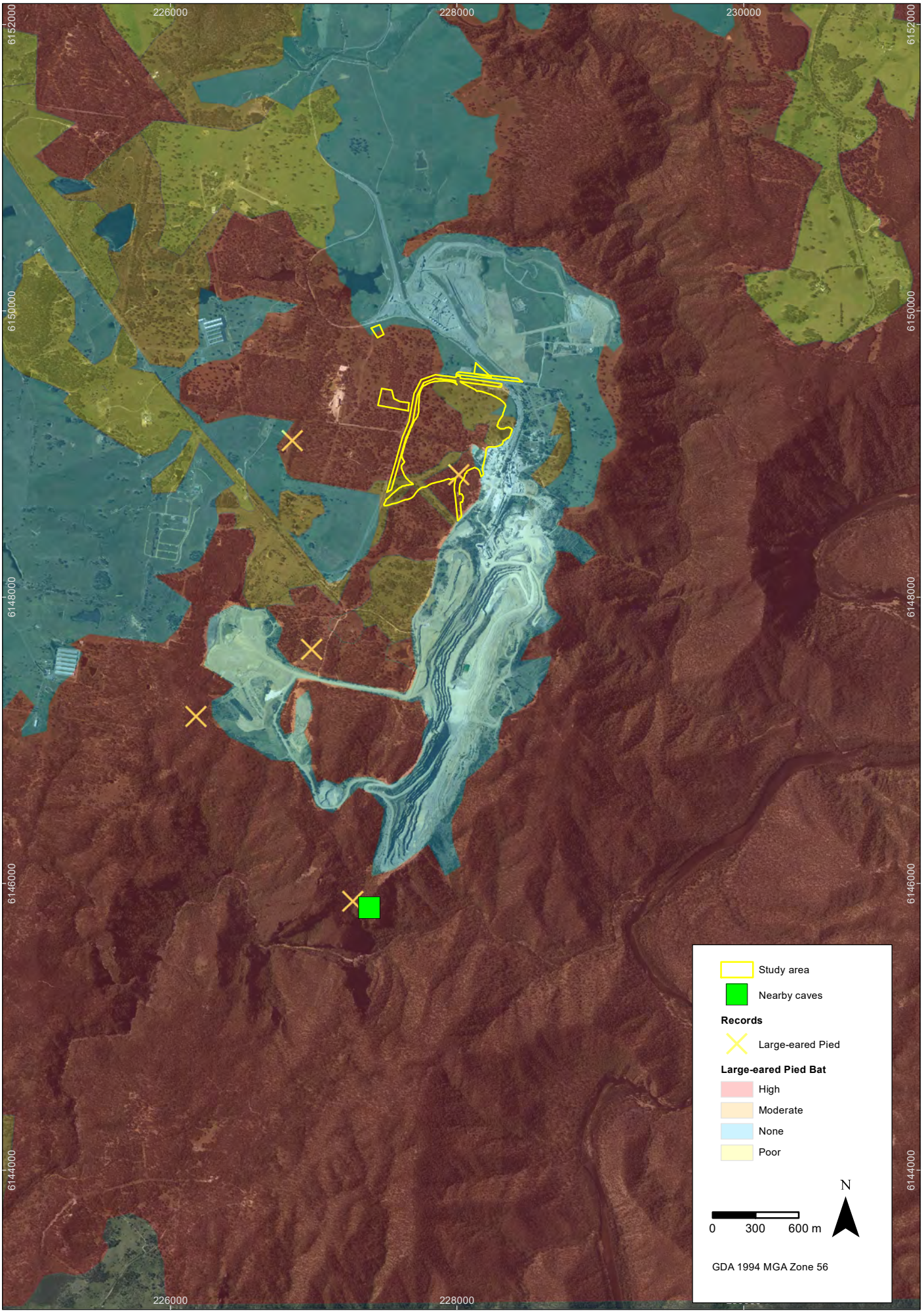
Koala Habitat

Peppertree Modification 5 Biodiversity Assessment

FIGURE 8

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Imagery: (c) Boral 2014



Drawn by: PR Project Manager: LB Project Number: 3557 Date: 30/08/2018

Large-eared Pied Bat habitat

Peppertree Modification 5 Biodiversity Assessment

FIGURE 9

Path: T:\SpatialWorking\LB\3557 Peppertree Mod 5\3557_Figure_9_LEPB.mxd

Imagery: (c) Boral 2014

Appendix 1. Likelihood of occurrence

Threatened flora likelihood of occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of Occurrence
Acacia bynoeana	Bynoe's Wattle	V	V	*A. bynoeana* occurs mainly in heath and dry sclerophyll forest (Morrison & Davies 1991). The substrate is typically sand and sandy clay, often with ironstone gravels and is usually very infertile and well-drained. The species seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds.	Low – habitat not suitable within study area and unlikely to remain undetected during survey if present.
Caladenia tessellata	Thick-lipped Spider-orchid	E	V	The Thick-lipped Spider-orchid is found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. Known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. is known to favour low, dry sclerophyll woodland (for example open Kunzea woodland) with a heathy or sometimes grassy understorey on clay loams or sandy soils. The population at Braidwood occurs in dry, low Brittle Gum (*Eucalyptus mannifera*), Inland Scribbly Gum (*E. rossii*) and *Allocasuarina* spp. woodland with a sparse understorey and stony soil.	Low – no records within 10km. Not detected during survey. Habitat within study area is not suitable.
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Grows in swamp-heath on sandy soils, chiefly in coastal districts, south from the Gibraltar Range. The Leafless Tongue-orchid has been reported to occur in a wide variety of habitats including heathlands, heathy woodlands, sedgelands, *Xanthorrheoa* spp. plains, dry sclerophyll forests (shrub/grass sub-formation and shrubby sub-formation), forested wetlands, freshwater wetlands, grasslands, grassy woodlands, rainforests and wet sclerophyll forests (grassy sub-formation). Soils are generally considered to be moist and sandy, however, this species is also known to grow in dry or peaty soils	Low – no records within 10km. Habitat within study area is not suitable.
Eucalyptus aggregata	Black Gum	V	-	Found in the NSW Central and Southern Tablelands, with small isolated populations in Victoria and the ACT. Has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands in the lowest parts of the landscape, on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Also occurs as isolated paddock trees in modified native or exotic pastures. Often grows with other cold-adapted eucalypts, such as Snow Gum or White Sallee (*Eucalyptus pauciflora*), Manna or Ribbon Gum (*E. viminalis*), Candlebark (*E. rubida*), Black Sallee (*E. stellulata*) and Swamp Gum (*E. ovata*). Black Gum usually occurs in an open woodland formation with a grassy groundlayer dominated either by River Tussock (*Poa labillardierei*) or Kangaroo Grass (*Themeda australis*), but with few shrubs.	Low - Recorded over 2 km to the north-east of the study area within Conservation Area. Relatively conspicuous species and unlikely to remain undetected during field survey.
Eucalyptus aquatica		V	V	Found primarily in the Penrose area near Goulburn where all records are either from State forest or private property. There is also one record from within Morton National Park. Occurs as scattered plants on open, swampy flats.	Low – habitat not suitable within study area and unlikely to remain undetected during survey if present.
Eucalyptus macarthurii	Paddys RiverBox	V	-	A moderately restricted distribution, recorded from the Moss Vale District to Kanangra Boyd National Park. In the Southern Highlands it occurs mainly on private land, often as isolated individuals in, or on the edges of paddocks. Isolated stands occur in the north west part of the range on the Boyd Plateau. The only known record in the conservation estate is within Kanangra Boyd National Park. Occurs on grassy woodland on relatively fertile soils on broad cold flats.	Low – recorded over 5 km to the west. Relatively conspicuous species which is unlikely to remain undetected during survey.
Genoplesium baueri	Yellow Gnat-orchid	-	E	The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections	None – no suitable habitat. No records. Not detected during

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of Occurrence
				have been made from those sites in recent years. Currently the species is known from just over 200 plants across 13 sites. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Grows in dry sclerophyll forest and moss gardens over sandstone.	field survey.
Genoplesium plumosum	Tallong Midge Orchid	CE	E	Occurs exclusively in heathland, generally dominated by violet kunzea, common fringe-mytre and parrot-peas. Grows on very shallow soils or within mosses on sandstone conglomerate shelves. Plants exist only as a dormant tuber for much of the year, with leaves or fruiting stems dying back in winter. Reproduces by seed and has no mechanism for vegetative reproduction.	Low – the disturbed area is not along sandstone shelves.
Grevillea molyneuxii	Wingello Grevillea	V	E	This species has only been recorded in low heathland on sandstone, where it grows in skeletal soil on flat, wet sandstone shelves above dissected valleys.	Low – no suitable habitat.
Haloragis exalata subsp. *exalata*	Square Raspwart	V	V	Occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the central coast, south coast and north-western slopes botanical subdivisions of NSW. The species appears to require protected and shaded damp situations in riparian habitats.	Low – not detected during field survey. Habitat marginal within study area.
Kunzea cambagei	Cambage Kunzea	V	V	Restricted to damp, sandy soils in wet heath or mallee open scrub at higher altitudes on sandstone outcrops or Silurian group sediments.	Low – no potential habitat.
Lepidium hyssopifolium	Aromatic Peppercress	E	E	Currently, the species is known from near Bathurst and Bungendore, in the South Eastern Highlands Bioregion (Tumino 2010). Historically, the Basalt Pepper-cress has been recorded from the Northern and Central Tablelands, with an atypical specimen from Cooma on the Southern Tablelands (Harden 2000). The Central Tablelands records are from the Bathurst area; the Northern Tablelands collections are from Gostwyck, near Armidale, and there was an 1884 record from 'near Maryland', though this record may have been from either NSW or Queensland, as the Maryland Station once extended over the border. Most other records have been found to be misidentifications. Generally, the Aromatic Peppercress is known to establish on open, bare ground with limited competition from other plants. The Aromatic Peppercress was previously recorded from Eucalypt woodland with a grassy ground cover, low open Casuarina woodland with a grassy ground cover and tussock grassland. Recently recorded localities have predominantly been in weed-infested areas of heavy modification, high degradation and high soil disturbance such as road and rail verges, on the fringes of developed agricultural land or within small reserves in agricultural land. Many populations are now generally found amongst exotic pasture grasses and beneath exotic trees such as the Radiata Pine (*Pinus radiata*) and Monterey Cypress (*Cupressus macrocarpus*), often associated with other species of Lepidium. The lack of competition from other shade-tolerant species allows the Aromatic Peppercress to persist (Tumino 2010).	Low – despite having marginal habitat present, there are no records within 10 km. Unlikely to be present.
Leucochrysum albicans var. *tricolor*	Hoary Sunray	-	E	Occurs in a wide variety of grassland, woodland and forest habitats, generally on relatively heavy soils. The Hoary Sunray occurs at relatively high elevations in woodland and open forest communities, in an area roughly bounded by Goulburn, Albury and Bega. The species has been recorded in the Yass Valley, Tumut, Upper Lachlan, Snowy River and Galong The species is known from the South Eastern Highlands, Australian Alps and Sydney Basin bioregions (Sinclair 2010). Herbarium records indicate that the taxa once occurred more widely in inland NSW, near Cobar, Dubbo, Lithgow, Moss Vale and Delegate (Sinclair 2010).	Low – grassland areas are highly disturbed. No records within 10 km of site.
Pelargonium sp. *Striatellum*	Omeo's Stork's-bill	E	E	Flowering occurs from October to March. Occurs in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds. The species is known to form clonal colonies by rhizomatous propagation. Known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. A population at a fourth known site on the Monaro has not been seen in recent years. The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang,	Low – no known records. No habitat present.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of Occurrence
				Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas.	
Phyllota humifusa		V	V	The species occurs in dry sclerophyll forest, sometimes near swamps, in deep sandy soils or gravely loams over a sandstone substrate. Accompanying trees are often Brittle Gum *Eucalyptus mannifera*, Narrow-leafed Peppermint *E. radiata* or Sydney Peppermint *E. piperita*.	Low – closest record over 6 km to the north-east. Lack of sandstone present. Habitat very marginal.
Pimelea axiflora subsp. *pubescens*	Bungonia Rice-flower	E	-	Occurs on limestone cliff edges and outcrops. Endemic to NSW and currently only known to occur in the Bungonia State Conservation Area, south east of Goulburn. Occurs in a single population which is estimated to contain a total of 50 to 500 plants within an area of less than 4 square kilometres.	Low – Habitat within study area is not suitable given absence of cliff edges and outcrops.
Pomaderris cotoneaster	Cotoneaster Pomaderris	E	E	Cotoneaster Pomaderris has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs. Habitat notes from specimens include: 'base of cliff, tall open forest (*E. fastigata*)'; 'alluvial terrace with tall open forest (*E. cypellocarpa*)'; 'alluvial terrace with tall open forest (*E. muelleriana*)'; 'rocky riparian site amongst tall open eucalypt forest (*E. viminalis*)'; 'rocky river bed'; 'Growing on dry south-westerly facing slope above river. Associated with *Westringia* sp. aff. *longifolia*, *Grevillea lanigera, Prostanthera* sp. *nov., Eucalyptus radiata, Olearia* sp., *Kunzea ericoides* and *Acacia pravissima'*; 'Growing in shrubby woodland of *Eucalyptus maidenii* & *E. elata*. south-facing slope with loamy soil on metasiltstone'	Low – Habitat within study area is not suitable.
Pomaderris pallida	Pale Pomaderris	V	V	This species usually grows in shrub communities surrounded by Brittle Gum (*Eucalyptus mannifera*) and Red Stringybark (*E. macrorhyncha*) or *Callitris* spp. woodland.	Low – Habitat within study area is not suitable.
Pultenaea pedunculata	Matted Bush-pea	E	-	The Matted Bush-pea occurs in a range of habitats. NSW populations are generally among woodland vegetation but plants have also been found on road batters and coastal cliffs. It is largely confined to loamy soils in dry gullies in populations in the Windellama area. The ability of stems to creep and root from the nodes has made this species a very good coloniser of bare ground in many parts of its range. Matted Bush-pea is widespread in Victoria, Tasmania, and south-eastern South Australia. In NSW however, it is represented by just three disjunct populations, in the Cumberland Plains in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn (where it is locally abundant). The Cumberland Plain occurrences were more widespread (Yennora, Canley Vale and Cabramatta were lost to development) and is now found at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel number 2 (Upper Sydney Water Supply Canal).	Low – out of known range. Unlikely to be present.
Rulingia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: snow gum woodland at Rose Lagoon; blue leaved stringybark open forest at Tallong; and in brittle gum low open woodland at Penrose; scribbly gum - swamp mahogany ecotonal forest at Tomago.	Low – habitat not suitable within study area and unlikely to remain undetected during survey if present.
Rutidosis heterogama	Buttone Wrinkewart	V	V	Recorded from near Cessnock to Kurri Kurri with an outlying occurence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides	Low – habitat not suitable within study area and unlikely to remain undetected during survey if present.
Rutidosis leptorrhynchoides	Button Wrinklewort	E	E	In the ACT and NSW, Button Wrinklewort occurs in box-gum woodland, secondary grassland derived from box-gum woodland or in natural temperate grassland; and often in the ecotone between the two communities.	Low – habitat not suitable within study area and unlikely to remain undetected during survey if present.

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of Occurrence
Solanum celatum		E	-	Grows on hills and slopes in eucalypt woodland; commonly found after fire or disturbance. Restricted to an area from Wollongong to a little south of Nowra and west to Bungonia Nature Reserve.	Low – Habitat within study area is not suitable. The species was recorded during the Niche (2014) for the Peppertree Mod 4 assessment, however this population is located approximately 1 kilometre to the east of the study area.
Thelymitra sp. Kangaloon	Kangaloon Sun Orchid	CE	CE	*Thelymitra* sp. Kangaloon is only known to occur on the southern tablelands of NSW in the Moss Vale - Kangaloon - Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. It is found in swamps in sedgelands over grey silty grey loam soils	None – no habitat present.
Thesium australe	Austral Toadflax	V	V	Grows in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland. Grows on kangaroo grass tussocks but has also been recorded within the exotic coolatai grass.	None. No records within 10 km. Habitat not suitable.

Threatened fauna likelihood of occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
Amphibians							
Heleioporus australiacus	Giant Burrowing Frog	V	V	The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with more sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis. No potential habitat is present within the area to be cleared. Some marginal habitat is present within the gullies to the east of the study area, however it was not recorded during field surveys for the Marulan South Limestone Mine Project (Niche 2015). It has not been recorded from the locality and there are no records in the region.	None	None	Species
Litoria aurea	Green and Golden Bell Frog	E	V	Inhabits a very wide range of water bodies including marshes, dams and streams, particularly those containing emergent vegetation such as bullrushes or spikerushes. It also inhabits numerous types of man-made water bodies including quarries and sand extraction sites. Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow, have a grassy area nearby and diurnal sheltering sites available.	None	None	Species
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Occurs in wet and dry sclerophyll forests and heathland associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range from the Central Coast down into Victoria. Individuals have been collected from a wide range of water bodies that includes semi-permanent dams, permanent ponds, temporary pools and permanent streams, with calling occurring from fringing vegetation or on the banks. Individuals have been observed sheltering under rocks on high exposed ridges during summer and within deep leaf litter adjacent to the breeding site. Calling occurs in all months of the year, often in association with heavy rains. The tadpoles are distinctive, being large and very dark in colouration. No potential habitat is present within the area to be cleared. Some marginal habitat is present within the gullies to the east of the study area, however it was not recorded during field surveys for the Marulan South Limestone Mine Project (Niche 2015). It has not been recorded from the locality and there are no records in the region.	None	None	Species
Birds							
Actitis hypoleucos	Common Sandpiper	-	M, MA	Utilises a wide range of coastal wetlands and some inland wetlands, mostly found around muddy margins or rocky shores. Forages in shallow water and on soft mud, roosts on rocks or vegetation such as mangroves. Northern hemisphere breeding.	Low – transient visitor only.	Unlikely – negligible impacts.	Species - excluded from further assessment – not detected during survey.
Anthochaera phrygia	Regent Honeyeater	CE	E,M	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. This species has contracted dramatically in the last 30	Low – transient visitor only.	Unlikely – negligible impacts.	Species - excluded from further assessment – not detected during survey.

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
				years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. Three records from the locality centred around the Bungonia National Park area to the south. As the species is migratory it may occur as a transient visitor to the site, including to forage, but would use the site rarely. No breeding habitat present. Not recorded during targeted bird survey.			
Apus pacificus	Fork-tailed Swift	-	M	The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 m above ground and probably much higher.	Moderate	Unlikely – negligible impacts. May fly over site.	
Ardea alba	Great Egret	-	M	Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	Low	Unlikely – negligible impacts.	N/A
Ardea ibis	Cattle Egret	-	M	The Cattle Egret is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. May occur intermittently within the study area – species is common and widespread.	Moderate	Low	Not considered further - no real chance of impacts.
Botaurus poiciloptilus	Australasian Bittern	E	E	The Australasian Bittern is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes. Single record from Bungonia Conservation Area. Potential habitat is very limited within the proposed study areas with permanent wetlands very limited in extent.	None	None	Species - excluded from further assessment
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Prefers muddy edges of shallow or brackish wetlands, with inundated or emergent sedges, saltmarsh or other low vegetation. Also found foraging in sewage ponds and flooded paddocks. Northern hemisphere breeding.	Low – transient visitor only.	Unlikely – negligible impacts.	Species - excluded from further assessment – not detected during survey.
Calidris ferruginea	Curlew Sandpiper	E	CE,M	It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland. Northern hemisphere breeding.	Low – transient visitor only.	Unlikely – negligible impacts.	Species - excluded from further assessment – not detected during survey.
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine snow gum woodland and occasionally in temperate or regenerating forest. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. It requires tree hollows in which to breed.	Moderate Recorded on Peppertree Quarry by ERM (2006)	Potential – with negligible impacts.	Ecosystem – involved in Ecosystem Credit calculations. No casuarina species triggering the need to offset.

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
				The species has been recorded to the south and north of the study area and has the potential to use the site on occasion to forage. There is no particularly important breeding or foraging habitat to be impacted.			
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Inhabits forest with low nutrients, characteristically with key *Allocasuarina* spp. Tends to prefer drier forest types with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead. Endangered population in the Riverina. The species has been recorded to the south and north of the study area. Preferred foraging habitat is not present in areas to be impacted. The species was not detected during survey.	Low	Unlikely	Ecosystem - excluded from further assessment
Chthonicola sagittata	Speckled Warbler	V	-	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. This species has been recorded from the locality within grassy woodland areas to the west of the study area. While the species was not recorded during field survey there is potential habitat that may be used on occasion or by migrating individuals. Three records exist for Speckled Warbler from the locality west of the study area. The species was not recorded during field survey.	Moderate	Potential – with negligible impacts.	Ecosystem – involved in Ecosystem Credit calculations
Climacteris picumnus victoriae	Brown Treecreeper	V	-	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. Whilst this species has been recorded within the locality, there is limited potential habitat within the study area as mature trees with hollows and large logs are rare. Conspicuous species not recorded during field survey.	High	Unlikely	Ecosystem – involved in Ecosystem Credit calculations
Daphoenositta chrysoptera	Varied Sittella	V	-	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia. Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows. Four records exist from the locality to the west of the study area. A single observation of this species was made adjacent to the impact area during field survey.	High	Likely – non-significant impacts	Ecosystem – involved in Ecosystem Credit calculations
Gallinago hardwickii	Latham's Snipe	-	M	Latham's Snipe is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are	Low	Unlikely	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
				found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. No records from locality and not recorded during field survey.			
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes. Most records from the region are from lower elevation near coastal areas. Not recorded during survey.	Low	Unlikely	Ecosystem – excluded from further assessment
Grantiella picta	Painted Honeyeater	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests.	Low	Unlikely	Ecosystem – excluded from further assessment
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	M	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna. Some potential habitat within the study area, though it would be infrequently used and for foraging only.	Low	Unlikely	N/A
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees. Wide ranging species, not recorded during field surveys. One record exists from the north of the locality. Two records from Marulan area. No individuals or breeding nests were observed during field surveys. May use impacted area to forage but rarely.	Low	Unlikely	Ecosystem – involved in Ecosystem Credit calculations
Hirundapus caudacutus	White-throated Needletail	-	M	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Potential overfly habitat only.	Low	Unlikely	N/A
Lathamus discolor	Swift Parrot	E	E	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability. No records within the locality and not recorded from surveys. Closest record is approximately 50 km east and most records in the region are coastal. As the species is migratory it may occur as a transient visitor to the site, including to forage, but would use the site rarely given the lack of records from the region.	Low	Unlikely	Ecosystem – excluded from further assessment

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
Melanodryas cucullata cucullata	Hooded Robin	V	-	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. One recent and one dated record from locality to west of study area. Conspicuous bird that is primarily sedentary and was not recorded during survey.	Low	Unlikely	Ecosystem – involved in Ecosystem Credit calculations
Melithreptus gularis gularis	Black-chinned Honeyeater	V	-	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). Two records from 30 years ago exist for this species from near Marulan and towards Goulburn. No other records occur from the region and the species was not recorded during field survey.	Low	Unlikely	Ecosystem – involved in Ecosystem Credit calculations
Merops ornatus	Rainbow Bee-eater	-	M	Found throughout mainland Australia most often in open forests, woodlands and shrublands, and cleared areas, usually near water. It will be found on farmland with remnant vegetation and in orchards and vineyards. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels. Widespread migratory species that may move through study area occasionally.	Moderate	Unlikely	N/A
Monarcha melanopsis	Black-faced Monarch	-	M	Found along the coast of eastern Australia, becoming less common further south. Inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Predominant habitat within study area is in lower areas away from proposed cleared areas. May move through other parts of the study area.	Moderate	Unlikely	N/A
Motacilla flava	Yellow Wagtail	-	M	Breeds in temperate Europe and Asia. The Yellow Wagtail is a regular wet season visitor to northern Australia. Increasing records in NSW suggest this species is an occasional but regular summer visitor to the Hunter River region. The species is considered a vagrant to Victoria, South Australia and southern Western Australia. Habitat requirements for the Yellow Wagtail are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	Low	Unlikely	Ecosystem – excluded from further assessment
Myiagra cyanoleuca	Satin Flycatcher	-	M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Low	Unlikely	N/A
Ninox strenua	Powerful Owl	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within red turpentine in tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are	Low	Potential – with negligible impacts.	Ecosystem – predicted associated within the PCTs of the study area.

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
				required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm. Single record from locality. No individuals or breeding habitat was observed during field surveys. May use impacted area to forage but rarely.			
Numenius madagascariensis	Eastern Curlew	-	CE, MA, M	A primarily coastal distribution. Found in all states, particularly the north, east, and south-east regions including Tasmania. Rarely recorded inland. Mainly forages on soft sheltered intertidal sand flats or mudflats, open and without vegetation or cover. Breeds in the northern hemisphere.	Low	Unlikely	Ecosystem – excluded from further assessment
Pandion cristatus	Eastern Osprey		M	Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging. They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. They exhibit a preference for coastal cliffs and elevated islands in some parts of their range, but may also occur on low sandy, muddy or rocky shores and over coral cays. They may occur over atypical habitats such as heath, woodland or forest when travelling to and from foraging sites.	None	None	N/A
Petroica boodang	Scarlet Robin	V	-	The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. Recorded at two sites during field survey, adjacent to impact area.	Known	Likely – non-significant impacts	Ecosystem – involved in Ecosystem Credit calculations
Petroica phoenicea	Flame Robin	V	-	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January. Two records from the locality around Marulan, however not recorded during survey. As the species is somewhat migratory it may visit the site, particularly grassy woodlands during winter.	Moderate	Potential – with minimal impacts.	Ecosystem – involved in Ecosystem Credit calculations
Rhipidura rufifrons	Rufous Fantail	-	M	Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany (*E. resinifera*); usually with a dense shrubby understorey often including ferns.	Moderate	Likely – non-significant impacts	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
Rostratula australis	Australian Painted Snipe	E	E, M	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Low	Unlikely	Ecosystem – excluded from further assessment
Stagonopleura guttata	Diamond Firetail	V	-	Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including box-gum woodlands and snow gum woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities. Recorded at two sites during field survey on several occasions within impact area. Local population regularly uses parts of impact area to forage.	High	Likely – non-significant impacts	Ecosystem – involved in Ecosystem Credit calculations
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. Three records south of study area 4 – 6 km away. No individuals or breeding habitat was observed during field surveys. May use impacted area to forage but rarely.	Low	Potential – with negligible impacts	Ecosystem – excluded from further assessment
Tyto tenebricosa	Sooty Owl	V	-	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude less than 500 metres. Nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 centimetres in diameter. Single record from Shoalhaven Gorge (Niche 2015). No individuals or breeding habitat was observed during field surveys. May use impacted area to forage but rarely.	Low	Potential – with negligible impacts	Ecosystem – excluded from further assessment
Fish							
Macquaria australasica	Macquarie Perch	E (FM Act)	E	Macquarie perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments. The conservation status of the different populations is not well known, but there have been long-term declines in their abundance. Macquarie Perch are found in both river and lake habitats; especially the upper reaches of rivers and their tributaries. They are quiet, furtive fish that feed on aquatic insects, crustaceans and molluscs. Sexual maturity occurs at two years for males and three years for females. Macquarie perch spawn in spring or summer in shallow	None	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
				upland streams or flowing parts of rivers and females produce around 50,000-100,000 eggs which settle among stones and gravel of the stream or river bed. Populations from the eastward-flowing Shoalhaven and Hawkesbury rivers are genetically distinct and may represent an undescribed species. Potential habitat exists in the upper reaches and tributaries of Shoalhaven River where one specimen has been recorded in 2007 (3km upstream of Bungonia confluence. However such habitat is not present within Bungonia or Barbers Creek.			
Prototroctes maraena	Australian Grayling	-	V	Historically, this species occurred in coastal streams from the Grose River Valley, southwards through NSW, Vic. and Tas, With occurences in the Shoalhaven catchment below Tallowa Dam. It also occasionally occurred high upstream in the Snowy R. A single juvenile specimen was collected from Lake Macquarie in 1974. This species spends only part of its lifecycle in freshwater. The Tambo River population inhabits a clear, gravel-bottomed stream with alternating pools and riffles, and granite outcrops. It has also been associated with clear, gravel-bottomed habitats in the Mitchell & Wonnangatta Rivers but was present in a muddy-bottomed, heavily silted habitat in the Tarwin River.	None	None	N/A
Mammals							
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals. Recorded at two out of two locations where bat recorders were placed within the study area including within the proposed study area. No breeding habitat.	Known	Likely – non significant impacts.	Assessed for impacts under the Commonwealth Assessment of Significance.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Spotted-tailed Quoll are found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. One regional record only. Not recorded during field survey. Low abundance of preferred prey items (ground dwelling fauna), no denning habitat and widespread presence of foxes which is likely to prevent establishment of a population in the area. Quolls may occur on the site (more likely dispersing males) given proximity of conservation areas but are unlikely to use site with any frequency and there is limited value in regard to prey density.	Low	Unlikely	Ecosystem – involved in Ecosystem Credit calculations
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor. This species also appears to be highly mobile and records showing movements of up to 12 km between	Moderate	Potential – with low level impacts.	Ecosystem – involved in Ecosystem Credit calculations

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
				roosting and foraging sites. Three records from locality to the west of the study area near Marulan. Not recorded during survey but one single possible record from recent surveys at Marulan South Limestone Mine (Niche 2015).			
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Known maternity caves within Bungonia Gorge. Recorded at one harp trap location and from all sites where echolocation recording was performed.	Known	Likely – non significant impacts.	Ecosystem and Species. Species credit component (breeding habitat) excluded from assessment.
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits. One record from locality from Hume Highway near Marulan. Not recorded during field survey. Hollows/required breeding habitat is rare within the areas to be impacted by clearing. Single record just outside locality near Marulan. Not recorded during the current survey or recent surveys.	Low	Unlikely	Ecosystem – predicted associated within the PCTs of the study area.
Petaurus australis	Yellow-bellied Glider	V	-	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Recorded from Bungonia Gorge during Marulan South Limestone Mine surveys (Niche 2015). Not recorded during surveys of the study areas and no obvious glider incisions found. Habitat poor due to typical distance between trees and open paddock areas.	Low	Unlikely	Ecosystem – predicted associated within the PCTs of the study area.
Petauroides volans	Greater Glider	-	V	The Greater Glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	Low	Unlikely	Ecosystem – predicted associated within the PCTs of the study area.
Myotis macropus	Southern Myotis	V	-	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Has been recorded from locality near Bungonia gorge on three occasions. Limited water resources and roost habitat (e.g. hollow trees, bridges and culverts) within study areas.	Low	Unlikely	Ecosystem and Species. Species credit component (breeding habitat) excluded from assessment
Petaurus	Squirrel	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense	Low	Unlikely	Species – Excluded from

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
norfolcensis	Glider			coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA. Not recorded during survey. No records from locality or region (one Atlas record from Marulan area with accuracy of 100 km).			further assessment
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices. No potential habitat within the study area and no habitat to be impacted indirectly. Not recorded during field survey.	Low	Unlikely	Species – excluded from further assessment
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall. There are preferred feed trees present on the site but these are predominantly scattered paddock trees. The majority of records from the locality are from the Bungonia National Park to the south. The species was not recorded during the current survey of the study area nor during previous surveys of the rest of the Peppertree Quarry nor surveys (spotlighting and aural surveys only) within the Barbers Creek gully for the Marulan South Limestone Mine Project (Niche 2015).	High	Likely	Species – not recorded during survey. No further assessment. Assessed for impacts under the Commonwealth Assessment of Significance.
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy.	Low	Unlikely	Ecosystem – predicted associated within the PCTs of the study area.
Pseudomys novaehollandiae	New Holland Mouse	-	V	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. No local records. Single record regionally. Habitat on site is not preferred habitat.	None	None	Ecosystem – however not predicted to occur
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km. Recorded from Bungonia Gorge and Barbers Creek during recent field survey for Marulan South Limestone Mine (Niche 2015) and expected to occur throughout area. Very limited foraging resources in impact area and would rarely occur within the study area. May fly over study area with some regularity, however such movements are unlikely to be impacted.	Moderate	Likely – negligible, non significant impacts.	Ecosystem and species. Species credit component (breeding habitat). excluded from further assessment.

Scientific Name	Common Name	BC Act	EPBC Act	Preferred habitat/previous records and habitat within impact area	Likelihood of Occurrence	Potential for Impacts	Species credit or Ecosystem Species
Reptiles							
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by kangaroo grass. Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. No records locally or regionally. Preferred habitat not present.	Low	Unlikely	Species - excluded from further assessment
Delma impar	Striped Legless Lizard	V	V	Found mainly in natural temperate grassland but has also been captured in grasslands that have a high exotic component. Also found in secondary grassland near natural temperate grassland and occasionally in open box-gum woodland. Sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter. No records locally, single record from Goulburn area regionally. Not recorded during survey and preferred sheltering habitat not present.	Low	Unlikely	Species – excluded from further assessment
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Occurs almost exclusively in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they spend most of the year sheltering in and under rock crevices and exfoliating rock. However, some individuals will migrate to tree hollows to find shelter during hotter parts of summer. No records locally or regionally. Required habitat not present.	Low	Unlikely	Species – excluded from further assessment
Varanus rosenbergi	Rosenberg's Goanna	V	-	This species is a Hawkesbury-Narrabeen sandstone outcrop specialist. Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests. No local records. No termite mounds in study area, not recorded during survey and preferred habitat not present in areas to be impacted.	Low	Unlikely	Species – excluded from further assessment

Threatened Ecological Community (TEC) Likelihood of occurrence

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within study area
Illawarra and South Coast Lowland Forest and Woodland	This community comprises vegetation types that occupy the Illawarra coastal plain and escarpment foothills. Characteristic tree species include Forest Red Gum Eucalyptus tereticornis, Thin-leaved Stringybark Eucalyptus eugenioides, Woollybutt Eucalyptus longifolia, Coast Grey Box Eucalyptus bosistoana and White Feather Honey-myrtle Melaleuca decora. The understorey is not necessarily grassy as moist forest vegetation types are also included within this broad community. Common shrub species include Acacia mearnsii and Dodonaea viscosa subsp. angustifolia. Floodplain vegetation dominated by Casuarina species or rainforests on latite soils are not part of this community.	Endangered	Critically Endangered	None – occurs more toward the coast. Was not recorded during the vegetation survey.
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	Montane Peatlands and Swamps comprises a dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. It is the only type of wetland that may contain more than trace amounts of Sphagnum spp., the hummock peat-forming mosses. Small trees may be present as scattered emergents or absent. The community typically has an open to very sparse layer of shrubs, 1-5 m tall, (eg. *Baeckea gunnian*a, *B. utilis, Callistemon pityoides, Leptospermum juniperinum, L. lanigerum, L. myrtifolium, L. obovatum, L. polygalifolium).* Species of *Epacris (*eg. *E. breviflora, E. microphylla, E. paludosa)* and *Hakea microcarpa* are also common shrubs. In some peatlands and swamps, particularly those with a history of disturbance to vegetation, soils or hydrology, the shrub layer comprises dense thickets of Leptospermum species. In other peatlands and swamps with a history of grazing by domestic livestock, the shrub layer may be very sparse or absent.	Endangered	Endangered	None – not recorded during vegetation survey, Project Area out of known range and not previously mapped by within the Project Area.
Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory	In the Southern Tablelands of NSW and the ACT, dominant grasses include Kangaroo Grass Themeda triandra, wallaby grasses Austrodanthonia spp., spear grasses Austrostipa spp., Red Grass Bothriochloa macra and tussock grasses Poa spp.. Themeda triandra and Snow Grass Poa sieberiana are co-dominant in a variety of landscape positions and soil types. In wetter areas, such as moist flats, Themeda dominates the grassland with Pinrush Juncus filicaulis, while River Tussock Poa labillardieri is dominant along drainage lines, seepage areas, creeks and river flats. Poa sieberiana is dominant on the undulating basalt plains of the Monaro. The upper slopes, hill crests and ridges with well drained soils are generally dominated by Corkscrew Austrostipa scabra subsp. falcata and Tall Speargrass A. bigeniculata, while species of Austrodanthonia and Bothriochloa macra dominate gentle slopes, ridges and flats with well drained, shallow to skeletal soils. Present grass species dominance is thought to have changed significantly since European settlement because of past land uses. Other grasses such as Common Wheat Grass Elymus scaber and Nineawn Grass Enneapogon nigricans may also be present frequently, in the inter-tussock spaces.	Endangered	Endangered	None – out of range. Not recorded during field survey.

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within study area
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions	Tableland Basalt Forest is dominated by an open eucalypt canopy of variable composition. *Eucalyptus viminalis, E. radiata, E. dalrympleana subsp. dalrympleana* and *E. pauciflora* may occur in the community in pure stands or in varying combinations. The community typically has an open canopy of eucalypts with sparse mid-story shrubs (e.g. *Acacia melanoxylon* and *A. dealbata*) and understory shrubs (e.g. *Rubus parvifolius*) and a dense groundcover of herbs and grasses, although disturbed stands may lack either or both of the woody strata. The structure of the community varies depending on past and current disturbances, particularly fire history, clearing and grazing. Contemporary tree-dominated stands of the community are largely relics or regrowth of originally taller forests and woodlands, which are likely to have had scattered shrubs and a largely continuous grassy groundcover. At some sites, mature trees may exceed 30 m tall, although regrowth stands may be shorter than 10 m tall. Tableland Basalt Forest is currently found in the Eastern Highlands and Southern and Central Tablelands, covering the local government areas of Bathurst Regional, Goulburn Mulwaree, Oberon, Palerang, Shoalhaven, Upper Lachlan and Wingecarribee. The community, however, may be found elsewhere within the designated bioregions.	Endangered	-	Low – not recorded during vegetation survey, or previously mapped by Tozer et al. (2006) within the Project Area.
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions	This community, commonly referred to as Tablelands Snow Gum Grassy Woodland, occurs as an open-forest, woodland or open woodland. This community may also occur as a secondary grassland where the trees have been removed, but the groundlayer remains. The main tree species are *Eucalyptus pauciflora* (Snow Gum), *E. rubida* (Candlebark), *E. stellulata* (Back Sallee) and *E. viminalis* (Ribbon Gum), either alone or in various combinations. Other eucalypt species may occur. A shrub layer may be present and sub-shrubs are common. The most common shrubs include Melicytus sp. 'Snowfileds' (Gruggly-bush) and *Melichrus urceolatus* (Urn Heath). The ground layer is grassy, with the most common species including *Themeda australis* (Kangaroo Grass), Poa spp. (snow-grasses), Austrostipa spp. (spear-grasses) and Rytidosperma spp. (wallaby-grasses). Sites in high condition have a range of forb (wildlfower) species, including *Leptorhynchos squamatus* (Scaly-buttons), *Chrysocephalum apiculatum* (Common Everlastings) and *Asperula conferta* (Native Woodlruff). Many threatened flora and fauna species have been recorded in this community.	Endangered	Critically Endangered	None – out of distribution range for this community.
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	The ecological community typically occurs as an open to tall open forest with a sparse to dense layer of shrubs and vines, and a diverse understorey of native grasses, forbs, twiners and ferns (Keith, 2004). However, the structure of the ecological community may vary from tall open forest with trees up to and above 30 m tall with a projected foliage cover of 30–70% (e.g. *Eucalyptus fastigata* forest on basalt near Sassafras in and around Morton National Park) to woodland with trees 10–30 m tall, with a projected foliage cover of 10–30% (e.g. exposed woodland on rocky microsyenite at Mt Jellore) depending on aspect, slope, soil conditions, soil depth, and previous clearing and disturbance (Fisher et al., 1995; NPWS & SCA, 2003; Eco Logical Australia, 2003; NSW Scientific Committee, 2001a, 2001b).	Endangered	Endangered	Low – not recorded during vegetation survey, or previously mapped by Tozer et al. (2006) within the Project Area.

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within study area
White Box, Yellow Box, Blakely's Red Gum Derived Native Grassland	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: White Box Eucalyptus albens, Yellow Box E. melliodora and Blakely's Red Gum E. blakelyi. Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs. The community also includes a range of mammal, bird, reptile, frog and invertebrate fauna species. Intact stands that contain diverse upper and mid-storeys and groundlayers are rare. Modified sites include the following: •Areas where the main tree species are present ranging from an open woodland formation to a forest structure, and the groundlayer is predominantly composed of exotic species; and •Sites where the trees have been removed and only the grassy groundlayer and some herbs remain. The Australian Government listing of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland is slightly different to the NSW listing. Areas that are part of the Australian Government listed ecological community must have either: •An intact tree layer and predominately native ground layer; or •An intact native ground layer with a high diversity of native plant species but no remaining tree layer.	Endangered	Critically Endangered	Yes – recorded within the study area and will be impacted by the Project.

Appendix 2. Plant Community Type Descriptions

PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands (SR670)

Habitat: PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland occupies the flat terrain and gentle slopes on relatively fertile soils which is located to the north of the study area.

Structure/Characteristics: Two different condition classes of the community were recorded in the study area. Typically, the best condition of the community consisted of a tree layer ranging in height from 15 - 25 m consisting of *Eucalyptus blakelyi,* and *Eucalyptus melliodora* with the occasional *E. eugenioides* and *E. bosistoana.* A midstorey contained *Acacia mearnsii*, was sparse. The sparse shrub layer consisted of *Cassinia aculeata, Lissanthe strigosa* and *Olearia viscidula.* The ground layer consisted of *Einadia hastata Austrodanthonia racemosa, Microlaena stipoides, Bothriochloa macra, Acaena novae-zelandiae, Lomandra filiform*is subsp. coriacea, Thysanotus patersonii, Anisopogon avenaceus, Poa sieberiana, Austrostipa scabra, and *Aristida ramosa*.

Nassella trichotoma (Serrated Tussock) was in relatively high cover and abundance throughout portions of this PCT within the study area.

Condition classes:

Two condition classes were assigned to PCT1334 within the study area:

Moderate: Consisting of close patches of Eucalypt stands (comprising of Eucalyptus blakelyi, and Eucalyptus melliodora with the occasional E. eugenioides and E. bosistoana) with a mixture of native and introduced ground cover.

Poor: Consisting of a few sparsly scattered Eucalypt stands, with a mixture of native and introduced ground cover.

Conservation Status: This vegetation community in both condition classes aligns to the NSW BC Act - White Box Yellow Box Blakely's Red Gum Woodland TEC (EEC) due to the following listing criteria (Scientific Committee 2002) being satisfied within the study area:

- Characterised by the presence or prior occurrence of Yellow Box and/or Blakely's Red Gum
- The understorey in intact sites is characterised by native grasses and a high diversity of herbs
- Shrubs are generally sparse or absent, though they may be locally common
- Characteristic species are present as identified in the Scientific Committee (2012)
- Occurs within the known range of the TEC.

In regards to the EPBC Act listing, an analysis of the Determination and Flow Chart Diagram within the EPBC Act Policy Statement (DoE undated) was undertaken. The two different condition classes occurring in the study area meet the criteria in different ways. The alignment of each condition class to the CEEC criteria is provided in Table 14.

Resilience and ability to regenerate:

The historic clearing coupled with the existing and historic grazing within the study area has resulted in most of the study area having a moderate resilience. Serrated tussock was a dominant grass within much of the study area. It is likely that the patches would continue to naturally regenerate and abundance and cover would increase, however given the small size of the patches, regular weed management would need to be established in order to assist natural regeneration from edge effects.

Table 14. Alignment to TEC determinations

Condition	Description	How it meets the TSC Act Determination	How it meets the EPBC Act Determination
Moderate	▪ The presence of diagnostic mature trees including *Eucalyptus blakelyi, E. melliodora* and *E. eugenioides* in an open woodland formation. ▪ Presence of diagnostic groundcover plant species including some important species (excluding grasses). ▪ Presence of regenerating over-storey species. ▪ Moderate occurrence of exotic plant species. ▪ The patch has a high resilience.	▪ Characterised by the presence or prior occurrence of *Eucalyptus albens, E. melliodora* and/or *E. blakelyi*. ▪ The understorey is characterised by native grasses and a high diversity of herbs. ▪ Shrubs are generally sparse or absent, though they may be locally common. ▪ Characteristic species are present as identified in the Scientific Determination. ▪ Occurs within the known range of the TEC.	▪ Diagnostic species present. ▪ Predominantly native understorey. ▪ Whilst the plots undertaken did not contain greater than 12 native understorey species (excluding grasses), the size of the patch when adjacent grassland areas are included is greater than 2 ha. ▪ Mature trees and natural regeneration of eucalypts is present.
Poor	▪ Reduced diversity of characteristic canopy dominants in the overstorey stratum with diagnostic tree species confined to *Eucalyptus blakelyi* and *E. melliodora.* ▪ Low to very low diversity of White Box Yellow Box Blakely's Red Gum Woodland CEEC groundcover plant species (excluding grasses). Rare occurrences of important species of which there were 0 to 2 of in floristic plots conducted within the degraded condition class. ▪ Regenerating over storey species ▪ Moderate to high occurrence of exotic plant species ▪ A long history of grazing.	▪ Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum. ▪ The understorey in intact sites is characterised by native grasses and some diversity of herbs. ▪ Shrubs are generally sparse or absent. ▪ Characteristic species are present as identified in the Scientific Determination. ▪ Occurs within the known range of the TEC.	▪ Whilst in a disturbed condition, diagnostic species such as overstorey eucalypts are present. ▪ Whilst the plots undertaken did not contain greater than 12 native understorey species (excluding grasses), the size of the patch when adjacent grassland areas are included is greater than 2 ha. ▪ Mature trees and natural regeneration of eucalypts are present

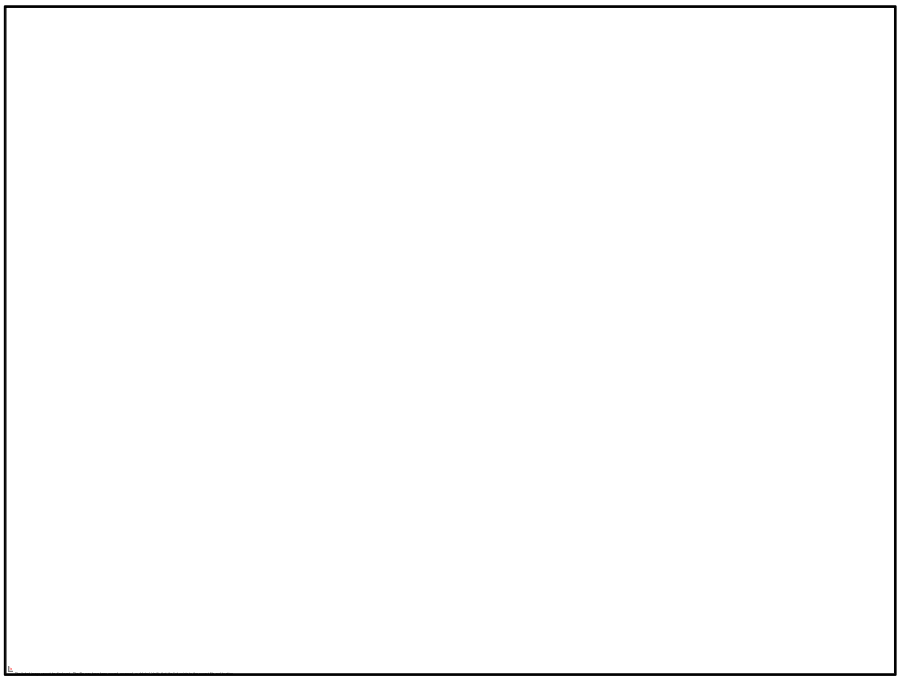


Photo 3. PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands moderate condition



Photo 4, PCT 1334 Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands poor condition

PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges - Southern Sydney Basin

Habitat: PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin is equivalent to Tozer et al (2006) mapping unit p.27 Bungonia Slates Woodland. The PCT is found in the study are on the slopes where it comprise of a woodland to forest formation particularly toward the south-east of the study area. The vegetation community transitions into PCT 1334 on the gentle slopes and flat terrain. A degree of difficulty in determining the transition zone between the two communities was attributed due to the presence of Eucalyptus bosistoana which intergraded with E. melliodora. As discussed with OEH botanist John Briggs whilst on-site on the 16th June 2015, landscape position plays an important part in separating PCT 778 from PCT 778. As such, the steeper slopes have been attributed to the PCT 778 community.

Structure/Characteristics: Two different condition classes of the community were recorded in the study area. The best condition of the community consisted of a tree layer ranging in height from 15 - 25 m consisting of *Eucalyptus bosistiana,* and *E. blakelyi/E. tereticornis* with *E. eugenioides.* The sparse shrub layer consisted of *Cassinia aculeata, Lissanthe strigosa* and *Olearia viscidula.* The ground layer consisted of *Austrodanthonia racemosa, Microlaena stipoides, Bothriochloa macra, Acaena novae-zelandiae, Lomandra filiform*is subsp. coriacea, T Anisopogon avenaceus, Poa sieberiana and *Aristida ramosa*.

Like that of PCT 1334, *Nassella trichotoma* (Serrated Tussock) was in relatively high cover and abundance throughout portions of this PCT within the study area.

Condition classes:

Two condition classes were assigned to PCT1334 within the study area:

Moderate: Consisting of a canopy dominated by *Eucalyptus bosistoana* and E. blakelyi/E.tereticornis with a mixture of native and introduced ground cover.

Poor: Typically lacked a canopy and shrub layer. Consisted predominantly of a native and introduced ground cover. This condition class typically occurred within the transmission line easement on steep slopes.

Conservation Status: This PCT does not align to a TEC under State or Commonwealth legislation.



Photo 5. PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin – Moderate Condition



Photo 6. PCT 778 Coast Grey Box – stringybark dry woodland on slopes of the Shoalhaven Gorges -Southern Sydney Basin – Poor Condition

Non-native vegetation

Portions toward the north and north-east of the study have been extensively cleared, and have a soil profile which offers very little resilience to regenerate to a native vegetation community. These areas are dominated by introduced grasses and herbaceous weeds, including: *Plantago lanceolata, Hypochaeris radicata, Pennisetum clandestina, Setaria gracilis, Nassella trichotoma and Paspalum dilatatum.*

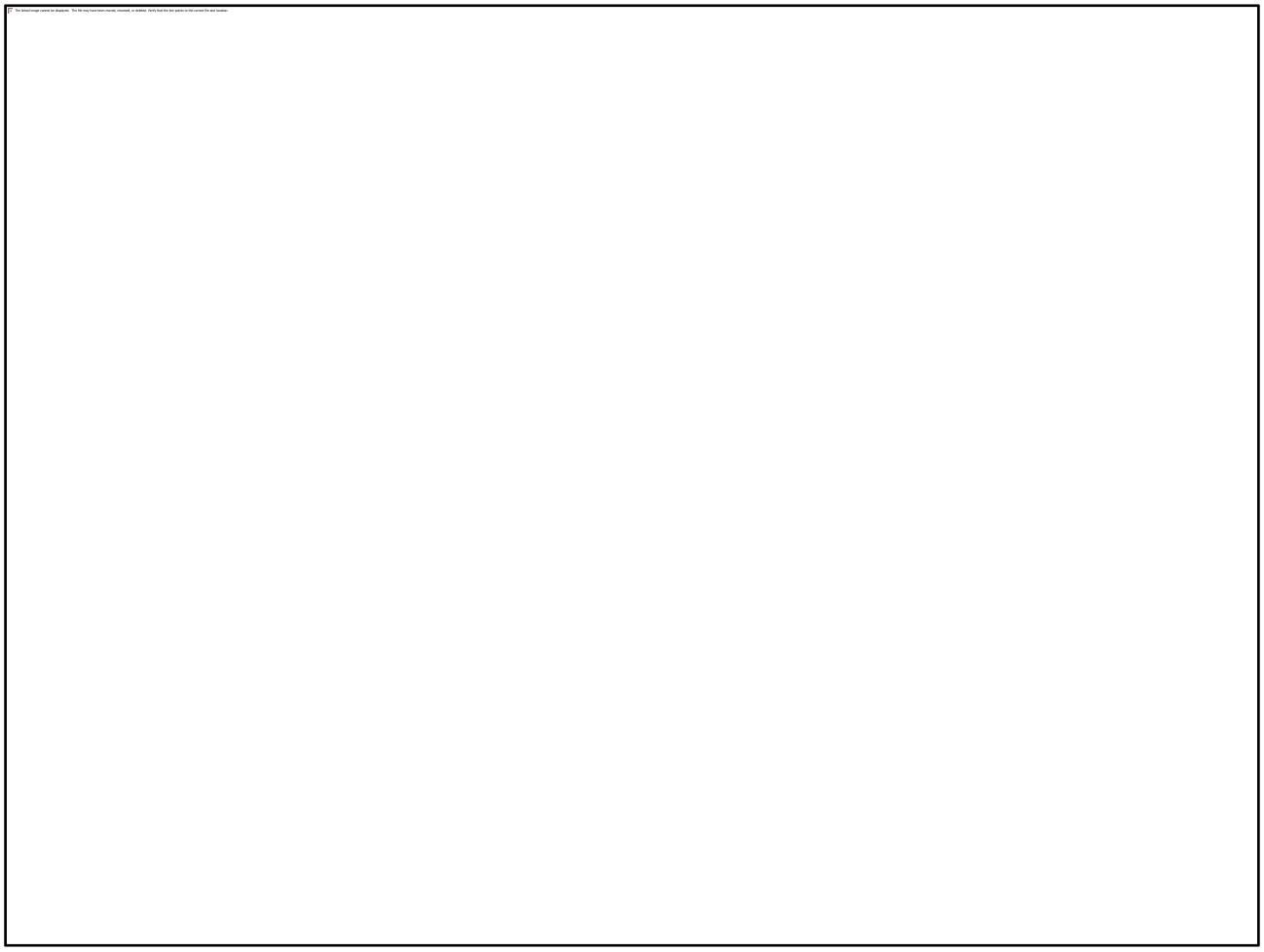


Photo 7. Non-native vegetation

Appendix 3. Floristic plot data

PCT778 - medium

Plot 1410				Plot 1413			
Genus	Species	Cover	Abundance	Genus	Species	Cover	Abundance
Acacia	*parramattensis*	1	1	*Austrodanthonia*	*racemosa*	25	
Cassinia	*longifolia*	20		*Bromus*	*cartharticus*	5	
Cirsium	*vulgare*	0.1	1	*Carex*	*inversa*	0.1	1
Clematis	*aristata*	0.1	1	*Cassinia*	*uncata*	2	4
Cotoneaster	*glaucophyllus*	0.5	5	*Cirsium*	*vulgare*	0.5	10
Cotula	*australis*	0.5		*Convolulous*	*graminetinus*	0.1	1
Dichondra	*repens*	0.1	50	*Desmodium*	*varians*	0.1	4
Entolasia	*stricta*	1	20	*Dichondra*	*repens*	0.2	30
Eucalyptus	*tereticornis*	5		*Eucalyptus*	*bosistiana*	15	
Eucalyptus	*bosistoana*	20		*Eucalyptus*	*blakelyi*	10	
Eucalyptus	*viminalis*	5		*Geranium*	*solanderi*	0.2	20
Geranium	*homeanum*	0.2	50	*Glycine*	*tabacina*	0.1	5
Geranium	*solanderi*	0.1	50	*Hymenanthera*	*dentata*	0.1	2
Hypochaeris	*radicata*	0.1	5	*Lissanthe*	*strigosa*	4	20
Lepidosperma	*laterale*	0.1	1	*Lomandra*	*filiformis*	0.3	15
Lomandra	*filiformis*	0.5	30	*Nassella*	*tenuissima*	30	
Microlaena	*stipoides*	5		*Passiflora*	*spp.*	0.1	1
Paspalum	*dilatatum*	2	50	*Plantago*	*debilis*	0.1	9
Plantago	*lanceolata*	0.1	5	*Poa*	*sieberiana*	5	
Poa	*sieberiana*	1	20				
Rubus	*fruticosus*	0.1	5				
Plot 1412							
Acacia	*parramattensis*	*1*	1				
Acaena	*novae-zelandiae*	*0.1*	5				
Austrostipa	*ramosissima*	*5*					
Cassinia	*longifolia*	*5*					
Cirsium	*vulgare*	*0.1*	2				
Dichelachne	*micrantha*	*5*					
Dichondra	*repens*	*0.1*	1				
Eucalyptus	*amplifolia*	*5*					
Eucalyptus	*tereticornis*	*2*					
Geranium	*solanderi*	*0.5*	1				
Microlaena	*stipoides*	*5*					
Nassella	*trichotoma*	*55*					
Olearia	*viscidula*	*0.5*	1				
Oxalis	*perennans*	*0.1*	1				
Paspalum	*dilatatum*	*15*					
Rhytidosporum	*spp.*	*5*					
Rumex	*brownii*	*0.1*	1				
Senecio	*linearifolius*	*0.1*	1				
Senecio	*madagascariensis*	*0.1*	3				
Sporobolus	*creber*	*5*					
Urtica	*incisa*	*0.1*	3				

PCT778 – poor

Plot 028	Species	Cover	Abundance
Nassella	*tenuissima*	45	
Bothriochloa	*macra*	25	
Austrodanthonia	*racemosa*	10	
Axonopus	*virginicus*	15	
Themeda	*australis*	5	
Austrostipa	*scabra*	3	100
Rubus	*fruticosus*	1	1
Acaena	*zelandiae*	0.1	10
Poa	*annua*	3	60
Cheilanthes	*seiberi*	0.1	3
Lissanthe	*strigosa*	1	5
Hypericum	*perforatum*	0.1	20
Lomandra	*filiformis*	0.5	25
Opuntia	*stricta*	0.1	2
Plot 031			
Genus	*Species*	Cover	Abundance
Hypericum	*peforatum*	0.1	5
Acaena	*novae-zelandiae*	0.1	5
Oxalis	*perennans*	0.2	20
Glycine	*tabacina*	0.1	15
Austrostipa	*scabra*	5	
Rubus	*fruiticosus*	1	2
Poa	*annua*	5	
Plantago	*lanceolata*	0.5	20
Centella	*asiatica*	0.2	10
Panicum	*effusum*	5	
Conyza	*bonariensis*	0.3	10
Medicago	*arabica*	0.1	10
Themeda	*australis*	5	
Bothriochloa	*macra*	15	
Austrodanthonia	*racemosa*	5	
Axonopus	*virginicus*	5	
Nassella	*tenuissima*	45	

PCT1334 – Moderate

Plot 1416				Plot 1415			
Genus	Species	Cover	Abundance	Genus	Species	Cover	Abundance
Nassella tenuissima	*tenuissima*	35		*Acaena*	*novae-zelandiae*	0.5	10
Eucalyptus eugenioides	*eugeniodes*	5		*Geranium*	*homeanum*	0.2	50
Austrodanthonia tenuior	*tenuior*	15		*Geranium*	*solanderi*	0.2	20
Bromus cartharticus	*cartharticus*	10		*Galium*	*propinquum*	0.5	50
Plantago lanceolata	*lanceolata*	0.5	20	*Dichondra*	*repens*	0.5	50
Austrostipa scabra	*scabra*	5		*Lagenophora*	*spp.*	0.5	2
Lolium perenne	*perenne*	15		*Bothriochloa*	*macra*	10	
Vulpia myuros	*myuros*	5		*Dichelachne*	*micrantha*	5	
Asperula conferta	*conferta*	0.2	5	*Lomandra*	*filiformis*	0.5	10
Dichondra repens	*repens*	0.3	5	*Nassella*	*trichotoma*	20	
Cirsium vulgare	*vulgare*	0.5	4	*Lycium*	*ferocissimum*	0.1	1
Dactylis glomerata	*glomerata*	0.2	4	*Glycine*	*tabacina*	0.1	10
Geranium solanderi	*solanderi*	0.1	10	*Lissanthe*	*strigosa*	0.5	5
Rumex brownii	*brownii*	0.1	1	*Eucalyptus*	*eugenioides*	5	
Eucalyptus melliodora	*melliodora*	15		*Acacia*	*parramattensis*	5	
Plot 1414				*Eucalyptus*	*bosistoana*	5	
Dichondra	*repens*	0.5	100	*Plantago*	*lanceolata*	1	100
Geranium	*solanderi*	0.2	50	*Rubus*	*fruticosus*	0.1	5
Oxalis	*perennans*	0.1	30	*Hypochaeris*	*radicata*	1	100
Geranium	*homeanum*	0.2	50	*Solanum*	*nigrum*	0.1	1
Acaena	*novae-zelandiae*	0.1	5				
Galium	*propinquum*	0.1	2				
Rumex	*brownii*	0.1	2				
Dichelachne	*micrantha*	10					
Bothriochloa	*macra*	5					
Entolasia	*stricta*	0.5	5				
Nassella	*trichotoma*	50					
Glycine	*tabacina*	0.1	2				
Desmodium	*varians*	0.2	20				
Rhytidosporum	*spp.*	15					
Eucalyptus	*bosistoana*	5					
Eucalyptus	*viminalis*	2	1				
Plantago	*lanceolata*	3	200				
Hypochaeris	*radicata*	0.5	50				
Cirsium	*vulgare*	0.1	5				

PCT1334 – Poor

Plot 25		SR670_mod		Plot 26			
Genus	Species	Cover	Abundance	Genus	Species	Cover	Abundance
Nassella	*tenuissima*	45		*Nassella*	*tenuissima*	25	
Austrodanthonia	*racemosa*	30		*Austrodanthonia*	*racemosa*	15	
Paspalum	*dilatatum*	10		*Paspalum*	*dilatatum*	5	
Austrostipa	*scabra*	5		*Wahlenbergia*	*gracilis*	0.1	1
Bothriochloa	*macra*	20		*Bothriochloa*	*macra*	20	
Plantago	*lanceolata*	0.5	5	*Pennisetum*	*cladenstina*	5	
Rubus	*fruticosus*	1	2	*Austrostipa*	*scabra*	5	
Setaria	*gracilis*	5		*Plantago*	*lanceolata*	0.5	5
Acaena	*zelandiae*	0.1	5	*Bidens*	*pilosa*	0.1	3
Asperula	*conferta*	0.1	5	*Setaria*	*gracilis*	5	
Carex	*inversa*	0.1	5	*Acaena*	*zelandiae*	0.1	2
Cheilanthes	*seiberi*	0.1	10	*Asperula*	*conferta*	0.1	2
Dichondra	*repens*	0.2	20	*Carex*	*inversa*	0.1	1
Hypochaeris	*radicata*	0.5	25	*Cheilanthes*	*seiberi*	0.1	3
Juncus	*spp.*	0.1	2	*Dichondra*	*repens*	0.2	4
Plot 24				*Hypochaeris*	*radicata*	0.5	5
Nassella	*tenuissima*	40					
Austrodanthonia	*racemosa*	25					
Axonopus	*virginicus*	5					
Dichelachne	*micrantha*	15					
Plantago	*lanceolata*	0.5	5				
Cheilanthes	*seiberi*	0.1	5				
Centella	*asiatica*	0.1	5				
Eucalyptus	*melliodora*	5					
Panicum	*effusum*	15					
Chrysophephalum	*apiculatum*	0.1	2				
Cyperus	*gracilis*	0.1	1				
Eucalyptus	*eugenioides*	5					
Lissanthe	*strigosa*	0.5	5				
Oxalis	*perennans*	0.1	20				

Appendix 4. Plot transect scores

Composition and structure

PCT	Condition	Plot	Easting	Northing	Zone	Compass direction	Tree	Shrub	Grass and grass like	Forb	Fern	Other
1334	Medium	1515	228141	6149142	56	40	3	1	3	6	0	1
1334	Medium	1414	227966	6149217	56	308	2	1	3	7	0	2
1334	Medium	1416	228078	6149316	56	195	2	1	2	5	0	0
1334	Poor	AG24	228136	6149301	56	101	1	2	6	4	0	2
1334	Poor	AG25	227875	6149491	56	100	2	3	4	2	0	2
778	Good	1410	228004	6148657	56	340	4	1	5	4	0	1
778	Good	1412	228007	6148770	56	10	3	3	4	7	0	0
778	Good	1413	227928	6148829	56	22	4	2	3	6	0	2
778	Derived	28	227725	6148828	56	56	0	1	4	2	0	2
778	Derived	31	227935	6148957	56	88	0	2	6	2	0	3
1134	Poor	AG26	228036	6149467	56	96	0	0	5	2	0	2

Function scores

PCT	Condition	Plot	Tree	Shrub	Grass and grass like	Forb	Fern	Other	Regen
1334	Medium	1515	15	0.5	15.5	2.4	0	0.1	Absent
1334	Medium	1414	7	15	15.5	1.3	0	0.3	Absent
1334	Medium	1416	14	15	13	3.5	0	0	Absent
1334	Poor	AG24	1	1	10	3	0	4	Absent
1334	Poor	AG25	1	1	15	5	0	3	Absent
778	Good	1410	31	20	7.6	0.9	0	0.1	Absent
778	Good	1412	8	10.5	20	1.1	0	0	Absent
778	Good	1413	14	15	14	2	0	0.5	Present
778	Derived	28	0	0.5	16	0.1	0	0.2	Absent
778	Derived	31	0	1.5	12	0.5	0	0.6	Absent
1134	Poor	AG26	0	0	22	0.6	0	0.1	Absent

Function scores (continued)

PCT	Condition	**Plot**	0 -9	10 to 19	20-29	30-49	50-79	No >50cm	HBT	Litter cover	FL	High threat weed
1334	Medium	**1515**	N	Y	Y	Y	N	0	0	44	20	20
1334	Medium	**1414**	N	N	N	Y	N	1	1	68	5	50
1334	Medium	**1416**	N	Y	Y	Y	N	2	1	40	24	40
1334	Poor	**AG24**	N	N	N	Y	N	0	0	60	0	50
1334	Poor	**AG25**	N	N	Y	N	N	0	0	65	0	55
778	Good	**1410**	N	Y	Y	Y	N	1	0	74	25	2
778	Good	**1412**	N	N	N	N	N	1	1	62	30	65
778	Good	**1413**	Y	Y	Y	Y	N	0	0	75	42	45
778	Derived	**28**	N	N	N	N	N	0	0	55	0	45
778	Derived	**31**	N	N	N	N	N	0	0	65	0	55
1134	Poor	**AG26**	N	N	N	N	N	0	0	55	2.5	50

Appendix 5. Fauna species list

Common Name	Scientific	Quantity	Status	Date	Observation	Observer	Camera number
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	2	P	06/02/2015	O s	Simon Tweed	0
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	2	P	06/02/2015	O s	Simon Tweed	0
Eastern Spinebill	Acanthorhynchus tenuirostris	1	P	06/02/2015	H s	Simon Tweed	0
Eastern Spinebill	Acanthorhynchus tenuirostris	1	P	06/02/2015	H s	Simon Tweed	0
Australian Owlet-nightjar	Aegotheles cristatus	1	P	06/02/2015	H	Simon Tweed	0
White-winged Chough	Corcorax melanorhamphos	1	P	06/02/2015	H distant	Simon Tweed	0
White-winged Chough	Corcorax melanorhamphos	1	P	06/02/2015	H distant	Simon Tweed	0
White-winged Chough	Corcorax melanorhamphos	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
White-throated Treecreeper	Cormobates leucophaea	1	P	06/02/2015	O s	Simon Tweed	0
White-throated Treecreeper	Cormobates leucophaea	1	P	06/02/2015	O s	Simon Tweed	0
Australian Raven	Corvus coronoides	1	P	06/02/2015	H	Simon Tweed	0
Australian Raven	Corvus coronoides	1	P	06/02/2015	H	Simon Tweed	0
Australian Magpie	Cracticus tibicen	1	P	06/02/2015	H distant	Simon Tweed	0
Australian Magpie	Cracticus tibicen	1	P	06/02/2015	H distant	Simon Tweed	0
Australian Magpie	Cracticus tibicen	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
White-throated Gerygone	Gerygone albogularis	1	P	06/02/2015	H s	Simon Tweed	0
White-throated Gerygone	Gerygone albogularis	1	P	06/02/2015	H s	Simon Tweed	0
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	H	Simon Tweed	0
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	H	Simon Tweed	0
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Spotted Pardalote	Pardalotus punctatus	1	P	06/02/2015	O s	Simon Tweed	0
Spotted Pardalote	Pardalotus punctatus	1	P	06/02/2015	O s	Simon Tweed	0
Scarlet Robin	Petroica boodang	1	V	06/02/2015	O	Simon Tweed	0
Tawny Frogmouth	Podargus strigoides	1	P	06/02/2015	O spot	Simon Tweed	0
Grey Fantail	Rhipidura albiscapa	1	P	06/02/2015	O	Simon Tweed	0
Grey Fantail	Rhipidura albiscapa	1	P	06/02/2015	O	Simon Tweed	0
Eastern Grey Kangaroo	Macropus giganteus	1	P	06/02/2015	O spot	Simon Tweed	0
Eastern Grey	Macropus	1	P	06/02/2015	Infrared Camera	Simon Tweed	37

Common Name	Scientific	Quantity	Status	Date	Observation	Observer	Camera number
Kangaroo	giganteus						
Eastern Grey Kangaroo	Macropus giganteus	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Common Wallaroo	Macropus robustus	1	P	06/02/2015	Infrared Camera	Simon Tweed	37
Common Wallaroo	Macropus robustus	1	P	06/02/2015	Infrared Camera	Simon Tweed	43
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	O spotlight	Simon Tweed	0
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	IO	Simon Tweed	0
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	Infrared Camera	Simon Tweed	37
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	Infrared Camera	Simon Tweed	38
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	Infrared Camera	Simon Tweed	42
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	Infrared Camera	Simon Tweed	42
Sugar Glider	Petaurus breviceps	1	P	06/02/2015	H and various incisions seen.	Simon Tweed	0
Sugar Glider	Petaurus breviceps	1	P	06/02/2015	H spot approx 100m to sth	Simon Tweed	0
Rattus sp.	Rattus sp.	1	U	06/02/2015	Infrared Camera	Simon Tweed	42
Short-beaked Echidna	Tachyglossus aculeatus	1	P	06/02/2015	Infrared Camera	Simon Tweed	38
Common Brushtail Possum	Trichosurus vulpecula	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Common Wombat	Vombatus ursinus	1	P	06/02/2015	O inc	Simon Tweed	0
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Fox	Vulpes vulpes	1	U	06/02/2015	O spot	Simon Tweed	0
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	37
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	37
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	38
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	37
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	38
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Lace Monitor	Varanus varius	1	P	06/02/2015	Infrared Camera	Simon Tweed	38
Lace Monitor	Varanus varius	1	P	06/02/2015	Infrared Camera	Simon Tweed	42
Chestnut-rumped Thornbill	Acanthiza uropygialis	1	P	06/02/2015	Infrared Camera	Simon Tweed	77
Eastern Spinebill	Acanthorhynchus tenuirostris	1	P	06/02/2015	H	Simon Tweed	0
Black-faced Cuckoo-shrike	Coracina novaehollandiae	1	P	06/02/2015	O s	Simon Tweed	0
White-winged Chough	Corcorax melanorhamphos	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
White-throated Treecreeper	Cormobates leucophaea	1	P	06/02/2015	H s	Simon Tweed	0

Common Name	Scientific	Quantity	Status	Date	Observation	Observer	Camera number
Australian Raven	Corvus coronoides	2	P	06/02/2015	H	Simon Tweed	0
Brown Quail	Coturnix ypsilophora	1	P	06/02/2015	O	Simon Tweed	0
Australian Magpie	Cracticus tibicen	1	P	06/02/2015	H	Simon Tweed	0
Australian Magpie	Cracticus tibicen	1	P	06/02/2015	Infrared Camera	Simon Tweed	40
Australian Magpie	Cracticus tibicen	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Eastern Yellow Robin	Eopsaltria australis	1	P	06/02/2015	Infrared Camera	Simon Tweed	77
Wonga Pigeon	Leucosarcia picata	1	P	06/02/2015	Infrared Camera	Simon Tweed	77
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	H s	Simon Tweed	0
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Superb Fairy-wren	Malurus cyaneus	1	P	06/02/2015	Infrared Camera	Simon Tweed	77
Spotted Pardalote	Pardalotus punctatus	1	P	06/02/2015	H	Simon Tweed	0
Noisy Friarbird	Philemon corniculatus	1	P	06/02/2015	O	Simon Tweed	0
Grey Fantail	Rhipidura albiscapa	1	P	06/02/2015	H	Simon Tweed	0
Willie Wagtail	Rhipidura leucophrys	1	P	06/02/2015	O	Simon Tweed	0
White-browed Scrubwren	Sericornis frontalis	1	P	06/02/2015	Infrared Camera	Simon Tweed	43
Pied Currawong	Strepera graculina	1	P	06/02/2015	Infrared Camera	Simon Tweed	40
Pied Currawong	Strepera graculina	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Large-eared Pied Bat	Chalinolobus dwyeri	3	V	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Gould's Wattled Bat	Chalinolobus gouldii	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Chocolate Wattled Bat	Chalinolobus morio	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Brown Hare	Lepus capensis	1	U	06/02/2015	Infrared Camera	Simon Tweed	39
Brown Hare	Lepus capensis	1	U	06/02/2015	Infrared Camera	Simon Tweed	39
Brown Hare	Lepus capensis	1	U	06/02/2015	Infrared Camera	Simon Tweed	43
Eastern Grey Kangaroo	Macropus giganteus	1	P	06/02/2015	O	Simon Tweed	0
Eastern Grey Kangaroo	Macropus giganteus	25	P	06/02/2015	O inc	Simon Tweed	0
Eastern Grey Kangaroo	Macropus giganteus	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Eastern Grey	Macropus	1	P	06/02/2015	Infrared Camera	Simon Tweed	39

Common Name	Scientific	Quantity	Status	Date	Observation	Observer	Camera number
Kangaroo	giganteus						
Eastern Grey Kangaroo	Macropus giganteus	1	P	06/02/2015	Infrared Camera	Simon Tweed	40
Eastern Grey Kangaroo	Macropus giganteus	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Nyctophilus sp.	Nyctophilus sp.	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	O spot	Simon Tweed	0
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	Infrared Camera	Simon Tweed	40
Rabbit	Oryctolagus cuniculus	1	U	06/02/2015	Infrared Camera	Simon Tweed	45
Eastern Horseshoe-bat	Rhinolophus megaphyllus	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Short-beaked Echidna	Tachyglossus aculeatus	1	P	06/02/2015	Infrared Camera	Simon Tweed	43
Short-beaked Echidna	Tachyglossus aculeatus	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Short-beaked Echidna	Tachyglossus aculeatus	1	P	06/02/2015	Infrared Camera	Simon Tweed	77
White-striped Freetail-bat	Tadarida australis	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Common Brushtail Possum	Trichosurus vulpecula	2	P	06/02/2015	O spot 100 m north and 200 m north	Simon Tweed	0
Common Brushtail Possum	Trichosurus vulpecula	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Common Brushtail Possum	Trichosurus vulpecula	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Common Brushtail Possum	Trichosurus vulpecula	1	P	06/02/2015	Infrared Camera	Simon Tweed	40
Common Brushtail Possum	Trichosurus vulpecula	1	P	06/02/2015	Infrared Camera	Simon Tweed	43
Common Brushtail Possum	Trichosurus vulpecula	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Large Forest Bat	Vespadelus darlingtoni	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Little Forest Bat	Vespadelus vulturnus	1	P	06/02/2015	Ultrasonic Recording	Simon Tweed, Matthew Stanton	0
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	40

Common Name	Scientific	Quantity	Status	Date	Observation	Observer	Camera number
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	43
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Common Wombat	Vombatus ursinus	1	P	06/02/2015	Infrared Camera	Simon Tweed	77
Fox	Vulpes vulpes	1	U	06/02/2015	O	Simon Tweed	0
Fox	Vulpes vulpes	1	U	06/02/2015	O inc	Simon Tweed	0
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	39
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	39
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	40
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	43
Fox	Vulpes vulpes	1	U	06/02/2015	Infrared Camera	Simon Tweed	45
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	O	Simon Tweed	0
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	O inc	Simon Tweed	0
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	39
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	40
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	43
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	45
Swamp Wallaby	Wallabia bicolor	1	P	06/02/2015	Infrared Camera	Simon Tweed	77

Key: P = Protected; V = Vulnerable; E = Endangered; - = not listed under act (exotic/introduced species).

Appendix 6. Serious and Irreversible Impact (SAII) Criteria

White Box Yellow Box Blakely's Red Gum Grassy Woodland SAII criteria

SAII criteria	Address of SAII criteria
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section 5.1.1 regarding avoidance.
(b) the area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone.	White Box Yellow Box Blakely's Red Gum Grassy Woodland occurs towards the far north of the study area on the flat and gentle slopes. Historically, it is likely the community occupied much of the flat and gentle terrain of the disturbance areas, in particular those areas of exotic pasture adjacent to mapped units of PCT 1334. A total 27.68 hectares of White Box Yellow Box Blakely's Red Gum Grassy Woodland Woodland would be directly impacted by the Project. The extent of this community is shown on Figure 7. The area to be cleared consists of two different condition classes (Appendix 2): Moderate: Consisting of close patches of Eucalypt stands (comprising of Eucalyptus blakelyi, and Eucalyptus melliodora with the occasional E. eugenioides and E. bosistoana) with a mixture of native and introduced ground cover. This condition class had a vegetation integrity score of 36. Poor: Consisting of a few sparsely scattered Eucalypt stands, with a mixture of native and introduced ground cover. This condition class had a vegetation integrity score of 19.8. Indirect impacts to the remaining White Box Yellow Box Blakely's Red Gum Woodland would be avoided by carrying out weed control, pest control, demarcating 'no go' areas, and contractor education. Details regarding these are provided in section 5.1.3.
(c) a description of the extent to which the impact exceeds the threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	No impact threshold has been attributed to this TEC.
(d) the extent and overall condition of the potential TEC within an area of 1000ha, and then	In an attempt to determine the extent of Box-Gum Woodland in the locality, mapping by Tozer et al. 2006 was examined as it covered the locality extent.

SAII criteria	Address of SAII criteria
10,000ha, surrounding the proposed development footprint	A total of 3,304.6 ha of the best equivalent vegetation type (p24, Tableland Grassy Box Gum Woodland) has been mapped within a 10 km radius of the study area. The p24 mapping unit has been described by Tozer et al. (2006) as potentially aligning to the CEEC and the state listed EEC. The mapped occurrence of White Box Yellow Box Blakely's Red Gum Woodland based on Tozer et al (2006) surrounding the development footprint is as follows: • 1,000 ha = < 230 hectare • 10,000 ha = 600.6 hectares. The condition of White Box Yellow Box Blakely's Red Gum Woodland within both the 1,000 ha and 10,000 hectares circles is likely to be predominately in a low to moderate condition, given the rural pressure and historic clearing of the area. It is highly likely that weeds would occupy portions of the lower stratums. The largest patches of White Box Yellow Box Blakely's Red Gum Woodland have been mapped (Figure 7) include: • A patch greater than 20 hectares which occurs to the north of Peppertree Quarry. This area is proposed for the establishment of a Stewardship Site as part of this Project. This patch has been assessed by Niche to be in a relatively good condition. • Scattered patches ranging in size from 5 hectares to 10 hectares occurring within private property, approximately 2 kilometres to the west of the study area.
(e) an estimate of the extant area and overall condition of the potential TEC remaining in the IBRA subregion before and after the impact of the proposed development has been taken into consideration	Throughout its range the TEC has been reduced in area and highly fragmented because of clearance for cropping, grazing and pasture improvement due to the ecological community's occurrence on fertile soils. Very few high quality remnants remain anywhere across its former range. The EPBC Policy Guidelines (DoE 2014) state that over 90% of the original extent of this ecological community has been cleared. This is supported by OEH (2014b) who regarded the equivalent Biometric Vegetation Type to be 90% cleared, and Thomas et al. (2000) estimate that within South-Eastern NSW 59,468 ha remain from the pre-1750 extent of 1,012,052 ha (approximately 94% cleared). Within the Bungonia IBRA subregion, Niche estimates that approximately 5,000 ha remain which is within a derived condition or as sparsely scattered woodland patches. The Project would reduce the extent of the Bungonia IBRA region extent by approximately 0.5 percent of the IBRA Subregion range.
(f) an estimate of the area of the potential TEC that is in the reserve system within the IBRA region and the IBRA subregion	Niche estimate that less than 3 percent of the Box Gum within the Bungonia Subregion, and similarly for the IBRA region, is formally protected within National Parks or Conservation Areas.
(g) the development, clearing or biodiversity certification proposal's impact on: (i) abiotic factors critical to the long-term survival	i. The Project will result in the loss to 27.68 ha of the TEC due to direct clearing. The position of the TEC to be impacted occurs immediately adjacent to the existing Marulan South Pit, and is already in a distriburbed condition due to historic land clearing and the occurrence of Serrated Tusk and grazing by goats and rabbits. The patch to be removed is unlikely to result in changes to the flow regime or ground water levels that may

SAII criteria	Address of SAII criteria
of the potential TEC; for example, how much the impact will lead to a reduction of groundwater levels or the substantial alteration of surface water patterns (ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants (iii) the quality and integrity of an occurrence of the potential TEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the potential TEC	impact upon other patches of the TEC within the locality. ii. The Project will not result in inappropriate fire and flooding regimes that would impact upon surrounding patches of TEC. A Fire Management Plan would be developed as part of the Project to minimise any potential fire ignition from the site, and to ensure that recommended fire management is carried out. Flooding as a result of the Project will not result in an impact to the TEC that occurs outside the study area. iii. The removal of 74.3 ha of White Box Yellow Box Blakely's Red Gum Woodland opens the surrounding patches to edge effects. Edge effects include the invasion of weeds, erosion and sedimentation. Mitigation measures to be undertaken as part of the project include: weed control, pest control, demarcating 'no go' areas, and contractor education. Details regarding these are provided in section 5.1.3.
(h) direct or indirect fragmentation and isolation of an important area of the potential TEC	The condition of the TEC within the study area is of a moderate to poor condition, typically containing a scattered canopy layer and mixture of native and introduced ground cover. It is likely that the patch would continue to decline without weed management, particularly targeting Serrated Tussock and Blackberry, and assisted tubestock or direct seeding regeneration. The affected patches of White Box Yellow Box Blakely's Red Gum Woodland in the study area are already fragmented by access roads, exotic pasture and infrastructure. This is a common theme for the TEC which is highly fragmented in the locality (Tozer et al. 2006 mapping of map unit p24). The Project will lead to increased fragmentation of the ecological community in the local context through the development of the Project however connectivity will be retained within contiguous habitat around the periphery of the study area.
(i) the measures proposed to contribute to the recovery of the potential TEC in the IBRA subregion.	The Project will require a like-for-like offset to satisfy the requirements of the BAM and EPBC Act. As such, this will result in the establishment of a conservation area that will protect and enhance White Box Yellow Box Blakely's Red Gum Woodland. The proposed offset would achieving no net loss in extent and condition of the ecological community throughout its geographic distribution as per the requirement of the BAM.

Koala habitat

SAII criteria	Address of SAII criteria
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section 5.1.1 regarding avoidance.
(b) the size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification	Impacts from the Project largely relate to the removal of foraging and dispersal habitat that has been defined as being critical to the survival of the Koala under the EPBC Act (DoE 2014; Appendix 8). Habitat mapped as good and moderate habitat potential within the study area (Figure 8) contained either two or more known feed trees (listed as primary, secondary or tertiary species under the species Recovery Plan (DECC 2008)) or a single feed species that occupied more than 50% of a 400 m2 floristic quadrat. Such habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The Project would result in the removal of 27.1 ha of such habitat. Due to the apparent limited use of the study area and its extremely small extent in relation to similar habitat for the Shoalhaven Gorge Koala population (7,500 ha), it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven gorge) such that a decline would occur or that the population is placed at risk of extinction. Active sites for this population are concentrated within protected areas and the study area is not thought to provide a link between active areas within the population's distribution or to any other Koala population. Mitigation measures detailed in section 5.1.3 would be employed to reduce the indirect impact toward the Koala.
(c) the extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	No impact threshold has been attributed to the Koala.
(d) the likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of	i. The Project would result in the removal of approximately 27.1 hectares of habitat. ii. Impacts from the Project largely relate to the removal of foraging and dispersal habitat. Good to moderate quality habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The Project would result in the

SAII criteria	Address of SAII criteria
the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	removal of 27.1 ha of such habitat. Due to the apparent limited use of the study area and its extremely small extent in relation to similar habitat for the Shoalhaven Gorge Koala population (7,500 ha), it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven gorge) such that a decline would occur or that the population is placed at risk of extinction. Active sites for this population are concentrated within protected areas and the study area is not thought to provide a link between active areas within the population's distribution or to any other Koala population. iii. The proposed development would result in the removal of approximately 27.1 hectares of koala habitat. This is a reduction less than 1 percent of the available occupiable habitat (7,500 ha of similar habitat for the Shoalhaven Gorge Koala population). The remaining habitat would not be impacted by the Project and therefore would not result in extinction of the population. The population is likely to utilise existing habitat within the surrounding area.
BioNet Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development (e) the likely impact on the ecology of the local population. At a minimum, address the following: (i) for fauna: breeding, foraging, roosting, and dispersal or movement pathways	As the area for removal is a small relative extent (less than 1percent) of habitat for the Shoalhaven population of Koala. It is not considered that the removal of this habitat alone would significantly adversely impact the relevant koala population. Active sites for this population are concentrated within protected areas and the study area is not thought to provide a link between active areas within the population's distribution or to any other koala population.
(f) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	No Koalas or evidence of Koalas were recorded within the study area, however the eucalypt species present in the study area are Koala feed trees. As discussed previously, the study area is not thought to provide a link between active areas within the population's distribution or to any other koala population. It is unlikely that the local koala population will become fragmented or isolated as a result of the Project.

SAII criteria	Address of SAII criteria
(g) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	It is unlikely that the study area provides a linkage to Koala populations. The species was not detected during field surveys, nor have there been any sightings within the study area historically.
(h) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The Project is likely to result in edge effects in the form of weed invasion, sedimentation and erosion within habitat for Koala immediately adjacent to the areas being cleared. However, mitigation measures detailed in section 5.1.3 would be employed to reduce the impact of edge effects occurring on habitat for the remaining population.
(i) an estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion	Based on previous mapping (Tozer et al 2006), the area of potential habitat in the locality is approximately 7,500 hectares. The proposed development would result in the removal of less than 1 percent of potential habitat in the locality. As can be seen from Figure 8, the records for the Koala predominately occur to the south of the study area within Bungonia Gorge, away from the study area.
(j) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.	The Project will require a like-for-like offset to satisfy the requirements of the BAM and EPBC Act. As such, this will result in the establishment of a conservation area that will protect and enhance Koala habitat. The proposed offset would achieving no net loss in extent and condition of the Koala habitat as per the requirement of the BAM.

Large-eared Pied Bat foraging habitat

SAII criteria	Address of SAII criteria
(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII	See section 5.1.1 regarding avoidance.
(b) the size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification	Impacts from the Project largely relate to the removal of foraging habitat for the Large-eared Pied Bat. Habitat mapped as good habitat potential within the study area (Figure 9) which contained foraging habitat within proximity to known caves and overhangs. The Project would result in the removal of 27.1 ha of such foraging habitat. The Project will not impact roosting habitat. Due to the small extent in relation to similar habitat within the locality (7,500 ha), it is not considered that removal of this habitat alone would significantly adversely impact the Large-eared Pied Bat such that a decline would occur or that the population is placed at risk of extinction. Known cave sites (located approximately 2.6 kilometres) for this population would not be impacted by the Project. Mitigation measures detailed in section 5.1.3 would be employed to reduce the indirect impact toward the Large-eared Pied Bat habitat.
(c) the extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact	Breeding habitat is identified as an SAII – however the Project would not impact upon breeding habitat for the Large-eared Pied Bat.
(d) the likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to: (i) an estimate of the change in habitat available to the local population as a result of the proposed	i. The Project would result in the removal of approximately 27.1 hectares of foraging habitat. No breeding habitat would be impacted. ii. Impacts from the Project largely relate to the removal of 27.1 ha of foraging habitat. Due to the small extent of foraging habitat impacted in relation to similar habitat in the locality, it is not considered that removal of this habitat alone would significantly adversely impact to the Large-eared Pied Bat. Furthermore, no roosting or breeding sites would be impacted. iii. The proposed development would result in the removal of approximately 27.1 hectares of foraging habitat

SAII criteria	Address of SAII criteria
development (ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and (iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	for the Large-eared Pied Bat. This is a reduction less than 1 percent of the available occupiable habitat (7,500 ha of similar habitat for the Large-eared Pied Bat in the locality). The remaining habitat would not be impacted by the Project and therefore would not result in extinction of the population. The population is likely to utilise existing habitat within the surrounding area. Furthermore, no breeding habitat would be impacted by the Project.
BioNet Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development (e) the likely impact on the ecology of the local population. At a minimum, address the following: (i) for fauna: breeding, foraging, roosting, and dispersal or movement pathways	As the area for removal is a small relative extent (less than 1percent) of foraging habitat for the Large-eared Pied Bat. It is not considered that the removal of this habitat alone would significantly adversely impact Large-eared Pied Bat. Study area is located adjacent to an operating Marulan South Quarry, and would essentially expand the footprint of the exiting quarry to the west. The foraging habitat to be impacted is unlikely to result in any disruption to flight paths and mobility. Extensive unimpeded bushland is located throughout the locality and throughout Bungonia gorge.
(f) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	It is highly unlikely that the local Large-eared Pied Bat population would be significantly impacted by the removal of 27.1 ha of foraging habitat given the extent available within the locality. Furthermore, the removal of such habitat is unlikely to result in a change to flight movements. The Project would also not result in any impact to known breeding or roosting sites.
(g) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other	It is highly unlikely that the Project would impact upon any important local Large-eared Pied Bat population. The removal of 27.1 ha of foraging habitat is relatively minor given the extent available within the locality. Furthermore, the removal of such habitat is unlikely to result in a change to flight movements. The Project would also not result in any impact to

SAII criteria	Address of SAII criteria
population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	known breeding or roosting sites.
(h) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	The Project is likely to result in edge effects in the form of weed invasion, sedimentation and erosion within foraging habitat for Large-eared Pied Bat immediately adjacent to the areas being cleared. However, mitigation measures detailed in section 5.1.3 would be employed to reduce the impact of edge effects occurring on foraging habitat for the remaining population.
(i) an estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion	Based on previous mapping (Tozer et al 2006), the area of potential habitat in the locality is approximately 7,500 hectares. The proposed development would result in the removal of less than 1 percent of potential habitat in the locality. As can be seen from Figure 8, a potential cave site occurs approximately 2.5 km to the south of the study area within Bungonia Gorge, away from the study area.
(j) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.	The Project will require a like-for-like offset to satisfy the requirements of the BAM and EPBC Act. As such, this will result in the establishment of a conservation area that will protect and enhance Large-eared Pied Bat habitat. The proposed offset would achieving no net loss in extent and condition of the Large-eared Pied Bat habitat as per the requirement of the BAM.

Appendix 7. Biodiversity Credit Calculator Report

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00011985/BAAS17066/18/00011987	3557 Peppertree Mod 5	24/02/2018
Assessor Name	**Report Created**	**BAM Data version ***
Sian Griffiths	26/08/2018	3
Assessor Number	* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.	
BAAS17066		

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Candidate SAII	Ecosystem credits
Coast Grey Box - stringybark dry woodland on slopes of the Shoalhaven Gorges, southern Sydney Basin Bioregion								
3	778_Good	42.4	8.5	0.25	High Sensitivity to Potential Gain	1.50		134
4	778_Poor	17.4	3.6	0.25	High Sensitivity to Potential Gain	1.50		23
							Subtotal	**157**

BAM Credit Summary Report

Yellow Box grassy woodland of the northern Monaro and Upper Shoalhaven area, South Eastern Highlands Bioregion								
1	1334_Medium	36.0	18.6	0.25	High Sensitivity to Potential Gain	2.00	TRUE	335
2	1334_Poor	19.8	9.0	0.25	High Sensitivity to Potential Gain	2.00	TRUE	89
							Subtotal	**424**
							Total	**581**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Candidate SAII	Species credits
Chalinolobus dwyeri / Large-eared Pied Bat (Fauna)						
778_Good	42.4	8.46	0.25	3	True	269
1334_Medium	36.0	18.64	0.25	3	True	503
					Subtotal	**772**
Phascolarctos cinereus / Koala (Fauna)						
778_Good	42.4	8.46	0.25	2	N/A	179
1334_Medium	36.0	18.64	0.25	2	N/A	335
					Subtotal	**514**

Appendix 8. Threatened species assessments of significance under the EPBC Act

Matters for Assessment

Assessments of Significance and supplementary information (where relevant) are presented for the following MNES in relation to the Project:

- Threatened Ecological Communities
  - Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- Threatened Fauna
  - Koala
  - Large-eared Pied Bat
  - Grey-headed Flying-fox
- Migratory Species
  - Rainbow Bee-eater
  - Black-faced Monarch
  - Rufous Fantail
  - Fork-tailed Swift

Yellow Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Likelihood
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will: reduce the extent of an ecological community	
A total maximum area of 27.68 hectares of Yellow Box Yellow Box Blakely's Red Gum Woodland (hereafter referred to as Box-Gum Woodland) will be removed by the Project. The Box-Gum Woodland CEEC has been heavily cleared across its range, with the remaining extent of the ecological community being highly fragmented, occurring in small isolated patches within a cleared environment, or within a landscape of other disturbed woodlands (DoE 2014). This is evident throughout the disturbance area and within the wider Project area. The EPBC Policy Guidelines (DoE 2014) also state that over 90% of the original extent of this ecological community has been cleared. This is supported by OEH (2014) who regarded the equivalent Biometric Vegetation Type to be 90% cleared, and Thomas et al. 2000 estimate that within South-Eastern NSW 59,468 ha remain from the pre-1750 extent of 1,012,052 ha (approximately 94% cleared). In an attempt to determine the extent of Box-Gum Woodland in the locality, mapping by Tozer et al 2006 was examined as it covered the locality extent. A total of 3,304.6 ha of the best equivalent vegetation type (p24, Tableland Grassy Box Gum Woodland) has been mapped within a 10 km radius of the Project area. The p24 mapping unit has been described by Tozer et al (2006) as potentially aligning to the CEEC and the state listed EEC, however it would include some areas that do not meet the CEEC. It has been assumed in this assessment that half of the total p24 area would be an approximate representation of the remaining CEEC in the locality (i.e. 1,652.3 ha). The potential habitat removed by the Project is therefore estimated to represent only 0.1% of the community in the locality. It is unclear what the condition and security of the remaining CEEC is within the locality. It is likely that much of it is on private land and that it is similarly disturbed compared with the disturbance area.	Known-marginal reduction.
fragment or increase fragmentation of an ecological community	
All of the CEEC within the disturbance area has experienced weed invasion, grazing pressures and clearing, which has resulted in a predominantly degraded condition of this community. The CEEC within the disturbance area is currently fragmented, however the Project will increase fragmentation by removing the northern extent of the larger patch of native vegetation.	Likely to increase fragmentation.
adversely affect habitat critical to the survival of an ecological community	
The CEEC to be disturbed by the Project consists of two condition classes. Both of the condition classes meet the Commonwealth listing despite prior historic disturbance and clearing. The Box-Gum Woodland Recovery Plan regards all areas of Box-Gum Woodland which meet the minimum condition criteria to be considered critical to the survival of the ecological community. Based on this statement, it would mean that all patches of the CEEC within the disturbance area, no matter of condition or size, are critical to the survival of the community and similarly, this would extend to all areas of the community within the locality.	Likely

Yellow Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Likelihood
As stated in the EPBC Act Policy Guidelines, the CEEC has been heavily cleared across most of its range with the remaining extent of the ecological community being highly fragmented, occurring in small isolated patches within a cleared environment, or within a landscape of other disturbed woodlands. With this in mind, any clearing of large patches of the CEEC may result in an adverse affect to critical habitat.	
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	
The clearing of the CEEC will result in the destruction of abiotic factors within the disturbance area necessary for the CEEC survival given that the CEEC will be cleared. The clearing of the CEEC will modify soil and soil seed bank within the disturbance area. Outside of the disturbance area, the impacts associated with the proposal are not likely to significantly exacerbate currently operating edge-effects in areas of the CEEC (e.g. weed invasion, areas of erosion and grazing). Within remaining areas of the CEEC, the proposed surface water drainage follows natural drainage lines which are unlikely to be impacted such that water availability to the CEEC is altered.	Unlikely to be a factor outside of disturbance area– impacts restricted to clearing of the proposed disturbance area
cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	
The Project will result in the loss of the CEEC within the disturbance area. Within the immediate surrounds, patches of CEEC may experience an increase in introduced species via increased edge effects. However, these areas are already subject to weed invasion, and the risk would be decreased via weed control measures within the Biodiversity Management Plan. As such, it is unlikely that a substantial change to species composition would occur in the CEEC immediately adjacent to the disturbance area as a result of the Project. The Project has some potential to alter the fire frequency of the area, however fire is already discouraged from occurring around the mine area due to the presence of mine infrastructure. The Biodiversity Management Plan to be prepared for the site, will consider the potential to implement a fire frequency appropriate to the existing remaining vegetation communities.	Unlikely
cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established, or	
The Project will likely increase edge effects for remaining areas of the CEEC that are adjacent to the proposed disturbance areas. It is likely that weed invasion may be exacerbated within adjacent patches of CEEC however establishment of new weed species is unlikely to occur particularly given control measures for weeds implemented through the Biodiversity Management Plan.	Potential
causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or	
The Project will not involve any spraying of fertilizers, herbicides or other chemicals of pollutants which will kill or inhibit the growth of the CEEC. Herbicides and fertilizers may be required for bushland restoration and rehabilitation purposes to reduce the spread of weeds and promote seed	Unlikely

Yellow Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Likelihood
germination and growth of seedlings, however these will only be used in accordance within bushland restoration principles and best practise and will not result in any significant impacts to the CEEC.	
interfere with the recovery of an ecological community.	
The National Recovery Plan for White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland has been prepared under the provisions of the EPBC Act. The overall aim of the recovery plan is to promote the recovery and prevent the extinction of the CEEC. The specific objectives of the recovery plan is to minimise the risk of extinction of the ecological community through: achieving no net loss in extent and condition of the ecological community throughout its geographic distribution; increasing protection of sites in good condition; increasing landscape function of the community through management and restoration of degraded sites; increasing transitional areas around remnants and linkages between remnants; and bringing about enduring changes in participating land manager attitudes and behaviours towards environmental protection and sustainable land management practices to increase extent, integrity and function of Box-Gum Grassy Woodland. The Project will interfere with recovery of the CEEC given that 27.68 hectares of the community will be cleared. The Project would not be consistent with the first objective of the above stated recovery aims for the community unless offsetting arrangements for the Project secure and improve the condition of the community elsewhere within the region to the extent that a 'no net loss' outcome is achieved. The Project will satisfy the NSW Offsets Policy for Major Projects which will result in a no net loss (otherwise known as improve or maintain) outcome for the community at a regional level by securing patches of the CEEC and managing these in perpetuity. In the long-term the offset is expected to benefit the recovery of the community given that a larger area of CEEC will be protected and managed in perpetuity.	Likely however greater recovery benefits will be achieved through an offset.
Conclusion: The proposal is likely to result in a significant impact on Box-Gum Grassy Woodland, primarily through the removal of habitat considered critical to the survival of the community.	

Koala

In assessing the significance of the impact from the proposed action on the Koala the '*EPBC Act referral guidelines for the vulnerable koala*' were applied to the assessment. The following information is presented prior to the Assessment of Significance for the Koala to demonstrate application of the guidelines and to assist with understanding the assessment and its conclusion.

Koala Habitat Assessment Scoring (REF referral guidelines):

Attribute	Score	Habitat Appraisal
Koala occurrence	+2	Koalas have been encountered infrequently adjacent to the existing mine (the most recent in December of 2017 along Marulan South Road approximately 1 km from the mine) according to communications with site personnel; A number of Koala records exist from contiguous habitat approximately 1-2 km south of the proposed disturbance area.
Vegetation Structure and composition	+2	Habitat scoring was applied across the Project area using floristic data and Braun Blanquet cover values from 400m^2 quadrats. The mapping indicated that the majority of the Project areas contained either 2 or more known feed trees or a single feed species that occupied more than 50% of the quadrat.
Habitat connectivity	+2	The area is part of a contiguous landscape of > than 1,000 hectares, however the existing mine and perimeter roads (incorporating steep rocky embankments in places) form a significant barrier to accessing the study area from the south, where extensive vegetated areas occur (the most extensive of which are within the Morton and Bungonia National Parks). There are no major barriers to Koala movement to the study area from the immediate south and west which allows for connectivity between the study area and the Bungonia State Conservation Area (despite the presence of steep terrain) where the majority of the Koala records for the region occur.
Key existing threats	+2	There is no known documented or anecdotal evidence of Koala mortality from dog attack or vehicle collision within the study area or surrounds. Dogs, trucks, and train movements are all present within the study area however wild dogs are not common (not detected on infrared cameras or seen during survey) and vehicle movements within the study area are regulated at low speeds.

Recovery value	+1	Uncertain whether the habitat within the proposed study areas will be important in achieving the interim recovery objectives. There is some relevance to the recovery objectives for inland areas (as per table 1 of the referral guidelines (REF)) in regard to the development area representing habitat on fertile soil, however the habitat is not thought to specifically act as a habitat refuge. There is some relevance to the objective of maintaining habitat around refuges (i.e. the area within Bungonia State Conservation Area is a known refuge). However connectivity to the known refuge area is somewhat limited though the existing mine and gorge habitat. Additionally, given the extensive reserve network surrounding the existing refuge areas, the importance of the Project area is lessened.
Total	**9/10**	

Koala (vulnerable)	
Preamble There are 137 Koala records from the NSW Atlas of Wildlife within a 10 km radius of the study area, all but three of which are post 1980 records. The majority of these records (105) are from the Bungonia National Park (NP) and Bungonia State Conservation Area (SCA) which occur approximately 1 - 2 km south of the Project area and collectively are considered one of the primary known active sites for a Koala population centred along the Shoalhaven Gorge and extending approximately 30 km to the south of the study area (e.g. Allen 2002) encompassing large areas of Morton National Park. The Bungonia NP/SCA active Koala area includes popular walking areas and a camping site and therefore observations of Koalas from this area are relatively frequent. Other unknown active Koala areas may exist within the locality where access is limited. The Bungonia NP/SCA areas are separated from the study area by the Bungonia Gorge, a limestone gorge approximately 350 m deep. The steepness of the gorge would undoubtedly limit connectivity between the main known breeding area of Koalas in the locality (Bungonia NP/SCA) and the Project area, however there are records of the Koala from both sides of the gorge (albeit very limited from the northern side) and connectivity to the study area exists indirectly, west of the main gorge area. North and west of the protected areas around the Bungonia and Shoalhaven gorges Koala records within the NSW Atlas of Wildlife are very limited with sporadic observations from private land and along roadsides, one being from the Marulan South Limestone Mine and two additional records (including road-kill) each from around the townships of Marulan and Tallong. These areas are more disturbed, predominantly private tenure. They generally consist of more fertile areas that have been developed traditionally for agriculture. It is clear that Koalas are able to travel through such areas and feed trees including primary feed trees are available to them throughout such areas. Targeted Koala survey in these areas (private land on the tablelands) is likely to have been minimal and therefore actual Koala distribution and abundance within such areas is poorly known. Despite the limits regarding Koala distribution and abundance, given previous disturbance resulting in fragmented vegetation and the lack of Koala records within the higher elevation areas away from the protected areas around the Bungonia and Shoalhaven gorges, it is considered unlikely that active Koala areas (with permanent and moderate to high densities of Koalas) such as those within the Bungonia NP/SCA would occur. Surveys and collection of anecdotal evidence of Koala sightings conducted within the study area as part of this assessment revealed that Koalas have been sighted sporadically within the south of study area over the past decade, with Koalas observed every 2- 3 years around the mine (pers. comm. Grant Thompson – Boral). However, no Koala observations are known from the study area. Scat surveys, spotlighting, call-playback and tree surveys did not identify repeated or on-going use of trees within any of the proposed disturbance areas. Therefore, whilst it is known that Koalas occur within these areas and that feed trees exist within them, it is likely that very low densities of Koalas occur or that Koalas use the areas whist moving through the landscape.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is considered unlikely that the Project would lead to a long-term decrease in the size of an important population of the Koala. It is considered that the population of Koalas occurring around the Shoalhaven and Bungonia gorges (as described in Allen - 2002) is an important population, however it has not been listed specifically as such within a recovery plan. The identified active Koala area within the Bungonia NP/SCA, which acts as a known breeding and regular feeding habitat is one of several active areas for this population. The Project is not considered to have impacts on the population such that it will lead to a long-term decline as records away from protected areas within the locality of the Project area are very sparse and use of the study area is thought to be transient only or support a very limited number of individuals.	Very unlikely

reduce the area of occupancy of a important population;	
The Project would not impact the area of occupancy of any population of the Koala as the areas to be cleared are not sufficient in extent to impact the area of occupancy of the Koala at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN). Koalas would still be expected to occur within the vicinity of the Project area (e.g. to the west of the proposed western and central emplacement areas).	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for the identified population. There may be some minor impacts on potential north-south migration routes west of the existing mine, however such migration will still be able to persist. There are no known important areas for Koalas to the north of the existing mine. Connectivity between the main active population areas would not be impacted.	Unlikely
adversely affect habitat critical to the survival of a species;	
Habitat within the Project area to be impacted constitutes habitat critical to Koala survival as determined through application of the Koala habitat assessment tool (DOE 2014), which is illustrated in the table above. The habitat within the disturbance area scores a 9/10.	Likely
disrupt the breeding cycle of an important population	
Habitat within the disturbance area is not thought to be a key breeding area due to the low number of records. Therefore removal of the habitat is unlikely to disrupt the breeding cycle of the population. The area constitutes a very small proportion of the overall habitat for the population, (considered to be the population centred on the Shoalhaven gorge (Allen 2002)), with active population areas, including the Bungonia NP/SCA site, being the prime candidate sites for breeding activity.	Unlikely
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The area to be removed is a patch supporting 27.1 of Koala habitat for the population and the species. Its removal may have a minor impact on patterns of Koala movement and no isolation between populations would occur from the Project.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
Invasive species such as foxes that may impact on the Koala are already established within the Project area. The Project is unlikely to further encourage these threats from occurring.	Unlikely
introduce disease that may cause the species to decline, or	
The main diseases affecting Koalas are chlamydial infections. The Project would not increase exposure to such infections as Koalas from the local population would not have increased contact with other Koala populations including infected populations.	Unlikely
interfere substantially with the recovery of the species.	
The following aspects are considered in relation to the possibility of the Project to interfere with the recovery of the Koala (from DOE 2014): *Increasing koala fatalities in habitat critical to the survival of the koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities.* There is no reason to suspect that dogs would become more prevalent within the Project area or surrounds as a result of the Project;	Unlikely

Increasing koala fatalities in habitat critical to the survival of the koala due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities. There have been no reported Koala fatalities due to vehicle strike within the mine site or along access roads. Additional vehicle movements are expected to occur as a result of the Project but would be negligible, with the Project mostly ensuring the continuation of the current regime of vehicle movements within the Project area. There are strict speed controls on the vehicles operating within the mine (20 and 40 km/hr) and given the very low number of Koala sightings from this area and the absence of recorded fatalities it is considered that the risk of increased fatalities such that multiple ongoing fatalities occur is very low; *Facilitating the introduction or spread of disease or pathogens for example Chlamydia or Phytophthora cinnamomi, to habitat critical to the survival of the koala, that are likely to significantly reduce the reproductive output of koalas or reduce the carrying capacity of the habitat*; This is considered unlikely as there would be no new sources of contamination as a result of the Project. The Project would not lead to Koalas being transported to the site from other areas. If vehicles coming to and from the mine are considered to be a potential agent of *Phytophthora cinnamomi,* the Project would not lead to a change in the source areas where vehicles travel from to arrive at the mine and therefore it is not considered that the Project increases the risk of *Phytophthora cinnamomi* spread; *Creating a barrier to movement to, between or within habitat critical to the survival of the koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala.* The proposed disturbance footprint is an extremely small proportion of Koala habitat for the population and the species. Its removal would have a minor impact on patterns of Koala movement and no isolation between populations would occur from the Project; and *Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term.* The Project would strive to maintain, pre-development drainage regimes and water quality in areas outside the disturbance footprint. The Project is therefore unlikely to alter the hydrology to the extent that it would result in the degradation of remaining habitat critical to the survival of the Koala.	
Conclusion: Impacts from the Project largely relate to the removal of habitat that has been defined as being critical to the survival of the Koala. Such habitat is recognised as critical habitat due to past impacts on similar habitat limiting the Koalas ability to persist throughout its former distribution. The Project includes the removal of 27.1 hectares of critical habitat, which through application of the guidelines is considered a significant impact. Due to the apparent limited use of the study area and its extremely small extent in relation to other habitat where Koala records occur, it is not considered that removal of this habitat alone would significantly adversely impact the relevant Koala population (centred around the Shoalhaven gorge) such that a decline would occur, as active sites for this population are concentrated within protected areas and the Project area is not thought to provide a link between active areas within the population's distribution or to any other Koala population.	

Large-eared Pied Bat (Vulnerable)	
Preamble The Large-eared Pied Bat has been recorded from a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. The species can also be found on the edges of rainforests and in wet sclerophyll forests. The Large-eared Pied Bat roosts in caves and mines in groups of between 3 and 37 individuals. During field survey the Large-eared Pied Bat was recorded in one location within the middle of the disturbance area by using an anabat recording device.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding habitat for the Large-eared Pied Bat would result from the Project as preferred breeding habitat comprises caves and mine shafts, neither of which will be impacted. Impacts from the Project constitute impacts to foraging habitat of which approximately 27.1 hectares would be cleared. The foraging habitat is considered to be of moderate to good quality for the species, being a mix of moderate condition woodland. Most of the foraging habitat to be removed occurs on fertile soils that are connected indirectly to likely breeding areas within Bungonia Gorge via vegetated links. Foraging habitat on fertile soils has previously been recognised as being important for the species (e.g. Pennay 2008), but the species has also been recorded foraging within a wide range of habitats including dry and wet sclerophyll forest; Cyprus Pine (*Callitris glauca*) dominated forest; tall open eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country (DOE 2015). Within the locality of the project area some 19, 032 hectares of tableland vegetation communities is mapped (Tozer et al 2006) including 4,888 hectares of grassy woodland communities. In addition, extensive areas of non-tableland vegetation communities occur within the reserve system of Bungonia National Park, Bungonia State Conservation Area and Morton National Park hectares within the project locality. Given the occurrence of the Large-eared Pied Bat in the centre of the study area and the quality of the surrounding woodlands in the study area and adjacent lands, it is assumed that the species forages over a wide range of habitats within the Project area and wider locality. It is noted however that survey concentrated on identification of presence/absence of target species rather than attempts to investigate habitat preferences within the Project area and data capture was not sufficient to confidently explain patterns of distribution. Despite the loss of some foraging land due to the clearing proposed here, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
The Project would not impact the area of occupancy of the Large-eared Pied Bat for the following reasons: The areas to be cleared are not sufficient in extent to impact the area of occupancy of the Large-eared Pied Bat at a 2km grid square scale (which is the	Unlikely

standard unit for measuring area of occupancy according to the IUCN); and Large-eared Pied Bats would still be expected to forage within the vicinity of the Project area given that the species was recorded at all sites including close to mining activities.	
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation of any population of the species. The Large-eared Pied Bat is a mobile species and the Project would not impact on areas where the species is known to breed and roost.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species has not been listed within guidelines or a recovery plan for the species. Such habitat is considered to include breeding caves and roost habitat. Such habitat would not be impacted from the Project. Foraging habitat of the type to be removed by the Project has been considered important for the species, however such habitat is considered to be well represented locally, and the habitat to be removed is not considered critical to the species survival.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding events for this species primarily take place within caves or other suitable roost habitats, none of which are expected to be adversely impacted by the Project.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Biodiversity Management Plan. Potential invasive predators such as the fox are already present within the Project area and the Project is not expected to increase the level of predation threat for the Large-eared Pied Bat.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project is not expected to cause an increased risk of any bat diseases.	Unlikely
interfere substantially with the recovery of the species.	
The list of recovery actions for this species on its DOE profile page (DOE 2015) includes: "Management of the species should focus on the protection and enhancement of higher fertility soils". Whilst some areas with higher fertility soils will be cleared, such areas are not in close proximity to breeding or maternity caves and constitute a very small proportion of similar habitat in the locality. As such, the Project is unlikely to interfere with the recovery of this	Unlikely

species. Cleared areas will be rehabilitated and topsoil retained.	
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Large-eared Pied Bat within the proposed disturbance areas. Whilst foraging habitat on fertile soils (or within fertile valleys) is considered an important overall requirement for this species, impacts from the Project are not considered to be significant for the following reasons: The habitat to be removed is not in close proximity to maternity caves; Similar habitat is common throughout the area; and Rehabilitation of areas to be cleared will occur with retention of topsoil, a feature of the rehabilitation.	

Grey-headed Flying-fox (Vulnerable)	
Preamble This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km. Recorded from Bungonia Gorge during field survey and expected to occur throughout area.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding or roosting habitat for the Grey-headed Flying-fox would result from the Project as breeding/roosting camps will not be impacted and do not occur in the study area. Impacts from the Project constitute impacts to foraging habitat of which approximately 27.1 hectares would be cleared. The foraging habitat is considered to be of moderate quality for the species, being a mix of degraded and moderate-good condition woodland. There are a variety of different Eucalyptus species present within proposed disturbance areas, some of which may contribute to winter and spring food availability. The significance of this contribution is not expected to be high as the expanse of similar foraging habitat within the locality is high. Over time, foraging habitat would be at least partially restored through rehabilitation works and retention of the topsoil would occur as part of rehabilitation works, aiding in maintaining fertility of habitats. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of a important population;	
The Project would not impact the area of occupancy of the Grey-headed Flying-fox for the following reasons: The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and Grey-headed Flying-fox would still be expected to forage within the vicinity of the Project area given that it was recorded at all sites including close to mining activities.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Grey-headed Flying-fox is a mobile species and the Project would not impact on areas where the species is known to breed and roost.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species has been loosely nominated within the National Recovery Plan for this species (DECC 2009) guidelines or a	Unlikely

recovery plan for the species, however "productive" areas are acknowledged as potentially being foraging habitat critical to the survival of the species. However no measure of productivity is given. There are no recognised 'prolific flowering or fruiting trees within the proposed disturbance areas. In addition, whilst the timing of productivity is considered to be important in determining whether habitat is critical to the survival of the species, the timing given as being important covers the entirety of the year (see DECC 2009). Foraging habitat of the type to be removed by the Project is considered important for the species, due to its capacity to add in some measure to locally available winter foraging resources. However, given that similar habitat is locally common, is well represented within adjacent conservation reserves, and that winter flowering pulses are not considered to be particularly high within the habitat to be cleared, the habitat to be removed is not considered critical to the species survival.	
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding events for this species primarily take place within camps, none of which would be adversely impacted by the Project.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Biodiversity Management Plan. Potential invasive predators such as the fox are already present within the Project area and the Project is not expected to increase the level of predation threat for the Grey-headed Flying-fox.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any bat diseases.	Unlikely
interfere substantially with the recovery of the species.	
The Project does not directly or substantially interfere with any of the specific recovery objectives under the National Recovery Plan (DECC 2009). A general objective is to lessen the currently operating threats to the species which includes the removal of foraging habitat. The Project is therefore not consistent with this general objective. However the level and type of foraging habitat removal is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Grey-headed Flying-fox within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons:	

The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size;
Similarly important foraging habitat occurs throughout the locality including within protected areas; and
Rehabilitation of areas to be cleared will occur which should mitigate the loss of foraging habitat to some extent.

Migratory Species (*Apus pacificus* (Fork-tailed Swift), *Merops ornatus* (Rainbow Bee-eater), *Monarcha melanopsis* (Black-faced Monarch), *Rhipidura rufifrons* (Rufous Fantail)	
Preamble: The above species all have potential habitat within the study area that would be impacted from the proposed action. All of the species subject to this assessment are considered to occur within the Project area on an irregular basis and the habitat within the Project area is similar to widespread and common habitat within the locality for these species.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species, or	
No important habitat for any of the potentially occurring migratory species is considered to occur within the Project area.	Unlikely
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	
No invasive species of particular significance to the identified migratory species are expected to be established as a result of the proposed action. The Project area is already affected by invasive plants including some noxious weeds and introduced fauna such as the Fox which have some potential to adversely impact most fauna occurring within the Project area and surrounds. New invasive species are unlikely to become established due to the proposed action.	Unlikely
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	
None of the potentially occurring migratory species would have a significant proportion of their population occurring within the Project area.	Unlikely
Conclusion: The Project would remove 27.1 hectares of native vegetation. None of the above species occur in significant numbers within the Project area and the Project area does not support significant breeding habitat such that it may be used by a significant number of individuals to conduct any aspect of their lifecycle including foraging, breeding, overwintering or sheltering.	

Appendix 9. Biodiversity Management Plan contents

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Boral Quarries

Peppertree Quarry
Biodiversity and Rehabilitation Management Plan

February 2017



Document Name	Peppertree Quarry: Biodiversity and Rehabilitation Management Plan
Document Filename	20170228 PtreeBRMP
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Rev No.	Date	Prepared By	Approved By	Comments
1	20th January 2011	ERM	Rod Wallace (Boral)	Landscape Rehab plan prepared as part of project approval 2007
2		Sharon Makin (Boral)	Angus Shedden (Boral)	Revision based upon Modification 3 requirements. No changes required
3	24th February 2017	Sharon Makin (Boral), Luke Baker and Craig Bagnall (Niche)	Sharon Makin (Boral)	Draft Biodiversity and Rehabilitation MP based upon Modification 4 requirements
4	28th February 2017	Sharon Makin (Boral), Luke Baker and Crag Bagnall (Niche)	Angus Shedden (Boral)	Final MP based upon Modification 4 requirements

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APPENDIX E

Aboriginal Cultural Heritage Assessment Report

Aboriginal and historic heritage impact assessment

Peppertree Quarry Modification 5

Prepared for Boral Resources (NSW) Pty Ltd | 30 August 2018



Aboriginal and historic heritage impact assessment

Peppertree Quarry Modification 5

Prepared for Boral Resources (NSW) Pty Ltd | 30 August 2018

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Aboriginal and historic heritage impact assessment

Final

Report J17374RP1 | Prepared for Boral Resources (NSW) Pty Ltd | 30 August 2018

Prepared by	**Ryan Desic**	Approved by	**Pamela Kottaras**
Position	Senior archaeologist	Position	Heritage Services Manager
Signature		Signature	
Date	30 August 2018	Date	30 August 2018

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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Document Control

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Executive Summary

ES1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry located in Marulan South, New South Wales.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to provide for the following (hereafter referred to as the proposed modification):

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

EMM Consulting Pty Limited Pty Limited (EMM) was engaged by Boral to prepare an Aboriginal cultural heritage assessment (ACHA) and historical heritage impact assessment for the proposed modification.

This assessment of the proposed modification was made on the basis that the study area is on land that has previously been investigated for its Aboriginal cultural and historical heritage values. The land on which the Western Overburden Emplacement is proposed has previously been assessed for Aboriginal cultural heritage values as part of the environmental assessment for the Quarry (ERM 2006). This also applies to the proposed modification haul route. The proposed Western Overburden Emplacement and the Haul route are on a previously proposed disturbance footprint layout that was approved under Modification 2 for the Quarry.

The remainder of the study area (South-western Overburden Emplacement (SWOE) and associated infrastructure) has previously been assessed by EMM as part the Marulan South Limestone Mine Continued Operations Project State Significant Development Application (SSD) (Limestone Mine SSD) (EMM 2018 in draft). It is proposed to incorporate the SWOE into the Quarry's consent boundary as the Quarry will require access to the emplacement area prior to the time it would have potentially been approved under the Limestone Mine SSD.EMM have prepared this standalone ACHA and historical heritage assessment for the proposed modification focusing on the study area and using existing results from the Limestone Mine SSD assessments where relevant.

ES2 Aboriginal heritage

In 2015, EMM conducted an archaeological survey and test excavation in the study area as part of a wider survey and test excavation for the Limestone Mine SSD ACHA. The archaeological survey identified two artefact scatters (MSL 017 and MSL 018) and one isolated find (MSL 019) in the study area.

The subsequent test excavation included five 3 m x 1 m test pits, a total of 15 m^2. Three test pits contained no artefacts whereas test pit (TP) 35 contained 40 artefacts (subsequently labelled site MSL 055) and TP36 contained only eight artefacts (subsequently labelled site MSL 056). EMM developed an archaeological sensitivity model as a guide to indicate subsurface archaeological potential. The study area was assessed to have low archaeological sensitivity apart from an area of moderate sensitivity surrounding site MSL 055.

Four out of the five sites in the study area were assessed to be of low archaeological significance. MSL 055 was assessed to be of moderate archaeological significance.

All five sites and the area of moderate archaeological sensitivity surrounding one site (MSL 055) will be impacted by the proposed modification. The surface artefacts from MSL 017, MSL 018 and MSL 019 will be collected prior to impacts. MSL 055 will be subject to salvage excavation and no further management will apply to MSL 056 as it is a subsurface site of low significance and does not warrant further investigation.

The proposed management measures will be incorporated into a version of the existing Peppertree Quarry Aboriginal Heritage Management Plan (current version – April 2017). The management measures will be implemented under the direction of Boral, the AMC and suitably qualified archaeologists.

ES3 Historical heritage

In 2015, EMM completed an historical heritage impact assessment for the Limestone Mine SSD Project. The assessment covered the current study area and the much broader Limestone Mine SSD Project site. The assessment involved primary and secondary research along with a targeted historical heritage survey. Furthermore, the archaeological survey for the Limestone Mine SSD ACHA also aimed to record historical items if identified during fieldwork.

During the survey, a number of heritage items were identified, primarily items associated with the mining history of the area, such as lime kilns, aerial ropeway towers, rail tracks and cottages. However, no items of historic heritage significance were identified within the Modification 5 study area.

No historic heritage evidence was uncovered during the research phase or field survey in the study area and as such no further significance assessment was required. No areas of historic views or community heritage value have been identified.

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1 Introduction

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry located in Marulan South, New South Wales.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Approval. The Minister for Planning is the consent authority for the proposed modification.

EMM Consulting Pty Limited (EMM) was engaged by Boral to prepare an Aboriginal cultural heritage assessment (ACHA) and historical heritage impact assessment for the proposed modification. The ACHA documents methods and results, and the initiatives built into the project design to avoid and minimise impacts to Aboriginal cultural heritage values. Additionally, it proposes mitigation and management measures to address residual impacts for sites that are unable to be avoided.

1.2 Existing environment and Quarry Operations

1.2.1 Site description

The Quarry is at Marulan South in the Goulburn Mulwaree Local Government Area (LGA) and is approximately 175 km south-west of Sydney (Figure 1.1). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Limestone Mine) with the Hume Highway approximately 9 km to the north-west. Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6 km to the north.

The Quarry is on approximately 650 ha of Boral owned land, which includes the Quarry (occupying approximately 70 ha), additional granodiorite resources to the south and surrounding land. The site is zoned RU1 –- Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009. Mining and extractive industries are permissible in this zone with consent.

1.2.2 Approved project

The current operations of the Quarry are approved under Project Approval PA06_0074 as modified.

1.2.3 Quarry activities and infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities.

Work to establish the quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E.

1.3 Proposed modification

The proposed modification is shown in Figure 1.2. The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and will take approximately 4 years to establish. The emplacement will cover approximately 44 ha and will be RL650 at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

The powerline, which supplies electricity to the Limestone Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Limestone Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 20 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine, and will be a component of the Limestone Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the project.

The only ground disturbance associated with the modification will be for the SWOE, powerline relocation and new haul road (see Figure 1.3).

1.4 Legislative framework

The Project Approval for the Quarry was granted under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Boral wishes to modify the Project Approval under Section 75W of the EP&A Act. Secretary's environmental assessment requirements have not been issued for this modification, however, the Department of Planning and Environment (DPE) has accepted the proposed Aboriginal and historic heritage assessment methods outlined in the following sections.

1.5 Study area

The study area for this assessment comprises the disturbance footprint of the proposed modification (Figure 1.2). This includes the SWOE, haul route, dam and relocated powerline.

The study area also includes the land on which modification to the WOE is proposed. This area has previously assessed for Aboriginal cultural heritage values as part of the environmental assessment for the Quarry (ERM 2006).

This also applies to the proposed modification haul route. The proposed WOE and the haul route are both on a previously proposed disturbance footprint layout that was approved under Modification 2.

The remainder of the study area (South-western Overburden Emplacement (SWOE) and associated infrastructure) has previously been assessed by EMM as part the Marulan South Limestone Mine Continued Operations Project State Significant Development Application (SSD) (Limestone Mine SSD) (EMM 2018 in draft). It is proposed to incorporate the SWOE into the Quarry's consent boundary as the Quarry will require access to the emplacement area prior to the time it would have potentially been approved under the Limestone Mine SSD.EMM have prepared this standalone ACHA and historical heritage assessment for the proposed modification focusing on the study area and using existing results from the Limestone Mine SSD assessments where relevant.

1.6 Objectives of this assessment

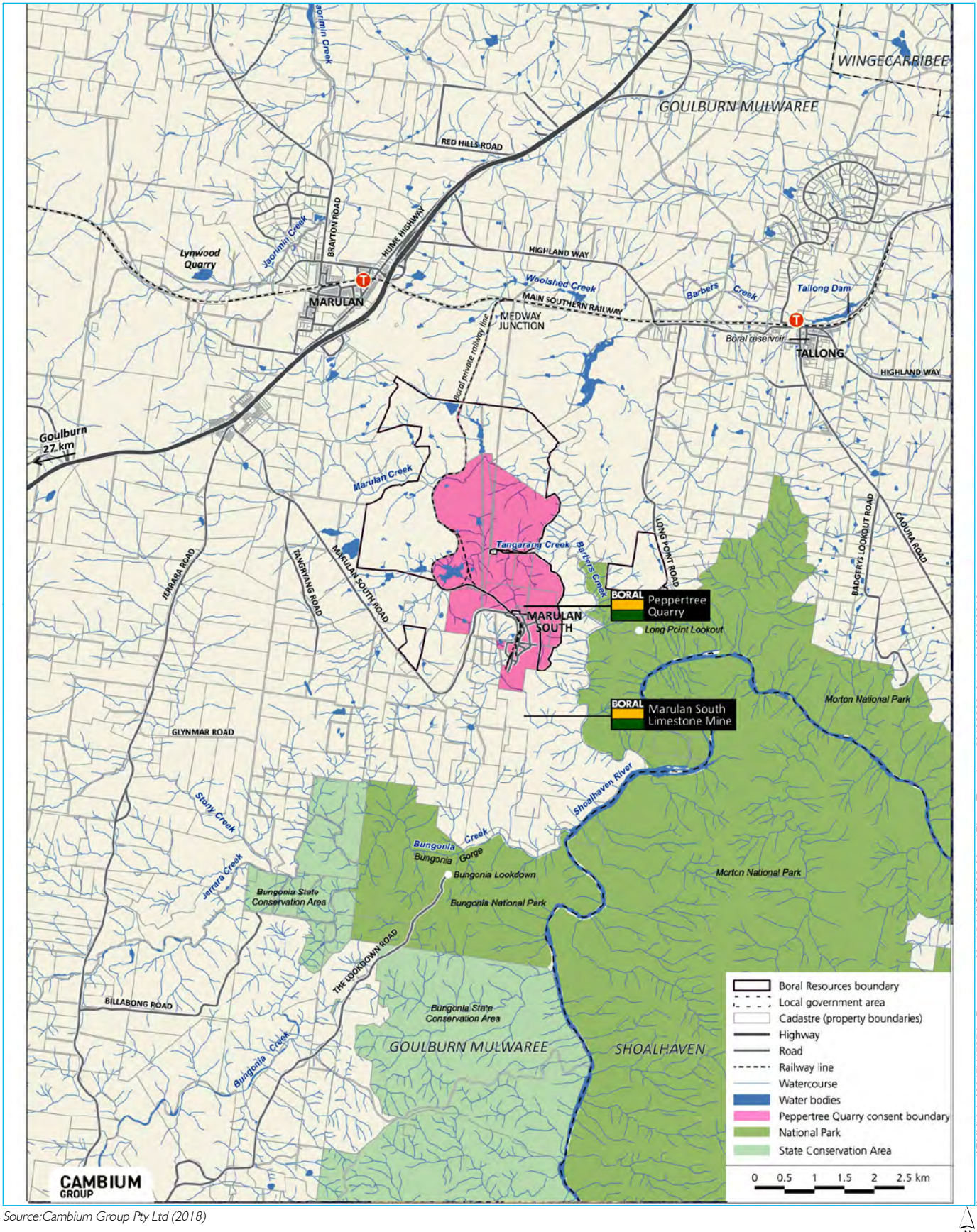
This assessment was made on the basis that the proposed modification is on land that has previously been investigated for its Aboriginal cultural and historical heritage values. Furthermore, the type of impacts from the proposed modification is consistent with those previously assessed for Modification 2 and the Limestone Mine SSD.

This report acknowledges that during the time of this assessment, the results of the Limestone Mine SSD ACHA and historical assessment are yet to be submitted to DPE. Therefore, EMM has prepared a standalone report focusing on the study area using the relevant existing information.

The objectives of this assessment are to:

- identify areas previously assessed and approved under existing Quarry approvals;

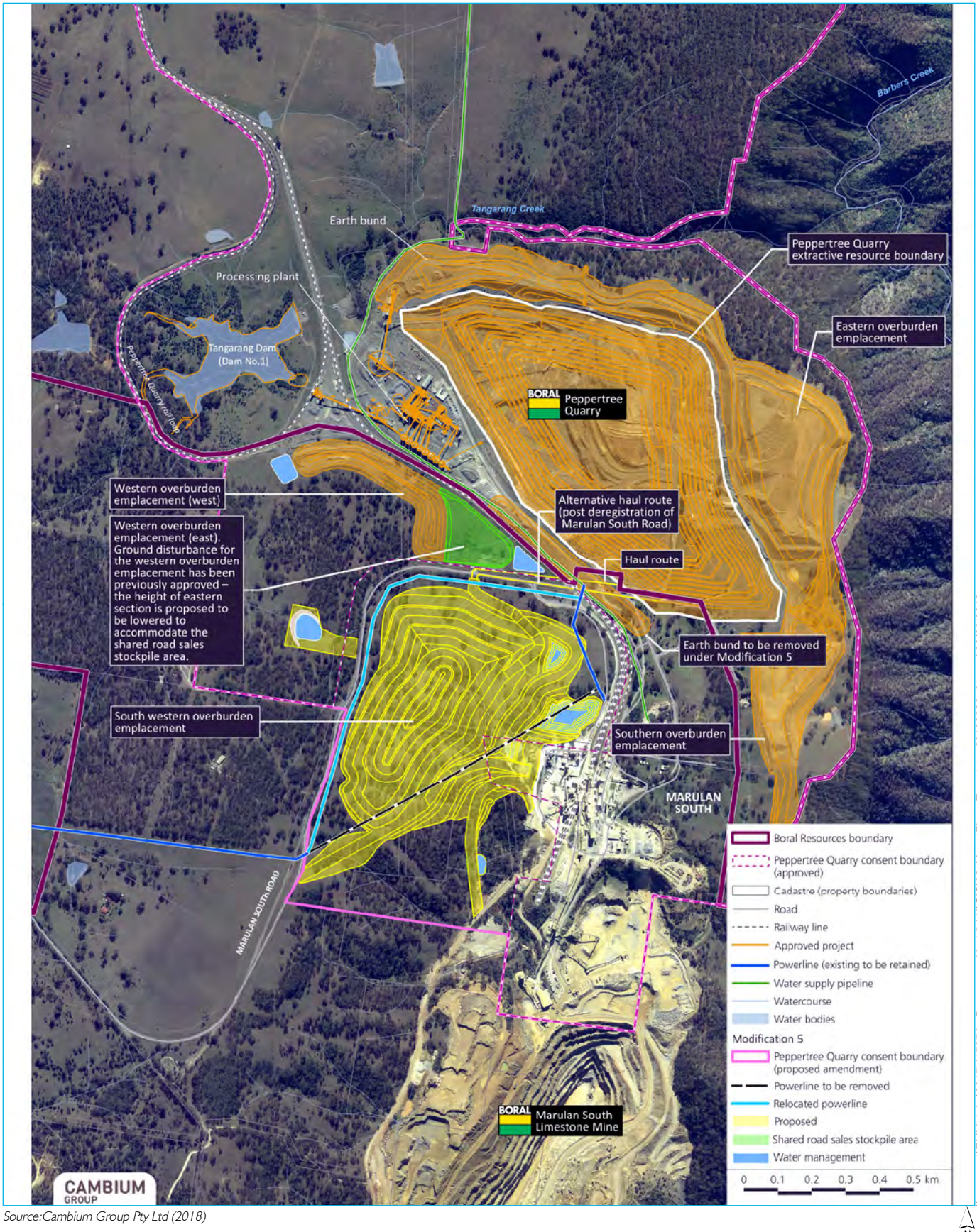
- identify Aboriginal heritage values relevant to the study area through analysis of previous assessments including the Limestone Mine SSD ACHA (EMM 2018 in draft);
- assess the significance of Aboriginal objects and sites identified during the EMM 2015 field investigations and through Aboriginal community consultation completed as part of the Limestone Mine SSD ACHA;
- assess the significance of historic heritage items and places;
- assess the impact of the proposed modification on the identified Aboriginal and historic heritage items; and
- identify appropriate management measures for Aboriginal and historic heritage that may be impacted by the modification in consultation with the Aboriginal community.



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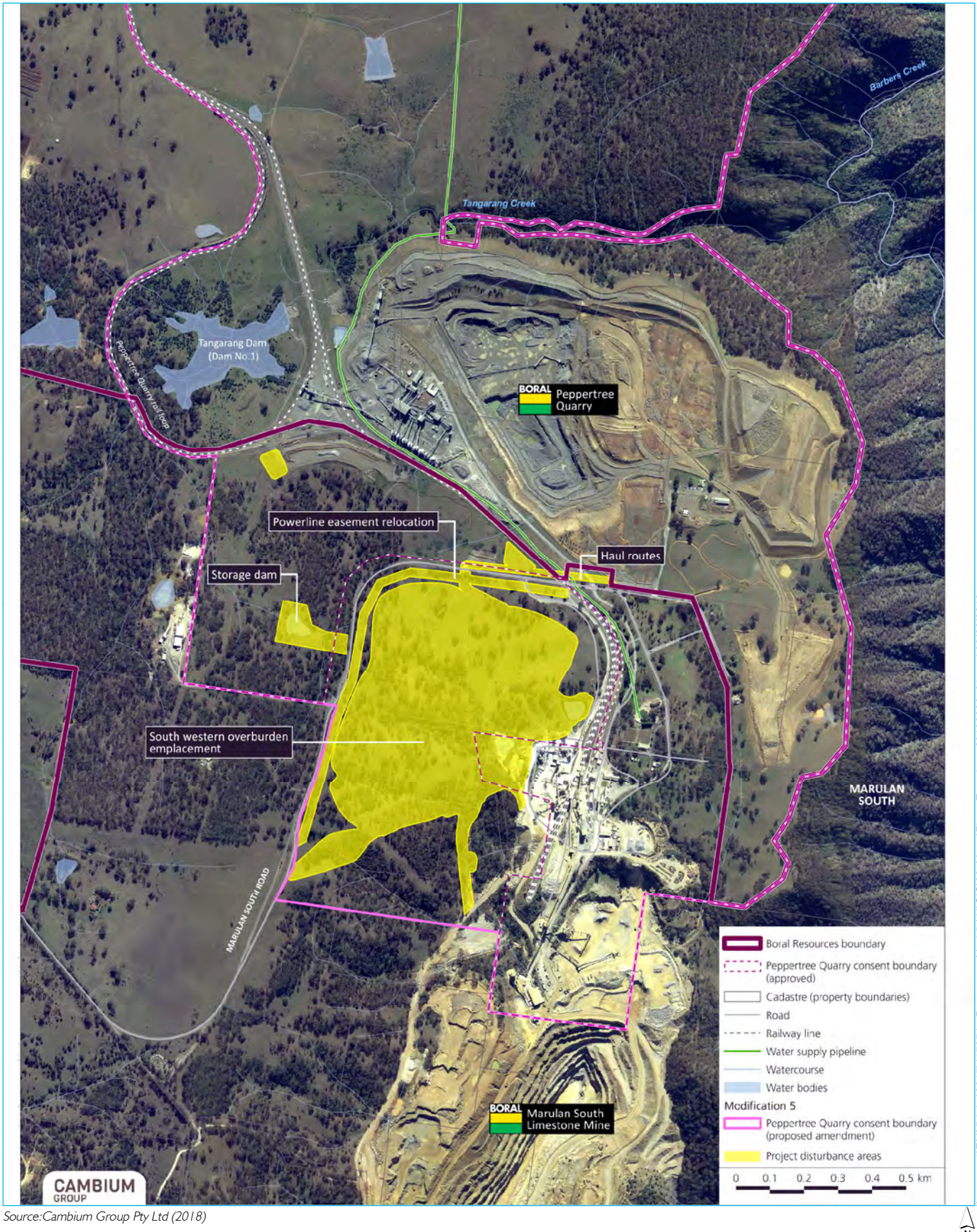
Source:Cambium Group Pty Ltd (2018)

Regional context



Source:Cambium Group Pty Ltd (2018)

The project and study area



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Source:Cambium Group Pty Ltd (2018)

Proposed modification elements

1.7 Aboriginal cultural and archaeological heritage assessment method

1.7.1 Guidelines

The Aboriginal cultural heritage assessment was guided by the following:

- *Draft guidelines for Aboriginal cultural heritage impact assessment and community consultation* (DEC 2005) the guideline required for Part 3A matters;
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010) completed for the Limestone Mine ACHA;
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (DECCW 2011); and
- *Code of practice for archaeological investigation of Aboriginal objects in NSW* (the Code) (DECCW 2010).

1.7.2 Method

Aboriginal cultural heritage values were identified using the following methods:

- consultation with members of the Quarry's Aboriginal Management Committee (AMC) in accordance with the existing Quarry Aboriginal Heritage Management Plan (AHMP) to identify cultural and social values of the study area and places of special significance that should be considered;
- consultation with registered Aboriginal parties (RAPs) for the Limestone Mine SSD initiated in February 2014 in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010) to identify cultural and social values of the study area and places of special significance that should be considered. Note that the AMC organisations are also Limestone Mine SSD RAPs;
- a search of the Aboriginal Heritage Information Management System (AHIMS - Aboriginal sites register) for records of previously registered Aboriginal sites;
- a review of Aboriginal heritage reports covering the study area and the region;
- analysis of landscape features to develop a predictive model for Aboriginal archaeological sites;
- an archaeological survey of the study area and its surrounds with RAPs for the Limestone Mine SSD (completed as part of the Limestone Mine SSD archaeological investigation); and
- an archaeological test excavation in the study area and its surrounds with RAPs for the Limestone Mine SSD (completed as part of the Limestone Mine SSD archaeological investigation).

The significance assessment, impact assessment and management measures for the proposed modification have been guided by the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (DECCW 2011).

1.8 Historic heritage assessment method

1.8.1 Guidelines

This assessment is conducted using the principles of *The Australian International Council on Monuments and Sites, Charter for Places of Cultural Significance* (also known as the *Burra Charter,* Australian ICOMOS 2013) and the New South Wales (NSW) *Heritage Manual* (Heritage Office 2006). OEH provides other best practice guides which have informed this report comprising:

- *Statements of Heritage Impact Guidelines* (Heritage Office 2006);
- *Investigating Heritage Significance* (Heritage Office 2004); and
- *Assessing Significance for Historical Archaeological Sites and 'Relics'* (Heritage Branch Department of Planning 2009).

1.8.2 Heritage listings

The following registers were searched:

Statutory

- The National Heritage Register (NHL) made under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- The Commonwealth Heritage Register (CHL) made under the (EPBC Act).
- The State Heritage Register (SHR) made under Part 3A of the NSW *Heritage Act 1977* (Heritage Act). Items on the SHR undergo a rigorous assessment process and must reach a high significance threshold to be included. Inclusion on the SHR is directed by the Minister of the agency that administers the Heritage Act.
- The Heritage and Conservation Register (s170 register) made under Section 170 of the Heritage Act. It is a register of heritage items that are owned or managed by state government authorities. Items on the s170 register may also be listed on other registers.
- Schedule 5 of the Goulburn Mulwaree Local Environmental Plan 2009 (LEP) Division 4 of the EP&A Act includes provision for the making of LEPs by the Minister. LEPs are prepared to a standard template, which includes environmental heritage in Schedule 5 (heritage schedule). Where an item is included in the heritage schedule, development applications must include an assessment of impacts to the item. Where a project is being assessed as an SSD, approval by the relevant council does not form part of the overall approval; however, the items require assessment and management if they are affected by the proposal.
- The State Heritage Inventory (SHI), which is a list of statutory registers except the SHR, was cross-checked with the Schedule 5 and the s170 register.

Non-statutory

- National Trust of Australia, NSW (NT); and
- Register of the National Estate (RNE).

Archaeological sites are protected by Section 139 of the Heritage Act if they are assessed to be relics, that is, of local or State significance. A formal listing is not required to ensure that protection. An approval under Part 4, or an excavation permit under section 139, of the Heritage Act 1977 is not required for Part 3A approvals in accordance with Section 75U of the EP&A Act (repealed). As such, the approvals to impact relics are typically managed through heritage management plans endorsed by DPE in consultation with OEH.

1.8.3 Methods

Desktop primary and secondary sources were reviewed to understand the history of the study area.

i Research

Primary research comprised:

- newspaper articles;
- photographs;
- land titles information; and
- maps, plans and sketches.

Secondary sources comprised:

- consultant reports; and
- histories of the local area.

The following facilities were visited to obtain primary and secondary research material on the study area:

- Berrima District Historical & Family History Society Inc;
- Sydney University Library;
- National Library of Australia *Trove* Online;
- State Library (Mitchell Wing); and
- Wingecarribee Local Studies Library.

ii Field survey

A targeted historical heritage field survey was undertaken using the information gathered in the background research for the Limestone Mine SSD. Field survey focused on areas predicted to hold tangible evidence of the historical development of the Limestone Mine SSD Project site.

Field survey was conducted on foot. Items and places were recorded through digital photography, GPS coordinates and written descriptions.

1.9 Authorship

This report was prepared by EMM archaeologist Pamela Chauvel (BA) and EMM Senior Archaeologist Ryan Desic (BA hons Prehistoric and Historical Archaeology). It has used previous information prepared by Rebecca Newell (BA hons Prehistoric and Historical Archaeology) who conducted research and reporting for the Limestone Mine SSD ACHA and historical heritage assessment.

Quality assurance was undertaken by Pamela Kottaras (Heritage Services Manager EMM), Mark Roberts (Senior Environmental Consultant Element Environment), Neville Hattingh (Director Element Environment) and Rod Wallace (Boral Property Group).

2 Consultation

2.1 Prior consultation

2.1.1 Overview of consultation for the Quarry

The land on which the WOE and Haul route is proposed has been assessed in consultation with the Quarry AMC as part of the original Quarry environmental assessment and subsequent Modification 2 and Modification 4 (ERM 2006 and EMM 2016 respectively). Initial consultation during the environmental assessment was completed in accordance with the *Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation* (DEC 2005). Subsequent to Project Approval for the Quarry (Condition 32), an AHMP was prepared. The plan details management procedures for Aboriginal heritage associated with the Quarry and for consultation with the Aboriginal community. The AMC comprises the following organisations:

- Pejar Local Aboriginal Land Council;
- Buru Ngunawal Aboriginal Corporation; and
- Ngunawal Heritage Aboriginal Corporation.

2.1.2 Overview of consultation for the Limestone Mine SSD

The proposed modification area that shares its boundary with the Limestone Mine SSD (the proposed SWOE and a portion of the WOE) has been assessed in consultation with the RAPs for the Limestone Mine SSD. This process has been ongoing since February 2014 and followed the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010). A total of 19 Aboriginal groups registered their interest in the Limestone Mine SSD and are listed in Table 2.1. Note that the organisations for the Quarry AMC are also RAPs for the Limestone Mine SSD.

Table 2.1 List of RAPs for the Project

Organisation	Contact name
Pejar Local Aboriginal Land Council (also AMC)	Delise Freeman
Mr Peter Falk Consultancy	Peter Falk
Buru Ngunawal Aboriginal Corporation (also AMC)	Walter Bell
Gundungurra Aboriginal Heritage Association Inc	Sharyn Halls
King Brown Tribal Group	Carl Brown
Koomurri Ngunawal Aboriginal Corporation	Donna Dobson
Corroboree Aboriginal Corporation	Steve Johnson
Murri Bidgee Mullangari Aboriginal Corporation	Darleen Johnson
Nundagurri Aboriginal Corporation	Aaron Broad
Walbunja Aboriginal Corporation	Hike Tekowhai
Wullung	Leeroy Bota
Badu	Karia Bond
Yerramurra	Nicholas Glover
Merrigarn Aboriginal Corporation	Shaun Carroll
Gulgunya Ngunawal Heritage Aboriginal Consultancy	Glen Freeman

Table 2.1 List of RAPs for the Project

Organisation	Contact name
Duncan Falk Consultancy	Duncan Falk
Thunderstone Aboriginal Cultural and Land Management Services	Tyronne Bell
Ngunawal Heritage Aboriginal Corporation (also AMC)	Dean Delponte
Gunyuu	Darlene Hoskins-Mackenzie

Aboriginal consultation for the Limestone Mine SSD has included:

- a consultation meeting for the presentation of information and assessment methods (25 March 2015);
- distribution of the assessment methods for the excavation program (8 May 2015);
- a consultation meeting to discuss the initial draft ACHA for the Limestone Mine (10 December 2015);
- distribution of the initial draft ACHA for the Limestone Mine SSD (27 November 2015); and
- ongoing consultation informing RAPs that a second draft ACHA for the Limestone Mine SSD will be issued to RAPs to reflect changes to the proposed 30 year mine plan.

2.2 Consultation for the proposed modification

2.3 Approach

Consultation for the proposed modification has been undertaken with the AMC and Limestone Mine SSD RAPs as the Quarry consent boundary will overlap with the Limestone Mine consent boundary around the SWOE.

Representatives from EMM, Boral, Element and OEH attended a teleconference on 9 February 2018 to discuss the proposed assessment and Aboriginal consultation methods. OEH agreed in principle to the assessment and consultation methods used for this ACHA.

2.4 Introductory letter

An introductory letter was sent to AMC and RAPs for the Limestone Mine on 27 February 2018.. It provided details of the proposed modification and the proposed assessment and consultation methods. All groups were offered to provide feedback the letter.

One RAP raised concern about RAP involvement in the proposed management measures presented in the letter. The letter originally proposed that the AMC would be responsible for undertaking the proposed management measures for the modification. However, one RAP suggested that Limestone Mine SSD RAPs should also be involved in undertaking management measures. After further consideration, Boral decided that both the AMC and Limestone Mine SSD RAPs would be involved in undertaking the proposed management measures. EMM presented a letter to the AMC and Limestone Mine SSD RAPs reflecting these changes on 9 April 2018.

2.5 Cultural information

Efforts to undertake cultural mapping and further understand the significance of this area to the Aboriginal community have occurred during previous Aboriginal heritage assessments by ERM in 2006 and 2011 for the Quarry. The RAPs for the Limestone Mine SDD were consulted to gather cultural information during the ACHA process. One cultural site with culturally sensitive information was identified during this process but it is well outside the study area. To date, no information has been received that identified specific social or cultural heritage values unrelated to the Aboriginal sites within the study area.

2.6 Draft report review

A draft report was sent to AMC members and Limestone Mine RAPs on 7 June 2018 requesting comments or feedback about the ACHA. EMM initially provided a three week review period, but an additional week was allowed for any further comments to be made.

Only one group, Murra Bidgee Mullangari, responded to the draft ACHA stating that they endorsed the recommendations presented in the ACHA (refer Appendix A).

3 Environmental background

3.1 Landscape overview

The study area is located in the Southern Tablelands of NSW - a plateau surrounded by steep gorges and valleys. The local landscape is characterised by hills and the large undulating plateau that the town of Marulan South was situated on; this is contrasted by the steeply inclined rugged gorges associated with the Morton National Park, Bungonia National Park and the Bungonia State Conservation Area. This terrain would have acted as a barrier to pedestrian access routes to the south and east (Gojak 2006).

The northern portion of the study area (the WOE) is on an elevated undulating plain that acts as a plateau before sloping south of Marulan South Road. The SWOE portion of the study area represents a transition from undulating plains and rolling hills into steep hills with deeply incised drainage channels (Figure 3.1).

The northern extent of the SWOE primarily features hill slopes leading south, divided by drainage depressions. However, broad, level to gently inclined spurs occasionally occur in this area.

The remainder of the SWOE is characterised by a ridge line that forms at the western extent of the study area and has a series of prominent spur lines leading east down slope. These spur lines start off relatively flat but become increasingly steep in gradient as they slope east. The spur lines are separated by deeply incised drainage channels that form steep side slopes and gullies.

3.2 Drainage

The main watercourses near the Project site include the Shoalhaven River approximately 3 km to the south-east which runs in a north-easterly direction. Its main tributaries nearby the study area are Barbers Creek and Bungonia Creek.

There are first and second order streams (Strahler system of stream order) in the study area that converge into a third order stream at the base of the hilly terrain in the SWOE. Prior to mining, these watercourses would have drained to Barbers Creek to the east and Bungonia Creek to the south, but are now intercepted by the Limestone Mine pit.

3.3 Geology and soils

The study area is characterised by the Silurian-Devonian geology formation known as the Bungonia Limestone Group. The Bungonia Limestone Group includes interbedded fossiliferous shale, sandstone, limestone and siltstone.

To the north of the study area, the geology is characterised by Devonian granodiorite, known as the Glenrock Granodiorite intrusion. Stone material which would have been suitable for the production of stone tools includes quartz, feldspar and tuff and areas of these stone types are located in the north approximately 5 km from the study area. Cherts are known to outcrop along the Wollondilly River approximately 25 km from the study area. The survey identified outcrops of naturally occurring silcrete along Marulan Creek where the underlying geology is siliceous.

The study area generally has duplex soil profiles with a thin, poorly structured loamy sand topsoil A horizon and a clayey B horizon. It is usually weakly pedal with pH range of 4.5 – 10. Extensive land clearing has exposed the topsoils to high levels of erosion (AGEC, 2018). A detailed soil assessment has been completed for the Limestone Mine SSD (AGEC, 2018).

3.4 Flora and fauna

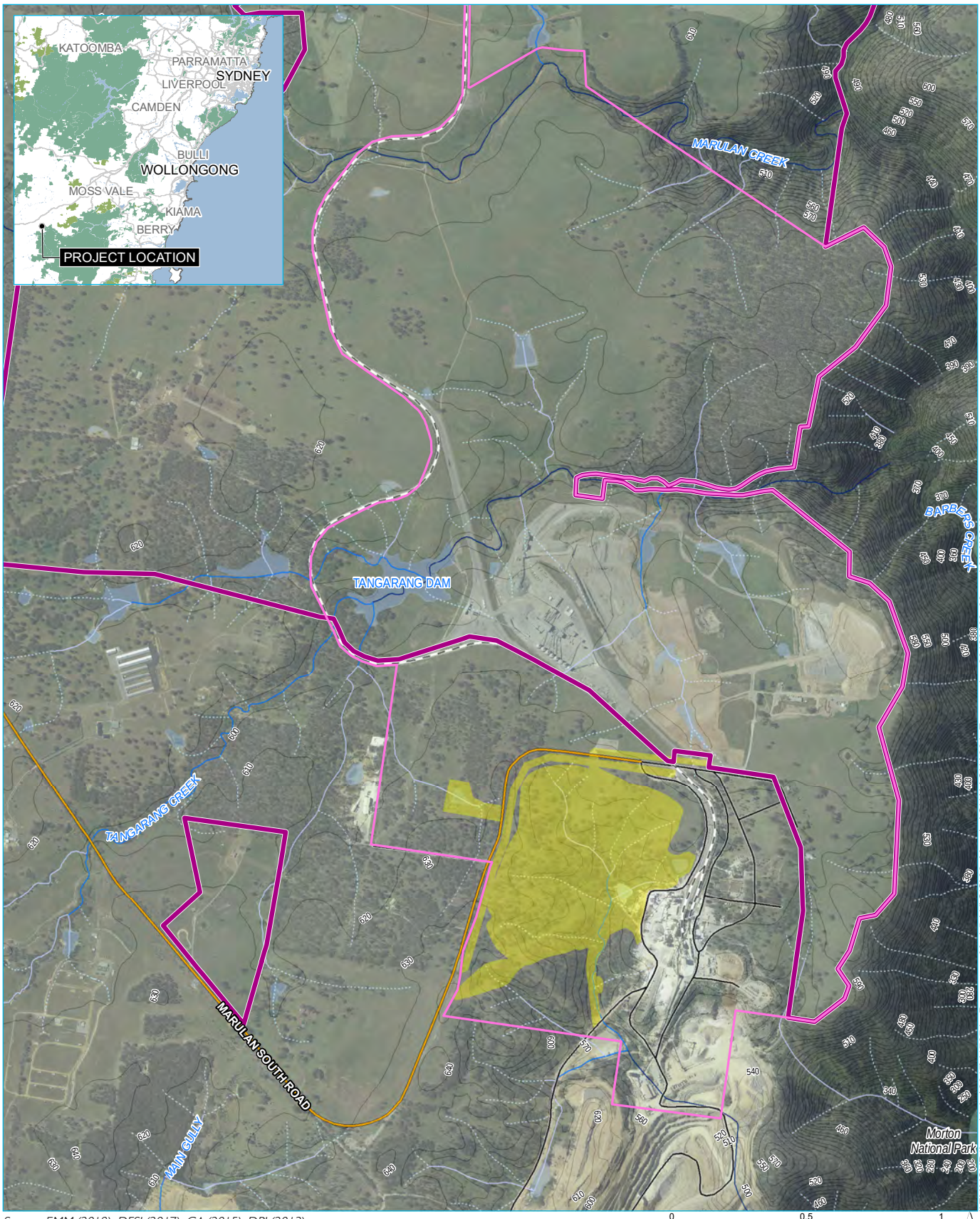
The majority of the Project site has been cleared for past agricultural land uses. Vegetation consists of open cultivated paddocks with scatters of eucalyptus trees or open woodland. The flora typical to the areas consists of grassy open eucalypt woodlands and pasture. Faunal resources in the study area include kangaroo, wallaby, wombat, reptiles and birds. In addition, the remains of turtles and crayfish have been observed during survey near local watercourses.

3.5 Land use and disturbance

Current land use in the study area is grazing and quarrying activities. The Quarry is north of the study area, an agricultural lime processing plant is located less than 1 km to the west of the study area, and the Limestone Mine is immediately south-east of the SWOE.

Prior to this mining, the area was characterised by agricultural and animal grazing which is still present in undeveloped portions of the study area and surrounding landscape. As such, clearing of the pre-settlement native vegetation has occurred across the study area.

Post deposition factors such as land clearing, cattle grazing and quarrying activities are likely to have cleared Aboriginal modified trees and disturbed stone artefacts. Disturbance would have resulted in the displacement of Aboriginal objects within the soil but would not fully diminish their archaeological and cultural value. Erosion also has the potential to more significantly displace Aboriginal objects through sheet wash and gully erosion, particularly on slopes and crests near watercourses.



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Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Rail line
- Main road
- Local road
- Contour (10 m)
- Waterbody
- NPWS reserve
- State forest
- Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order

Topography and drainage

Peppertree Modification 5

Aboriginal cultural heritage assessment

Figure 3.1

EMM

4 Aboriginal heritage background

4.1 Pre-European history

Information on the practices of Aboriginal people has been lost due to settlement and interactions with European settlers but certain generalisations can be made from early colonial records and subsequent research. Aboriginal people moved in small family groups (Smith 1992), which belonged to clans, all of which were united by language and cultural affinities with ties to specific territories.

The study area is located on the boundary of four Aboriginal groups comprising the Gandangara, Ngunawal, Wodi Wodi and Wandandian.

Generally Aboriginal people lived in family based groups of between 30 and 50 people of various ages with approximately four to eight pairs of husband and wives and their extended families. Most men were considered to have only one wife although Govett (1836) notes that the chiefs of each tribe were able to have two wives. Each group lived within a defined area and would have been mobile for at least part of the year, within their defined territory but would have also left to join other clans and groups for ceremonial/social event.

Covered shelters known as gunyahs were erected at campsites using bark and tree branches and may have been reused (Bluett 1927 p.11). Timber and bark were also used to make tools, implements and weapons adhered with resin. Local and imported stones including quartz and silcrete were used to make a variety of tools.

Aboriginal people subsisted on plant foods, aquatic life from the surrounding waterways and ate a variety of animal life such as possum, kangaroo, snakes and lizards. Migrating Bogong moths were the basis of the food supply during the summer months and were the basis for large tribal gatherings during these months (Matthews 2007).

Burial in the region appeared to occur in a number of ways. Individuals could be interred in the ground in a shallow grave covered by stone, rocks or cobbles. Positioning of the burial may have been associated with ownership of areas (ERM 2012). Other reports of burial included placing the corpse in a hollow tree or in a sitting position in the ground (Gillespie 1988 p.2).

As a result of its location at the centre of a number of different geographic areas, it has been hypothesised (ERM 2012 p.26) that the Marulan and Marulan South area may have been suitable for large or regular ceremonial and tribal meetings.

4.2 Previous Aboriginal archaeological investigations

4.2.1 Regional studies

Archaeological investigations have been undertaken around the study area over the last 30 years. The following section presents a representative summary of archaeological investigations completed in the Southern Highlands and Southern Tablelands region. The results of previous investigations in the region have guided the predictive model and subsequent fieldwork for the proposed modification.

i Koettig and Lance 1986, *An Aboriginal Resource Planning Study for the City of Goulburn*, report by ANUTECH to Goulburn City Council.

Lance and Koettig undertook a large scale investigation aimed at identifying land use patterns in the Marulan region as part of a regional study for the City of Goulburn. The results of the investigation identified that stone artefacts scatters were most commonly found within 50 to 100 m of water. They also hypothesised that the largest and most dense artefact scatters would be found at the junctions of creeks and rivers with site size and frequency decreasing with the increased distance from water.

ii Haglund 1986, *Archaeological Survey of Areas within Bungonia State Recreation Area likely to be Affected by Present and Future Recreational Activities and Associated Development*, report to Bungonia State Recreation Area Trust.

This report details an investigation of areas of potential archaeological sensitivity within the Bungonia National Park approximately 10 km south of the Project site. In total 15 sites were identified with artefacts consisting of flakes, cores and blades made of silcrete, quartz and indurated mudstone. From these sites Haglund hypothesises that artefact numbers and their distribution indicated that sites were repeatedly used by small groups. The sites were also described as containing large amounts of flaked debris and reject material.

iii Williams, 2004, *An archaeological survey of a proposed pyrotechnics facility Lots 11 and 12 DP 1056566, Marulan South, near Marulan NSW*.

Williams completed a survey and assessment of an 80 ha area approximately 3 km north-west of the Project site. In total eight archaeological sites were identified comprising six artefact scatters and two isolated finds. These sites were mostly found in areas of exposure near permanent drainage lines, ridge crests and simple slopes.

iv Australian Archaeological Survey Consultants 2007, Proposed *hard rock quarry Marulan NSW: Preliminary archaeological assessment,* for Readymix Holdings.

Australian Archaeological Survey Consultants completed a survey and assessment of a proposed quarry and haul road located approximately 13 km north of the Project site. The field survey identified five Aboriginal sites including one isolated find and four artefact scatters of less than ten artefacts. The sites were identified on landscapes consisting of gently undulating slopes near semi-permanent to permanent water courses or on hill crests above watercourses.

v Umwelt, *Lynwood Quarry Project, Marulan* (2005, 2007a, 2007b, 2007c, 2008a, 2008b, 2008c, 2008d, 2008e, 2009, 2012 draft).

The following summarises the investigations completed as part of the approvals for the Lynwood Quarry facility, located approximately 5 km north-west of the study area.

To date the investigations have included survey, test and salvage excavation and a detailed artefact analysis and excavation report is in production.

The survey area for the Lynwood Quarry project was approximately 5 km north-west of the Peppertree Quarry study area. The first stage of survey involved sampling transects over the different landscapes in the project area. The survey located 52 Aboriginal sites including 30 artefact scatters, 13 isolated finds, seven culturally modified trees and two stone arrangements. Several artefact scatters with more than 150 stone artefacts were recorded. Artefact material included silcrete, quartz and chert.

Umwelt also developed an identification system based on archaeological terrain units (ATUs). The ATUs take into account both the environmental and cultural context of the Lynwood Quarry project area and are used as part of the predictive model for surface and subsurface sites.

An additional survey was conducted for proposed transmission lines at the Lynwood Quarry area approximately 1 km south of the study area. The survey identified 15 sites, eight of which were within the boundary of their project area. The sites generally consisted of artefact scatters with no more than ten artefacts. The dominant raw material was silcrete and quartz.

The results of the survey and impact assessment were used to inform three stages of test and salvage excavation:

- Stage 1 included three separate stages of excavation. Stage 1a consisted of the excavation of 20 power pole locations. Over 300 artefacts were identified including flakes, flaked pieces and cores. The dominant raw material type was quartz followed by quartzite, silcrete and chert. Stage 1b involved five additional testing sites and 110 test pits, which yielded a total of 52 artefacts. Stage 1c involved artefact analysis.

- Stage 2 consisted of four phases of investigation. Stage 2a included subsurface testing of known sites and Stage 2b tested the remaining ATUs in the development impact area. Stage 2c involved monitoring of the historic heritage investigations at Old Marulan Town and Stage 2d consisted of reporting and updates to AHIPs to ensure works were able to proceed.

- Stage 3 consisted of two stages of investigation. Stage 3a involved further subsurface salvage of ATUs and potential archaeological deposits (PADs) and Stage 3b consisted of a final report incorporating the results of all stages (in production).

As a result of proposed modifications to the Lynwood Quarry facilities, an additional 10 ha approximately 5 km to the north of the original project area were surveyed and assessed . The assessment included survey and consultation with registered Aboriginal stakeholders. The survey did not identify any artefacts but three areas were identified as PADs. Additional impacts were also proposed in areas previously identified as containing Aboriginal sites and potential archaeological deposits. The recommendations for the project included retaining topsoil in the project areas and a variation to the existing AHIP #1100264 to allow additional construction elements. The variation to AHIP #1100264 included subsurface testing of areas of potential archaeological deposit.

The combined survey and excavation program at Lynwood Quarry identified 94 Aboriginal sites. Ten of these sites have been combined into one site (Joarimin Creek South). A total of 34 ATUs were identified with survey and testing identifying 29 with Aboriginal sites present. The preliminary analysis of the results of the survey and three stages of excavation have identified that:

- The largest numbers of known sites are within the Bindook Porphyry geological unit, on spur crest and gentle slope landforms.

- The entire area was used by Aboriginal people including for ceremonial purposes. All ATUs provided light background artefact scatter.
- Areas associated with ridge crests, saddles on ridge crests, saddles on spur crests and slopes of moderate gradient reflect transient use.
- Four areas have artefact numbers and densities which may reflect long term occupation including spur crests, parts of Joarimi Creek South and gentle slopes in association with a reliable water source.
- Silcrete and quartz were the dominant raw materials used and it was assessed that most of the stone used for tool manufacture was brought into the area.

Management of the identified sites included the creation of a cultural heritage management zone (CHMZ) to conserve 11 Aboriginal sites long term, with an additional 51 Aboriginal sites conserved in-situ outside the project area. A total of 32 sites will be subject to partial or total impact by the project.

vi AMBS 2012, *Goulburn Mulwaree LGA Aboriginal Heritage Study,* prepared for Goulburn Mulwaree Council.

AMBS undertook a comprehensive historical and ethnographic study of the region, which identified areas of Aboriginal sensitivity within the Goulburn Mulwaree LGA. The outcomes of the study are for proponent and Council consideration during developments in the LGA. This study identified the area around South Marulan as an area of Aboriginal heritage significance.

4.2.2 Previous investigations at Peppertree Quarry

i ERM 2006, *Marulan South Quarry Aboriginal Heritage Assessment*, prepared for Boral Resources (NSW) Pty Limited.

Environmental Resource Management (ERM) completed an Aboriginal heritage assessment as part of the environmental assessment of Peppertree Quarry (formerly Marulan South Quarry). The assessment identified 11 sites with high potential to contain subsurface deposits and moderate scientific significance within the proposed water storage dam, and eight sites of low cultural significance within the proposed quarry footprint. The area surrounding Tangarang Creek was identified as having a high density of open sites and salvage excavation was recommended. This was completed in 2010.

The assessment included an area, originally intended as the location for the plant but subsequently changed, which lies within the north-west corner of the WOE (Modification 2) and the proposed haulage route for Modification 5. No Aboriginal sites were identified in this area.

ii Modifications to Peppertree Quarry

In 2007, Boral received approval to extract and process material at the Quarry. Since then Boral has sought and received approval for four modifications.

A summary of the Aboriginal cultural heritage assessments that were undertaken for each of the modifications are outlined in Table 4.1. The areas of Modifications 1, 3 and 4 are outside the proposed modification study area.

Table 4.1 Modifications to Peppertree Quarry

Modification	Aboriginal assessment type	Modifications relevant to Aboriginal heritage	Result
1	Desktop (2006)	Modification 1 sought approval for an exploratory test pit within the approved Quarry footprint.	The assessment identified two Aboriginal heritage sites in the vicinity of the test pit; however, the sites are highly disturbed and are assessed as having low archaeological significance. Regardless the test pit did not impact these sites.
2	Desktop ERM (2011)	Modification 2 sought approval for: • an earthen embankment for new rail loop; • relocation of processing and rail-loading site; • former processing plant site to be used for overburden (which is now where part of Modification 5 is proposed); and • reduce size of dam 1.	No further archaeological investigation was completed as part of Modification 2. No Aboriginal sites or places were identified in the area when it was previously assessed by ERM as part of the original environmental assessment. The disturbance footprint for Modification 2 was approved but no construction eventuated. This area is now part of the proposed modification.
3	Survey EMM (2012)	Modification 3 sought approval for: • construction of a high voltage power line; and • a minor extension to the private rail line.	EMM undertook a pedestrian survey along the proposed HV route and rail extension. One Aboriginal site (10 m by 5 m) containing 6 stone artefacts was identified in an area disturbed by quarrying activities and trucks (PTQ1). An area of archaeological sensitivity was identified within a 200 m buffer, either side of Tangarang Creek. The proposed modification is outside the area of archaeological sensitivity and also will not impact PTQ1.
4	Survey EMM (2016)	Modification 4 sought approval for the development of a new overburden emplacement area.	EMM undertook a pedestrian survey of the Modification 4 disturbance footprint in areas not previously surveyed One Aboriginal site was identified, a culturally modified tree (MQ120). EMM recommended fencing and protecting the modified tree. The assessment predicted that the Modification 4 area may have subsurface artefacts but in low densities and likely representing low archaeological significance. As such, no further investigation was proposed.

iii ERM 2012, Peppertree Quarry Archaeological Excavation Report, prepared for Boral Resources (NSW) Pty Limited (draft only).

As part of the requirements of the project approval and the AHMP, ERM undertook a large scale test and salvage excavation prior to the commencement of quarry activities.

The test excavation followed that of Umwelt (2007- 2008) for the excavation of the Lynwood Quarry with landforms across the project area sampled along linear transects. A total of ten test transects covered six landforms within the Tangarang Creek Dam area and another three outside this area. Test pits were located at 5 m intervals along each transect. This resulted in the excavation of 103 test pits and a total of 2,089 artefacts recovered.

The areas determined for salvage excavation were based on the results of the test transects. Ten open area trenches were expanded and salvaged. These ten trenches were distributed across four hills.

A total of 122 m^2 of open excavation was undertaken with 20,956 artefacts excavated. During the open area excavation a number of high density artefact concentrations, hearths and ovens and a human burial were uncovered (ERM 2012, p. 51). The results of the salvage excavation identified seven domiciliary areas around high artefact concentrations, suggesting the varied and long term use of the area for habitation. Flakes dominate the assemblage, with backed artefacts, cores and retouched flakes also present. Seven types of raw material were present, dominated by silcrete, quartz, quartzite and chert. Chalcedony, basalt and granite artefacts are present in low numbers.

The occupation pattern from the excavations demonstrated that the preferred camping area was shallow hill slopes and hill tops associated with Tangarang Creek. Long term and frequent habitation by a large group is suggested by the relatively high technological diversity of artefacts, volume of artefacts and the presence of non-transportable items such as grinding stones. There was also evidence of a lack of initial manufacture stages across the quarry site, and suggests that initial reduction of material may have occurred in another area. Thus the tools in the project area are the result of later stages of tool manufacture and tool maintenance (Hiscock 2001). It was also considered possible that the area was used as a trading or ceremonial location considering the size and type of artefacts recovered and the location of the project area at the boundaries of four Aboriginal clan groups.

iv Peppertree Quarry Project, ongoing salvage measures (Boral and EMM)

Subsequent to the salvage excavation program led by ERM in 2011, additional salvage measures have been ongoing at Peppertree Quarry under an approved AHMP in consultation with the AMC. This has included construction topsoil monitoring and artefact collection from 2011 by the AMC. In 2013 EMM were engaged to provide advice on how to approach archaeological salvage excavation if high density artefact scatters were identified during topsoil monitoring of the quarry pit footprint; within a 50 m radius of an identified site or 100 m of the first and second order streams feeding north into Tangarang Creek. A method was developed that included placing 1 m^2 test pits in areas where 10 artefacts or more were exposed from topsoil stripping in a 50 cm^2 area. If the test pits recovered over 50 artefacts, then surrounding pits were excavated. This method continued in all directions in the surrounding pits until less than 50 artefacts were recovered.

This method has resulted in the recovery of extensive artefact assemblages. As of June 2016, over 90,000 artefacts had been salvaged, over 50,000 of which were recovered from salvage excavation squares. Analysis and reporting for these results are yet to be completed, but the results of salvage excavation have been mapped as part of the AHMP (Boral 2017). The preliminary results support previous excavations in that broad hill crests and spurs next to watercourses contain distinct artefact concentrations. Examples of these results are shown in Figures 4 to 11 of the AHMP (Boral 2017).

4.2.3 Previous investigations at Marulan South Limestone Mine

i ERM 2006, Marulan South Continuation of Operations: Aboriginal Cultural Heritage Assessment, report for Blue Circle Southern Cement.

ERM was commissioned by Blue Circle Southern Cement (BCSC) to complete an Aboriginal heritage assessment of an area to be impacted by continued mining operations. The three hectare area was located to the north-west of the existing mine. This area is located within the Project site.

The landform was considered to be a gently undulating limestone plateau. Three minor drainage lines were identified running east to west and feeding into the Bungonia Creek. The archaeological survey identified one Aboriginal site (BCSC 1). BCSC 1 was an artefact scatter located at the confluence of two drainage lines. The majority of the artefacts were uncovered within 20 m of the drainage lines.

ERM considered the Project site to have little archaeological potential due to severe disturbance from previous quarrying activities and bioturbation and the small amount of artefacts found in an area with large areas of good exposure and visibility. The recommendation for the site was a Section 90 (NWPS Act 1974) permit for surface salvage and that no further archaeological excavation was warranted.

ii RPS HSO 2008 Cultural Heritage S.90 Salvage, report prepared for Blue Circle Southern Cement

RPS Harper Somers O'Sullivan (RPS HSO) undertook the salvage of site BCSC 1 identified by ERM (2006) and described above. The salvage was undertaken due to the impact to the site which would occur through the continuation of mining.

A total of 91 artefacts were collected from BCSC 1 which was 53 more than identified in the original site investigation. It was noted as being in a highly disturbed area with visible impacts from both natural and human events. Alluvial disturbance was also indicated through the presence of flattened grass and debris. The majority of the collected artefacts were located within 50 m of drainage lines, with the exception of one artefact scatter which was located approximately 100 m from the drainage line. It was considered that no further contextual data could be attached to the collected assemblage. Site BCSC1 was considered to be of low archaeological significance and the majority of artefacts considered to be disturbed and displaced. No further investigation was undertaken.

iii RPS HSO, 2009, Cultural Heritage Assessment Marulan South Limestone Mine, report prepared for Blue Circle Southern Cement.

RPS HSO conducted an Aboriginal heritage assessment for a review of environmental factors to support the continued mine operations within CML 16. Marulan South Limestone Mine is located 1 km to the south of the study area. The assessment included a pedestrian survey during which a total of 16 Aboriginal sites, including 11 isolated finds and 5 artefact scatters, were recorded. The majority of these sites were located on lower slope landform units adjacent to water sources. Two artefacts were located outside the boundaries of impact areas so were not impacted by the project. An additional area on the western side of their study area was not surveyed because of the steepness of the terrain.

The primary recommendation was to protect the archaeological resource by redesigning the overburden emplacement areas. If redesign was not feasible, it was recommended that archaeological salvage be undertaken to minimise the loss of information by project impacts. The sites are currently in situ and have not been subject to impacts from overburden emplacement areas.

iv EMM 2018 (draft), Aboriginal Cultural Heritage Assessment Marulan South Limestone Mine Continued Operations Project (including the results of a test excavation).

The investigation of most relevance to the proposed modification is the ACHA for the Marulan South Limestone Mine SSD (EMM 2018 –in draft). The Limestone Mine SSD Project site is broadly divided into a main Project site which comprises the mine pit, the proposed emplacement areas and associated infrastructure and Marulan Creek Dam to the north of the main Project site and the Quarry.

As outlined in Section 1.5 of this report, the proposed modification shares its boundary with a component of the main Project site of the Limestone Mine SSD Project. This shared boundary was originally planned for mine overburden emplacement as part of the Limestone Mine SSD, but was later added as a part of this modification (Modification 5Modification 5) because the Quarry needs additional areas for overburden in the short term. Due to timing delays for the Limestone Mine SSD application, it was not possible to wait until the Limestone Mine SSD is approved to place Peppertree Quarry overburden in this area. As such, the northern portion of the proposed Limestone Mine SDD northern overburden emplacement area will be incorporated into the proposed Quarry modification as the new SWOE .

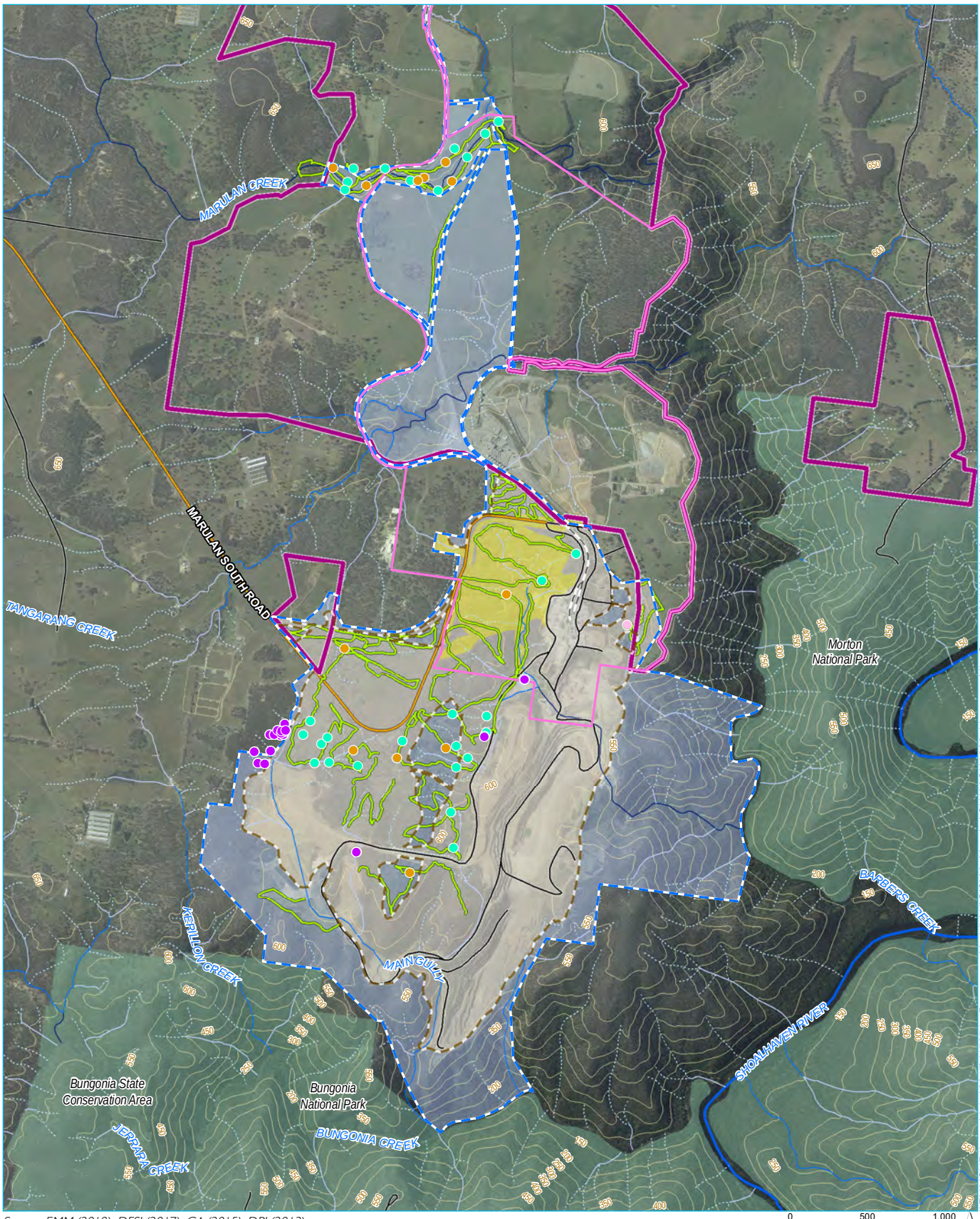
The ACHA for the Limestone Mine SSD included an archaeological survey and test excavation program, the extent of which is provided in Figure 4.1 and Figure 4.2. Portions of these investigations were undertaken in the current study area which forms the basis of the archaeological assessment for this ACHA. The results of the survey and test excavation specific to the proposed modification are detailed in Chapter 6 of this report.

A total of 57 new Aboriginal sites were identified during the ACHA, which includes 40 sites identified during the survey (28 artefact scatters and 12 isolated finds) and 17 identified during the test excavation (subsurface deposits).

The ACHA concluded that the archaeological survey was most effective in the main Project site which provided larger exposures and was generally situated on skeletal soils. This resulted in the identification of a number of isolated finds and artefact scatters on spurs, ridges and hill slopes. In contrast, test excavation across the same landscape and landforms in the main Project site recovered only 13% of the total number of artefacts from the whole program, despite more than half of the test pitting occurring in this area. These results show that Aboriginal occupation extended across the entire geographic extent of the Project site, but is better evidenced by surface material than through archaeological excavation in the main Project site.

In comparison to the above, the archaeological survey around Marulan Creek was an example where artefacts were only revealed in eroded stream banks and nearby subsurface deposits were covered in thick grass on a broad spur. As such, the landscape bordering Marulan Creek was far better characterised by archaeological excavation which identified high subsurface artefact frequencies.

EMM developed an archaeological sensitivity model as a guide to indicate subsurface archaeological potential, with the primary aim of guiding the management and mitigation measures – ie where to focus salvage excavation measures. Moderate and high archaeological sensitivity was applied to the area surrounding Marulan Creek and a small area of moderate archaeological sensitivity was applied to a spur feature surrounding MSL 055 which is in the current study area. The archaeological sensitivity model and its implication for the proposed modification are discussed further in Section 6.5.



Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

0 500 1,000 m
GDA 1994 MGA Zone 56
N

\\EMMSVR1\emmJobs\2017\J17374 - Peppertree Mod 5 AH\GIS\02_Maps_ACHA\ACHA002_LimestoneMineSurvey_20180606_03.mxd 6/06/2018

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Limestone Mine SSD project boundary
- Limestone Mine SSD disturbance footprint
- Limestone Mine SSD survey transects
- AHIMS site (previously surveyed)
- Artefact scatter
- Isolated find
- Not a scar tree
- Rail line
- Main road
- Local road
- Contour (50 m)

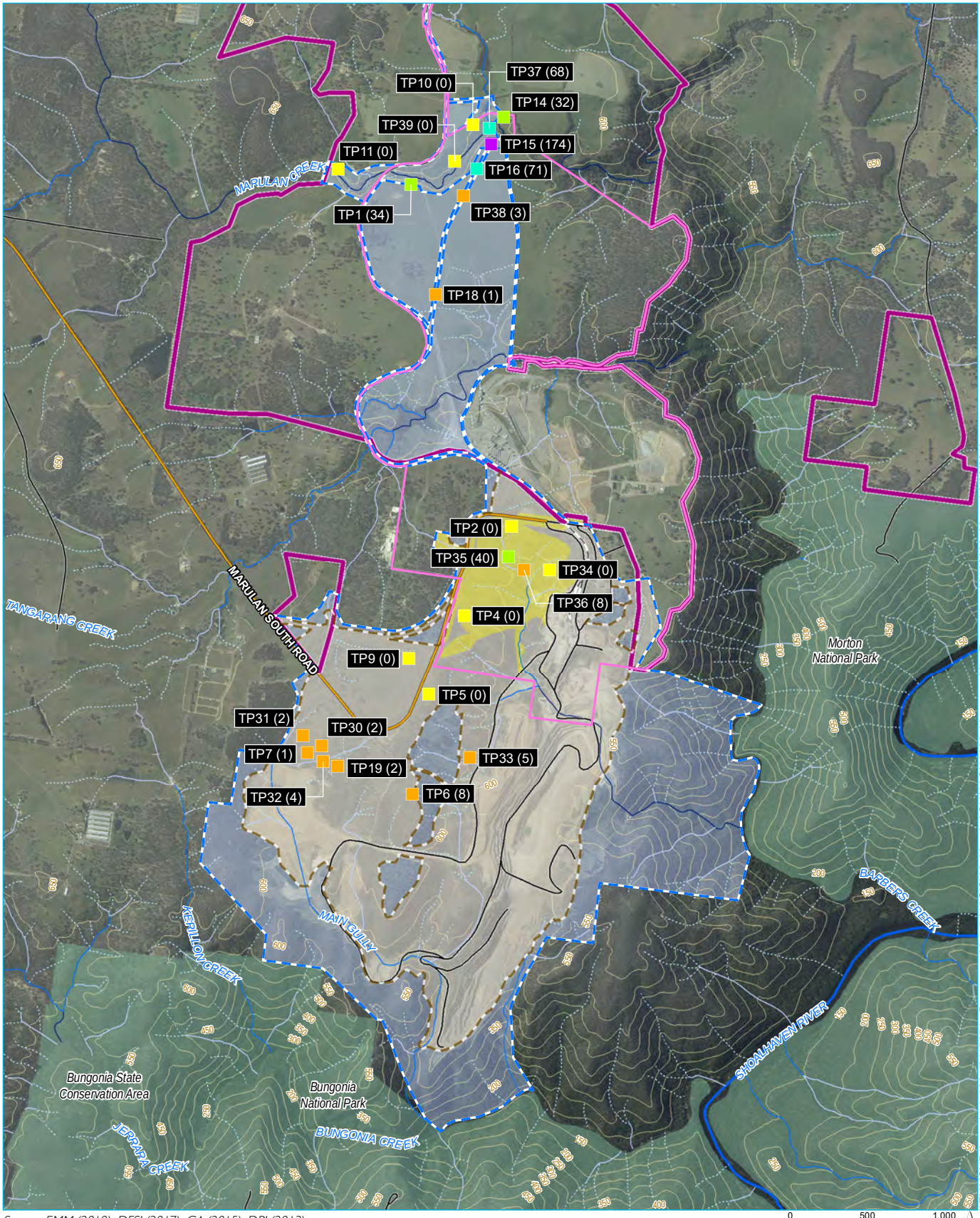
Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 8th order

Survey completed for the Limestone Mine SSD

Peppertree Modification 5
Aboriginal cultural heritage assessment
Figure 4.1

EMM



\\EMMSVR1\emmJobs\2017\J17374 - Peppertree Mod 5 AH\GIS\02_Maps_ACHA\ACHA003_LimestoneMineExcavation_20180606_03.mxd 6/06/2018

Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Limestone Mine SSD project boundary
- Limestone Mine SSD disturbance footprint

Test pit name (number of artefacts)

- 0
- 1 - 10
- 11 - 40
- 41 - 100
- 101 - 200
- Rail line
- Main road
- Local road
- Contour (10 m)

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 8th order

Test excavation completed for the Limestone Mine SSD

Peppertree Modification 5

Aboriginal cultural heritage assessment

Figure 4.2

EMM

4.3 AHIMS search results

An AHIMS search was initially completed on 1 September 2014 for an area of 10 km by 10 km centered on the study area. The AHIMS search results are shown on Figure 4.3 and are attached in Appendix B.

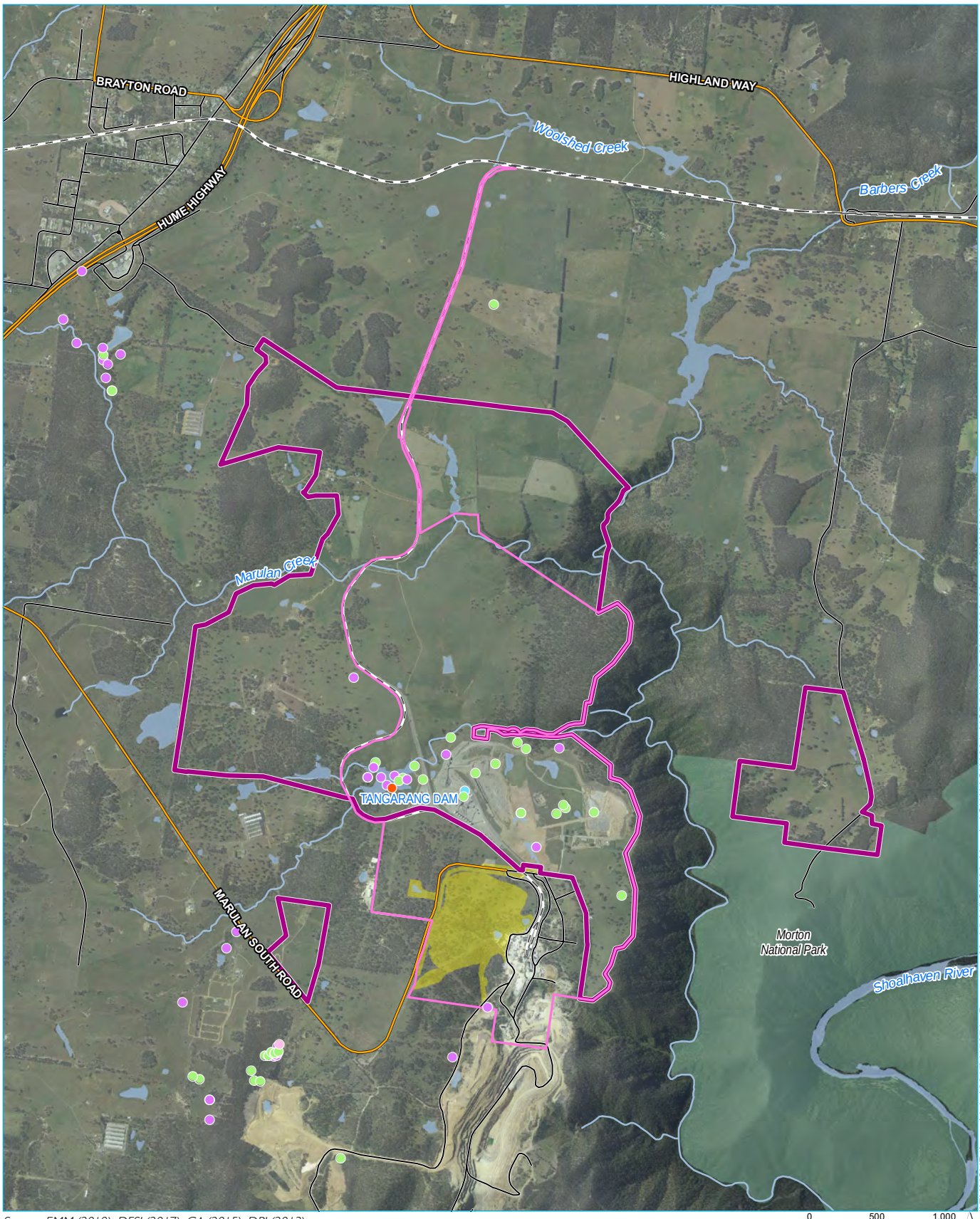
A variety of Aboriginal site types were identified. Sites were distributed across multiple landforms but clustered near watercourses. A total of 112 Aboriginal sites were identified within the search area and are summarised in Table 4.2. The most common Aboriginal site types were isolated finds and open artefact sites which made up over 90% of the total sites in the region. A small number of culturally modified trees and stone arrangements were also present; and one rock shelter with art was also identified.

The AHIMS search was updated on 20 February 2018. The search results confirmed that the site cards EMM submitted as part of the Limestone Mine ACHA were registered, but apart from that, no other Aboriginal sites were registered in the study area. The sites identified for the Limestone Mine ACHA are presented in Chapter 6 of this report rather than in this section in order to present the ACHA results in clear chronological order.

Only one site was previously recorded in the proposed Quarry consent boundary. Site M1 (BSC1) was an artefact scatter that has since been collected as part of approved mining activities (refer Section 4.2.3). This site is classed as destroyed.

Table 4.2 AHIMS registered sites in the search area

Site type	Number of sites	Percentage
Isolated find	49	44%
Open artefact site	54	48%
Quarry	1	1%
Shelter with art	1	1%
Culturally modified tree	5	4%
Stone arrangement	2	2%
Total	**112**	**100%**



Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

0 500 1,000 m
GDA 1994 MGA Zone 56

N

\\EMMSVR1\emmJobs\2017\J17374 - Peppertree Mod 5 AH\GIS\02_Maps_ACHA\ACHA004_MOD5AHIMS_20180606_03.mxd 6/06/2018

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Rail line
- Main road
- Local road
- Watercourse / drainage line
- Waterbody
- NPWS reserve

AHIMS site type

- Artefact scatter
- Isolated find
- Modified tree
- Open camp site
- Stone arrangement

AHIMS sites in the vicinity of the Modification 5 area (2014)

Peppertree Modification 5
Aboriginal cultural heritage assessment
Figure 4.3

EMM

4.4 Predictive model of Aboriginal site location

4.4.1 Synthesis of background information

The results from the regional and local studies have indicated that the most common Aboriginal site types are open artefact scatters and isolated finds. These sites are usually found in relation to water with site size and frequency dependant on the distance to the water source. The majority of large sites are located along major creeks or at the confluences of minor creeks and drainage lines. Sites decrease in size and frequency as the distance from water increases. Sparse sites may exist on ridgelines and may represent evidence of the travelling routes used across the wider Southern Tablelands landscape.

The study area has a number of different landscape factors which influence the potential for Aboriginal sites to be identified. There are no perennial watercourses; however, there are numerous first and second order streams that converge into a third order stream at the base of the hilly terrain in the SWOE. These features are likely to have supported intermittent periods of camping focused near the third order stream, but only on suitably level to gently inclined terrain. Only discrete parts of the study area offer the favourable conditions of broad and gentle spurs, whereas all of the spurs with an easterly aspect slope considerably before reaching the third order stream.

Culturally modified trees, while rare, have been previously identified in the AHIMS search area but are outside the study area and would only be present within the study area if trees of a suitable age have been retained.

Aboriginal objects identified on the ground surface may indicate the presence of subsurface archaeological deposits depending on landform type and level of post-depositional ground disturbance. Post deposition factors such as land clearing, cattle grazing and mining activities are likely to have disturbed stone artefacts. Disturbance would have resulted in the displacement of Aboriginal objects within the soil but would not fully diminish their archaeological and cultural value. Erosion also has the potential to more significantly displace Aboriginal objects through sheet wash and gully erosion, particularly on the slopes and narrow, cleared crests near incised drainage lines that characterise most of the study area south of Marulan South Road.

The surface geology of the area provides stone for use in the manufacture of stone tools including quartz, feldspar and tuff. Chert outcrops are also known to occur along the Wollondilly River approximately 25 km to the north-west. Silcrete outcrops were evident along Marulan Creek.

The temperate climate was suitable for Aboriginal occupation of the area. The environment of the study area would have provided a variety of resources for exploitation by Aboriginal people including plants and animals for food, adequate water supplies in the nearby creeks and rivers. Vegetation in the study area would also have provided wood to make implements and shelters.

4.4.2 Predictions

Based on the items described above the following predictions can be made of the study area:

- Open camp sites evidenced by stone artefacts are likely to occur on prominent or elevated, level to gently inclined terrain overlooking watercourses. Moderate to steeply inclined slopes are far less likely to have archaeological evidence.

- Historical vegetation clearance and mining associated disturbance has occurred in the study area and this indicates that modified trees will be rare or non-existent.

- Rock shelters are not predicted to occur as the landscape does not have suitable rock outcrops or overhangs.
- The likelihood of grinding groove sites is low as rock outcrops are rare. The outcropping granite is generally too coarse to have been used for stone tool manufacture or food preparation.
- Quarries are unlikely to occur. Although silcrete has been identified eroding from the banks of Marulan Creek, similar conditions are not expected in the study area due to a difference in geology.
- Stone arrangements are unlikely to occur due to their general rarity and disturbance from historic clearing and mining activities.

5 Historical background

5.1 Post settlement history

European explorers first visited the Southern Tablelands as early as 1798 when John Wilson was sent to the area by Governor Hunter (Chisholm 2006). His reason for exploring the area was to dispel the myth that convicts would be able to walk to China (Higginbotham 2009, p.21). He ascended Mt Towrang and viewed the Goulburn Plains before returning home.

Major towns included Marulan, which was established first in 1834 and then moved approximately 2 km to the north-west in 1868 when the Great South Railway Line was constructed. Other towns established in the area included Bungonia (1836), Tallong (1869) and Wingello (1871). The town of Marulan South was created in the mid-twentieth century to service the Marulan South Limestone Mine. Marulan South became a community hub for the miners and their families and a well known place in the local district. The town was closed in 1998 when the decision was made to move the residents rather than complete additional repairs and upgrades, particularly for sewerage treatment. People's houses were transported to Marulan as part of the closure and a large wake was held to farewell the town.

Stock and cattle stations were established in the 1820s throughout the Goulburn plains and the wool industry dominated the area during the 1800s (Firth 1983). Pastoralists set up stations run by the convict labour force. The wealthiest pastoralists ran their stations from Sydney or the Cumberland Plain sending sons or overseers to run the day to day operations (Higginbotham 2009, p.27).

One of the largest pastoral holdings in the area was the Glenrock Estate along Marulan South Road. It was purchased in 1862 by John Morris (The Sydney Morning Herald 1862).

Peppertree Quarry commenced operations in early 2014 and the area has been modified through development of the quarry pit and associated infrastructure.

With the exception of the Marulan South Limestone Mine and Peppertree Quarry, the area is predominantly used for cattle and sheep grazing, along with poultry farming and other commercial operations. Tourism to the Southern Highlands has increased as the improvements to the Hume Highway connected the area to Sydney. The former Mulwaree Shire was amalgamated into the Goulburn Mulwaree local government area (LGA) in 2005.

5.2 Previously identified historic heritage items

The heritage registers listed in Section 1.6.2 were searched and no items of historic heritage significance were identified in the Modification 5 area or immediate vicinity. No areas of historical archaeological potential were identified.

Further afield and approximately 3 km from the study area, Bungonia National Park and the Bungonia State Conservation area are consolidated into one local listing on the *Goulburn Mulwaree Local Environmental Plan 2009* as Bungonia State Recreation Area (Item No. I027). It is considered to be significant for its natural and cultural associations.

The site of Old Marulan Town, an item listed on the State Heritage Register (Item number 00127) is located approximately 10 km from the study area, in the vicinity of the Hume Highway – Marulan South Road Intersection. It is considered significant for its ability to illustrate details of an early colonial service, predominantly from 1835-67 through its archaeological resource.

5.3 Previous historical heritage studies

Historic heritage investigations have included two publications used in the historical background above (Eddy 1985 and Leighton-Daly 2010) as well as many publications on aspects of mining and domestic life in the Southern Tablelands. Investigations specific to the study area have been completed as part of various environmental assessments for the Quarry operations.

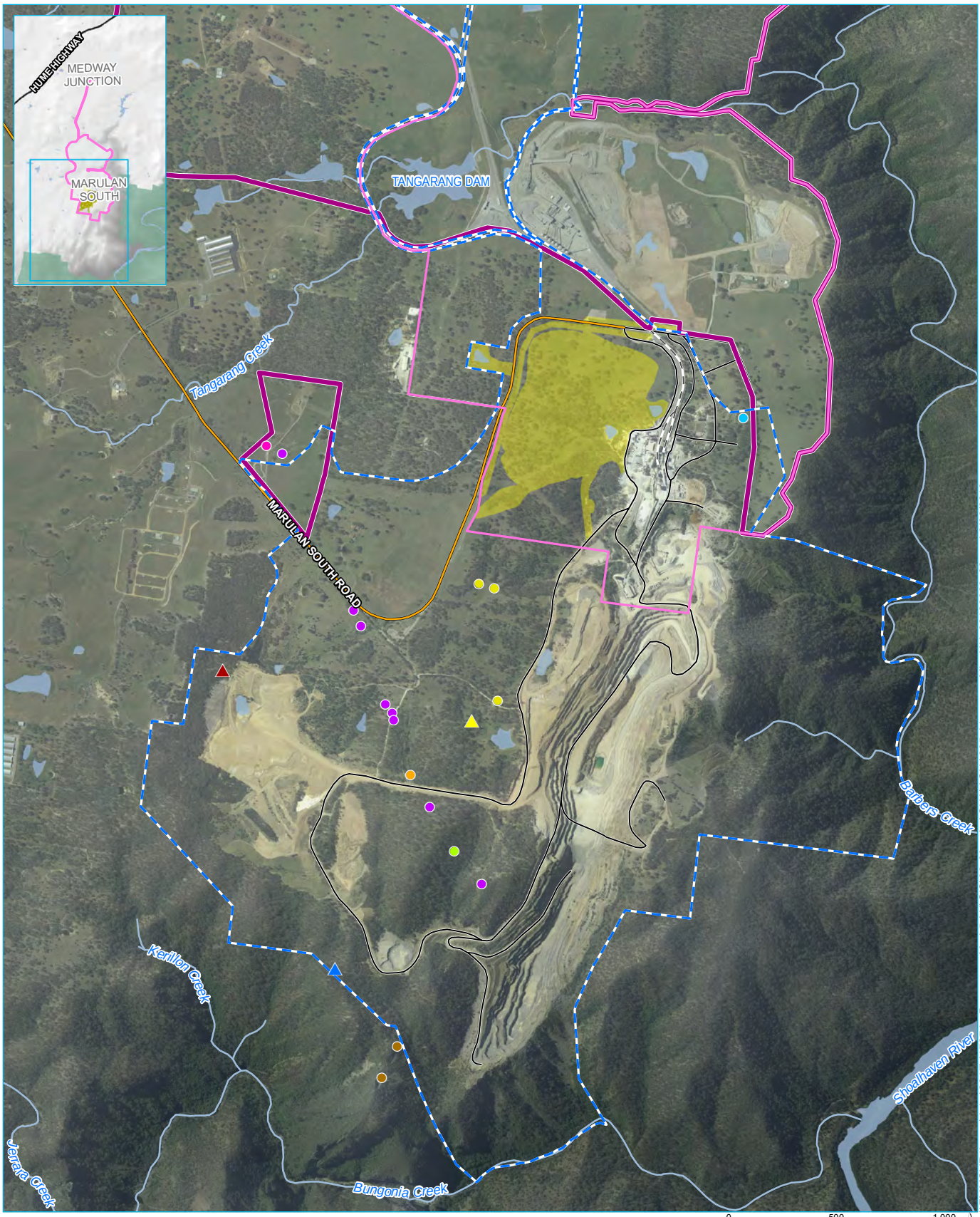
A historic heritage investigation was completed by ERM (2006) for the Environmental Assessment for the Quarry. It did not identify any listed heritage items or archaeological evidence in the Quarry footprint. The project was not considered to have a significant impact on historic heritage.

EMM (2012) completed a historic heritage investigation as part of Modification 3 OF the project approval. It did not identify any historic heritage items or areas of archaeological potential. The modification was not considered to have a significant impact on historic heritage.

In 2015, EMM commenced an historical heritage impact assessment for the Limestone Mine SSD Project. The assessment covered the current study area and the much broader Limestone Mine SSD Project site. The assessment involved primary and secondary research along with a targeted historical heritage survey. Furthermore, the archaeological survey for the Limestone Mine SSD ACHA also aimed to record historical items if identified during fieldwork.

The assessment identified the following items of historical heritage (Figure 5.1), none of which occur in the current study area:

- a lime burning complex of five kilns;
- elements of the aerial ropeway system that operated in the Limestone Mine SSD Project site;
- MS Site 1, a structure identified in previous assessments as a house probably built and occupied in the late nineteenth and early twentieth centuries;
- MS Site 2, the elements of a structure, possibly a house consisting of a flat area of ground overlooking a dam and ephemeral creek line;
- MS Site 3, the elements of a structure consisting of a flat area of ground, landscape modification including remnants of fence posts and some fragments of sandstone and brick;
- elements of the mining area at Mt Frome including a rail track and evidence of early blasting;
- ephemeral camps, including broken glass ceramics and landscape modification;
- the Marulan South town area including the remains of the bowling club and town hall as well as landscape modifications indicating the original town layout; and
- the Bungonia National Park, which is an item of local heritage significance on the Goulburn Mulwaree LEP (Item I027).



Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

0 500 1,000 m
GDA 1994 MGA Zone 56

N

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KEY

- Boral Resources boundary

Peppertree Modification 5

- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Rail line
- Main road
- Local road
- Watercourse / drainage line
- Waterbody
- Limestone Mine SSD project boundary

Historic heritage items

- Site 1
- Site 2
- Site 3
- Tower 1
- Tower 2
- Aerial ropeway
- Camps
- Mt Frome mine
- Marulan South town
- Engine room

Historical heritage items identified for the Limestone Mine SSD

Peppertree Modification 5
Aboriginal cultural heritage assessment
Figure 5.1

EMM

6 Archaeological Investigation

6.1 Rationale

The results presented in this chapter have been gathered from the archaeological investigations completed by EMM and Aboriginal representatives for the Limestone Mine SSD ACHA (refer to Section 4.2.3.iv for a summary). Figure 4.1 and Figure 4.2 provide some context on the scope of the investigations. Although this chapter references the broader results of the investigation to provide context where relevant, its focus is to extract and report the results of the investigation specific to the study area.

Considering the above, the survey and test excavation effort and results within the study area should not be considered in isolation. This is because they were completed as part of a much wider sample of the local landscape, which was used alongside information from previous investigations, to form conclusions about the local archaeological character.

The western half of the approved disturbance footprint of the WOE was not included in the survey for the Limestone Mine SSD ACHA. Notwithstanding, further investigation of this area for the proposed modification was considered unnecessary, given that the same disturbance footprint had previously been assessed by ERM as part of Modification 2, which was subsequently approved by DPE.

6.2 Aboriginal archaeological survey

6.2.1 Overview

Field survey was conducted over one week from the 13 – 17 April 2015. The survey included EMM archaeologists and members of the RAPs. A list of stakeholders who participated in the field survey is included in Appendix C.

The primary aims of the survey were to:

- identify Aboriginal sites or potential Aboriginal places with the assistance of Aboriginal knowledge holders; and
- characterise the landscape to aid predictions of surface and sub-surface archaeological potential.

6.2.2 Survey strategy

A survey strategy was developed for the Limestone Mine SSD ACHA. The sampling strategy was proportionate to the predicted archaeological sensitivity across the Limestone Mine SSD Project site. The survey was guided by the following aims:

- to focus the survey on the land adjacent to reliable watercourses such as both sides of Marulan Creek and the eastern side of Main Gully (outside the study area);
- to focus the survey on the hill spurs and crests in the main Project site which are frequently separated by deeply incised drainage channels causing steep side slopes, (this included parts of the study area); and

- to gather a representative sample of the relatively flat and undulating land that occasionally intersects with the headwaters of first order streams such as the land directly south of the Quarry within the current study area (eg Transects 10 to 12). These areas were predicted to have lower archaeological sensitivity to the land next to reliable watercourses and hill spurs and crests.

Although the survey aimed to cover the entire geographic extent of the Limestone Mine SSD Project site, a full coverage survey (a survey that covers the entire ground surface of the disturbance footprints) was not adopted because of the following factors:

- a large portion of the Limestone Mine has been disturbed by existing mining activities;
- a large portion of the main Project site is characterised by steep to very steep spur slopes and side slopes and deeply incised drainage channels that would have been hazardous to walk and for these reasons were also unlikely to feature Aboriginal sites; and
- large portions of the relatively flat and undulating land away from watercourses are currently thickly grassed and currently used for grazing. This means that ground exposures are rare and extensive survey of such areas would have been ineffective.

6.2.3 General fieldwork method

The archaeological survey and data collection methods followed Section 2.2 of the Code which sets out best practice recording methods. The survey comprised pedestrian field transects across defined landform elements. The survey team varied between eight to nine people each day who inspected the ground surface of each transect while spaced within a 50 m wide corridor where possible (typically spaced between five and six metres apart).

These methods were considered to be suitable as a large portion of the surveyed area was grassed, and exposures were easily identified at this spacing.

The survey team targeted ground exposures such as vehicle and cattle tracks, eroded scalds and stream banks, all which provided good ground surface visibility for identifying Aboriginal objects. However, ground surface visibility was hindered in thickly grassed grazing paddocks and forested areas with gravelly surfaces and leaf litter.

The survey team inspected all mature trees within the transect paths. All outcropping rock was inspected for grinding grooves, rock pools or engravings.

6.2.4 Survey recording

Site locations were recorded using a hand-held GPS unit and with recorded data confirmed on GIS. Transects were accurately recorded and mapped by downloading the daily tracks recorded on GPS, which was supplemented by daily field notebook entries and photos. In all instances GPS-recorded locations corresponded exactly with ground exposures on geo-referenced air photos displayed in GIS (ArcMap).

Survey transects were recorded using the *Australian Soil and Land Survey Field Book* (CSIRO 2009) as a guide.

For the purposes of this assessment an Aboriginal site is defined as a location where a person in the present day can observe one or more Aboriginal objects. The boundaries of a site are limited to the extent of observed Aboriginal objects.

A site does not include the assumed extent of unobserved Aboriginal objects (such as archaeological deposit). 'Aboriginal objects' are items or objects owing their form to past Aboriginal activity.

6.2.5 Survey limitations

EMM acknowledge that there is vegetation of varying densities within the study area. Although it was established that this vegetation is largely the result of regrowth after historical clearing, it is unknown if mature trees outside the survey transects remain. Subsequently, although predicted to be rare, further mature trees of sufficient age to have been carved or scarred cannot be discounted. As such, any further mature trees with potential Aboriginal scarring or carving will be managed under the discovery of new Aboriginal sites protocol set out in the AHMP (Boral 2017).

6.2.6 Survey coverage results

The aim of recording and analysing survey coverage data is to determine the effectiveness of a survey. It is evaluated for its effectiveness in identifying the distribution of Aboriginal objects across the landscape, taking into account the potential for archaeological deposits.

A total of 71 transects were walked covering an area of 51 km walked by participants spread across a 50 m wide path. Nineteen (19) of those transects were within the study area, totalling approximately 8 km.

Figure 6.1 illustrates the survey transects logged by the GPS. However, the survey track data represents only where the archaeologist walked and does not represent the broader transect covered by the survey team of between eight and nine people.

Effective coverage within the study area is summarised in Table 6.1. Plates 6.1 to 6.9 provide representative photographs of the landforms and visibility conditions observed during the survey.

Table 6.1 Summary of effective survey coverage in the study area

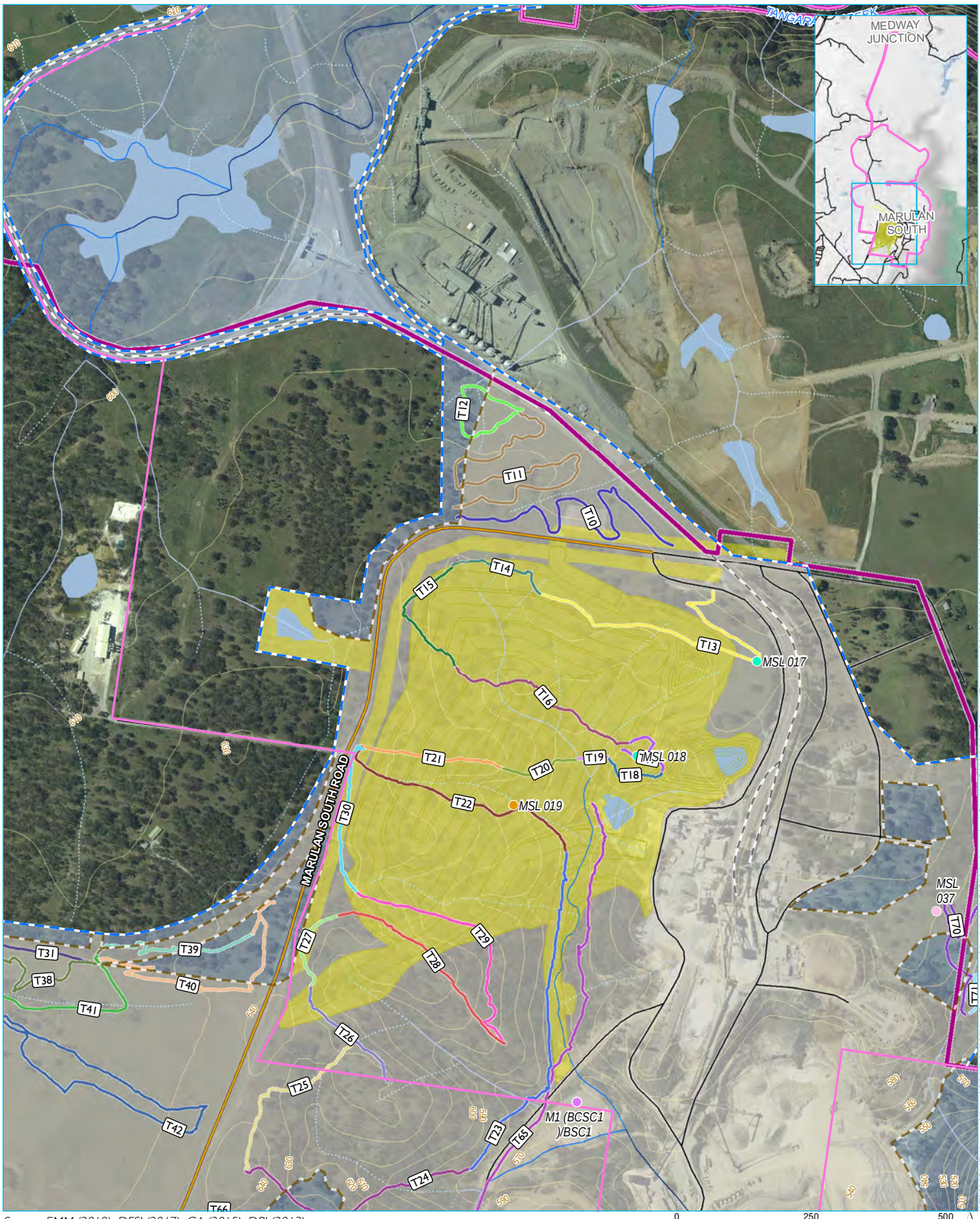
Row Labels	Length (m)	Area (m²)	Area available for detection (m²)	Effective coverage %
Hill slope	1,761	88,050	9,203	6
Ridgeline	507	25,350	1,521	2
Spur	2,541	121,650	6,794	5
Undulating plain	734	36,700	367	1
Watercourse	2,870	141,250	12,672	6
Total	**8,413**	**413,000**	**30,557**	

Table 6.1 shows that effective coverage in the survey area was relatively low from between 1% to 6% and with an average of 4%. This is lower than the average effective coverage of 15.7% for the total survey for the Limestone Mine SSD ACHA; which was higher because it included large tracts of exposed creek banks associated with Marulan Creek to the north of the study area.

Visibility was constrained in grazing paddocks through the growth of grass, obscuring the ground surface. Transects through paddocks (ie T10–15) targeted areas with exposure, but otherwise were limited to areas of visibility resulting from vehicle track or cattle tread exposures. The hill slopes, spurs and watercourse banks provided a slightly higher level of exposure and visibility. This was the result of bank erosion, sheet wash and scalding.

Disturbance across the Project site was variable with some areas within the south eastern edges of the survey area showing high levels of disturbance from earthmoving and mining activities. Approximately half of the survey area was cleared grassed paddocks, a result of historical vegetation clearance and clearance for existing electricity line easements.

Overall, survey coverage in the study area was not particularly effective because the ground surface visibility conditions were generally low. Notwithstanding, it was effective for characterising the landscape of the study area. The prominent observation was that most of the SWOE is characterised by moderate to steep sloping ground. The spur lines leading east-west of the main ridge start gently at higher elevations, but transition into steep slopes towards the watercourses below. This is also applicable to the hill slopes at the northern end of the SWOE. This means that most of the suitably level ground for Aboriginal camping is set back beyond 200 m of watercourses (with some discrete exceptions) and that most of the spur lines in the study area would have been more useful for transit between higher and lower elevation than for camping activities.



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Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Peppertree Modification 5
- Proposed pit design
- Limestone Mine SSD project boundary
- Limestone Mine SSD disturbance footprint
- Limestone Mine SSD survey transects
- AHIMS site (previously surveyed)
- Artefact scatter
- Isolated find
- Not a scar tree
- Rail line
- Main road
- Local road
- Contour (10 m)
- Waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order

Survey coverage and results in the study area

Peppertree Modification 5
Aboriginal cultural heritage assessment
Figure 6.1

EMM



Plate 6.1 **Transect 10 undulating plain with low visibility adjacent to Peppertree Quarry (view east)**

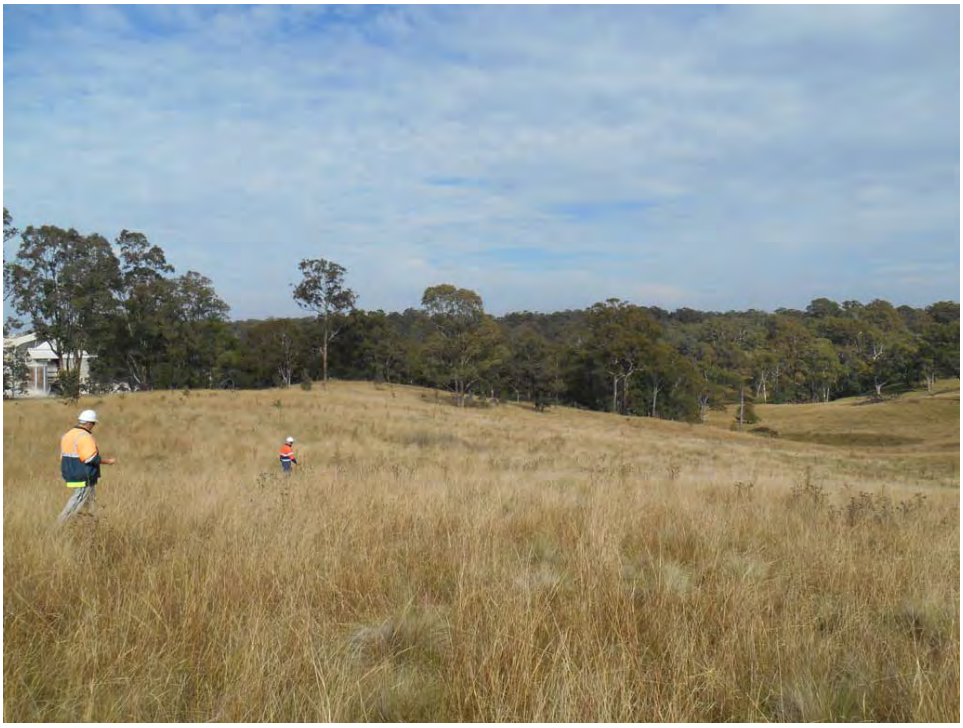


Plate 6.2 **Transect 13 on a rolling hill facing south towards a landscape of steeper slopes and lower elevation (Lime Plant to the far left)**



Plate 6.3 Transect 16 showing a prominent spur crest bordering on steep slopes and incised gullies to the south (view west). Also location of MSL 055.



Plate 6.4 Transect 20 following the moderately inclined lower portion of a spur (view east)



Plate 6.5 **Transect 22 showing moderate to steep hill slope gradient (view north).**



Plate 6.6 **Transect 23 showing a section of modified land adjacent to a third order stream. The current mine embankment is on the left (view south).**



Plate 6.7 Looking west from Transect 23 showing steep, densely vegetated drainage channels



Plate 6.8 Transect 28 following the top of a spur line along an existing electricity transmission easement (view east).



Plate 6.9 Northern end of Transect 65 looking onto the depression caused by a confluence of ephemeral watercourses (view east).

6.2.7 Aboriginal site results

i Sites identified in the study area

The survey team identified 41 new sites during the survey across the Limestone Mine SSD Project site and their distribution is illustrated in Figure 4.1 in Chapter 4. Three of the sites (MSL 017, MSL 018 and MSL 019) were identified in the study area. The sites identified as part of the total survey are presented in Table 6.2, whereas the sites in the study area are summarised in Table 6.3. The sites are shown on Figure 6.1.

Plate 6.10 to Plate 6.12 provide some examples of the sites in the study area.

Table 6.2 Site frequencies and landform associations

Site type	Hill slope	Ridgeline	Spur	Undulating Plain	Watercourse	Total
Artefact scatter	2	1	11		14	28
Isolated find	1	2		1	8	12
Potential scar tree			1			1
Total	**3**	**3**	**12**	**1**	**22**	**41**
Artefact counts	16	4	72	1	143	

Table 6.3 Sites identified in the study area from survey

Site Name	Easting	Northing	Site type	Landform element	Distance to nearest stream	Description
MSL 017	228378	6149319	Artefact scatter	Hill slope	10	One silcrete and one quartz flake located in ground exposed by the falling of a large eucalyptus tree.
MSL 018	228156	6149143	Artefact scatter	Spur	50	Six artefacts comprising five flakes and one core. Exposure is approximately 20m^2 on a spur crest with a south-west aspect. Materials include quartz, silcrete, chert and quartzite.
MSL 019	227926	6149051	Isolated find	Hill slope	10	One mudstone core eroding located on a steep hill slope on heavily disturbed context near the creek an incised drainage line. Artefact is unlikely to be in situ.



Plate 6.10 Artefacts identified in Transect 18 (AHIMS site MSL 018)



Plate 6.11 Transect 18: hill crest exposure where artefacts in Plate 6.10 (AHIMS MSL018) were identified (view south-west).



Plate 6.12 A mudstone core exposed in an eroding creek bank in Transect 65 (MSL 019).

ii Discussion

Ground surface exposure and visibility conditions have great influence on the detection of Aboriginal sites. The incidence of most sites and artefacts being recorded along watercourses, particularly Marulan Creek outside the study area, is primarily because there were large tracts of eroded banks available for inspection. The land away from the stream bank of Marulan Creek (but still within 200 m) features the gentle slopes of undulating plains and occasional spur crests, however these are thickly grassed and no surface material was identified during survey. However, the prominent landforms such as spurs next to Marulan Creek were predicted to be archaeologically sensitive features, especially based on the outcomes of subsurface investigations at the Quarry. As such, archaeological investigation was undertaken on these landforms which is summarised in Section 6.3.

Isolated artefact and artefact scatters were identified consistently along spurs within the Limestone Mine SSD main Project site (including the study area). This is largely attributed to the high ground surface visibility conditions on spurs to the south of the study area, which suggest that significant subsurface deposits are unlikely to exist, particularly because the drainage network in this area is ephemeral and that soils are more skeletal in this area when compared to Marulan Creek and the land surrounding the Quarry.

6.3 Test excavation

6.3.1 Overview

A test excavation was conducted over two and a half weeks from 15 June 2015 to 1 July 2015. EMM archaeologists and RAPs participated in the fieldwork (see Appendix E for personnel). This section provides an overview of the results from the wider test excavation completed for the Limestone Mine SSD ACHA and focuses on the results in the study area. It does not include the details of artefact analysis completed for Limestone Mine SSD ACHA; instead it discusses the outcomes that are relevant to the study area.

6.3.2 Test excavation strategy

The aims of the test excavation program were to:

- characterise the subsurface archaeological deposit across representative sample landforms spread across the geographical extent of the Project site;
- test the predictive model and survey results:
    - particularly to understand if areas with frequent surface artefacts generally indicate extensive subsurface deposits; or
    - if significant subsurface deposits are typically buried without surface artefact expressions; meaning that landscape analysis is a better guide to subsurface character than survey site results based on artefact expressions.

Some of the areas of interest correlated with excavations planned for the soils and landscape assessment for the Limestone Mine SSD. As such, EMM used these locations as archaeological test pits to test areas predicted to have low archaeological potential. This approach allowed for the excavation needed for soil testing to be completed in a controlled manner and for the data to support the archaeological investigation.

EMM discussed the suitability of this method with the OEH South East Region archaeologist in May 2015 during a teleconference. OEH supported this method on the basis that all soil test pit locations were excavated archaeologically until culturally sterile layers were encountered.

The locations of all test pits are shown in Figure 4.2. Further details of the test pits in the study are shown in Figure 6.2.

6.3.3 Fieldwork method

Each area chosen for archaeological excavation was divided into a 3 m by 1 m test pit. This approach was primarily used because the soil testing pits required these dimensions for the soils and landscapes assessment. Accordingly, all test excavation locations used the same 3 m by 1 m sample size for consistency.

Each test pit was divided into North, Centre, and South 1 m by 1 m squares aligned on a north-south axis. Each 1 m by 1 m square was excavated and recorded separately, with artefacts placed in individual bags according to square and spit number. Test pits were divided into 1 m by 1 m squares to refine sample size and to allow comparison of artefact densities within the broader archaeological context.

Excavation was a combination of hand and machine methods. The first test pit in each landscape area was excavated by hand. Excavation then proceeded by machine excavator monitored by archaeologists. Sustained rain in the first week of fieldwork hampered the number of machine excavated test pits, resulting in the majority of all pits being excavated by hand.

Test pits were excavated in 10 cm spits to culturally sterile deposits. Each pit was also finished with a shovel to refine square boundaries and remove any remaining soil. All pits were backfilled.

6.3.4 Overview of all results

A total of 25 test pits were excavated across the landscapes of the Limestone Mine SSD Project site, totalling 45 m^2.

A total of 539 artefacts were recovered during the test excavation. Seventeen out of the 25 test pit locations contained artefacts. Each test pit that featured artefacts was attributed with a new site name, with seventeen new sites being recorded and labelled consecutively from MSL 042 to MSL 058. These sites are labelled as ‘subsurface artefact deposits’.

Notably, 86% of the artefacts (n=466) were recovered from test pits near Marulan Creek to the north of the study area despite less than half of the excavation effort being placed in that area. The average artefact frequency for test pits with artefacts near Marulan Creek is 22 artefacts per square metre. There is a distinct concentration of artefacts in one area which is on spur crests near Marulan Creek Dam. The highest densities of artefacts were associated with large, flat areas overlooking Marulan Creek with 174 artefacts recovered from TP15 and 74 artefacts from TP16.

The remaining 73 artefacts were recovered from 10 out of 14 test pits within the main Limestone Mine SSD Project site. Over half of these were recovered from one location (TP35) which is within the current study area. Even with the considerable outlier in TP35, the artefact frequency for test pits with artefacts within the main Limestone Mine SSD Project site was low at four artefacts per square metre.

Most artefacts were found in the upper 30 cm of soil across the Limestone Mine SSD Project site (N=433 or 80% of the assemblage). The remaining 20% of artefacts were uncovered within 30-70 cm depth (N=106), but this only occurred in deeper soils near Marulan Creek.

The dominant materials in the assemblage were silcrete and quartz which made up 79% of the assemblage. Materials were likely to come from both the local area and through trade or importation. A total of 17 implements (tools) comprising of one Bondi point and 16 retouched tools were found.

6.3.5 Results in the study area

Five 3 m x 1 m test pits were dug within the study area, a total of 15 m^2 (Figure 6.2). The test pits in the study area were part of a broader strategy to test suitably level to gently inclined landforms distributed amongst the surrounding steeper terrain. The test pits in the study area are shown in Appendix D.

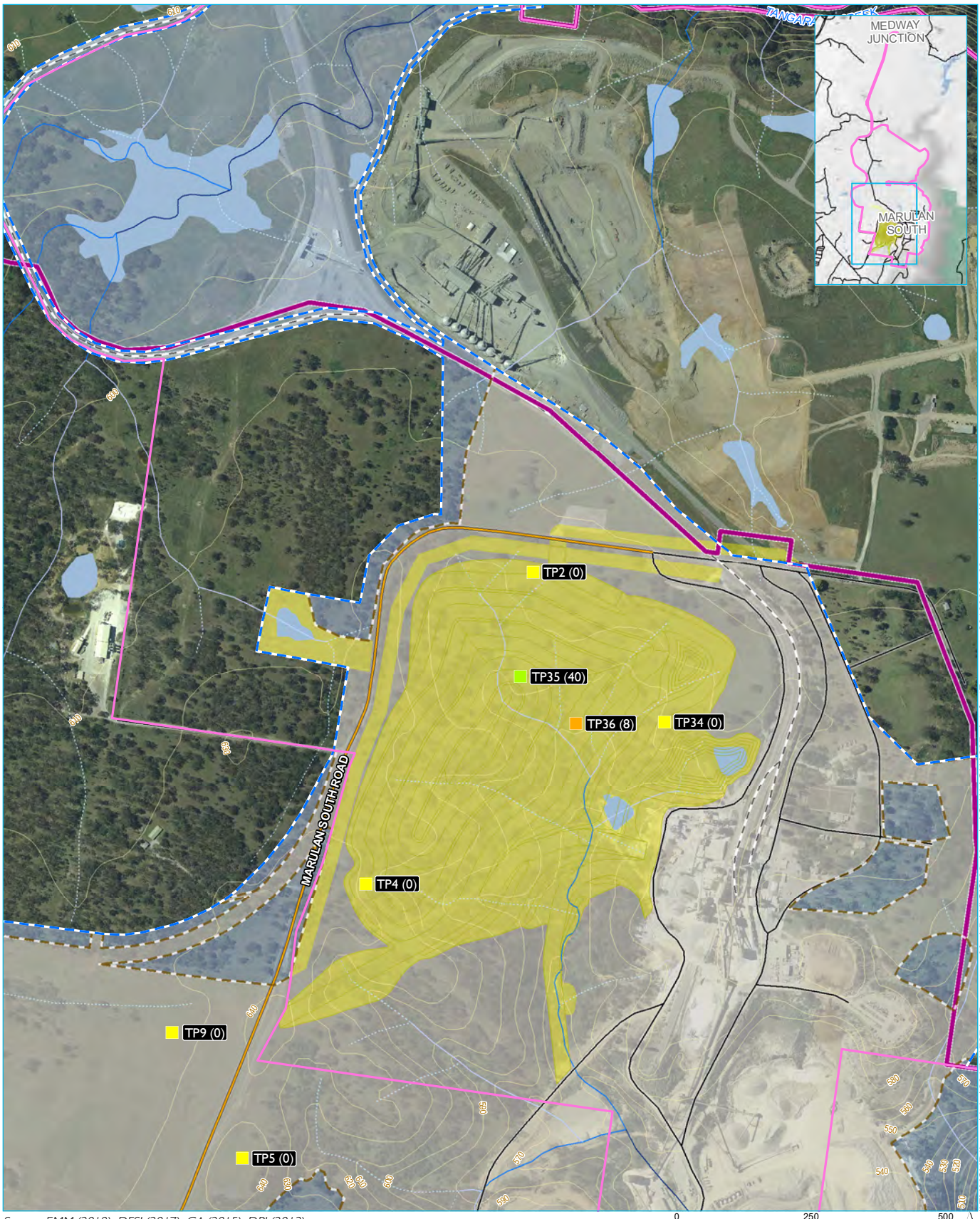
TP34, TP35 and TP36 were on broad spurs featuring duplex soils with dark brown loams overlying silty clays of varying plasticity. Only TP35 had a well formed soil profile (32 cm before impermeable clay was reached) whereas TP34 and TP36 had skeletal soils of only up to 15 cm. TP2 and TP4 were on a ridge and displayed soil profiles of sandy loam topsoil overlaying olive brown clay deposits.

Test pit artefact frequencies in the study area were generally low or non-existent (refer Table 6.4). TP2, TP4 and TP34 contained no artefacts. The highest frequencies of artefacts were recovered from TP35 which contained 40 artefacts (subsequently labelled site MSL 055). This test pit was located on a large flat spur overlooking two drainage lines (Plate 6. to 6.15). Further south, the landscape increases in gradient dramatically and the conditions for camping decrease in quality. Test pits in these steeper locations outside the study area but on comparable landforms contained artefact counts of less than ten. The remaining test pit in the study area (TP36) had only eight artefacts (subsequently labelled site MSL 056).

Most of the artefacts were flakes or broken flakes. However, only two silcrete artefacts from TP35 showed evidence of retouch. Six cores were found in TP35, and apart from one quartz core, all were silcrete. No cores were found in TP36. The artefacts were predominantly silcrete (N=35) and quartz (N=12) with only one of chert.

Table 6.4 Summary of test excavation results in the study area

Test pit	landform	Square	Artefact frequency	Total
TP2	Ridge	North	-	
		Centre	-	
		South	-	0
TP4	Ridge	North	-	
		Centre	-	
		South	-	0
TP34	Spur	North	-	
		Centre	-	
		South	-	0
TP35	Spur	North	11	
		Centre	11	
		South	18	40
TP36	Spur	North	2	
		Centre	6	
		South	-	8
		Total	48	48



\\EMMSVR1\emmJobs\2017\J17374 - Peppertree Mod 5 AH\GIS\02_Maps_ACHA\ACHA007_ArtefactFrequency_20180606_03.mxd 6/06/2018

Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Peppertree Modification 5
- Proposed pit design
- Limestone Mine SSD project boundary
- Limestone Mine SSD disturbance footprint
- Test pit name (number of artefacts)
  - 0
  - 1 - 10
  - 11 - 40
- Rail line
- Main road
- Local road
- Contour (10 m)
- Waterbody
- Strahler stream order
  - 1st order
  - 2nd order
  - 3rd order
  - 4th order

Artefact frequencies uncovered during test excavation

Peppertree Modification 5
Aboriginal cultural heritage assessment
Figure 6.2

EMM

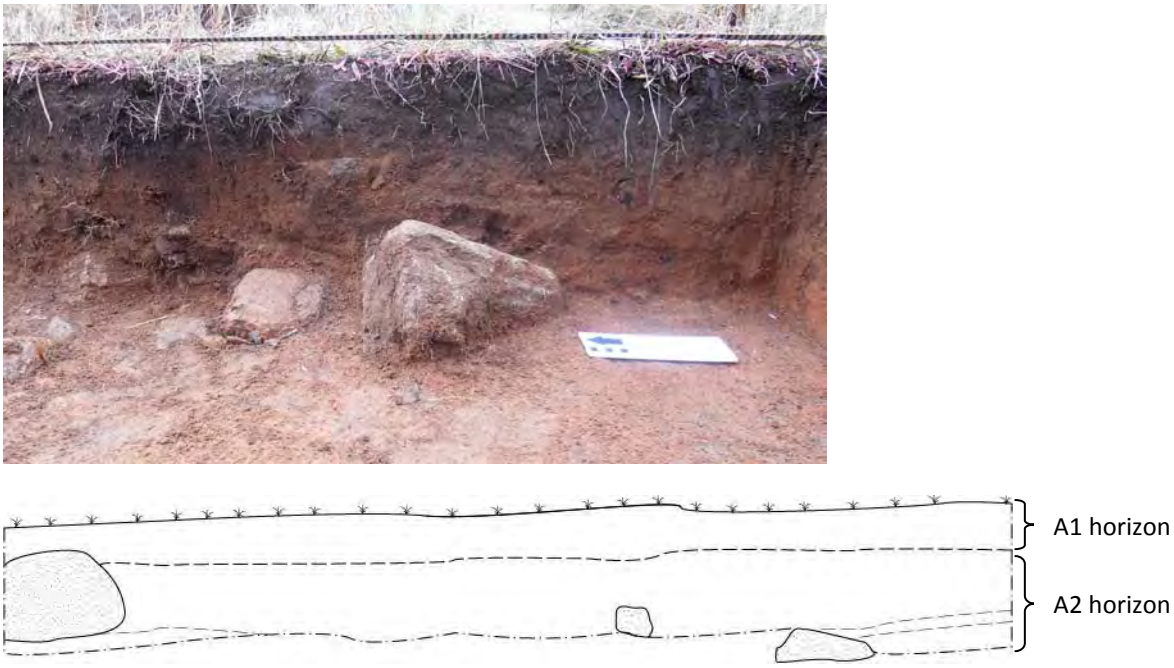


Figure 6.13 Soil profile of TP35



Plate 6.14 Location of TP35 (AHIMS MSL055)



Plate 6.15 Completed TP35

6.4 Discussion

The following discussion aims to provide a summary on the broader results gathered as part of the Limestone Mine SSD ACHA. Overall, the results show that Aboriginal occupation extended across the entire geographic extent of the Limestone Mine Project site, but more visible through surface material in the Limestone Mine main Project site (including the current study area) than through archaeological excavation. The presence of mainly surface artefacts and minimal subsurface artefacts in the main Project site (and study area) is likely to be a combination of the following:

- less intensive long term prehistoric Aboriginal camping activities in this area because of the steeper terrain and ephemeral drainage network; followed by
- increased erosion and loss of surface artefacts because of steeper topography and skeletal soils; and
- minimal soil depth formation which would have prevented significant subsurface deposits from accumulating.

One location in study area (MSL 055/TP35) was anomalous by being a relatively flat spur in a prominent point in the landscape. It also had the deepest soil profile in the study area. This is a unique area where the landscape starts its transition from the rolling hills associated with the archaeologically sensitive Peppertree Quarry to the much steeper terrain that characterises most of the study area.

In comparison to the above, the results of the archaeological survey around Marulan Creek (outside the study area) is an example of where surface artefacts were only revealed by stream bank erosion and nearby subsurface deposits on a broad spur (MSL 046, MSL 057, and MSL 047) were covered in thick grass. As such, the landscape bordering Marulan Creek is best characterised by archaeological excavation. The test excavation results also indicate that higher artefact frequencies do not occur consistently across all areas of Marulan Creek, but are more dependent on prominent landforms such as broad spur crests. For example, a number of creek side test pits (TP11, TP39 and TP10) contained no artefacts despite being within 50 m of Marulan Creek. Overall, the test excavation results indicate that Marulan Creek is likely to have experienced more intensive Aboriginal occupation on prominent landforms, possibly similar to that bordering Tangarang Creek and its tributaries as evidenced by previous investigations at the Quarry.

6.5 Archaeological sensitivity model

EMM developed an archaeological sensitivity model using the implications of previous nearby assessments (primarily the Quarry) combined with the results gathered from the results of the archaeological investigation for the Limestone Mine SSD ACHA. The archaeological sensitivity model has been developed as a guide to indicate subsurface archaeological potential, with the primary aim of guiding the management and mitigation measures for the Limestone Mine SSD and by extension, the proposed modification – ie where to focus salvage excavation measures.

The Limestone Mine SSD Project site has been divided into three levels of archaeological sensitivity. The areas of archaeological sensitivity are described below:

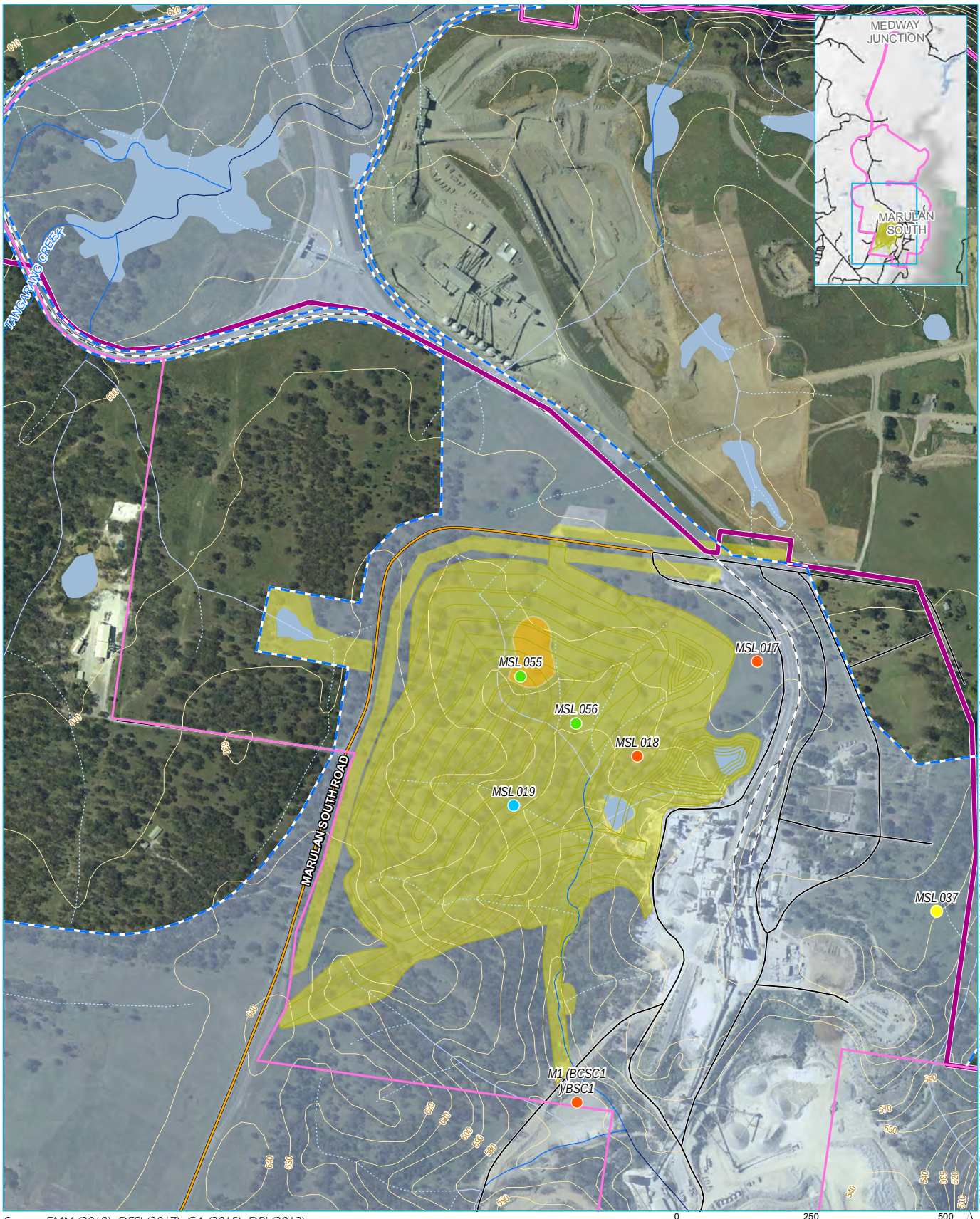
- Low sensitivity (not mapped): although surface artefacts may occur in these areas, subsurface artefact frequencies are expected to be very low (less than 2 artefacts per metre squared). This is primarily related to skeletal soils and ephemeral drainage networks. This also includes areas of disturbance and depressions which sometimes separate areas of moderate or high sensitivity, such as certain areas adjacent to Marulan Creek.

- Moderate sensitivity:
    - land within 200 m of Marulan Creek on flat or undulating landforms (not prominent) shown to feature sporadic incidences of artefact frequencies of approximately 10 artefacts per square metre; and
    - the spur crest surrounding site MSL 055 in the study area which is on an anomalous landscape context; being a relatively flat spur in an area where the landscape starts its transition from the rolling hills associated with the archaeologically sensitive Peppertree Quarry to the much steeper terrain of the study area (Figure 6.4). This area was shown to have an average artefact density of 13 artefacts per square metre.
- High sensitivity: the broad prominent crests surrounding Marulan Creek. This area was found to have 174 artefacts at one location (TP15) and an average of 28 artefacts per square metres across the pits associated with this area. No areas of high sensitivity occur in the study area.

Figure 6.4 shows the area of moderate sensitivity within the study area. It does not show the areas of moderate and high sensitivity around Marulan Creek. The areas not mapped with the sensitivity layer in Figure 6.4 are considered to have low archaeological sensitivity.

6.6 Historical heritage

Field survey conducted by EMM for the Limestone Mine SSD in April 2015 included the study area. During the survey, a number of heritage items were identified, primarily items associated with the mining history of the area, such as lime kilns, aerial ropeway towers, rail tracks and cottages. However, no items of historic heritage significance were identified within the study area.



\\EMMSVR1\emmJobs\2017\J17374 - Peppertree Mod 5 AH\GIS\02_Maps_ACHA\ACHA008_ArchSensitivity_20180606_03.mxd 6/06/2018

Source: EMM (2018); DFSI (2017); GA (2015); DPI (2013)

KEY

- Boral Resources boundary
- Peppertree Modification 5
- Peppertree Quarry consent boundary (proposed amendment)
- Peppertree Modification 5 disturbance footprint
- Peppertree Modification 5
- Proposed pit design
- Limestone Mine SSD project boundary
- AHIMS site type
- Artefact scatter
- Isolated find
- Not a scar tree
- Subsurface artefact deposit
- Archaeological sensitivity
- Moderate
- Rail line
- Main road
- Local road
- Contour (10 m)
- Waterbody
- Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order

Area of archaeological sensitivity in the project area

Peppertree Modification 5
Aboriginal cultural heritage assessment
Figure 6.4

EMM

7 Significance assessment

7.1 Aboriginal heritage significance

7.1.1 Socio-cultural value: significance to the Aboriginal community

Research and consultation with the Aboriginal community was conducted to determine whether any socio-cultural heritage value relates specifically to the study area regardless of archaeological evidence. This was completed for the Limestone Mine SSD ACHA. While it is accepted that the broader landscape is of significance to Aboriginal people, this study sought to identify whether the study areas held specific values either in themselves, or as part of a specific local area of particular significance.

Efforts to undertake cultural mapping and further understand the significance of this area to the Aboriginal community have occurred during previous Aboriginal heritage assessments by ERM in 2006 and 2011. To date, no information has been received that identifies specific heritage value unrelated to the Aboriginal sites. Aboriginal heritage sites with archaeological evidence are all of value to the Aboriginal community through the tangible connection that they represent to past Aboriginal land use.

7.2 Scientific value

7.2.1 Overview

The following scientific values are identified as 'low', 'moderate' or 'high' for each identified Aboriginal site with an overall rating identified based on the results of each individual assessment. The significance criteria are outlined below:

- Research potential: the potential of a site to contribute to the present understanding of society and the human past.
- Rarity and representativeness: the frequency of a site type and how the sites relate to the wider archaeological record. The results may be due to sites being uncommon because of the related activity or preservation, or they are uncommon now because of ongoing site destruction from more recent development.
- Integrity: the level of disturbance or intactness of a site and how this may affect research potential.
- Education potential: the potential of a site to be used as an educational tool. This usually includes sites with easily identifiable and accessible characteristics that are good representative examples.

The scientific significance of the sites in the study area are summarised in Table 7.1.

Table 7.1 Statements of significance for sites in the study area

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 017	Artefact scatter	Low - sparse assemblage	Low - common type	Low - impact from erosion and clearing	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low

Table 7.1 Statements of significance for sites in the study area

Site Name	Site type	Research potential	Rarity	Integrity	Research themes	Educational value	Overall significance level
MSL 018	Artefact scatter	Low – surface artefacts on skeletal soils	Low - common type	Low - impact from erosion and clearing	Low - common types	Low - common types, sparse assemblage	Low
MSL 019	Isolated find	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low
MSL 055	Subsurface artefact deposit	Moderate - further excavation in surrounding area of sensitivity could add to further information about the Aboriginal occupation in the landscape of Marulan South	Moderate unique artefact concentration in local landscape	Moderate - impact from erosion and cattle grazing	Moderate - production process elements	Low – common type	Moderate
MSL 056	Subsurface artefact deposit	Low - sparse assemblage	Low - common type	Low - impact from erosion, cattle and flooding	Low - common types, sparse assemblage	Low - common types, sparse assemblage	Low

7.3 Historic heritage significance

No historic heritage evidence was uncovered during the research phase or field survey in the study area and as such no further significance assessment is required. No areas of historic views or community heritage value have been identified.

8 Impact assessment

8.1 Sources of development impact

The proposed modification will result in impacts to Aboriginal objects. The following ground disturbance activities have the potential to impact known and unknown Aboriginal objects in the study area:

- the covering of areas by overburden emplacement; and
- construction of infrastructure including haul roads, the relocated section of powerline and water management structures.

8.2 Definition of impact types

Aboriginal sites can be impacted to varying degrees: disturbance, where artefacts are moved locally from their original setting, is distinguished from loss where artefacts will be removed or destroyed.

Loss entails complete removal of a site's elements, such as large scale earthworks. The total modification of a landscape can also constitute loss, even if artefacts are collected and later returned to the modified surface in their original positions, because the context (an integral part of archaeological site value) is irretrievably lost. Total loss is when the entirety of a site will be lost as a result of the proposed modification. Partial loss describes the loss of a section of a site. It may also experience some loss of significance as a result of the loss of some of its components.

This report has defined the impacts from overburden emplacement as loss. The creation of an emplacement involves truck movements, the deposition of large amounts of soil, landscaping and landform rehabilitation. Artefacts below the surface will not be retrievable once the emplacement is created.

Previous investigations on the short term impacts of emplacement areas (in cases where the topsoil is not stripped prior to emplacement) (KNC 2012 and 2013) indicate that while some compaction of the ground is evident, the artefact themselves remain intact beneath layers of soil if separated by a synthetic barrier. However, without using a barrier it was anticipated that the deposit would degenerate and devalue over time as bioturbation causes the stockpiled soils to mix with the archaeological deposit. This loss of a secure context would reduce the scientific value of the site and make the original site almost irretrievable.

8.3 Impacts to Aboriginal objects

All five sites within the study area (MSL 017, MSL 018, MSL 019 MSL 055, MSL 056) and the area of moderate sensitivity will be impacted by the construction of the SWOE. This will constitute total loss. Although the disturbance footprint shown on Figure 6.1 does not overlap with MSL 017 at present, the site will be impacted when the SWOE is increased in size as part of the Limestone Mine SSD. As such this report acknowledges that MSL 017 will be impacted rather than stating that it will be avoided temporarily and then impacted by the Limestone Mine SSD.

8.4 Measures to minimise harm and alternatives

Overburden emplacement at the Quarry is approved in:

- noise bunds along the northern and eastern boundaries of the site;

- Western Overburden Emplacement;
- Southern Overburden Emplacement;
- Eastern Overburden Emplacement; and
- noise bund to the west of the Quarry that crosses Marulan South Road between Boral's private railway line and the entrance to the Quarry.

Remaining overburden was proposed to be emplaced within the south pit of Boral's adjoining Limestone Mine.

The noise bunds were completed during construction of the Quarry, the Eastern Overburden Emplacement will reach capacity in 2017 and the Western Overburden Emplacement will be completed by late 2018.

Mine planning for the Limestone Mine has ruled out emplacement of the Quarry's remaining overburden in the south pit. There is substantial limestone remaining in the south pit and extraction of this will continue beyond the Quarry's need for additional overburden emplacement space. Additionally, as much in-pit space as possible needs to be created in the south pit to minimise the need for future out of pit emplacements at the Limestone Mine.

The Limestone Mine, under its forthcoming development application, was seeking to hold 5 million m^3 (approximately 15 Mt) of overburden for the Quarry. However, the Mine's SSD application is unlikely to be determined until 2019. As the Quarry will run out of overburden emplacement space in 2018, Boral is seeking approval to incorporate this approximately 15 Mt overburden emplacement into the Quarry's project approval.

The proposed location for the SWOE is not over any granodiorite resources, which means it will not prevent future access to granodiorite resources.

Alternative locations for the SWOE on Boral owned land were considered and discounted on noise or logistical grounds. These alternatives included:

- A patch of Boral owned land (within the Peppertree Quarry consent boundary) bordered by the Western Overburden Emplacement to the north-east, Boral's private railway line to the north, the agricultural lime manufacturing facility to the west, the agricultural lime manufacturing facility's driveway to the south and Marulan South Road to the east. This site was discounted as it:
  - is located significantly closer to sensitive receivers than the proposed SWOE site, with associated noise implications; and
  - requires a longer haulage distance resulting in greater dust and greenhouse gas emissions.
- An area of Boral owned land (within the Peppertree Quarry consent boundary) located immediately north of Tangarang Creek. This site was discounted as it:
  - is located closer to sensitive receivers than the proposed site, with associated noise implications;
  - is likely to be of higher aboriginal heritage significance due to its proximity to a prominent creek – Tangarang Creek;

- is logistically more complex as trucks need to drive through the processing plant and cross the Tangarang Dam wall to access the site; and

- is the location of an additional approved water supply dam for the Quarry.

The location for the proposed SWOE was therefore selected as the preferred location due to the following:

- it is located the furthest from noise sensitive receivers;
- trucks don't need to drive through the processing plant and cross the Tangarang Dam wall; and
- the site has limited Aboriginal heritage values. Apart from the area of moderate archaeological sensitivity surrounding MSL 055, the landscape chosen for the emplacement is more ideal than to the north or west where the landscape transitions from incised to gently undulating, which would be of higher archaeological sensitivity than the generally moderate to steep terrain of the study area.

8.5 Ecologically sustainable development

Aboriginal heritage management is based on the principle of intergenerational equity which has the intention to ensure present generations consider future generations when making management decisions. This principle is possibly the most relevant part of the notion of ecologically sustainable development (ESD) when considering Aboriginal heritage management.

While it is acknowledged that the proposed modification is for activities that are common in the region and will result in additional impacts to Aboriginal heritage, the proposed management measures, including collection of all surface sites and salvage excavation of more significant areas within the impact footprint are anticipated to provide detailed information about the Aboriginal heritage of the study area to ensure all information about the Aboriginal history of the area is not lost. This will contribute to intergenerational equity by allowing retention of cultural materials for the enjoyment and education of future generations.

Additionally, areas adjacent the Quarry and in both the Bungonia National Park and the Moreton National Park, which include highly sensitivity archaeological sites, have been set aside for passive management and protection to ensure the area retains a record of Aboriginal sites and landscapes. The preservation of these areas will ensure that a record of Aboriginal sites is preserved in its landscape for future generations.

8.6 Cumulative impact

Unavoidable harm to Aboriginal objects is acknowledged as a result of the proposed modification. While quarrying and mining has resulted in impacts to sites in the region, the management and mitigation of impacted sites through archaeological excavation, collection and consultation with the Aboriginal community has contributed to our understanding of the Aboriginal past in this region.

The impacts to Aboriginal objects by the proposed emplacement within the study area will not substantially add to the cumulative impact on a local or regional level, primarily because of the typically low scientific significance of the sites within this area. These sites are primarily surface expressions of artefacts on eroded and skeletal soils. Apart from providing evidence that Aboriginal people occupied this landscape, these sites provide little further information.

However, salvage of site MSL 055 (moderate significance) may give insight into why discrete areas were occupied in preference of others, or if the results are dependent on environmental conditions.

An additional 41 sites will be impacted as part of the Limestone Mine SSD. However, the cumulative impact of this more extensive development is addressed as part of the Limestone Mine SSD (EMM 2018 in draft).

8.7 Historic heritage impact assessment

The modification will not impact known historic heritage as no evidence of historic heritage items were found in the study area.

9 Management

9.1 Aboriginal heritage

9.1.1 Management framework

The proposed modification will share part of its project boundary with the Limestone Mine SSD Project site. It was initially planned for the Aboriginal cultural heritage values within the study area to be managed under development consent for the Limestone Mine SSD. However, as it is anticipated that the proposed modification will be approved prior to the Limestone Mine SSD, it means that the management measures relevant to the study area need to be brought forward to be carried out under the development consent for the proposed modification.

Aboriginal heritage consultation and management for the Quarry is undertaken in accordance with the AHMP for the Quarry. Aboriginal consultation protocols and procedures for the Quarry is directed by the AMC.

9.1.2 Update Peppertree Quarry AHMP

The Aboriginal heritage management measures for the proposed modification will be incorporated into an updated version of the existing Peppertree Quarry AHMP (current version – April 2017). The AHMP will be updated to include a chapter specific to the management measures for the proposed modification.

The management measures will be implemented under the direction of Boral, the AMC, Marulan Limestone Min SSD RAPs and suitably qualified archaeologists. The AHMP prescribes specific consultation and unexpected finds protocols which are not repeated in this assessment, including the discovery of new sites, and skeletal remains protocols.

9.1.3 Collection

All surface artefact sites (artefact scatters and isolated finds) in the study area will be collected by an archaeologist and members of the Aboriginal community. Sites MSL 017, MSL 018 and MSL 019 will be collected prior to overburden emplacement at these sites.

The entire extent of each site will be collected into labelled bags recording the site name, location and collection date. Collected Aboriginal objects will be retained in accordance with the AHMP which states that they will be under Boral management in a secured area prior to being buried in designated locations. The specific location for reburial is not yet determined (Boral 2017, Section 4.11).

9.1.4 Salvage excavation

Site MSL 055 and its surrounding area of moderate archaeological sensitivity will be subject to salvage excavation. The salvage excavation measures and scope are consistent with those proposed as part of the Limestone Mine SSD ACHA which is summarised below.

Salvage excavation will aim to retrieve the most significant portions of the site and will involve a two stage process of further sampling followed by open area excavation. All salvage excavation will be completed by hand digging.

The first phase will involve further sampling using regularly spaced 1 metre squared pits dug to the base of the topsoil layer in each area of investigation to understand the spatial distribution of artefacts across the area of archaeological sensitivity. Excavation will be undertaken manually in designated salvage pits.

The information from the first phase will be used to expand areas in to open area excavation. Expansion of pits will be based on the following:

- evidence of hearths or other features; and
- in the event that an artefact density of 50 artefacts or above is encountered in a 1 metre square, then at least one of the squares with such evidence will be expanded into an open area within the site being investigated. The final scope of the salvage areas will be determined during the update of the AHMP which will allow flexibility so that decisions can be made during fieldwork dependent on the results. If an artefact density of 50 artefacts or above is not identified in the area of moderate archaeological sensitivity (MSL 055), then the pit(s) with the highest artefact frequencies will be expanded.

The use of a density of 50 artefacts as a benchmark for the expansion of excavation areas is based on the archaeological character of the region, with particular attention paid to excavations at the nearby Peppertree Quarry. The regional archaeological context has artefacts of over 20 per square meter as evidence of moderate to high artefact density (see Lynwood Quarry excavations). However, the similar landscape of the Peppertree Quarry excavations at Tangarang Creek with artefact densities of between 70 and 100 per square metres were evidence of high artefact density with some areas displaying very high artefact density of between 100 and 200 artefacts per square meter (ERM 2012). Furthermore, preliminary data from recent salvage excavation at Peppertree Quarry has identified some 1 m x 1 m squares with concentrations between 500 and 1000 artefacts and one pit with a total of 1722 artefacts (Boral 2017). Using this data it can be suggested that regionally low artefact density is under 10 artefacts, moderate artefact density is between 10 and 50 artefacts and high artefact density is above 50 artefacts. As such, 50 artefacts uncovered in a 1 m^2 area are likely to correlate to moderate or high artefact densities warranting a stronger focus of the archaeological investigation.

Excavation will cease once a significant drop off in artefact frequencies is encountered in an expanded area (possibly indicating the boundary of specific activity areas), or if an area of approximately 10 m^2 is reached. Open area excavation can continue in special cases, particularly if high densities continue within the Project impact areas or certain features require further investigation.

If suitable conditions are identified, excavation will also aim to obtain suitable samples for use-wear analysis, radiocarbon dating and pollen analysis. Where feasible and water is available, wet sieving may occur.

The artefacts salvaged as part of the archaeological excavation and collection program will be subject to attribute analysis to understand manufacturing technology, site function and to compare the assemblage to studies completed in the wider region.

9.1.5 Unmitigated impacts

Unmitigated impacts will apply to MSL 056. This is the most appropriate option as there are no surface objects to collect and the site comprises only subsurface material of low scientific significance. This site does not warrant further investigation or salvage.

9.1.6 Monitoring considerations

No topsoil monitoring is proposed for the study area. This measure is in keeping with the existing AHMP management of approved overburden emplacements for the Quarry where no monitoring has been undertaken: ie MQ18 and MQ26 and the land covering the Modification 4 footprint (refer Boral 2017, section 4.4, 4.5 and 4.10).

9.2 Historical heritage management

If unexpected historical archaeology is discovered during construction, work in the immediate area must cease and an archaeologist must be contacted to make an assessment of the find. If it is determined to be a relic under the Heritage Act, further investigation may be required. Examples of unexpected finds may include consolidated bricks, sandstone blocks and artefact deposits.

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Appendix A

Aboriginal consultation

27February 2018

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Re: Proposed changes to the Marulan South Limestone Mine Continued Operations Project. Peppertree Quarry Modification 5 – proposed Aboriginal cultural heritage assessment and consultation approach.

Dear Registered Aboriginal Party

1 Introduction

Thank you for your continued contribution to the consultation process for the Marulan South Limestone Mine Continued Operations Project (Limestone Mine) Aboriginal cultural heritage assessment . This letter provides an update on the recent changes to the proposed mine operations and how they relate to the Aboriginal cultural heritage assessment.

2 Overview of changes

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South which is directly north and north-east of the Limestone Mine.

Boral is seeking to modify the current Project Approval (PA 06_0074) of the Quarry under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to provide for the following which are shown on Figure 1:

- develop a new overburden emplacement area (South-western Overburden Emplacement or SWOE);
- amend the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (previously approved but yet to be constructed);
- relocate a powerline; and
- provide a new haulage route from the southern extent of the pit to the new overburden emplacement.

The proposed modification to the Quarry is referred to as Modification 5 (MOD 5). Note that the final disturbance boundary of the South West Overburden Emplacement may extend beyond to the proposed footprint shown in yellow in Figure 1.

MOD 5 is proposed within the same area of the Northern Overburden Emplacement and Road Sales Stockpile Area proposed for the Limestone Mine. This change will effectively make the MOD 5 project boundary overlap with parts of the Limestone Mine project boundary. This overlap is best shown by the

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white shaded area on Figure 1. Furthermore, the proposed MOD 5 Western Overburden Emplacement area was previously assessed and approved for development under Modification 2 of the Quarry.

The Quarry overburden is currently approved to be placed in the south pit of the Limestone Mine, however, due to future requirements of the Limestone Mine, this can no longer occur. The overlap of the MOD 5 and Limestone Mine boundaries is the result of the Quarry needing to place overburden somewhere else in the Limestone Mine project boundary in the short term. Due to timing delays for the Limestone Mine State Significant Development (SSD) application, it is not possible to wait until the Limestone Mine SSD is approved. As such, the Limestone Mine Northern Overburden Emplacement area will be incorporated into the Peppertree Quarry project approval.

3 What does this mean for the Aboriginal cultural heritage assessment?

3.1 Previous assessment

The MOD 5 area has already been assessed for Aboriginal cultural heritage values. The proposed WOE (north of Marulan South Road) was previously assessed by ERM in 2006 as part of the Aboriginal cultural heritage assessment for the Peppertree Quarry. This area was originally planned for loading facilities, processing plant and stockpiling, but was modified and approved in 2011 to be the location for overburden emplacement (Modification 2).

The proposed South Western Overburden Emplacement was previously surveyed and test excavated as part of the Limestone Mine Aboriginal cultural heritage assessment in 2015. This included fieldwork participation by registered Aboriginal parties (RAPs) for the Limestone Mine. Five Aboriginal sites were identified in this area, comprising two artefact scatters (MSL 017 and MSL 018), one isolated artefact (MSL 019) and two subsurface deposits identified during the test excavation (MSL 055 and MSL 056).

3.2 Proposed assessment

EMM will prepare an Aboriginal cultural heritage assessment report for Peppertree's MOD 5, which will be based on the results of the Limestone Mine Aboriginal cultural heritage assessment for the previously proposed Northern Overburden Emplacement. No further survey or test excavation is proposed because the disturbance footprint is within previously assessed areas.

The impact assessment and management recommendations for the sites within the MOD 5 boundary are consistent with those presented in the draft Aboriginal cultural heritage assessment for the Limestone Mine, which are summarised in Table 1.

Table 1 Summary for sites within the MOD 5 area

Site name	Site type	Significance	Impact	Management
MSL 017	Artefact scatter	Low	Loss from emplacement	Collection
MSL 018	Artefact scatter	Moderate	Loss from emplacement	Collection
MSL 019	Isolated artefact	Low	Loss from emplacement	Collection
MSL 055	Subsurface deposit	Moderate	Loss from emplacement	Salvage excavation
MSL 056	Subsurface deposit	Low	Loss from emplacement	Unmitigated impact (no surface collection possible as artefacts were recovered from test excavation)

Draft

3.3 Aboriginal consultation approach

Aboriginal consultation for the Quarry is currently directed through an Aboriginal Heritage Management Committee (AMC) where protocols and procedures are followed under an approved Aboriginal heritage management plan. As the MOD 5 and Limestone Mine project boundaries now overlap, the AMC will be included in consultation for MOD 5 along with RAPs for the Limestone Mine. The plan for ongoing consultation is as follows:

- Once drafted, the AMC and Limestone Mine RAPs will be invited to review and comment on the MOD 5 Aboriginal cultural heritage assessment.
- The MOD 5 Aboriginal cultural heritage assessment will be updated and finalised once the review period is over. A final version will be sent to the AMC and Limestone Mine RAPs.
- It is predicted that MOD 5 will be approved before the Limestone Mine SSD. As such, the management measures presented in the MOD 5 Aboriginal cultural heritage assessment will be incorporated into the Peppertree Quarry Aboriginal heritage management plan.. The AMC will not be expanded to include Limestone Mine RAPs who are not already members of the AMC.
- The AMC, Boral and qualified archaeologists will be responsible for implementing the proposed management measures. The salvage measures required in the MOD 5 area make up only a minor portion of the overall salvage measures proposed for the Limestone Mine. The majority of salvage measures are still proposed as part of the Limestone Mine SSD, which will include fieldwork involvement with the RAPs for the Limestone Mine SSD. This will involve four other areas of salvage excavation in areas of high archaeological sensitivity, and surface collection of 29 other sites as part of the Limestone Mine.
- Once the Limestone Mine SSD is approved, the remaining sites within the Limestone Mine will be managed in consultation with the Limestone Mine RAPs. It is anticipated that a separate Limestone Mine Aboriginal heritage management plan will be prepared subsequent to development consent. This will provide opportunities for suitably qualified RAPs to participate in fieldwork.

3.4 What's next?

A draft of the MOD 5 Aboriginal cultural heritage assessment will be sent to Limestone Mine RAPs and the AMC in the following months. Furthermore, an updated version of the Limestone Mine Aboriginal cultural heritage assessment will be provided to Limestone Mine RAPs shortly after, reflecting some minor development changes.

Each RAP will be invited to review and comment on these reports.

3.5 Closing

Thank you for taking the time to read this letter. The draft MOD 5 Aboriginal cultural heritage assessment will provide more detailed information for your consideration, but please do not hesitate to contact me on my details below if you have any questions in the interim.

Yours sincerely,

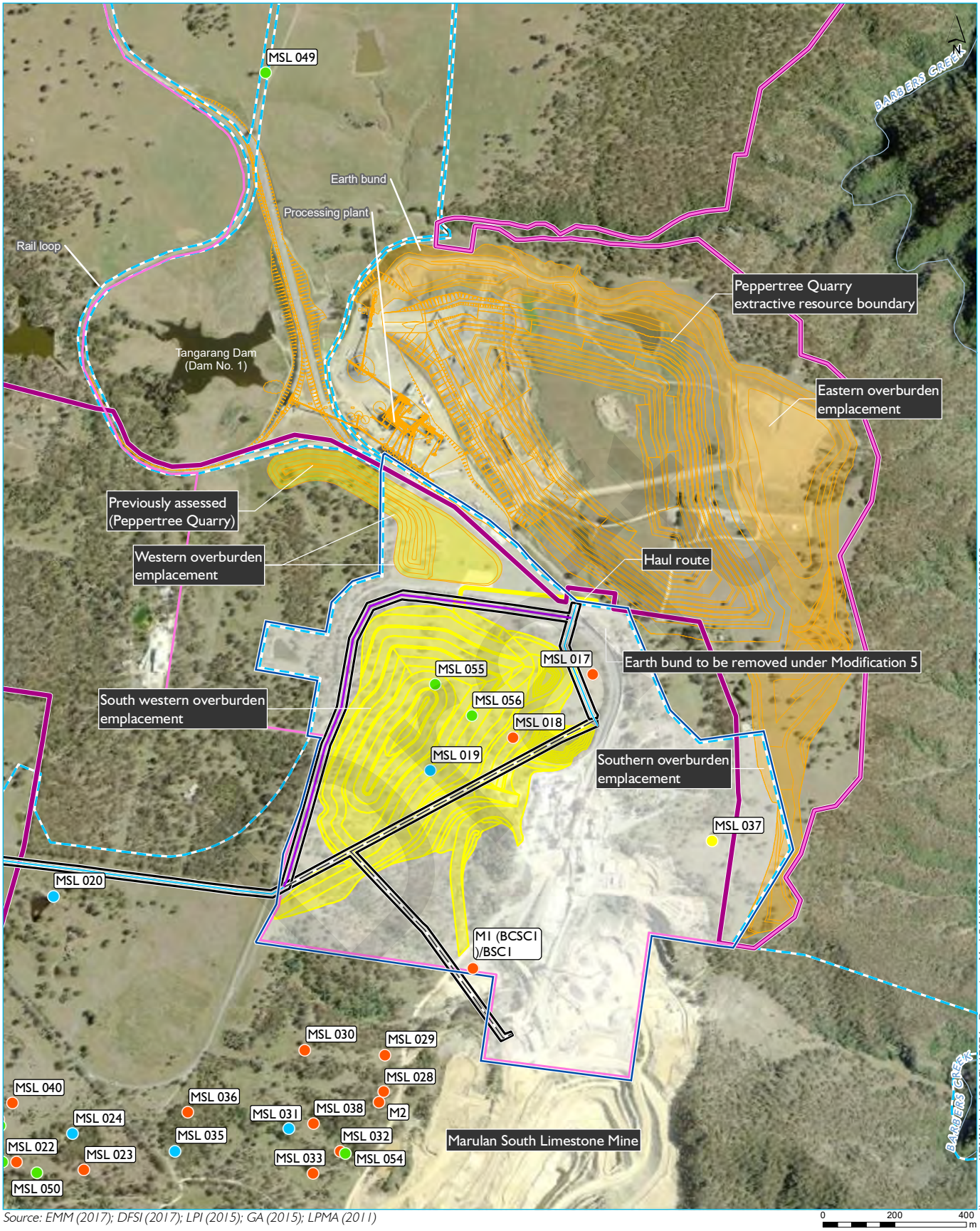
Ryan Desic



Draft

Ryan Desic
Senior Archaeologist
rdesic@emmconsulting.com.au
02 9493 9541

Draft



Source: EMM (2017); DFSI (2017); LPI (2015); GA (2015); LPMA (2011)

0 200 400 m
GDA 1994 MGA Zone 56

KEY

Site type
- Artefact scatter
- Isolated find
- Not a scar tree
- Subsurface artefact deposit
- Marulan South Limestone Mine boundary

Peppertree Quarry
- Approved project
- Boral Resources boundary

Modification 5
- Proposed
- Peppertree Quarry consent boundary (proposed amendment)

- High voltage powerline relocation
- HV powerline (existing to be retained)
- High voltage powerline (existing)
- High voltage powerline easement
- Project overlap

Peppertree Quarry Modification 5 and its relation to the Marulan South Limestone Mine

Peppertree Quarry MOD 5

Figure 1

EMM

9 April 2018

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St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

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F +61 2 9493 9599
E info@emmconsulting.com.au

www.emmconsulting.com.au

Re: Peppertree Quarry Modification 5 – Aboriginal consultation approach update

Dear Registered Aboriginal Party,

1.1 Proposed amendment

This letter proposes an amendment on the Aboriginal consultation approach for the Peppertree Quarry Modification 5. The consultation approach was previously described in the letter dated 27 February 2018 *"Proposed changes to the Marulan South Limestone Mine Continued Operations Project. Peppertree Quarry Modification 5 – proposed Aboriginal cultural heritage assessment and consultation approach."*

The amendment relates specifically to Section 3.3 – *Aboriginal consultation approach* dot point four presented in the previous letter:

- "The AMC, Boral and qualified archaeologists will be responsible for implementing the proposed management measures. The salvage measures required in the MOD 5 area make up only a minor portion of the overall salvage measures proposed for the Limestone Mine. The majority of salvage measures are still proposed as part of the Limestone Mine SSD, which will include fieldwork involvement with the RAPs for the Limestone Mine SSD. This will involve four other areas of salvage excavation in areas of high archaeological sensitivity, and surface collection of 29 other sites as part of the Limestone Mine."

Subsequent to RAP feedback and further discussions with Boral, the decision has been made to invite suitably qualified Limestone Mine SSD RAPs (along with the Peppertree Quarry Aboriginal Heritage Management Committee (AMC)) to the proposed salvage fieldwork in the MOD 5 area. This approach is inclusive for all Aboriginal groups and consistent with that originally planned in the area prior to proposed MOD 5 development.

In practical terms, it is anticipated that the Peppertree Quarry Aboriginal heritage management plan will be updated with a separate chapter for the MOD 5 development which will include provisions and procedures specific to the MOD 5 area. As stated in the previous letter, the AMC membership will not be expanded to include Limestone Mine RAPs who are not already members of the AMC.

1.2 Closing

Thank you for your participation so far. The draft MOD 5 Aboriginal cultural heritage assessment will provide more detailed information for your consideration, but please do not hesitate to contact me on my details below if you have any questions in the interim.

Yours sincerely,



Ryan Desic
Senior Archaeologist
rdesic@emmconsulting.com.au
9493 9541

Draft

Appendix B

AHIMS search results

AHIMS Web Services (AWS)
Search Result

Your Ref Number : J14107 - Marulan 3

Client Service ID : 146358

EMGAMM-St Leonards (previously EMGA)

Ground Floor, Suite 01 20 Chandos Street
St Leonards New South Wales 2065

Attention: Rebecca Newell

Email: rnewell@emgamm.com

Date: 01 September 2014

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters, conducted by Rebecca Newell on 01 September 2014.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

112	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

PO BOX 1967 Hurstville NSW 2220
43 Bridge Street HURSTVILLE NSW 2220
Tel: (02)9585 6345 (02)9585 6471 Fax: (02)9585 6094

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14107 - Marulan 3

Client Service ID : 146358

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0102	Isolated Find 3	AGD	55	777420	6153370	Open site	Valid	Artefact : -	Isolated Find	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0101	Isolated Find 2	AGD	55	774550	6152900	Open site	Valid	Artefact : -	Isolated Find	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
52-4-0027	Dungeon Creek Quarry;	AGD	56	234810	6148750	Open site	Valid	Stone Quarry : -, Artefact : -	Quarry	
	Contact	**Recorders**	Mr.Doug Williams,Ms.Sue Feary					**Permits**		
52-4-0002	South Marulan;Caoura;	AGD	56	233778	6148430	Closed site	Valid	Grinding Groove : 1, Art (Pigment or Engraved) : -	Shelter with Art	
	Contact	**Recorders**	Kinsella					**Permits**		
51-6-0091	Marulan 6	AGD	55	774310	6153270	Open site	Valid	Artefact : -	Open Camp Site	3605,99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0059	Marulan Quarry 1	AGD	55	771860	6152890	Open site	Valid	Artefact : -	Open Camp Site	1995,99404
	Contact	**Recorders**	Peter Higgins,J Klavin,Kerry Navin					**Permits**		
51-6-0086	Marulan 1	AGD	55	774500	6153130	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0087	Marulan 2	AGD	55	774530	6153100	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0088	Marulan 3	AGD	55	774630	6153170	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0089	Marulan 4	AGD	55	774510	6153000	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0090	Marulan 5	AGD	55	774380	6153800	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0092	Marulan 7	AGD	55	774220	6153450	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0093	MF 1 - Winfarthing Road	AGD	55	765080	6151200	Open site	Valid	Artefact : -	Isolated Find	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0094	MF 3 - Narambulla Creek	AGD	55	765870	6151120	Open site	Valid	Artefact : -	Open Camp Site	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.

Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0095	MF 2 - Winfarthing Road	AGD	55	765190	6151120	Open site	Valid	Artefact : -	Isolated Find	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**	1607	
51-6-0096	MF 4 - Narambulla Creek	AGD	55	765950	6150620	Open site	Valid	Artefact : -	Open Camp Site	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0097	MF 5 - Narambulla Creek	AGD	55	765700	6150360	Open site	Valid	Artefact : -	Open Camp Site	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0098	MF 6 - Narambulla Creek	AGD	55	765590	6150170	Open site	Valid	Artefact : -	Isolated Find	99404,102090,102091,102092
	Contact	**Recorders**	Mr.Charles Dearling					**Permits**		
51-6-0103	Isolated Find 1	AGD	55	774500	6153170	Open site	Valid	Artefact : -	Isolated Find	99404
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0104	Isolated Find 4	AGD	55	774550	6152900	Open site	Valid	Artefact : -	Isolated Find	
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**		
51-6-0105	Marulan ER Site 1	AGD	55	774500	6153220	Open site	Valid	Artefact : -	Open Camp Site	99404
	Contact	**Recorders**	Miss.Jackie Taylor					**Permits**		
51-6-0060	Marulan Quarry 2	AGD	55	772450	6153000	Open site	Valid	Artefact : -	Open Camp Site	1995,99404,100613,100615,100637,101183
	Contact	**Recorders**	Kerry Navin					**Permits**	2760,2761	
51-6-0242	MRN1	AGD	55	773179	6153116	Open site	Valid	Artefact : 3		
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0243	MRN2	AGD	55	773077	6153038	Open site	Valid	Artefact : 6		
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0244	MRN3	AGD	55	773043	6152939	Open site	Valid	Artefact : 8		
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0245	MRN4	AGD	55	772313	6152581	Open site	Valid	Artefact : 6		100614
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**		
51-6-0246	MRN5	AGD	55	772404	6152969	Open site	Valid	Artefact : 6		100613,100615,100637,101183
	Contact Searle	**Recorders**	Mr.Graham Houghton					**Permits**	2760,2761	

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0249	MRN8	AGD	55	771061	6153668	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0250	MRN9	AGD	55	771252	6153592	Open site	Valid	Stone Arrangement : -		
	Contact Mr.Bill Hardie	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0251	MRN 10	AGD	55	771106	6153698	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0252	MRN 11	AGD	55	771093	6153692	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0254	MRN 13	AGD	55	771280	6153826	Open site	Valid	Artefact : 20		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0259	MRN18	AGD	55	772327	6153801	Open site	Valid	Artefact : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0262	MRN21	AGD	55	771559	6153669	Open site	Valid	Artefact : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0263	MRN22	AGD	55	771713	6153691	Open site	Valid	Artefact : 11		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
51-6-0265	MRN24	AGD	55	771946	6153098	Open site	Valid	Artefact : 1		
	Contact Searle	**Recorders** Mr.Graham Houghton						**Permits**		
48-4-0086	DP1056566 Lot 11/1	AGD	56	225675	6148350	Open site	Valid	Artefact : 12		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**	2536,2675,2676	
48-4-0087	DP1056566 Lot 11/2	AGD	56	226075	6148875	Open site	Valid	Artefact : 37		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**	2536,2675,2676	
48-4-0088	DP1056566 Lot 11/3	AGD	56	226000	6148750	Open site	Valid	Artefact : 3		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**	2536,2675,2676	
48-4-0089	DP1056566 Lot 12/1	AGD	56	225875	6147475	Open site	Valid	Artefact : 21		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**		
48-4-0090	DP1056566 Lot 12/2	AGD	56	225875	6147625	Open site	Valid	Artefact : 8		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**		
48-4-0091	DP1056566 Lot 12/3	AGD	56	225875	6147625	Open site	Valid	Artefact : 8		99346,99362
	Contact T Russell	**Recorders** Mr.Doug Williams						**Permits**		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
48-4-0092	DP1056566 Lot 12/IF1	AGD	56	225800	6147780	Open site	Valid	Artefact : 1		99346,99362
	Contact T Russell	**Recorders**	Mr.Doug Williams					**Permits**		
48-4-0093	DP1056566 Lot 12/IF2	AGD	56	225750	6147800	Open site	Valid	Artefact : 1		99346,99362
	Contact T Russell	**Recorders**	Mr.Doug Williams					**Permits**		
51-6-0378	LA 23	AGD	55	769978	6153907	Open site	Valid	Artefact : 2		99620
	Contact Searle	**Recorders**	Archaeological Heritage Surveys					**Permits**		
51-6-0381	LA 26	AGD	55	770030	6153824	Open site	Valid	Artefact : 1		99620
	Contact Searle	**Recorders**	Archaeological Heritage Surveys					**Permits**		
52-4-0143	MSQ 1	GDA	56	228406	6149690	Open site	Destroyed	Artefact : -		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0144	MSQ2	GDA	56	228292	6149943	Open site	Destroyed	Artefact : 3		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0145	MSQ3	GDA	56	228625	6149982	Open site	Destroyed	Artefact : 1		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0146	MSQ4	GDA	56	228608	6150001	Open site	Destroyed	Artefact : 1		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0147	MSQ5	GDA	56	228557	6149936	Open site	Destroyed	Artefact : 1		
	Contact Searle	**Recorders**	Mr.Chris Lange,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0148	MSQ6	GDA	56	227050	6150950	Open site	Valid	Artefact : 2		
	Contact Searle	**Recorders**	Mr.Chris Lange					**Permits**		
52-4-0149	MSQ7	GDA	56	227735	6150380	Open site	Valid	Artefact : 2		
	Contact Searle	**Recorders**	Mr.Chris Lange					**Permits**		
52-4-0150	MSQ8	GDA	56	227353	6150223	Open site	Destroyed	Artefact : 9		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0151	MSQ9	GDA	56	227297	6150151	Open site	Destroyed	Artefact : 4		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0152	MSQ10	GDA	56	227252	6150208	Open site	Destroyed	Artefact : 2		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0153	MSQ11	GDA	56	227153	6150213	Open site	Destroyed	Artefact : 8		
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0154	MSQ12	GDA	56	227213	6150319	Open site	Destroyed	Artefact : 1		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		
52-4-0155	MSQ13	GDA	56	227153	6150213	Open site	Destroyed	Artefact : 4		103083
	Contact Searle	**Recorders**	Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont					**Permits**		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
52-4-0156	MSQ14	GDA	56	227414	6150203	Open site	Destroyed	Artefact : 1		103083
	Contact Searle	**Recorders** Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0157	MSQ15	GDA	56	227383	6150181	Open site	Destroyed	Artefact : 1		103083
	Contact Searle	**Recorders** Mr.Neville Baker,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0158	MSQ16	GDA	56	227447	6150191	Open site	Destroyed	Artefact : 2		103083
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0159	MSQ17	GDA	56	227198	6150283	Open site	Destroyed	Artefact : 3		103083
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0160	MSQ18	GDA	56	228576	6150429	Open site	Destroyed	Artefact : -		
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont,ERM Australia Pty Ltd-Pyrmont						**Permits**		
52-4-0161	BCSC1	GDA	56	227944	6148309	Open site	Destroyed	Artefact : -		100467
	Contact Searle	**Recorders** ERM Australia Pty Ltd-Pyrmont						**Permits**	2687,2976	
51-6-0428	Winfarthing Road - Isolated Find - WRIF1	AGD	55	765994	6150702	Open site	Valid	Artefact : 1		
	Contact T Russell	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0429	Winfarthing Road - WR2	AGD	55	765920	6150600	Open site	Valid	Artefact : -		
	Contact T Russell	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0430	Winfarthing Road - WR3	AGD	55	765672	6149673	Open site	Valid	Artefact : 3		
	Contact T Russell	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0422	Winfarthing Road - WR 1	GDA	55	765887	6150772	Open site	Valid	Artefact : 14		
	Contact Searle	**Recorders** Navin Officer Heritage Consultants Pty Ltd						**Permits**		
51-6-0467	Marulan T6 S1	AGD	55	772216	6152641	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0468	Marulan T6 S2	AGD	55	772010	6153579	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0469	Marulan T6 S4	AGD	55	772089	6153660	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0470	Marulan T6 S3	AGD	55	771997	6153599	Open site	Valid	Artefact : 1		100614
	Contact T Russell	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
52-4-0195	M1 (BCSC1)	AGD	56	227940	6148310	Open site	Destroyed	Artefact : -		100467,101390
	Contact	**Recorders** ERM Australia Pty Ltd-Pyrmont						**Permits**	2687,2976	
51-6-0638	MRN73	AGD	55	772847	6152659	Open site	Valid	Artefact : -		
	Contact	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		
51-6-0628	MRN67	AGD	55	772764	6152846	Open site	Valid	Artefact : -		101034
	Contact	**Recorders** Umwelt (Australia) Pty Limited						**Permits**		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
51-6-0631	MRN70	AGD	55	772755	6152859	Open site	Valid	Artefact : -		101034
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0632	MRN71	AGD	55	772797	6152713	Open site	Valid	Artefact : -		101034
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0633	MRN72	AGD	55	772868	6152814	Open site	Valid	Artefact : -		
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0636	MRN76	AGD	55	771409	6153691	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
Contact		Recorders	Umwelt (Australia) Pty Limited					Permits		
52-4-0246	M2	GDA	56	227783	6148128	Open site	Valid	Artefact : 3		
Contact		Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0264	Peppertree Burial 01 (stone arrangement)	GDA	56	227335	6150132	Open site	Valid	Stone Arrangement : 1		
Contact		Recorders	Godden Mackay Logan Heritage Consultants,Doctor.Tim Owen					Permits		
52-4-0265	Peppertree Scarred Tree 02	GDA	56	227874	6150107	Open site	Valid	Modified Tree (Carved or Scarred) : -		
Contact		Recorders	Godden Mackay Logan Heritage Consultants,Doctor.Tim Owen					Permits		
52-4-0266	BCSC AS1	AGD	56	226352	6147944	Open site	Valid	Artefact : 8		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0267	BCSC AS2	AGD	56	226371	6147950	Open site	Valid	Artefact : 2		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0268	BCSC AS3	AGD	56	226381	6147968	Open site	Valid	Artefact : 2		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0269	BCSC AS4	AGD	56	226380	6148020	Open site	Valid	Artefact : 22		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0270	BCSC IF2	AGD	56	226284	6147952	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0271	BCSC IF3	AGD	56	226206	6147767	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0272	BCSC IF4	AGD	56	226182	6147840	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0273	BCSC IF7	AGD	56	226313	6147951	Open site	Valid	Artefact : 1		
Contact		Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0274	BCSC IF8	AGD	56	226313	6147951	Open site	Valid	Artefact : 1		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0275	BCSC IF9	AGD	56	226333	6147978	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0276	BCSC IF11	GDA	56	226354	6147952	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0277	BCSC IF12	AGD	56	226357	6147961	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0278	BCSC IF13	AGD	56	226359	6147974	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0279	BCSC IF14	AGD	56	226386	6147978	Open site	Valid	Artefact : 1		
	Contact	Recorders	RPS Australia East Pty Ltd -Hamilton					Permits		
52-4-0291	MQ 19	GDA	56	227498	6150292	Open site	Valid	Artefact : 1		103083
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0292	MQ 20	GDA	56	227952	6150239	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0293	MQ 21	GDA	56	228103	6150306	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0294	MQ 22	GDA	56	228292	6149943	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0295	MQ 23	GDA	56	227565	6150191	Open site	Destroyed	Artefact : 1		103083
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0296	MQ 24	GDA	56	227864	6150067	Open site	Destroyed	Artefact : 1		103083
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0297	MQ 25	GDA	56	229040	6149327	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0298	MQ 26	GDA	56	228833	6149949	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0299	MQ 27	GDA	56	227770	6150502	Open site	Valid	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0300	MQ 28	GDA	56	228264	6150468	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
52-4-0301	MQ 29	GDA	56	228330	6150417	Open site	Destroyed	Artefact : 1		
	Contact	Recorders	ERM Australia Pty Ltd-Pyrmont					Permits		
51-6-0704	MRN85	GDA	55	771793	6152895	Open site	Valid	Artefact : 1		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14107 - Marulan 3

Client Service ID : 146358

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0705	MRN82	GDA	55	772955	6153079	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0706	MRN83	GDA	55	771622	6153881	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
51-6-0707	MRN84	GDA	55	772089	6153292	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		

Report generated by AHIMS Web Service on 01/09/2014 for Rebecca Newell for the following area at Lat, Long From : -34.77, 149.9 - Lat, Long To : -34.73, 150.1 with a Buffer of 1000 meters.
Additional Info : environmental assessment - Aboriginal cultural heritage assessment. Number of Aboriginal sites and Aboriginal objects found is 112

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Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

New Recording ☒ Additional information ☐

SITE IDENTIFICATION

Site name	BCSC1	**NPWS Site Number**	52-4-0161
Owner/manager	Blue Circle Southern Cement		
Owner Address	Hume St, Marulan South 2579		

LOCATION

Location	Marulan South				
How to get to the site	Access is via Blue Circle Southern Cement mine				
1:250,000 map name	Mossvale			**NPWS map code**	
AMG Zone	56	**AMG Easting**	227944	**AMG Northing**	6148309
Method for grid reference	Hand-held GPS	**Map scale (if method = map)**		**Map name**	Goulburn
NPWS District				**NPWS Zone**	
Portion no.				**Parish**	Marulan

SITE DESCRIPTION

Site type(s)	Stone artefact scatter	**Site type code (NPWS use only)**	

Description of site and contents
CHECKLIST: eg. length, width, depth, height of site, shelter, deposit, structure, element eg. tree scar, grooves in rock.
DEPOSIT: colour, texture, estimated depth, stratigraphy, contents-shell, bone, stone, charcoal, density & distribution of these, stone types, artefact types.
ART: area of decorated surface, motifs, colours, wet,/dry pigment, engraving technique, no. of figures, sizes, patination.
BURIALS: number & condition of bone, position, age, sex, associated artefacts.
TREES: number, alive, dead. likely age, scar shape, position, size, patterns, axe marks, regrowth.
QUARRIES: rock type, debris, recognisable artefacts, percentage quarried

Low density artefact scatter associated with a number of converging minor drainage lines. The artefacts were present in five broad areas. Site boundaries were defined by the study area and the scatter is likely to have extended over a much larger area but has been truncated by mining activity in the past. The majority of artefacts occur close to the drainage lines. The artefacts in each area are listed below.

Location 1(227944E 6148309N) - 3 quartz flakes, 4 silcrete flakes, 1 silcrete broken flake, 1 silcrete flaked piece and 1 FGS (mudstone) broken flake (other fragment).

Location 2 - 6 silcrete flakes, 2 silcrete broken flakes, 1 silcrete broken flake (other fragment), 1 quartz flake and 1 quartz broken flake (proximal fragment).

Location 3 - 3 silcrete flakes, 2 silcrete broken flakes (longitudinal cone split), 1 silcrete broken flake (other fragment) and 1 silcrete core (multidirectional).

Location 4 - 2 silcrete flakes, 1 silcrete broken flake (longitudinal cone split) and 1 silcrete core (multidirectional).

Location 5 (227783E 6148128N) - 3 silcrete flakes, 1 silcrete broken flake (proximal fragment), 1 silcrete broken flake (other fragment) and 1 FGS (chert) flaked piece

Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

SITE ENVIRONMENT

Land form	Drainage line	**Aspect**		**Slope**	
Mark position of the site					
Local rock type		**Land use/effect**	Mining		
Distance from drinking water	within 50 metres	**Source**	ephemeral drainage line		
Resource zone (eg. estuarine, river, forest)		**Vegetation**			
Edible plants		**Faunal resources** (include shellfish)			
Other exploitable resources (eg. ochre)					
Are there other sites in the locality	Yes	**Are they in the Sites Register**	Yes	**Other site types include**	Stone artefact scatters, rockshelters with art

SITE MANAGEMENT

Site condition	Very disturbed	The site has been disturbed by vehicle tracks, grading or heavy machinery and the construction of a haul road for the associated mine.	
Management recommendations	A Section 90 should be obtained and surface collection undertaken.		
Have artefacts been removed from site	No	**When**	
By whom		**Deposited at**	
Consent applied for	☒	**Consent issued**	☐
Date of issue		**Consent number**	

SITE INSPECTION AND RECORDING

Reason for investigation	Continuation of mining operations at Blue Circle Southern Cement Mine.		
Were local Aborigines contacted or present for the recording	☐ Not contacted ☒ Contacted and present ☐ Contacted but not present	**Names and addresses**	Justin Boney (Pejar LALC), Graeme Dobson (United Ngunawal), Tyronne Bell and Bronwyn Ireland-Bell (Buru Ngunawal Aboriginal Corporation) and Dean Delponte (Yurwanga Gundana)
Is the site important to local Aborigines	refer to report (named below)		
Verbal/written reference sources	Marulan South Continuation of Operations Aboriginal Cultural Heritage Assessment	**ASR report number(s)**	C- C-
Photographs taken	Yes	**No of Photos attached**	

Version: June 1998 Data entered by: Date entered:

Aboriginal Sites Register of NSW

52-4-0195.

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

New Recording ☐ Additional information ☐

SITE IDENTIFICATION

Site name	M1	**NPWS Site Number**	
Owner/manager	Blue Circle Southern Cement		
Owner Address			

LOCATION

Location	Marulan South				
How to get to the site	drive				
1:250,000 map name	Mossvale			**NPWS map code**	
AMG Zone	56	**AMG Easting**	227944	**AMG Northing**	6148309
Method for grid reference	Hand-held GPS	**Map scale (if method = map)**		**Map name**	
NPWS District				**NPWS Zone**	
Portion no.				**Parish**	Marulan

SITE DESCRIPTION

Site type(s)	Stone artefact scatter	**Site type code (NPWS use only)**	
Description of site and contents CHECKLIST: eg. length, width, depth, height of site, shelter, deposit, structure, element eg. tree scar, grooves in rock. DEPOSIT: colour, texture, estimated depth, stratigraphy, contents-shell, bone, stone, charcoal, density & distribution of these, stone types, ertefact types. ART: area of decorated surface, motifs, colours, wet,/dry pigment, engraving technique, no. of figures, sizes, patination. BURIALS: number & condition of bone, position, age, sex, associated artefacts. TREES: number, alive, dead. likely age, scar shape, position, size, patterns, axe marks, regrowth. QUARRIES: rock type, debris, recognisable artefacts, percentage quarried	Small artefact scatter located on SE bank of a minor drainage line. Five artefacts were found within an area of 10 metres by five metres disturbed by construcjton of a vehicle track/cutting across the drainage line. The area is cleared and much of the surrounding area is disturbed by mining/quarrying activites. Gully erosion and dumped material also occur. Visbility on the site/track was approximately 70 percent and on surrounding area approximatley 10 percent. Artefacts: Flake Quartz 50 mm Flake Quartz 15 mm Flake Silcrete 30 mm Flake Sicrete 30 mm Broken flake Silcrete 25 mm.		

Version: June 1998	Data entered by:	Date entered:

Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

	Attach photographs and sketches, eg. plan & section of shelter. **Do NOT dig, disturb or damage site or contents.**

Version: June 1998	Data entered by:	Date entered:

Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

SITE ENVIRONMENT

Land form		**Aspect**		**Slope**	
Mark position of the site					
Local rock type		**Land use/effect**			
Distance from drinking water		**Source**			
Resource zone (eg. estuarine, river, forest)		**Vegetation**			
Edible plants		**Faunal resources** (include shellfish)			
Other exploitable resources (eg. ochre)					
Are there other sites in the locality		**Are they in the Sites Register**		**Other site types include**	

SITE MANAGEMENT

Site condition			
Management recommendations			
Have artefacts been removed from site		**When**	
By whom		**Deposited at**	
Consent applied for	☐	**Consent issued**	☐
Date of issue		**Consent number**	

SITE INSPECTION AND RECORDING

Reason for investigation			
Were local Aborigines contacted or present for the recording	☐ Not contacted ☐ Contacted and present ☐ Contacted but not present	**Names and addresses**	
Is the site important to local Aborigines			
Verbal/written reference sources		**ASR report number(s)**	C- C-
Photographs taken		**No of Photos attached**	
Site recorded by		**Date of recording**	
Address/institution	Environmental Resources Management Australia Pty Ltd (ERM), Building C 33 Saunders Street Pyrmont NSW 2009		

Version: June 1998	Data entered by:	Date entered:

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AHIMS Web Services (AWS)

f/PO Number : J14107 Marulan Sth update

Client Service ID : 329804

Note: This Excel report shows the sites found in AHIMS on the 23/02/2018. If this date is not the same as the original date of the Search Results letter obtained during the Basic Search, then the search results might be different. The PDF version of this report will always coincide with the Basic Search Results letter.

Site ID	Site name	Datum	Zone	Easting	Northing	Context	Site status	Primary contact	Site features	Site types	Recorders	Reports	Permits	Longitude GDA94	Latitude GDA94
52-4-0195	M1 (BCSC1)	AGD	56	227940	6148310	Open site	Destroyed		Artefact : -		ERM Australia Pty Ltd- !	100467,101390	2687,2976	150.03	-34.77
52-4-0264	Peppertree Burial 01 (s	GDA	56	227335	6150132	Open site	Valid		Stone Arrangement : 1		GML Heritage Pty Ltd +	103137		150.02	-34.75
52-4-0265	Peppertree Scarred Tre	GDA	56	227874	6150107	Open site	Valid		Modified Tree (Carved or Scarred) : -		GML Heritage Pty Ltd +	103137		150.03	-34.75
52-4-0266	BCSC AS1	AGD	56	226352	6147944	Open site	Valid		Artefact : 8		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0267	BCSC AS2	AGD	56	226371	6147950	Open site	Valid		Artefact : 2		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0268	BCSC AS3	AGD	56	226381	6147968	Open site	Valid		Artefact : 2		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0269	BCSC AS4	AGD	56	226380	6148020	Open site	Valid		Artefact : 22		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0270	BCSC IF2	AGD	56	226284	6147952	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0271	BCSC IF3	AGD	56	226206	6147767	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0272	BCSC IF4	AGD	56	226182	6147840	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0273	BCSC IF7	AGD	56	226313	6147951	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0274	BCSC IF8	AGD	56	226313	6147951	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0275	BCSC IF9	AGD	56	226333	6147978	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0276	BCSC IF11	GDA	56	226354	6147952	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0277	BCSC IF12	AGD	56	226357	6147961	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0278	BCSC IF13	AGD	56	226359	6147974	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0279	BCSC IF14	AGD	56	226386	6147978	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.01	-34.77
52-4-0263	BCSC IF 1	GDA	56	226967	6147161	Open site	Valid		Artefact : 1		RPS Australia East Pty Ltd	-Hamilton		150.02	-34.78
48-4-0086	DP1056566 Lot 11/1	AGD	56	225675	6148350	Open site	Valid	T Russell	Artefact : 12		Mr.Doug Williams	99346,99362	2536,2675,2676	150.00	-34.77
48-4-0087	DP1056566 Lot 11/2	AGD	56	226075	6148875	Open site	Valid	T Russell	Artefact : 37		Mr.Doug Williams	99346,99362	2536,2675,2676	150.01	-34.76
48-4-0088	DP1056566 Lot 11/3	AGD	56	226000	6148750	Open site	Valid	T Russell	Artefact : 3		Mr.Doug Williams	99346,99362	2536,2675,2676	150.01	-34.76
48-4-0089	DP1056566 Lot 12/1	AGD	56	225875	6147475	Open site	Valid	T Russell	Artefact : 21		Mr.Doug Williams	99346,99362		150.01	-34.78
48-4-0090	DP1056566 Lot 12/2	AGD	56	225875	6147625	Open site	Valid	T Russell	Artefact : 8		Mr.Doug Williams	99346,99362		150.01	-34.78
48-4-0091	DP1056566 Lot 12/3	AGD	56	225875	6147625	Open site	Valid	T Russell	Artefact : 8		Mr.Doug Williams	99346,99362		150.01	-34.78
48-4-0092	DP1056566 Lot 12/IF1	AGD	56	225800	6147780	Open site	Valid	T Russell	Artefact : 1		Mr.Doug Williams	99346,99362		150.00	-34.77
48-4-0093	DP1056566 Lot 12/IF2	AGD	56	225750	6147800	Open site	Valid	T Russell	Artefact : 1		Mr.Doug Williams	99346,99362		150.00	-34.77
52-4-0246	M2	GDA	56	227783	6148128	Open site	Valid		Artefact : 3		ERM Australia Pty Ltd-	Sydney CBD		150.03	-34.77
52-4-0291	MQ 19	GDA	56	227498	6150292	Open site	Valid		Artefact : 1		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0292	MQ 20	GDA	56	227952	6150239	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0293	MQ 21	GDA	56	228103	6150306	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0294	MQ 22	GDA	56	228292	6149943	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.76
52-4-0295	MQ 23	GDA	56	227565	6150191	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0296	MQ 24	GDA	56	227864	6150067	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103083,103137		150.03	-34.76
52-4-0297	MQ 25	GDA	56	229040	6149327	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.04	-34.76
52-4-0298	MQ 26	GDA	56	228833	6149949	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.04	-34.76
52-4-0299	MQ 27	GDA	56	227770	6150502	Open site	Valid		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0300	MQ 28	GDA	56	228264	6150468	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0301	MQ 29	GDA	56	228330	6150417	Open site	Destroyed		Artefact : 1		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0143	MSQ 1	GDA	56	228406	6149690	Open site	Destroyed	Searle	Artefact : -		Mr.Chris Lange,ERM Au	103137		150.03	-34.76
52-4-0144	MSQ2	GDA	56	228292	6149943	Open site	Destroyed	Searle	Artefact : 3		Mr.Chris Lange,ERM Au	103137		150.03	-34.76
52-4-0145	MSQ3	GDA	56	228625	6149982	Open site	Destroyed	Searle	Artefact : 1		Mr.Chris Lange,ERM Au	103137		150.04	-34.76
52-4-0146	MSQ4	GDA	56	228608	6150001	Open site	Destroyed	Searle	Artefact : 1		Mr.Chris Lange,ERM Au	103137		150.04	-34.76
52-4-0147	MSQ5	GDA	56	228557	6149936	Open site	Destroyed	Searle	Artefact : 1		Mr.Chris Lange,ERM Au	103137		150.03	-34.76
52-4-0148	MSQ6	GDA	56	227050	6150950	Open site	Valid	Searle	Artefact : 2		Mr.Chris Lange	103137		150.02	-34.75
52-4-0149	MSQ7	GDA	56	227735	6150380	Open site	Valid	Searle	Artefact : 2		Mr.Chris Lange	103137		150.03	-34.75
52-4-0150	MSQ8	GDA	56	227353	6150223	Open site	Destroyed	Searle	Artefact : 9		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0151	MSQ9	GDA	56	227297	6150151	Open site	Destroyed	Searle	Artefact : 4		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0152	MSQ10	GDA	56	227252	6150208	Open site	Destroyed	Searle	Artefact : 2		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0153	MSQ11	GDA	56	227153	6150213	Open site	Destroyed	Searle	Artefact : 8		Mr.Neville Baker,ERM A	103137		150.02	-34.75
52-4-0154	MSQ12	GDA	56	227213	6150319	Open site	Destroyed	Searle	Artefact : 1		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0155	MSQ13	GDA	56	227153	6150213	Open site	Destroyed	Searle	Artefact : 4		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0156	MSQ14	GDA	56	227414	6150203	Open site	Destroyed	Searle	Artefact : 1		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0157	MSQ15	GDA	56	227383	6150181	Open site	Destroyed	Searle	Artefact : 1		Mr.Neville Baker,ERM A	103083,103137		150.02	-34.75
52-4-0158	MSQ16	GDA	56	227447	6150191	Open site	Destroyed	Searle	Artefact : 2		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0159	MSQ17	GDA	56	227198	6150283	Open site	Destroyed	Searle	Artefact : 3		ERM Australia Pty Ltd- !	103083,103137		150.02	-34.75
52-4-0160	MSQ18	GDA	56	228576	6150429	Open site	Destroyed	Searle	Artefact : -		ERM Australia Pty Ltd- !	103137		150.03	-34.75
52-4-0161	BCSC1	GDA	56	227944	6148309	Open site	Destroyed	Searle	Artefact : -		ERM Australia Pty Ltd- !	100467	2687,2976	150.03	-34.77
52-4-0571	MSL010	GDA	56	227014	6151710	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.02	-34.74
52-4-0572	MSL011	GDA	56	227303	6151742	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.02	-34.74
52-4-0573	MSL012	GDA	56	227351	6151743	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.02	-34.74
52-4-0574	BCSC AS 5	GDA	56	226394	6148034	Open site	Valid		Artefact : 1		O'Sullivan			150.01	-34.77
52-4-0517	MQ120	GDA	56	228983	6148847	Open site	Valid		Modified Tree (Carved or Scarred) : -		Mrs.Rebecca Newell			150.04	-34.77
52-4-0575	MSL047	GDA	56	227733	6151810	Open site	Valid		Artefact : 1		Mrs.Rebecca Newell,EMM Consulting			150.03	-34.74
52-4-0576	MSL051	GDA	56	226726	6148062	Open site	Valid		Artefact : 1		Mrs.Rebecca Newell,EMM Consulting			150.01	-34.77
52-4-0527	MSL013	GDA	56	227480	6151678	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.02	-34.74
52-4-0528	MSL014	GDA	56	227573	6151736	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.02	-34.74
52-4-0529	MSL015	GDA	56	227670	6151893	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.03	-34.74
52-4-0530	MSL016	GDA	56	227790	6152047	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.03	-34.74
52-4-0531	MSL017	GDA	56	228378	6149319	Open site	Valid		Artefact : 1		EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell			150.03	-34.76

52-4-0532	MSL018	GDA	56	228156	6149143	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0533	MSL019	GDA	56	227926	6149051	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0534	MSL020	GDA	56	226874	6148700	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0535	MSL021	GDA	56	226651	6148231	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0536	MSL022	GDA	56	226773	6147960	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0537	MSL023	GDA	56	226960	6147938	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0538	MSL024	GDA	56	226929	6148039	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0539	MSL025	GDA	56	227298	6147245	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0540	MSL026	GDA	56	227583	6147404	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0541	MSL027	GDA	56	227564	6147638	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0542	MSL028	GDA	56	227796	6148156	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.77
52-4-0543	MSL029	GDA	56	227799	6148259	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.77
52-4-0544	MSL030	GDA	56	227576	6148273	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0545	MSL031	GDA	56	227532	6148053	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0546	MSL032	GDA	56	227675	6147990	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0547	MSL033	GDA	56	227599	6147928	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0548	MSL034	GDA	56	226677	6147956	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0549	MSL035	GDA	56	227214	6147991	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0550	MSL036	GDA	56	227250	6148100	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0551	MSL037	GDA	56	228711	6148854	Open site	Valid	Modified Tree (Carved or Scarred) : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.04	-34.77
52-4-0552	MSL038	GDA	56	227600	6148067	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0553	MSL039	GDA	56	226722	6148080	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0554	MSL040	GDA	56	226761	6148124	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0555	MSL041	GDA	56	226604	6148142	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0556	MSL042	GDA	56	227306	6151708	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0557	MSL043	GDA	56	227316	6147747	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.78
52-4-0558	MSL044	GDA	56	226634	6148017	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0559	MSL045	GDA	56	227908	6152143	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0560	MSL046	GDA	56	227827	6151971	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0561	MSL048	GDA	56	227927	6152149	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0562	MSL049	GDA	56	227467	6150995	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.75
52-4-0563	MSL050	GDA	56	226829	6147930	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0564	MSL052	GDA	56	226604	6148129	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0565	MSL053	GDA	56	226733	6147960	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.01	-34.77
52-4-0566	MSL054	GDA	56	227689	6147985	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.77
52-4-0567	MSL055	GDA	56	227939	6149291	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0568	MSL056	GDA	56	228042	6149204	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.76
52-4-0569	MSL057	GDA	56	227817	6152074	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0570	MSL058	GDA	56	227647	6151634	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0518	MSL001	GDA	56	227874	6152125	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.03	-34.74
52-4-0519	MSL002	GDA	56	227590	6151948	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0520	MSL003	GDA	56	227531	6151862	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0521	MSL004	GDA	56	227391	6151763	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0522	MSL005	GDA	56	227138	6151821	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0523	MSL006	GDA	56	226932	6151817	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0524	MSL007	GDA	56	226894	6151731	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0525	MSL008	GDA	56	226798	6151823	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74
52-4-0526	MSL009	GDA	56	226875	6151683	Open site	Valid	Artefact : 1	EMGAMM-St Leonards (previously EMGA),Mrs.Rebecca Newell	150.02	-34.74

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Appendix C

Survey data

Stage	Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m²)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m²)	Area available for detection (m²)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Sites	Comments
1	T1	13/04/2015	Pedestrian survey	Low Hills	Watercourse	1	900	127	50	6350	20	60	0.2	0.6	3810	762	12	Marualn	Marulan Granite Batholith	Granite, silcrete	30	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock		A transect through a drainage depression, in flat paddock. The area is cut by a vehicle track and has a moderate level of disturbance. Marulan creek lies to the north. Vegetation consists of pature grasses and weeds. One large tree, not scarred.
1	T2	13/04/2015	Pedestrian survey	Low Hills	Ridgeline	10	10	4590	50	229500	20	60	0.2	0.6	137700	27540	12	Marualn	Marulan Granite Batholith	Granite, silcrete	20	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock		The transect followed a flat hill crest in paddocks, generally exposures are areas of erosion through cattle tracks and resting places. Vegetation is pasture grasses and weeds, no trees or shrubs along transect. Follows the route of the proposed haul road.
1	T3	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	10	13235	50	661770	40	60	0.4	0.6	397062	158824.8	24	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock		A transect along Marulan Creek following the slope. Due to the large group the transect crossed the gentle slope landform adjacent to the creek. This included the lower mid and upper slope landforms. Vegetation was pasture grass and weeds, with very few trees or shrubs. Erosion along the transect was a result of machine works including channel creation and from wind and water erosion as well as some cattle tracks.
1	T4	13/04/2015	Pedestrian survey	Low Hills	Watercourse	1	10	458.1	20	9162	40	70	0.4	0.7	6413.4	2565.36	28	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock		A transect along a drainage depression, a tributary of Marulan Creek. Large areas of erosion have been created through creek bank slip and possibly flooding. Background scatter of granite and other gravels
1	T5	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	10	460	50	23000	40	70	0.4	0.7	16100	6440	28	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock		A transect along Marulan Creek following the slope. Due to the large group the transect crossed the gentle slope landform adjacent to the creek. This included the lower mid and upper slope landforms. Vegetation was pasture grass and weeds, with very few trees or shrubs. Erosion along the transect was a result of machine works including channel creation and from wind and water erosion as well as some cattle tracks.
1	T6	13/04/2015	Pedestrian survey	Low Hills	Spur	N/A	5	151	30	4530	30	70	0.3	0.7	3171	951.3	21	Marualn	Marulan Granite Batholith	Granite, silcrete	5	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock		Transect along the upper hill crest overlooking Marulan Creek. A vehicle track cut through the majority of the transect. Pasture and weed grasses throughout. Large trees framed the creek section of the transect
1	T7	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	1	10	10	100	10	50	0.1	0.5	50	5	5	Marualn	Marulan Granite Batholith	Granite, silcrete	5	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Transect through Marulan Creek. Marshy area with water flowing through and very high creek banks on either side from erosion.
1	T8	13/04/2015	Pedestrian survey	Low Hills	Watercourse	N/A	5	1954	50	97700	40	80	0.4	0.8	78160	31264	32	Marualn	Marulan Granite Batholith	Granite, silcrete	5	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	10	A transect along Marulan Creek following the slope. Due to the large group the transect crossed the gentle slope landform adjacent to the creek. This included the lower mid and upper slope landforms. Vegetation was pasture grass and weeds, with very few trees or shrubs. Erosion along the transect was a result of machine works including channel creation and from wind and water erosion as well as some cattle tracks.
1	T9	13/04/2015	Pedestrian survey	Low Hills	Hill slope	N/A	10	132	50	6600	20	70	0.2	0.7	4620	924	14	Marualn	Marulan Granite Batholith	Granite, silcrete	20	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	6	The transect followed a flat hill crest in paddocks, generally exposures are areas of erosion through cattle tracks and resting places. Vegetation is pasture grasses and weeds, no trees or shrubs along transect. Follows the route of the proposed haul road.
1	T10	14/04/2015	Pedestrian survey	Low Hills	Spur	5	290	734	50	36700	10	10	0.1	0.1	3670	367	1	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	This transect was over a small paddock covered in long grass with very low visibility. Very few trees scattered through. Evidence of a small ephemeral drainage line. Vegetation is high pasture grass. The transect is on a flat hillcrest landform. Appears that the area was a large crest overlooking Tangarang Creek in the northg

Stage	Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m^2)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m^2)	Area available for detection (m^2)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Sites	Comments
1	T11	14/04/2015	Pedestrian survey	Low Hills	Spur	10	300	875	50	43750	10	5	0.1	0.05	2187.5	218.75	0.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	This transect was over a small paddock covered in long grass with very low visibility. Very few trees scattered through. Evidence of a small ephemeral drainage line. Vegetation is high pasture grass. The transect is on a flat hillcrest landform. Appears that the area was a large crest overlooking Tangarang Creek in the northg
1	T12	14/04/2015	Pedestrian survey	Low Hills	Watercourse	4	350	331	50	16550	10	5	0.1	0.05	827.5	82.75	0.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	The transect covered a small ephemeral drainage line on a flat crest landform. Vegetation was very high pasture grass and visibility was very low.
1	T13	14/04/2015	Pedestrian survey	Low Hills	Spur	5	500	702	50	35100	10	40	0.1	0.4	14040	1404	4	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	The transect covered a hillcrest landform. The area was characteised by many rolling open low hills and the transect was large enough to cover some of the slopes associated with the hillcrest.
1	T14	14/04/2015	Pedestrian survey	Low Hills	Watercourse	3	500	210	50	10500	20	60	0.2	0.6	6300	1260	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A transect following two drainage depressions also encompassiing the banks of the depressions. No water in any. The vegetation was pasture grasses very high making visibility very low.
1	T15	14/04/2015	Pedestrian survey	Low Hills	Hill slope	10	500	283	50	14150	30	60	0.3	0.6	8490	2547	18	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Hillcrest transect. Vegetation cover was high, with pasture grasses and some trees.
1	T16	14/04/2015	Pedestrian survey	Low Hills	Watercourse	2	500	470	50	23500	20	60	0.2	0.6	14100	2820	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Transect following two drainage depressions. A number of mature trees and pasture and weed grasess dominate the transect. Many large outcrops of granite throughout
1	T17	14/04/2015	Pedestrian survey	Low Hills	Spur	4	800	180	20	3600	40	80	0.4	0.8	2880	1152	32	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks possibly quarry activities	Grassed paddock	0	Transect on hillcrest, trees and leaft litter. Many gravels as cover, the area has been highly disturbed, it could be a hill maunfactured as a result of the quarry activities.
1	T18	14/04/2015	Pedestrian survey	Low Hills	Hill slope	5	800	136	50	6800	10	70	0.1	0.7	4760	476	7	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	Transect on a hillslope showing mid and lower slop characteristics towards an ephermeral watercourse. Vegetation cover is thick pasture grasses and weeds.
1	T19	14/04/2015	Pedestrian survey	Low Hills	Watercourse	2	800	75	20	1500	10	60	0.1	0.6	900	90	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Drainage depression transect, crosses two
1	T20	14/04/2015	Pedestrian survey	Low Hills	Hill slope	40	800	150	50	7500	20	70	0.2	0.7	5250	1050	14	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Transect on lower hillslop leading to large flat hillcrest. Vegetation was thick with many large bloulders of granite spread throughout the transect.
1	T21	14/04/2015	Pedestrian survey	Low Hills	Spur	50	815	274	50	13700	10	70	0.1	0.7	9590	959	7	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Transect on flat crest landform asdjacent to drainage line.
1	T22	14/04/2015	Pedestrian survey	Low Hills	Spur	30	830	510	50	25500	20	60	0.2	0.6	15300	3060	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Transect onbank of ephemeral creek bank following slope landform Like a spur
1	T23	14/04/2015	Pedestrian survey	Low Hills	Watercourse	2	900	693	50	34650	30	60	0.3	0.6	20790	6237	18	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Transect onbank of ephemeral creek bank following flat landform
1	T24	14/04/2015	Pedestrian survey	Low Hills	Hill slope	3	1000	495	50	24750	10	60	0.1	0.6	14850	1485	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Following hillslope lower mid and upper to finish on the crest of a ridge landform. Vegetation is thick pasture grass and weeds with some granite outcropping evident.
1	T25	14/04/2015	Pedestrian survey	Ridge	Ridgeline	5	1000	388	50	19400	10	60	0.1	0.6	11640	1164	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Ridgecrest landform following the line of a flat ridge adjacent to Marulan South Road. Vegetation cover is high with pasture grasses and weeds throughout.
1	T26	14/04/2015	Pedestrian survey	Low Hills	Hill slope	30	1000	251	50	12550	10	60	0.1	0.6	7530	753	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Hill slope landform between two drainage depressions
1	T27	14/04/2015	Pedestrian survey	Ridge	Ridgeline	40	1000	196	50	9800	10	60	0.1	0.6	5880	588	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Ridgecrest landform following the line of a flat ridge adjacent to Marulan South Road. Vegetation cover is high with pasture grasses and weeds throughout.
1	T28	14/04/2015	Pedestrian survey	Ridge	Hill slope	20	1500	423	50	21150	10	60	0.1	0.6	12690	1269	6	Marualn	Marulan Granite	Granite, silcrete	10	natural gravels	water erosion,	paddock	0	depressions, quite steep landform
1	T29	14/04/2015	Pedestrian survey	Ridge	Hill slope	10	1500	518	50	25900	20	60	0.2	0.6	15540	3108	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Hill slope landform between two drainage depressions, quite steep landform
1	T30	14/04/2015	Pedestrian survey	Ridge	Ridgeline	30	1500	311	50	15550	10	60	0.1	0.6	9330	933	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Ridgecrest landform following the line of a flat ridge adjacent to Marulan South Road. Vegetation cover is high with pasture grasses and weeds throughout.
1	T31	15/04/2015	Pedestrian survey	Low Hills	Plain	80	800	314	50	15700	20	60	0.2	0.6	9420	1884	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Plain landform used for cattle and sheep grazing. Paddock and weed grass cover was high and an epheral stream was 80m away.

Stage	Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m^2)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m^2)	Area available for detection (m^2)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Sites	Comments
1	T32	15/04/2015	Pedestrian survey	Low Hills	Watercourse	2	800	97	50	4850	5	60	0.05	0.6	2910	145.5	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Drainage depression transect in low hills landform pattern. Vegetation was high and there was no water in the drainage depression.
1	T33	15/04/2015	Pedestrian survey	Low Hills	Hill slope	10	850	82	50	4100	5	60	0.05	0.6	2460	123	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	mid upper and lower hillslope in paddocks. Vegetation grass cover was very high and visibility was very low.
1	T34	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	340	50	17000	5	50	0.05	0.5	8500	425	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A plain landform crossing grazing paddocks with very high grass cover and very low visibility. A large imported gravel track has been created at the northern end of the transect. Farm tracks are also present throughout the transect.
1	T35	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	373	50	18650	5	50	0.05	0.5	9325	466.25	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks with very high grass cover and very low visibility. A large imported gravel track has been created at the northern end of the transect. Farm tracks are also present throughout the transect.
1	T36	15/04/2015	Pedestrian survey	Low Hills	Hill slope	10	850	71	68	4828	5	60	0.05	0.6	2896.8	144.84	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	mid upper and lower hillslope in paddocks. Vegetation grass cover was very high and visibility was very low.
1	T37	15/04/2015	Pedestrian survey	Low Hills	Watercourse	2	800	68	50	3400	5	60	0.05	0.6	2040	102	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Drainage depression transect in low hills landform pattern. Vegetation was high and there was no water in the drainage depression.
1	T38	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	542	50	27100	5	50	0.05	0.5	13550	677.5	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
1	T39	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	352	50	17600	5	50	0.05	0.5	8800	440	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks with very high grass cover and very low visibility. It contains a scattering of small trees and shrubs. Evidence of termite damage in exposures
1	T40	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	707	50	35350	5	50	0.05	0.5	17675	883.75	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
1	T41	15/04/2015	Pedestrian survey	Low Hills	Watercourse	50	800	543	50	27150	5	50	0.05	0.5	13575	678.75	2.5	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A drainage depression grazing paddocks with very high grass cover and very low visibility.
1	T42	15/04/2015	Pedestrian survey	Low Hills	Plain	50	800	707	50	35350	20	50	0.2	0.5	17675	3535	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
1	T43	15/04/2015	Pedestrian survey	Low Hills	Watercourse	3	900	129	50	6450	30	50	0.3	0.5	3225	967.5	15	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A drainage depression grazing paddocks with very high grass cover and very low visibility. Large dam has been created at the start of the transect.
1	T44	15/04/2015	Pedestrian survey	Low Hills	Plain	10	900	429	50	21450	20	30	0.2	0.3	6435	1287	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A plain landform crossing grazing paddocks with very high grass cover and very low visibility.
1	T45	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	900	650	50	32500	20	60	0.2	0.6	19500	3900	12	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A drainage depression through grazing paddocks. The drainage depression has been subject to extensive disturbance through machine excavation of the depression, the dumping of car parts and other materials and animal movement.
1	T46	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	729	50	36450	50	80	0.5	0.8	29160	14580	40	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
1	T47	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	729	50	36450	50	80	0.5	0.8	29160	14580	40	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
1	T48	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	900	650	50	32500	30	60	0.3	0.6	19500	5850	18	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A drainage depression through grazing paddocks.
1	T49	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	729	50	36450	40	80	0.4	0.8	29160	11664	32	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
1	T50	15/04/2015	Pedestrian survey	Low Hills	Spur	10	1000	343	50	17150	40	80	0.4	0.8	13720	5488	32	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A ridge crest landform overlooking a number of drainage depressions. Vegetation was leaf litter and pasture grasses. Visibility was good.
1	T51	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	1000	500	50	25000	20	70	0.2	0.7	17500	3500	14	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A treansect crossing a hill slope and drainage depressions. Vegetation cover is pasture grasses, weeds and leaf litter from eucalypt trees in the vicinity. No mature trees identified.

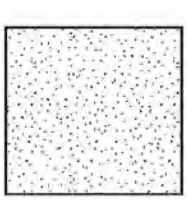
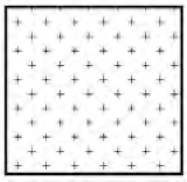
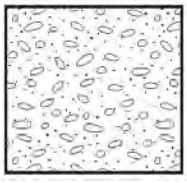
Stage	Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m^2)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m^2)	Area available for detection (m^2)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Sites	Comments
1	T52	15/04/2015	Pedestrian survey	Low Hills	Plain	10	1000	266	50	13300	10	60	0.1	0.6	7980	798	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A plain landform crossing grazing paddocks, with low grass and many exposures visible. The area follows a very gentle slope. Vegetation is pature grasses and trees.
1	T53	15/04/2015	Pedestrian survey	Low Hills	Spur	10	1000	262	50	13100	20	50	0.2	0.5	6550	1310	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A steep crest following a drainage line, vegetation was thick and terrain was difficult. Large number of boulders and granite outrcrops visible.
1	T54	15/04/2015	Pedestrian survey	Low Hills	Watercourse	10	1000	255	50	12750	30	70	0.3	0.7	8925	2677.5	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A steel drainage depression with two large dams located in each area.
1	T55	15/04/2015	Pedestrian survey	Low Hills	Spur	15	1500	232	50	11600	30	70	0.3	0.7	8120	2436	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A steep crest following a drainage line, vegetation was thick and terrain was difficult. Large number of boulders and granite outrcrops visible.
1	T56	15/04/2015	Pedestrian survey	Low Hills	Spur	15	1500	316	50	15800	30	70	0.3	0.7	11060	3318	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A steep crest following a drainage line, vegetation was thick and terrain was difficult. Large number of boulders and granite outrcrops visible.
1	T57	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	200	2000	950	50	47500	10	60	0.1	0.6	28500	2850	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A steep ridgeline near the Bungonia George with very high vegetation cover, including thick trees and ground vegetation. Many granite boulders of varying sizes
1	T58	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	200	2000	451	50	22550	10	60	0.1	0.6	13530	1353	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A steep ridgeline near the Bungonia George with very high vegetation cover, including thick trees and ground vegetation. Many granite boulders of varying sizes
1	T59	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	200	2000	334	50	16700	10	60	0.1	0.6	10020	1002	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A steep ridgeline near the Bungonia George with very high vegetation cover, including thick trees and ground vegetation. Many granite boulders of varying sizes. Followed a vehicle track with dumped car located alongside.
1	T60	16/04/2015	Pedestrian survey	Low Hills	Spur	200	2000	698	50	34900	10	60	0.1	0.6	20940	2094	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A moderately inclined crest over looking a number of drainage lines.
1	T61	16/04/2015	Pedestrian survey	Low Hills	Watercourse	1	2000	443	50	22150	30	70	0.3	0.7	15505	4651.5	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	Following a number of drainage depressions and a possible remnant creek line as they move up into more inclined areas. Very steep and difficult to naviage terrrain.
1	T62	16/04/2015	Pedestrian survey	Low Hills	Ridgeline	10	2000	426	50	21300	30	70	0.3	0.7	14910	4473	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A moderately inclined crest over looking a number of drainage lines.
1	T63	16/04/2015	Pedestrian survey	Low Hills	Watercourse	10	2000	564	50	28200	30	70	0.3	0.7	19740	5922	21	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	2	A drainage depression finishing in a large dam adjacent to the mine haul road. Vegetation was pasture grass and exposure and visibility were moderate.
1	T64	16/04/2015	Vehicel	Low Hills	Ridgeline	10	1000	997	10	9970	10	40	0.1	0.4	3988	398.8	4	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	A vehicle transect on the crest of a ridge. It is in an area of previous dumping for the quarry and is a highly modified environment. The slope to the south is very steep and goes into the gorge. Vegetation renewal has occured and gravels, soil and sand have been introduced.
1	T65	17/04/2015	Pedestrian survey	Low Hills	Watercourse	20	20	1091	50	54550	10	40	0.1	0.4	21820	2182	4	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	A creek bank overlooking a section of the now removed unnamed creek flowing through the quarry area. Vegetation was high with leaf litter and grass cover. The other side of the bank was also traversed.
1	T66	17/04/2015	Pedestrian survey	Low Hills	Spur	10	30	921	50	46050	20	50	0.2	0.5	23025	4605	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	2	A spur crest between a number of drainage lines, gentle aspect with many flat sections as it climbs to the main redgeline in the area.
1	T67	17/04/2015	Pedestrian survey	Low Hills	Spur	10	30	565	50	28250	20	50	0.2	0.5	14125	2825	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	2	A spur crest between a number of drainage lines, gentle aspect with many flat sections as it climbs to the main redgeline in the area.
1	T68	17/04/2015	Pedestrian survey	Low Hills	Spur	10	30	1313	50	65650	20	50	0.2	0.5	32825	6565	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	3	A spur crest between a number of drainage lines, gentle aspect with many flat sections as it climbs to the main redgeline in the area.
1	T69	17/04/2015	Pedestrian survey	Low Hills	Ridgeline	50	1000	619	50	30950	20	50	0.2	0.5	15475	3095	10	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	The gentle crest of a rdige in the surrounding area. Possibly the easiest route through the area. Vegetation was high and visibility was low
1	T70	17/04/2015	Pedestrian survey	Low Hills	Watercourse	10	10	692	50	34600	20	30	0.2	0.3	10380	2076	6	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	1	the bank of a creek running towards the Bungong George. Disturbed through erosion, farm tracks, and the use of concerete and dumping at the end of transect

Stage	Transect	Date	Method	Landform pattern	Landform element	Distance to Temp water (minimum)	Distance to permanent water (minimum)	Length (m)	Width (m)	Area (m^2)	Exposure	Visibility	Exposure %	Visibility %	Visible area (m^2)	Area available for detection (m^2)	Effective coverage %	Soil landscape	Underlying geology	Rock outcrop material	Extent of rock outcrop %	Ground cover types	Exposure types	Vegetation	Sites	Comments
1	T71	17/04/2015	Pedestrian survey	Low Hills	Watercourse	10	10	692	50	34600	10	30	0.1	0.3	10380	1038	3	Marualn	Marulan Granite Batholith	Granite, silcrete	10	Grass/imported and natural gravels	Vehicle, wind and water erosion, cattle tracks	Grassed paddock	0	the bank of a creek running towards the Bungong George. Disturbed through erosion, farm tracks, and the use of concerete and dumping at the end of transect

Appendix D

Soil profiles

Key

	**Sandstone**
	**Charcoal**
	**Degraded sandstone**

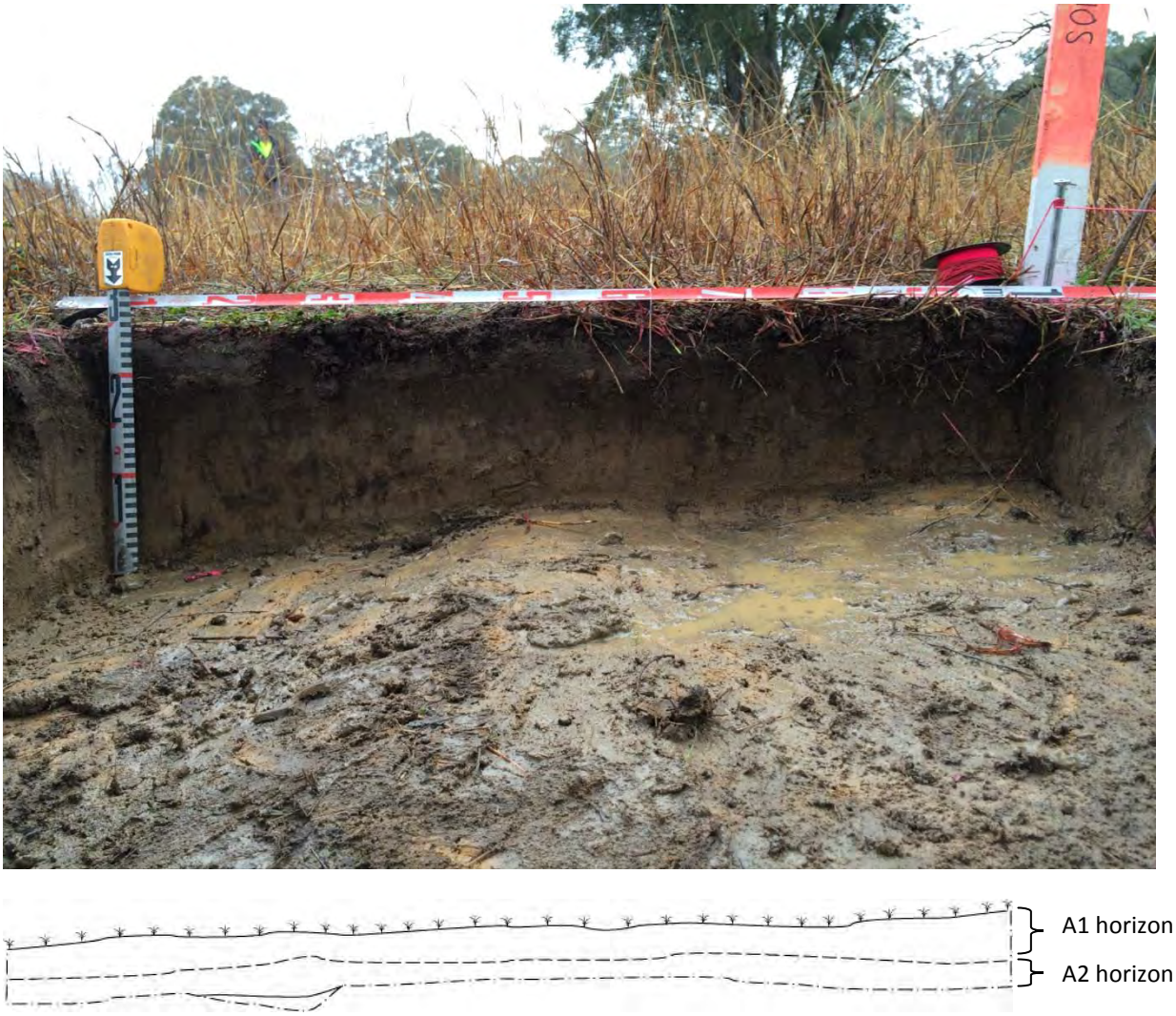


Figure D.1 Soil profile of TP2

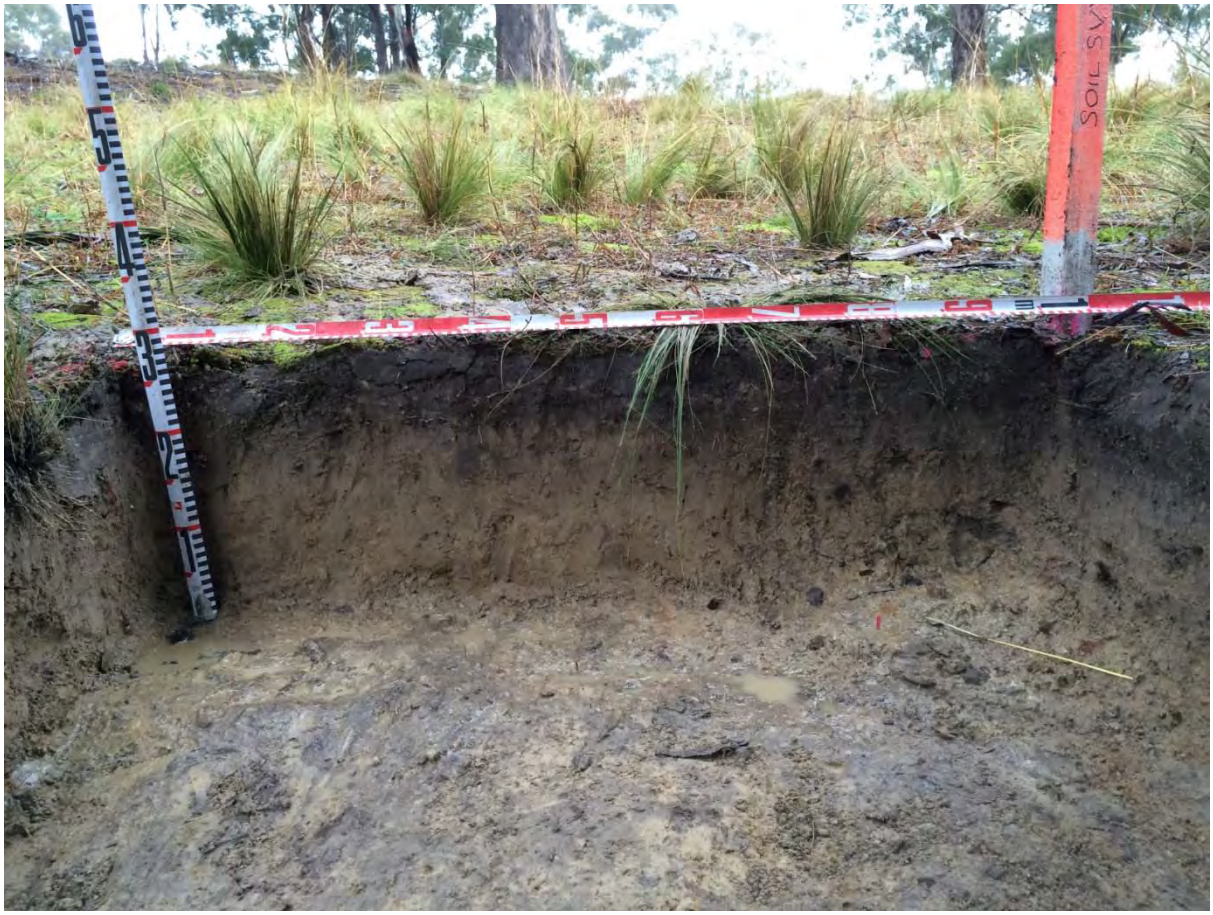




Figure D.2 Soil profile of TP4



Figure D.3 Soil profile of TP34



Figure D.4 Soil profile of TP35



Figure D.5 Soil profile of TP36

Appendix E

Fieldwork team

Table E.1 Survey personnel

Participants	
Ryan Desic	Adam Patterson
Rebecca Newell	Karen Denny
Deidre Patterson	Steve Johnson
Justin Boney	Duncan Falk
Tyronne Bell	Glen Freeman
Deidre Patterson	Kayleen Busk
Leeroy Boota	Shaun Carroll
Lee Patterson	Ryan Johnson
Izahaya Clay	Tammy Muscat

Table E.2 Excavation personnel

Participants	
Rebecca Newell	Newton Carriage
Pamela Kottaras	Karen Denny
Ryan Desic	Steve Johnson
Pamela Chauvel	Duncan Falk
Nick Svede	Newton Bond
Irek Golka	Kieran McNally
Grant Thompson	Georgette Lord
Justin Boney	Tina O'Sullivan
Glen Freeman	Shaun Carroll
Leeroy Boota	Ryan Johnson
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APPENDIX F

Surface Water Assessment Report

Advisian

WorleyParsons Group



Boral Resources (NSW) Pty Ltd

Peppertree Quarry Modification 5

Surface Water Assessment

August 2018

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Project No: A26549 (301015-03904) - Peppertree Quarry Modification 5

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0.1	Draft for review	AT	MB	11/05/2018
0.2	Draft for review	AT	Element, Boral	10/8/2018
0.3	Updated in response to Boral and Element comments	AT	Element, Boral	22/8/2018
1.0	Final	AT	Element, Boral	28/08/2018

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Abbreviations

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average recurrence interval
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
Boral	Boral Resources (NSW) Pty Ltd
BoM	Bureau of Meteorology
CAP	Catchment Action Plan
DECC	Department of Environment and Climate Change
DPI	Department of Primary Industries
EC	Electrical Conductivity
EA	Environmental Assessment
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	Environmental Protection Licence
HRC	Healthy Rivers Commission
MHRDC	Maximum harvestable right dam capacity
NorBE	Neutral or beneficial effect
NRAR	Natural Resources Access Regulator
NWQMS	National Water Quality Management Strategy
PoEO Act	NSW *Protection of the Environment Operations Act 1997*
SCA	Sydney Catchment Authority
SEPP	State Environmental Planning Policy
SWMOP	State Water Management Outcomes Plan
SWA	Surface Water Assessment
The Limestone Mine	Marulan South Limestone Mine
The Project	Peppertree Quarry Modification 5
The Quarry	Peppertree Quarry
WaterNSW	State-Owned Corporation established under the *Water NSW Act 2014*
WMA	*Water Management Act 2000*
WQO	Water Quality Objective
WSP	Water Sharing Plan

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1 Introduction

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement (SWOE))
- extend the consent boundary to the south to encompass the SWOE
- construct a new haul road from the pit to the SWOE
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE
- amend the Western Overburden Emplacement (WOE)
- remove the approved Western Earth Bund (which has not yet been constructed) and
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Approval. The Minister for Planning is the consent authority for the proposed modification.

This Surface Water Assessment (SWA) has been prepared by Advisian on behalf of Boral as an appendix to the Environmental Assessment (EA) for the proposed Project.

1.2 Existing Environment and Quarry Operations

1.2.1 Site description

The Quarry is at Marulan South in the Goulburn Mulwaree Local Government Area (LGA) and is approximately 175 km south-west of Sydney (Figure 1.1). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Limestone Mine) with the Hume Highway approximately 9 km to the northwest (Figure 1.2). Boral's private rail line connects the Quarry and the Limestone Mine with the Main Southern Railway approximately 6 km to the north (Figure 1.2).

The Quarry is on approximately 650 hectares (ha) of Boral owned land, which includes the Quarry (occupying approximately 70 ha) and additional granodiorite resources to the south and surrounding land (Figure 1.3 and Figure 1.4). The site is zoned RU1 - Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 (Figure 1.5). Mining and extractive industries are permissible in this zone with consent.

There is an extensive ground water, surface water and air quality monitoring network around the Quarry and Limestone Mine (Figure 1.6).

1.2.2 Approved project

The current operations of the Quarry are approved under Project Approval PA06_0074 as modified.

Quarry Activities and Infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities. The location of infrastructure at the Quarry is shown on Figure 1.7.

Work to establish the Quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E.

Operating hours and workforce

The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5 am to 11 pm. Approved operating hours are outlined in detail in Table 1.1.

Table 1.1: Approved operating hours

Activity	Day	Time
Construction works	Monday to Friday Saturday Sunday and public holidays	7.00 am to 6.00 pm 8.00 am to 1.00 pm None
Topsoil/overburden removal/emplacement	Any day	7.00 am to 7.00 pm
Blasting	Monday to Saturday Sunday and public holidays	9.00 am to 5.00 pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00 am to 11.00 pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

The Quarry employs 30 full time persons distributed over two to three shifts.

1.3 Proposed modifications

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and

will take approximately four years to establish. The emplacement will cover approximately 44 ha and will be RL650 at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

The powerline, which supplies electricity to the Limestone Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Limestone Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 20 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine, and will be a component of the Limestone Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

Two sediment dams (P1 and P2) will be constructed either end of the WOE to catch and treat dirty water until the batters are rehabilitated. Sediment dam P2 will also catch clean water from upslope of the WOE. Sediment dam P1 will be approximately 2.1 ML in volume and sediment dam P2 will be approximately 5.8 ML in volume.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the Project.

The only ground disturbance associated with the modification will be for the SWOE, sediment dams P1 and P2, powerline relocation and new haul road (see Figure 1.8).

1.4 Scope of this Report

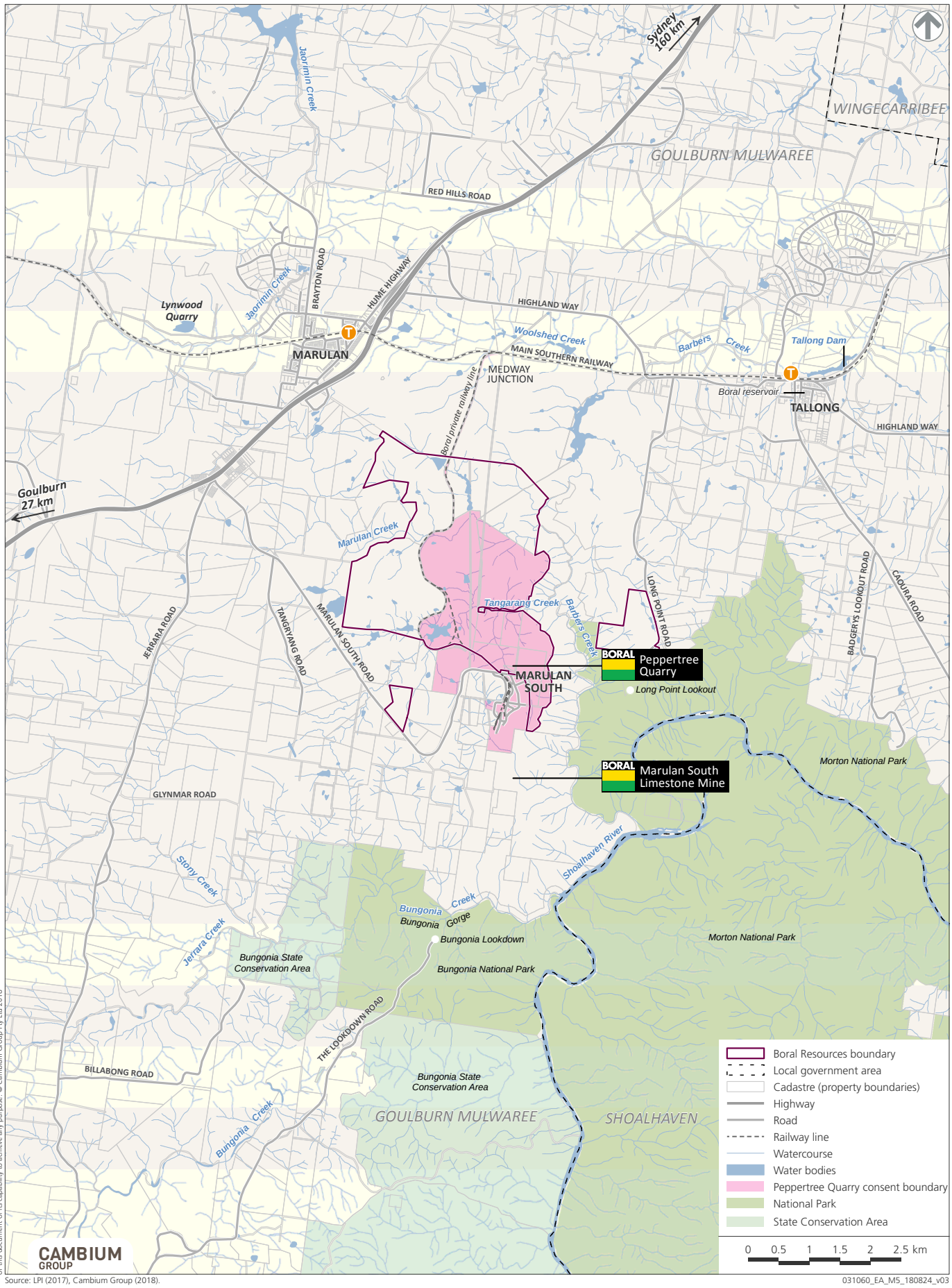
This SWA provides an assessment of the potential surface water impacts of the Project and describes the proposed water management system to address these impacts. Specifically, this report:

- identifies legislation, policy and guidelines relevant to the Project (Section 2)
- documents the existing catchment conditions and water quality in the receiving waters (Section 3)
- describes the proposed water management system for the Project including management measures (Section 4)
- provides an assessment of the impacts of any changes in the flow and water quality resulting from the proposed Project (Section 5) and
- identifies monitoring and licensing requirements or other approvals that relate to water use, management and discharge (Section 6).

Figure 1.1

Regional context

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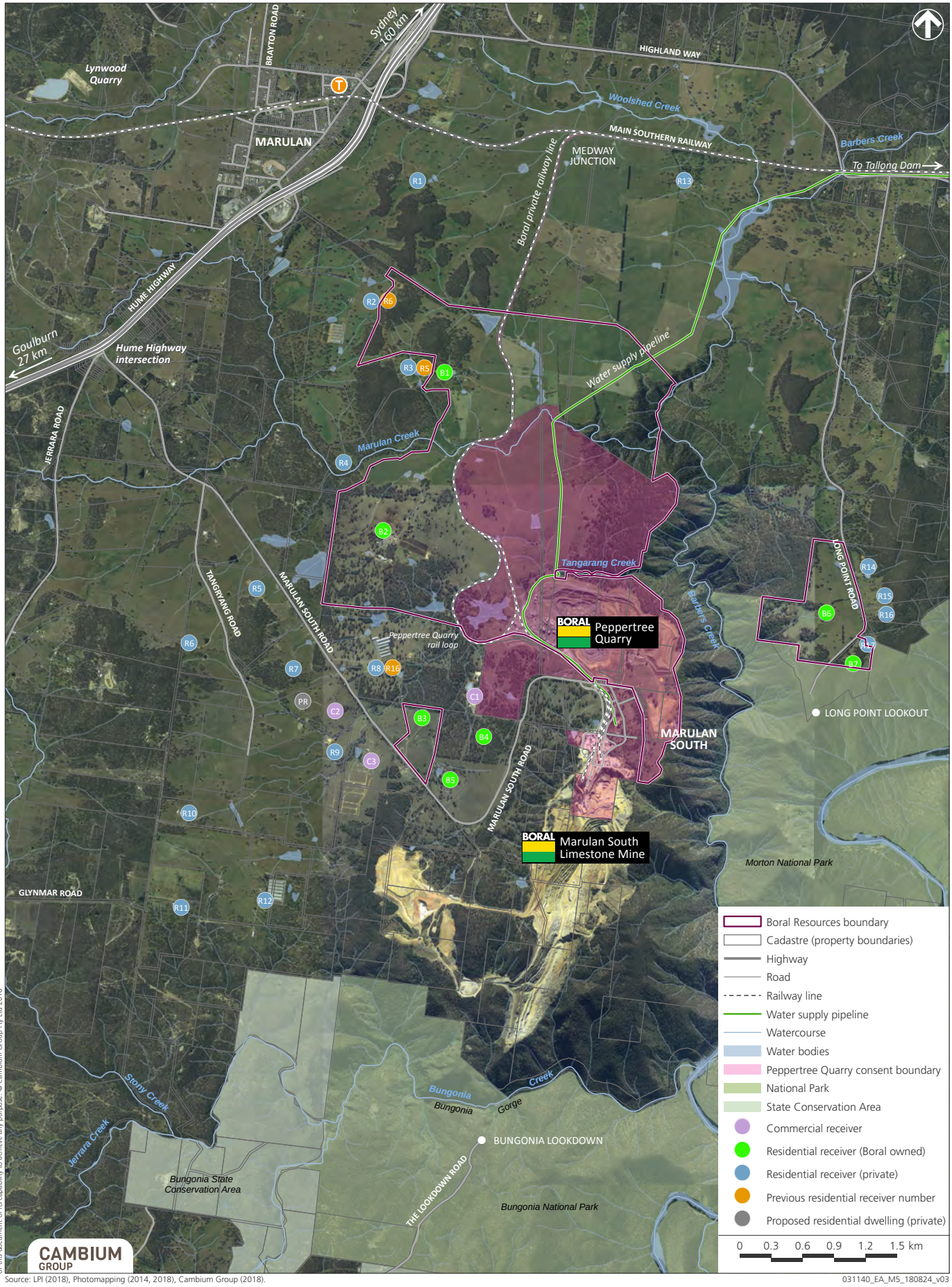
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Figure 1.2
Local context

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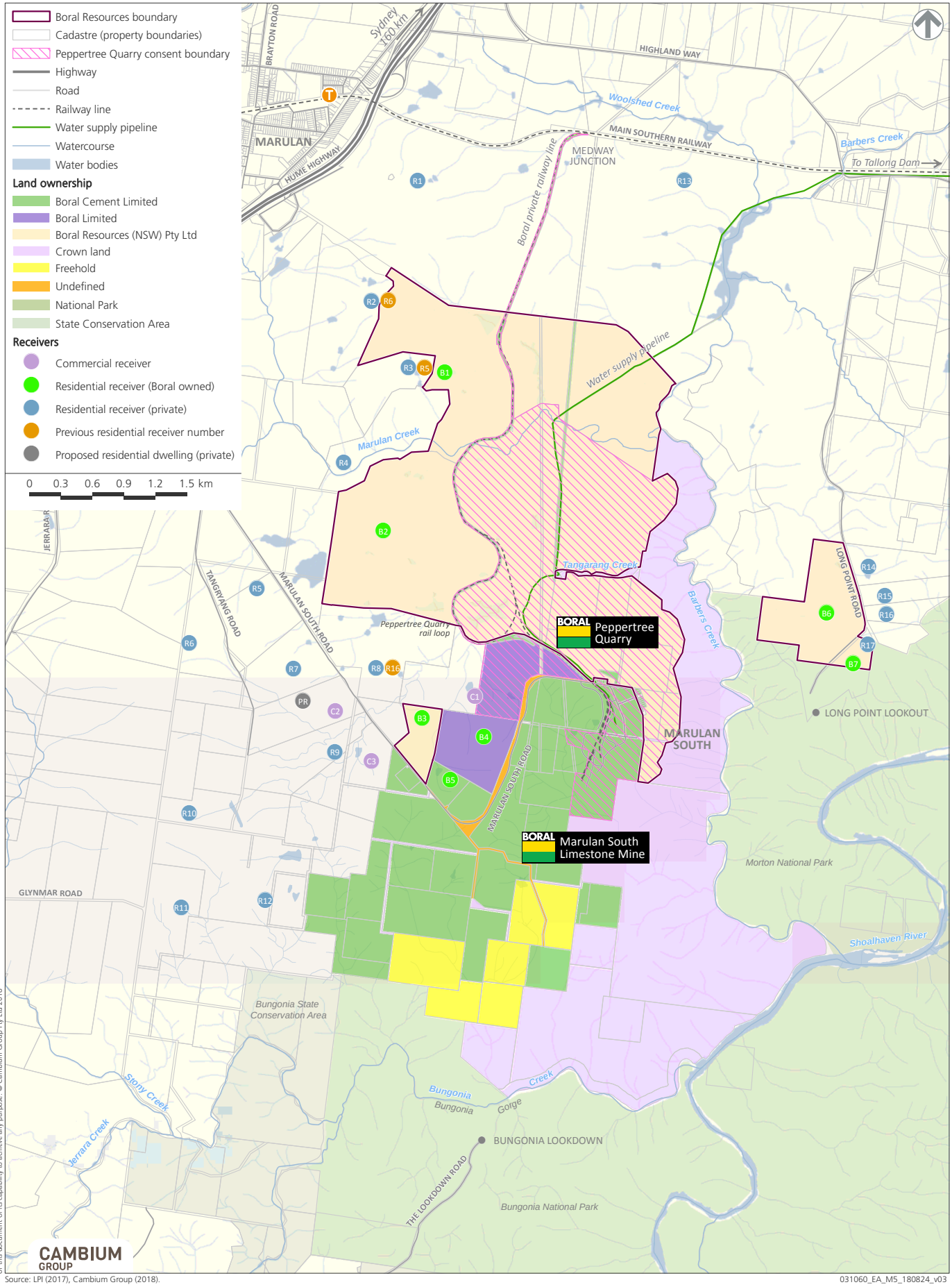


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Figure 1.3
Land ownership

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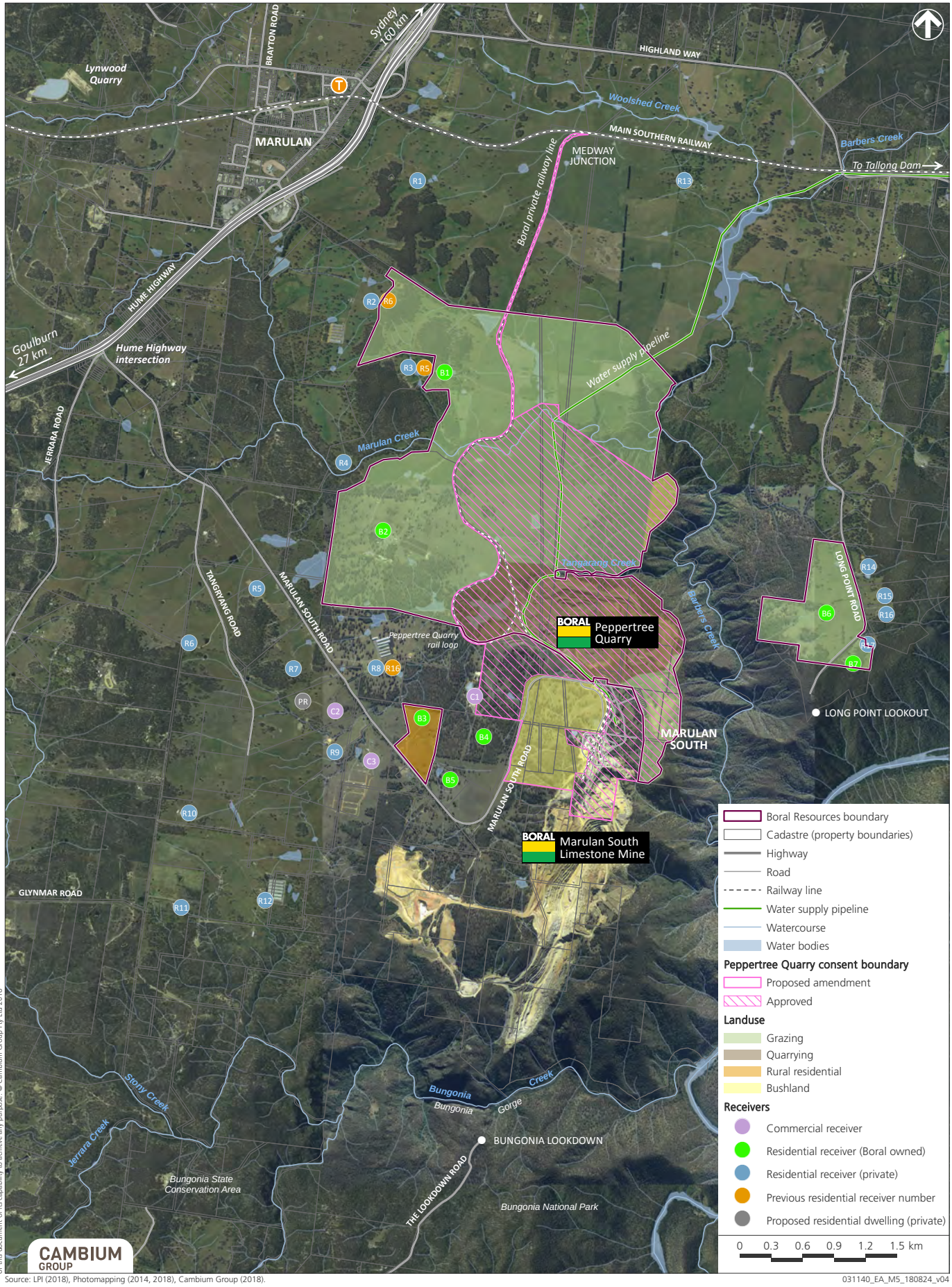
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Figure 1.4
Landuse

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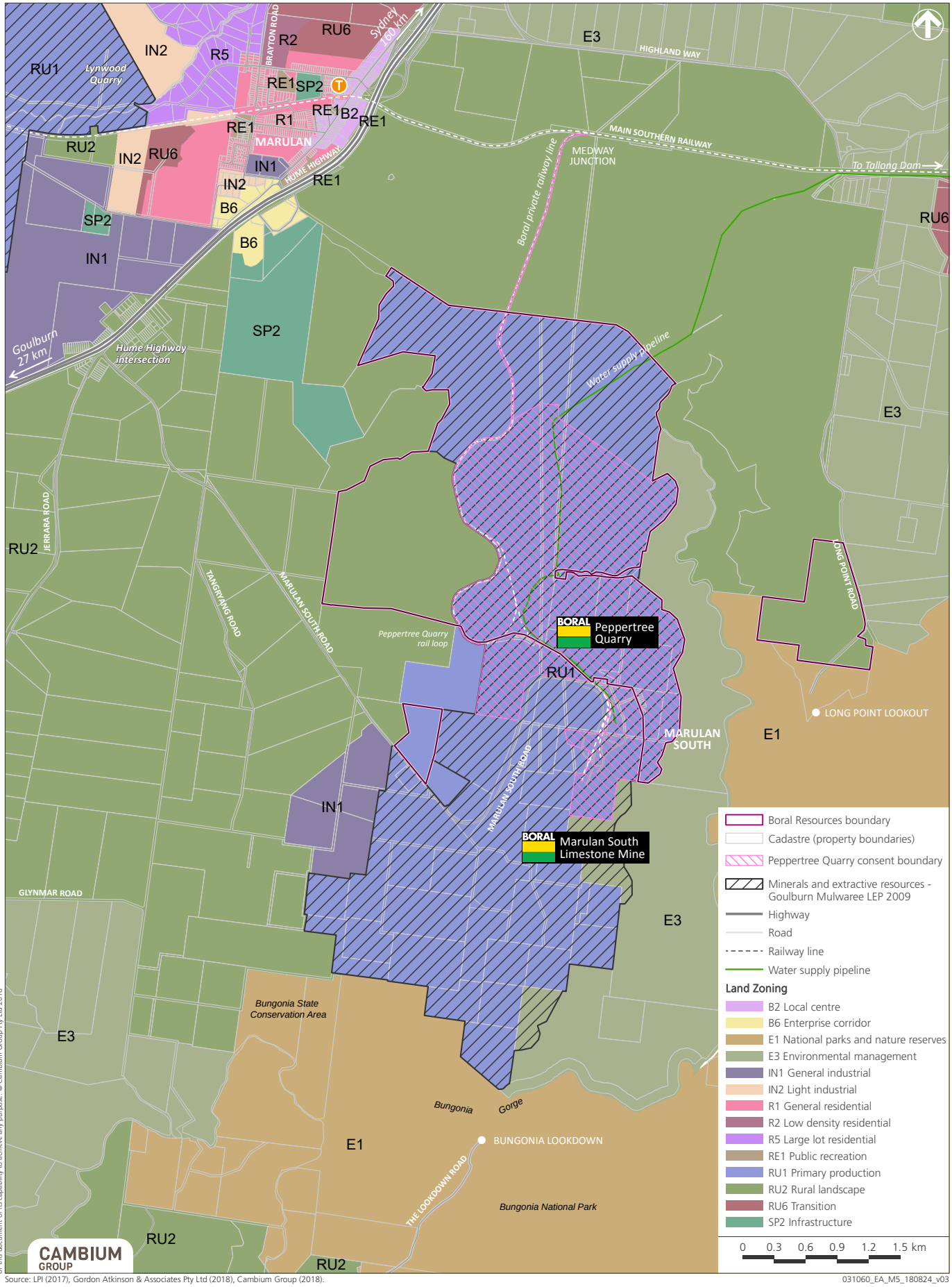
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Figure 1.5
Land zoning

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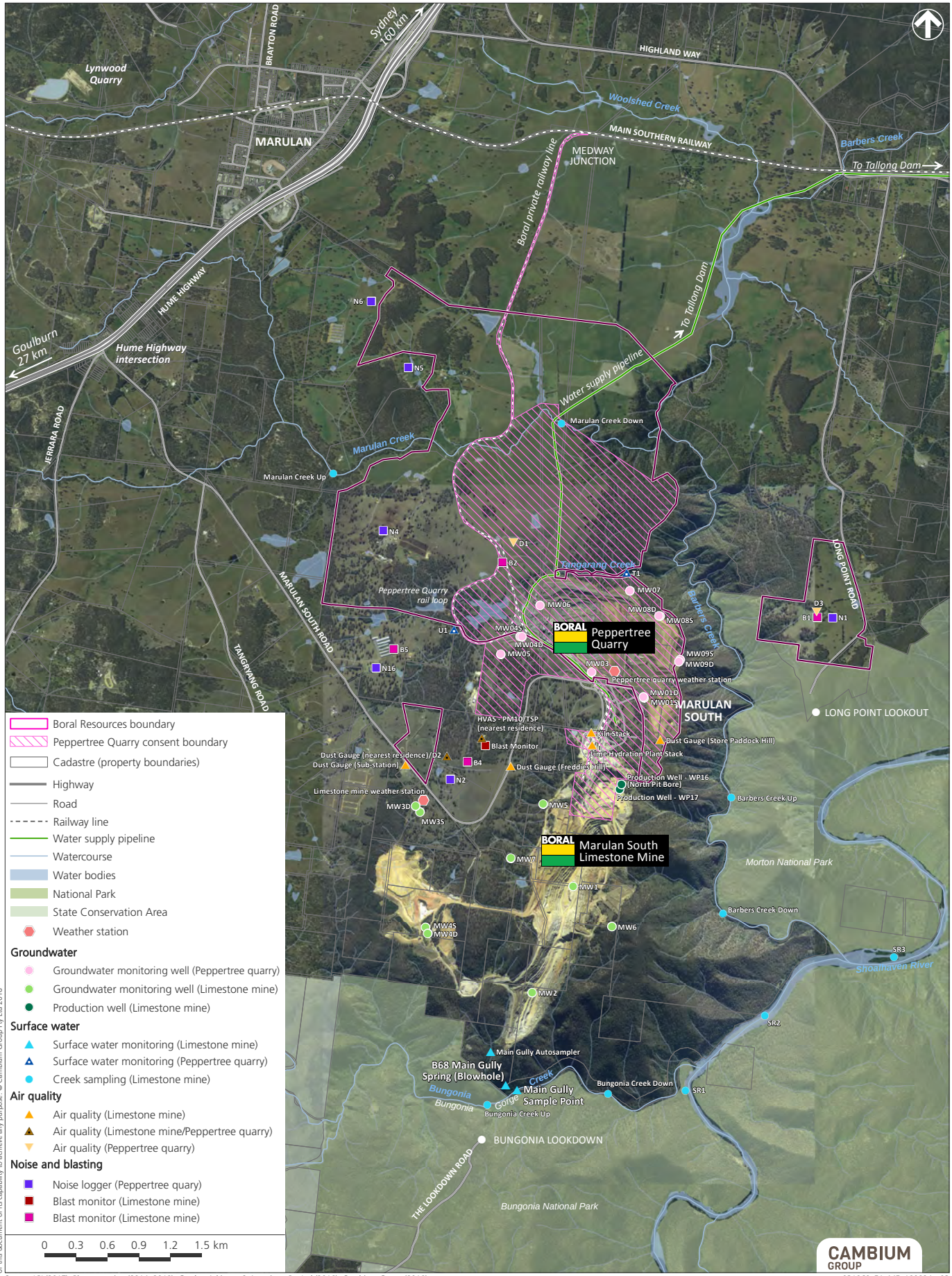
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Figure 1.6
Environmental monitoring locations

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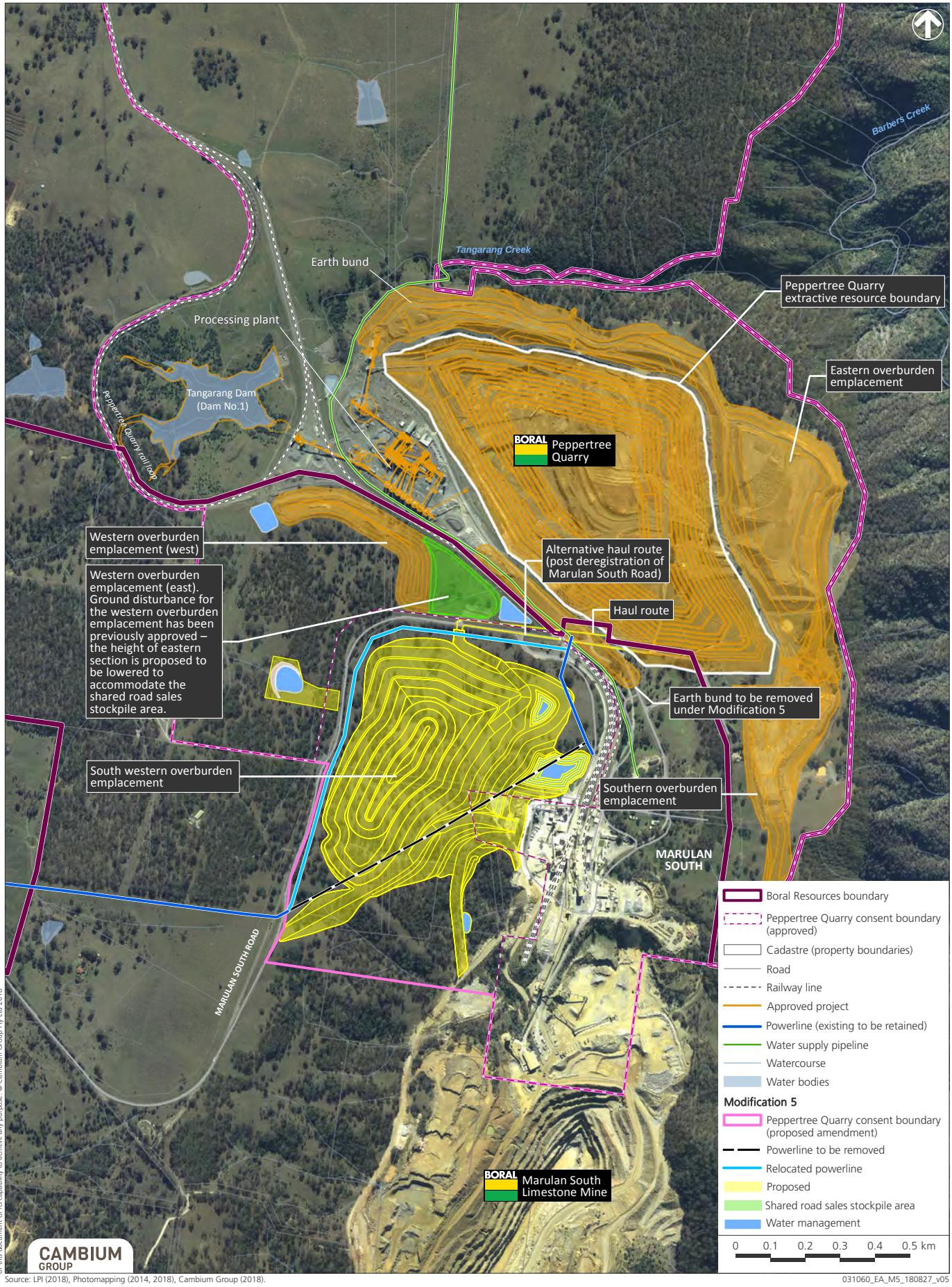


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Figure 1.7
The Project

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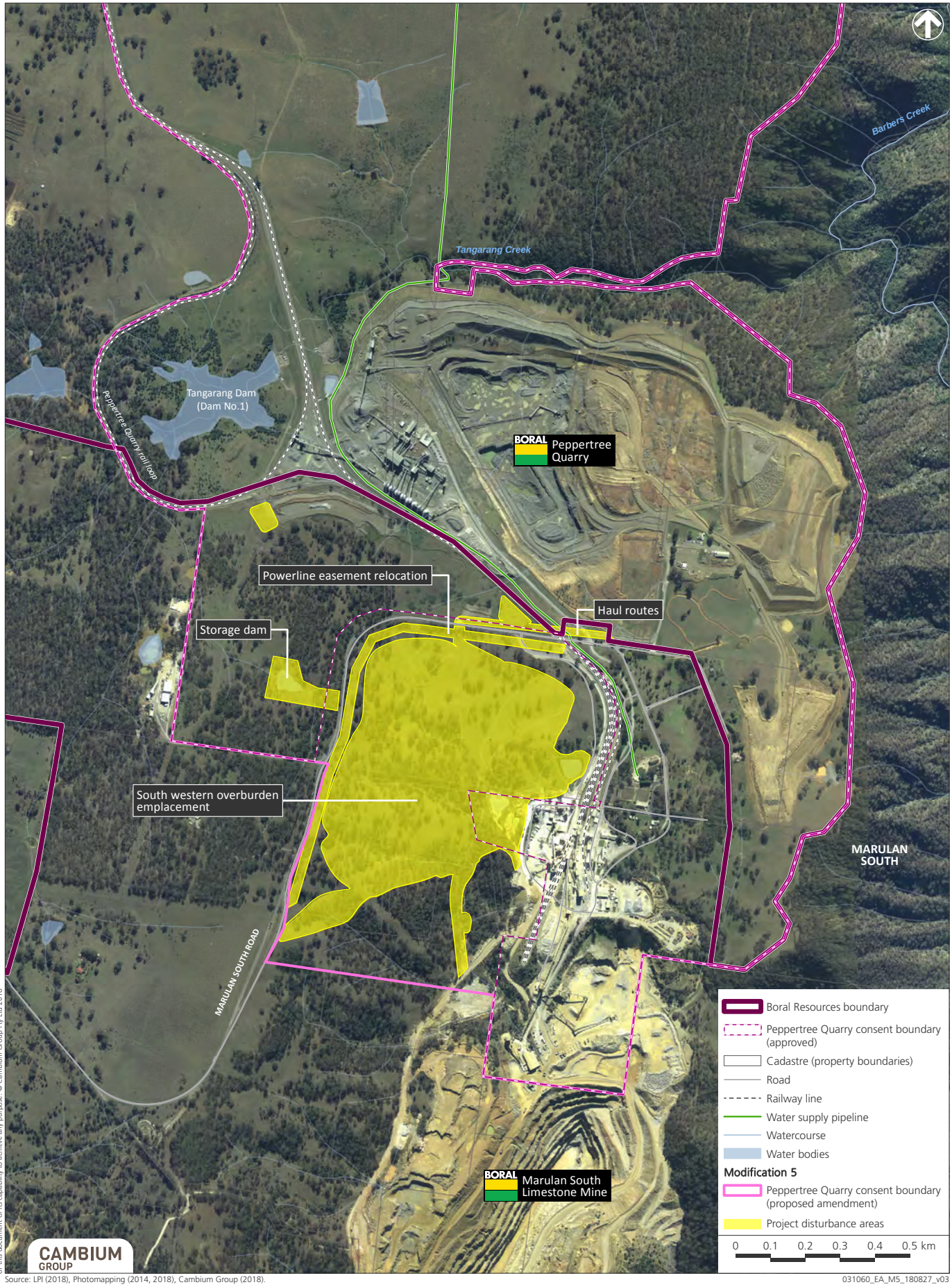
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Figure 1.8
Project disturbance areas

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2 Relevant Legislation, Policy and Guidelines

A range of legislation, policies, regulations and guidelines contain relevant considerations for the assessment of the surface water related aspects for the Project. Key issues that have been considered in finalising the details of the Project are set out below.

2.1 Legislation

2.1.1 Water Management Act and Water Act

The aim of the *Water Management Act 2000* (WMA) is to provide for the sustainable and integrated management of the water sources of NSW for the benefit of both present and future generations and defines rules for management of surface water and groundwater in NSW. The WMA contain provisions for the licensing of water capture and use. If any dams are proposed as part of the water management system, consideration must be given to whether the dams need to be licensed. A controlled activity approval under the WMA is typically not required for activities approved as State Significant Developments.

2.1.1.1 Harvestable rights

Harvestable rights orders made by the Minister under Section 54 of the WMA give a landholder the right to capture 10% of the average regional rainwater runoff on the land by means of a dam or dams having not more than the total capacity calculated in accordance with Schedule 1 of the orders, providing such structures are located on minor streams only (i.e. first and second order streams). This water can, in most cases, be used for any purpose.

The *Water Management (General) Regulation 2011 (Schedule 1)* excludes certain types of water storage structures from Harvestable Rights considerations:

1. Dams solely for the control or prevention of soil erosion:

a. from which no water is reticulated (unless, if the dam is fenced off for erosion control purposes, to a stock drinking trough in an adjoining paddock) or pumped, and

b. the structural size of which is the minimum necessary to fulfil the erosion control function, and

c. that are located on a minor stream.

...

3. Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.

The DPI (Water) Guideline "*Dams in NSW - Do you need a licence*" (2015) indicates that the following dams do not require a licence:

- dams that capture water under a harvestable right
- dams built before 1999 and
- dams up to one megalitre on small properties.

The Guideline states that landholders may construct and use a dam to store different kinds of water taken under different rights and licences in addition to their harvestable right, providing the landholder holds:

- a licence for the volume of water that exceeds the maximum harvestable right dam capacity (MHRDC), unless the water is taken under a domestic and stock right or native title right
- a water supply work approval for a dam which exceeds the MHRDC.

The Guideline also states that special dams which are not included in harvestable right calculations include:

1. dams for the control or prevention of soil erosion (gully control structures)
2. dams for flood detention and mitigation
3. dams for the capture, containment and recirculation of drainage
4. dams endorsed by the Minister for specific environmental management purposes
5. dams without a catchment and
6. dams licenced under the *Water Act 1912* before 1 January 1999.

All sediment basins associated with the Project would be constructed and operated for the purposes of sediment control, and are therefore excluded from the requirements of the harvestable rights order and do not require licensing under the WMA. There are no restrictions on the use of water from dams that comply with these provisions.

2.1.2 Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (PoEO Act) and the NSW *Protection of the Environment Operations (General) Regulation 2009* set out the general obligations for environmental protection. The PoEO Act is relevant to the Project as it contains requirements relating to the prevention of the pollution of waters.

The current Environmental Protection Licence (EPL No. 13088, version date 10 November 2017) does not specify any surface water requirements.

2.1.3 SEPP (Sydney Drinking Water Catchment) 2011

The Project is located within the Sydney Drinking Water Catchment. The *State Environmental Planning Policy* (SEPP) *(Sydney Drinking Water Catchment) 2011* aims to provide for healthy water catchments, delivering high quality water while permitting development that is compatible with that goal. The SEPP also aims to support the maintenance or achievement of the water quality objectives for the Sydney drinking water catchment and requires developments to demonstrate a neutral or beneficial effect (NorBE) on water quality.

All sediment basins proposed as part of the Project would be constructed and operated in accordance with the requirements for discharge to 'sensitive environments' as set out in *Managing Urban Stormwater: Soils & Construction, Volume 2E – Mines and Quarries* (DECC, 2008). All water transfers and overflows from the sediment basins would be retained within the Quarry water management system. Following construction the emplacements would be revegetated to a standard that minimises erosion. These management actions would ensure that the Project complies with the requirements of the SEPP.

2.1.4 WaterNSW Act 2014

The *WaterNSW Act* establishes and defines the objectives of WaterNSW, as an amalgamation of the former SCA and State Water. For this Project, the relevant objectives of the Act include:

- to ensure that declared catchment areas and water management works in such areas are managed and protected so as to promote water quality, the protection of public health and public safety, and the protection of the environment
- to provide for the planning, design, modelling and construction of water storages and other water management works and
- to conduct its operations in compliance with the principles of ecologically sustainable development.

2.2 Policies and Plans

Relevant issues related to NSW State Government natural resource management policies and guidelines that have been considered in relation to surface water management for the Project are set out below.

2.2.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) is a joint national approach to improving water quality in Australian and New Zealand waterways. The NWQMS aims to protect the nation's water resources by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The main mechanism for promoting this aim has been the publication of a number of water quality guidelines, including the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) (commonly referred to as the *ANZECC Guidelines*). These guidelines are reflected in the following NSW guidelines:

- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006) (refer Section 2.2.2 below)
- *NSW Water Quality and River Flow Objectives* (http://www.environment.nsw.gov.au/ieo).

For the Shoalhaven River catchment, the specific requirements of the *Independent Inquiry to Shoalhaven River System* (Healthy Rivers Commission, 1999), as described in Section 2.2.3 below, take precedence over the *NSW Water Quality and River Flow Objectives*.

2.2.2 ANZECC Guidelines for Fresh and Marine Water Quality 2000

The ANZECC Guidelines set out a range of water quality criteria for assessment of the suitability of water for protection of ecosystem health, recreational amenity, drinking water, irrigation and stock water use, and potential toxic effects on aquatic fauna.

The main aspects of the ANZECC Guidelines that relate to matters covered in this report are the default 'trigger values' for common water quality characteristics for ecosystem protection for which there is minimal risk of ecosystem harm. The trigger values are based on 20th and 80th percentile data derived for appropriate reference systems (as set out in Tables 3.3.2 and 3.3.3 of the Guidelines). It is important to note that the default trigger concentrations are frequently misinterpreted as water quality targets. As noted in Section 3.3.2.3 of the ANZECC Guidelines:

> *'The guideline trigger values are the concentrations (or loads) of the key performance indicators, below which there is a low risk that adverse biological effects will occur. The physical and chemical trigger values are not designed to be used as 'magic numbers' or threshold values at which an environmental problem is inferred if they are exceeded.'*

The NSW guideline *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (Department of Environment and Conservation, 2006) specifically notes that trigger values are not 'pass/fail/ compliance criteria'.

The ANZECC Guidelines recognise that the water quality values quoted in Tables 3.3.2 and 3.3.3 for south-eastern Australia are default values to be used in the absence of local data for a particular watercourse, and provide the following advice (Section 3.3.2.4) in relation to the derivation of locally specific data:

> *'For naturally occurring stressors, use data for appropriate reference systems to determine the low-risk trigger value for each key indicator. For these Guidelines, data collected after two years of monthly sampling are regarded as sufficient to indicate ecosystem variability and can be used to derive trigger values'.*

Further discussion relating to the water quality data in the watercourses in the vicinity of the site, including the site specific triggers derived for the site, is contained in Section 3.6 below.

A further aspect of the ANZECC Guidelines relates to the use of trigger values for regulatory purposes. Section 2.2.1.9 of the ANZECC Guidelines provides the following advice in relation to the use of the trigger values for regulatory purposes:

> *'The Guidelines have not been designed for direct application in activities such as discharge consents, recycled water quality or stormwater quality, nor should they be used in this way. (The exception to this may be water quality in stormwater systems that are regarded as having some conservation value.) They have been derived to apply to the ambient waters that receive effluent or stormwater discharges, and protect the environmental values they support.'*

This advice is reflected in the Department of Environment and Conservation (2006) guideline '*Using the ANZECC Guidelines and Water Quality Objectives in NSW*', which notes:

> *'The NSW WQOs [Water Quality Objectives] are the environmental values and long-term goals for consideration when assessing and managing the likely impact of activities on waterways. They are not intended to be applied directly as regulatory criteria, limits or conditions but are one factor to be considered by industry, the community, planning authorities or regulators when making decisions affecting the future of a waterway.'*

2.2.3 Healthy Rivers Commission

Tangarang Creek and Barbers Creek are sub-catchments of the Shoalhaven River. The Healthy Rivers Commission's (HRC) *Independent Inquiry into the Shoalhaven River System* (HRC, 1999) endorsed the following environmental values for the Shoalhaven River and its tributaries:

- healthy waters – protection of aquatic ecosystems
- recreation – protection of primary and secondary recreation and visual amenity
- water supplies – protection of livestock, irrigation and farmstead water and
- protection of drinking water to be treated with coarse screening and disinfection, within sections of stream where water is extracted for use in urban water supply.

The HRC (1999) recommended that the water quality criteria specified in the prevailing water quality guidelines published by NHMRC/ ARMCANZ/ANZECC for primary and secondary contact recreation and for drinking water supplies should be adopted as WQOs throughout the Shoalhaven catchment. Further details on the ANZECC Guidelines and environmental performance criteria to achieve these water quality objectives are outlined in Section 2.2.2 above.

The HRC also provided the following commentary and advice in relation to water quality objectives for nutrients:

> *"The criteria specified in Table WQ2 (taken from Table 3.2) should be adopted as indicative water quality objectives for nutrients throughout the catchment to be used in the initial phases of an adaptive management regime for water quality.*
>
> *The recommended objectives generally should not be used for regulatory purposes. They are indicative and only should be used in policies and planning instruments, as criteria for the first round of strategic planning. Further monitoring and evaluation may demonstrate the need for their revision.*

Table WQ2. Recommended indicative water quality objectives for nutrients

Location	Dry weather	Wet weather
Total Phosphorus (µg/L)		
Upper and middle catchment	40	60
Kangaroo Valley	30	60
Estuary	50	
Total Nitrogen (µg/L)		
Upper and middle catchment	500	500
Kangaroo Valley	500	500
Estuary	400	

2.2.4 State Water Management Outcomes Plan

The *Water Management Act 2000* provides for the establishment of the *State Water Management Outcomes Plan* (SWMOP) to set out the over-arching policy context, targets and strategic outcomes for the development, conservation, management and control of the State's water sources.

The SWMOP promotes the objects of the WMA and its water management principles and seeks to give effect to the NSW Government's salinity management strategies. The SWMOP provides for the protection and enhancement of the environmental services provided by aquatic ecosystems while delivering a framework for the use of water to meet human needs, including more secure access licences. The SWMOP details the Government's commitment to manage the linkages between environment, human health, communities and industries.

The Project is consistent with the objectives of the SWMOP, both within the Project area and on downstream users, as avoidance and mitigation measures would be implemented to minimise potential impacts on the creeks and rivers.

2.2.5 Southern Rivers Catchment Action Plan

The *Southern Rivers Catchment Action Plan* (CAP) 2013–2023 is an overarching 10-year plan that has been developed to guide the implementation of natural resource management in the Southern Rivers region, in collaboration with a range of partners.

The Southern Rivers CAP 2023 lists a number of objectives and targets for the Southern Rivers region, which includes the Shoalhaven River catchment. This includes the following objectives pertaining to surface water:

- private and public land and water managers make well-informed decisions about use and care of natural resources
- private and public land and water managers effectively respond and adapt to change
- diverse, healthy, connected and productive natural environments
- health and integrity of natural habitat supports people and the environment and
- fresh water, estuarine and marine assets support people and the environment.

The *Southern Rivers CAP 2023 Paper – Water* describes the desired state of rivers within the region that support water quality, quantity and movement:

- good geomorphic condition, close to reference condition for the particular Riverstyle
- natural hydraulic function—balance for surface and base flows
- functional connectivity within stream, to adjacent floodplains, between surface and groundwater
- healthy and diverse native aquatic fauna
- water quality supports community uses and values suitable for human consumption that meet ANZECC guidelines 100% of the time and
- sufficient riparian buffers to manage pollution sources.

Avoidance and mitigation measures would be implemented as part of the Project to support the objectives of the CAP.

2.2.6 Surface Water Sharing Plans

Water sharing plans (WSPs) have been developed for rivers under the WMA. WSPs establish rules for sharing water between river environmental needs and water users. The Project is located within the area of the Greater Metropolitan Region Unregulated Area WSP and three surface water sources within the WSP as follows:

- Bungonia Creek Management Zone (commenced July 2011)
- Barbers Creek Management Zone (commenced July 2011) and
- Shoalhaven River Gorge Management Zone (commenced July 2011).

The Quarry is located within the Barbers Creek Management Zone and has a Water Access Licence for 145 ML/year (Licence 10SL056926).

2.2.7 Neutral or Beneficial Effect on Water Quality Assessment Guideline 2015

The *Neutral or Beneficial Effect on Water Quality Assessment Guideline* (SCA, 2015), is a revised version of guidelines first published in 2011, developed in response to SEPP (Sydney Drinking Water Catchment) 2011. The Guideline responds to the requirement for all development in the Sydney drinking water catchment to have a NorBE on water quality, and provides clear definition for assessment and management of water quality, including provision of a standard Assessment Tool. The Guideline requires assessment commensurate with project risk, and promotes source management and control strategies over 'end of pipe' control solutions.

A NorBE for water quality is satisfied if the development:

- has no identifiable potential impact on water quality or
- will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site or
- will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

Table A2 of the Guideline provides a checklist for identifying potential impact occurring to water quality for project activities where:

- flow of water is concentrated on part of the site during construction or operation
- flow of water is impeded on part of the site during construction or operation
- proposed development during construction or operation will involve a discharge of effluent, dust, stormwater or other pollutants
- any other matter considered to result in an identifiable impact on water quality.

Minimum information requirements to assess development applications have been established by WaterNSW (*Developments in the Drinking Water Catchment – Water Quality Information Requirements*, 2015) which define water quality as comprising both surface and groundwater in characterising the existing environment.

For the purposes of WaterNSW and the above guidelines, erosion and sediment controls that comply with the requirements for overflow discharge to 'sensitive' environments (as defined in Table 6.1 of *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries*) are considered to comply with the requirements of NorBE. The design and operating requirements specified in these guidelines have been adopted for the Project sediment basins.

The elements of the NorBE Guideline Checklist as recommended for extractive industries (Module 5) applied to the Project are summarised in Table 2.1 below.

Table 2.1: NorBE Assessment Checklist

Documentation Requirements (Table A3, SCA, 2015)	Specific Requirements	Where addressed in this Report
On site water management report	Where on-site wastewater management is proposed	No new on-site wastewater management systems are proposed as part of the Project therefore no further assessment is required.

Documentation Requirements (Table A3, SCA, 2015)	Specific Requirements	Where addressed in this Report
Conceptual erosion and sediment control plan (ESCP)	For a construction area > 250 m^2 and < 2,500 m^2	The proposed maximum area of disturbance due to overburden emplacements and new haul road is greater than 2,500 m^2. Proposals for managing runoff from overburden emplacements are an integral part of the proposed drainage systems described in Section 4. In accordance with the *Peppertree Quarry Water Management Plan* (Boral, 2017), an ESCP would be prepared for the overburden emplacements and new haul road prior to construction.
Conceptual Soil and water management plan (SWMP)	For construction or impervious areas > 2,500 m^2	A conceptual Surface Water Management System for the Project is described in Section 4, which details the proposed drainage system and sediment controls for the emplacement areas. The *Peppertree Quarry Water Management Plan* (Boral, 2017) also details the management and mitigation measures proposed for surface water and erosion and sediment control and would be updated to include the SWOE and WOE following approval of this modification.
Small scale stormwater quality modelling	For < 2,500 m^2 impervious area	A new unsealed haul road approximately 420 m long would be constructed. As the road would be unsealed, it is not considered to constitute an impervious surface and therefore stormwater quality modelling would not be required. Standard erosion and sediment controls would be implemented during construction (see Sections 2.2.8 and 4.4) to minimise water quality impacts.
MUSIC stormwater modelling	For > 2,500 m^2 impervious area	A new unsealed haul road approximately 420 m long wide would replace approximately 200 m of the existing road. As the road would be unsealed, it is not considered to constitute an impervious surface and therefore stormwater quality modelling would not be required. Standard erosion and sediment controls would be implemented during construction (see Sections 2.2.8 and 4.4) to minimise water quality impacts.
Contamination report	Where historical land use of the development area indicates potential contamination	Not applicable
Flood study	Where the development area is within or potentially within the AEP and the water sensitive parts of the development are located in the flood area	Not applicable, as the Project is not located within a flood-liable area.
Any SEPP1 (Development Standards) objection		Not applicable, as the Project is State Significant Development.

2.2.8 Erosion and Sediment Control Guidelines

Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008) provides guidelines to specifically address requirements for erosion and sediment control on mines and quarries based on the principles set out in *Managing Stormwater: Soils and Construction, Volume 1* (Landcom 2004).

Specific aspects of the guidelines applicable to the Project include the recommended minimum design criteria for erosion and sediment control measures set out in Table 6.1 of *Volume 2E – Mines and Quarries*. These guidelines have been adopted for the design and operation of all sediment control basins and runoff conveyance structures as described in Section 4.1.

Appendix D of *Managing Stormwater: Soils and Construction, Volume 2D – Main Roads* (DECC, 2008) provides guidelines to specifically address requirements for erosion and sediment control for road construction based on the principles set out in *Managing Stormwater: Soils and Construction, Volume 1* (Landcom 2004). Relevant aspects of these guidelines have been adopted for the erosion and sediment controls for the construction of the new haul road as referenced in Section 4.4.

2.2.9 Controlled Activity Guidelines

In accordance with Division 2 of the *Water Management (General) Regulation* 2011, a controlled activity approval under the WMA is not required for activities approved as State Significant Development under the EP&A Act. However, the general standards used by DoI-Water (now Natural Resources Access Regulator (NRAR)) in implementing the WMA still need to be adhered to. Consideration of the following guidelines has been included in this SWA:

- *Guidelines for Controlled Activities on Waterfront Land - Riparian Corridors (NRAR, 2018)*
- *Guidelines for Instream Works on Waterfront Land (DPI Water, 2012a)*
- *Guidelines for Laying Pipes and Cables in Watercourses on Waterfront Land (DPI Water, 2012b)*
- *Guidelines for Outlet Structures on Waterfront Land (DPI Water, 2012c)*
- *Guidelines for Vegetation Management Plans on Waterfront Land (DPI Water, 2012d)* and
- *Guidelines for Watercourse Crossings on Waterfront Land (DPI Water, 2012e)*.

2.2.10 NSW State Rivers and Estuaries Policy (1993)

The *NSW State Rivers and Estuaries Policy* (NSW Water Resources Council, 1993) contains state-wide objectives for the protection and enhancement of watercourses. The proposed surface water management should be consistent with the *NSW State Rivers and Estuaries Policy* objectives which are to:

- manage the rivers and estuaries of NSW in ways which slow, halt or reverse the overall rate of degradation in their systems
- ensure the long term sustainability of their essential biophysical functions and
- maintain the beneficial use of these resources.

The surface water management of the Project has been designed in accordance with the objectives of the Policy. The key aspect of this is to demonstrate that there is no degradation of Tangarang Creek as a result of the Project.

3 Surface Water Environment

3.1 Overview

3.1.1 Location and Existing Topography

The Quarry is located within the catchment of the Shoalhaven River on a ridge line west of Barbers Creek Gorge, and generally at the eastern edge of a plateau above the Shoalhaven River.

Land elevations in the vicinity of the Quarry range from around 590 m AHD to 610 m AHD. The proposed SWOE is located south of the Quarry as shown on Figure 1.7. The emplacement would be located over a drainage line on land varying from about 620 m AHD at the western and northern sides to about 590 m AHD in the central area. The drainage line drains from the north-west to the south-east with a slope of around 4%. The WOE is located between the Quarry and the SWOE on relatively flat land with an elevation of around 610 m AHD.

The existing land is mainly open grassland with areas of open woodland.

3.1.2 Existing Surface Drainage

Tangarang Creek is an ephemeral creek which flows along the western and northern edge of the Quarry site to join Barbers Creek, approximately 500 m to the east of the Quarry. Dam 1 (also known as Tangarang Creek Dam) is located on Tangarang Creek west of the Quarry pit and is part of the existing Quarry water management system. Upstream of the Dam, Tangarang Creek is a third order stream with a catchment area of about 615 ha. Barbers Creek flows into the Shoalhaven River 6.5 km downstream of the Quarry and 30 km upstream of Tallowa Dam, which supplies raw water to the Sydney and Illawarra drinking water systems.

The existing area on which the proposed SWOE would be located currently drains in a south-easterly direction to the Limestone Mine pit. The area to be covered by the WOE drains in a generally northerly direction, with the north-western portion draining north-westerly towards Dam 1 and the south-eastern and central portions draining north-easterly to the Quarry pit.

All drainage lines within the Project area are first or second order streams as per the Strahler Stream Order system.

3.2 Existing Quarry Water Management

Surface water within the Quarry site is managed in accordance with the *Peppertree Quarry Water Management Plan* (Boral, 2017). The surface water management system is based on segregating 'clean' and 'dirty' water and capturing and reusing stormwater runoff for use in the quarry processes, dust suppression and environmental controls.

The existing site is currently subdivided into twelve sub catchment areas. Sub-catchments 8 to 10 and 12 are clean water catchments where water is diverted around the site and the remainder are dirty water catchments. The locations of the dams and associated catchments are shown in Figure 3.1.



Figure 3.1: Peppertree Quarry Operational Catchment Plan

(Source: Peppertree Quarry Water Management Plan (2017), Figure 5.2)

A number of catchments within the site drain to the Quarry pit, Dam K and Dam 1 from where water is either used for dust suppression purposes, reused in operations or discharged to Tangarang Creek as environmental flows. Other catchments within the Quarry drain to a series of small sediment basins, mainly located on the outer edge of the northern noise bund or the eastern side of the Eastern Overburden Emplacement. In large storm events these basins overflow to either Tangarang Creek or Barbers Creek.

3.3 Rainfall

3.3.1 Daily Rainfall

Collection of continuous weather records at the Quarry commenced in 2009. However, the Scientific Information for Landowners (SILO) climate database provides a more comprehensive record of the long term climate of the area. The daily rainfall records for Marulan, George St (Station 070063) were obtained from SILO for the period 1 July 1889 – 30 June 2017. Table 3.1 contains the monthly and annual rainfall statistics and Figure 3.2 provides the statistics graphically. Analysis of the site rainfall record demonstrates similar trends as the SILO rainfall record.

Table 3.1: Monthly Rainfall Statistics for Marulan (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average	70	70	70	50	52	51	48	45	46	58	59	63	696
Minimum	1	0	0	0	0	0	0	0	0	1	0	0	288
10th %ile	14	7	10	8	7	9	9	10	15	16	8	13	473
Median	62	52	49	39	30	42	33	33	38	47	50	53	663
90th %ile	145	160	140	114	116	131	98	101	91	115	121	128	960
Maximum	222	273	330	233	406	382	319	224	166	263	248	220	1469

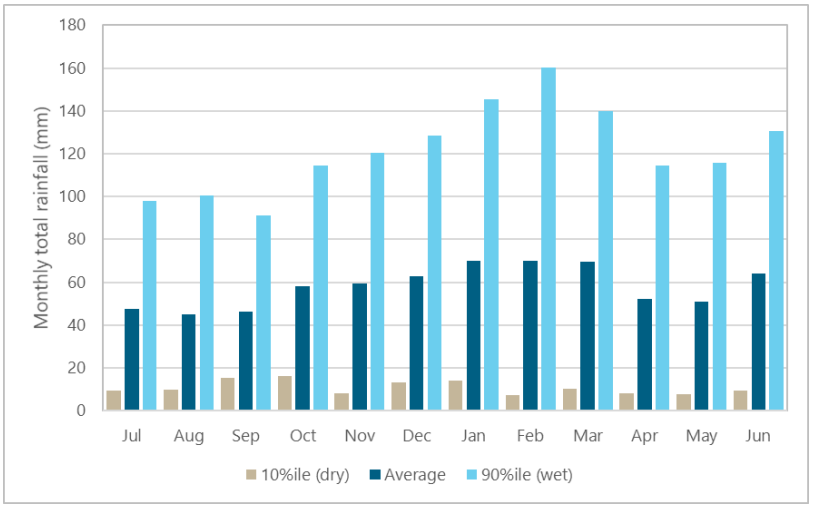


Figure 3.2: Monthly Rainfall Analysis (1889 - 2017)

The statistics show that average annual rainfall in the vicinity of the Project is approximately 696 mm. On average, January, February and March are the wettest months of the year and August is the driest. Rainfall is highly variable ranging from a minimum of zero in a month up to a maximum of 406 mm. In wet (90th percentile) years the annual rainfall can be up to 960 mm while in a dry (10th percentile) year it can be as low as 473 mm. On average, however, there is little variation in monthly rainfall between winter and summer.

3.3.2 Five Day Rainfall

For purposes of determining the required capacity, the sediment basins have been provisionally sized to comply with the requirements for capture of fine and dispersive sediments as set out in Table 6.1 of *Managing Urban Stormwater: Soils and Construction: Volume 2E Mines and Quarries* (DECC, 2008). The table specifies the adoption of the 95th percentile rainfall as the basis for sizing sediment basins that would overflow into 'sensitive' receiving environments and the 90th percentile rainfall for a standard receiving environment sensitivity. Table 3.2 lists the 90th and 95th percentile five day rainfall depths for various durations for Mittagong and Goulburn (as set out in Table 6.3 of *Managing Urban Stormwater: Soils & Construction – Volume 1*). The value for Marulan South has been derived on the basis of the relative proximity of the Quarry to Mittagong and Goulburn.

Table 3.2: 95th Percentile Five Day Rainfall Depths (mm)

Rainfall percentile	Mittagong	Goulburn	Marulan South
90th	49.0	28.6	35.7
95th	75.2	40.8	52.8

3.4 Evaporation

SILO daily pan evaporation dataset for Marulan George St (Station No. 70063) was obtained to correspond with the daily rainfall record for Marulan South for the period 1 July 1889 to 30 June 2017. The data comprised long term average monthly data from 1889 to the end of 1968 and daily data from 1969 to current. Statistics for the patched pan evaporation data for Marulan (1969 – 2017) are provided in Table 3.3.

Table 3.3: Monthly Evaporation Statistics for Marulan (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average	185	142	122	79	53	37	43	66	93	126	148	185	1278
Minimum	137	95	86	48	39	24	29	48	62	86	100	121	1017
10th %ile	146	111	97	61	43	28	34	52	76	98	116	143	1088
Median	189	143	121	78	51	36	43	64	91	122	146	174	1257
90th %ile	223	175	151	96	66	47	54	82	112	159	179	236	1478
Maximum	267	215	178	120	78	51	71	98	165	186	261	296	1752
Pan Factor	0.785	0.791	0.770	0.801	0.802	0.849	0.881	0.879	0.873	0.883	0.852	0.811	0.785

Table 3.3 also includes mean monthly 'pan factors' for Canberra Airport which is the nearest station with high quality Class-A pan evaporation data (McMahon et al, 2013). These pan factors were used to convert the daily pan evaporation data to estimates of open water evaporation from water storages.

3.5 Climate Change

In 2015, Commonwealth Scientific & Industrial Research Organisation (CSIRO) updated the 2014 predictions in *Climate Change in Australia Projections for Australia's Natural Resource Management (NRM) Regions* (CSIRO, 2015). The Project is located in the East Coast cluster and East Coast South sub-cluster (CSIRO, 2015 *Climate Change in Australia Projections – Cluster Report- East Coast*). The projections are based on current understanding of the climate system, historical trends and model simulations of the climate response to changing greenhouse gas and aerosol emissions. Projections are given for two 20-year time periods: the near future 2020 – 2039 and far future 2080 – 2099.

The key predictions for the East Coast likely to impact on the Quarry water management system are:

- average, maximum and minimum temperatures are projected to continue to increase
- the temperature reached on the hottest days, the frequency of hot days and the duration of warm spells are projected to increase
- average winter rainfall is projected to decrease and a range of changes are projected in other seasons
- increased intensity of extreme rainfall events is projected
- little change in relative humidity for the near future and a decrease for late in the century
- potential evapotranspiration indicate increases in all seasons by late in the 21st century.

The construction of the SWOE and WOE is expected to occur over approximately four years and one year respectively and to be fully rehabilitated within five years of the completion of construction, by which time the sediment basins would no longer be required. Accordingly, climate change effects have not been considered in this SWA.

However, the detailed water balance undertaken for the Limestone Mine has used the CSIRO predictions as the basis for assessing the sensitivity of the water balance results to uncertainties in future climate conditions. This water balance includes the water received from the Quarry sediment basins N1 and N2.

3.6 Surface Water Quality

3.6.1 Monitoring Site Locations

Boral maintains a comprehensive environmental monitoring network within, and surrounding, the Quarry and the adjacent Limestone Mine. Water quality monitoring has occurred at Tangarang Creek since February 2012. In addition, baseline creek surface water quality monitoring has been undertaken for the Limestone Mine since July 2014.

The relevant sites for purposes of this assessment are listed in Table 3.4 and include sites on Tangarang Creek, Marulan Creek (a tributary of Barbers Creek located to the north of Tangarang Creek) and Barbers Creek downstream of the Tangarang Creek confluence. The locations of the surface water monitoring sites are shown on Figure 1.6.

Marulan Creek, although not impacted by the Quarry, provides additional data showing the typical runoff quality from the open grazing land on the plateau to the west of Barbers Creek from which both Marulan Creek and Barbers Creek drain. In addition, routine monitoring has been undertaken at three locations in the Shoalhaven River (designated SR1, SR2 and SR3). SR1 and SR2 are located upstream of the confluence of the Shoalhaven River with Barbers Creek, while SR3 is located downstream of the confluence.

Table 3.4: Routine Creek Water Quality Monitoring Sites and Locations

Site	Description	Easting	Northing	Commenced	Frequency
U1	Tangarang Creek upstream of Dam 1	226950	6149970	February 2012	Quarterly
T1	Tangarang Creek downstream of Dam 1	228730	6150550		
Marulan Up	Marulan Creek upstream of proposed Marulan Creek Dam	225825	6151504	November 2014	Monthly until 2017, quarterly since 2017
Marulan Down	Marulan Creek downstream of proposed Marulan Creek Dam	228002	6151977		
Barbers Up	Barbers Creek upstream	229518	6148416	September 2014	Monthly until 2017, quarterly since 2017
Barbers Down	Barbers Creek downstream	229542	6147306		
SR1	Shoalhaven River site 1	229183	6145620	July 2014	Monthly until 2017, quarterly since 2017
SR2	Shoalhaven River site 2	229940	6146335		
SR3	Shoalhaven River site 3	231172	6146891		

3.6.2 Creek Water Quality

Table 3.5 presents key water quality statistics from the various monitoring locations within the waterbodies in the vicinity of the Quarry. The statistics are compared to the relevant ANZECC default trigger values for ecosystems and the site specific triggers identified in the *Peppertree Quarry Water Management Plan*, based on the monitored data. Values in red font in Table 3.5 indicate exceedances of the ANZECC default trigger values while values in green font indicate exceedances of the site specific trigger values.

Table 3.5: Summary of Creek Water Quality Statistics

Analyte	Unit	Trigger Value	Statistic	U1	T1	Marulan Up	Marulan Dn	Barbers Up	Barbers Dn	SR1	SR2	SR3
pH	pH value	6.5-7.5[1]	Count	6	30	25	25	28	27	30	30	30
			20%ile	7.2	7.7	7.6	7.8	7.8	7.9	7.3	7.2	7.2
			Median	7.4	7.9	7.8	8.0	8.0	8.0	7.4	7.4	7.4
		6.5-8.5[2]	80%ile	7.7	8.0	7.9	8.2	8.1	8.1	7.5	7.5	7.5

Analyte	Unit	Trigger Value	Statistic	U1	T1	Marulan Up	Marulan Dn	Barbers Up	Barbers Dn	SR1	SR2	SR3
Electrical Conductivity @ 25°C	µS/cm	350[1]	Count	6	30	25	25	28	27	30	30	30
			20%ile	214	356	451	648	414	445	84	89	94
			Median	249	654	1,160	1,000	541	553	103	105	110
		1,500[2]	80%ile	288	813	1,556	1,248	853	933	139	143	146
Total Dissolved Solids	mg/L	N/A	Count	3	24	25	25	28	27	30	30	30
			20%ile	98	340	293	421	269	290	55	58	61
			Median	159	444	754	650	352	359	67	69	72
			80%ile	175	583	1,014	811	555	607	90	93	95
Suspended Solids	mg/L	N/A	Count	3	24	16	16	18	17	18	18	18
			20%ile	5.5	<5	<5	<5	<5	<5	<5	<5	<5
			Median	10	<5	7	<5	<5	<5	<5	<5	<5
			80%ile	21	41	10	6	<5	<5	8	6	8
Total Nitrogen as N	mg/L	0.25[1]	Count	5	29	25	25	28	27	30	30	30
			20%ile	0.86	0.20	0.48	0.40	0.34	0.20	0.28	0.20	0.30
			Median	1.20	0.25	0.80	0.60	0.40	0.50	0.45	0.40	0.45
		1.1[2]	80%ile	1.24	0.58	1.02	0.80	0.66	0.60	0.60	0.50	0.62
Total Phosphorus as P	mg/L	0.02[1]	Count	6	30	25	25	28	27	30	30	30
			20%ile	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
			Median	0.12	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		0.09[2]	80%ile	0.34	0.07	0.08	0.02	<0.01	0.02	0.02	0.02	0.02

[1] South East Australia, slightly disturbed ecosystems, upland river

[2] *Peppertree Quarry Water Management Plan site specific triggers*

The analysis indicates that 80th percentile water quality in the vicinity of the Project does not exceed the site specific trigger values, with the exception of Total Nitrogen and Total Phosphorus at U1 and EC at Marulan Up.

4 Water Management System

This section describes the water management system for the proposed SWOE and WOE areas. The proposed system follows the general principles set out in the approved *Peppertree Quarry Water Management Plan* (Boral, 2017).

4.1 Proposed Overburden Emplacement Drainage Concepts

4.1.1 South-Western Overburden Emplacement

The proposed drainage arrangements for the SWOE are shown in Figure 4.1. Runoff would be directed as follows:

- Catchment A would drain to Sediment Basin N2. Water from N2 would be pumped to Kiln Dam (part of the Limestone Mine water management system) and overflow to Tangarang Creek. Basin N2 is an existing farm dam approximately 4 ML in volume which would be enlarged for purposes of sediment control from Catchment A.
- Catchment B would drain north-east to new Sediment Basin N1. Water from N1 would be pumped to Kiln Dam and overflow to Kiln Dam
- Catchment C would drain overland to Sediment Basin N3 and overflow via the existing natural drainage line to the Limestone Mine pit. N3 is a temporary basin which would remain in place until the Limestone Mine builds the southern platform of their Northern Overburden Emplacement for the new stockpile reclaim area.

Table 4.1 summarises the catchment areas and the provisional sizing of the sediment basins in accordance with Table 6.1 of *Managing Urban Stormwater: Soils & Construction – Volume 2E: Mines and Quarries* (DECC, 2008) using the criteria for 'fine' or 'dispersive' sediments. The basins have been sized to capture the runoff from a 95th percentile five day rainfall (52.8 mm) (Table 3.2). The required basin volume quoted in Table 4.1 includes an allowance for 50% additional storage for sediment.

The sediments basins would be operated so as to restore the required 'air space' within five days of the end of a rainfall event. Water taken from the sediment basins to meet this requirement would be transferred to the Kiln Dam, which would be a source of water for the Limestone Mine operations including dust suppression and limestone processing.

Table 4.1: SWOE Sediment Basin Capacity Requirements

Sediment Basin	Catchment	Catchment Area (ha)	Settlement Zone (ML)	Sediment Zone (ML)	Required Volume (ML)
N1	B	15	6.4	3.2	9.6
N2	A	25	8.5	4.2	12.7
N3	C	8	1.7	0.9	2.6

4.1.2 Western Overburden Emplacement

The proposed drainage system for the amended WOE and future shared road sales stockpile area is shown in Figure 4.2 . The main components of the WOE drainage system include:

- A portion of the natural area upstream of the emplacement (Catchment 1) would be diverted around the WOE via the natural ground levels towards Dam 1.
- The remainder of the natural area on the southern side of the WOE (Catchment 2), together with runoff from the southern portion of the WOE (Catchment 4), would drain to a pipe under the WOE and discharge to the channel on the north-western side of the WOE which discharges to sediment basin P2. P2 would be dewatered via a bioswale to Dam 1.
- Runoff from the north-western and central portions of the WOE (Catchments 3 and 5) would also drain to the channel on the north-western side of the WOE which discharges to sediment basin P2. P2 would be dewatered via a bioswale to Dam 1.
- Runoff from the north-eastern side of the emplacement and the future shared road sales stockpile area (Catchment 6) would be captured in a channel running parallel to the railway line which drains in a south-easterly direction to a new sediment basin P1. Runoff from the south-eastern portion of the emplacement drains via a channel on the southern side of the emplacement to P1. P1 is dewatered to the in-pit sump and then pumped to the Heritage Dam. Water from the Heritage Dam is pumped back to the channel on the northern side of the WOE which discharges to P2 when there is adequate capacity in sediment basin P2 to receive this water.

Table 4.2 summarises the catchment areas and the provisional sizing of the sediment basins in accordance with Table 6.1 of *Managing Urban Stormwater: Soils & Construction – Volume 2E: Mines and Quarries* (DECC, 2008) using the criteria for 'fine' or 'dispersive' sediments. P1 has been sized to capture the runoff from a 90th percentile five day rainfall (35.7 mm) as it discharges to the pit, while P2 has been sized to capture the runoff from a 95th percentile five day rainfall (52.8 mm) as it discharges to Dam 1 (refer Table 3.2), from where environmental flows occur. The required basin volumes quoted in Table 4.2 include an allowance of 50% additional storage for sediment.

As for the SWOE sediment basins, the WOE basins would be operated to restore the required 'air space' within five days of the end of a rainfall event.

Table 4.2: WOE Sediment Basin Capacity Requirements

Sediment Basin	Catchment	Catchment Area (ha)	Settlement Zone (ML)	Sediment Zone (ML)	Required Volume (ML)
P1	6	4.1	1.3	0.8	2.1
P2	2, 3, 4, 5	10.9	4.6	1.2	5.8

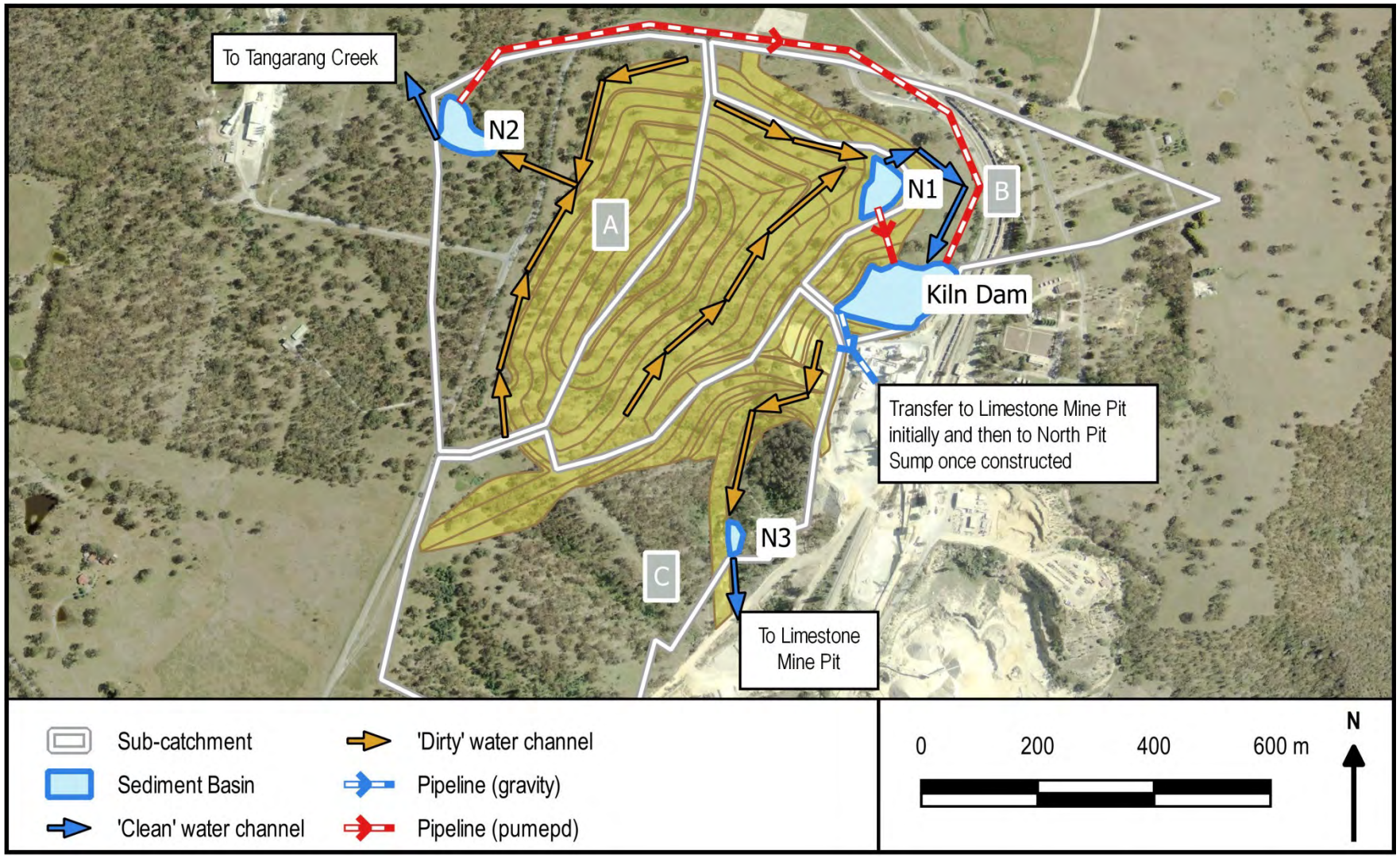


Figure 4.1: Proposed South-Western Overburden Emplacement Drainage Concept

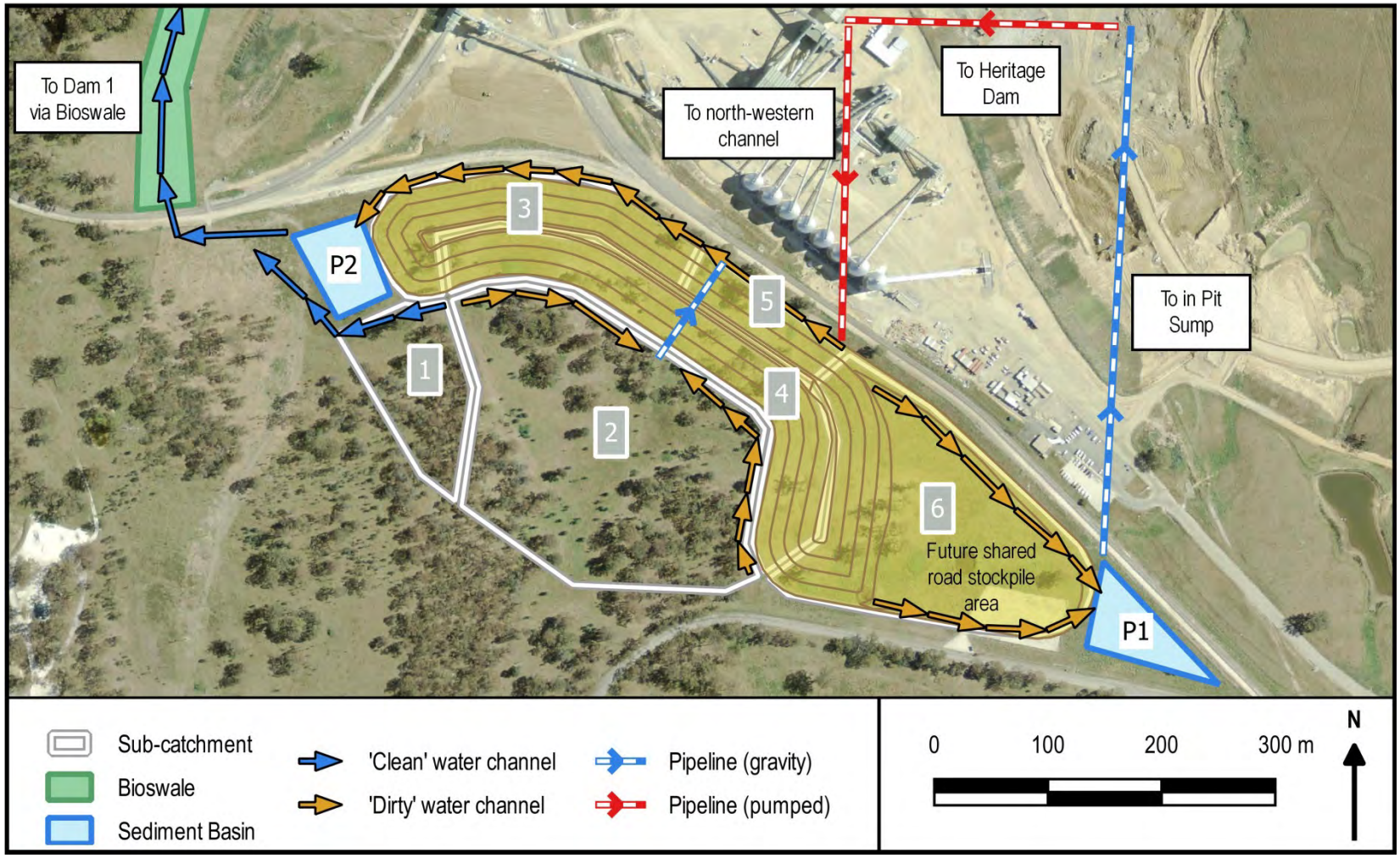


Figure 4.2: Western Overburden Emplacement Drainage Concept

4.2 Runoff Diversion Channels and Spillways

All diversion channels and sediment basin spillways would be designed to be stable when carrying runoff from a 100 year average recurrence interval (ARI) storm for the time of concentration of each catchment (as specified in Table 6.1 of *Managing Urban Stormwater: Soils & Construction, Volume 2E – Mines and Quarries).*

Due to the natural topography, channel slopes range from 4% to 12% in places along the alignment of the diversion drains shown on Figure 4.1 and Figure 4.2 and therefore scour protection and drop structures may be required in some locations. The channel cross section configuration and the areas requiring scour protection would be determined during detailed design in accordance with the requirements of *Managing Urban Stormwater: Soils & Construction – Volume 1* and details included in a revision of the *Peppertree Quarry Water Management Plan*.

A vegetated bioswale upstream of the primary water storage dam is proposed in the *Peppertree Quarry Water Management Plan (Boral, 2017).* The aim of the bioswale, as stated in the *Water Management Plan*, is to improve the quality of runoff entering Dam 1 and to act as a filter for dewatering sediment basin P2. An indicative cross section for the bioswale is provided in Figure 4.3 below, with indicative widths for W1 and W2 of 06 m and 1.2 m respectively. The final configuration of the bioswale would be determined during detailed design.

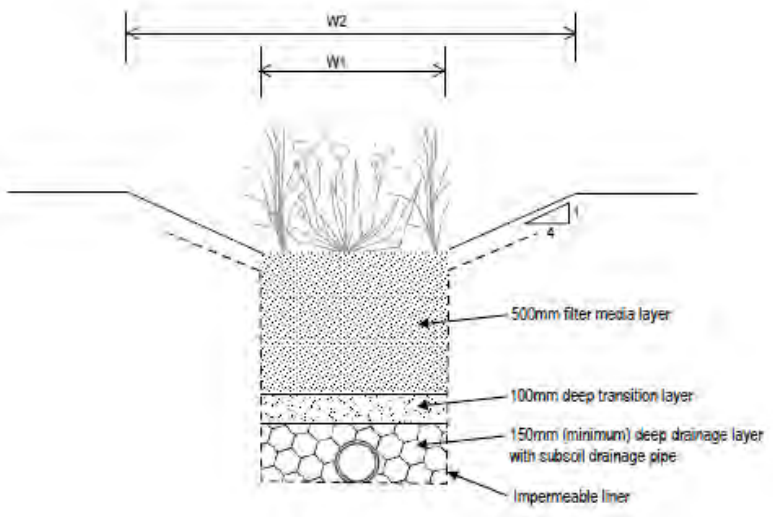


Figure 4.3: Indicative Bioswale Cross Section

4.3 Sediment Basin Operation

As required in *Managing Urban Stormwater: Soils & Construction, Volume 2E – Mines and Quarries,* the sediment basins would be operated to ensure that the runoff capture capacity of each basin is restored within five days of the end of a rainfall event.

The runoff capture capacity of basins N1 and N2 draining the SWOE would be restored by transfer to the Kiln Dam as a source of water for the Limestone Mine operations including dust suppression and limestone processing. The capacity of basin N3 would be restored by discharge to the Limestone Mine pit and as a source of water for dust suppression and limestone processing.

The capacity of basin P1 draining the WOE would be restored by pumped transfer to the Heritage Dam via the in-pit sump. This water would be pumped to the channel draining to basin P2 when there is capacity in basin P2 to receive water from the Heritage Dam. The capacity of basin P2 would be restored by discharge to Dam 1 via the bioswale from where water would be used for dust suppression purposes, reused in operations or discharged to Tangarang Creek as environmental flows.

4.4 Land Disturbance

Land disturbance prior to the placement of overburden and for construction of the haul road would be undertaken in accordance with the procedures set out in the *Peppertree Quarry Water Management Plan (Boral, 2017)* and the *Peppertree Quarry Biodiversity and Rehabilitation Management Plan* (Boral, 2017). This would principally involve:

- disturbance of the minimum area necessary for the proposed phase of work
- installation of sediment fencing down-slope of any proposed disturbance
- construction of diversion channels and sediment basins
- pre-clearance surveys and tree clearing in accordance with the procedures set out in the *Peppertree Quarry Biodiversity and Rehabilitation Management Plan* (Boral, 2017).

In accordance with the *Water Management Plan*, an Erosion and Sediment Control Plan (ESCP) would be prepared for the overburden emplacements and new haul road prior to construction.

4.5 Rehabilitation

Rehabilitation of the proposed SWOE and WOE would be undertaken progressively as each section of the emplacements are completed. The rehabilitation would be undertaken in accordance with the *Peppertree Quarry Biodiversity and Rehabilitation Management Plan* (Boral, 2017).

4.6 Decommissioning of Sediment Basins

Once vegetation establishment has achieved the required surface cover to reduce the erosion rate to negligible, active management of the sediment basins would no longer be required. Sediment basins could either be retained and allowed to overflow after rainfall or removed and the storage area rehabilitated.

5 Surface Water Impacts

5.1 Surface Water Flow

The steep slopes and bare surface of the emplacements can initially be expected to lead to increased rates of runoff compared to the existing conditions. However, the flow downstream of the sediment basins would be moderated by the volume captured in the sediment basins. As indicated in Table 6.2 of *Managing Urban Stormwater: Soils & Construction, Volume 2E – Mines and Quarries,* sediment basins designed to capture runoff from the 95th percentile five day rainfall can be expected to overflow 1 to 2 times per year while basins design to capture the 90th percentile five day rainfall can be expected to overflow 3 to 4 times per year.

Under normal operating conditions, water from the sediment basins would be transferred to either the Limestone Mine or Quarry water management systems. Basins N1, N3 and P1 would overflow (during rainfall events greater than the design event) to either the Limestone Mine or Quarry pit. Sediment basin N2 would overflow to a tributary of Tangarang Creek, which discharges to Dam 1. Basin P2 would overflow to Dam 1.

The existing area which underlies the western portion of the proposed SWOE (which would in future drain to basin N2) currently drains east to a creek which flows drains into the Limestone Mine pit. Under Modification 5, N2 would overflow to a tributary of Tangarang Creek in high rainfall events, approximately 1 to 2 times per year. Therefore, during high rainfall events, there may be a slight increase in flows in Tangarang Creek and a slight reduction in runoff to the Limestone Mine compared to existing conditions. However, as Tangarang Creek discharges to Dam 1, which is part of the Quarry water management system, no impacts are likely to be experienced by downstream users.

In summary, only a very minor redistribution of flow would occur compared with existing conditions during the few times per year that sediment basin N2 overflows to Tangarang Creek.

5.2 Water Quality

The diversion drains and sediment basins would be constructed and operated in accordance with the requirements of *Managing Urban Stormwater*. Relatively few overflow events (1 to 4 times per year) would be expected each year on average. Overflows from the basins would be contained within either the Quarry or Limestone Mine water management systems and no overflow from the basins would discharge directly to the environment. Discharges from Dam 1 may occur after heavy rainfall exceeding the design capacity of the basins, when significant runoff and dilution can be expected from other parts of the landscape.

Discharges from P2 would be treated in the bioswale to remove additional sediment prior to discharge into Dam 1. The additional treatment is required because overflows and environmental flows from Dam 1 discharge to Tangarang Creek. Further details of the bioswale are provided in Section 4.2.

A bioswale is not required downstream of N2 as N2 is dewatered by pumping to the Kiln Dam and only overflows to Dam 1 during high rainfall events when significant runoff and dilution can be expected from other parts of the landscape.

Therefore, no adverse water quality impacts are expected on water quality downstream of the Quarry.

The proposed design and operating standard for the sediment basins is consistent with the objective of achieving a NorBE as required under *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*.

5.3 Cumulative Impacts

Based on the information provided above, the proposed SWOE and WOE would have no impact on surface water quality and flow in the surrounding drainage systems.

Under Modification 5, only a very minor redistribution of flow would occur compared with existing conditions during the 1 to 2 times per year that sediment basin N2 would overflow to a tributary of Tangarang Creek. Previously the area underlying the SWOE, that would in future drain west to N2, drained east and south into the Quarry pit.

Overflows from the sediment basins would be contained within either the Quarry or Limestone Mine water management systems, as per existing conditions.

In accordance with the *Water Management Plan,* measures would continue to be implemented to allow for conservation of potable water resources through recycling or reuse of water for activities such as truck washing or dust suppression as part of the Quarry's integrated water management system. Demand on potable water resources would be reduced through the reuse of water harvested from the new sediment basins proposed in this SWA.

6 Monitoring and Licencing Procedures

All activities associated with the proposed SWOE and WOE would be carried out monitored in accordance with the *Peppertree Quarry Water Management Plan* and the *Peppertree Quarry Biodiversity and Rehabilitation Management Plan*. These Plans would be amended to include the new sediment basins and specific management measures associated with the proposed SWOE and WOE.

6.1 Monitoring

Boral currently undertakes water quality monitoring of overflows from the out of pit sediment basins during large storm events in accordance with the *Water Management Plan*. The additional basins identified in this SWA would be incorporated into the water quality monitoring regime.

Meteorological monitoring would continue at the Quarry monitoring station and routine surface water quality monitoring would continue at sites U1 and T1 listed in Table 3.4. Should any exceedance of the site specific trigger values identified in the *Peppertree Quarry Water Management Plan* occur, the management measures provided in the Plan would be implemented.

6.2 Licensing

The Project would not require any amendment to the Environmental Protection Licence (EPL No. 13088) or to the existing Water Access Licence (10SL056926).

7 Conclusions

This SWA:

- identifies legislation, policy and guidelines relevant to the Project (Section 2)
- documents the existing catchment conditions and water quality in the receiving waters (Section 3)
- describes the proposed water management system for the Project including management measures (Section 4)
- provides an assessment of the impacts of any changes in the flow and water quality resulting from the proposed Project (Section 5) and
- identifies monitoring requirements that relate to the management of water(Section 6).

All activities associated with the proposed emplacements would be carried out in accordance with the procedures and management measures set out in the following management plans for the Quarry operations, or subsequent revisions:

- *Peppertree Quarry Water Management Plan (Boral, 2017) and*
- *Peppertree Quarry Biodiversity and Rehabilitation Management Plan (Boral, 2017).*

These *Water Management Plan* would be amended to include the new sediment basins and management measures associated with the proposed SWOE and WOE.

In accordance with the *Water Management Plan*, an Erosion and Sediment Control Plan (ESCP) would be prepared for the overburden emplacements and new haul road prior to construction.

The proposed water management system would capture runoff from the SWOE and WOE in sediment basins that would be designed and operated in accordance with the relevant requirements of *Managing Urban Stormwater* and would become part of the integrated site water management system. Water retained in the sediment basins would be transferred for reuse in either the Quarry or the Limestone Mine for processing and dust suppression.

Transfers and overflows from the sediment basins would be contained within either the Quarry or Limestone Mine water management systems. Overflows from the basins would only occur in the event of exceedance of the design rainfall (approximately 1 - 4 times per year).

Discharge from a sediment basin located on the western side of the site may lead to a minor change in the flow regime in Tangarang Creek during high rainfall events. However this is not expected to impact on users downstream of the Quarry on Tangarang Creek.

Water quality monitoring of overflows from the proposed basins would be undertaken consistent with the requirements of the *Water Management Plan*.

The proposed design and operating standard for the proposed sediment basins is consistent with the objective of achieving neutral or beneficial effect of water quality (NorBE) as required under *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*. No adverse impacts are expected on the water quality in Tangarang Creek, Barbers Creek or the Shoalhaven River.

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1:25,000 topographic maps: Wingello 8928-4S, Caoura 8928-3N, Bungonia 8828-2N.

APPENDIX G

Visual Impact Assessment Report

Peppertree Quarry MOD 5 Environmental Assessment



Visual Impact Assessment

Prepared for: Boral Resources (NSW) Pty Ltd

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August 2018

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richard lamb & associates

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Executive Summary

Purpose of this report

- This report by Richard Lamb and Associates (RLA) is an assessment of the visual impacts of Boral Resources (NSW) Pty Ltd (Boral) application to modify the existing Project Approval (PA 06_0074) for Peppertree Quarry, Marulan South (the Modification).
- The report consists of an assessment of the likely nature, extent and significance of the visual impacts of the Modification (MOD 5), considered with regard to the range of public and private places that could be affected, primarily the visual impacts of the proposed South-western Overburden Emplacement (SWOE).

Visual context of existing quarry

- The Quarry is situated on the edge of a dissected plateau of the Southern Tablelands of NSW, which is locally drained to the south and east by the Shoalhaven River and its tributaries, Bungonia and Barbers Creeks.
- Land use to the west and north is rural, while to the east, the landscape is dominated by the natural topography and vegetation of Morton National Park (NP) in the Barbers Creek gorge.
- The Quarry is in a secluded area and is not exposed to high intensity public domain features with large numbers of potential viewers such as main roads or urban areas.
- Access to the Quarry is provided by Marulan South Road, which is a public but a dead-end road leading to the Quarry, Aglime Fertiliser plant and Marulan South Limestone Mine.

Visual exposure of proposed modification

- Overall, the Modification is of very low visual exposure to the public and private domain, other than its exposure to adjacent natural landscape in part of Morton NP.
- Visual exposure is low to the adjacent rural land to the south west, west and north.
- Detailed analysis of the likely changes in visual exposure caused by the proposed SWOE and changes to the Western Overburden Emplacement (WOE) show that the overall low visual exposure will remain low.
- The visual exposure of the Modification will be to a slightly larger area than that of the approved existing Quarry operations because of the proposed location of overburden to the south-west of the Pit.
- In some views from the landscape to the south-west, north and east, the topography of the intermediate horizon will be slightly changed as the South-western Overburden Emplacement is constructed, elevating newly formed topography into views.

Visual effects of the modification

- The height and visual exposure of the proposed South-western Overburden Emplacement will not significantly alter the composition of the view.
- The changed Western Overburden Emplacement and re-aligned high voltage powerline will be of low external visibility and have localised effects on Marulan South Road only.

- A minor change will occur in the mid-ground horizon of the view in the most exposed view, due to an increase in the height of the landscape caused by the South-western Overburden Emplacement.
- In the long-range views from the Bungonia Lookdown area the proposed South-western Overburden Emplacement will be of minor visibility.

Field analysis of effects on viewing locations

- A detailed field assessment was carried out. 14 publicly accessible viewing places and views from 8 residential and commercial receivers were analysed and assessed.
- Of the 6 residential Receivers with potential views, with the exception of Receiver R7, access to which could not be secured, the views were documented and compared to the views predicted by 3D modelling.
- It was determined that Receivers R5 and R7 are unlikely to have a significant view of the proposed South-western Overburden Emplacement and that R8 has no potential view.
- Three remaining residential receivers (R10, R14 and R15) were considered to have potential for view of some part of the proposed South-western Overburden Emplacement, the most substantial of which were predicted to be from R14 and R15 (see analytical 3D graphics in Appendix 2).
- The photomontages for R14 and R15 show that the worst-case effects of the Modification on residential views are low.
- The scenic quality of the proposed site of the South-western Overburden Emplacement and Western Overburden Emplacement are moderate. The base-line for scenic quality has been significantly modified by the existing and long history of limestone mining and quarrying directly adjacent to the Site of the Modification.
- The moderate scenic quality base-line means that subject to other considerations, the landscape has a higher potential to absorb visual impacts than one of higher scenic quality.

Visual sensitivity

- Marulan South Road is essentially a private road and considered a low sensitivity location.
- View place sensitivity was rated as medium for views between 500-3000m from the proposed SWOE site. Four viewing places fall into this category: VP21, R10, R14 and R15.
- Five viewing places and two residences are in the low sensitivity class, being beyond 3000m; VP14, VP15, VP18, VP19, VP20 and Residence R13.
- The proposed SWOE is therefore generally exposed to views from locations of medium to low sensitivity to the likely visual effects.
- The proposed (WOE) is exposed only to the low sensitivity location of Marulan South Road in its immediate vicinity.

Accessibility to the public domain

- The proposed South-western Overburden Emplacement has low accessibility to the public and no significant exposure to roads with high viewer numbers in the public domain, or to close views from residential receivers.

- With the exception of views from off-track sites accessed from part of the Long Point Track in Morton NP to the east, there would overall be low, or no effects on view composition.
- With regard to the effect of viewing period, which would increase viewer sensitivity, the proposed SWOE has very low overall exposure to views from residential receivers and the effect of viewing period for residential receivers is therefore only increased for Receivers R14 and R15.

View loss

- The planning principles in *Tenacity* and *Rose Bay* were considered in relation to view loss or blocking in Sections 2.2.4 and 3.2.2.
- No views from residences of the public domain call for the application of the Tenacity principles or those in Rose Bay as no scenic features of the views are lost.

Night time lighting

- No change is proposed in the Modification to the amount or purpose of night-time lighting.
- Existing general and security lighting will remain unchanged and will continue to have the same visual effects.

Overall visual effects ratings

- The overall visual effects of the proposed South-western Overburden Emplacement on its total visual catchment is assessed as low.
- The physical absorption capacity (PAC) for the proposed South-western Overburden Emplacement and changes to the Western Overburden Emplacement would be high.
- The visual compatibility of the proposed South-western and Western Overburden Emplacements with quarrying/industrial features would be high for all viewing locations.

Overall visual impacts ratings

- The overall visual impacts rating of the Modification on its total visual catchment was assessed to be low, with initial medium impacts on VP 21 (off-track site accessed from the McCauleys Flat Track) and Residential Receivers R10, R14 and R15.
- The medium rating primarily results from the visual exposure of the proposed South-western Overburden Emplacement to daytime views only. Night time lighting is not considered to be a significant impact.
- Impacts on different visual sensitivity zones did not significantly change the ratings for overall visual impacts.
- The medium to low sensitivity zone applies to the remainder of viewing places assessed. As no significant impacts can occur for the low sensitivity zone, this was not analysed in relation to the need for mitigation measures.
- The visual impacts on the medium sensitivity zone is analysed against the relevant mitigation measures in Section 3.4, to determine whether the proposed controls adequately mitigate the impacts.
- All visual impacts ratings revert to low after the completion of revegetation of the SWOE with the exception of VP21 which would have a visual impact rating of low-medium.

Assessment of mitigation measures

Assessment of the proposed visual impact mitigation measures considers proposed landform, rehabilitation and lighting. Specific recommendations are made in relation to each of the mitigation measures other than lighting, which will not change.

Conclusion

- This assessment finds that while there are some residual visual impacts, assuming compliance with the recommendations for impact mitigation, that these are minor in significance.

1.0 Introduction

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Approval. The Minister for Planning is the consent authority for the proposed modification.

The purpose of this report by Richard Lamb and Associates (RLA) is to assist in the assessment of the proposed Modification by the NSW Department of Planning and Environment (DP&E).

The report consists of an assessment of the likely nature, extent and significance of the visual impacts of the Modification as part of the Environmental Assessment (EA), considered with regard to the range of public and private places that could be affected. This report is therefore focussed primarily on the visual impacts of the proposed SWOE, proposed amended WOE and removal of the existing Western Earth Bund.

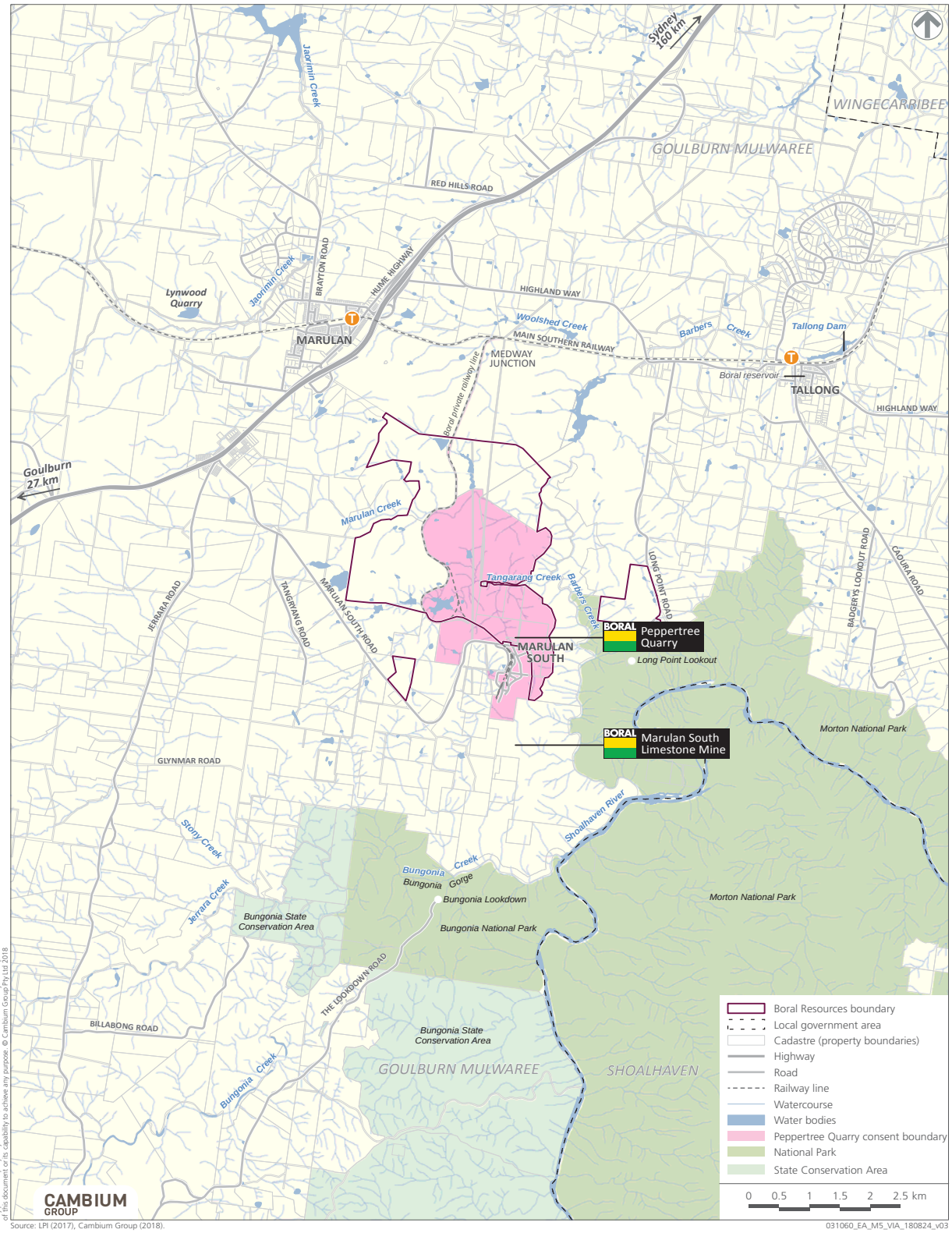
1.1 Existing Environment and Quarry Operations

1.1.1 Site Description

The Quarry is at Marulan South in the Goulburn Mulwaree Local Government Area (LGA) and is approximately 175 km south-west of Sydney (**Figure 1).** Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Limestone Mine) with the Hume Highway approximately 9 km to the north-west **(Figure 2).** Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6 km to the north **(Figure 2).**

The Quarry is on approximately 650 ha of Boral owned land, which includes the Quarry (occupying approximately 70 ha), additional granodiorite resources to the south and surrounding land **(Figure3).** The site is zoned RU1 –- Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 **(Figure 4).** Mining and extractive industries are permissible in this zone with consent.

Figure 1
Regional context



Source: LPI (2017), Cambium Group (2018).

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1.2 Approved Project

The current operations of the Quarry are approved under Project Approval PA06_0074 as modified.

1.2.1 Quarry Activities and Infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities. The location of infrastructure at the Quarry is shown on **Figure 5.**

Work to establish the quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E.

Operating hours and workforce

The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5 am to 11 pm. Approved operating hours are outlined in detail in **Table 1.**

Table 1: Approved operating hours

Activity	Day	Time
Construction works	Monday to Friday Saturday Sunday and public holidays	7.00 am to 6.00 pm 8.00 am to 1.00 pm None
Topsoil/overburden removal/emplacement	Any day	7.00 am to 7.00 pm
Blasting	Monday to Saturday Sunday and public holidays	9.00 am to 5.00 pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00 am to 11.00 pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

The Quarry employs 30 full time persons distributed over 2-3 shifts.

1.3 Proposed Modification

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and will take approximately four years to establish. The emplacement will cover approximately 44 ha and will be RL650 at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

> The powerline, which supplies electricity to the Limestone Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Limestone Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 20 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine, and will be a component of the Limestone Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

Two sediment dams will be constructed either end of the WOE to catch and treat dirty water until the batters are rehabilitated. sediment dam P2 will also catch clean water from upslope of the WOE. Sediment dam P1 will be approximately 2.1 ML in volume and sediment dam P2 will be approximately 5.8 ML in volume.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the project.

The only ground disturbance associated with the modification will be for the SWOE, sediment dams P1 and P2, powerline relocation and new haul road (see **Figure 7**).

1.4 Documents Consulted

In preparing this report, RLA consulted the following documents:

1. Marulan South Quarry Environmental Assessment Report (EAR), prepared by ERM for Boral Resources (NSW) Pty Ltd, October, 2006.
2. Marulan South Quarry Submissions Report, prepared by ERM for Boral Resources (NSW) Pty Ltd, December, 2006
3. Major Project Assessment: Marulan South Quarry Project, NSW Department of Planning: Director General's Environmental Assessment Report, February, 2007.
4. Pepper Tree Quarry MOD 4 consolidated Project Approval 06_0074, 2007.
5. Peppertree Quarry Biodiversity and Rehabilitation Management Plan (Niche 2017).
6. Peppertree Quarry Mod 4 VIA and EAR, February 2016.

1.5 Context for the Development

1.5.1 The Regional and Local Visual Context

The regional and local visual context of the Quarry is described in the EA for the proposed Modification (See also Figure 1, Regional Context). The Quarry is situated on the edge of a dissected plateau of the Southern Tablelands of NSW, which is locally drained to the east by Barbers Creek (a tributary of the Shoalhaven River) and to the north by Tangarang Creek (a tributary of Barbers Creek) south and east by the Shoalhaven River and its tributaries, Bungonia and Barbers Creeks (see Figure 2, Local Context).

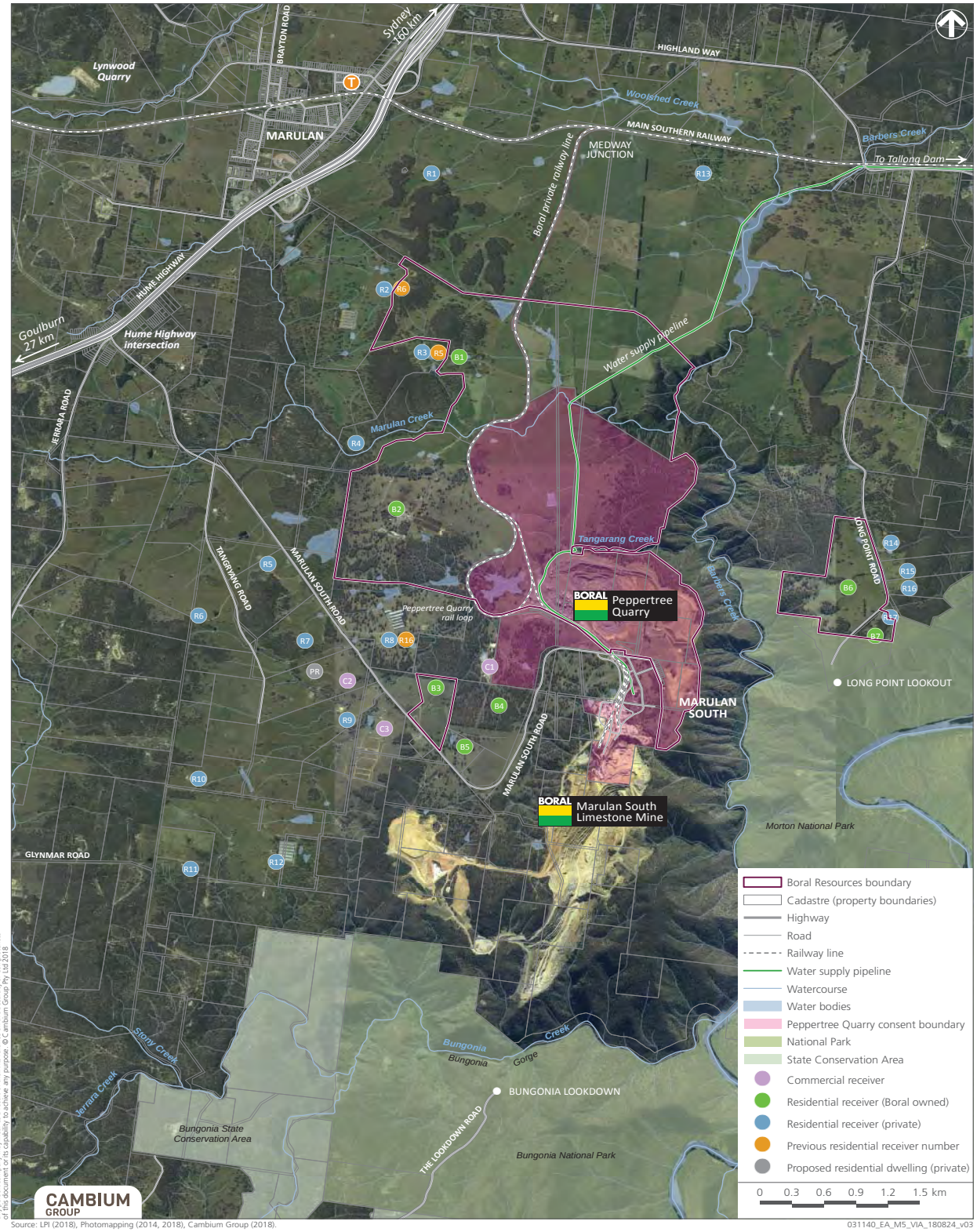
The Quarry is bordered to the south by the Limestone Mine, to the east by Morton National Park (NP) and by rural properties to the north and west. Surrounding land uses include mining, grazing, rural properties including an agricultural lime manufacturing facility, fireworks storage facility, turkey farms and rural residential. Rural residential properties are also located to the east of the Quarry along Long Point Road. These properties are separated from the mine by the deep Barbers Creek gorge. The Bungonia NP and Bungonia State Conservation Area (SCA) are located to the south of the Limestone Mine, across the deep Bungonia Creek Gorge. (see Figure 3, Land ownership).

The Quarry is in a secluded area and not exposed to high intensity public domain features with large numbers of potential viewers such as main roads or urban areas. It is a significant distance (greater than six kilometres) from the nearest highway (Hume Highway) and the nearest urban settlement (Marulan) and is not significantly exposed to either.

Access to the Quarry is provide by Marulan South Road, which is a public but a dead-end road leading to the Limestone Mine, the Quarry and Aglime Fertiliser plant. It is a minor rural road that provides access to a small number of private properties and commercial enterprises before entering what is predominantly Boral-

Figure 2
Local context

PEPPERTREE QUARRY MODIFICATION 5
VISUAL IMPACT ASSESSMENT



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owned land. There is no other public access to the immediate environment of the Quarry. East of the Quarry and across the Barbers Creek valley is Long Point Road, a minor dead-end rural road that terminates in the carpark of the Long Point Lookout. It provides access to a small number of rural properties. Other rural roads that provide potential viewing places of the proposed SWOE and WOE from isolated locations are Jerrara Road, which leads to Bungonia and Glynmar Road and Government Roads, both dead-end rural roads, to the south-west.

To the east and south beyond the gorges of Barbers Creek and the Shoalhaven River respectively, the landscape is undeveloped and in a natural state in the Morton NP and Bungonia NP and SCA (see Figures 1 and 2). In Bungonia NP to the south, is the Bungonia Lookdown area and lookouts. To the east a track from the Long Point Lookout (McCauley's Flat Track) runs for a short distance south, after which it turns east to descend into the Shoalhaven River gorge. The Quarry is partly visible over a short distance south of the Long Point Lookout from informal viewing places west of the first section of the established track.

Overall, the Quarry and sites of the proposed Modification are of very low visual exposure to the public domain, other than its exposure to adjacent natural landscape in part of Morton NP to its east.

1.5.2 Existing Scenic Resources

The existing Quarry occupies land formerly used for agriculture and which is relatively flat. Aerial imagery shows that the area was essentially devoid of any wooded vegetation before the development of the Quarry.

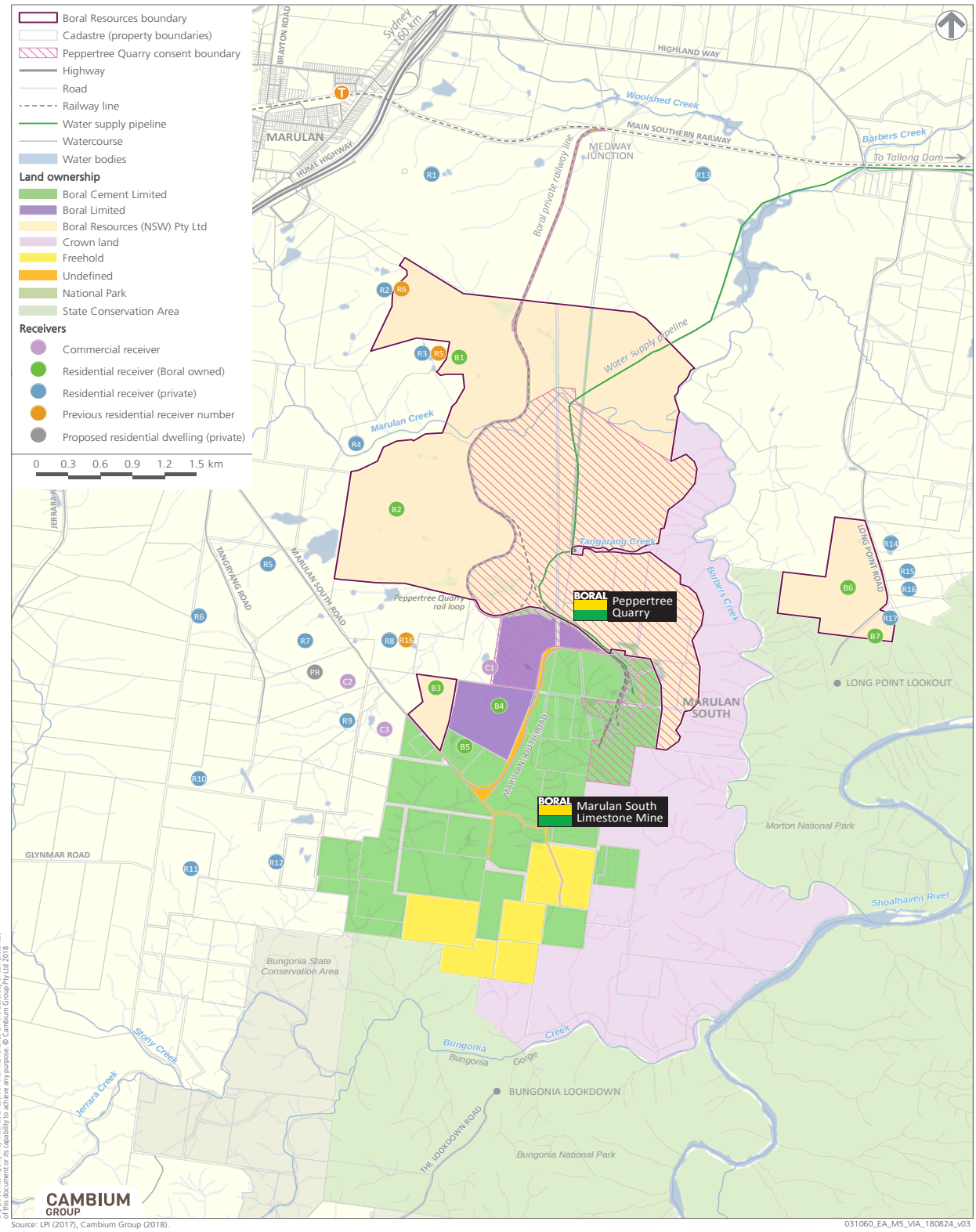
The recent history of utilisation of the granodiorite resource, construction of earth bunding to the north of the pit and emplacement of overburden to the north-east, east and south-east of the pit has resulted in changes to the existing topography, form, line, colour and textures of the landscape. However, other than in the view from Marulan South Road, those visual effects are highly localised.

The proposed location of the SWOE and the western part of the WOE are in flat to undulating partly wooded former agricultural land.

In all, the existing scenic resources are minor. The visual quality and character of the land is common in the locality and of low accessibility to the public. That character is also widespread in the immediate locality and the Southern Tablelands generally and is neither rare nor under threat.

Figure 3
Land ownership

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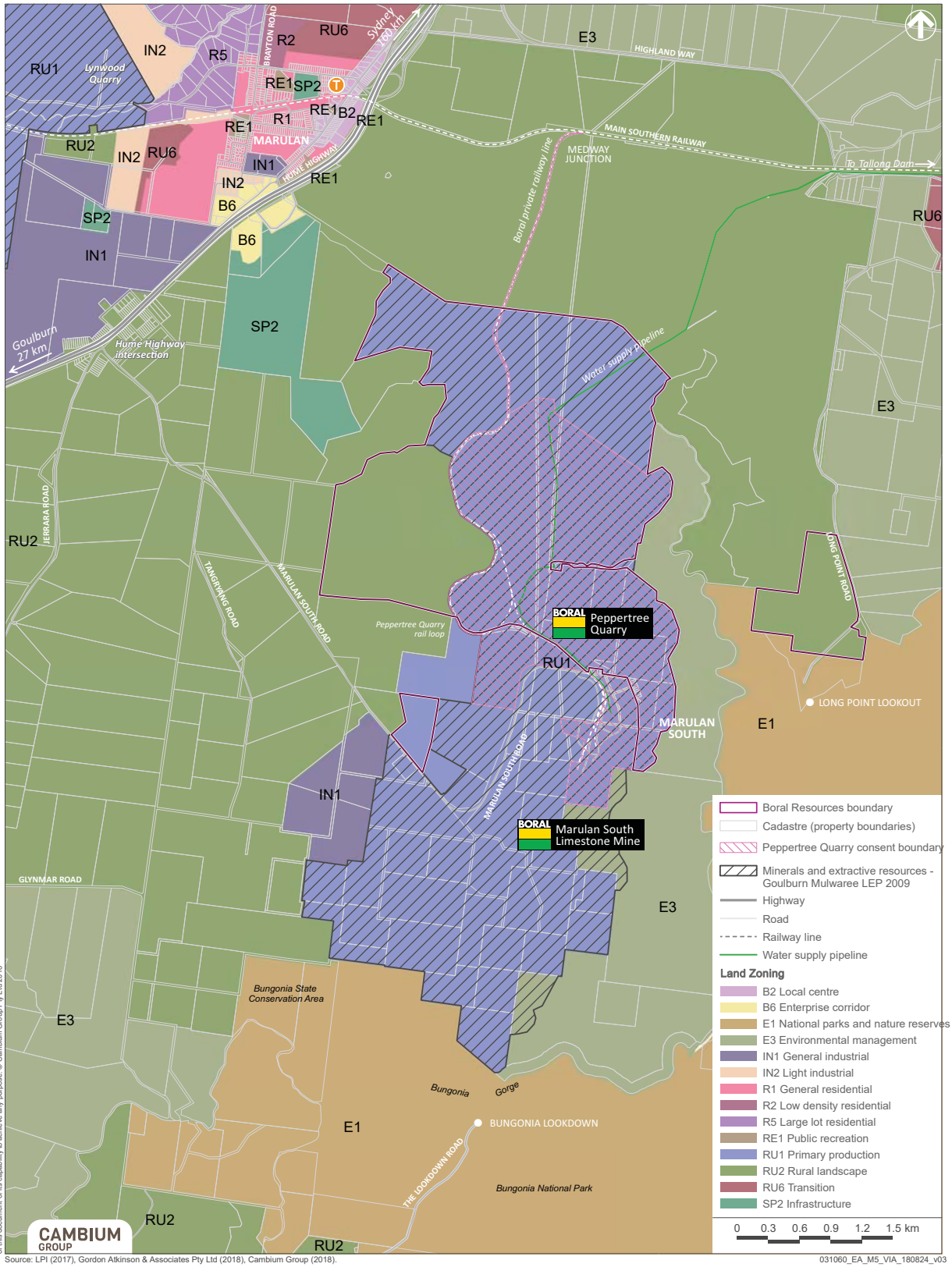
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Figure 4
Land zoning

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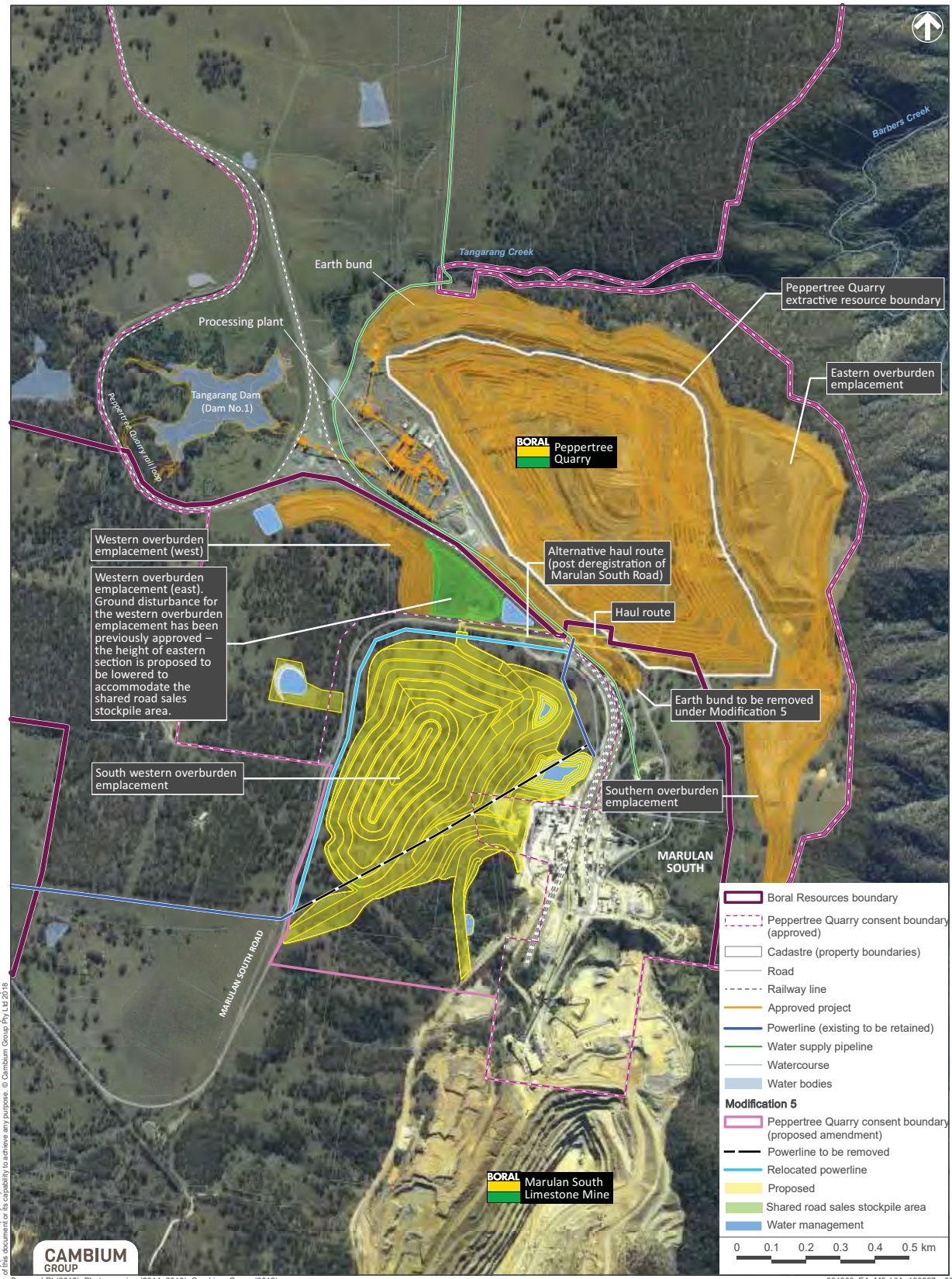
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Figure 5
The Project

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2.0 Assessment Methodology

The assessment of visual impacts is a field that requires a degree of subjective judgement and cannot be made fully objective. It is therefore necessary to limit the subjectivity of the work by adopting a systematic, explicit and comprehensive approach. This has the aim of separating aspects that can be more objective, for example the physical setting, visual character, visibility and visual qualities of a project, from more subjective elements, such as visual absorption capacity and the compatibility of the Modification with the setting.

The methodology used in this assessment has been developed over several years and uses relevant aspects of methods accepted in landscape assessment, extended and modified to adapt to extractive industry and rural environments. The modifications introduced are informed by visual perception research that has been carried out by RLA and others in both natural and extractive industry contexts.

2.1 Assessment Methodology Flow Chart

The flow chart at Figure 6 below indicates the relationships among the components of the visual impact assessment methodology and the logic of the process of analysis and assessment.

2.2 Components of the Methodology

Overall, the major components of the visual impact assessment are determining the concept for the Modification and general strategic planning principles, view analysis, visual effects analysis, visual impact evaluation and assessment of significance of residual visual impacts. This assessment is also supplemented with an assessment of the merits and compliance of the proposed Modification (Figure 5) with the relevant Planning Principles in relation to view loss and the mitigation measures that have been undertaken to reduce or eliminate residual impacts.

2.2.1 The Components of the View Analysis

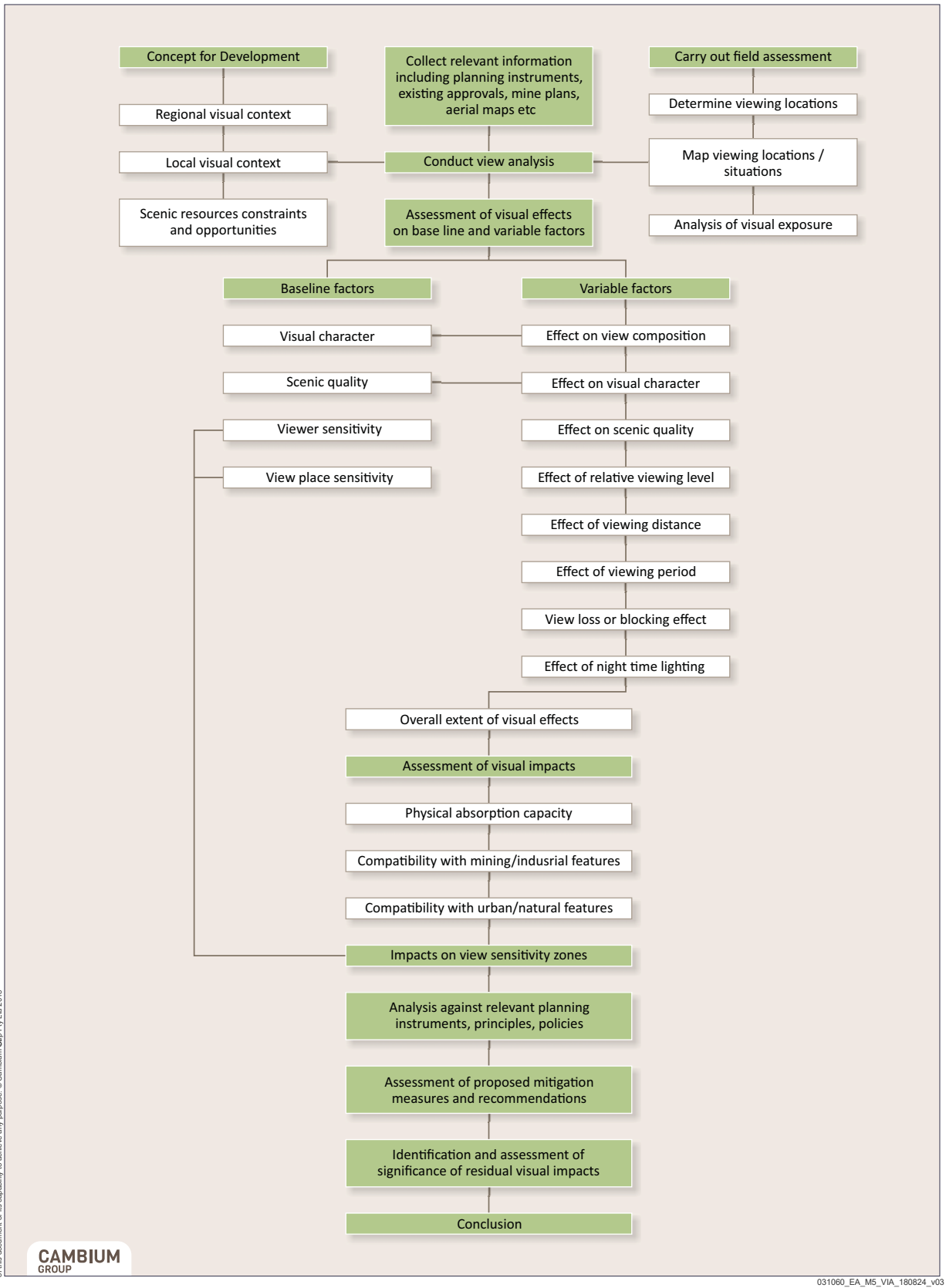
The proposed Modification and detailed field assessment

This component of the view analysis includes gaining a thorough understanding of the proposed Modification including its location and extent, to understand its scale and spatial arrangement. The next step is to carry out a detailed field assessment by identifying the potential viewing locations (see Figure 7), visiting the representative locations, documenting the locations of the proposed SWOE and WOE on a base map, photographing representative locations and filling out an evaluation sheet for each, which contains separate and overall assessment of the visual effects and relative visual impacts factors. View points analysed include Residences (numbered and prefixed by R on Figure 7, eg. Receiver R10), Commercial Receivers (eg. C2) and external View Points (prefixed VP, eg. VP1).

The analysis also utilises objective aids to visualising the likely visual effects of the proposed Modification such as 3D modelling of the terrain of the Site and its surroundings and the simulation of views from a series of representative viewing locations, including sensitive residential receivers (refer to Appendix 2). The 3D model's simulated views are cross-checked by observations on site to confirm or modify the models.

At each documented viewing location or situation, an analysis sheet is prepared on which observations are

Figure 6
Richard Lamb and Associates visual assessment flow chart



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recorded along with a log of photograph locations, image numbers, GPS coordinates and altitude recorded by a camera-mounted GPS. Representative images are presented in the Photographic Plates, (see Appendix 2 of this report).

Examples of the analysis sheets are in Appendix 4. The assessment factors are explained in Section 2.2.2 and 2.2.3. The analysis sheet that was filled out for each viewing location rated the assessment on each factor in three qualitative ranges; Low, Medium or High.

Identifying viewing locations and viewing situations

Viewing location is the term given to be a fixed place from which a view can be experienced. The period of view (how long that view is likely to be sustained) is also a criterion of assessment that gives greater or lesser weight to the effect of the proposed modification on the view. Viewing situation is the term used to identify the circumstance in which the view can be experienced. For example, a view from a road may be of a single experience of a view, or provide the opportunity to experience many different aspects of what is a view, may also be fleeting, but may be repeated regularly by local users. A view from a National Park by contrast may be part of a relatively sustained view over a longer period, but not be regularly repeated. Different viewing situations have different view and viewer sensitivities.

To represent all of the kinds of viewing locations which could be affected by each of these factors and variations among them, a view point analysis is conducted. This is carried out as part of the ground-truthing exercise associated with mapping the visual exposure of the Quarry operations and proposed Modification. Viewing places are chosen to represent the full range of possible view experiences, situations, distances and intervening land uses, in the effective visual catchment, as required by good visual impact assessment practice (see Figure 7).

The effective visual catchment is the term used for an area within which there is sufficient detail, including view of the surrounding visual context, for the proposed changes to the environment to be perceived as either positive or negative impacts.

The viewing locations fall into two categories, a) Public domain locations and b) Private domain locations. Public domain locations are major and minor roads, public reserves and recreation areas. The private domain viewing locations are predominantly residences and their settings.

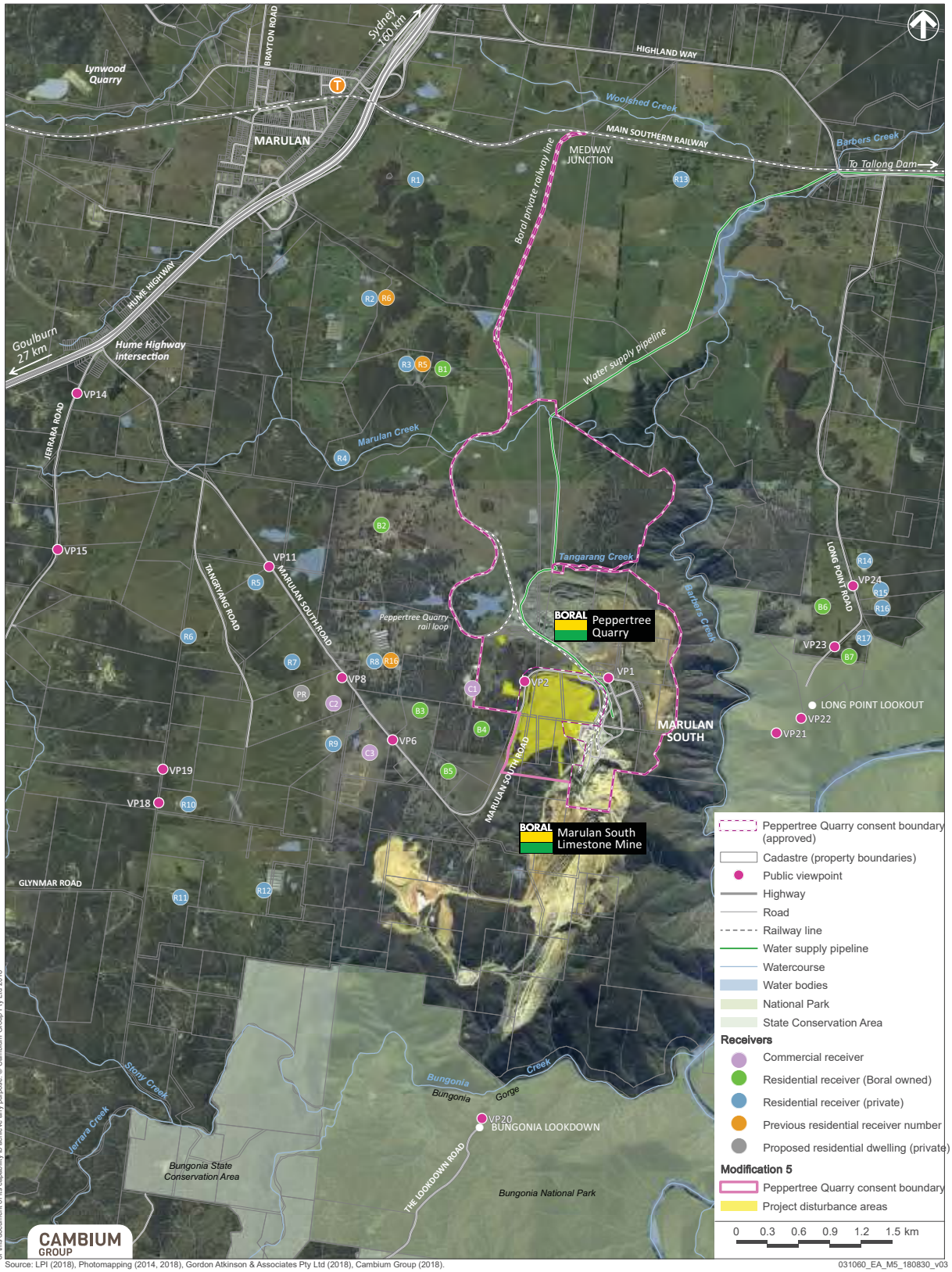
It was possible for views to be assessed from most of the relatively few residences from which the proposed SWOE be visible. It was also possible to interpret the likely effects of the proposed SWOE and WOE, based on views taken toward the Site from roads and reserves in the vicinity of residences that could not be visited and assessed and also by observing the locations of windows and outdoor areas which would or may provide views.

The viewing places visited and analysed therefore represent views from both the public and the private domain. Significant vantage points from which the Site can be viewed and from which views are publicly available were also assessed. A sample of the large number of general viewing places assessed, which represents examples of each relevant kind of viewing place, was abstracted from the total number of places assessed, for detailed analysis.

There are large numbers of potential viewing locations in areas such as the National Parks, from which views of some kind may be possible, from informally accessible locations. However, increasing the number of such viewing places assessed does not lead to greater accuracy of the assessment process. This is because increasing the sampling frequency of low usage or largely inaccessible places would skew the results in favour of low sensitivity places and situations, which would tend to minimise the overall level of

Figure 7
Viewpoint locations

PEPPERTREE QUARRY MODIFICATION 5
ENVIRONMENTAL ASSESSMENT



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visual effects and impacts.

Mapping viewing locations and situations

The representative viewing locations and situations analysed during the field assessment are mapped including the ones for which photomontages have been prepared to represent the future appearance of the proposed SWOE and WOE in the existing context.

Identification of the potential visual catchment

Visibility is an objective measure, as it means the extent to which the Modification would be physically visible, and identified, for example, as a new, novel, contrasting or alternatively a familiar, recognisable but compatible feature. Features such as vegetation, buildings and intervening topography can affect the degree of visibility. RLA first locate the area within which the Modification would be identifiable and where it could cause visual impacts by assessing its visibility.

2.2.2 The Components of the Visual Effect Analysis

2.2.2.1 Base-Line Factors

The criteria that remain predominantly constant and independent of the nature of viewing locations and factors which condition the viewing situation, are known as base-line factors.

Visual character

The visual character of the locality is the setting in which the Modification would be seen and is identified. It consists of identification of the physical and biological components of the area and the setting of the proposed SWOE and WOE that contribute to its visual character. The character elements include topography, vegetation, natural systems, land use, settlement pattern, rural, industrial and infrastructure elements.

Visual character is a base-line factor against which the level of change caused by the proposed SWOE is assessed. The future character of the locality and the effect that the proposed SWOE is intended to make to the setting is also relevant to assessing the extent of acceptable change to visual character.

Scenic quality

Scenic quality is a measure of the ranking which the setting of the proposed SWOE would be predicted to have, on the basis of empirical research carried out on scenic beauty, attractiveness, preference, or other criteria of landscape perception. Scenic quality is another base-line factor against which the visual impacts caused by the proposed SWOE and WOE are assessed.

View place sensitivity (public domain sensitivity)

View place sensitivity is the term given to a measure of the public interest in the view. The public interest is considered to be reflected in the relative number of viewers in publicly accessible locations that are likely to experience the view, their expectations for the viewing experience and the public significance of the viewing

location.

The public significance of viewing places is considered to increase from low to high in the following order: publicly accessible or main roads, general lookouts, reserves. Places from which there would be close or middle-distance views available to large numbers of viewers from public places such as heavily used or tourist roads, or to either large or smaller numbers of viewers over a sustained period of viewing time in places such as lookouts and reserves, are considered to be more sensitive viewing locations.

Marulan South Road, in particular the section in the vicinity of the proposed Modification, is considered to be a lower sensitivity location than other roads, as a result of low usage by the public and the fact that it is not only through Boral-owned land throughout, but also as it leads only to the Quarry and Limestone Mine, which are not destinations likely to attract viewers, tourists or those seeking natural or high scenic quality views.

Viewer sensitivity (private domain sensitivity)

Viewer sensitivity is the term given to a measure of the private interests in the effects of the proposed SWOE and WOE on views. The private interest is considered to be reflected in the extent to which viewers, predominantly viewing from private residences, would perceive the effects of the proposed SWOE or WOE on the existing view. Residences from which there would be close or medium distance range views affected, particularly those which are available over extended periods from places such as living rooms and outdoor recreational spaces, are considered to be places of medium and high viewer sensitivity, respectively.

Viewing places that are of low sensitivity that are not individually assessed include commercial receivers, receivers owned by Boral and roads that carry predominantly industrial traffic, such as the section of Marulan South Road beyond (north and east of) the entry to the Aglime Fertilisers' facility.

2.2.2.2 Variable Factors

The assessment factors that vary between viewing places with respect to the extent of visual effects, are known as variable factors.

View composition type

View composition type means the spatial situation of the proposed SWOE and WOE with regard to the organisation of the view when it is considered in formal pictorial terms. The types of view composition identified are:

1. Expansive (an angle of view unrestricted other than by features behind the viewer, such as a hillside, vegetation and buildings).
2. Restricted (a view which is restricted, either at close range, or some other distance, by features between or to the sides of the viewer and the view such as vegetation, buildings and topography (form elements)).
3. Panoramic (a 360 degree angle of view unrestricted by any features close to the viewer who is surrounded by space elements).
4. Focal (a view that is focused and directed toward the proposed SWOE by lateral features close to the viewer, such as road corridors, roadside vegetation, buildings, etc).

5. Feature (a view where the proposed Modification is the form element that dominates the view, for example as a topography feature, building or structure, isolated in close range views).

It is considered that the extent of the visual effects of the proposed SWOE or WOE is related to its situation in the composition of the view. The visual effect is considered to be greater on a focal or a feature view, cognisant of the distance effect, compared to a restricted, panoramic or expansive view.

Relative viewing level

Relative viewing level is the term given to the location of the viewer in relative relief, compared to the location of the proposed SWOE. It is conventional in landscape assessment to assess views from locations above, level with and below the relative location of the proposed SWOE

It is considered that the visual effects of a project are related to both the relative viewing level and distance. Viewing levels above the proposed SWOE or WOE, where views are possible over and beyond it, commonly decrease the visual effects, whereas views from level with and close to the structures, dependent on viewing distance, may experience higher effects, particularly if they intrude into horizons.

Viewing period

Viewing period in this assessment means the influence on the visual effects of the proposed SWOE which is caused by the time available for a viewer to experience the view. It is assumed that the longer the potential viewing period, experienced either from fixed or moving viewing places such as dwellings, roads or reserves, the higher the potential for a viewer to perceive the visual effects of the proposed SWOE or WOE. Repeated viewing period events, for example views repeatedly experienced from roads as a result of regular travelling or from residences, are considered to increase perception of the visual effects.

Viewing distance

Viewing distance is the term given to the influence on the perception of the visual effects of the proposed SWOE and WOE which is caused by the distance from the viewer. It is considered that the viewing distance is inversely proportional to the perception of visual effects. The greater the potential viewing distance, experienced either from fixed or moving viewing places, the lower the potential for a viewer to perceive and respond to the visual effects of the proposed SWOE.

This also acknowledges the relationship between distance and the size of the retinal image of a viewed item in the eye. While the relationship is proportional, it is not direct, as there is an inverse exponential relationship between the retinal size of the image and the distance from the viewer. As an example, doubling the distance between a viewer and an item of a given size leads to the image appearing to be one quarter of its former size (by the inverse square of the distance). It is therefore conventional to use an exponential scaling between the effects on close range views and middle range views to acknowledge the rapid decrease in apparent size that occurs in closer range views compared to distant views. For small items such as buildings, classes of <100m, 100m-1000m and >1000m are conventionally used in our methodology.

However, for large infrastructure items such as open cut mines, quarries, wind farms, etc. which cover significant horizontal areas, larger distance ranges are necessary. RLA have adopted the following range classes: close range (<500m), medium range (500-3000m) and distant (>3000m).

View loss or blocking effects

View loss or blocking effects in this assessment means a measure of the extent to which the Modification, in this case the proposed SWOE and WOE could be responsible for view loss or blocking the visibility of items in the view. View loss and blocking effects would increase the perception of the visual effects of the proposed overburden emplacements if this occurred. View loss and view blocking can be important matters for consideration in regard to short range views from the public domain of roads and lookouts and potentially from nearby adjacent residences.

View loss is considered in relation to the two relevant planning principles enunciated in the Land and Environment Court of NSW by Roseth SC in *Tenacity Consulting v Warringah [2004] NSWLEC 140 and by Moore SC in Rose Bay Marina Pty Limited v Woollahra Municipal Council and anor. [2013] NSWLEC 1046 (Rose Bay Marina). Tenacity concerned view losses from residential properties only. It is unlikely, based on observations, analysis of 3D simulations and the photomontages, that any significant view loss would occur to residential properties. The planning principles in Rose Bay Marina have extended Tenacity to considering view loss from the public domain and these have been considered in relation to views from roads and reserves. Similarly with regard to Tenacity, it is unlikely that the proposed Modification will cause significant view loss to the public domain.*

Overall Extent of Visual Effect

Based on the inspection of the pattern of the assessment ratings for the above factors on the relevant analysis sheet for each viewing location an overall rating is arrived at which represents an overall extent of visual effects for a viewing location.

2.2.3 The Components of the Visual Impact Analysis

The criteria in Section 3.0 concern assessment of the extent of the visual effects of the proposed SWOE and WOE when seen from specific viewing places. The extent of the visual effects is the base-line assessment against which to judge the visual impacts. The locations of the viewing places analysed and documented are shown on Figure 7.

Whether or not a visual effect is an impact of potential significance however, cannot be equated directly to the extent of the visual effect. A high visual effect can be quite acceptable, whereas a small one can be unacceptable. For example, in the context of the existing Project Approval to change the topography of the Site and for a final landform that includes the existing Quarry, completed Eastern Overburden Emplacement, approved Southern Overburden Emplacement, Western Overburden Emplacement and Western Earth Bund shows that there are high levels of acceptable change.

To distinguish between the extent of change and the significance of the impact, it is necessary to give a weighting to the assessed levels of effects to arrive at an assessment of the impact.

This method therefore does not equate visual effects directly to visual impacts. The approach is to assess visual effects as in Section 2.2.2 to arrive at an overall level of visual effect of the Modification for each kind of viewing place and then to assess the level of impact, if any, by giving differential weighting criteria to the level of effect determined. This means that the relative importance of impacts is distinguished from the size of the effect. RLA consider that three weighting criteria are appropriate to the overall assessment of visual impacts; Physical Absorption Capacity (PAC), Visual Compatibility and Sensitivity. Two kinds of compatibility are evaluated (i.e. Compatibility with quarrying/industrial and compatibility with rural/natural features). Each

of these addressed the primary question of the acceptability of the visual effects and changes caused by the Modification and how much weight ought to be given to them.

Each weighting criterion is applied to the overall level of visual impacts assessed. PAC and Visual Compatibility are negative weighting factors (ie, as the rating on the criterion increases, the significance of impacts decreases), whereas Sensitivity is a positive weighting factor (as the rating for Sensitivity increases, the relative significance of impacts also increases).

2.2.3.1 Physical Absorption Capacity

PAC is the term given to the extent to which the existing visual environment can reduce or eliminate the perception of the visibility of the proposed SWOE and WOE.

PAC includes the ability of existing elements and approved elements including those that are under construction, in of the landscape to physically hide, screen or disguise the proposed SWOE. It also includes the extent to which the colours, textures, line and form and the scale and character of these allows them to blend with or reduce contrast with others of the same or closely similar kinds of items, to the extent that they cannot easily be distinguished.

Prominence is also an attribute with relevance to PAC. It is assumed in the assessment that higher PAC can only occur where there is low to moderate prominence of the proposed SWOE and WOE in the scene.

Low to moderate prominence means:

1. Low: The proposed Modification has either no visual effect on the landscape or is evident but subordinate to other elements in the scene by virtue of its small scale, screening by intervening elements, or difficulty of being identified.
2. Moderate: The proposed Modification is either evident or identifiable in the scene, but is less prominent, makes a smaller contribution to the overall scene, or does not contrast substantially with other elements, or is a substantial element, but is equivalent in prominence to other elements and landscape alterations in the scene.

Design and mitigation factors are also important to determining the PAC. Appropriate colours, materials, building forms, line, geometry, textures, scale, character, lighting and appearance of extraction areas, overburden emplacements and infrastructure are relevant to increasing PAC and decreasing prominence.

PAC is related to but distinct from Visual Compatibility.

2.2.3.2 Visual Compatibility

Visual Compatibility is not a measure of whether the proposed SWOE and WOE can be seen or distinguished from their surroundings. The relevant parameters for Visual Compatibility are whether they can be constructed and utilised without the intrinsic scenic character of the locality being unacceptably changed. It assumes that there is a moderate to high visibility of the proposed SWOE and WOE to some viewing places. It further assumes that novel elements such as the proposed and approved overburden emplacements, which presently do not exist in the immediate context, can be perceived as visually compatible with that context, provided that they do not result in the loss of or excessive modification of the visual quality and character of the locality.

In this regard, both the quarrying/industrial environment and the rural/natural environment are attributes

of relevance. Hence, it is considered that there are two relevant measures of Visual Compatibility, i.e. compatibility with quarrying/industrial features, and compatibility with rural/natural features.

Visual compatibility with quarrying/industrial features

This assessment is a measure of the extent to which the visual effects of the Modification are compatible with existing quarrying and industrial features. It is assumed that in some views the proposed SWOE and WOE can be seen and clearly distinguished from their surroundings. Compatibility does not require that identical or closely similar features to those which are proposed exist in the immediate surroundings.

Compatibility with quarrying/industrial features means that the proposed SWOE and WOE respond positively to or borrow from within the range of features of character, scale, form, colours, textures, materials and geometrical arrangements of quarrying and industrial features of the surrounding area, or of areas of the locality which have the same or similar existing visual character.

The features of the proposed SWOE and WOE are located in the immediate vicinity of the existing Quarry operations. The Quarry is also located adjacent to the Limestone Mine which has seen mining activity since 1875 and major limestone mining since the 1920s, or nearly 100 years. Therefore, the compatibility of the visual effects of the proposed SWOE has to also be considered in relation to an existing environment, the scenic resources of which have been fundamentally and in many ways irreversibly changed in a variety of ways (see 1.3.2 above).

Visual compatibility with rural/natural features

This assessment is a measure of the extent to which the visual effects of the proposed SWOE are compatible with the adjacent semi-rural and natural features. The proposed SWOE and WOE may be able to be seen and clearly distinguished from their surroundings, locally.

Compatibility with rural/natural features means that the proposed SWOE and WOE respond positively to or borrow from within the range of features of character, scale, form, colours, materials, vegetation and geometrical arrangements of the surrounding area, or of other areas of the locality which have compatible existing visual character.

2.2.3.3 Overall Extent of Visual Impact

Based on the inspection of the pattern of the assessment ratings for the above factors on the relevant analysis sheet for each viewing location, an overall rating is arrived at which represents an overall extent of visual impacts for a viewing location.

2.2.4 Visual Sensitivity Zones

Three visual sensitivity zones are identified which are based on the view place sensitivity or viewer sensitivity as explained in 2.2.2.1 These are related to the distance zones from the proposed sites of the Modification proposed and whether views are from significant public domain or private viewing locations. Viewing places within the high or medium visual sensitivity zones are further assessed as explained below.

Impact assessment for each zone

An overall impact rating for each of the three visual sensitivity zones is arrived at by inspecting the pattern of the assessment ratings for the visual impact factors (as given in Section 2.2.3) on the relevant analysis sheet for each viewing location in that zone. It is generally found that the close range visual sensitivity zone is most affected by any project as it may form part of the foreground views from the viewing locations within this zone.

Planning principles relevant to view sharing

The Modification and its overall impacts is analysed in relation to relevant information concerning visual impacts in the following Land and Environment Court of New South Wales planning principle specifically related to view sharing in the public domain:

> *Rose Bay Marina Pty Limited v Woollahra Municipal Council and anor. [2013] NSWLEC 1046 (Rose Bay Marina).*

Assessment of the mitigation measures proposed

The mitigation measures that are proposed as part of the Modification are then assessed in terms of their capability to overcome the visual effects and impacts of the Modification on each of the visual sensitivity zones. Other mitigation recommendations and management guidelines may be formulated to overcome possible negative visual effects or potential residual visual impacts.

Significance of residual visual impacts

Finally and subsequent to the visual effects of the mitigation factors being assessed, a relevant question is whether there are any residual visual impacts of the Modification itself, and whether they are acceptable in the circumstances. These residual impacts are predominantly related to the extent of visual change independent of the history of permanent and irreversible change that has occurred, with consent, in the past.

The significance of these residual impacts is assessed on the basis of the relative sensitivity of viewers and viewing places that may experience these impacts. Whether overcoming these impacts would result in undermining of the potential capacity of the proposed Modification to economically support the intended use is not the focus of a visual impacts assessment such as this.

3.0 Assessment of Visual Effects

Summary of Visual Exposure

Below is a summary of the likely future visual exposure of the Modification. This is considered in more detail in relation to individual viewing locations and situations in Sections3.1 and 3.2.

There are two landform elements proposed to be constructed in the proposed Modification, that would cause visible changes. The first and largest is the SWOE and the second the WOE, which is proposed to be modified in shape and form compared to the current approval. The currently approved but un-built Western Earth Bund would not be constructed.

There would be no change to the nature of the existing operations of the Quarry that would cause significant external visual effects. Night-time lighting, for example, would remain as approved. As a result, it is considered unlikely that this aspect of the Modification will cause any significant change to the visual environment.

The proposal includes re-alignment of the existing high voltage power line from the point where it currently meets Marulan South Road adjacent to the south-western corner of the proposed SWOE, to follow Marulan South Road. The visual exposure of the amended powerline would be minimal as it would be shielded from view by vegetation to its west and the SWOE to its east.

Visual exposure of the existing quarrying operations is low to the adjacent rural land to the south west, west and north, as the current operations are predominantly below the horizons of view, with the exception of work evident on the crest of the approved Eastern Overburden Emplacement and the future visibility of the approved Southern Overburden Emplacement, which will be of limited visibility. The Eastern Overburden Emplacement is currently partly and of minor visibility to some medium to distant range views. The proposed SWOE will also be of limited visibility to similar viewing places, with detailed view, confined to a short section of Marulan South Road approximately between the entrance road to the adjacent Agricultural Lime plant and the common entries to Peppertree Quarry and the Limestone Mine.

The visual exposure of the proposed WOE (see Figure 5) would be to a small area largely confined to the same section of Marulan South Road. No other roads or residences would be significantly exposed to views of the proposed WOE.

A consequence of the construction of the proposed SWOE is that in some views from the landscape to the south-west and east, the topography of the intermediate horizon will be slightly changed as the emplacement is constructed, potentially increasing the visual exposure of newly formed topography to views. The same view places affected would be likely to also contain minor exposure of the approved Eastern and the Southern Overburden Emplacement, the latter yet to be constructed. However, the overall visibility of the proposed SWOE will be minor and the WOE of generally minimal visual impacts other than from Marulan South Road in its immediate vicinity.

A visual consequence of the construction of the WOE will be reduction in visibility of the processing and rail load-out facility in the Quarry from Marulan South Road in the view west.

Parts of the proposed location of the SWOE are exposed to medium range views from the east (part of the area accessible from the McCauleys Flat track from Long Point Lookout in the Morton NP (VP21 on Figure 7). The highest part of the SWOE is not visible from the Bungonia Lookdown northern lookout (VP20 on Figure 7). From VP21, a minor change will occur in the mid-ground horizon of the view due to an increase in the height of the landscape caused by the Southern Overburden Emplacement.

Assessment aided by 3D visualisation and analysis of photographic records indicates that no residences or

commercial receivers to the west and south-west of the Site are likely to have significant views of the SWOE and none would have visibility of the WOE.

In the medium range views from the east, from the two residences in the Long Point Road locality with any potential views, Receivers V14 and R15, the visual exposure of the SWOE will be minor, of overall low visual exposure and similar in appearance to existing approved works at Peppertree Quarry. Visibility of the Modification will not significantly alter the composition of the views.

3.1 Field Assessment

Field assessments were undertaken in June, 2014, more detailed field work was undertaken on two occasions in July, 2015, in relation to the approved MOD 4 application and updated field work, including new photography for selected view points was undertaken in relation to the current MOD 5 application in February, 2018.

3.1.1 Viewing Locations and Viewing Situations

To assess the visual impacts that would be experienced by viewers, an updated view point analysis was conducted. This consisted of analysing the likely visual exposure of the proposed SWOE and WOE using topographic, cadastral and aerial images, then visiting the Site and locality to ground-truth potential viewing places and situations. A selection of places was abstracted from the total number of potential viewing locations and situations for individual documentation and assessment, based on assessment work carried out in 2015 for the approved MOD 4. The key viewing locations as before included a number of public domain locations including those on roads, recreational areas and lookouts, as well as the vicinity of a number of residential and commercial receivers. The location of the receivers and selected public view points are shown on Figure 7. It is anticipated that there would be no overall change to the extent of visual exposure and therefore the visual catchment of the proposal.

The locations were selected to represent the kinds of viewers' experience of the proposed modifications that would exist in the immediate area. Locations that represent the main kinds of viewing areas that would be affected were visited and in some cases, where changes had occurred to the visual environment, were either newly photographed or re-photographed. The photographs were taken with a Canon EOS 5D Mark 3 full-frame digital SLR camera with a fixed 35mm focal length lens, to approximate the correct proportions of the elements of views as experienced by the human eye. A GPS unit attached to the camera wrote the coordinates and altitude and in most cases the bearing direction of each photograph onto the electronic meta-data of each electronic image file. In this way, the locations could be accurately determined for the purpose of 3D modelling of the likely visual effects of the proposal and so viewing locations can be accurately located in the future, if necessary.

At each viewing place a series of observations and assessments were made, as documented in the Photographic Plates in Appendix 1 and in the assessment sheets in Appendix 4. A variety of other locations were also visited to ascertain the extent of the visual catchment and the characteristics of the views.

3.1.2 Visual Catchment

The potential total visual catchment of the proposed SWOE and WOE is small. The visual exposure to the private domain is limited to a small number of residential receivers, and the maximum area of potential public domain exposure, although significantly larger, contains few individual locations with potential views. The theoretic visual catchment extends toward the east to a medium range part of Morton NP on the crest of a ridge that runs south for a short distance from the terminus of Long Point Road. The catchment also extends to the south to the Bungonia Lookdown in Bungonia NP in the distant viewing range.

Visibility is strongly influenced by the undulating topography, vegetation and clearing pattern. There is low exposure to formalised viewing situations such as high-usage roads, lookouts and public recreation areas. The potential area over which views may be possible in the Morton NP is large, but the number of places that would offer practical access to the views of the proposed SWOE and WOE would be small and typically restricted to small numbers of viewers, predominantly pursuing environmental tourism and recreational activities.

Visibility would also be constrained by distance, perspective effects, and by intervening elements such as topography and vegetation. In general, other than medium distance parts of Morton NP to the east at similar elevations, such as informal viewing places accessible by leaving the McCauley's Flat Track, views would be from locations significantly below the Site in relative elevation. The situation of the existing and proposed disturbed areas of the Quarry being below the horizon of the views means that there would be few opportunities to perceive significant visual effects of the proposed SWOE and WOE from the Morton NP. The re-aligned high voltage powerline would be unlikely to be significantly visible.

The visibility of the proposed SWOE and WOE is largely confined to the following public and private domain viewing locations:

Public Domain locations:

The proposed SWOE and WOE are of overall low exposure to the public domain.

The few areas of the public domain (roads) that are exposed to views of any part of the existing Quarry are:

1. Close range views from part of Marulan South Road immediately adjacent to the Quarry and the entrance to the Limestone Mine.
2. Distant range views from a short section of Glynmar/Government Road to the south-west, that may have a view of part of the SWOE.
3. Distant range views from an isolated section of Jerrara Road to the north-west, of the crest of the SWOE.

Distant range views above may include at the most, a part of the crest of the SWOE. 3D graphics and observations indicate that there would be no view of the proposed WOE in these views.

Other areas of the public domain that are exposed to views are confined to the Morton NP to the east and Bungonia NP to the south, from which there is a distant view to the crest of the southern extent of the proposed SWOE. The WOE and re-aligned power line would not be visible. There are no other views from formal viewing locations (formed lookouts).

The track from the Long Point Lookout area to the east, to McCauley's Flat, is an informal viewing place in Morton NP. The lookout itself has a view to the south-east which does not include the Quarry. The McCauleys Flat Track runs south along the eastern side slope of a spur, from the carpark near the lookout to a point where it turns east and descends into the Shoalhaven River Gorge. The track provides access to locations, off the track to its west, from which some partial views are available. Between the viewer and the proposed SWOE, the approved Southern Overburden Emplacement will rise into the view line and substantially block the view. The WOE will not be visible.

Private Locations:

Private locations identified as potential sensitive receivers include 17 non-involved or 'Boral-owned' residences on rural land (see residential receiver locations marked with blue circles and corresponding numbers beginning with R on Figure 7). Of the 17, only 4 were determined as potentially having views of any part of the proposed SWOE and none are likely to have views of the WOE. RLA's visual impact assessment methodology places some residential receivers in the category of medium sensitivity, primarily based on the associated distance class of the dwelling. However as discussed below in Section 3.3.4, despite a medium rating for distance and sensitivity on those criteria, residential receivers may not be exposed to direct or potential views of the Modification site, for example Receiver R8. Potential visual impacts on this dwelling were discounted after ground-truthing during fieldwork, which confirmed that no physical view is available from the dwelling.

Commercial Receiver Locations:

Two of the closest commercial receivers C2 and C3 were visited and the views photographed, documented and analysed using 3D modelling. A potential future dwelling site proposed on the same property as Receiver C2 was also assessed. It is unlikely that either property would have a view significantly affected by the proposed SWOE and neither could view the WOE.

Boral Owned Receivers:

Seven residences owned by Boral are identified by green circles and numbers with the prefix B on Figure 2. As the residences are associated with the Limestone Mine, they were not visited and the views have not been documented.

3.1.3 3D Modelling to Represent Views

Cambium Group were commissioned to prepare a 3D terrain model of the Site and surrounding environment using 1m contour survey data. The topography of the proposed SWOE and WOE at maximum final landform height was added to the model.

To represent views from individual sensitive receiver locations, a virtual camera was located at each receiver and the view was simulated in 3D graphics (see Appendix 2). A georeferenced and orthorectified aerial photograph was draped over the topography model. As an aid to predicting the likely effect of vegetation on the views, the vegetation plotted in the view cone from each virtual camera was added to the model.

The model was then rendered with the same colour coding for the overburden emplacement areas as in the key plan at pages 1 and 2 of Appendix 2. This is intended to identify and differentiate the individual proposed and approved emplacement structures and not to represent the likely visual effects of the proposed overburden emplacements.

The approved Eastern Overburden Emplacement that is largely complete is coloured yellow and the approved but yet to be constructed Southern Overburden Emplacement is coloured orange in the 3D analytical views and photomontages (see Appendix 3). To distinguish the proposed Modification from these, the SWOE is coloured light blue and the WOE coloured dark blue. The stanchions carrying the re-aligned high voltage powerline are shown in white.

The views from Receivers were modelled in 3D with topography, but initially with no representation of vegetation, to analyse the theoretical visibility of the SWOE, WOE and re-aligned high voltage powerline. The 3D model was then populated with vegetation plotted from the aerial imagery, so as to predict the likely effect of the vegetation on visibility. Vegetation height was set to a maximum of 20m which is conservative, based on observations and analysis of photographs taken from selected receivers.

Of the 17 residential Receivers identified in the locality the Site, six were identified as having potential views and the owners were contacted by Boral staff and visited by RLA, with the exception of R7, access to which could not be secured. The views from the Receivers with potential views of the proposed SWOE were photographed and the views were documented and compared to the views predicted by 3D modelling. The actual views are included in the photographic plates in Appendix 1 and in the analytical 3D graphics (for Receivers other than those for which photomontages were prepared) are shown in Appendix 2.

3.1.4 Rendered Photomontages to Represent Views

Three locations were identified for the preparation of fully rendered photorealistic montages, i.e. the Bungonia Lookdown lookout (VP20), the dwelling at residential Receiver R10 and a site accessed from McCauleys Flat Track south of Long Point Lookout (VP21). The photomontages are shown in Appendix 3.

View point camera locations used to prepare photomontages were obtained by a GPS mounted to a Canon EOS 5D Mark III camera using a Canon EF 35mm F1.4L USM lens with co-ordinates and elevation data recorded in World Geodetic System (WGS84). The geotagged images were captured by RLA. Co-ordinates were exported to a MS Excel data file and imported to ArcGIS then re-projected to the local co-ordinate system, being Map Grid of Australia (MGA94). These co-ordinates were exported from ArcGIS as a DWG file and opened in AutoCAD 2014.

Using AutoCAD, view point elevation was cross checked with the elevation recorded by the GPS and compared with LiDAR contour data and ortho-rectified aerial photography. Photographs with a focal length of 35mm were then selected for the purposes of photomontage and corrected for distortion using specific camera and lens profiles for the Canon EOS 5D in Adobe Photoshop. Camera co-ordinates were then merged with the 3D model of the approved Quarry plan including the proposed SWOE design and virtual cameras were set up using these locations and adjusted for elevation based on earlier findings. Camera matching was then undertaken using a combination of the existing 3D infrastructure survey, 3D terrain model and virtual views, setup as part of the desktop study. Final photomontages were rendered with foreground and background vegetation adjusted using aerial photography and virtual views as an indicator.

3.2 Visual Effects Analysis

3.2.1 Base-Line Factors

3.2.1.1 Visual character

The landscape setting of the Quarry (see Figure 2, Local Context) is within an area of intermediate character between the rural and semi-rural landscapes of the nearby tablelands to the west and north and the natural gorges and undeveloped landscapes of the Morton NP to the east.

The existing scenic resources have been identified in Section1.5 The existing visual character of the approved Quarry and the underlying character of the area proposed for the SWOE and WOE are base-line factors to be taken into account in considering the visual effects and impacts of the proposed Modification.

This is because critical factors in establishing the importance of visual impacts are physical absorption capacity and compatibility (see Section 3.3.2 and 3.3.3 Visual character is a base-line criterion which allows an assessment to be made of the extent to which the existing visual character will either absorb or be compatible with the proposed SWOE The visual character is also important in assessing the appropriate strategies for increasing physical absorption capacity and compatibility by means of mitigation measures.

The rural landscape underlying the Quarry and the location of the proposed SWOE is largely cleared and of rolling topography and supports livestock grazing.

The formal aesthetic qualities of the Quarry bunds and overburden emplacements in terms of their line, form, texture and colour are the most prominent visual features in views from outside the Quarry. These cause some contrasts with the rural and semi-natural adjacent landscape.

4.2.1.2 Scenic quality

Scenic quality is a second base-line against which the effects of changes to the physical environment can be predicted to impact either positively or negatively on the perceptions and emotional reactions of viewers. There is an extensive empirical research literature concerning general relationships between aspects of the physical environment and predicted judgments of scenic quality or other expressions of this, such as scenic beauty or scenic preference. In general, a location of lower scenic quality has a greater intrinsic capability to absorb change than one of higher quality.

This research would predict that the rural setting of the Quarry and its locality would be of low-moderate scenic quality. While it shows the presence in many views of slightly varied topography, managed landscape and vegetation, it does not contain significant water bodies, diversity, or areas of high scenic integrity (naturalness). It also exhibits factors which decrease scenic quality, such as vegetation clearing, lack of prominent topography and presence of large scale industrial structures.

By comparison, the views from inside the natural reserves of Morton NP and Bungonia NP of the unmodified landscapes which are probably the main motivation for their visitation would be predicted to be moderate-high in scenic quality, as they contain significant topographic variation, naturalness, complexity, diversity of forms and vegetation and also some limited water bodies.

As is noted above with regard to scenic character, the base-line for scenic quality is also significantly modified by the existing and long history of adjacent limestone mining and recent granodiorite quarrying. This has to some extent irreversibly changed the scenic quality of the setting. In this context it would be unrealistic and unreasonable to take the theoretical, past moderate-high scenic quality of the landscape, pre-quarrying and mining, as the base-line against which to judge the effects of the proposed SWOE and WOE.

It is therefore reasonable to determine that the visual quality of the Quarry in the context of its setting, which is composed of both moderate and moderate-high quality landscape, but has been significantly degraded in the past, is at best of moderate scenic quality.

A moderate scenic quality base-line means that subject to other considerations, the landscape has a higher potential to absorb visual impacts than one of higher scenic quality.

3.2.1.3 View place sensitivity (public domain sensitivity)

The public domain viewing locations are constituted by roads, lookouts and reserves. The view place sensitivity for public domain viewing locations such as high usage or tourist routes on roads is usually rated as high for locations with a clear view that is less than 500m from the proposed Modification Site. Places of this sensitivity are confined to the immediate streetscape of Marulan South Road, (VP1 and VP2), as no other view places in the public domain exist within the close range category (Refer to Photographic Plates in Appendix 1).

In this case however, where the road is a dead-end road that terminates virtually at the Site and is not commonly used by the public, which services industrial and extractive sites over the part with close range views, the sensitivity ranking for views from the road was decreased to low.

Medium view place sensitivity ranking was determined for public domain views from VP21 (off-track sites accessed from the McCauleys Flat Track).

The view place sensitivity was rated medium for most other locations in the private and public domain between 500-3000m from the proposed SWOE and WOE. Almost all viewing places fall into this distance category. Two isolated viewing places on Jerrara Road (VP14 and VP15) one residence (Glenrock, R13) and Bungonia Lookdown (VP20) are viewing places in the low sensitivity class, being beyond 3000m (at approximately 5.6, 5.7, 4.2, 4.9km and 3.5km distance, respectively).

3.2.1.4 Viewer sensitivity (private domain sensitivity)

The viewer sensitivity is rated high in the methodology for any dwellings within 500m of the proposed SWOE. No residential Receivers are in this category. Viewer sensitivity is rated medium for dwellings between 500m and 3000m. Three residential receivers in this category (R10, R14 and R15) would have a minor view of part of the proposed SWOE, in the context of existing and future approved overburden emplacements in the Quarry. One other potentially affected residential receiver (R13) is in the distant category.

It is to be noted from the results in relation to variable factors that the proposed SWOE and WOE have low visual accessibility to the public and no significant exposure to roads with high viewer numbers in the public domain or to close views from residential Receivers. The proposed Modification is therefore exposed to generally medium to low sensitivity viewing places.

3.2.2 Variable Factors

Effect on view composition

With the exception of views from off-track locations to the east, in the McCauleys Track area, where there would be a medium effect on view composition, it was found that there would overall be low effects on view composition caused by the proposed SWOE. No residential receivers would experience significant change to view compositions.

3D modelling and confirmation on-site show that there would be no perceptible change to the composition of the view from the residential Receivers R14 and R15, which potentially have the highest residential exposure to views of the proposed SWOE.

Effect of relative viewing level

The topography of the rural land that dominates the setting to the south-west, west and north of the proposed SWOE is relatively uniform in topography. It has no major ridge systems to interrupt view lines, other than an area of low hills between the Quarry and the majority of Jerrara Road that is to its west north-west and another of more pronounced and separate hills between the Site and Marulan township to the north north-west (see Figures 1 and 2).

However as outlined previously, these areas of low hills are predominantly vegetated with open forest and woodland, with varied understorey. Significant areas of either uncleared or regrowth vegetation also occur on some private landholdings. The combination of rolling topography and significant areas of woodland and forest vegetation, means that there are very few locations that are elevated above the surrounding countryside that provide significant viewing opportunities of the proposed SWOE and WOE.

Effect of viewing distance

With the exception of view places on Marulan South Road, all viewing places are in the medium range or the distant range category at greater than 3000m from the nearest part of the disturbance footprint of the proposed SWOE and WOE. In the private domain, Receivers R14 and R15 to the east and Receivers R10 and R8 to the west are the only residential receivers that are not in the distant viewing category above 3000m. Receiver R8 has no view toward the proposed Site, R10 has a limited minor view towards the location of the SWOE, and R14 and R15 have views that would be significantly screened by existing approved overburden emplacements; the Eastern and Southern Overburden Emplacements.

Receiver R13 has a distant view of the crest of the existing Eastern Overburden Emplacement from a distance of approximately 4.2-4.9km. 3D modelling indicated that part of the crest of the proposed SWOE may barely become visible above the existing and approved Eastern Overburden Emplacement. A greater viewing distance decreases the effects of visual impacts to low.

In summary, for residential receivers, the effect of viewing distance does not change the extent of visual effects.

In the public domain, VP21 (off-track site accessible from the McCauleys Flat track) is the only viewing place that has clear views of parts of the disturbance footprint of the proposed SWOE, from a distance of approximately 1.5km. The WOE would not be visible.

VP20 (Bungonia Lookdown) has a distant view (3.5km) to the closest part of the proposed SWOE, which would not be visible over foreground topography. The effect of viewing distance is therefore rated as medium to low on all viewing places and situations. Overall, viewing distance has either a neutral effect on the rating for the extent of visual effects, or decreases it.

Effect of viewing period

The effect of viewing period is a base-line factor that acknowledges that greater visual effects occur for places from which there are potential sustained individual views, either from fixed locations such as dwellings or lookouts, or moving (dynamic) locations where the view may be repeated, such as high usage roads. There are no roads that provide sustained view opportunities.

With regard to residential Receivers, the proposed SWOE has very low overall exposure to views from residences and the WOE has no exposure to residential views. 3D modelling confirmed by documentation and photography of representative views showed that the effect of viewing period is relevant only to Receivers R10, R13, R14 and R15, which may experience sustained views of some part of the final landform of the proposed SWOE.

Receiver R13 has a distant view of part of the existing Eastern Overburden Emplacement and may barely view a small part of the final landform of the SWOE, prior to its rehabilitation.

Residences at Receivers R10, R14 and R15 could have sustained views of part of the SWOE and are therefore rated as moderate in the effect of viewing period. A photomontage of the likely view from R10, also distant, is in Appendix 3.

There are no roads that provide sustained view opportunities. A fleeting view of the existing Eastern Overburden Emplacement is possible from VP14 and VP15 (Plates 1/9 and 1/10 in Appendix 1) on Jerrara Road, between areas of elevated topography and vegetation, which otherwise block views from the majority of the road.

Views from Marulan South Road west and north-west of the Site are generally blocked in the foreground and middle distance by vegetation in the road reserve and on properties to the north-east and east of the road (see Plate 1/8 for an example). Views from Marulan South Road would otherwise be restricted to a short section between VP6 (Plate 1/3 and 1/4 in Appendix1) and the general vicinity of VP1 and VP2 (Plates 1/1 and 1/2 respectively, in Appendix 1: see Figure 7 for detail of the view point locations).

As the road is essentially private in this area and would be unlikely to be frequented by tourists or provide the opportunity or attractions for sight-seeing, the effect of viewing period on visual effects was rated as low.

Sustained views are possible from VP21 (off-track sites accessible from the McCauleys Flat track) and potentially similarly accessed areas to the east and south-east in the Morton NP. The effect of viewing period for views from this lookout and reserves is therefore increased for these public viewing places.

View loss or blocking effects

This assessment of view loss considered the planning principles in *Tenacity* and in *Rose Bay Marina. I*t is considered that the threshold test in *Tenacity* is not met in the visual effects of the proposed SWOE. That is, there is no significant loss of views to residences and it is not considered necessary to go through the four-step process of the planning principle in *Tenacity.*

The planning principles in *Rose Bay* extended *Tenacity* to considering view loss from the public domain which includes roads, lookouts and reserves. *Rose Bay* does not concern general changes in the character or quality of the view.

The proposed SWOE has overall low visual exposure and the WOE, lower still. The landform structures proposed would be unlikely to cause significant view loss or view blocking effects.

The extent of view loss is negligible from roads and is minor from lookouts and reserves and the extent of view loss to the public domain is negligible or minor. It is therefore considered that the *Rose Bay* planning principles are also not relevant in this case.

Night time lighting

Three kinds of lighting are potentially relevant to visual impacts. These are:

1. General and security lighting, that is of low luminance;
2. Lighting for safe working in the Quarry environment; and
3. Lighting associated with machinery and vehicles working in the pit at night.

The Modification does not propose any change to working arrangements that would generally change the effects of lighting on the environment. As a result it is considered that the Modification would not have any effect on perception of night-time lighting by Receivers.

3.2.3 Overall Extent of Visual Effects

The overall extent of visual effects of the Modification was established through an evaluation of all of the impact factors for each viewing location as presented in Table 4.2. In summary, the overall visual effects rating of the Modification on its total visual catchment has been assessed as low.

3.3 Visual Impact Analysis

3.3.1 Overall Extent of Visual Impact

The overall extent of visual impacts was established through an evaluation of all of the impact factors for each viewing location presented in the Data Sheets in Appendix 4. The overall assessments of the visual impacts of the Modification are shown in summary in Table 4.2. The overall visual impacts rating of the Modification on its total visual catchment has been assessed as low, with initial medium impacts of the proposed SWOE on VP21 (see photomontage in Appendix 3), R14 and R15. The medium rating for VP21 results from the visual exposure of the proposed SWOE to daytime views only, as the Morton NP is likely to be primarily used for day-time recreation.

The significance of the visual impacts is then determined by applying the weighting factors set out in 2.2.3 above, which are intended to distinguish between the extent of impact (how much) from the significance (importance) of the impact.

3.3.2 Physical Absorption Capacity

The PAC for the Modification would be high for the majority of the visual catchment, with the exception of the off-track viewing location,McCauleys Flat Track in Morton NP (VP21: see photomontage in Appendix 3), which would experience medium PAC, and three residences (Receiver R10, R14 and R15). When rehabilitation is completed, the PAC would revert in all cases to high.

As PAC is rated as high and is a negative weighting factor (ie. as PAC increases, visual impacts decrease), this justified a down-weight on the assessment of the significance of overall visual impacts.

3.3.3 Visual Compatibility

Visual compatibility with quarrying/industrial features

The visual compatibility of the proposed Modification with quarrying/industrial features would be high for all viewing locations as:

1. The Modification does not include changes to any of the existing infrastructure, machinery used, methods of quarrying, means of construction of overburden emplacements or overall rehabilitation strategies;
2. The shapes, form, line, colours and textures of landform structures proposed i.e. SWOE and WOE would be of high compatibility with the existing quarrying landscape, being located near to and in a similar visual character as the approved Eastern and Southern Overburden Emplacements;
3. The site of the SWOE, within the vicinity of the Limestone Mine and Quarry, would be compatible with the character and appearance of existing overburden emplacements; and
4. There would be no change with regard to the effects of night lighting.

Visual compatibility with rural and natural features

There is no proposed change to the built components of the Quarry, which in the context of a Quarry provide the built fabric. The Modification is therefore of high compatibility with the built fabric of the Quarry.

Notwithstanding the natural character and moderate quality of adjacent land far to the east of the proposed Modification, the proposed SWOE and WOE are in a visual context immediately adjacent to the existing Quarry on one side and the Limestone Mine on the other. The setting demonstrates a significant history of disturbance and contains prominent, large scale infrastructure associated with the roads, railway lines, processing area, stockpiling and rail load-out facility of the Quarry, along with similar facilities immediately adjacent in the Limestone Mine. The proposed SWOE and WOE are therefore considered to be of high visual compatibility with these features of historical disturbance.

As both measures of compatibility are negative weighting factors, similarly to PAC (ie. as compatibility increases, visual impacts decrease) and as compatibility is high on both criteria, this also justified a down-weight on the assessment of the significance of the overall extent of visual impacts.

3.3.4 Visual Sensitivity

A medium or low sensitivity zone applies to all viewing places and situations assessed. The effects on low sensitivity zones were not analysed as it was considered that no significant impacts would occur for these locations.

The low sensitivity zone includes the section of Marulan South Road, immediately adjacent to the Sites proposed for the SWOE and WOE. This area is also adjacent to entries to the Quarry and the Limestone Mine, railway line crossing and other infrastructure, reducing sensitivity further.

This section of Marulan South Road is also proposed to become a private road as a result of deregistration of the section east of the entrance to the Aglime Fertiliser facility as a public road.

In the medium sensitivity zone, only VP21, R10, R14 and R15 have any views of some part of the SWOE or WOE over or beyond existing and approved landforms that will be revegetated.

Medium sensitivity was determined for fourReceivers for different reasons, with VP 21 as apublic domain location in a reserve with medium view place sensitivity, while R10, R14 and R15 are private domain locations, with medium viewer sensitivity.

As the four viewing locations are all rated medium in sensitivity (mid-range), it was concluded that as a weighing factor, sensitivity was neutral (neither adding to nor subtracting from the significance of impacts).

3.3.5 Applying the weighting factors to impact significance

Taking into account the weighting factors of PAC, compatibility and sensitivity, three are considered to justify a down-weight (PAC and two compatibility criteria) and the other (sensitivity) is considered to be neutral. The overall level of visual impacts of medium, assessed in relation to VP21, R10, R14 and R15, when the weightings are applied, decreases to low in impact significance and to Low-medium for VP21.

The visual impacts are then analysed against the relevant mitigation measures in Section 3.4 to determine whether the proposed controls adequately mitigate the impacts.

3.4 Assessment of the proposed Mitigation Measures

This part of the assessment considers whether specific mitigation measures will satisfactorily mitigate direct visual effects and impacts. It is acknowledged that indirect visual impacts can be caused by factors such as attention attracted by noise and the visibility of dust and machinery, all of which are in a sense evidence of the Modification. Indirect visual impacts may be associated with such kind of visual experience. It is outside of RLA's expertise to comment on these indirect technical aspects, which are the subject of individual specialist studies that will be included in the EA.

3.4.1 Proposed Landform

Notwithstanding the low overall visibility of the proposed SWOE and WOE to most of the visual catchment, the compatibility of this constructed landform to existing and future landform has been carefully considered in regard to mitigation of visual impacts.

In most of the visual catchment, the visual character of the proposed overburden emplacement will not cause any visual effects. However, in views from the natural settings in the Long Point track areas (VP21) and three residences (R10, R14 and R15), the visual effects of the proposed overburden emplacement will be evident to varying degrees as a result of initial contrasts with the colour, line, form and texture of the existing environment. These changes will be seen in the context of the existing Eastern Overburden Emplacement and future, approved Southern Overburden Emplacement (yet to be constructed) at the Quarry and the Limestone Mine, both of which are located near the proposed SWOE.

The proposed landform of both the SWOE and WOE are compatible with the existing and natural topography, to the extent that is reasonably possible. The side slopes are compatible with the gradients of natural precedents in the vicinity i.e. Barbers Creek Gorge and there is opportunity for minor variations in the topography of the faces so as to create a natural appearance.

It is considered that the proposed landforms are satisfactory with regard to visual impacts.

3.4.1.1 Specific recommendations

While the final landform is considered satisfactory with regards to visibility and character, there may be some visibility and visual impacts associated with the construction of the SWOE. The 3D graphics (Appendix 2) indicate that the only three residential receivers identified that might have views of some part of the proposed SWOE, however Receiver R10 to the south-west and Receivers R14 and R15 to the east, will not have significant views of the SWOE .

So as to minimise the visibility of construction of the overburden emplacement in view from the south-east in the Morton NP it is recommended that the final embankments of the SWOE, especially the western and southern faces, are rehabilitated progressively and as soon as practically possible, following final embankment shaping.

3.4.2 Rehabilitation

The SWOE will be of low overall visibility, however the crest will become partly visible as it approaches final landform height in views from the south-west and earlier in views from the east. There would potentially be contrasts between the SWOE and the existing Eastern Overburden Emplacement and approved but yet to be constructed Southern Overburden Emplacement unless similar rehabilitation strategies are adopted.

The greatest visual exposure is to the east. Rehabilitation has other objectives than visual impact mitigation alone, such as positive ecological and water quality outcomes. As a result, rehabilitation of the SWOE and WOE would be required, even though the overall visual impacts on views are minor.

The existing and approved Eastern and Southern Overburden Emplacements will be progressively rehabilitated in accordance with the approved Peppertree Quarry Biodiversity and Rehabilitation Plan (Niche 2017) and will provide significant screening of the SWOE in views from the east for example from R14 and R15.

> *…prevent erosion on bunds and overburden, establish self-sustaining native vegetation and native habitats and ensure natural regeneration of the endangered ecological community of Box-Gum Grassy Woodland.*

Initially, landscape structures for the stabilisation and drainage of the outer slopes of the SWOE may be visible by way of their line and form, such as graded drains and rock-lined water drop structures. Their visibility will decrease to zero as vegetation establishes through successful rehabilitation. Because of shadows cast by even small individual plants, the visibility of surfaces and of linear drainage structures will significantly decrease well before maturity of any of the planted canopy (tree) species.

This character is reflected in the photomontages in Appendix 3. The analytical 3D models that underlie the photomontages are brightly coloured to distinguish the proposed landform and rehabilitation surfaces from the surrounding environment, for clarity. The colour coding is the same as the analytical 3D models of views shown in Appendix 2 other than for the proposed vegetation to be added in rehabilitation, to both the approved and the proposed Modification landform, which is shown in red.

When rehabilitated, the new landform structures shown in the photomontages, and those that can be interpreted from the 3D graphics in Appendix 2, will be virtually indistinguishable from the surrounding landscape.

3.4.2.1 Specific recommendations

Rehabilitation of the landscape structures should be undertaken to implement the main objectives of the Peppertree Quarry Biodiversity and Rehabilitation Management Plan, prepared by Niche, for the stabilisation of the batters and progressive rehabilitation to Box-Gum Grassy Woodland, which is intended to result in:

1. A stable landform with minimal erosion;
2. A net improvement in the ecological value of the rehabilitated final landform; and
3. The creation of a final landform of appropriate colour, texture and scenic quality, by providing a vegetation cover that is compatible with the existing and adjacent natural environment. In this way, the major contrasts of overburden emplacements with the surrounding environment will be minimised.

As a general principle, rehabilitation should be undertaken sequentially as stable lift faces are established and not left until landform structures are completed.

3.4.3 Lighting

As noted above, there is no proposed change to the existing Quarry lighting as a result of the proposed Modification. There would therefore be no significant change to the effects of lighting compared to the current approved operations which are subject to compliance with Australian Standard AS 4282-1997, Control of Obtrusive Effects of Outdoor Lighting.

4.0 Residual Visual Impacts and Conclusions

The proposed SWOE has a low overall visual exposure to its visual catchment. Despite there being a number of rural properties and commercial operations within 3km of the closest part of the Modification, (medium viewing distance and sensitivity classes) there is low visual exposure to those receivers and most have no views of it.

The proposed WOE is of lower visual exposure of approved WOE. It is a smaller structure overall and its visual effects are confined to a short section of Marulan South Road in its immediate vicinity. Construction of the WOE would have a minor visual benefit in decreasing visibility of the Peppertree Quarry processing area and rail load-out facility from part of the road.

Both overburden emplacements in the proposed Modification would have localised effects on views from an area of Marulan South Road that is highly modified and features minimal natural or scenic attributes. The road is considered to be a low sensitivity location. The re-aligned high voltage powerline would be of low visibility, largely confined to the Marulan South Road corridor over a short distance

With the assistance of rehabilitation methods, consistent with the existing consent, the proposed emplacement will have only a minor effect and impact on the visual environment.

VP21 is the only viewing location assessed that has a substantial view of the proposed SWOE, while there is minor exposure to residences R10, R14 and R15. The existing Eastern and the Southern Overburden Emplacement will significantly screen views of the proposed Modification.

In relation to night-time lighting, there is no proposed change to the existing Quarry lighting.

This visual assessment finds that while there are some residual visual impacts, these are minor in significance. The visual impacts have also been considered in relation to the changes to the visual environment that have been approved and occurred in the past. The residual impacts that will occur are considered compatible with both the quarrying/industrial and the rural/natural visual environment.



Plate 1/1

VP1, Marulan South Road, looking west. The proposed South-western Overburden Emplacement would be partly visible on the left and part of the proposed Western Overburden Emplacement would be partly visible to the right of the vehicle that is visible on the road in axial view.



Plate 1/2

VP1, Marulan South Road, looking east toward the site of the proposed South-western Overburden Emplacement



Plate 1/3
VP6, Marulan South Road, looking east



Plate 1/4
VP6, Marulan South Road, looking north east



Plate 1/5

VP8, View of C2 from Marulan South Road, opposite the entrance to R8, which is on the north side of the road. There is a minimal view of the Modification from the commercial receiver. A potential residential site west of the commercial buildings was also assessed on the C2 property. The analysis shows that it is unlikely that there would be a view from the potential residential site.



Plate 1/6

VP8, View of entrance to R8 from Marulan South Road. The residence faces the road (away from the Quarry site)



Plate 1/7

VP11, View of R5 from Marulan South Road. The residence faces north toward the road and away from the Modification site. Pine tree belts, one visible in this photograph and another along the access road to the residence on the right of the photograph, are likely to further confine views to the north-west in the future, as they grow to maturity



Plate 1/8

VP11, Marulan South Road looking east. Vegetation in properties and the undulating topography combine to block views toward the Quarry site



Plate 1/9

VP14, Jerrara Road. Part of the existing Eastern Overburden Emplacement area is distantly visible. Vegetation in this view will be likely to prevent views of the proposed South-western and Western Overburden Emplacements from this location.



Plate 1/10

VP15, Jerrara Road. Part of the exising Eastern Overburden Emplacement at Peppertree Qarry is distantly visible from this isolated location. It is likely that mid-ground topography and vegetation will block views of most of the proposed South-western Overburden Emplacement from this location.



Plate 1/11

VP18, Glynmar/Government Road near the entry to R10. Part of the existing Eastern Overburden Emplacement at Peppertree Quarry is distantly visible from this location. It is likely that mid-ground topography and vegetation will block most of the views of the proposed South-western Overburden Emplacement from this location and the Western Overburden Emplacement will not be visible.



Plate 1/12

VP19, Glynmar/Government Road. Part of the Eastern Overburden Emplacement at Peppertree Quarry is distantly visible from this location. It is likely that mid-ground topography and vegetation will block most of the views of the proposed South-western Overburden Emplacament from this location and the Western Overburden Emplacement will not be visible.



Plate 1/13

VP20, The Lookdown northern lookout, Bungonia National Park, image from 2015, afternoon view



Plate 1/14

VP20, The Lookdown northern lookout, Bungonia National Park, image February, 2018, morning view. This view has been used as the base for a photomontage in Appendix 3.



Plate 1/15

VP20, The Lookdown northern lookout, Bungonia National Park, looking east toward the Shoalhaven River gorges in Morton NP. Views like this and the karst landscapes of the Bungonia National Park and SCA are likely to be the primary reasons for visitation.



Plate 1/16

VP20, The Lookdown northern lookout, Bungonia National Park, looking south east. The landscape in the foreground is similar to the character intended in rehabilitation of the Modification.



Plate 1/17
VP21, View from a site west of the McCauleys Flat track, south of Long Point Lookout, looking west



Plate 1/18
VP21, View toward part of the Marulan Limestone Mine, looking south west.



Plate 1/19

VP22, Long Point Lookout, View from the lookout to the east into Shoalhaven River gorge. The lookout has no view of the Modification.



Plate 1/20

VP22, View toward the Modification from the parking area at Long Point lookout. Intervening topography blocks the view



Plate 1/21

VP23, Long Point Road, View of R17. The residence does not have views of the proposed Modification.



Plate 1/22

VP24, View of R15 and the location of R16 from Long Point Road. R16 is out of sight over the foreground dam wall to the right, but it has no view of the proposed Modification because of a dense and high screen of trees, visible on the right.



Plate 1/23

C3, Foti Fireworks, view from the commercial office. 3D graphics indicate that the site would not have views of the proposed Modification.



Plate 1/24

R5, 359 Marulan South Road. View from the south east corner of the veranda of the residence. 3D graphics indicate that the site would not have significant views of the Modification as a result of blocking of the view by foreground topography and by vegetation in the middle distance. The avenue planting of pine trees along the driveway, partly grown, is likely in time to form a substantial vegetative screen.



Plate 1/25

R5, view in the same direction as Plate 1/34, from the veranda and near the front door of the residence. The same observations made above are relevant to this view.



Plate 1/26

R8, 381 Marulan South Road

View of the east side of the residence, which faces the Quarry site. The shadow on the left of the photograph is that of a large shed, which blocks most of the view north east. The formal orientation of the residence is to the entrance drive and the road, on the south west, or other, side.



Plate 1/27

R8, view toward the Peppertree Quarry site from land east of the shed. 3D graphics and the evident height of open to dense vegetation in the view line show that there will not be any direct views of the proposed Modification.

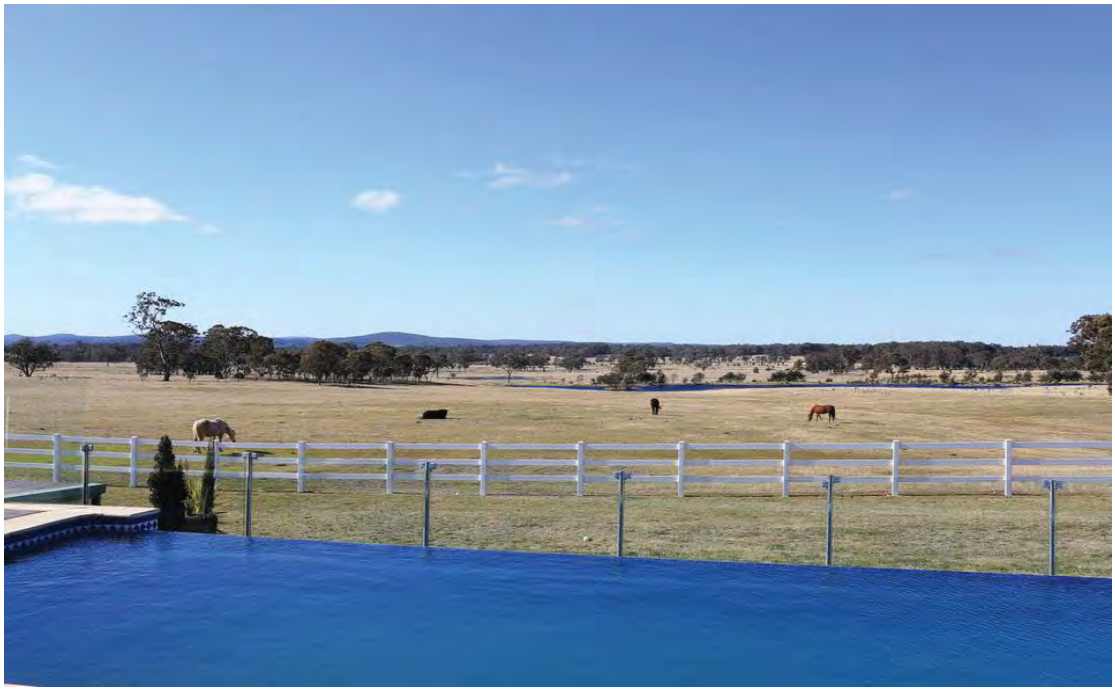


Plate 1/28

R10, 290 Glynmar Road

View from east-facing outdoor entertainment area. An image from this location was used to prepare a photomontage in Appendix 3. It is likely that mid-ground topography and vegetation will block most of the views of the proposed Modification from this location.



Plate 1/29

R13, Glenrock, 248 Highland Way

View from near the stables area south east of the residence. Part of the Eastern Overburden Emplacement at Peppertree Quarry is distantly visible from this location. 3D modelling indicates that the existing emplacement will largely block views of the proposed Modification.



Plate 1/30

R13, Glenrock

View from the rear on axis of the residence. The same observations in regard to the view above apply to this view.



Plate 1/31

R13, Glenrock

View of the rear of the residence from the south. The formal orientation of the residence is to its gardens to the north.



Plate 1/32

R14, 387 Long Point Road, Tallong

3D modelling indicates that the residence will not have significant views of the proposed South-western Overburden Emplacement. Vegetation in the middle distance blocks any direct view lines.



Plate 1/33

R15, 443 Long Point Road, Talllong

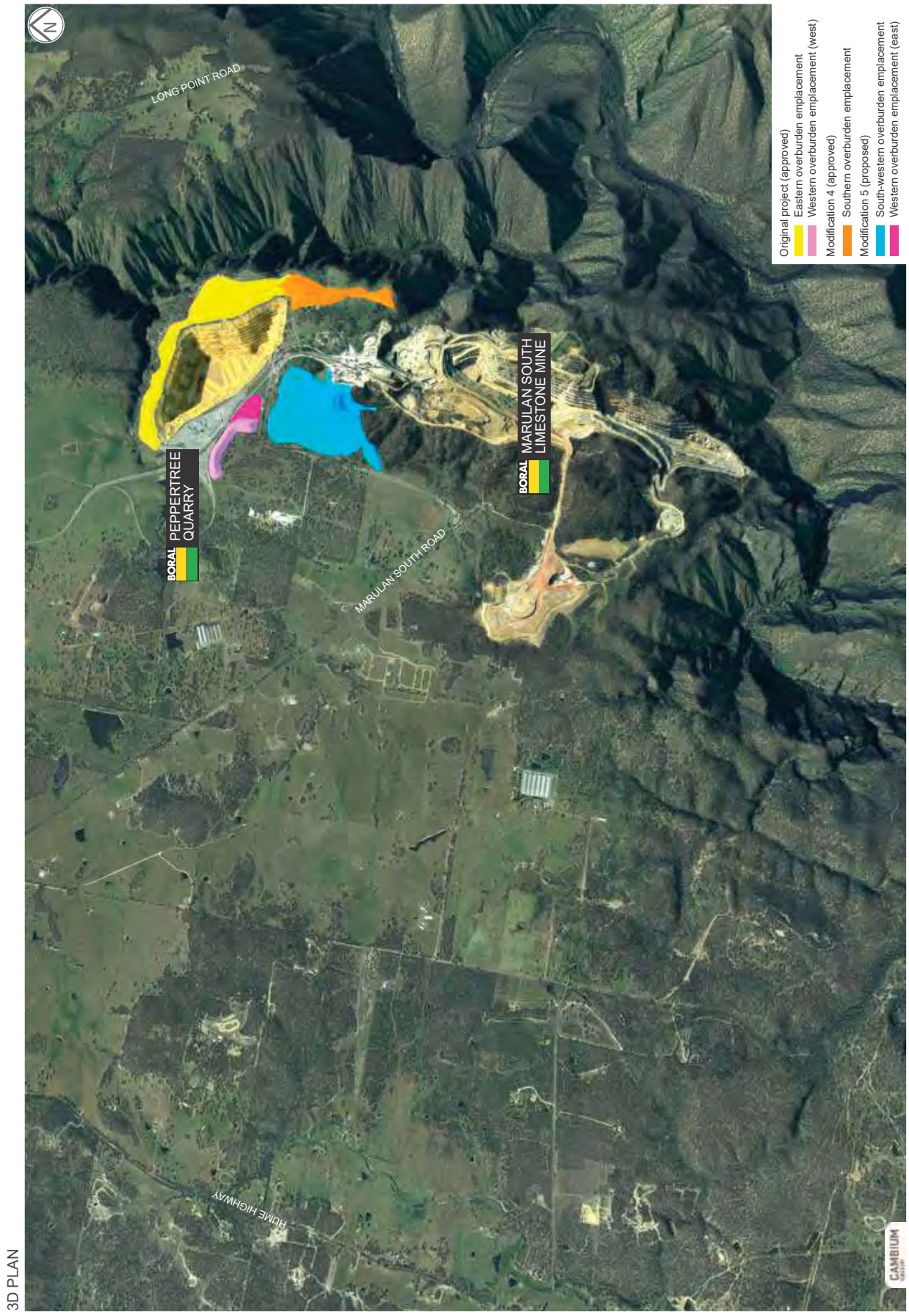
View from the balcony. 3D modelling indicates that the residence will have minor views of part of the proposed South-western Overburden Emplacement, being the last lifts. Vegetation in the middle distance blocks any direct view lines. This view was analysed and used as the base for a photomontage in Appendix 3.



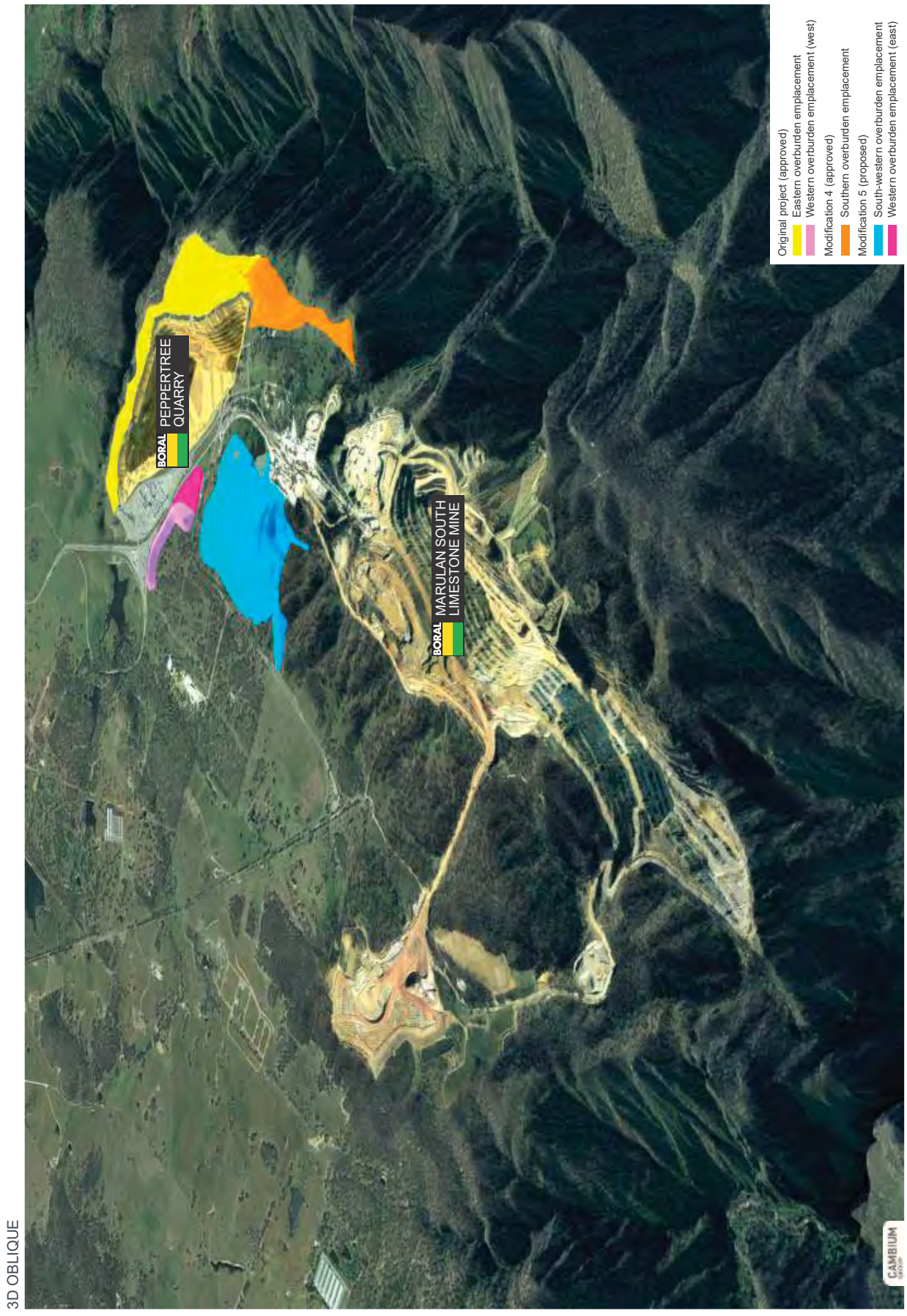
Plate 1/34

R15, viewing toward R16 (445 Long Point Road)

The dense vegetation screen between R16 and the direction of the proposed Southern Overburden Emplacement (to the right in this photograph) blocks views.

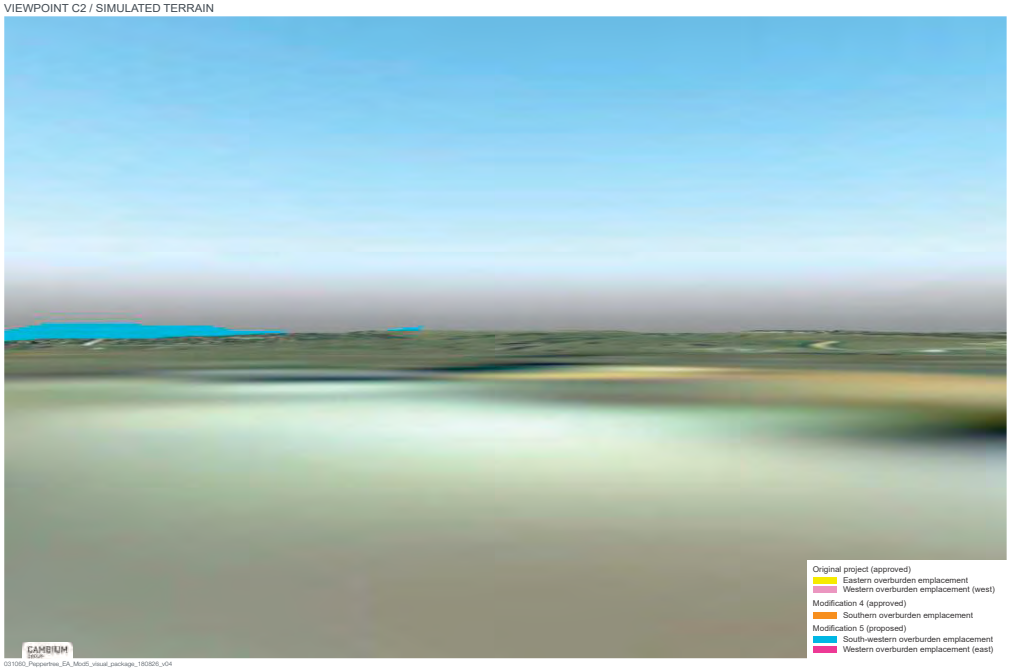


3D Key Plan to Analytical 3D Graphics Prepared by Cambium Group, in vertical view



3D Key Plan to Analytical 3D Graphics Prepared by Cambium Group, in oblique view from the south

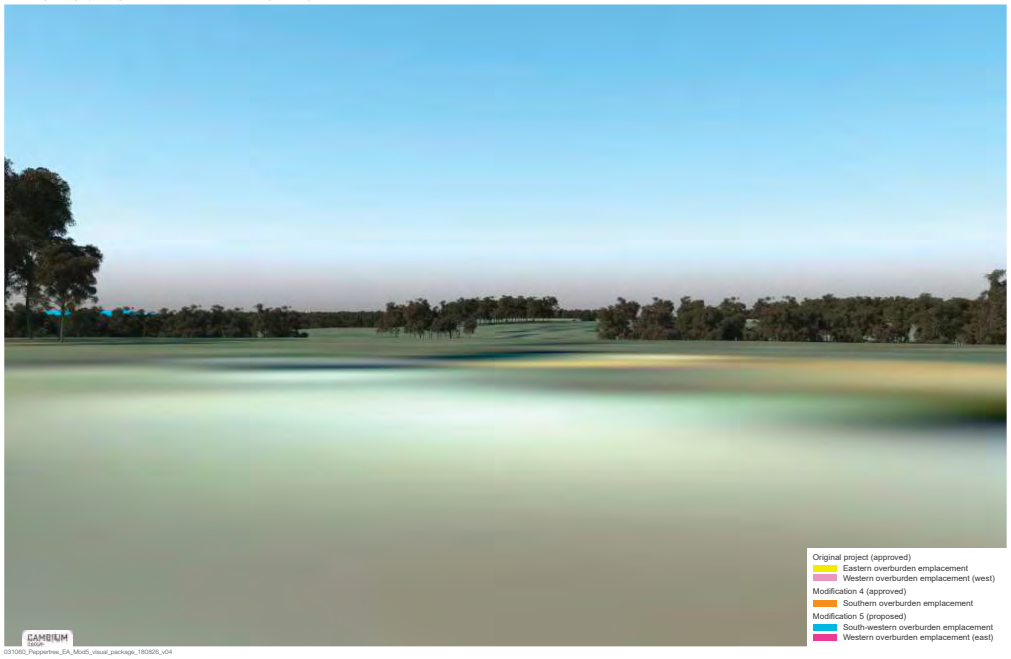
VIEWPOINT C2 / SIMULATED TERRAIN



Receiver C2

3D render of terrain and proposed landforms only

VIEWPOINT C2 / SIMULATED TERRAIN WITH VEGETATION



Receiver C2

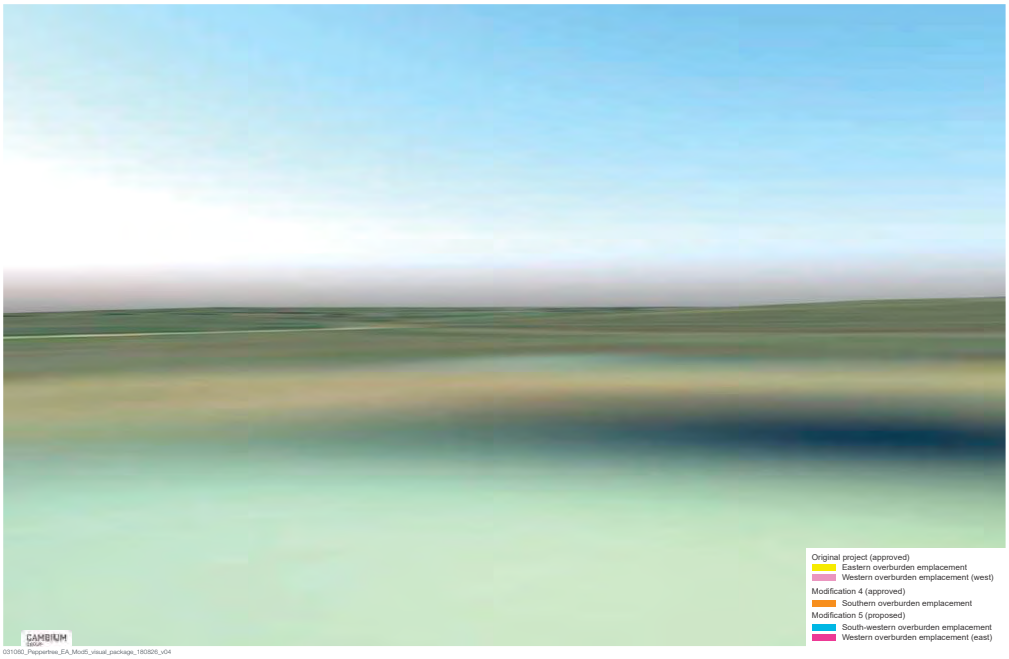
3D render of terrain and proposed landforms with vegetation



Receiver C2

Actual image from adjacent to buildings at C2 taken by Boral staff member in 2015. The image focal length is equivalent to 50mm and is therefore less in field of view than the 35mm virtual camera used to prepare the 3D analytical. The centre of view is the same. It is unlikely that there would be significant visibility of the Modification from this location

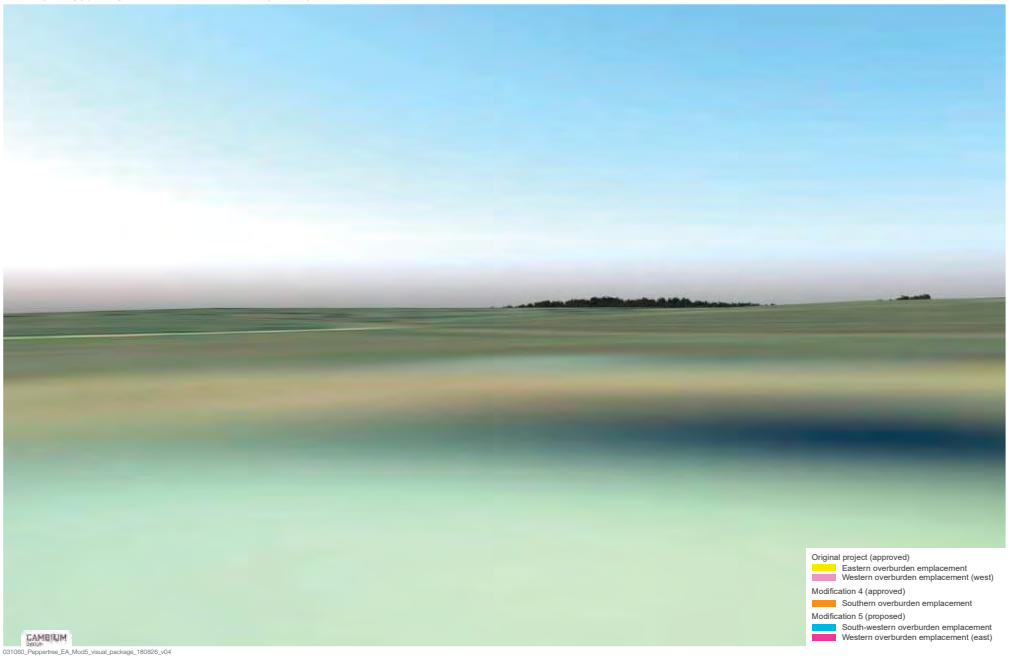
VIEWPOINT C3 / SIMULATED TERRAIN



Receiver C3

3D render of terrain and proposed landforms only

VIEWPOINT C3 / SIMULATED TERRAIN WITH VEGETATION



Receiver C3

3D render of terrain and proposed landforms with vegetation

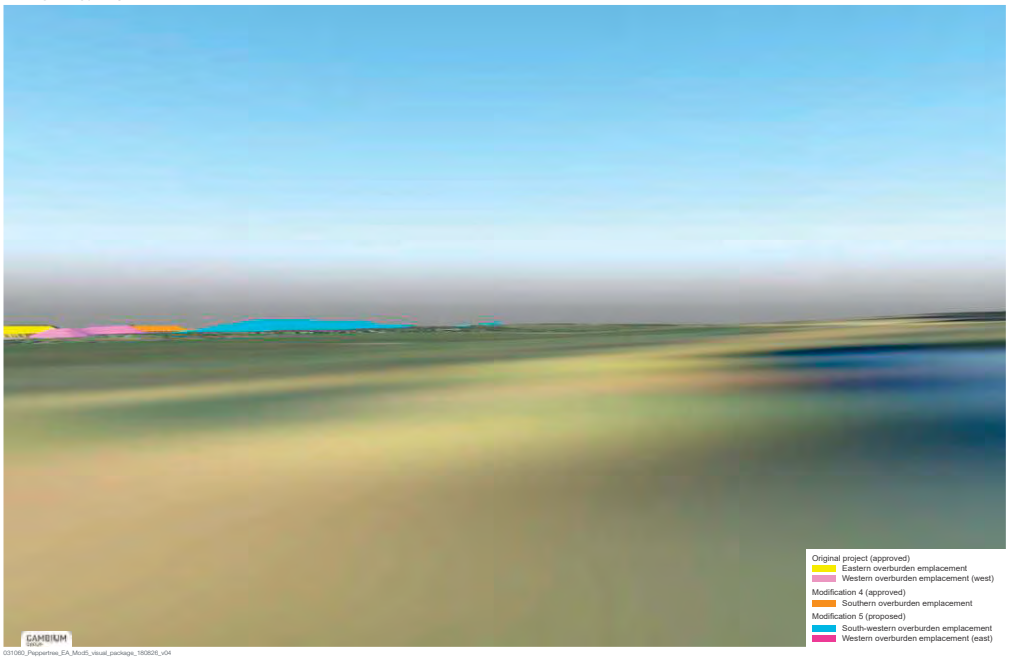


Receiver C3

Photographic image from office balcony at C3

The centre of the photograph is to the left of the centre of the 3D render and at a higher focal length. C3 will not have a view of the Modification

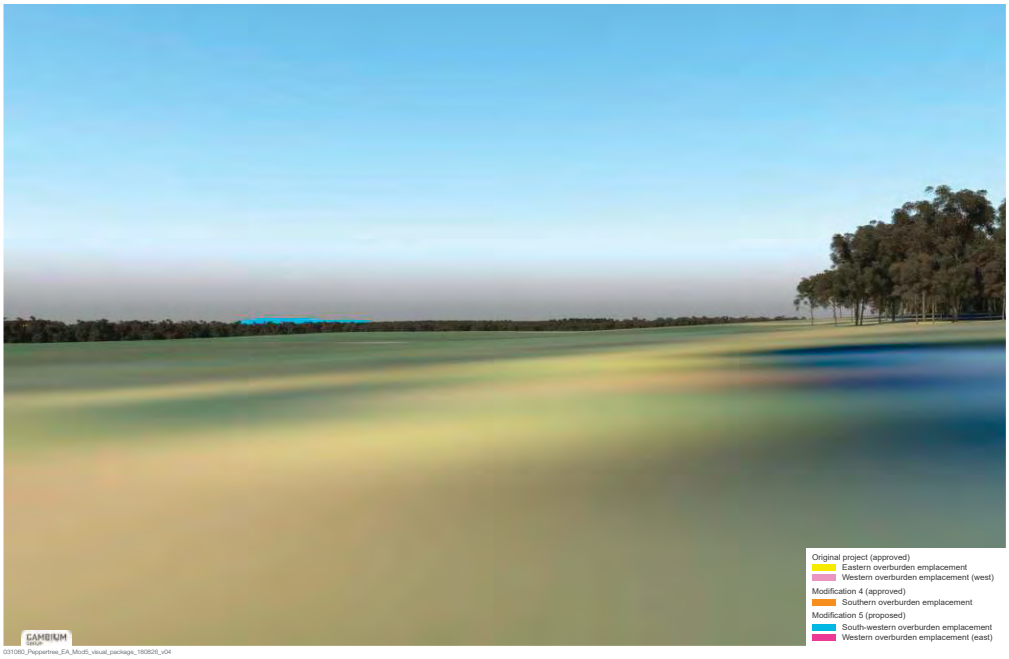
VIEWPOINT R5 / SIMULATED TERRAIN



Receiver R5

3D render of terrain and proposed landforms only

VIEWPOINT R5 / SIMULATED TERRAIN WITH VEGETATION



Receiver R5

3D render of terrain and proposed landforms with vegetation

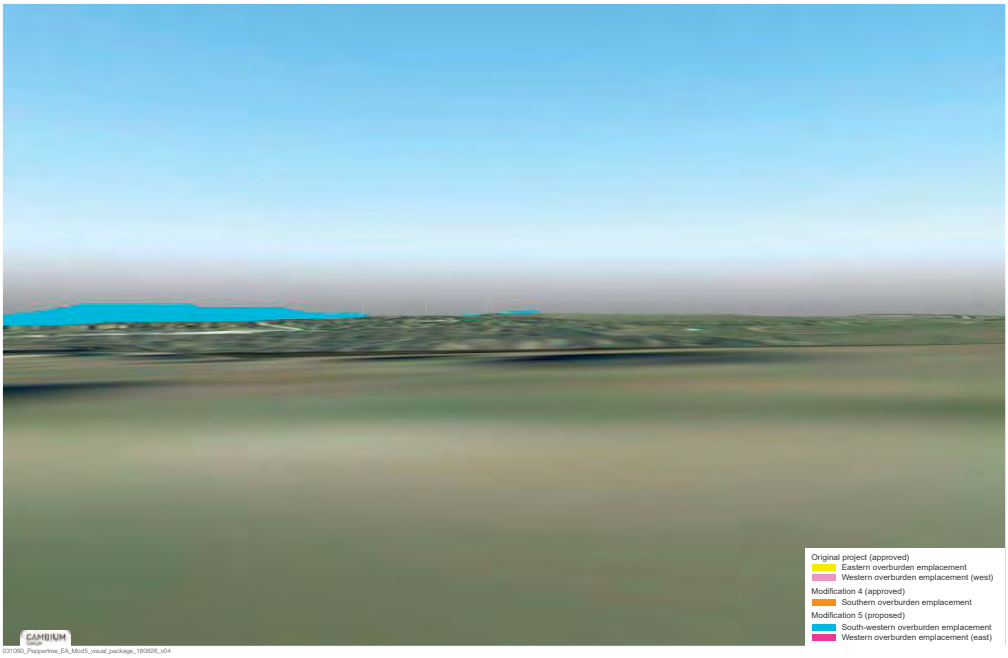


Receiver R5

Photographic image from the dwelling balcony at R5

The centre of the photograph is slightly to right of the centre of the 3D render. It is unlikely that R5 will have any view of the Modification

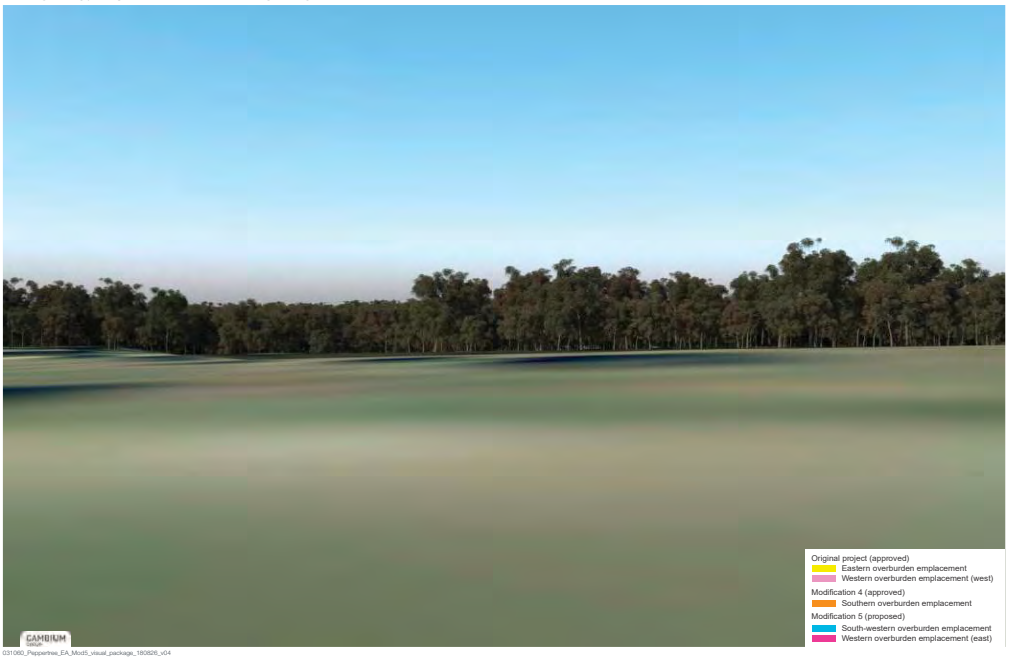
VIEWPOINT R8 / SIMULATED TERRAIN



Receiver R8

3D render of terrain and proposed landforms only

VIEWPOINT R8 / SIMULATED TERRAIN WITH VEGETATION



Receiver R8

3D render of terrain and proposed landforms with vegetation

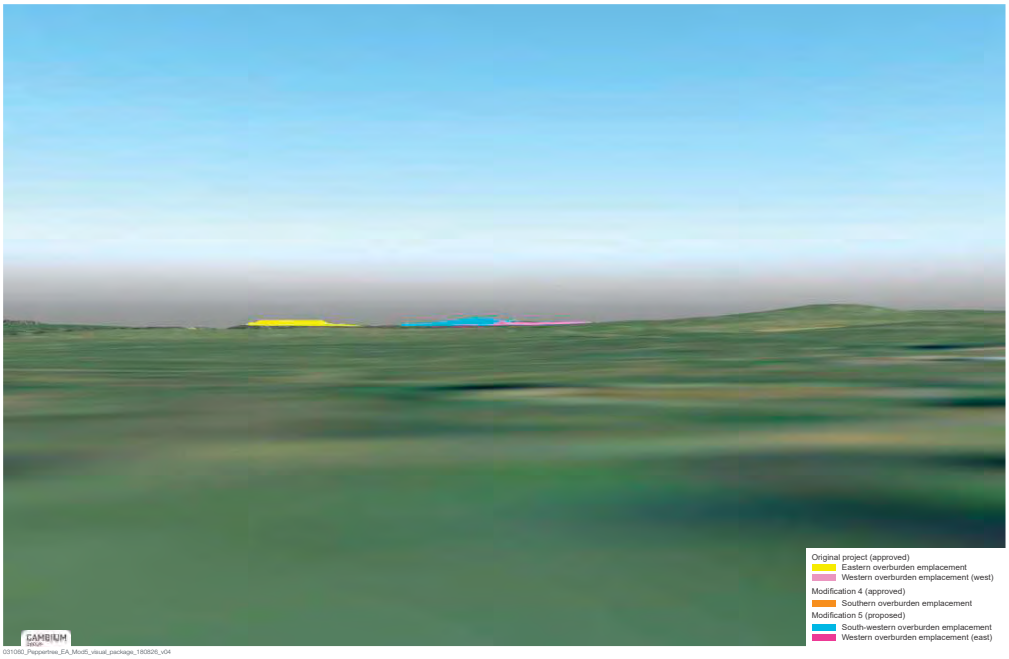


Receiver R8

Photographic image from the land east of sheds that block view from the dwelling at R8

R8 will not have a view of the Modification

VIEWPOINT R13 / SIMULATED TERRAIN

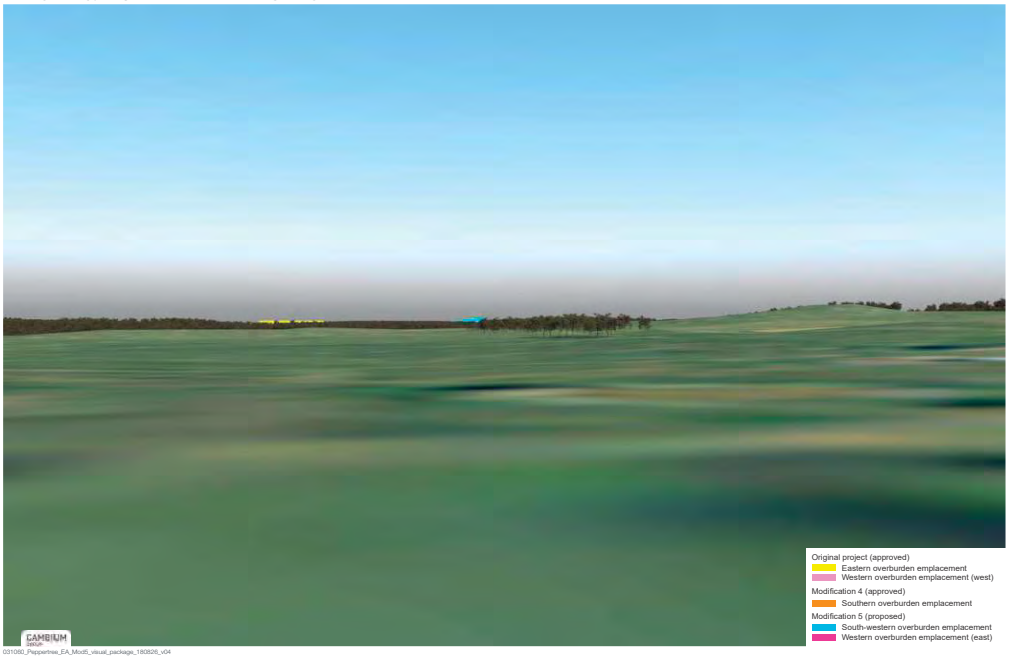


031060_Peppertree_EA_Mod5_visual_package_180826_v04

Receiver R13

3D render of terrain and proposed landforms only

VIEWPOINT R13 / SIMULATED TERRAIN WITH VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

Receiver R13

3D render of terrain and proposed landforms with vegetation

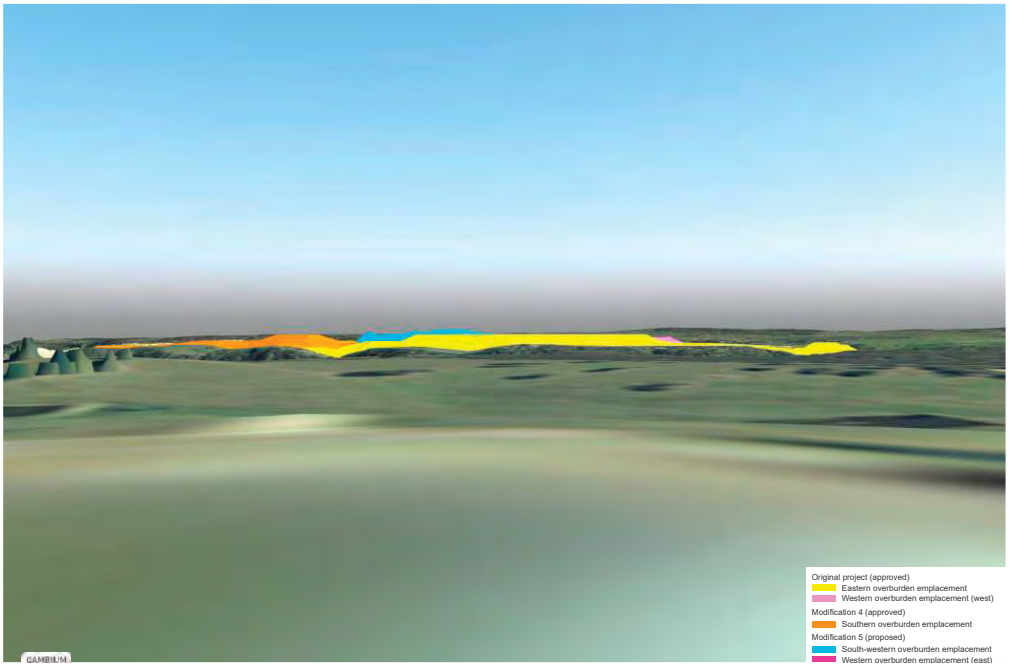


Receiver R13

Photographic image on the axis from the rear of the residence

R13 is unlikely to have any significant view of the proposed South-western Overburden Emplacement area , which would be of minimal visibility after rehabilitation

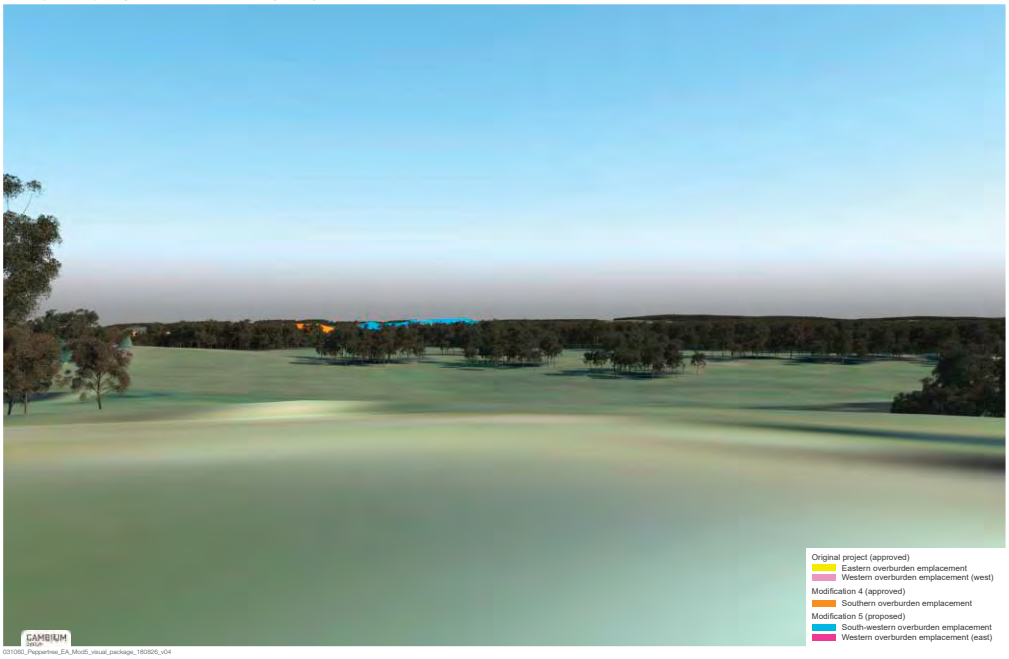
VIEWPOINT R14 / SIMULATED TERRAIN



Receiver R14

3D render of terrain and proposed landforms only

VIEWPOINT R14 / SIMULATED TERRAIN WITH VEGETATION



031082_Peppertree_EA_Mod5_visual_package_180926_v04

Receiver R14

3D render of terrain and proposed landforms with vegetation

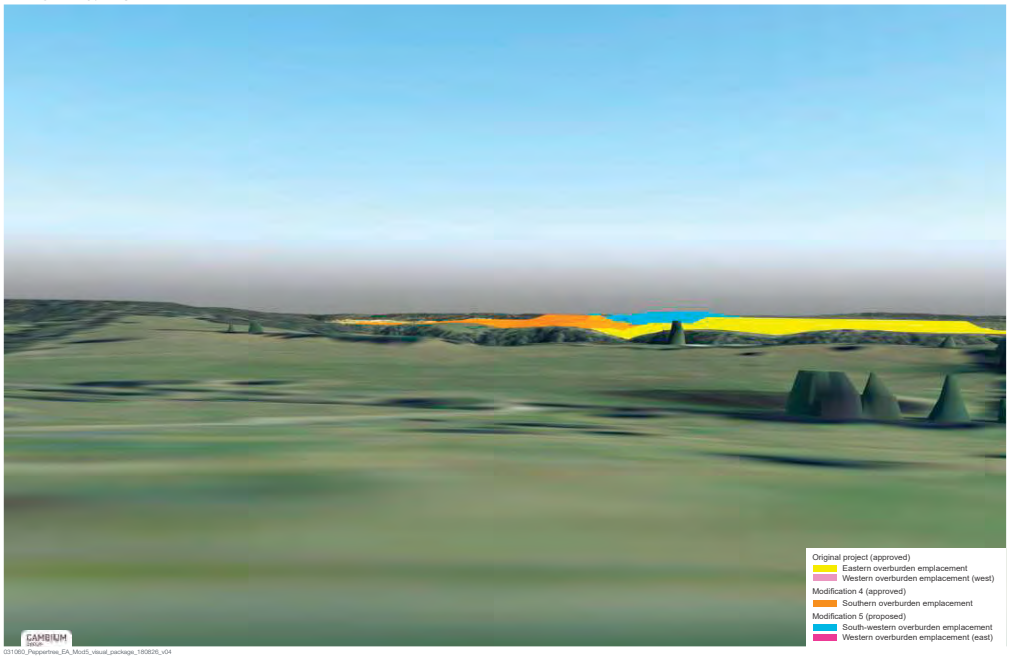


Receiver R14

Photographic image taken from veranda north side of residence

It is unlikely that R14 will have a view of the proposed South-western or Western Overburden Emplacement

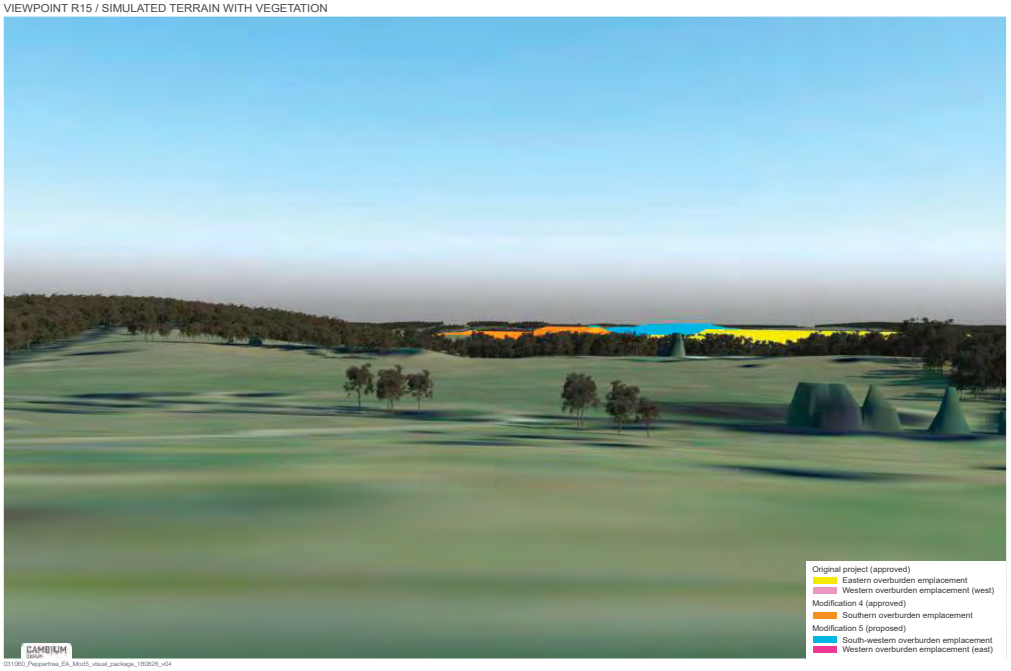
VIEWPOINT R15 / SIMULATED TERRAIN



Receiver R15

3D render of terrain and proposed landforms only

VIEWPOINT R15 / SIMULATED TERRAIN WITH VEGETATION



Receiver R15

3D render of terrain and proposed landforms with vegetation



Receiver R15

Photographic image taken from veranda north side of residence

R15 may have a view of part of the South-western Overburden Emplacement. The photomontage shows the impact of the proposed Modification would be minimal when rehabilitated



VIEWPOINT 20 (9946) LOOK DOWN / EXISTING

031060_Pepperiree_EA_Mod5_visual_package_180826_v04

VIEWPOINT 20 (9946) LOOK DOWN / ANALYTICAL LANDFORM



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT 20 (9946) LOOK DOWN / ANALYTICAL LANDFORM WITH MATURE VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT 20 (9946) LOOK DOWN / PHOTOMONTAGE LANDFORM WITH MATURE VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT R10 (4629) / EXISTING



VIEWPOINT R10 (4629) / ANALYTICAL LANDFORM



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT R10 (4629) / ANALYTICAL LANDFORM WITH MATURE VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT R10 (4629) / PHOTOMONTAGE LANDFORM WITH MATURE VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

R10: Residential receiver, photomontage

VIEWPOINT 21 (9924) LONG POINT TRACK / EXISTING



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT 21 (9924) LONG POINT TRACK / ANALYTICAL LANDFORM



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT 21 (9924) LONG POINT TRACK / ANALYTICAL LANDFORM WITH MATURE VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

VIEWPOINT 21 (9924) LONG POINT TRACK / PHOTOMONTAGE LANDFORM WITH MATURE VEGETATION



031060_Peppertree_EA_Mod5_visual_package_180826_v04

View Place Documentation Sheets

Receiver ID: VP1	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Peppertree Quarry	RLA_9930	34,45.6453	150,2.0141	623



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition			X	
Effect of Relative Viewing Level			X	
Effect of Viewing Period		X		
Effect of Viewing Distance				X
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low-medium		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low (View is from an effectively private road)		

View Place or Viewer Sensitivity)				
		L	M	H
Public Domain	Roads	X		
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP2	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Peppertree Quarry	RLA_9933	34,45.6524	150,1.4856	627.2



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View			X	
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition			X	
Effect of Relative Viewing Level			X	
Effect of Viewing Period		X		
Effect of Viewing Distance				X
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low-medium		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity			X	
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low (View is from an effectively private road)		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads	X		
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP6	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Marulan South Road	IMG_4661	34,45.9299	150,0.6473	633.7
	IMG_4662	34,45.9299	150,0.6473	633.7





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View				
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads		X	
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP8	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Marulan South Road adjacent R8, C2	IMG_4649	34,45.5981	150,0.3415	630.3
	IMG_4650	34,45.5948	150,0.3385	626.2





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads		X	
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP11	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Marulan South Road adjacent R5	IMG_4652	34,45.0077	149,59.9056	647.2



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads		X	
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP14	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Jerrara Road	IMG_4471	34,44.0751	149,58.7341	664.2



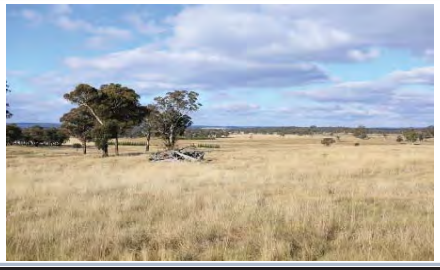
Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads	X		
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP15	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Jerrara Road	IMG_4472	34,44.8859	149,58.5826	671.3



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads	X		
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP18	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Glynmar Road adjacent to R10	IMG_4476	34,46.2216	149,59.1682	670.6
				
Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads	X		
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

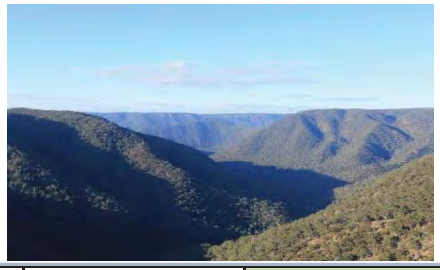
View Place Documentation Sheets

Receiver ID: VP19	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Glynmar Road	IMG_4477	34,46.0473	149,59.2004	674.7
				
Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Negligible		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads	X		
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP20	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
The Lookdown Lookout Morton NP	RLA_9946	34,47.9232	150,1.1372	552.4
	IMG_4485	34,47.9164	150,1.1372	552.4
	IMG_4489	34,47.9164	150,1.1372	552.4
	IMG_4607	34,47.9164	150,1.1372	552.4
				
Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level			X	
Effect of Viewing Period				X
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts	X		
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP21	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Long Point track Morton NP	RLA_9924	34,45.9602	150,3.0609	638.5
	IMG_9924	34,45.955	150,3.0587	637.9
				
Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View			X	
Effect on Scenic Quality of View			X	
Variable factors				
Effect On View Composition			X	
Effect of Relative Viewing Level			X	
Effect of Viewing Period				X
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Medium		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low-medium		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts		X	
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP22	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Long Point Lookout	IMG_4453	150,3.2231	150,3.2231	624.7
	IMG_4454	34,45.8797	150,3.2149	624.9





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Negligible		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts		X	
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP23	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Long Point Road adjacent B7 and R17	IMG_4463	34,45.5123	150,3.4385	632.8
	IMG_4464	34,45.4271	150,3.5599	625





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Negligible		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads		X	
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: VP24	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Long Point Road adjacent R15, R16	IMG_4465	34,45.1974	150,3.565	622.4



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level			X	
Effect of Viewing Period			X	
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads		X	
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: R5	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
359 Glynmar Road	IMG_4624	34,45.0843	149,59.823	658
	IMG_4625	34,45.0871	149,59.8296	639.7





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level			X	
Effect of Viewing Period			X	
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low-Medium		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence		X	
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: R8	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
381 Marulan South Road	IMG_4438	34,45.5061	150,0.509	629.2
	IMG_4439	34,45.5062	150,0.510	629.4
	IMG_4440	34,45.4994	150,0.53	629.7
	IMG_4441	34,45.507	150,0.4974	625.6





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period			X	
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence		X	
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: R10	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
290 Glynmar Road	IMG_4638	34,46.2284	149,59.3644	662.7



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level			X	
Effect of Viewing Period			X	
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence		X	
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: R13	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
Glenrock 248 Highland Way	IMG_4633	34,43.0789	150,2.6343	621.9
	IMG_4635	34,43.0657	150,2.5836	623
	IMG_4636	34,43.0602	150,2.610	623.3





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period			X	
Effect of Viewing Distance		X		
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features		X		
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence	X		
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: R14	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
387 Long Point Road	IMG_4468	34,45.0618	150,3.6452	631.4



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level			X	
Effect of Viewing Period			X	
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence		X	
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: R15	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
443 Long Point Road	IMG_4638	34,45.2228	150,3.7212	639.8
	IMG_4642	34,45.256	150,3.7319	635.9





Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level			X	
Effect of Viewing Period			X	
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence		X	
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: C2	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
408 Marulan South Road	IMG_4627	34,45.7	150,0.0747	637.1
Potential residence	IMG_4628	34,45.699	150,0.0777	635.6





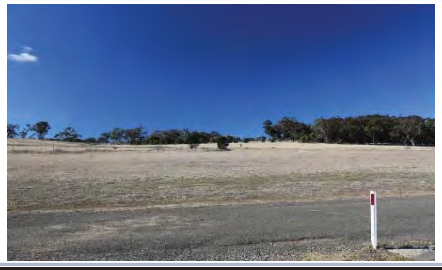
Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period			X	
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence		X	
		>3000m	500-3000m	<500m
		Viewing Distance		

View Place Documentation Sheets

Receiver ID: C3	R=Residence	C=Commercial	B=Boral owned	VP=Public View
Address/Location	Image No.	LATITUDE	LONGITUDE	ELEVATION (M)
452 Marulan South Road	IMG_4620	34,45.9358	150,0.487	626.7



Expansive	Restricted	Panoramic	Focal	Feature

Assessment and weighting factors		Ratings		
Assessment Factor where effects increase as ratings increase	Assessment	Low	Medium	High
	Visual Effect	(Low Effect)	(Medium effect)	(High effect)
Base-line factors				
Effect On Visual Character of View		X		
Effect on Scenic Quality of View		X		
Variable factors				
Effect On View Composition		X		
Effect of Relative Viewing Level		X		
Effect of Viewing Period		X		
Effect of Viewing Distance			X	
View Loss or Blocking Effect		X		
Overall Extent of Visual Effect		Low		
Weighting factors				
Weighting Factor where impacts decrease as ratings increase	Assessment	High	Medium	Low
	Visual Impact	(Low Impact)	(Medium impact)	(High impact)
Physical Absorption Capacity		X		
Compatibility with mining/industrial features		X		
Compatibility with Urban/ Natural Features			X	
Overall Extent of Visual Impact		Low		

View Place or Viewer Sensitivity (N/A)				
		L	M	H
Public Domain	Roads			
	Lookouts			
	Reserves			
Private Domain	Residence			
		>3000m	500-3000m	<500m
		Viewing Distance		

Appendix 5: Curriculum vitae Dr Richard Lamb

Summary

I am a professional consultant specialising in landscape heritage and visual impacts assessment and the principal of Richard Lamb and Associates (RLA). I was a senior lecturer in Architecture and Heritage Conservation in the Faculty of Architecture, Design and Planning at the University of Sydney for 28 years and Director of the Master of Heritage Conservation program. I have taught and specialised in environmental impact assessment and visual perception studies for 30 years.

As the principal of RLA I provide professional services, expert advice and landscape heritage and aesthetic assessments in many different contexts. I carry out strategic planning studies to protect and enhance scenic quality and heritage values, conduct scenic and aesthetic assessments in contexts from rural to urban, provide advice on view loss and view sharing and conduct landscape heritage studies. I act for various client groups on an independent basis, including local councils, government departments and private clients to whom I provide impartial advice. I provide expert advice, testimony and evidence to the Land and Environment Court of NSW and the Planning and Environment Court of Queensland in various classes of litigation. I have appeared in over 250 cases and made submissions to several Commissions of Inquiry. I have been the principal consultant for over 1000 consultancies concerning the visual impacts and landscape heritage area of expertise during the last ten years.

At the University of Sydney I had the responsibility for teaching and research in my areas of expertise, which are visual perception and cognition, aesthetic assessment, landscape assessment and conservation of heritage items and places. I taught postgraduate students in these areas and also gave specialised elective courses in aesthetic heritage assessment. I supervise postgraduate research students undertaking PhD and Masters degree academic research in the area of heritage conservation and Environment Behaviour Studies (EBS). The latter field is based around empirical research into human aspects of the built environment, in particular, in my area of expertise, aspects of visual perception, landscape preference and environmental cognition.

I have a number of academic research publications in local and international journals that publish research in EBS, environmental psychology and cultural heritage management. I have developed my own methods for landscape heritage assessment, based on my education, knowledge from research and practical experience.

Qualifications

- Bachelor of Science, First Class Honours, University of New England (Botany and ecology double major).
- Doctor of Philosophy, University of New England in 1975.
- Visiting lecturer, University of New South Wales, School of The Built Environment
- Principal of Richard Lamb and Associates and Director of Lambcon Associates Pty Ltd.

Employment History

- Tutor, Botany and Ecology, School of Botany, UNE (1968-1974)
- Lecturer in Resource Management, School of Life Sciences, UTS (1975-1980)
- Lecturer, Foundation Program in Landscape Architecture, Faculty of Architecture, University of Sydney (1980-1989)
- Lecturer and Senior Lecturer, Architecture and Heritage Conservation, University of Sydney (1989-2011)

Since 1975 I pursued research related to my teaching responsibilities and professional practice. My research works are in:

- Plant ecology
- Landscape heritage assessment
- Visual perception
- Social and aesthetic values of the natural and built environment

Publications and presentations relevant to visual perception and assessment of landscapes are listed at the end of this CV.

International Journals for which papers have been refereed

- Landscape & Urban Planning
- Journal of Architectural & Planning Research
- Architectural Science Review
- Journal of the Australian & New Zealand Association for Person Environment Studies
- Journal of Environmental Psychology
- Australasian Journal of Environmental Management
- Ecological Management & Restoration
- Urban Design Review International

Recent experience

Landscape Planning

Assessment and Advice

Private Clients

- Advice on merits of proposal for SEPP HSPD development, Pokolbin.
- Advice on visual impacts of alternative building footprint locations, Foxground Road, Foxground.
- Advice on visual impacts of proposed residential development at Cambewarra.
Report on strategic planning issues related to Scenic Preservation hatching and Draft LEP specific to visual quality protection, Cambewarra Village.
- Advice on visual impacts of proposed subdivision and draft submission to Gosford Council, The Scenic Road, MacMasters Beach.
- Aesthetic assessment and evaluation of REF for proposed wind farm by Pacific Power and Partners, Crookwell.
- Assessment of visual impacts of proposed development and submisson to Shoalhaven City Council, Bendeela Road, Kangaroo Valley.
- Heritage and visual impacts assessment as part of statement of environmental effects, proposed monastery at Mangrove Mountain, City of Gosford
- Independent assessment and advice concerning identification of viewing places and presentation of visual impact scenarios, Harrington Park Stage II, Camden.
- Initial advice concerning visual resources of site and potential to accommodate large scale institutional development, Campbelltown Road, Denham Court.
- Landscape assessment and evaluation of alternative building sites, Saddleback Mountain, Kiama.
- Landscape character analysis and visual assessment in relation to “Gateway” concept, The Northern Road, Glenmore Park.
- Landscape constraints and development capability assessment for potential residential development, Governors Way, Macquarie Links.
- Landscape planning strategy and visual impacts assessment, proposed cemetery and crematorium, Elizabeth Drive, Luddenham.
- Landscape visual constraints and capability assessment for potential for residential development, Shellharbour Road, Dunmore.
- Landscape visual constraints and capability assessment for potential residential development, Old Princes Highway, Dunmore.
- Landscape visual constraints and capability assessment of a land proposed fo be rezoned for residential development, Cooby Road, Albion Park
- Landscape visual constraints and capability assessment of a parcel of land proposed for rezoning, Ashburton Drive, Albion Park
- Landscape visual constraints and capability assessment of parcels of land proposed for rezoning to

residential use within the urban fringe area, Albion Park.

- Pre DA advice and statement of visual exposure, seniors living proposal, Cobbitty, Camden municipality.
- Pre DA advice on constraints and development envelopes, strategy and advice, Windang, Lake Illawarra.
- Pre-DA advice and visual impact assessment of proposed rezoning of rural land for potential residential development, Corner Kirkham Lane and Macquarie Grove Road, Kirkham.
- Pre-DA advice on design, visual and streetscape impacts assessment, proposed Islamic school, Burragorang and Cawdor Roads, Camden
- Pre-DA advice on visual impacts of proposed SEPP 5 development at Cambewarra.
- Report on visual impacts and effects on adjoining zones of a proposed subdivision, Glenhaven Road, Glenhaven.
- Pre DA advice and advocacy on proposed rural residential subdivision, The Northern Road, Glenmore Park.
- Statement of visual impact to accompany rezoning application, Old Northern Road, Castle Hill.
- Strategic planning advice concerning development potential, Fernhill, Mulgoa.
- Strategic planning and 3D modelling study to establish visibility constraints on zone boundaries, East Leppington Urban Release Area.
- Submission of feasibility study for re-zoning of land and subdivision for rural residential uses, Macquarie Grove Road, Kirkham.
- Submission to NSW Department of Planning against proposed extension of Catherine Hill Bay, Mooney Village and Gwandalan for residential development by Asquith & Dewitt Pty Ltd for Rosecorp Ltd.
- Visual and environmental impact assessment, proposed new dwelling, Dora Creek.
- Visual and heritage landscape assessment of impacts of proposed additions on the locality and Landscape Conservation Area, Benedictine Abbey, Jamberoo Pass.
- Visual and scenic impacts advice both pre- and post-DA, SEPP 5 Development, Old Northern Road, Castle Hill.
- Visual and scenic resources management study and visual impact assessment of a Concept Plan for Mixed Use Development, Tallawarra Lands, Tallawarra.
- Visual assessment and development strategy for proposed re-zoning of land partly for cemetery purposes, Varroville, Campbelltown.
- Visual assessment and development strategy for proposed re-zoning of land partly for residential purposes, Grange Hills, Campbelltown.
- Visual assessment and statement of environmental effects, proposed rezoning and subdivision, Cooranbong, Lake Macquarie.
- Visual assessment of proposed Town Centre land, Nambucca Drive, Scotts Head.
- Visual impact advice and report regarding location of dwellings on subdivided lots, Princes Highway, Kiama.
- Visual impact advice for proposed location of new dwelling, Weir Street, Kiama.
- Visual impact assessment and scenic amenity statement, proposed rural residential development, Dido Street, Kiama.
- Visual impact assessment for Jack Nicklaus Golf Resort, Rothbury, Hunter Valley
- Visual impact assessment for proposed Seniors Living Development, Pokolbin, Hunter Valley.
- Visual impact assessment of potentially unsightly landscape features vis-à-vis the Local Government Act definition in the vicinity of Vacy Downs Estate subdivision, Vacy.
- Visual impact assessment of proposed new dwelling, Pheasant Point Drive, Kiama.
- Visual impact assessment of proposed rezoning of land for urban residential use, Blue Seas Parade, Lennox Head.
- Visual impact assessment of proposed subdivision, Hillcrest Road, Mirrabooka, Lake Macquarie.
- Visual impact assessment, assessment against the provisions of Wingecarribee DCP 53 and advice concerning merits of proposed new dwelling location and design, Bibbys Lane, Werai Junction, Southern Highlands.
- Visual impact assessment, residential subdivision and development application, Scotts Head.

- Visual impact assessment, strategic planning analysis and peer review of proposed Forde Masterplan, Canberra.
- Visual impacts assessment of the proposed residential subdivision, Old Northern Road, Castle Hill.
- Visual resources and visual constraints study to accompany DA for establishment of new necropolis, Berrima district, Southern Highlands of NSW.
- Visual resources and visual constraints study, design advice and advocacy for potential DA, proposed resort and seniors living development, Glossodia.

Government Clients

- *Camden Council*

Camden Scenic and Cultural Landscape Study, Local Government Area of Camden.
Report on strategic planning for landscape protection based on the Camden Scenic and Cultural Landscape Study, for the Camden Rural Lands Study.

- *Dungog Council*

Assessment of visual and heritage impacts, scenic protection controls and heritage impact performance standards, proposed rezoning and rural residential development, Paterson, Upper Hunter Valley.

- *Shellharbour City Council*

Strategic planning study for identification, protection and conservation of landscapes of natural and cultural heritage significance, Shellharbour Local Government Area.

- *The Joint Old Growth Forest Project*

Empirical study to assess the feasibility of including cultural and aesthetic values in the evaluation of old growth forest.

- *The Resources and Conservation Council of New South Wales (RaCAC)*

Aesthetic values audit of the Upper North East region of NSW.

Expert workshop on integrating heritage values into the CRA/RFA process for evaluation of Australian forests.

Land and Environment Court Proceedings

Australian Native Landscapes v Warringah Council: s82A Review of conditions of consent, retail nursery, Mona Vale Road, Terrey Hills.

Baevski v Wingecarribbee Shire Council: proposed covered dressage arena, Myra Vale Road, Robertson.

Baulkham Hills Council ats Gelle: proposed extension to existing caravan park, KoVeda Caravan Park, Wisemans Ferry.

Broken Bay Pty Ltd v The National Parks and Wildlife Service of NSW: valuation matter concerning acquisition of land, Hawke Head Road, Killcare.

CD Barker Pty Ltd for Eodo Pty Ltd v Council of the City of Blue Mountains: proposed subdivision and detached residential development, Heather Road, Winmalee.

Design Collaborative Pty Ltd v Wingecarribee Shire Council: proposed spring water extraction facility, Governors Street, Bundanoon.

Erolmore Park Pty Ltd v Maitland City Council: proposed industrial development, New England Highway, Thornton.

Flower and Samios v Shoalhaven Council: proposed Seniors Living Development, Main Road, Cambewarra.

Heathcote Gospel Trust v Sutherland City Council: proposed place of worship, Forum Drive, Heathcote.

Hornsby Shire Council

- *ats Haoushar*, proposed attached dual occupancy dwellings, Crosslands Road, Galston.
- *ats Momentum Architects*, proposed SEPP5 development, Old Northern Road, Kenthurst.
- *ats M&R Civil*, proposed SEPP5 development, Old Northern Road, Kenthurst.

Kiama Council ats Moss: proposed new residence in rural land, Alne Bank Road, Gerringong.

Liverpool City Council ats Kira Holdings Pty Ltd: proposed subdivision and low density residential development, Hoxton Park.

Luke Tappouras v Lake Macquarie City Council: proposed Heritage College, Ironbark Road, Morisset.

Marsim (Queensland) Pty Ltd and Gold Coast City Council ats Hoffman & Ors: proposed neo-traditional settlement development, Killowill Avenue, Paradise Point, Gold Coast.

Molusso J v Gosford Council: proposed apartment building, Grosvenor Road, Terrigal.

Penrith City Council

- *ats Pacific Waste Management Pty Ltd*, proposed waste facility, Elizabeth Drive, Badgery's Creek.
- *ats Penrith Waste Services Pty Ltd*, prosecution for alleged breaches of conditions of consent, Mulgoa Quarry.
- *ats Sydney Anglican Schools Corporation*, proposed rural school construction, Homestead Road, Orchard Hills.

Pope Shenouda Coptic Christian Centre v Campbelltown City Council: proposed redevelopment of religious and community facilities, Wills Road, Long Point.

RTA ats Scollard: valuation matter concerning compulsory acquisition of land, Olympic Way, Gerogery.

Sangha Holdings Pty Ltd v Kiama Council: proposed subdivision, Cooby Road, Albion Park.

Save Hawkesbury's Unique River Environment (SHURE) ats Consensus Developments: proposed tourist accommodation facility, Kangaroo Point, Brooklyn.

Seaview Gardens Pty Ltd v Port Stephens Shire Council:proposed medium density residential development, One Mile Close, Boat Harbour, Port Stephens.

Sherringhams v Baulkham Hills Council: proposed retail nursery, Old Northern Road, Dural.

Sutherland Shire Council: primary submission to Commission of Inquiry into land use, Helensburgh.

The Coffs Harbour Environment Centre v the Minister for Planning: proposed rezoning of Look at Me Now Headland for the purpose of sewage treatment plant and outfall, Coffs Harbour.

*The Jehovah's Witnesses Congregations v Penrith Counci*l: proposed place of worship, Homestead Road, Orchard Hills.

Tony Fidler as Trustee for Howship Holdings v Port Stephens Shire Council: valuation matter concerning acquisition of land, Lily Hill, Nelson Bay.

Townsend W & D v Lake Macquarie City Council: proposed rural dwelling, Chelston Street, Warners Bay.

Warringah Council ats Vigor Master: proposed dwelling construction, Brooker Avenue, Beacon Hill

Wingecarribee Shire Council

- *ats Knox*, prosecution for illegal construction of earth bank, Range Road, Kangaloon.
- *ats Webb*, proposed rural dwelling, Silver Springs Hill, Burrawang.
- *ats Allen*, proposed rural dwelling Greenhills Road, Berrima.

Visual Impacts

Assessment and Advice

Private Clients

- Advices and visual impact assessment of a proposed aged care facility, McLaren Street, North Sydney.
- Advices and visual impact assessment of the proposed concept plan for a medium density residential development, Belmore Street, Ryde.
- Advices and visual impact assessment of the proposed new dwelling and swimming pool, Mountain Road, Austinmer.
- Advices and visual impact assessment of the proposed retirement resort, Oakey Creek Road and Marrowbone Road, Pokolbin.
- Advices on potential visual impacts of the proposed driveway and basement car park, Musgrave Street, Mosman.

Advice on potential visual impacts of proposed amendments to existing consent, Minamurra Road, Northbridge.

- Assessment and advice on visual effects of lighting from adjacent parking garage, Ocean Street, Woollahra
- Assessment of visual impacts of additions and alterations to existing retirement village, Jersey Road,

Paddington.

- Assessment of visual impacts of proposed subdivision, Bantry Bay Road, Frenchs Forest.
- Landscape assessment, curtilage study and heritage impact assessment as part of a Local Environmental Study, curtilage of Duckenfield House, Duckenfield, Hunter Valley.
- Local environmental study, proposed subdivision and residential development, Berkeley Vale, Wyong Shire.
- Report on strategic planning issues and submission to Shoalhaven City Council related to Scenic Preservation hatching being proposed over the locality of Cambewarra Village, North Nowra.
- Scenic resources and visual constraints study, proposed seniors living proposal involving concurrent rezoning, Milton, South Coast.
- Strategic planning and visual impact assessment for proposed rezoning and master plan application, Riverlands Golf Course, Milperra.
- Strategic planning study for Stage 1 Master Plan, visual impact assessment for rezoning applications, principles for siting of buildings and mitigation of potential impacts, Boydtown, Eden region.
- Submission to Council against a proposed industrial development on Burley Road, Horsley Park on the visual amenity, Capitol Hill Drive, Mt Vernon.
- Submission to Council against a proposed industrial development on Burley Road, Horsley Park on the visual amenity, Greenway Place, Horsley Park.
- Submission to Waverley Council concerning visual impacts of proposed amended DA, Birrell Street, Tamarama.
- ▪ Urban design and visual impact study, Beach Street, Coogee.
- Urban design and visual impacts assessment, proposed Trinity Point Marina and tourism development Concept Plan, Lake Macquarie.
- Visual and landscape strategic planning assessment of proposed draft amendment to Wingecarribee LEP 1989, Burradoo, Moss Vale
- Visual constraints and residential development strategy advice, Lennox Head.
Advocacy concerning strategic planning process and proposed rezoning of land, Lennox Head.
- Visual impact and view loss assessment for proposed seniors living development, former Loreto site, Bronte Road, Bronte
- Visual impact assessment and advice on building height controls for Greystanes Estate, Southern Employment Land, Greystanes.
- Visual Impact Assessment and advices on rural subdivision, The Northern Road, Glenmore Park.
- Visual impact assessment and strategic planning for proposed rezoning and subdivision of land at Menangle Road, Menangle
- Visual impact assessment as part of the Review of Environmental Factors for Shellharbour Waste Water Treatment Works.
- Visual impact assessment for subdivision application, The Northern Road, Glenmore Park.
- Visual impact assessment of land proposed for rezoing to support a proposed clay target shooting facility, Bong Bong Road, Huntley.
- Visual impact assessment of new school house, Kingswood Road, Orchard Hills.
- Visual impact assessment of proposed amendments to existing consent, Tulloch Avenue, Concord
- Visual impact assessment of proposed residential development, Bray Street, Mosman.
- Visual impact assessment of proposed residential subdivision, mitigation measures and advice on conditions for site specific DCP, Scarborough Gardens, Bonnells Bay
- Visual impact assessment of proposed seniors living development, St Albans Street, Abbotsford.
- Visual impact assessment of the proposed mixed use development, Columbia Precinct, Parramatta Road and Columbia Lane, Homebush.
- Visual impact assessment of the proposed residential townhouses development including preparation and certification of photomontages, Johnston Street, Annandale.
- Visual Impact Assessment Part 3A Concept Plan application. Old Canterbury Road, Lewisham.
- Visual impact evaluation of a series of possible locations for dwelling sites, Menai.
- Visual impacts assessment of proposed residential developments, Thomas and Dumbarton Streets, McMahons Point.

Government Clients

- *Ashfield City Council*

Ashfield Town Centre, Study of Building Heights to be incorporated into the Town Centre Development Control Plan.
Review of DA for Abacus Ashfield Mall Redevelopment, against the performance standards of Building Heights Study.

- *Brisbane City Council*

Cultural Mapping exercise, for Quality Urban Corridors Program, Logan Road, Lutwyche/Gympie Roads, in association with Archimix Brisbane.

- *Brisbane City Council and the Department of Natural Resources, Queensland*

Protection of Scenic Landscapes Study; Regional landscape study to develop a methodology for the documentation of scenic values of the South East Region of Queensland.
South East Queensland Regional Organisation of Councils
advice on Scenic Amenity Study

- *Council of the City of Gosford*

City Wide Visual Quality Study in association with David Kettle Consulting Services.
Development Control Plan-Scenic Quality.
Local Environmental Study, The Scenic Highway, Terrigal.

- *Department of Infrastructure, Planning and Natural Resources and The Uniting Church of Australia*

Visual impact assessment for subdivision of land at Ingleside Road, Ingleside.

- *Hastings Shire Council*

Review and redrafting of DCPs 9 and 20 relating to scenic and heritage resource protection, Port Macquarie.
Visual resources and scenic conservation study as part of Camden Haven River Estuary Processes Study, in association with Patterson Britton and Partners.

- *Ku ring gai Council*

Brief development for municipality wide neighbourhood visual and streetscape study.
Local Environmental Study: scenic quality of South Turramurra.

- *Landcom*

Strategic planning advice and visual impact assessment for proposed NSW Police Facilities on former Sydney Water land, Potts Hill.

- *Manly Council*

advice on and provision of certified photomontages of proposed Major Projects developments in Manly Town Centre.

- *Pittwater Council*

Scenic qualities, landscape resources and visual constraints study, potential rezoning and land swap exercise, Council Works Depot site, Ingleside.

- *Sydney Water*

Review of visual environmental effects for Wongawilli Reservoir proposal, West Dapto, Illawarra.

- *Road Transit Authority*

Review of visual environmental effects for Oak Flats Highway Interchange proposal, Oak Flats to Dunmore section, Princes Highway, Illawarra.

- *Office of Marine Administration and Department of Environment and Planning*

Methodology for assessment of visual issues and design guidelines for the DCP to accompany SREP 22 and 23, Sydney and Middle Harbours and Parramatta River: and Part 5 checklist.

- *Rockdale City Council*

Development control strategy and advice for Draft DCP, Rocky Point Road, Ramsgate.

- *Singleton City Council*

Visual impact assessment of proposed temporary accommodation village, Putty Road, Singleton.

- *Shoalhaven City Council*

East Nowra Local Environmental Study.
Old Erowal Bay visual quality study.
- Visual impacts assessment relating to land swap and rezoning proposals, Milton and Narrawallee.

- *Wingecarribee Shire Council*

Preparation of Development Control Plan No 53 for the siting of buildings in rural zones.

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APPENDIX H

Traffic Impact Assessment Report

TRAFFIC IMPACT ASSESSMENT

FOR

MODIFICATION 5

FOR

PEPPERTREE QUARRY

MARULAN SOUTH ROAD
MARULAN SOUTH

Ref. 18033r

31 August 2018

Prepared By

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Appendix 1 Warrants for Turn Treatments on the Major Road at Unsignalised Intersections

1.0 INTRODUCTION

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) to provide for the following (hereafter referred to as the Project):

- develop a new overburden area (South-west Overburden Emplacement – SWOE);
- extend the consent boundary to the south to encompass the SWOE;
- construct a new haul road from the pit to the SWOE;
- construct a new intersection at Marulan South Road to link the new haul road with the SWOE;
- amend the design of the Western Overburden Emplacement (WOE);
- remove the Western Earth Bund (which has not been constructed); and
- relocate a powerline which runs through the proposed SWOE site.

This will be Modification 5 to the current Project Approval. The Minister for Planning is the consent authority for the proposed modification.

1.2 Structure of this Report

This report has been prepared to assess the traffic impacts associated with Modification 5 and will inform the preparation of the (EA).

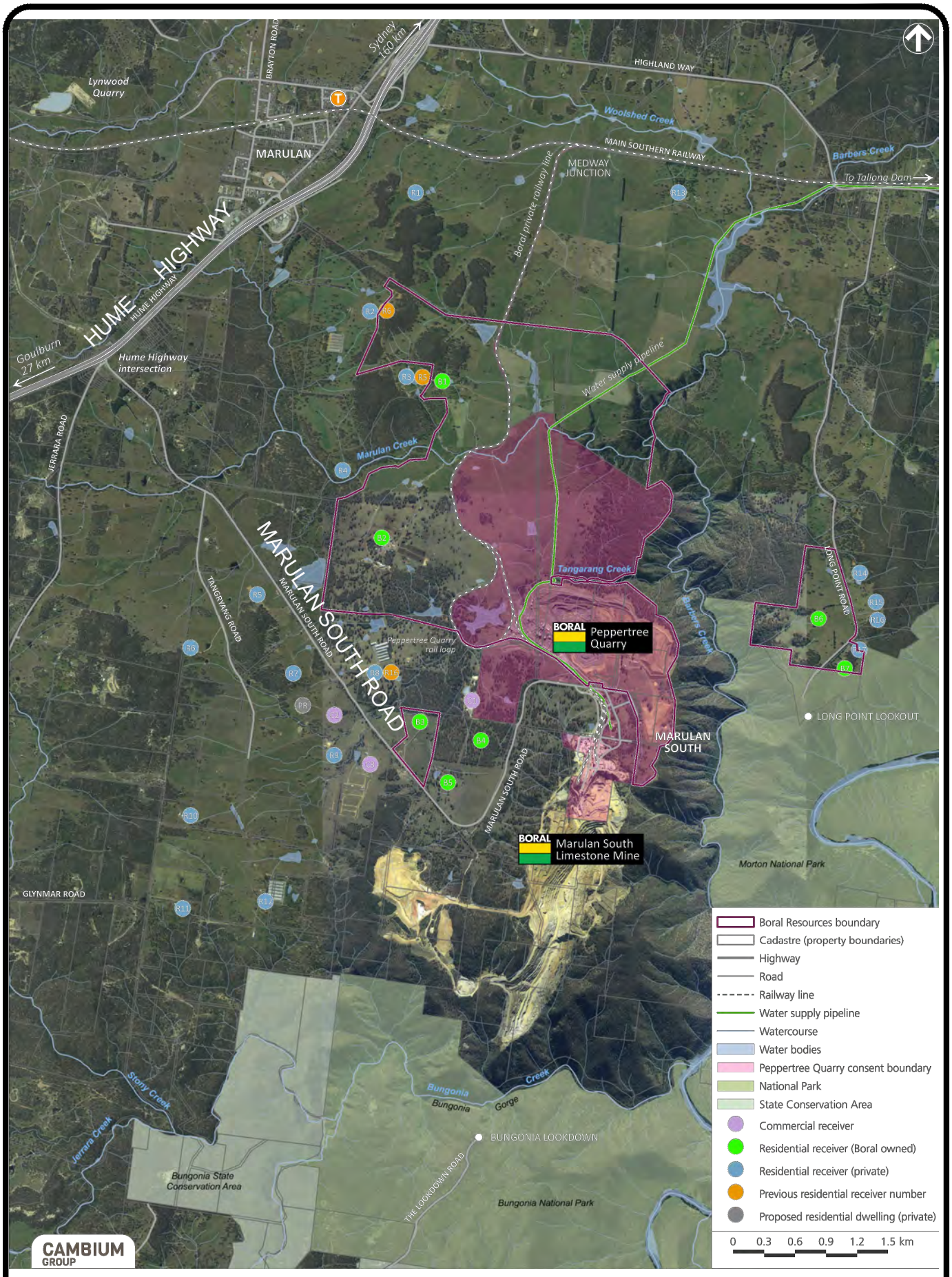
The assessment has been undertaken in accordance with the requirements of Roads and Traffic Authority's now Roads & Maritime Services (RMS) *Guide to Traffic Generating Developments October 2002*.

Other technical standards/publications referenced in this assessment include:

- Austroads Guide to Road Design and RMS supplements.
- Austroads Guide to Traffic Management and RMS supplements.
- Austroads Guide to Traffic Management Part 12. Traffic Impacts of Developments.
- Goulburn Mulwaree Council Development Control Plan (DCP) 2009.
- Goulburn Mulwaree Council's Section 94 Development Contributions Plan 2009 Amendment No. 2.

The remaining sections of this report address the following;

- Section 2 – provides an overview of the existing operations at the Quarry;
- Section 3 – describes the Project;
- Section 4 – evaluates the traffic impacts of Modification 5; and
- Section 5 – presents conclusions.



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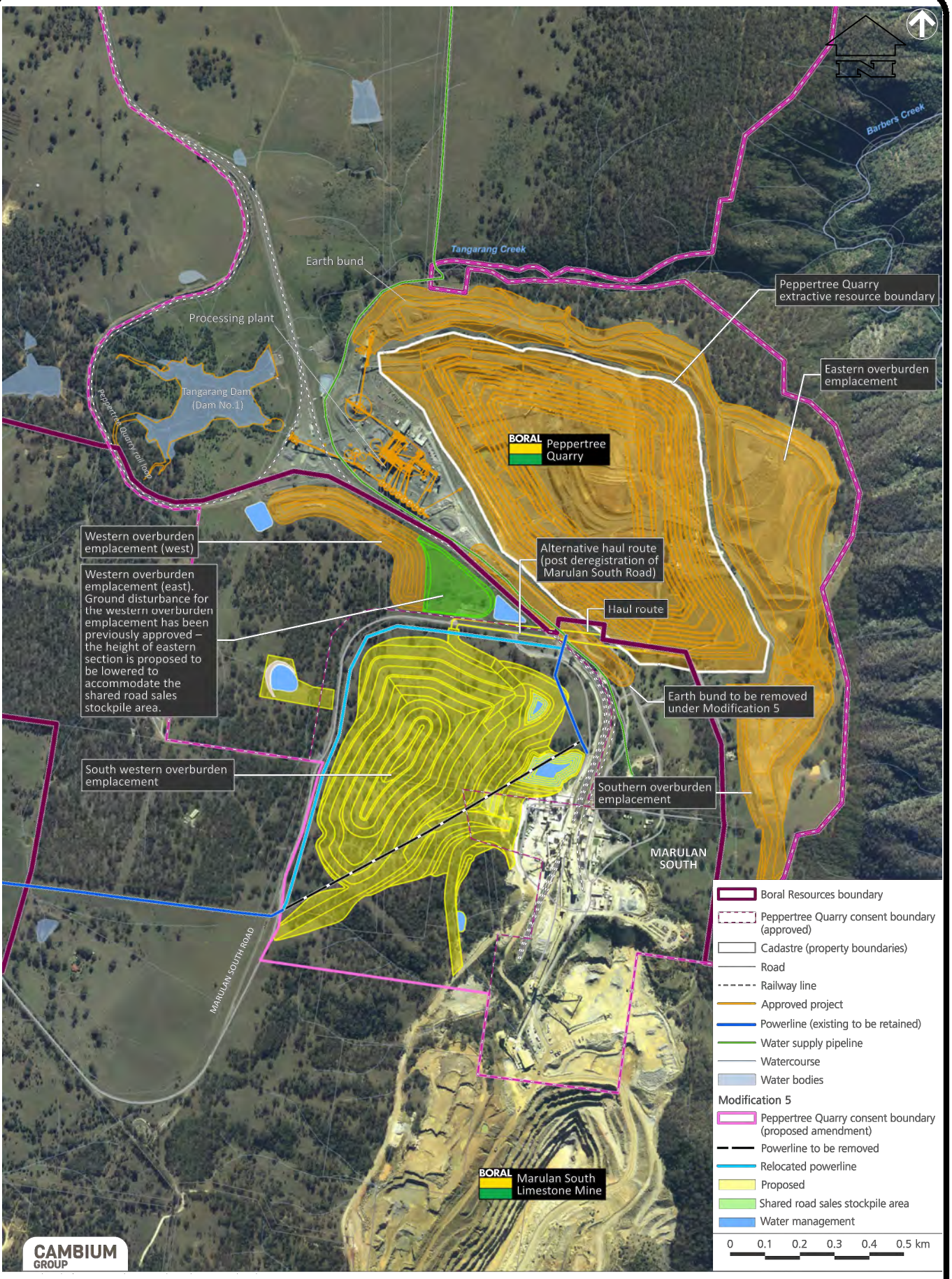
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FIGURE 1

PEPPERTREE QUARRY
MODIFICATION 5

SITE LOCATION

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FIGURE 2

PEPPERTREE QUARRY
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THE PROJECT

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2.0 SITE AND EXISTING APPROVED PROJECT

2.1 Site Description

The Quarry is at Marulan South in the Goulburn Mulwaree Local Government Area (LGA) and is approximately 175 km south-west of Sydney. Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine (the Limestone Mine) with the Hume Highway approximately 9 km to the north-west. Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6 km to the north.

The Quarry is on approximately 650 ha of Boral owned land, which includes the Quarry (occupying approximately 70 ha), additional granodiorite resources to the south and surrounding land. The site is zoned RU1 –- Primary Production under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009. Mining and extractive industries are permissible in this zone with consent.

There is an extensive ground water, surface water and air quality monitoring network around the Quarry and Limestone Mine.

2.2 Approved project

The current operations of the Quarry are approved under Project Approval PA06_0074 as modified.

Quarry Activities and Infrastructure
The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from the Limestone Mine to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities.

Work to establish the quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E.

Operating hours and workforce
The Quarry operates 24 hours, 7 days a week with in-pit activities restricted to the hours of 5 am to 11 pm. Approved operating hours are outlined in detail in **Table 1**.

Table 1: Approved operating hours

Activity	Day	Time
Construction works	Monday to Friday Saturday Sunday and public holidays	7.00 am to 6.00 pm 8.00 am to 1.00 pm None
Topsoil/overburden removal/emplacement	Any day	7.00 am to 7.00 pm
Blasting	Monday to Saturday Sunday and public holidays	9.00 am to 5.00 pm None
In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit)	Any day	5.00 am to 11.00 pm
Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance)	Any day	24 hours

The Quarry employs 30 full time persons distributed over 2-3 shifts.

3.0 PROPOSED MODIFICATIONS

The proposed SWOE will be south of the WOE, south of Marulan South Road and in the north-western corner of the Limestone Mine. This new overburden emplacement area will be needed in late 2018 and will take approximately four years to establish. The emplacement will cover approximately 44 ha and will be RL650 at completion.

A new haul road is proposed to be constructed from the southern extent of the pit to the SWOE. A new intersection is proposed to allow haul trucks to cross Marulan South Road from the new haul road to the SWOE. Alternatively, the haul road will be along an upgraded length of Marulan South Road from the southern extent of the pit to the proposed intersection, if Boral takes ownership of this section of road from council.

The powerline, which supplies electricity to the Limestone Mine, passes through the area where the SWOE is proposed to be constructed. Therefore, Boral proposes to relocate the powerline along the eastern and southern side of Marulan South Road (and adjacent to the western and northern sides of the SWOE) to the intersection with Cooper Crescent, then divert south into the Limestone Mine's infrastructure area.

The powerline will be approximately 1,300 m long and will require an approximately 20 m wide easement along its length.

Part of the WOE is planned for a future shared road sales stockpile area for the Quarry and Limestone Mine, and will be a component of the Limestone Mine's State significant development application. The proposed amendment to the WOE would involve replacing the 30 m high triangular section of the emplacement with approximately 2 m of emplaced overburden material, which once completed would serve as a foundation for the shared road sales stockpile area.

Two sediment dams will be constructed either end of the WOE to catch and treat dirty water until the batters are rehabilitated. sediment dam P2 will also catch clean water from upslope of the WOE. Sediment dam P1 will be approximately 2.1 ML in volume and sediment dam P2 will be approximately 5.8 ML in volume.

The approved Western Earth Bund is a 10 m high bund located to the north of the railway line, south of the Quarry's entrance driveway and extending along the south-western edge of the Quarry pit. This has not been constructed yet, and it is proposed to abandon this component of the project.

The only ground disturbance associated with the modification will be for the SWOE, sediment dams P1 and P2, powerline relocation and new haul road.

4.0 ASSESSMENT OF TRAFFIC IMPACTS

4.1 Background

Boral are negotiating with Goulburn Mulwaree Council regarding the purchase and deregistration of the section of Marulan South Road between the Peppertree Quarry/Limestone Mine and the Aglime Fertiliser facility's access road to the west.

As outlined in Section 4.2, Boral is proposing a new intersection along this section of Marulan South Road. The assessment of the new intersection assumes that the section of Marulan South Road to the east of the Aglime facility's driveway, is still a public road when Modification 5 is approved.

4.2 Proposed New Intersection of Marulan South Road at New Haul Road Crossing

Figure 3 shows the proposed intersection layout for the intersection of the new Haul Road and the SWOE access road with Marulan South Road.

This will be a new cross junction intersection on Marulan South Road located some 310 metres west of the rail level crossing near the entrance to the Limestone Mine and 175 metres west of the truck access road to the Limestone Mine.

The intersection will be located at/near the change of the speed limit between 60km/h and 80km/h. If this section of Marulan South Road is to remain a public road, then it is recommended that the 60km/h speed limit that applies in the old Marulan South village, be extended 200 metres to the west, so that the new intersection is located in the 60km/h speed limit area.

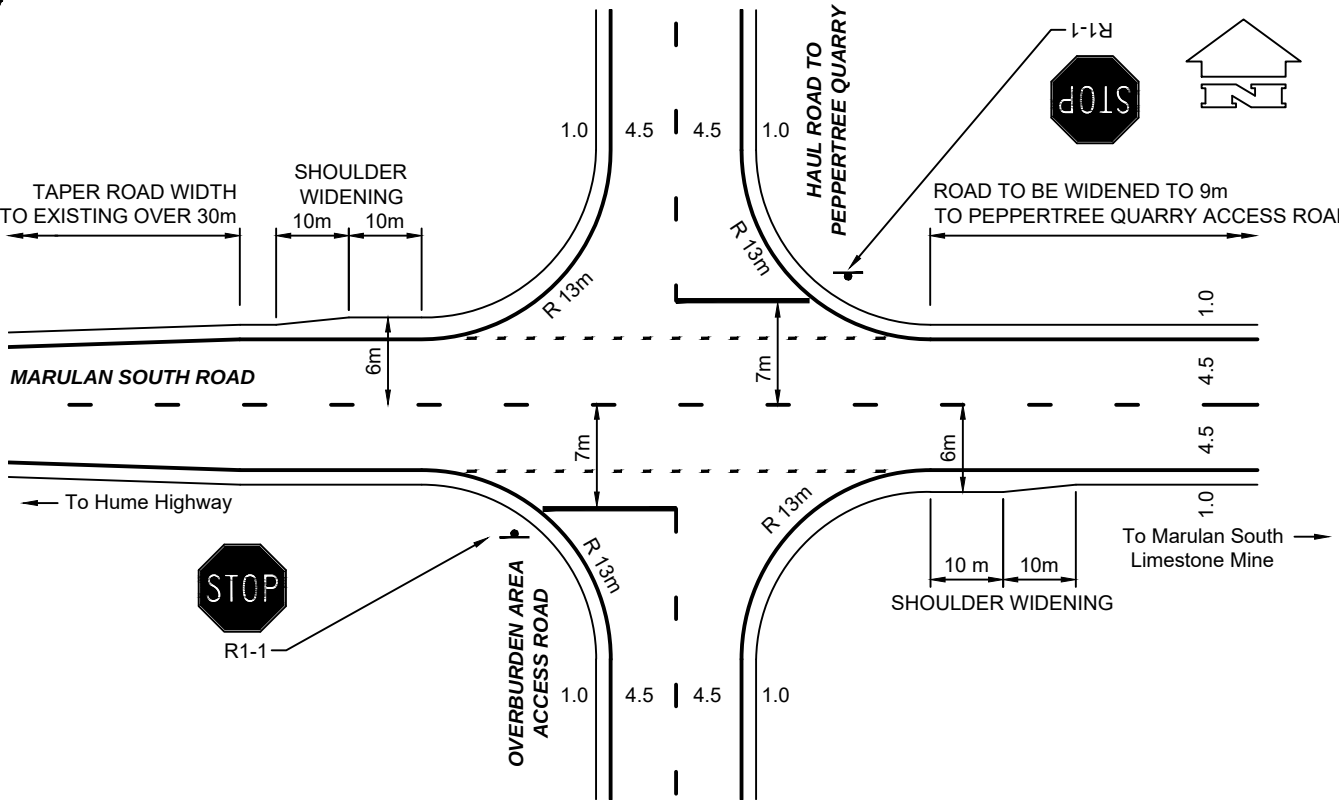
The intersection will be designed with suitable geometry including wider road pavement on Marulan South Road to cater for the wider trucks that will transport the overburden from Peppertree Quarry to the SWOE.

Trucks hauling overburden from the Peppertree Quarry pit to the SWOE, will travel along one of two routes:

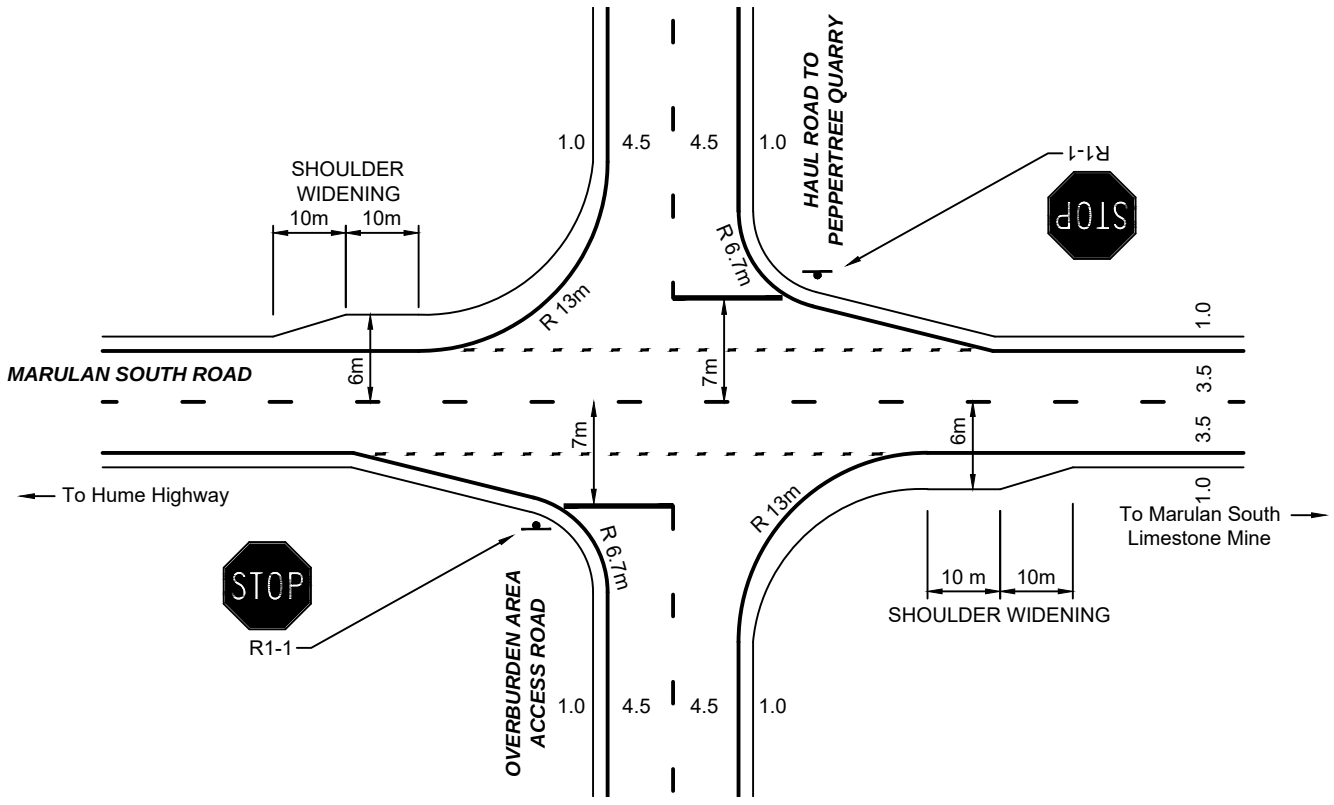
(i) Along Marulan South Road to and from the east with the overburden trucks turning left into the SWOE access road and right out of the SWOE access road.

(ii) From the new Haul Road into the SWOE access road and vice versa as a cross movement across Marulan South Road.

Two options are proposed for the intersection design based on the haul route from Peppertree Quarry to the SWOE.



SCENARIO 1
MARULAN SOUTH ROAD WIDENED TO 9m
FROM INTERSECTION TO PEPPERTREE QUARRY ACCESS ROAD



SCENARIO 2
MARULAN SOUTH ROAD TO REMAIN 7m WIDE

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FIGURE 3

PEPPERTREE QUARRY MODIFICATION 5
CONCEPT LAYOUT OF PROPOSED INTERSECTION OF MARULAN SOUTH RD, NEW HAUL ROAD & OVERBURDEN AREA ACCESS ROAD
JOB NO.18033

4.3 Traffic Impacts of New Haul Road Intersection at Marulan South Road

The traffic volumes using the intersection will consist of:

(i) The existing traffic generated by the Limestone Mine and Peppertree Quarry travelling between the sites and the Hume Highway;

(ii) Boral's internal heavy vehicle movements generated by overburden removal from the Peppertree Quarry pit and emplacement at the proposed SWOE; and

(iii) Traffic associated with the Limestone Mine's forthcoming development application including the future shared road sales stockpile area.

Peppertree Quarry's development approval allows for topsoil/overburden removal and emplacement, 7 days a week between 7am-7pm (i.e. 12 hours a day). A total of 28 haul trucks per hour will be generated by the transport of the overburden material to the SWOE. (i.e. 28 truck movements in each direction).

Figure 4 shows the estimated traffic generated by the above truck movements for the following two scenarios.

1. The overburden trucks travelling along Marulan South Road to and from Peppertree Quarry to the east; and

2. The overburden trucks travelling along internal Peppertree Quarry haul roads, crossing Marulan South Road using the new intersection and access road to the SWOE.

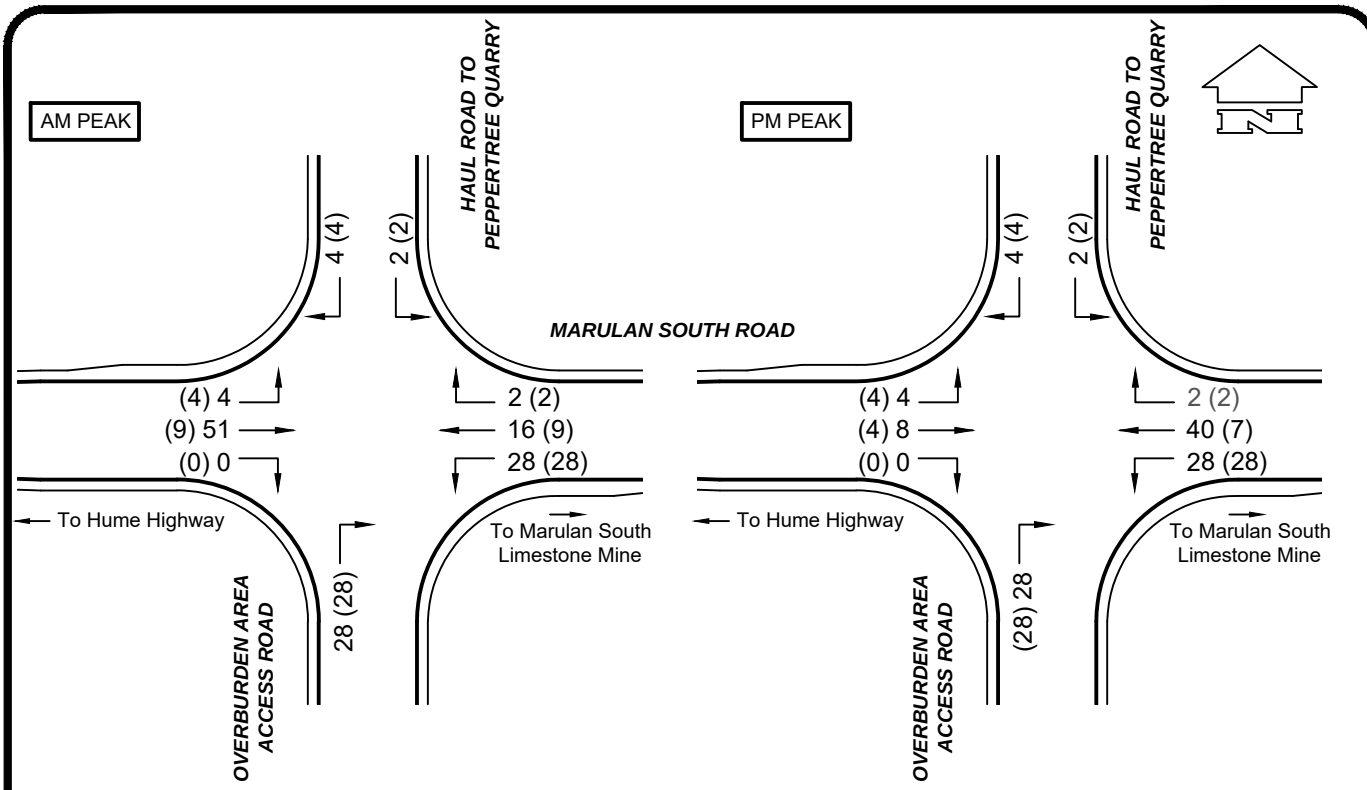
Also included in **Figure 4** are the other light and heavy vehicles estimated to use the intersection in the AM and PM peak hours, including vehicles that will access the proposed road sales stockpile area which will be developed by the Limestone Mine.

Austroads Guide to Road Design – Part 4A Unsignalised and Signalised intersections provide guidance on the warrants for turn treatments on a major road at unsignalised intersections. **Figure 4.9** of the above document which is included in **Appendix 1** shows that for an intersection where the design speed is less than 100km/h, a left turn movement of 28vph (which is the highest turning volume at the intersection) the major road through volume either in the same direction or the opposing direction would need to be equal to or greater than 250vph, for the warrant to be met for the provision of an auxiliary lane for right or left turn movements.

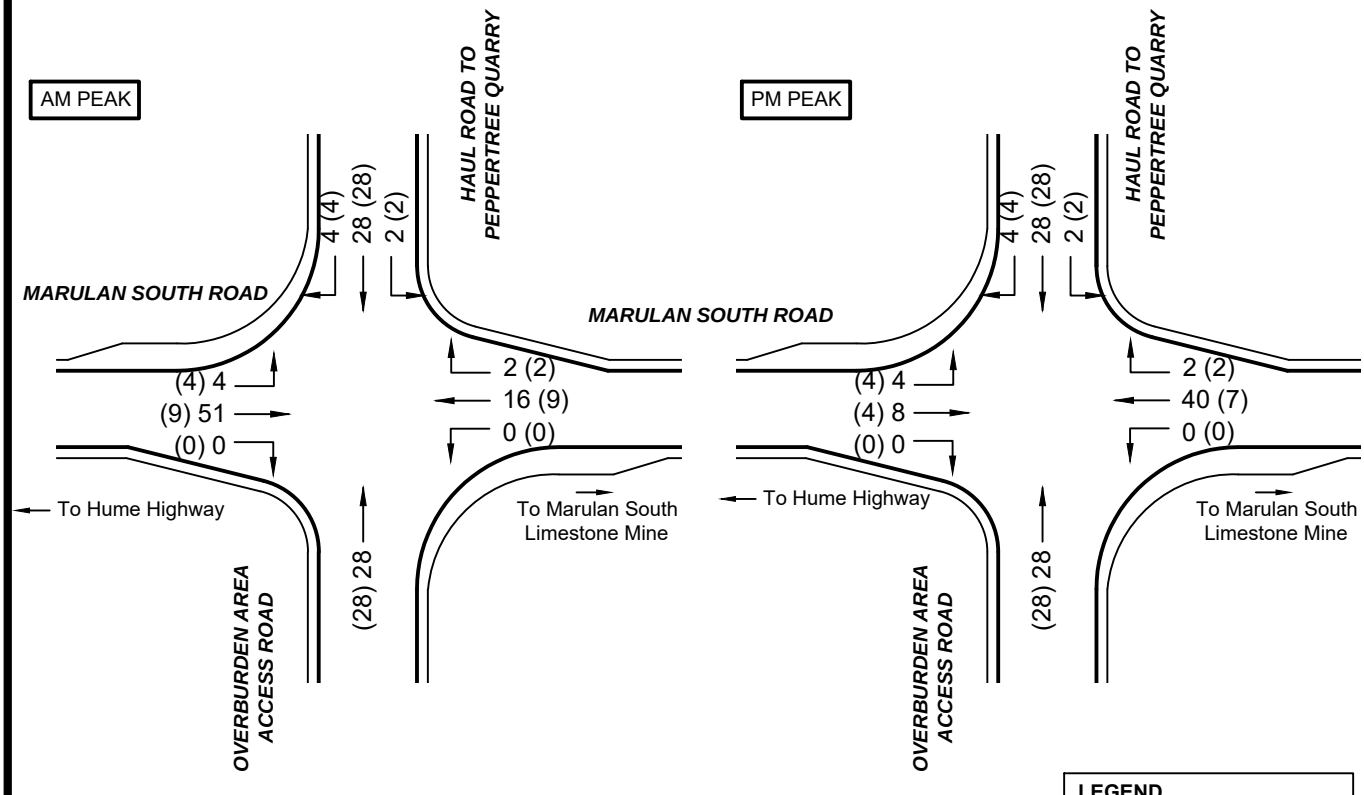
The overall approach volumes using Marulan South Road in each direction are significantly less than this threshold of 250vph and therefore the provision of auxiliary lanes in Marulan South Road to cater for turning movements at the proposed intersection is not warranted.

To examine the likely delays at the proposed intersection, SIDRA traffic modelling has been undertaken using the traffic volumes shown in **Figure 4.**

The modelling has assumed the geometry shown on **Figure 3** with single lane approaches for each leg of the intersection based on a wider lane width to cater for the oversize vehicles. Stop Sign control has been provided on the overburden access road and the new haul road and increased (larger) gap acceptance times due to the proportion of heavy vehicles using the intersection.



SCENARIO 1
MARULAN SOUTH ROAD WIDENED TO 9m
FROM INTERSECTION TO PEPPERTREE QUARRY ACCESS ROAD



SCENARIO 2
MARULAN SOUTH ROAD TO REMAIN 7m WIDE

LEGEND

4	TOTAL VEHICLES
(4)	HEAVY VEHICLES

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FIGURE 4

PEPPERTREE QUARRY MODIFICATION 5

FUTURE PEAK HOUR TRAFFIC VOLUMES
AT INTERSECTION OF MARULAN SOUTH RD, NEW HAUL ROAD & OVERBURDEN AREA ACCESS ROAD
JOB NO.18033

The results of the modelling are shown in Table 4.1 show that the intersection would have a good operation in both peak hours for both scenarios. RMS Guidelines indicate a Level of Service D or better (i.e. A, B, C or D) is the desirable criteria for intersections.

For Scenario 1, with the overburden trucks travelling to and from the east along Marulan South Road, the intersection would operate at a Level of Service A with low delays to all movements. Vehicle delays for the minor access roads controlled by the Stop sign were 12.2 seconds or less per vehicle indicating relatively low delays.

For Scenario 2, with the overburden trucks crossing over Marulan South Road and using both the new haul road and SWOE access roads, the intersection will also operate at a Level of Service A (good operation) with low vehicle delays for all movements at the intersection. Vehicle delays for minor access roads controlled by the Stop signs would be around 13.1 seconds per vehicle

TABLE 4.1

SIDRA MODELLING RESULTS FOR INTERSECTION OF MARULAN SOUTH ROAD/NEW HAUL ROAD/OVERBURDEN ACCESS ROAD IN AM AND PM PEAK HOURS WITH STOP SIGN CONTROL

	Scenario 1		Scenario 2	
	AM	**PM**	**AM**	**PM**
LS	A	A	A	A
AVD (sec)	4.8	5.2	5.7	6.1
HMD (sec)	12.2	11.3	11.3 (13.1)	10.5 (12.5)

Where: LS – Level of Service
AVD – Average Vehicle Delay in seconds for all vehicles using intersection
HMD – Highest Movement Delay in seconds for any movement at the intersection

Scenario 1 – Overburden trucks use Marulan South Road east of intersection
Scenario 2 – Overburden trucks use New Haul Road
11.3 (13.1) – HMD in seconds for cross movement and for right turn out of New Haul Road

Geometric Considerations

In terms of sight distance, the intersection will be designed to comply with Austroad requirements. Available sight distance to and from the intersection along Marulan South Road will be a minimum of 200 metres to the west (i.e. to the curve) and 250 metres to the east.

Austroad's Safe Intersection Sight Distance for a design speed of 60km/h is 113 to 121 metres depending on a 2.0 second or a 2.5 second reaction time.

Therefore, the intersection will have satisfactory sight distance.

As noted previously, it is recommended that the existing 60km/h speed limit in the vicinity of the mine entrance and old Marulan South village be extended and relocated 200 metres to the west along Marulan South Road, if the intersection is constructed and operational while this section of Marulan South Road remains a public road. If Marulan South Road is purchased, deregistered and under Boral's control, it is also recommended that the speed limit for this section of road be reduced to 60km/h.

4.3 Future Intersection Treatment Option of Traffic Signals

In the event that the section of Marulan South Road from the Aglime facility's driveway eastwards, becomes a private road under the control of Boral (i.e. deproclaimed/deregistered as a public road), Boral may decide to provide traffic signal control of the intersection to ensure safety is maximised for vehicles using the intersection and its workforce.

The design volumes shown in **Figure 4** indicate that single lane approaches and departures would be sufficient to cater for the estimated vehicles using the intersection. Also a simple two phase operation with Marulan South Road operating in one phase (i.e. A phase) and the Haul Road/Overburden Access Road operating the second phase (i.e. B phase) would safely accommodate vehicle movements at the intersection.

The traffic signals being located on private roads could either be vehicle activated (i.e. have detectors in each approach) or operate as fixed time, with preset phase times and the type of operation could be determined at design stage.

As noted above, single lane approach and departures would be adequate. The intersection layout would be determined by the size of the vehicles using the intersection and their turning requirement.

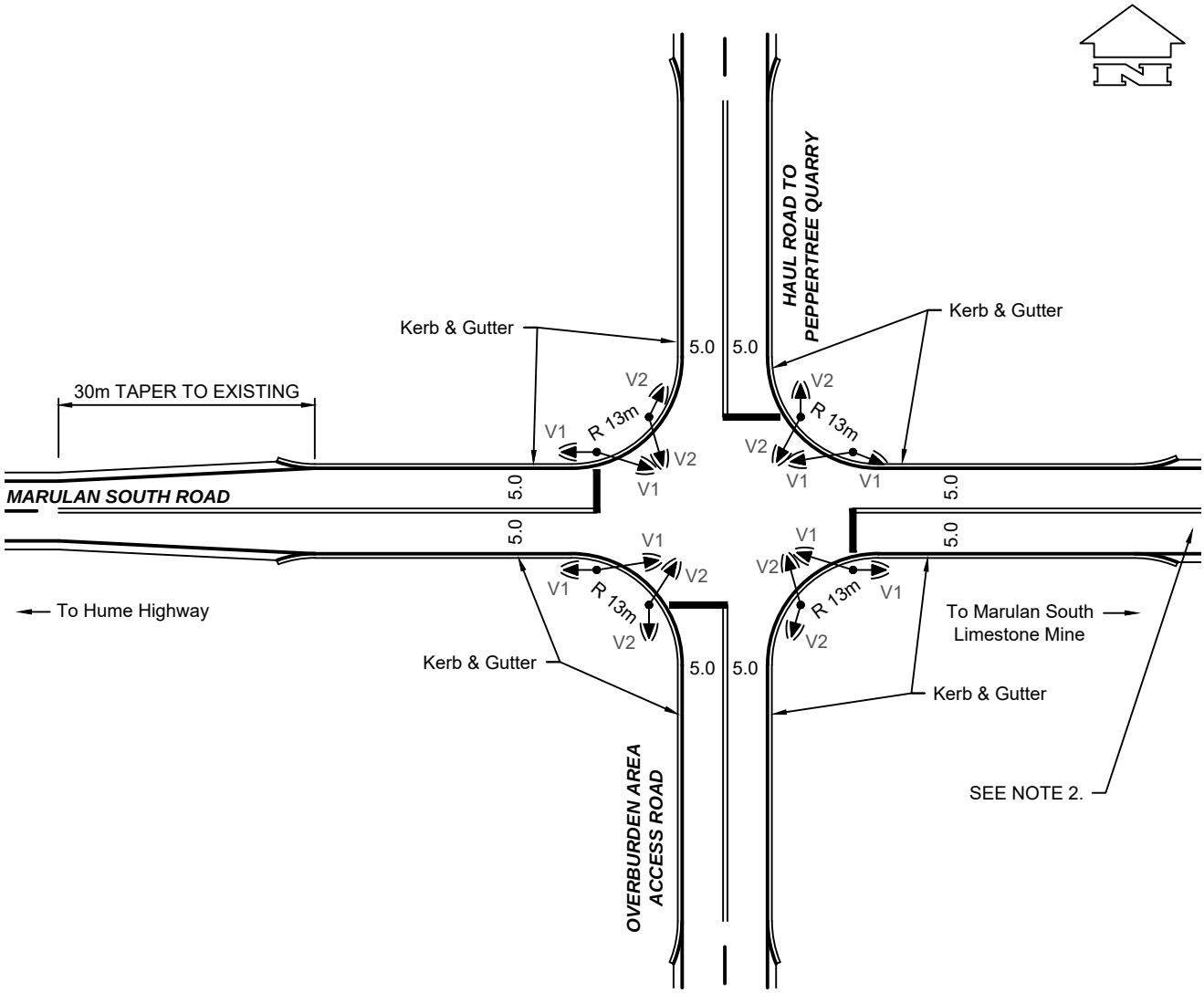
No pedestrian crossing facilities would be required.

A concept layout for the intersection under traffic signal control is shown in **Figure 5**. This layout would suit Scenario 2 where the haul trucks cross Marulan South Road from the Haul Road to the Overburden Access Road and vice versa. However, the intersection could also cater for Scenario 1 where the haul trucks use Marulan South Road east of the intersection and turn left into and right out of the SWOE Access Road.

To examine the operation of the intersection under traffic signal control, SIDRA traffic modelling has been undertaken using the future AM and PM traffic volumes shown for Scenario 2 on **Figure 4**. A cycle length of 45 seconds was adopted, together with fixed phase times for each phase, due to the number of heavy vehicles.

The results of the modelling are shown in Table 4.2 and indicate that the intersection would operate at a good Level of Service (Level of Service A operation) under traffic signal control with average vehicle delays in the order of 11.6 seconds to 13.5 seconds per vehicle for both Scenario 1 and Scenario 2. The low degree of saturation (DS) for all the models indicates that the intersection has plenty of spare capacity.

Therefore, future traffic signal control is a suitable option for the traffic management at this intersection, if Marulan South Road becomes a private road.



NOTES:

1. Kerb & gutter to be provided for 30m on all legs of intersection.

2. Marulan South Road to be widened to 9m east of intersection and existing vehicle access to Peppertree Quarry if overburden haul trucks use this section of Marulan South Road (ie Scenario 1).

3. Mast arm posts may be required for primary lanterns subject to height of trucks.

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FIGURE 5

PEPPERTREE QUARRY MODIFICATION 5

CONCEPT LAYOUT OF PROPOSED INTERSECTION OF MARULAN SOUTH RD, NEW HAUL ROAD & OVERBURDEN AREA ACCESS ROAD FOR TRAFFIC SIGNALS

JOB NO.18033

TABLE 4.2

SIDRA MODELLING RESULTS FOR INTERSECTION OF MARULAN SOUTH ROAD/NEW HAUL ROAD/SWOE ACCESS ROAD IN AM AND PM PEAK HOURS WITH TRAFFIC SIGNAL CONTROL

	Scenario 1		Scenario 2	
	AM	PM	AM	PM
LS	A	A	A	A
AVD (sec)	12.9	13.5	11.6	11.9
DS	0.104	0.125	0.104	0.104

Where: LS – Level of Service
AVD – Average Vehicle Delay in seconds for all vehicles using intersection
DS – Degree of saturation

Scenario 1 – Overburden trucks use Marulan South Road east of intersection
Scenario 2 – Overburden trucks use New Haul Road

5.0 CONCLUSIONS

Modification 5 for Peppertree Quarry has very minor traffic impacts associated with the construction of a new intersection in Marulan South Road, just west of the railway line crossing near the entrance of the Quarry and the Limestone Mine.

The new cross junction intersection will connect a proposed new haul road between the pit of Peppertree Quarry and the SWOE which will be south of Marulan South Road.

Two conceptual design options have been developed for the intersection with Stop Sign control on the new haul road and the SWOE Access Road. It is recommended that the speed limit in Marulan South Road at the intersection be reduced to 60km/h, if this section of Marulan South Road remains a public road.

The assessment has found that the future use of this Stop Sign controlled intersection by trucks travelling between the SWOE and the pit at Peppertree Quarry, together with other vehicles using Marulan South Road at the intersection will have relatively minor impacts. The intersection will have a Level of Service A operation, which represents a good operation.

In the event that Marulan South Road becomes a private road, Boral may, at a future time, install traffic signals at the cross junction intersection. Analysis of the intersection's operation under traffic signal control shows that the intersection would have a good operation, if this option is adopted.

REFERENCES

1. Austroads Guide to Road Design

2. Austroads Guide to Road Safety – Version 1 December 2010

3. Austroads Guide to Traffic Management including Part 12. Traffic Impacts of Development

4. RTA (now RMS) Austroads Guide Supplements – Austroads Guide to Traffic Management – January 2011

5. RTA (now RMS) Supplement to Austroads Guide to Road Design Parts 1-5, 6 and 8

6. RMS Supplements to Austroads Guide to Road Safety

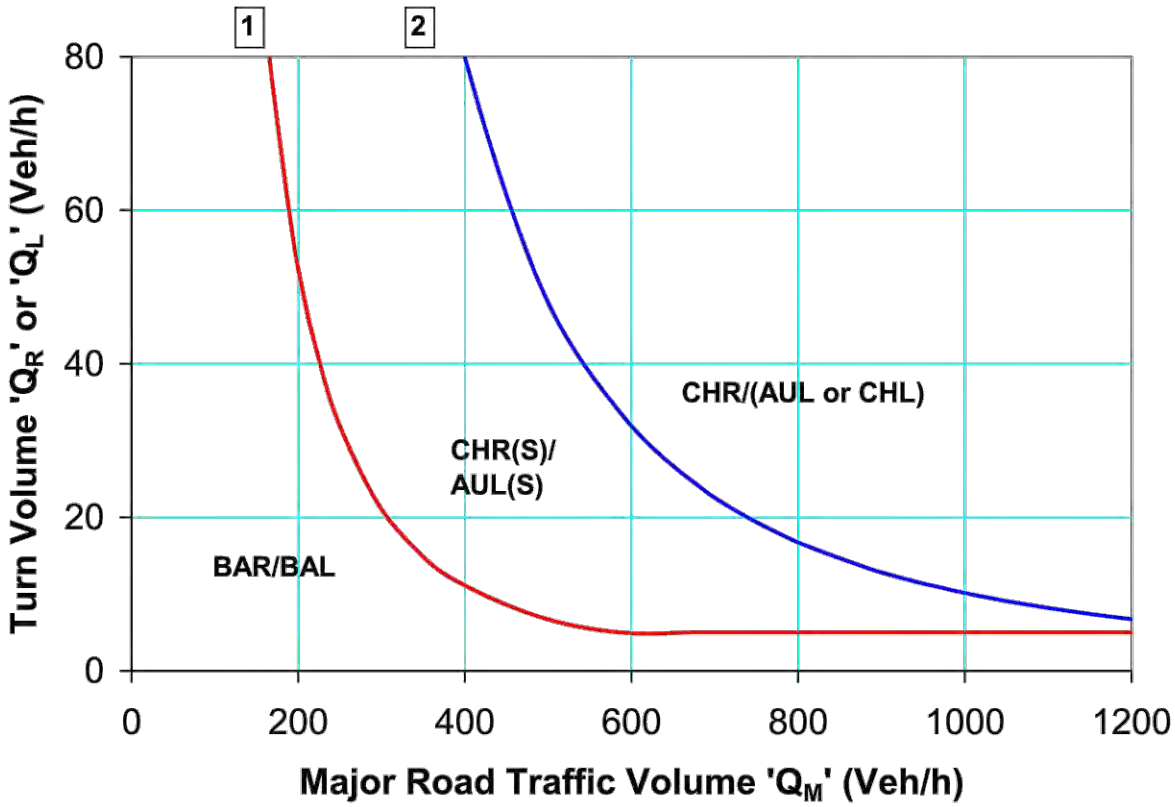
7. RTA (now RMS) Guide to Traffic Generating Developments October 2002

8. Goulburn Mulwaree Council Development Control Plan

9. Goulburn Mulwaree Council Section 94 Development Contributions Plan 2009 Amendments No. 2

APPENDIX 1

WARRANTS FOR TURN TREATMENTS ON THE MAJOR ROAD AT UNSIGNALISED INTERSECTIONS



Design Speed < 100 km/h

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APPENDIX 1

PEPPERTREE QUARRY MODIFICATION 5
WARRANTS FOR TURN TREATMENTS ON THE MAJOR ROAD AT UNSIGNALISED INTERSECTIONS
JOB NO.18033