11 February 2022

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Jessie Evans
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Department of Planning and Environment

via email: jessie.evans@planning.nsw.gov.au

Dear Jessie,

RE: DENDROBIUM MINE MODIFICATION – GAS MANAGEMENT INFRASTRUCTURE MODIFICATION REPORT

We refer to our previous correspondence regarding the Dendrobium Mine Gas Management Infrastructure Modification (the Modification). This document is a Modification Report for the proposed Modification.

Overview

- Illawarra Coal Holdings Pty Ltd (IMC) is the proponent of the Dendrobium Mine that was approved under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) in 2001 (Development Consent DA 60-03-2001).
- The Project is an underground coal mine situated in the Southern Coalfield of New South Wales (NSW) approximately 8 kilometres (km) west of Wollongong.
- IMC proposes a modification to Development Consent (DA 60-03-2001) under section 4.55(1A) of the EP&A Act to allow the development of additional gas management infrastructure at the Dendrobium Mine.
- The additional gas management infrastructure would be developed in an area previously cleared for the Dendrobium No. 2 and 3 shafts and would allow the continuation of mining at the Dendrobium Mine at the existing production rate, allowing the existing employment, royalties and other benefits to continue.
- In consideration of the assessment of impacts in this Modification Report, the Modification would involve minimal environmental impact as defined under section 4.55(1A) of the EP&A Act.
- In weighing up the main environmental impacts (costs and benefits) assessed and described in this Modification Report, the Modification is, on balance, considered to be in the public interest of the State of NSW.

1 INTRODUCTION

The Dendrobium Mine is an underground coal mine situated in the Southern Coalfield of New South Wales (NSW) approximately 8 kilometres (km) west of Wollongong (Figure 1).

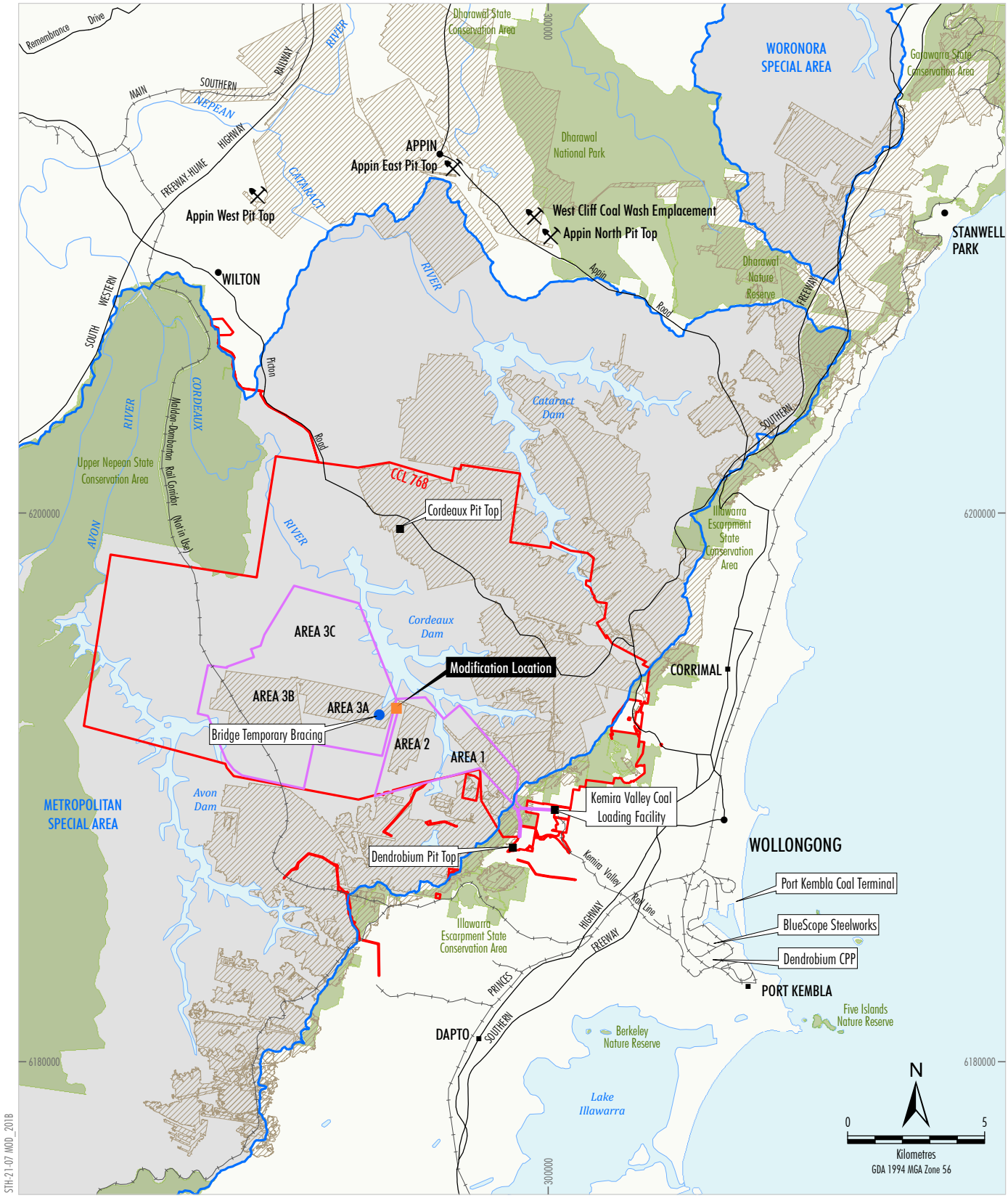
Illawarra Coal Holdings Pty Ltd (Illawarra Metallurgical Coal [IMC]), a wholly owned subsidiary of South32, is the owner and operator of the Dendrobium Mine. IMC is proposing a modification of the Dendrobium Mine Development Consent DA 60-03-2001 (the Modification) to allow the development of additional gas management infrastructure at the Dendrobium Mine. The purpose of this Modification Report is to provide a detailed description of the Modification and to provide a statement of the resulting potential environmental effects.

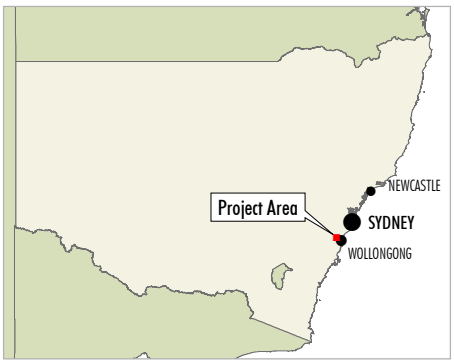
The Dendrobium Mine currently extracts from the Wongawilli Seam within Consolidated Coal Lease (CCL) 768 using underground longwall mining methods. The Dendrobium Mine primarily produces metallurgical coal for steelmaking and has an approved operational capacity of up to 5.2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 31 December 2030 under Development Consent DA 60-03-2001. The existing operations at the Dendrobium Mine are also undertaken in accordance with the Approval Decision (EPBC 2001/214) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Dendrobium Mine has an Environmental Management Strategy that provides a framework to allow the operation to be conducted in an environmentally responsible manner and in accordance with relevant statutory requirements.

Key surface facilities at the Dendrobium Mine include the (Figure 1):

- Dendrobium No. 1, 2, and 3 Shafts (i.e. ventilation shafts);
- Dendrobium Pit Top;
- Kemira Valley Coal Loading Facility;
- Kemira Valley Rail Line;
- Dendrobium Coal Preparation Plant (DCPP) located at Port Kembla; and
- West Cliff Stage 3 Coal Wash Emplacement.





LEGEND

- Dendrobium Mining Lease
- Road
- Railway
- National Park, Nature Reserve and State Conservation Area
- Historic Mine Workings
- Declared Catchment Area
- Dendrobium Underground Mining Area - Existing Mine (DA 60-03-2001)

Source: Geoscience Australia (2006); Department of Industry (2018); Department Finance, Services & Innovation (2018)

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DENDROBIUM MINE

Regional Location

Figure 1

2 STRATEGIC CONTEXT

Dendrobium Mine is located within the Wollongong, Wingecarribee and Wollondilly Local Government Areas. The underground mining areas are located within the catchments of the Avon and Cordeaux Rivers, which are part of Greater Sydney's water supply system. These catchments are included within the Metropolitan Special Area (a WaterNSW Special Area) declared under the *Water NSW Act 2014*. There has been a long history of underground longwall coal mining in these water catchments.

IMC is planning the extraction of approved longwall (LW) blocks LW21, and the proposed LW22 and LW23 in Area 3C of the Dendrobium Mine (Figure 1). The forecast gas quantities in Area 3C exceed the dilution capacity of the ventilation circuit, necessitating the capture and reticulation of post-drainage gas through new gas management infrastructure, instead of through the ventilation infrastructure as currently occurs. The infrastructure would also be used for pre-drainage of other LW blocks within the Area 3C domain and potentially for the Dendrobium Mine Extension Project (State Significant Infrastructure [SSI]-33143123), if approved.

The Modification would allow the development of additional gas management infrastructure at the Dendrobium Mine. The additional gas management infrastructure will allow the continuation of operations into Area 3C. As the Modification would allow for flaring of some of the gas, thus converting some methane into carbon dioxide (CO_2), greenhouse gas emissions associated with mining operations at Dendrobium Mine would be reduced by implementing the additional gas management infrastructure when compared to current venting of greenhouse gases.

IMC has considered several alternatives to the Modification to manage gas whilst achieving planned production rates.

1. Pre-drainage of all sources likely to contribute to gas make ahead of longwall extraction (elimination of the hazard by removing the gas).
2. Maximise ventilation such that all likely gas production rates are diluted to safe levels (elimination of the hazard by dilution to safe concentrations).
3. Implementation of a post-drainage programme that provides an alternate pathway for some of the gas such that it is directed to a gas drainage range rather than mine ventilation (substitution of the hazard for a lower gas make in the mine ventilation).
4. Allow return roadways to run at high gas concentrations and prevent access to these roadways (isolation of the hazard to an area with no access). This has been utilised to some extent regarding CO_2, where return roadways are designed based on the short-term exposure limit rather than a time weighted average. However, the explosive nature of methane means that such an approach when dealing with methane is not appropriate.

Of these potential solutions, only the two 'substitution' solutions (2 and 3) are considered viable by IMC, and only option 3 is viable to deliver planned production rates. Option 3 (i.e. a post-drainage programme) is proposed for the Modification as it provides the lowest risk practically achievable. The infrastructure is required to be installed and commissioned prior to the commencement of longwall mining in LW22, which is anticipated in mid-2023 and would be used until the completion of mining in Area 3C. In addition, the same gas management infrastructure may be used to assist to pre-drain LW blocks for the Dendrobium Mine Extension Project (State Significant Infrastructure [SSI]-33143123), if approved.

In addition, consideration was given to using the gas for power generation using a gas turbine rather than a flare. IMC has a good understanding of the unique challenges associated with power generation using mine waste gas from the Appin-Tower Power Project at IMC's Appin Mine. In consideration of this, power generation is not proposed as part of the Modification as it would:

- result in a much larger Modification footprint and associated complexity in managing the impacts of a larger construction area;
- result in a heavy industrial activity within the catchment with a requirement for a range of associated infrastructure such as electricity transmissions lines and substations;
- require continuous operators/supervision/access, which is not required for flaring; and
- not be viable due to short duration of gas (i.e. Area 3C is a relatively small mining area and the gas contains areas of CO_2, which cannot be used for power generation).

It is noted that IMC is preparing an Environmental Impacts Statement (EIS) for the Dendrobium Extension Project (SSI-33143123). At the time of writing, Secretary's Environmental Assessment Requirements have been issued for this project and IMC intends to submit the EIS in the first quarter of 2022. As a determination of this project is not expected until late 2022, when construction of the Modification would be nearing substantial completion, cumulative impacts between the Modification construction and the Dendrobium Extension Project are not expected to be material.

3 DESCRIPTION OF THE MODIFICATION

Overview

The Modification would involve (Figures 2 and 3):

- Construction of new gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre-drainage gas from Area 3C at the site of the existing Dendrobium No. 2 and 3 Shafts.
- Gas extraction from the underground mine via a borehole and vacuum pump, with associated infrastructure including a cooling water system incorporating cooling towers.
- Gas treatment using an enclosed flare on the surface. Under conditions not suitable for flaring, gasses would alternatively be vented via a stack approximately 25 metres (m) high.
- Ancillary infrastructure, such as fencing, pumps, CO_2 tanks, condensate tanks and surface pipes.
- Additional water management infrastructure (e.g. sediment controls).
- Process/fire water system, including bores to pump water from and return water to the underground mine workings and pipes/tanks to convey and store this water.
- Installation and use of a transportable substation for electricity requirements.
- Upgrade of the three surface ventilation fans at the gas plant construction site, including upgraded fan impellers, shafts, drives and motors within the existing footprint.
- Minor upgrades of existing electricity transmission infrastructure, such as replacement poles and aerial conductors within Mining Lease (ML) 1566.
- Temporary bracing of the 2-span Bailey bridge that is on the access trail (Sandy Creek crossing) using props at regular spacing to support the bridge's structure if heavy loads are to be transported across the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).

Once constructed, the gas infrastructure may also receive gas from Area 5, should it be approved as part of SSI-33143123.

The Modification would involve no change to:

- Approved LW mining.
- Surface disturbance outside of ML 1566 (i.e. the temporary bridge bracing would not require vegetation disturbance).
- Mine life, mining activities or other surface activities associated with the approved Dendrobium Mine.
- The quantity of gas required to be managed for the approved Dendrobium Mine.
- Groundwater take associated with the underground mine.

The Modification would involve no material change to employment numbers at the Dendrobium Mine.

STH-21-07 MOD_202Cmxd

Source: Geoscience Australia (2006); Department of Industry (2018); Department Finance, Services & Innovation (2018); South32 (2021)

LEGEND

- Mining Lease (ML 1566)
- Modification Component Indicative Location
- Area to be Cleared
- Asset Protection Zone - Vegetation Management
- Vegetation Management

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DENDROBIUM MINE

Dendrobium - Gas Management Infrastructure General Arrangement

Figure 2

STH-21-07 MOD_203B

Source: Geoscience Australia (2006); Department of Industry (2018); Department Finance, Services & Innovation (2018); South32 (2021) Orthophoto: Google Earth (2009)

LEGEND

- Mining Lease (ML 1566)
- Modification Component Indicative Location
- Area to be Cleared
- Asset Protection Zone - Vegetation Management
- Vegetation Management

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DENDROBIUM MINE

Dendrobium - Gas Management Infrastructure General Arrangement (2009 Background Photo)

Figure 3

It should be noted that:

- All construction activities and infrastructure would be located wholly within the previously approved and previously cleared area associated with Dendrobium No. 2 and 3 Shafts (Figure 3).
- Clearance of vegetation (and management of vegetation for bushfire control purposes) is required within areas of revegetation (i.e. revegetation that has occurred following the approved clearance activities to establish the existing ventilation shaft infrastructure).

To date, DA 60-03-2001 has been modified on eight occasions. Table 1 provides a summary comparison of the approved Dendrobium Mine (as modified) and the Modification.

Table 1
Comparison of the Approved Dendrobium Mine and Modified Project

Project Component	Approved Dendrobium Mine (DA 60-03-2001)	Modified Project
Mine Life	Until 31 December 2030.	No change.
Mining Method	Underground extraction using longwall mining methods.	No change.
Resource	Mining of the Wongawilli Seam in Areas 1, 2, 3A, 3B and 3C within CCL 768.	No change.
Annual Production	Handling and processing of up to 5.2 Mtpa of ROM coal.	No change.
Coal Handling and Processing	Transport of coal from underground workings to the Kemira Valley Coal Loading Facility via an underground conveyor network. Sizing and stockpiling of coal at the Kemira Valley Coal Loading Facility prior to transport to the Dendrobium CPP via the Kemira Valley Rail Line, in accordance with the approved hours of operation. Processing of up to 5.2 Mtpa of sized ROM coal at the Dendrobium CPP.	No change.
Management of Mining Waste	Transportation of up to approximately 1.1 Mtpa of coal wash by road from the Dendrobium CPP to the West Cliff Stage 3 and Stage 4 Coal Wash Emplacement. Development and rehabilitation of the West Cliff Stage 3 Coal Wash Emplacement. Supply of coal wash to customers for engineering purposes (e.g. civil construction fill) or for other beneficial uses.	No change.
General Infrastructure	• Dendrobium Pit Top. • Kemira Valley Coal Loading Facility. • Kemira Valley Rail Line. • Dendrobium CPP. • Dendrobium Shafts No. 1, 2 and 3. • West Cliff Stage 3 Coal Wash Emplacement.	New gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre-drainage gas from Area 3C at the site of the existing Dendrobium No. 2 and 3 Shafts.
Product Transport	Delivery of product coal from the Dendrobium CPP to the BlueScope Port Kembla Steelworks or to Port Kembla Coal Terminal for transport to Liberty Primary Steel Whyalla Steelworks or for export.	No change.

Table 1 (Continued)
Comparison of the Approved Dendrobium Mine and Modified Project

Project Component	Approved Dendrobium Mine (DA 60-03-2001)	Modified Project
Water Management	Water management infrastructure to separate clean, oily and dirty water. Use of a combination of recycled treated mine water and potable water purchased from Sydney Water in underground and surface operations. Release of water in accordance with the conditions of EPL 3241.	Additional water management infrastructure (e.g. sediment controls).
Workforce	Current workforce of approximately 400 personnel (including South32 staff and on-site contractor personnel).	30 additional workers would be required for construction of the additional infrastructure. The Modification would increase the operational workforce by 1 person (note: this person would generally not be based on site, however, would visit approximately daily).
Hours of Operation	Operated on a continuous basis, 24 hours per day, seven days per week. Trains do not travel on the Kemira Valley Rail Line between 11.00 pm and 6.00 am, unless written approval is obtained from the NSW Environment Protection Authority (EPA) for emergency use of the rail line.	No change.

Construction Activities

Construction of the new gas management infrastructure would occur in three phases as indicatively described in Table 2.

Table 2
Indicative Description of Construction Phases

Phase	Description	Typical Fleet	Estimated Period
Site Establishment/Civils Typical fleet	Initial vegetation clearance, earthworks and site preparation phase	Semi-trailer equipment float, Grader, 20t Excavator, Skid Steer Loader	6 weeks
Drilling	Drilling and installation of gas and water boreholes	Semi-trailer equipment float, drill rigs, and specialty auxiliary drilling equipment	4 Weeks
Gas Plant Construction	Installation of surface infrastructure including a portable substation, vacuum pumps, enclosed flares, vent stack and flame detector, piping, valves and instruments, seal water tank and associated equipment, cooling tower, compressed air, gas analysers, overflow tank and electrical switch room.	Semi-trailer equipment float, rough terrain cranes	8 Weeks

In addition to the above main construction activities associated with the Modification, additional minor construction works would be conducted for:

- Upgrade of the three surface ventilation fans at the gas plant construction site, including upgraded fan impellers, shafts, drives and motors within the existing footprint.
- Minor upgrades of existing electricity transmission infrastructure, such as replacement poles and aerial conductors within ML 1566.

As these activities would be short-term in nature, this Modification Report has a focus on the main construction activities detailed in Table 2.

Workforce and Construction and Operational Hours

Thirty additional workers would be required for construction of the additional infrastructure. Once constructed, one additional worker would be required to operate the new infrastructure.

The base construction roster would be 7.00 am to 5.00 pm; Monday to Saturday. Notwithstanding, critical construction and commissioning activities e.g. drilling would be undertaken up to 24 hours a day, 7 days per week. Workers would access the site through the Cordeaux Dam entry to the catchment (located off Picton Road) and via Fire Roads within the Metropolitan Special Area.

In order to facilitate construction activities, heavy vehicle traffic movements would be required through the Cordeaux Dam entry to the catchment (note model types are indicative only):

- Trucks including flat top semi-trailers.
- 6 m^3 and 5 m^3 agitators.
- Construction cranes of various sizes.
- 40 foot shipping container on semi-trailer.
- Borehole drilling equipment.

Heavy vehicle movements would be restricted to daylight hours and in accordance with WaterNSW requirements.

Wet Weather Access

Access to the Modification area is through Fire Roads within the Metropolitan Special Area (a WaterNSW Special Area). There are two current restrictions on IMC access to the special area:

- A self-monitored requirement to not access when there has been 10 millimetres (mm) of rain locally in the previous 24 hours or if IMC considers local conditions are wet such that roads etc will be impacted by its access.
- WaterNSW imposed catchment-wide closures.

Access to critical mine infrastructure is required for safe operations, including during periods of catchment closures, such as wet weather or bushfire.

To maintain continued operations and for mine safety purposes, IMC has an access arrangement that allows controlled access to mine infrastructure sites, exploration sites and some environmental monitoring areas by adopting an agreed WaterNSW Special Areas Wet Weather Access Plan (IMC, 2020) (The Access Plan). This Access Plan has been developed to facilitate access in periods of wet weather including periods where the general closure limits of > 10 mm in a 24 hour period applies, prepared pursuant to Condition 3.1.4 of the WaterNSW Access Consent (F2020/1545).

As part of the Modification, IMC seeks a new access protocol with WaterNSW under the WaterNSW Special Areas Wet Weather Access Plan (IMC, 2020) to allow for the construction program to proceed as planned as far as practicable whilst minimising potential for erosion and sediment impacts associated with traffic movements during wet weather. It is expected that this will include additional road condition monitoring, maintenance and repair obligations.

IMC's overriding commitment is to repair and maintain the WaterNSW Fire Roads it has had an effect on, as well as manage any impacts that have the potential to impact water quality within the WaterNSW Special Areas by rapid response. Accordingly, as the new protocol would be subject to WaterNSW requirements, it follows that any additional access required for the Modification would have a neutral or beneficial effect to water quality in accordance with the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (Drinking Water SEPP).

IMC would consult further with WaterNSW regarding these changes.

Proposed Administrative Changes to Development Consent Conditions

IMC proposes that administrative modifications to the Dendrobium Mine consent (DA 60-03-2001) are required to align the consent with the outcomes of recent rehabilitation reforms under the *Mining Regulation 2016*, which commenced on 2 July 2021. Conditions that may require revision as a result of the legislation change are listed below:

- Schedule 1, Condition 5.
- Schedule 2, Condition 14.
- Schedule 4, Conditions 18 – 21.

4 STATUTORY CONTEXT

This section outlines the statutory requirements relevant to the assessment of the Modification. In accordance with the guideline *Preparing a Modification Report* prepared by the former Department of Planning, Industry and Environment (DPIE, 2021), now the Department of Planning and Environment (DPE), Attachment 1 provides a statutory compliance table for the Project incorporating the Modification that identifies all the relevant statutory requirements and the relevant sections in this Modification Report that address these requirements.

Environmental Planning and Assessment Act 1979

IMC is seeking to modify Development Consent (DA 60-03-2001) under section 4.55(1A) of the EP&A Act. Section 4.55(1A) relevantly provides.

> *(1A)* ***Modifications involving minimal environmental impact*** *A consent authority may, on application being made by the applicant or any other person entitled to act on a consent granted by the consent authority and subject to and in accordance with the regulations, modify the consent if—*
>
> *(a) it is satisfied that the proposed modification is of minimal environmental impact, and*
>
> *(b) it is satisfied that the development to which the consent as modified relates is substantially the same development as the development for which the consent was originally granted and before that consent as originally granted was modified (if at all), and*
>
> *(c) it has notified the application in accordance with—*
>
> *(i) the regulations, if the regulations so require, or*
>
> *(ii) a development control plan, if the consent authority is a council that has made a development control plan that requires the notification or advertising of applications for modification of a development consent, and*
>
> *(d) it has considered any submissions made concerning the proposed modification within any period prescribed by the regulations or provided by the development control plan, as the case may be.*
>
> *Subsections (1), (2) and (5) do not apply to such a modification.*

In accordance with clause 3BA(6) of Schedule 2 of the *Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017*, the consent authority is required to satisfy itself that any consent as modified would result in the Project remaining substantially the same development.

A comparative analysis that outlines the Dendrobium Mine components of the approved Project and the key components of the Modification is provided in Table 1. The Project incorporating the Modification would demonstrably remain a large coal mine project that incorporates the key elements approved under Development Consent (DA 60-03-2001).

Furthermore, this Modification Report includes a Statement of Environmental Effects in accordance with clause 115(1)(e) of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). The assessments contained herein conclude that the Modification is of “minimal environmental impact”.

Accordingly, the consent authority can be satisfied that the Project incorporating the Modification would remain “substantially the same” and that the Modification is of “minimal environmental impact”.

Objects of the NSW Environmental Planning and Assessment Act 1979

Section 1.3 of the EP&A Act describes the objects of the EP&A Act. The modification is considered to be generally consistent with the objects of the EP&A Act, as it:

- would continue to involve the orderly economic use and development of land at the Project;
- would facilitate ecologically sustainable development, as it would reduce Scope 1 greenhouse gas emissions, with no significant change to the currently accepted environmental impacts, and not increase in the duration of existing impacts of the Project;
- would not require new surface development areas and therefore potential impacts on biodiversity and cultural heritage items as a result of the Modification would be minimised; and
- would be developed in a manner that incorporates community engagement, with a range of stakeholders consulted through the preparation of this Modification Report.

Evaluation under section 4.15(1) of the Environmental Planning and Assessment Act 1979

In evaluating the Modification, under section 4.15(1) of the EP&A Act, the consent authority is required to take into consideration a range of matters as they are of relevance to the subject of the application. While this is a requirement of the consent authority, this Modification Report has been prepared to generally address the requirements of section 4.15(1) of the EP&A Act to assist the consent authority as follows:

- Detail on potential Modification requirements under the key environmental planning instruments is included in the statutory compliance table provided in Attachment 1.
- Clause 11 of the *State Environmental Planning Policy (State and Reginal Development) 2011* states that development control plans do not apply to State Significant Developments, such as the Modification.
- IMC will continue to make contributions for community enhancement in accordance with the requirements of Development Consent (DA 60-03-2001).
- This Modification Report has been prepared in consideration of the prescribed matters in the EP&A Regulation.
- A description of the existing environment, an assessment of the potential environmental impacts associated with the Modification, and a description of the potential measures to avoid, mitigate, rehabilitate, remediate, monitor and/or offset the potential impacts of the Modification are described in this Modification Report.
- The suitability of the Modification site has previously been considered and would not change for the Modification (i.e. the Modification disturbance areas are wholly located within ML 1566).
- Consideration of whether, on evaluation, the Modification is considered to be in the public interest is provided in this Modification Report.

Water Management Act 2000

IMC may employ some temporary bracing of the Sandy Creek bridge, which is a third order stream. This may involve a requirement for a Controlled Activity approval, however several exemptions exist for existing creek crossings. IMC would consult further with DPE and Natural Resources Access Regulator regarding this.

Other Relevant NSW Legislation

Other NSW legislation that may be applicable to the Project were described in the Project Environment Impact Statement (Olsen Environmental Consulting, 2001). IMC would continue to obtain relevant licences or approvals required under this NSW legislation for the Project, incorporating this Modification.

Environment Protection and Biodiversity Conservation Act 1999

The Project was approved under the *Environment Protection and Biodiversity Conservation Act 1999* on 20 December 2001 (EPBC 2001/214). It is concluded that the Modification would not have a significant impact on Matters of National Environmental Significance for the following reasons:

- The Modification would not have a significant impact on listed threatened species and ecological communities and/or migratory species as there would be no additional surface development area.
- The Modification would not have a significant impact on wetlands of international importance.
- The Modification would not have a significant impact on World Heritage properties or national heritage places.
- The Modification would not impact the Great Barrier Reef Marine Park and/or Commonwealth marine areas.
- The Modification is not a nuclear action.
- The Modification would not have a significant impact on water resources.

It is therefore considered that there is no need to refer the Modification to the Commonwealth Minister.

Notwithstanding, upgrades to Sandy Creek Crossing must '*take all reasonable measures to minimise the effect of the proposed action on the Giant Burrowing Frog*' per Condition 4 of the existing EPBC Approval (EPBC 2001/214).

5 ENGAGEMENT

Early consultation with WaterNSW regarding the Modification occurred on 5 November 2021. At this meeting, the following key matters were discussed:

- assessment approach and timing;
- potential bushfire impacts resulting from flaring and proposed control measures;
- potential need for emergency access; and
- Sandy Creek crossing and potential need for reinforcement to account for heavy loads being transported across the bridge.

WaterNSW provided further correspondence on 3 February 2022 containing comments on the Modification. These comments, along with an explanation of how these comments have been considered, are detailed in Table 3.

In addition to the above, IMC has consulted with the following government agencies and stakeholders regarding the Modification:

- Wollongong City Council;
- NSW Environment Protection Authority; Water NSW;
- Regional NSW – Mining Exploration and Geoscience; and
- DPE – Biodiversity Conservation Division.

IMC has also consulted with the Dendrobium Mine Community Consultative Committee regarding the Modification.

Consultation with the Biodiversity and Conservation Division (BCD) within the Environment, Energy and Science branch of the then DPIE (now DPE) regarding the Modification began in December 2021. The BCD requested further information in relation to the proposed use of the Streamlined Assessment Module – Small Area modification of the Dendrobium Mine Development Consent DA 60-03-2001.

In January 2022, IMC provided responses to the further information requested by BCD. The further information and justification provided by IMC concluded that the Streamlined Assessment Module for small area developments is the most appropriate assessment method to prepare the Biodiversity Development Assessment Report for the Modification within the context of clause 30A of the *Biodiversity Conservation (Savings and Transitional) Regulations 2017*. This justification was accepted by BCD in January 2022.

Table 3
WaterNSW Letter (3 February 2022) – Reconciliation Table

Section	Comment	Section of Modification Report where Comments Addressed
Fire Risk and Management	Consideration of bushfire risk from and to the gas drainage infrastructure is necessary. Conceivable ignition sources include an electrical storm, bushfire (naked flame, embers), bushfire causing damage to power cables or direct intervention by a person. A fire risk assessment including assessment of potential radiation from an ignited vent plume is necessary to determine an adequate cleared fire break or asset protection zone (APZ) that: • if the vented gas become flammable and is ignited, the flame shall not ignite surrounding vegetation, and • to provide a bushfire break between vegetation and the gas management infrastructure.	Appendix 4 *Bushfire Management Plan – Dendrobium Ventilation Shaft 2 and 3 Gas Drainage Plant* (Peterson Bushfire, 2022). As part of this study, a radiant heat study was completed by Ramboll (2021). The APZ for the ventilation stack considers the outcomes of the radiant heat study (Appendix 4).
	Water NSW requests that the fire risk assessment has due consideration to: • Any potential ignition risk, particularly through late spring to mid-autumn, is of concern due to the impact of unplanned bushfires on water quality.	Appendix 4 *Bushfire Management Plan – Dendrobium Ventilation Shaft 2 and 3 Gas Drainage Plant* (Peterson Bushfire, 2022).
	• Potential impact of unplanned fire on staff, contractors and visitors.	
	• Potential impact of unplanned fires on WaterNSW operations and infrastructure.	

Table 3 (Continued)
WaterNSW Letter (3 February 2022) – Reconciliation Table

Section	Comment	Section of Modification Report where Comments Addressed
Fire Risk and Management (Continued)	• Any exemption from total fire ban shall be consistent with Schedule of Standards Exemption for Total Fire Bans, particularly Standard Exemptions 14 (Mining Operations) and 16 (Exhaust Stacks).	Modification proposal is consistent with the standard exemption to the RFS total fire ban. The flare technology proposed in the project is enclosed flares selected for their efficiency and inherent safety having no exposed flame. Enclosed flares do not require an exemption to operate in a total fire ban. Under some circumstances, mine gasses would need to be vented via the exhaust stack. The exhaust stack does not operate ignited. In the event of a lightning strike, the vent stack has two key layers of protection to prevent ignition of surrounding vegetation: • vegetation offset selected to maintain radiant heat to well below ignition temperatures; and • automated extinguishing system that shuts off flow if a flame is detected. The gas drainage plant does not have any other ignition sources and does not require any hot work for normal operation.
	Water NSW recommends the following fire risk mitigation measures: • Sufficiently large bushfire clearances for any wildfire that may impact the site.	Appendix 4 *Bushfire Management Plan – Dendrobium Ventilation Shaft 2 and 3 Gas Drainage Plant* (Peterson Bushfire, 2022).
	• Installation of infrastructure on the site such as water storage tanks, fire pumps and hoses for fire suppression activities.	
	• Develop a Gas Flaring Protocol that clearly specifies when flaring can/cannot occur.	Flaring and operational protocols/procedures would be developed for the site in line with operational guidelines and procedures, as well as any relevant conditions of approval. Risk is mitigated by the use of a fully enclosed flare, which limits the potential for the flare to be an ignition source.

Table 3 (Continued)
WaterNSW Letter (3 February 2022) – Reconciliation Table

Section	Comment	Section of Modification Report where Comments Addressed
Fire Risk and Management (Continued)	• Works suspended or deferred during Total Fire Ban times. Risks, environmental impacts, and controls relating to venting via a 25m stack when flaring is not possible must also be considered.	Modification proposal is consistent with the standard exemption to the RFS total fire ban, as described above.
	• Gas flaring strictly controlled and monitored and have an emergency remote cut-off.	All functions of the flaring facility (including emergency cut off) would be controlled remotely.
	• Installation of 'fusible plugs' in the vent stack. Should the vent ignite, the heat would melt the fusible plug and automatically shut down the gas source to the vent stack.	The design incorporates an alternate system to achieve the same intent consisting of an optical flame detector that automatically closes an isolation valve in the event of a flare-up.
	• CCTV monitoring.	Included in design.
	• Security fencing around the gas drainage project site to prevent unauthorised access.	Included in design.
Surface Water Management	The proposal shall include: • Borehole drilling works (including drilling fluids and cuttings management) for gas extraction from the underground mine and associated infrastructure including a cooling water system incorporating cooling towers.	Included in design.
	• Additional water management infrastructure (e.g. sediment controls).	Appendix 1 *Dendrobium Gas Management Infrastructure – Modification Surface Water Review* (Hydro Engineering and Consultants Pty Ltd [HEC], 2022).
	• Process/fire water system, including bores to pump water from and return water to the underground mine workings and pipes/tanks to convey and store this water.	Appendix 1 *Dendrobium Gas Management Infrastructure – Modification Surface Water Review* (HEC, 2022).

Table 3 (Continued)
WaterNSW Letter (3 February 2022) – Reconciliation Table

Section	Comment	Section of Modification Report where Comments Addressed
Surface Water Management (Continued)	The water management assessment shall: • Provide detail how water for each of the above works will be sourced and managed and include any licensing considerations for mine water take or groundwater and reuse.	Appendix 1 *Dendrobium Gas Management Infrastructure – Modification Surface Water Review* (HEC, 2022). The proposed Modification includes construction of a process water and fire water management system. The water management system is proposed to comprise bores to pump water from and return water to the underground mine workings in addition to pipes/tanks to convey and store recovered water within the Modification area. The Modification area water management system would operate independently to the Dendrobium Mine water management system. The Modification would operate a neutral site water balance with water recovered from underground workings managed on site and recycled to the underground for process water supply or used on-site for fire management purposes. There would be no change to the groundwater take associated with the underground mine and hence no additional licenses would be required.
	• Review the site water balance considering water necessary during site construction and operation.	
	• Consider any requirements for upgrades to access roads, if water is proposed to be trucked in for any of the works proposed.	Water for drilling and associated purposes would be trucked to site using the existing protocols for exploration activities within the Special Areas. Any road maintenance requirements would be implemented in consultation with WaterNSW using the same protocols as currently used for exploration activities in the Special Area. It is not proposed to truck water to site as part of the operational phase of the Modification.
	• Prepare a Soil and Water Management Plan (SWMP) that assessed the existing settling ponds and design of new systems to handle the extra cleared areas, during and after construction. The SWMP may need to be designed for larger events than those used previously for No 2 and 3 shafts. The working ponds need more free board than those at No 2 and 3 shafts alone to ensure the working water is contained during significant rain events (pH is a major issue, as well as the fine suspended solids and clays (lubricant) used during the drilling works).	Appendix 1 *Dendrobium Gas Management Infrastructure – Modification Surface Water Review* (HEC, 2022). IMC agrees with the intent of the comment (to prepare an SWMP) and intends to consult further with WaterNSW regarding this comment.

Table 3 (Continued)
WaterNSW Letter (3 February 2022) – Reconciliation Table

Section	Comment	Section of Modification Report where Comments Addressed
Infrastructure upgrades – access roads, Bailey Bridge, all weather/wet weather access, power needs	WaterNSW recommends the following: • Road improvements and upgrades were a major issue for the SCA (now WaterNSW) during the construction of ventilation shafts 2 and 3, requiring constant supervision, and issuances of clean up notices. Increases in construction traffic due to the gas drainage proposal along FR 6, 6C, 6F and 6K will require upgrading of these fire trails. More consultation with WaterNSW is necessary regarding any fire road upgrade proposal.	IMC seeks a new access protocol with WaterNSW under the *WaterNSW Special Areas Wet Weather Access Plan* (IMC, 2020) to allow for the construction program to proceed as planned as far as practicable whilst minimising potential for erosion and sediment impacts associated with traffic movements during wet weather. It is expected that this would include additional road condition monitoring, maintenance and repair obligations. Further consultation with WaterNSW would be undertaken to address this recommendation.
	• Due to increased requirement for all weather access and continuous maintenance, a helipad may need to be built to accommodate light to medium helicopters.	IMC has considered the need for a helipad however, on the basis of operational needs, planned automation of the site operations, additional clearing required, and existing and planned infrastructure constraints does not believe this is required or suitable for the Modification. IMC would continue to consult with WaterNSW on any need for additional emergency access to the site.
	• The Bailey Bridge over Sandy Creek will require engineering inspection and possible upgrading.	Following engineering evaluation conducted by IMC, temporary bracing of the 2-span Bailey bridge that is on the access trail (Sandy Creek crossing) is proposed using props at regular spacing to support the bridge's structure if heavy loads are to be transported across the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).
	• A back-up generator should be included in the design.	The plant design includes battery uninterruptable power supplies to maintain critical control functions for remote operation and monitoring in the event of a power outage. In addition, the plant can utilise the existing back-up generator on site to accommodate extended outages. Back-up power for the plant operation is not feasible, not required and would add unnecessary risk due to diesel transport and storage within the Special Areas

Table 3 (Continued)
WaterNSW Letter (3 February 2022) – Reconciliation Table

Section	Comment	Section of Modification Report where Comments Addressed
Infrastructure upgrades – access roads, Bailey Bridge, all weather/wet weather access, power needs (Continued)	• A wet weather access protocol for construction needs to be approved.	IMC seeks a new access protocol with WaterNSW under the *WaterNSW Special Areas Wet Weather Access Plan* (IMC, 2020) to allow for the construction program to proceed as planned as far as practicable whilst minimising potential for erosion and sediment impacts associated with traffic movements during wet weather. It is expected that this would include additional road condition monitoring, maintenance and repair obligations. Further consultation with WaterNSW would be undertaken to progress this recommendation.
	• Emergency evacuation plan during construction works.	IMC would continue to use emergency protocols in place for existing operations within the Special Areas. These protocols and plans would be updated to address the additional works associated with the Modification, should it be approved. IMC would consult with WaterNSW in this regard.
	• Does Endeavour Energy power supply need to be upgraded and how will this be done?	The scope of future power upgrades are not fully defined. Any potential upgrades are a result of total mine requirements changing as the mine progresses and are not solely attributed to the introduction of the gas plant. IMC would consult with WaterNSW and other stakeholders once any upgrade requirements are known.
	• Are alternative access routes to the ventilation shafts 2 and 3 site still viable? Any upgrades necessarily need to be discussed.	No alternative access routes are considered to be necessary for construction and operational purposes. Existing emergency access and egress protocols would be used for the Modification, should it be approved. IMC would continue to consult with WaterNSW in this regard.

6 ASSESSMENT OF IMPACTS

IMC has prepared this Modification Report to address the key potential environmental impacts of the Modification. The Modification Report includes:

- a description of the approved and modified Dendrobium Mine;
- a description of the strategic and statutory context of the Modification;
- a summary of the stakeholder engagement undertaken for the Modification; and
- an assessment of the potential environmental impacts of the Modification, including comparison with approved potential environmental impacts of the Dendrobium Mine.

The key environmental matters identified are summarised in Table 4 and addressed in this section.

Table 4
Summary of Key Potential Environmental Matters/Impacts

Environmental Aspect	Key Potential Environmental Issues/Impacts	Report Section
Water Resources	• potential water quality impacts within water catchment area during construction, mitigated by erosion and sediment control measures	Appendix 1
Biodiversity	• biodiversity impacts associated with clearing and management of vegetation for bushfire purposes, mitigated by appropriate vegetation clearance protocols.	Appendix 2
Aboriginal Cultural Heritage	• limited potential for impact due to avoidance of a known Aboriginal heritage site and absence of other sites.	Appendix 3
Bushfire	• potential for ignition on-site leading to an offsite fire, or an off-site fire causing a hazard at the site, mitigated by proposed vegetation management zone (i.e. fire break).	Appendix 4
Noise and Air Quality	• limited potential for noise impacts during construction or operation due to large distance to receivers.	Appendix 5

Surface Water Review

A Surface Water Review was conducted by HEC (Appendix 1).

As the Modification is located within the Sydney drinking water catchment, the consent authority must be satisfied that the development will have neutral or beneficial effect to water quality in accordance with the Drinking Water SEPP.

The Surface Water Review prepared by HEC (2022) comprised an assessment of the effects of the Modification on the water quality of surrounding watercourses and the recommendation of measures for the management of potential water quality effects.

The Modification would be located wholly within the previously approved and previously cleared area associated with the Dendrobium No. 2 and 3 shafts as approved under Development Consent DA 60-03-2001. Providing the Modification has the same or lesser impact on water quality than that of the existing development if it were extended or expanded under similar conditions as the existing development consent, the Modification will have a neutral effect to water quality in accordance with clause 11A of the Drinking Water SEPP.

Providing that erosion and sediment control measures are implemented, managed and monitored in accordance with best practice guidelines, it is expected that the Modification would have the same impact on water quality as the existing approved development, and therefore, a neutral effect to water quality. Best practice measures recommended by HEC (2022) include:

- Existing site drainage channels and overland flow paths are visually inspected to confirm that all existing and proposed vegetation clearance and infrastructure areas are or will be directed to the existing sediment basins during construction and operation.
- Areas of erosion should be repaired, and trapped sediment removed.
- Construction of collection drains within the approved clearance area where construction activities or proposed infrastructure have potential to impede the conveyance of surface water runoff.
- Construction of short-term sediment control measures (i.e. sediment traps, sediment fences, etc.) downstream of sediment basins to manage sediment runoff during construction activities.
- Visual inspections of drainage channels and sediment basins undertaken on a monthly basis and following rainfall events in excess of 95.6 mm.
- Equip sediment basins with a de-silting marker post to indicate maximum height of the sediment storage zone.

Additionally, the proposed method for temporarily bracing/shoring the Bailey bridge which crosses Sandy Creek will have a negligible potential of increased erosion or scouring of the watercourse bed or banks associated with the temporary bracing/shoring of the bridge. As such, this activity would have a neutral effect to water quality (HEC, 2022).

Biodiversity Development Assessment Report

A Biodiversity Development Assessment Report (BDAR) was conducted by Niche Environment and Heritage (Niche, 2022a) (Appendix 2).

The *Streamlined Assessment Module – Small Area* for assessing small areas was applied to the BDAR as the area to be disturbed by the Modification is below the maximum clearing area threshold set in the Biodiversity Assessment Method (BAM) (Appendix 2).

As no threatened biodiversity listed under the EPBC Act are considered likely to be impacted by the Modification, no assessment/s of significance under the EPBC Act were required (Niche, 2022a). As such, there is no requirement for an EPBC Act Referral regarding Commonwealth threatened species, communities or populations (Niche, 2022a).

The 0.84 ha of vegetation removal required for the Modification would be limited to areas within the mining lease which were previously cleared in 2005 for the construction of the vent shaft (Niche, 2022a) (Plate 1). 0.74 ha of this vegetation removal required would be managed as an Asset Protection Zone (APZ), requiring the removal of trees, shrubs and fallen logs only (modified non-threatened fauna habitat).

Niche (2022a) determined that there would be no impacts to threatened flora and fauna, and no impacts to Serious and Irreversible Impact entities.

Many of the management and mitigation measures suggested by Niche (2022a) are already documented within the *Dendrobium Mine and Cordeaux Colliery Mining Operations Plan* and implemented at the Dendrobium Mine and Cordeaux Colliery. These measures are provided in Table 11 of Appendix 2.

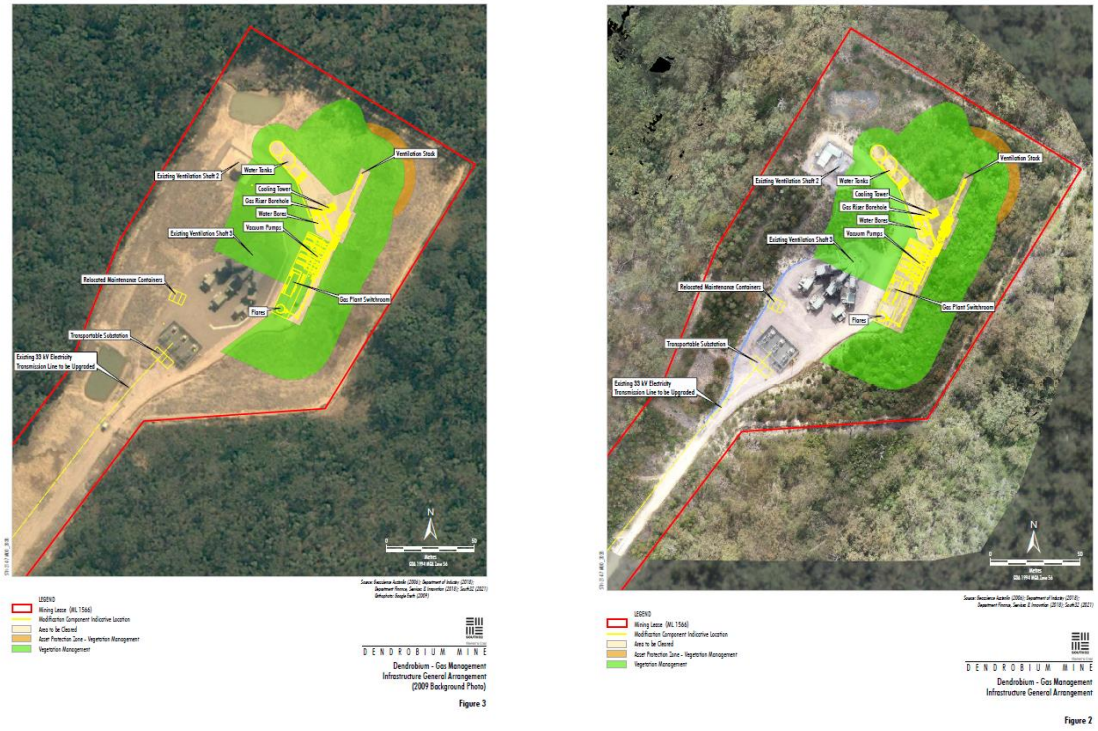

Plate 1: *Comparison of 2009 aerial (left) with existing aerial photos (right) at Dendrobium No. 2 and 3 Shafts.*

IMC has aimed to avoid and minimise environmental impacts from the Modification through detailed design and siting of the Modification and implementation of actions aimed at mitigating and managing potential indirect impacts of the Modification (Niche, 2022a).

Accordingly, Niche (2022a) have determined that no biodiversity offsets are required for the Modification (Appendix 2).

Aboriginal Objects Desktop Due Diligence Assessment

An Aboriginal Objects Desktop Due Diligence Assessment was conducted by Niche (2022b) (Appendix 3). The assessment conducted by Niche divided the Modification into the proposed construction of new gas management infrastructure and ancillary infrastructure to facilitate management of gas from Area 3C at the site of the existing Dendrobium No. 2 and 3 shafts ('Activity Area A') and the proposed temporary shoring/bracing works of the bridge crossing at Sandy Creek on Fire Trail no. 6C ('Activity Area B').

No Aboriginal heritage constraints were identified within or in proximity to Activity Area A. Accordingly, the assessment concluded that IMC proceed with the proposed activities at Dendrobium Colliery with the following general recommendations (Niche, 2022b):

- All site workers and contractors should be inducted to the area and informed of their obligations under the *National Parks and Wildlife Act 1974.*
- In the unlikely event that any Aboriginal objects are found, all activities with the potential to impact the objects must stop. A temporary fence is to be erected around the Aboriginal cultural heritage site, with a buffer zone of at least 10 m around the known edge. An appropriately qualified archaeologist is to be engaged to assess the findings, and notification is to be provided to Heritage NSW. Works should not proceed without advice from Heritage NSW or an appropriately qualified archaeologist.

- In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact must cease immediately and:
  - The location, including a 10 m curtilage, should be secured using barrier fencing to avoid further harm;
  - The NSW Police must be contacted immediately;
  - No further action is to be undertaken until the NSW Police confirm the origin of the remains as non-human and provide a case number for South32's records;
  - If the skeletal remains are identified as Aboriginal, the Proponent or their agent must contact: Heritage NSW via the Environment Line on 131 555; and representatives of the Registered Aboriginal Parties (RAPs); and
  - No works are to continue until the Heritage NSW provides notification to the Proponent or their Agent.

Aboriginal heritage site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) is located in close proximity to Activity Area B. However, the Modification would not involve vegetation clearing and will subsequently not impact the partially destroyed site. Accordingly, the assessment concluded that IMC proceed with the proposed activities at Dendrobium Colliery with the following recommendation (Niche, 2022b) (in addition to those general recommendations listed above for Activity Area A):

- No ground surface disturbance should occur within proximity of Aboriginal heritage site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043).

Niche (2022b) concluded that no further investigations and impact assessments are required at both Activity Area A and Activity Area B.

Bushfire Management Plan

A Bushfire Management Plan was developed by Peterson Bushfire (2022) for the protection of the proposed infrastructure and any surrounding assets associated with the Modification (Appendix 4).

Based on information gathered for the Bushfire Management Plan, Peterson Bushfire is able to predict likely fire behaviour. Predicted bushfire behaviour would be the combination of undesirable fire weather (i.e. hot and dry westerly winds during spring and early summer) combined with ignition somewhere within or adjacent the catchment lands (natural, accidental or arson). This would create the potential for a bushfire to spread generally in a west to east direction (Appendix 4).

The risk assessment within the Bushfire Management Plan acknowledges that despite risk treatments that are able to be put in place, some bushfire risk will remain. As described in Appendix 4, Illawarra Bush Fire Risk Management Plan' and 'Wollondilly/Wingecarribee Zone Bushfire Risk Management Plan' states that the level of acceptability for the area is 'high' due to a combination of risk priority and capacity to undertake works on a regional scale. Accordingly, the identified risk level to external assets and communities identified in Appendix 4 is acceptable. Notwithstanding, risk treatments are recommended to address the extreme risk of fire impact on the site and prevent the spread of fire from the site and potentially impacting on community assets. These risk treatments include (Peterson Bushfire, 2022):

- APZ (Figure 2).
- Ember and radiant heat protection.
- Water supply for fire-fighting.

- Access for fire-fighting.
- Emergency response and evacuation planning.

Additionally, the Bushfire Management Plan recommends that a complete evaluation, review and updating of the plan should occur every five years at a minimum. This review should (Peterson Bushfire, 2022):

- Consider whether the plan has achieved the objectives.
- Re-assess the strategies and bushfire threat in light of current research and best practice.
- Re-assess the strategies taking into account any legislative changes, financial constraints, and any changes in hazard and threat.

Noise Review

A Noise Review was conducted by Renzo Tonin & Associates (2022) for the Modification (Appendix 5).

The estimated construction noise produced from proposed construction works are estimated to be at least 5 dB(A) below the most stringent Noise Management Levels at the nearest receiver, located approximately 3 km away from the site.

The estimated operational noise at the nearest receiver would be at least 10-15 dB(A) below the most stringent Project Specific Trigger Levels.

Therefore, noise generated during construction and operational phases are expected to comply comfortably with the established noise criteria at the nearest affected receiver location and no further mitigation measures are required (Renzo Tonin & Associates, 2022).

Greenhouse Gases

The flaring of pre- and post-drainage gas from Area 3C to the greatest extent practicable would result in methane being converted to CO_2 which in turn would result in fewer Scope 1 emissions (i.e. as methane has a Global Warming Potential 28 times that of CO_2). The Modification would therefore reduce Scope 1 greenhouse gas emissions relative to the approved Dendrobium Mine.

Road Transport

The Modification area would be accessed via Picton Road and Cordeaux Dam Access Road and then via a series of access tracks with the Upper Nepean Catchment. Picton Road is a (Main Road 95) State Road, which extends from Mount Ousley Road at its south-eastern end to Picton at its north-western end.

Traffic movements would consist of up to approximately 30 construction workers accessing the site via light vehicles, predominantly for day shifts only. IMC would encourage carpooling of these workers wherever possible to reduce traffic movements through the catchment and on the local road network.

In addition, a number of heavy vehicle deliveries will be required, including oversize vehicle movements to deliver equipment to site. These movements would occur only during daylight hours.

Overall, given the main construction period is limited to approximately 5 months, with the movements occurring during daytime hours and generally limited in volume, potential traffic impacts during the construction phase are considered to be minor. As the construction phase would occur during 2022, it is not expected to materially overlap with the proposed Dendrobium Extension Project (SSI-33143123), if it is approved.

Following commissioning of the Modification infrastructure, movements would be limited to approximately 1 personnel inspecting the site on a daily basis, which would result in negligible traffic impacts.

Preliminary Hazard Analysis

A Preliminary Hazard Analysis (PHA) has previously been conducted to evaluate potential hazards associated with activities at the Dendrobium Mine (South32, 2019). The PHA was conducted in accordance with the general principles of risk evaluation and assessment outlined in the NSW Department of Planning and Infrastructure (DPI [now DPE]) *Assessment Guideline: Multi-level Risk Assessment* (DPI, 2011) and has been documented in general accordance with the NSW Department of Planning (DoP [now DPE]) *Hazardous Industry Planning Advisory Paper No 6: Hazard Analysis* (DoP, 2011).

Attachment 2 presents a qualitative assessment of risks associated with the construction and operation of the Modification. The assessment particularly evaluates the off-site risks of fixed installations at the Project to the people, their property and the environment arising from atypical and abnormal hazardous events and conditions.

Hazard treatment measures were proposed, where required, to produce a tolerable level of risk in accordance with the risk acceptance criteria.

The Level 1 assessment conducted was justified, as the PHA demonstrates a societal risk in the negligible zone and there are no potential scenarios with significant off-site consequences in accordance with *Multi-level Risk Assessment* (DPI, 2011).

Visual Review

The Modification area is located within the Upper Nepean Catchment, which is a declared protected catchment area (i.e. the Metropolitan Special Area). As a protected catchment, the area is generally undisturbed (apart from historical development of water supply infrastructure), with public access being restricted by WaterNSW. The Upper Nepean Catchment is located at the southern end of the Woronora Plateau, which extends from Robertson, northwards to Liverpool and is bordered by the Illawarra Escarpment to the east, Campbelltown to the north-west and the towns of Bargo and Yerrinbool in the south-west. The area is visually characterised by native vegetation covering the undulating topography of the Woronora Plateau, and the various streams and associated tributaries of the Upper Nepean Catchment.

Two key potential viewer locations have been identified:

- Cordeaux Dam wall.
- Harry Graham Drive.

The Cordeaux Dam wall is located approximately 5.6 km north north-east of the Modification area and has an elevation of approximately 306 m Australian Height Datum (AHD). Although the ventilation stack proposed for the Modification would be some 25 m in height, the elevation at the site is approximately 350 m AHD and significant intervening topography exists within the Upper Nepean Catchment (i.e. up to 380 m AHD), which will mean that views will not be available.

Harry Graham Drive (at its closest point) is located some 5.5 km east south-east of the Modification area and has an elevation of approximately 330 m AHD. Similarly, significant intervening topography exists within the Upper Nepean Catchment (i.e. up to 490 m AHD), which will mean that views will not be available.

Potential incremental impacts of Project night-lighting and flaring are expected to be minimal given the distance of flaring activities from potential viewers, intervening topography and native vegetation at other surface facilities.

Air Quality Review

Flaring of pre-drainage gas, which contains methane, has the potential to produce oxides of nitrogen (NOx) emissions and give rise to odour concerns. The impacts of NOx emissions on the local air quality environment are expected to be minimal because the infrastructure would be located away from any sensitive receptors (the closest receiver is approximately 3 km away from the site).

7 EVALUATION OF MERITS

The Modification would allow the development of additional gas management infrastructure at the Dendrobium Mine. The modified Dendrobium Mine would be substantially the same as the existing/approved Dendrobium Mine. The Modification Report concludes that the Modification is of minimal environmental impact.

The additional gas management infrastructure would be developed in an area previously cleared for the Dendrobium No. 2 and 3 shafts and would facilitate the continuation of mining at the Dendrobium Mine at the existing production rate, allowing the existing employment, royalties and other benefits to continue.

In weighing up the main environmental impacts (costs and benefits) associated with the proposal as assessed and described in this Modification Report, the Modification is, on balance, considered to be in the public interest of the State of NSW.

If you have any queries please don't hesitate to contact the undersigned on 0438 042 897.

Yours sincerely
SOUTH32 LIMITED

Gary Brassington
Approvals Manager
South32 Illawarra Metallurgical Coal

8 REFERENCES

Department of Planning (2011). *Hazardous Industry Planning Advisory Paper No 6: Hazard Analysis.*

Department of Planning and Infrastructure (2011). *Assessment Guideline: Multi-level Risk Assessment.*

Department of Planning, Industry and Environment (2021). *State Significant Development Guidelines – Preparing a Modification Report.*

Hydro Engineering and Consulting Pty Ltd (2022). *Dendrobium Gas Management Infrastructure – Modification Surface Water Review.*

Illawarra Metallurgical Coal (2020). *WaterNSW Special Areas Wet Weather Access Plan.*

Niche Environment and Heritage (2022a). *Dendrobium Gas Infrastructure No 2 and No 3 Vent Shaft – Biodiversity Development Assessment Report – Streamlined assessment module – Small area.*

Niche Environment and Heritage (2022b). *Dendrobium Gas Infrastructure No 2 and 3 Vent Shaft - Aboriginal Objects Desktop Due Diligence Assessment.*

Olsen Environmental Consulting (2001). *Environmental Impact Statement Air Quality Assessment.*

Peterson Bushfire (2022). *Bushfire Management Plan – Dendrobium Ventilation Shaft 2 and 3 Gas Drainage Plant.*

Renzo Tonin & Associates (2022). *Additional Gas Management Infrastructure at Dendrobium No. 2 and 3 Shafts – Noise Review.*

South32 (2019) *Dendrobium Mine – Plan for the Future: Coal for Steelmaking – Environmental Impact Statement.*

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APPENDIX 1

DENDROBIUM GAS MANAGEMENT INFRASTRUCTURE – MODIFICATION SURFACE WATER REVIEW (HYDRO ENGINEERING AND CONSULTANTS, 2022)

HYDRO ENGINEERING & CONSULTING PTY LTD

11 February 2022

Principal Mining Approvals
Illawarra Metallurgical Coal
via Email
Attention: Nicola Curtis
C/O: Resource Strategies

Nicola,

Re: Dendrobium Gas Management Infrastructure – Modification Surface Water Review

1. BACKGROUND

Illawarra Metallurgical Coal (IMC), a wholly owned subsidiary of South32, is the owner and operator of the Dendrobium Mine. IMC is proposing a modification of the Dendrobium Mine Development Consent DA 60-03-2001 (the Modification) to allow the development of additional gas management infrastructure at the Dendrobium Mine. The Modification location is shown in Figure 1.

The Modification would involve:

- Construction of new gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre-drainage gas from Area 3C at the site of the existing Dendrobium no. 2 and 3 shafts.
- Gas extraction from the underground mine via a borehole and vacuum pump, with associated infrastructure including a cooling water system incorporating cooling towers.
- Gas treatment using enclosed flares on the surface. Under conditions not suitable for flaring, gasses would alternatively be vented via a stack approximately 25 metres (m) high.
- Ancillary infrastructure, such as fencing, pumps, CO_2 tanks, condensate tanks and surface pipes.
- Additional water management infrastructure as required.
- Process/fire water system, including bores to pump water from and return water to the underground mine workings and pipes/tanks to convey and store this water.
- Installation and use of a transportable substation for electricity requirements.

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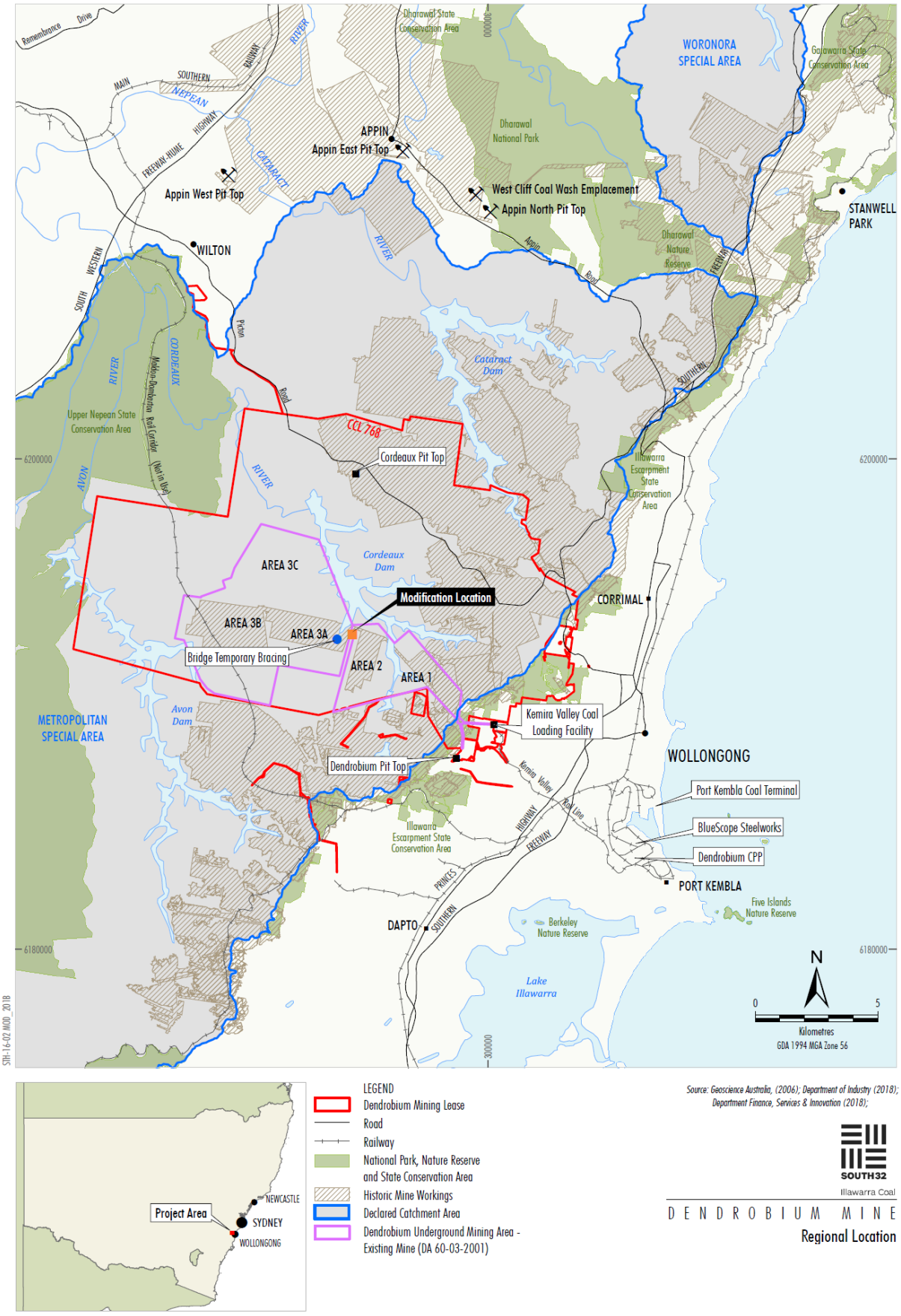


Figure 1 Regional Location

- Upgrade of the three surface ventilation fans at the gas plant construction site, including upgraded fan impellers, shafts, drives and motors within the existing footprint.
- Minor upgrades of existing electricity transmission infrastructure, such as replacement poles and aerial conductors within mining lease (ML) 1566.
- Temporary bracing of the 2-span Bailey bridge that is on the access trail (Sandy Creek crossing) using props at regular spacing to support the bridge's structure if heavy loads are to be transported across the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).

It is noted that:

- All construction activities and infrastructure would be located wholly within the previously approved and previously cleared area associated with Dendrobium no. 2 and 3 shafts.
- Clearance of vegetation (and management of vegetation for bushfire control purposes) is required within areas of revegetation (i.e. revegetation that has occurred following the approved clearance activities to establish the existing ventilation shaft infrastructure).

As the Modification would be located within the Sydney drinking water catchment, the consent authority must be satisfied that the development will have a neutral or beneficial effect to water quality in accordance with the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (the SEPP).

Consequently, Hydro Engineering & Consulting Pty Ltd (HEC), a division of ATC Williams Pty Ltd, has undertaken a Surface Water Review for the proposed Modification. The Surface Water Review comprised an assessment of the effects of the proposed development on the water quality of surrounding watercourses and the recommendation of measures for the management of potential water quality effects. Additionally, the site water balance has been reviewed with respect to the water supply and demand requirements for the proposed Modification.

The outcomes of the Surface Water Review are documented herein and are to form a component of the application for modification to the Development Consent.

2. MODIFICATION AREA

The general arrangement of the Modification is shown in Figure 2. The gas management and ancillary infrastructure would be constructed to the east of the existing Dendrobium no. 2 and 3 shafts and associated infrastructure.

The estimated total area to be cleared for the Modification is 1,340 square metres (m^2). As stated in Section 1, this area was previously approved and cleared for the establishment of the existing ventilation shaft infrastructure.

An asset protection zone and vegetation management area of 9,639 m^2 in total is proposed to provide a buffer zone between the adjacent bushland and the existing and proposed assets thereby providing protection against potential bushfire risks. The asset protection zone and vegetation management area will provide an area of reduced bushfire fuel that allows suppression of fire; the conduct of backburning if required and safe access for emergency services (NSW Rural Fire Service, undated). Within these areas, some vegetation will be maintained including ground cover necessary to prevent soil erosion (NSW Rural Fire Service, undated).

At its closest point, the gas management infrastructure would be located approximately 277 m to the east of Sandy Creek (Figure 3) and at an elevation approximately 47 m higher than that of the Sandy Creek bank. Sandy Creek forms the upper extent of Lake Cordeaux (i.e. the downstream reach of the creek would be inundated when Lake Cordeaux is at a sufficiently high level). Cordeaux Dam is one of four dams that make up the Upper Nepean water supply scheme servicing greater metropolitan Sydney.

As stated in Section 1, temporary bracing of the 2-span Bailey bridge that crosses Sandy Creek will be undertaken using props at regular spacing to support the structure of the bridge if heavy loads are to be transported across the bridge. It is understood that the props are to comprise stacked railway sleepers which will be placed on the watercourse rock outcrop to the height of the bridge undercarriage.

3. SURFACE WATER MANAGEMENT

Surface water management for the existing infrastructure area comprises two sediment basins – Sediment Basin A to the north of the infrastructure area and Sediment Basin B to the south-west of the infrastructure area adjacent to the entrance road (refer Figure 3). Both sediment basins discharge off-site to adjacent bushland within the catchment area of Sandy Creek.

The existing catchment area of Sediment Basin A is estimated at 1.2 hectares (ha) and the catchment area of Sediment Basin B is estimated at 1.1 ha (refer Figure 3). The area to be cleared for the Modification would be located wholly within these two catchment areas with surface water runoff from the proposed construction and infrastructure area to be directed to the existing sediment basins.

In the Sediment Basin B catchment, the vegetation management and natural vegetation area to the east of the area to be cleared would be directed via an existing drainage channel to Sediment Basin C which is located to the south of the Modification area (refer Figure 3). As indicated in Figure 3, minor realignment of the existing drainage channel would be required such that the Modification catchment area directed to Sediment Basin C would be of the same land use type (i.e. vegetation) and equal in size, or less than, the current catchment area.

Figure 2 Gas Management Infrastructure General Arrangement

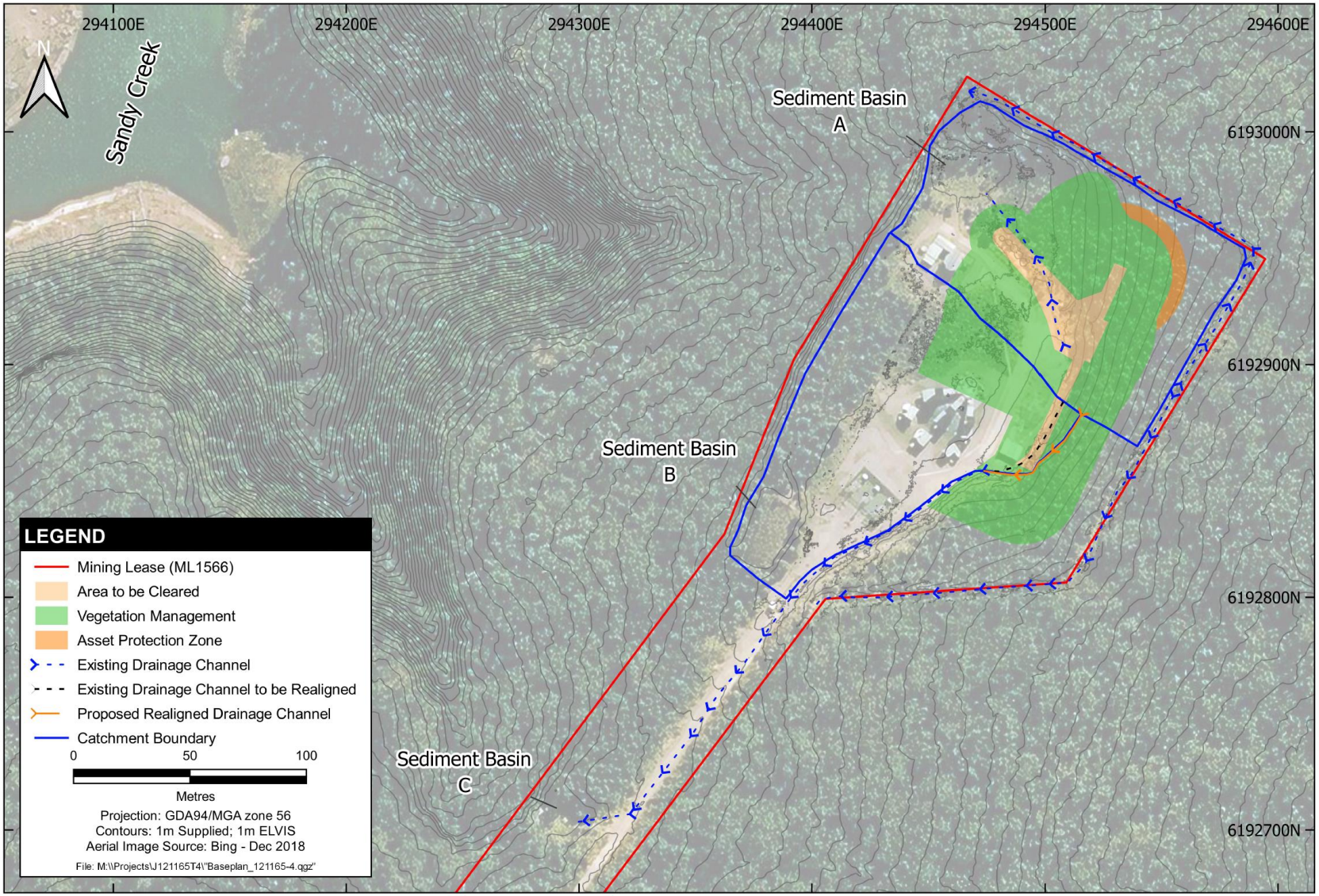


Figure 3 Modification Area Surface Water Management

4. NEUTRAL OR BENEFICIAL EFFECT TO WATER QUALITY

As stated in Section 1, the Modification would be located within the Sydney drinking water catchment and, as such, it must be demonstrated that the Modification would have a neutral or beneficial effect to water quality in accordance with the SEPP.

A neutral or beneficial effect on water quality is satisfied if the development (WaterNSW, 2021):

a) has no identifiable potential impact on water quality; or

b) 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

c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

Clause 11A of the SEPP states:

1. *This clause applies for the purposes of determining under this Policy whether the carrying out of continuing development on land in the Sydney drinking water catchment would have a neutral or beneficial effect on water quality.*

2. ***Continuing development** is any development (such as mining) for which development consent was limited to the carrying out of the development for a particular time or to a particular area or intensity, but which was likely to be the subject of future applications for consent for its extension or expansion.*

3. *If:*

   a) *development consent was granted for continuing development ("the existing development consent"), and*

   b) *a development application is made for consent to extend or expand the carrying out of the development ("the proposed development"), and*

   c) *the development application is made before the authority conferred by the existing development consent expires or is exhausted,*

   the carrying out of the proposed development will have a neutral or beneficial effect on water quality if it will have the same or a lesser adverse impact on water quality when compared to the adverse impact that the continuing development would have if it were extended or expanded under similar conditions as the existing development consent.

   ...

Vegetation clearance, construction activities and infrastructure development were approved for the Dendrobium no. 2 and 3 shafts under Development Consent DA 60-03-2001. The Modification would be located wholly within the previously approved and previously cleared area associated with the Dendrobium no. 2 and 3 shafts. As such, it is understood that the Modification would constitute the extension or expansion of the carrying out of the development. Accordingly, providing that the Modification will have the same or a lesser impact on water quality than that of the existing development if it were extended or expanded under similar conditions as the existing development consent, the Modification will have a neutral effect to water quality in accordance with Clause 11A of the SEPP.

4.1 Gas Management Infrastructure Area

The existing surface water management system would be retained for the gas management infrastructure area, with surface water runoff from construction and infrastructure areas to be directed to the existing sediment basins. Providing that erosion and sediment control

measures are implemented, managed and monitored in accordance with best practice guidelines, as described in Section 5, it is expected that the development of the gas management infrastructure will have the same impact on water quality as the existing approved development and will therefore have a neutral effect to water quality.

4.2 Bailey Bridge Bracing/Shoring

The proposed method for temporarily bracing/shoring the Bailey bridge which crosses Sandy Creek was previously adopted for the development of the Dendrobium no. 2 and 3 shafts, with negligible surface water impacts. The bracing/shoring would only be implemented at times when heavy loads are required to be transported via the bridge. As such, the works would be temporary only and implemented sporadically.

The bracing/shoring of the bridge would only be undertaken at times of low flow such that the materials would not restrict surface water flow within Sandy Creek. The bracing/shoring would rest on the watercourse rock outcrop only and would not rest on soil banks. The works would not require vegetation removal and impacts to the watercourse rock outcrop are not expected to occur. As such, there is negligible potential of increased erosion or scouring of the watercourse bed or banks associated with the temporary bracing/shoring of the bridge.

Consequently, it is expected that the temporary bracing/shoring activities will have the same impact on water quality as the existing approved development and will therefore have a neutral effect to water quality.

4.3 Wet Weather Access

Access to the Modification area is through Fire Roads within the Metropolitan Special Area (MSA; a WaterNSW Special Area). There are two current restrictions on IMC access to the MSA:

- a self-monitored requirement of no access when there has been 10 mm of rain locally in the previous 24 hours or if IMC considers that local conditions are such that roads may be impacted by access; and
- WaterNSW imposed catchment-wide closures.

Access to critical mine infrastructure is required for safe operations, including during periods of catchment closures, such as wet weather or bushfire. To maintain continued operations and for mine safety purposes, IMC has an access arrangement that allows controlled access to mine infrastructure sites, exploration sites and some environmental monitoring areas as defined in the agreed *WaterNSW Special Areas Wet Weather Management Plan* (IMC, 2020) (Management Plan). The Management Plan has been developed to facilitate access in periods of wet weather including periods where the general closure limits of greater than 10 mm in a 24 hour period applies, prepared pursuant to Condition 3.1.4 of the *WaterNSW Access Consent* (F2020/1545).

As part of the Modification, IMC is seeking a new access protocol with WaterNSW under the Management Plan to allow for the construction program to proceed as far as practicable whilst reducing the potential for erosion and sedimentation impacts associated with traffic movements during wet weather. It is expected that this will include additional road condition monitoring, maintenance and repair obligations.

If affected, IMC has committed to repair and maintain the WaterNSW Fire Roads in addition to implementing rapid response measures to manage any associated potential impacts to water quality within the MSA. Accordingly, as the new access protocol would be subject to

WaterNSW requirements, it follows that any additional access required for the Modification would have a neutral or beneficial effect to water quality in accordance with the SEPP.

5. CONCEPTUAL EROSION AND SEDIMENT CONTROL

5.1 Design Approach

The conceptual water management system for the Modification, shown in Figure 3, is subject to detailed design. Further optimisation of the water management system may be undertaken at the detailed design stage to reduce the area of disturbance associated with the construction of drainage channels and enlargement of the existing sediment basins. Following detailed design, IMC will review, and if necessary, revise the current Water Management Plan to incorporate the Modification water management system.

5.2 Drainage Channels

Prior to the detailed design stage, it is recommended that the existing site drainage channels and overland flow paths are visually inspected to confirm that all existing and proposed vegetation clearance and infrastructure areas are or will be directed to the existing sediment basins during construction and operation. The drainage channels should be visually inspected to ensure that they are operating as intended. Areas of erosion should be repaired and trapped sediment removed.

Where the construction activities or proposed infrastructure have the potential to impede the conveyance of surface water runoff to the sediment basins, bunds and/or collection drains should be constructed within the approved clearance area to direct surface water runoff from the proposed construction and infrastructure areas and to the existing sediment basins.

Given the location of the proposed construction and infrastructure areas reporting to Sediment Basin A, with a small upstream catchment area, construction of upslope diversion drains is not considered warranted.

5.3 Sediment Basins

The required size of the sediment basins to manage runoff potentially containing sediment from the associated catchment areas has been assessed in accordance with the Landcom (2004) and the Department of Environment and Climate Change (2008) guidelines. The conceptual basin sizing was undertaken assuming the following:

- Type F sediment retention basin – predominantly fine-grained soils requiring a longer residence time to settle.
- Sediment basins to be in place for more than three years.
- A sensitive receiving environment given the proximity of the Modification to Lake Cordeaux.
- Capacity required to capture runoff from a 95th percentile 5-day duration rainfall event of 89.7 mm (interpolated between Wollongong and Mittagong 5-day rainfall depth in Table 6.3a of Landcom (2004) based on the proximity of the site to Wollongong and Mittagong).
- An average volumetric runoff coefficient of 0.57 for the northern catchment area and 0.64 for the southern catchment area based on the land use type.
- Allowance for sediment storage zone capacity equal to 50% of the above calculated settling zone capacity.

A summary of the estimated catchment areas and conceptual sizing of the sediment basins is provided in Table 1. Note that the catchment areas include the existing and proposed construction and infrastructure areas.

Table 1 Summary of Proposed Sediment Basins

Sediment Basin	Estimated Catchment Area (ha)	Settling Zone Volume (ML)	Sediment Zone Volume (ML)	Minimum Required Volume (ML)
A	1.2	0.6	0.3	0.9
B	1.1	0.6	0.3	0.9

ML = megalitres

In accordance with Landcom (2004), the water stored in the settling zone should be drained within five days following a rainfall event in order to re-instate the settling zone capacity. Water drained from the sediment basins should be directed to a level spreader prior to discharging off-site to the adjacent bushland.

IMC has estimated the capacity of the existing sediment basins, when de-silted to a depth of 2 m, at 0.75 ML for Sediment Basin A and 0.7 ML for Sediment Basin B. As such, the estimated capacity of the existing sediment basins is less than that estimated as required to manage runoff potentially containing sediment from the associated catchment areas. It is therefore recommended that the capacities of the existing sediment basins are confirmed by survey and enlarged as necessary to achieve the minimum required volume specified in Table 1. As indicated in Section 5.1, the approach adopted for enlargement of the existing sediment basins i.e. an increase in depth or surface area, would be determined during the detailed design stage.

Short-term sediment control measures, i.e. sediment traps, sediment fences etc., should be constructed downstream of the sediment basins to manage sediment runoff during construction activities required to enlarge the existing sediment basins. Material excavated from the sediment basins should be stockpiled within the basin catchment area and stabilised to control erosion (e.g. by revegetating).

5.4 Maintenance and Management

Visual inspections of the drainage channels and sediment basins are recommended to be undertaken on a monthly basis and following rainfall events in excess of 89.7 mm in 5 days. The structures should be inspected for integrity and function and to identify areas of accumulated sediment or erosion. Areas of erosion in drainage channels should be repaired and trapped sediment removed.

It is recommended that the sediment basins are equipped with a de-silting marker post to indicate the maximum height of the sediment storage zone. If the settled sediment approaches the marker point, the basin should be de-silted.

6. SITE WATER BALANCE

The proposed Modification includes construction of a process water and fire water management system. The water management system is proposed to comprise bores to pump water from and return water to the underground mine workings in addition to pipes/tanks to convey and store recovered water within the Modification area.

The Modification area water management system will operate independently to the Dendrobium Mine water management system. The Modification will operate a neutral site

water balance with water recovered from underground workings managed on site and recycled to the underground for process water supply or used on-site for fire management purposes.

7. CLOSURE

The Modification would be located wholly within the previously approved and previously cleared area associated with the Dendrobium no. 2 and 3 shafts. As such, it is understood that the Modification would constitute the extension or expansion of the carrying out of the development and is therefore subject to Clause 11A of the SEPP.

Implementation of the erosion and sediment control measures described above would result in the Modification having the same impact on water quality as that of the existing development if it were extended or expanded under similar conditions as the existing development consent. Accordingly, the Modification would have a neutral effect to water quality in accordance with Clause 11A of the SEPP.

Thank you for the opportunity to be of service. Please do not hesitate to contact the undersigned if you have any queries.

Yours faithfully,

Camilla West
Associate Scientist

Tony Marszalek
Senior Principal Engineer

References:

Department of Environment and Climate Change (2008). "Managing Urban Stormwater Soils and Construction – Volume 2E – Mines and Quarries". NSW Department of Environment and Climate Change, Sydney, June.

Illawarra Metallurgical Coal (IMC) (2020). "WaterNSW Special Areas Wet Weather Management Plan", October.

Landcom (2004). "Managing Urban Stormwater: Soils & Construction Volume 1", 4th edition, March.

NSW Rural Fire Service (undated). "Standards for Asset Protection Zones".

WaterNSW (2021). "Neutral or Beneficial Effect on Water Quality Assessment Guideline", March.

APPENDIX 2

DENDROBIUM GAS INFRASTRUCTURE NO 2 AND NO 3 VENT SHAFT - BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT – STREAMLINED ASSESSMENT MODULE – SMALL AREA (NICHE, 2022A)

Excellence in your environment

niche Environment and Heritage

Dendrobium Gas Infrastructure No 2 and No 3 Vent Shaft

Biodiversity Development Assessment Report

Streamlined assessment module – Small area

Prepared for South32 Illawarra Metallurgical Coal | 11 February 2022

niche-eh.com

Excellence in your environment

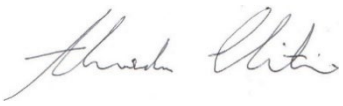
Project number	Client	Project manager/Accredited assessor	LGA
7066	South32 Illawarra Metallurgical Coal	Luke Baker (Accreditation No BAAS17033). Sian Griffiths (Accreditation No. BAAS17066) Alex Christie (Accreditation No. BAAS18131)	Wollongong LGA

This Biodiversity Development Assessment Report has been prepared on the basis of the requirements of (and information provided under) the Biodiversity Assessment Method as certified by BAM Accredited Assessor: Alex Christie (BAAS # BAAS18131)

Version	Author	Review	Status	Date
Draft 1	Alex Christie	Luke Baker	Draft 1	17 January 2022
Final	Alex Christie	Sian Griffiths	Final	31 January 2022
Final	Alex Christie	Clive Berry	Final	4 February 2022
Final	Alex Christie	Clive Berry	Final	8 February 2022
Final	Alex Christie		Final	11 February 2022

Niche Environment and Heritage Pty Ltd (ACN 137 111 721)
Enquiries should be addressed to Niche Environment and Heritage
PO Box 2443, Parramatta NSW 1750, Australia
Email: info@niche-eh.com

As required by section 6.15(1) of the NSW *Biodiversity Conservation Act 2016*, I certify that this Biodiversity Development Assessment Report has been prepared by Niche Environment and Heritage, on the basis of the requirements of (and information provided under) the Biodiversity Assessment Method.



Alex Christie

31 January 2022

Executive summary

Context

Niche Environment and Heritage Pty Ltd (Niche) was engaged by Illawarra Metallurgical Coal (IMC) to prepare a Biodiversity Development Assessment Report (BDAR) for the establishment of additional gas management infrastructure at the Dendrobium Mine (the Project) located on land at Cordeaux, NSW, approximately 12km north-west of Wollongong. The Subject land covers the area within the approved No 2 and No 3 vent shaft location (mining lease 1566).

This report describes the ecological values within the Subject land as per the Biodiversity Assessment Methodology (BAM) (DPIE 2020a) and determines whether the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The 'Streamlined assessment module – Small area' for assessing small areas has been applied for this BDAR on the basis that the area to be disturbed by the Project is below the maximum clearing area threshold set out in the BAM. The minimum lot size associated with the Subject land is ≤40 ha and the proposed activity would involve clearing/disturbance to less than 2ha of native vegetation (i.e. less than 0.84 ha).

The ecological assessment, undertaken in accordance with the BAM (DPIE 2020a), included the following:

- Site walkover to map type and extent of native vegetation and determine habitat for threatened biodiversity.
- Collection of floristic and habitat data from two BAM plots and two Rapid Data Points (RDPs).
- Targeted surveys for flora species.
- Targeted fauna survey was not undertaken.

Results

Vegetation occurring across the Subject land aligned to a single PCT and occurred as one condition class, *PCT 1083 – Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion* in moderate condition.

Two candidate species, Gang-gang Cockatoo (*Callocephalon fimbriatum*) and Littlejohn's Tree Frog (*Litoria littlejohni*) were incidentally recorded within or near the Subject land during the field survey. No threatened flora are considered to have a moderate or higher likelihood of occurrence in the Subject land.

As no threatened biodiversity listed under the EPBC Act were considered likely to be impacted in the Subject land, no assessment/s of significance under the EPBC Act were required. As such, there is no requirement for an EPBC Act Referral regarding Commonwealth threatened species, communities or populations.

Impact assessment

The Project will result in the following:

- Direct removal of 0.84 ha of regenerating native vegetation. Only 0.1 ha of vegetation would be totally removed, 0.74 ha would be managed as an APZ requiring the remove of trees, shrubs and fallen logs only (modified non-threatened fauna habitat).
- No impacts to threatened flora or fauna.
- No impacts to Serious and Irreversible Impacts (SAII) entities.

Avoid/mitigate impacts

IMC have aimed to avoid and minimise environmental impacts from the Project through detailed design, siting of the Project and implementation of actions aimed at mitigating and managing potential indirect impacts of the Project as detailed in Section 3.1.1.

Measures to reduce the impact of the Project on biodiversity values are detailed in this report.

Credit calculations and offsetting

No biodiversity offsets are required for this Project.

Glossary and list of abbreviations

Term or abbreviation	Definition
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method Credit Calculator
BC Act	NSW *Biodiversity Conservation Act 2016*
BC Reg	NSW *Biodiversity Conservation Regulation 2017*
BDAR	Biodiversity Development Assessment Report
BMP	Biodiversity Management Plan
BOS	NSW Biodiversity Offsets Scheme
CEEC	Critically Endangered Ecological Community
cm	Centimetre/s
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DCP	Development Control Plan
DPIE	NSW Department of Planning, Industry and Environment (formerly DECCW, DECC, DEC, OEH)
EEC	Endangered Ecological Community
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ha	Hectare/s
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometre/s
LEP	Local Environment Plan
LGA	Local Government Area
Locality	The Subject land and surrounds, nominally a 10 km radius from the Subject land
m	Metre/s
MNES	Matters of National Environmental Significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*).
PCT	Plant Community Type
RDP	Rapid Data Point
SAII	Serious and Irreversible Impacts
SEPP	State Environmental Planning Policy
SSD	State Significant Development
TBDC	Threatened Biodiversity Data Collection
TEC	Threatened Ecological Community
VI	Vegetation Integrity as calculated by the BAM-C

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1. Introduction

1.1 Project description

The Dendrobium Mine is an underground coal mine situated in the Southern Coalfield of New South Wales (NSW), approximately 8 kilometres (km) west of Wollongong (Figure 1). The Dendrobium Mine is operated by Illawarra Coal Holdings Pty Ltd (IMC), a wholly owned subsidiary of South32.

IMC is planning the extraction of approved longwall (LW) blocks LW21, and the proposed LW22 and LW23 in Area 3C of the Dendrobium Mine. The forecast gas quantities in Area 3C exceed the dilution capacity of the ventilation circuit, necessitating the capture and reticulation of post-drainage gas through new gas management infrastructure, instead of through the ventilation infrastructure as currently occurs. The infrastructure would also be used for pre-drainage of other LW blocks within the Area 3C domain (Figure 2). Therefore, IMC are proposing a modification of the Dendrobium Mine Development Consent DA 60-03-2001 (the Modification) to allow the development of additional gas management infrastructure at the Dendrobium Mine (the Project) (Figure 2).

Approval for the Modification to Project Approval (DA 60-03-2001) is being sought under section 4.55(1A) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). In summary, the Project would include the following changes to the approved Dendrobium Mine:

- Construction of new gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre-drainage gas from Area 3C at the site of the existing Dendrobium No 2 and 3 Shafts.
- Gas extraction from the underground mine via a borehole and vacuum pump, with associated infrastructure including a cooling water system incorporating cooling towers.
- Gas treatment using enclosed flares on the surface. Under conditions not suitable for flaring, gasses would alternatively be vented via a stack approximately 25 metres (m) high.
- Ancillary infrastructure, such as fencing, pumps, CO2 tanks, condensate tanks and surface pipes.
- Additional water management infrastructure (e.g. sediment controls).
- Process/fire water system, including bores to pump water from and return water to the underground mine workings and pipes/tanks to convey and store this water.
- Installation and use of a transportable substation for electricity requirements.
- Upgrade of the three surface ventilation fans at the gas plant construction site, including upgraded fan impellers, shafts, drives and motors within the existing footprint.
- Minor upgrades of existing electricity transmission infrastructure, such as replacement poles and aerial conductors within mining lease (ML) 1566.
- Temporary bracing of the 2-span Bailey bridge that is on the access trail (Sandy Creek crossing) using props at regular spacing to support the bridge's structure if heavy loads are to be transported across the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).

Figure 3 shows the development footprint, including areas of total clearing and Asset Protection Zones (APZ).

It should be noted that all construction activities and infrastructure would be located wholly within the approved and previously cleared area associated with Dendrobium No 2 and 3 Vent Shafts and there would be no surface disturbance outside of mining lease (ML) 1566 (Figure 2). Works undertaken as part of the temporary bridge bracing would not require vegetation disturbance.

Clearance of vegetation (and management of vegetation for bushfire control purposes) is required within areas of revegetation that has occurred following the approved clearance activities to establish the existing ventilation shaft infrastructure. IMC have consulted with the NSW Biodiversity and Conservation Division - Environment, Energy and Science and received confirmation that the use of the 'Streamlined assessment module – Small area' is appropriate for this Project. Justification of the use of the 'Streamlined assessment module – Small area' is provided in Section 1.3.2.

1.2 Description of the Subject land

The proposed Project is located on land at Cordeaux, NSW, approximately 12km north-west of Wollongong, within the Wollongong local government area (LGA) (Figure 1).

The Subject land is associated with gas infrastructure for the Project and encompasses approximately 3.12 hectares (ha) of land, which is currently zoned C2 (Environmental Conservation) in the Wollongong Local Environmental Plan 2009 (NSW Government 2010).

The Subject land is situated at Vent Shaft 2 and Vent Shaft 3 (ML 1566) located within the Sydney Catchment Area. All areas within the Subject land were previously cleared of all vegetation in approximately 2005 as part of the approval for the construction of the vent shafts, however these areas have been rehabilitated through the planting of native tubestock and regeneration of the existing seedbank. Disturbance within the Subject land as part of clearing associated with the previous development approval for the construction of the vent shaft can be seen in Plate 1. Regeneration of this area over time can be seen in Plate 2, Plate 3 and Plate 4.

There are two separate small areas which are also included within the Subject land, both located to the west of the vent shaft site where Fire Trail 6C crosses Sandy Creek. These areas have been included as they are part of the works associated with bridge upgrade at Sandy Creek crossing, however no vegetation removal is required in these areas (Figure 3). The only works required within these areas involve temporary bracing of the existing bridge using props comprising of stacked railway sleepers which will be placed on the watercourse rock outcrop to the height of the bridge undercarriage at regular spacing to support the structure of the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).

The Subject land is well connected to extensive areas of native vegetation within the surrounding Sydney Catchment Area. A large proportion of the broader landscape remains intact as high quality vegetation. Sandy Creek, a third order waterway (Strahler 1957) runs through the small areas of Subject land in the south-west, draining into Cordeaux Dam located approximately 0.2 km to the west of the Subject land (Figure 2).

Plate 1: Aerial imagery of the Subject land from 2008

Plate 2: Aerial imagery of the Subject land from 2010

Plate 3: Aerial imagery of the Subject land from 2011

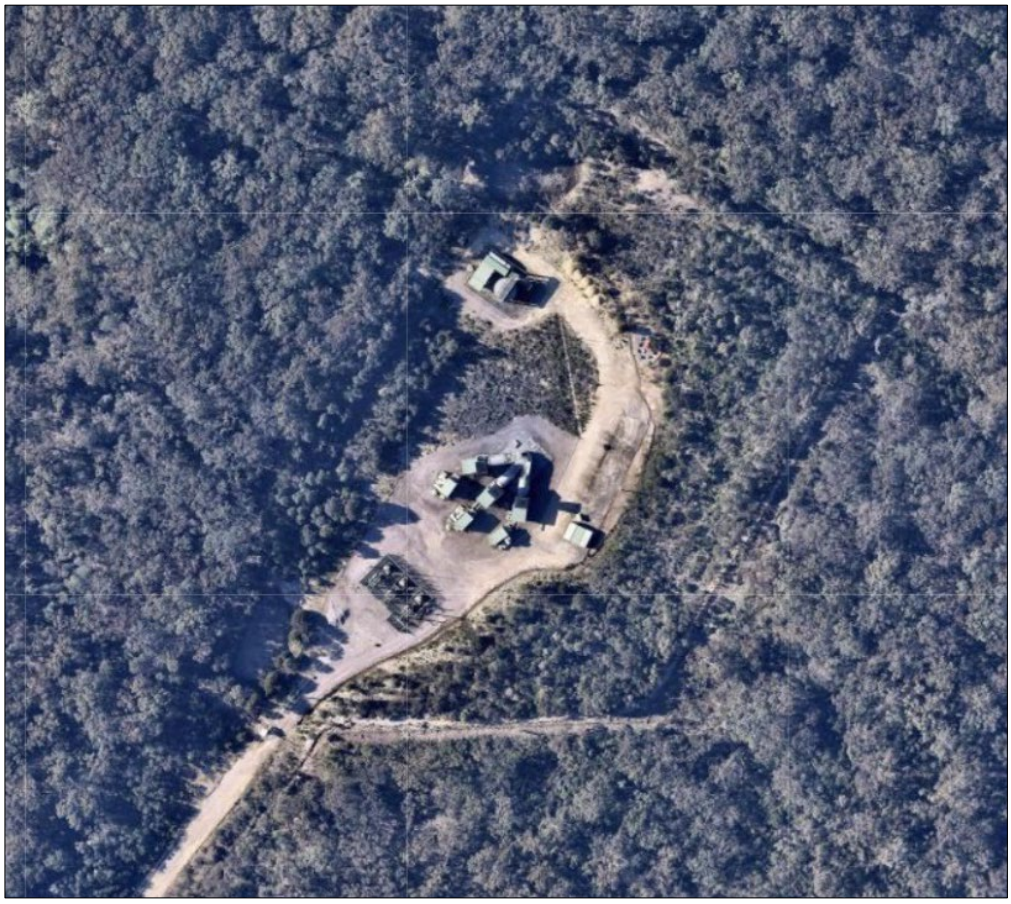


Plate 4: Aerial imagery of the Subject land from 2019

1.3 Assessment objectives and format

1.3.1 State approval and assessment process

The proposed Modification to the Stage 2 Project Approval (DA 60-03-2001) will be sought under section 4.55(1A) of the EP&A Act. As such, a Biodiversity Development Assessment Report (BDAR) prepared in accordance with the NSW Biodiversity Assessment Method (BAM) (NSW Department of Planning, Industry and Environment [DPIE] 2020a) is required to assess impacts to biodiversity as per the NSW *Biodiversity Conservation Act 2016* (BC Act). As the Project includes additional infrastructure beyond what has previously been assessed and approved for the Dendrobium Mine, the Project would result in additional clearing of vegetation and habitat. However, biodiversity offsets prescribed by the BAM Credit Calculator (BAM-C) will not be required (see Sections 4.1 and 4.2).

In accordance with section 30A of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, the BDAR to be submitted with the application for modification must take into account:

- Any measures already taken to avoid, minimise or offset the impact on biodiversity values in connection with the planning approval before the proposed modification; and
- Only the additional impact on biodiversity values resulting from the modification of the development and not those associated with the development as approved.

1.3.2 Application of the BAM (Streamlined assessment module – Small area)

The 'Streamlined assessment module – Small area' for assessing small areas has been applied for this BDAR on the basis that the area to be disturbed by the Project is below the maximum clearing area threshold set out in the BAM. The minimum lot size associated with the Subject land is ≤40 ha and the Project would involve clearing/disturbance to less than 2ha of native vegetation (i.e. less than 0.84 ha). The assessment approach adopted is consistent with the assessment requirements outlined in Appendix C and Table 27 of the BAM.

IMC have consulted with the NSW Biodiversity and Conservation Division -Environment, Energy and Science and received confirmation that the use of the 'Streamlined assessment module – Small area' is appropriate for this Project.

1.3.3 Commonwealth approval and assessment process

Matters of National Environmental Significance (MNES) are protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The BAM (DPIE 2020a) 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 development footprint. Where threatened biodiversity listed under the EPBC Act may be potentially impacted by the Project, an assessment of impacts will be undertaken via the Significance Impact Criteria provided under the EPBC Act.

Under the EPBC Act, activities that have potential to result in significant impacts on MNES must be referred to the Commonwealth Minister for the Environment and Energy for assessment.

This report considers the impact of the Project on MNES.

1.3.4 Assessment format

The primary objective of this assessment is to use the guidelines and methodology provided in the BAM (DPIE 2020a) to determine the impact the Project would have on biodiversity, avoid and mitigate these impacts and then calculate the Project's biodiversity offset requirement.

This BDAR consist of two broad stages consistent with the BAM (DPIE 2020a):

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.

1.4 Assessment resources and assessor qualifications

This BDAR has been prepared by the accredited personnel and support staff identified in Table 1. Resources and survey guidelines used in the preparation of this BDAR are detailed in Table 2.

Table 1: Assessor and support staff qualifications and resources

Personnel	Role	Qualifications	Tasks carried out
Luke Baker	Discipline Manager, Ecology – Flora Biodiversity Lead; BAM Accredited Assessor	BappSc Accredited Biodiversity Assessor (BAAS17033)	Quality assurance.
Sian Griffiths	Principal – Ecology	BEnvSc (Hons) Accredited Biodiversity Assessor (BAAS 17066)	Project Management, Data management, Field survey planning and coordination and quality assurance.
Alex Christie	Senior Consultant - - Ecology	BEnvSc Accredited Biodiversity Assessor (BAAS18131)	Project Management, Report Preparation and Impact Assessment.

Table 2: Assessment resources and guidelines used

Assessment resources/guideline	
Resources	• BAM (DPIE 2020a). • BAM 2020 Operational Manual – Stage 1 (DPIE 2020b). • BAM Operational Manual – Stage 2 (DPIE 2019a). • BAM 2020 Operational Manual – Stage 3 (DPIE 2020c). • BAM Calculator User Guide (NSW Office of Environment and Heritage 2018). • Biodiversity Assessment Method Calculator (BAM-C), app version 1.4.0.00, data version 50 (DPIE 2022a). • The BioNet Atlas of NSW Wildlife (DPIE 2022b). • EPBC Act Protected Matters Search Tool (PMST) (Commonwealth Department of the Agriculture, Water and Environment (DAWE) 2022a). • BioNet Threatened Species Database (DPIE 2022c). • The NSW Bionet Vegetation Information System database, access via the Bionet Vegetation Classification database (DPIE 2022d). • Species Profile and Threats Database (SPRAT) with information on threatened species profiles, recovery plans and final determinations (DAWE 2022b).
Survey guidelines	• Surveying threatened plants and their habitats, NSW survey guide for the Biodiversity Assessment Method (DPIE 2020d).

2. Biodiversity Assessment

2.1 Landscape context

As detailed in Section 3 of the BAM (DPIE 2020a), a landscape assessment for the Project is required. Landscape value is derived from the 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 Project were to proceed.

Table 3 provides details of the landscape settings and scored landscape features for the Project.

Table 3: Landscape features and scoring under the NSW BAM (DPIE 2020a)

Landscape features	Description	Figure reference
Interim Biogeographic Regionalisation for Australia (IBRA) bioregion/subregion	Sydney Basin bioregion/Sydney Cataract subregion	Figure 2
NSW (Mitchell) Landscapes	Woronora Plateau Mitchell Landscape	Figure 2
Rivers, streams and estuaries and Strahler stream order	Sandy Creek, a Strahler third stream order waterway (Strahler 1957), runs through the small areas of Subject land in the south-west. An ephemeral first order stream begins on the western edge of the main Subject land and runs into Cordeaux Dam.	Figure 2
Wetlands within and adjacent to development	Cordeaux Dam is a manmade reservoir located 0.2km to the west of the Subject land. The nearest important wetland consists of Minnamurra River Estuary which is located 28 km to the south-east of the Subject land (Department of Environment and Energy [DoEE] 2010). The nearest RAMSAR wetland consists of the Towra Point Nature Reserve located 50 km to the north-east of the Subject land (DPIE 2012).	-
Connectivity features	Native vegetation within the Subject land is directly connected to extensive areas of native vegetation associated with the Sydney Catchment Area. Upper Nepean State Conservation Area, 12 km to the west, and Illawarra Escarpment State Conservation Area 6km to the east, via a corridor of hills and mountains swathed in remnant native vegetation forming high quality fauna and flora habitat. This wildlife corridor allows for dispersal of native fauna from the eastern seaboard into other extensive conservation areas to the west.	Figure 2
Buffer area (percent native vegetation cover)	A 1,500 m buffer was applied to the Subject land resulting in an overall buffer area of 815.35 ha. Existing vegetation mapping (DPIE 2016) was used to identify native vegetation within the buffer area. ***Woody vegetation cover*** The native vegetation extent and cover of woody vegetation was determined via aerial photography interpretation based on canopy cover. For woody	Figure 2

Landscape features	Description	Figure reference
	vegetation 82% of the buffer area was determined to support native woody vegetation with benchmark cover (671.6 ha). ***Non-woody vegetation cover*** For non-woody vegetation, experience of the Subject land was drawn upon in addition to aerial photography interpretation to estimate cover of native grassland vegetation. No areas of non-woody vegetation were identified within the buffer area. ***Total native vegetation cover*** Combining the estimated woody and non-woody vegetation cover resulted in 82% of the buffer area supporting native vegetation.	
Karst, caves, crevices, cliffs, rocks and other geological features of significance	The Subject land does not contain any geological features of significance. Sandy Creek comprises of an exposed sandstone creek bed which is consist with many other creeklines within the Sydney Catchment. Areas of the Sydney Catchment surrounding the Subject land contain a number of sandstone cliffs, shelters and rock outcropping. The area where Sandy Creek meets Cordeaux Dam (approximately 130 m from Sandy creek bridge) there is a sandstone cliff which is approximately 8 m high and acts as a waterfall into Cordeaux Dam. The majority of the Subject land contains high hazard soil areas mapped as capability 8 – extreme limitations.	Figure 2
Areas of Outstanding Biodiversity Value (AOBVs)	The Register of Declared Areas of Outstanding Biodiversity Value (AOBV) has information about declared AOBV in NSW. AOBV declarations in NSW include the following: ▪ Gould's Petrel – critical habitat declaration. ▪ Little penguin population in Sydney's North Harbour – critical habitat declaration. ▪ Mitchell's Rainforest Snail in Stotts Island Nature Reserve – critical habitat declaration. ▪ Wollemi Pine – critical habitat declaration. No registered AOBVs occur within the Subject land or surrounds.	

2.2 Data review

A review of relevant literature, databases and existing vegetation mapping was undertaken to identify likely vegetation communities and threatened biodiversity with the potential to occur in the Subject land. This information was reviewed prior to field surveys to inform initial survey effort and design and identify species for consideration.

Database searches within the locality (a 10 km radius around the Subject land) were conducted to identify threatened species and TECs with known occurrences or with the potential to occur on the Subject land. A likelihood of occurrence analysis (Annex 2) was then undertaken prior to field surveys for each species/TEC, based on preliminary information regarding habitat present within the Subject land. The following resources were used for this purpose:

- Database searches:
  - NSW BioNet Atlas Database (DPIE 2022b) for spatial records of threatened flora listed under the BC Act within a 10 km radius of the Subject land.
  - EPBC Act (PMST) (DAWE 2022a) for flora and ecological communities identified as MNES known from or with potential habitat within a 10 km radius of the Subject land.
  - Preliminary run of the BAM-C tool (using benchmark condition for previously mapped Plant Community Types [PCTs]) to identify candidate species credit species and predicted ecosystem credit species known or predicated to occur within the IBRA subregion.
- Vegetation mapping: existing vegetation mapping (DPIE 2016) was examined prior to the field survey to determine the vegetation communities likely to be present in the Subject land.

Five categories for likelihood of occurrence were attributed to threatened biodiversity after considering the number and proximity of known records, presence or absence of preferred habitat types (e.g. native vegetation types) and professional judgement. The categories are outlined in Table 4. Species considered further for impact assessment included:

- Those in the 'Known', 'High' or 'Moderate' categories and where impacts for the species could reasonably occur from the Project.
- Candidate species as identified by the BAM-C.

Table 4: Likelihood of occurrence criteria

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
Known	The species was observed within the Subject land.	The species was observed within the Subject land.
High	It is likely that a species inhabits or utilises habitat within the Subject land.	It is likely that a species inhabits or utilises habitat within the Subject land.
Moderate	Potential habitat for a species occurs within the Subject land. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the Subject land.	Potential habitat for a species occurs within the Subject land and the species may occasionally utilise that habitat. Species unlikely to be wholly dependent on the habitat present within the Subject land.
Low	It is unlikely that the species inhabits the Subject land.	It is unlikely that the species inhabits the Subject land. If present, the species would likely be a transient visitor. The Subject land contains only very common habitat for this species which the species would not rely on for its on-going local existence.

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
None	The habitat within the Subject land is unsuitable for the species.	The habitat within the Subject land is unsuitable for the species.

Species listed with a 'Low' or 'None' likelihood of occurrence are those for which there is limited, or no habitat present within the Subject land.

The likelihood of occurrence analysis (Annex 2) was then updated for each species, based on the PCTs mapped within the Subject land, following the onsite habitat assessment.

All candidate species identified in the BAM-C and those considered likely to occur are listed in Table 8.

2.3 Native vegetation, threatened ecological communities and vegetation integrity

This section describes the survey effort, identification and determination of the extent of Plant Community Types (PCTs) occurring across the Subject land.

2.3.1 Field survey

One day of field survey was undertaken on 19 November 2021. Plot/transect surveys and targeted threatened species surveys were conducted throughout the Subject land with results used within the BAM-C to generate credit requirements. PCTs across the Subject land were recorded and mapped using a combination of vegetation quadrats, transects and walking meanders. Vegetation mapped as occurring within the Subject land and flora survey effort is shown on Figure 4. Table 5 lists the PCT present, including its vegetation formation, class and status. Alignment of the vegetation to a PCT is discussed in Section 2.3.3.

The following survey tasks were completed for the flora survey:

- Plant community delineation and mapping, using a combination of floristic assessments within BAM plots (two plots as per the BAM requirements [DPIE 2020a]).
- Targeted flora surveys, including quadrats and random meander (see details below).
- Opportunistic observations of threatened flora, Threatened Ecological Communities (TECs), habitat quality and high threat and priority weeds.

Ecological values of the Subject land (including potential threatened species habitat) were appraised via survey and assessment of vegetation communities and their condition.

2.3.2 BAM plots

The BAM plot requirement was determined using the BAM (DPIE 2020a) and was based on the area of each PCT condition type to be impacted. Existing vegetation mapping was used to estimate the number of plots required prior to survey.

The number of plots conducted for each PCT and vegetation zone is provided in Table 5 and the location of the completed plots is shown on Figure 4. Details regarding PCT delineation and mapping are provided in Section 2.3.3.

2.3.3 Plant community delineation and mapping

All vegetation within the Subject land was validated via field survey with mapping updated to reflect vegetation observed and surveyed during field assessment. Vegetation occurring across the Subject land aligned to a single PCT and occurred as one condition class, *PCT 1083 – Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion* in moderate condition (Table 5).

A more detailed vegetation community description including species used to aid in determining the PCT and justification for alignment is provided in Annex 1.

Table 5: PCTs present across the Subject land

PCT ID	PCT name	Zone (Condition)	TEC status per BioNet Vegetation Classification (BC Act/EPBC Act)	Vegetation Formation (Keith 2004)	Vegetation Class (Keith 2004)	PCT % cleared (DPIE 2022d)	Patch size (ha)	Total area in Subject land (ha)	Area to be cleared /impacted for development (ha)	BAM Plots required for the impact area	BAM Plots completed
PCT 1083	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Moderate	Not a TEC	Dry Sclerophyll Forests (Shrubby sub-formation)	Sydney Coastal Dry Sclerophyll Forests	17	>101	3.12	0.84	1	2
Total								**3.12**	**0.84**	**1**	**2**

2.3.4 Site values

Flora

A total of 62 flora species were recorded across the two plots; including 61 native species and one exotic species. Floristic plot data including cover and abundance of all species recorded is provided in Annex 3.

Plot and transect values

Results of the floristic composition, structure and function data obtained during the field assessment is provided in Annex 4.

Site value scores

The site value assessment was carried out by entering plot data into the BAM-C. The data provides quantitative measures of composition, structure and function for each vegetation zone (Annex 4). The BAM-C compares the values recorded at the Subject land with the benchmark for the vegetation class to provide the site value score. This score represents the overall condition of the vegetation compared to the benchmark value (out of 100).

The score from these inputs was used to determine the number of ecosystem credits that are required for the Project. Patch size for PCT 1083 moderate was given the highest score in the BAM-C (>101 ha) as this vegetation zone is directly connected to other large areas of vegetation considered to be in a better condition than that present in the Subject land (as can be seen on Figure 2).

The current and future vegetation integrity (VI) scores from the BAM-C are detailed in Table 6.

. The future VI scores for the direct impact zones were reduced depending on the level of clearing required in each vegetation zone. For the vegetation zone where infrastructure is proposed, attributes within the BAM-C were reduced to zero for composition, function and structure components to reflect total clearing of vegetation within this zone. Where partial clearing is proposed in the APZ, trees and shrubs have been reduced to zero for both the composition and structure components, fallen logs have been reduced to zero and tree regeneration changed to absent for the function component. Areas within the APZ are producing a future VI score of 17.2 as opposed to the areas of proposed infrastructure which are generating a score of zero.

Given the mitigation measures to reduce the impact of indirect impacts (see Section 3), only the direct impact areas are required to be entered into the BAM-C for the purpose of calculating the ecosystem credits, as shown in Table 6.

Table 6: Vegetation zones with current and future VI scores

Vegetation zone	Area	Vegetation removal	Impacted area (ha)	Patch size (ha)	Composition condition score	Structure condition score	Function condition score	Current VI score	Future VI score	Change in VI score
PCT 1083 moderate	Proposed Infrastructure	Total clearing of vegetation	0.1	>101	88.7	62.1	58.1	68.4	0	-68.4
PCT 1083 moderate	Asset Protection Zone	Removal of trees, shrubs and fallen logs	0.74	>101	88.7	62.1	58.1	68.4	17.2	-51.2

2.3.5 High threat and priority weeds

No High Threat Weed (HTW) species or priority weeds were recorded during the field survey. Only one exotic species, Catsear (*Hypochaeris radicata*), was recorded within the Subject land during the field survey.

2.3.6 Threatened ecological communities

PCT 1083 does not align to a TEC under the BC Act or EPBC Act. Therefore, the Project would not impact any Commonwealth or State listed TECs. Using the 'Streamlined assessment module – Small area' only requires impacts to TECs to be offset, consequently vegetation within the Subject land would not need to be offset.

2.4 Habitat suitability for threatened species

2.4.1 Data review

A review of relevant literature, databases and existing vegetation mapping was undertaken to identify threatened species habitat and their potential to occur on the Subject land. Methodology is detailed in Section 2.2, including database searches and literature reviews and assessment of the likelihood of occurrence of each species. Results of the searches and reviews were undertaken prior to field survey to inform field survey requirements.

A likelihood of occurrence analysis was undertaken for each species, prior to field surveys, based on the PCTs/vegetation mapped within the Subject land. This was updated within the current report (Annex 2) to reflect the suitability and condition of habitat present within the Subject land, as identified following the onsite habitat assessment.

2.4.2 Methods – field survey

Field surveys were undertaken on 19 November 2021. The following tasks were completed:

1. Habitat assessment – identification of important habitat features.
2. Evaluation of habitat quality of native vegetation present.

2.4.2.1 Habitat assessment

The key habitat features recorded were used to determine the likely presence of threatened species. These features included:

- Type, condition and diversity of vegetation communities present.
- Presence of roosting/breeding/shelter resources such as:
  - large stick nests suitable for raptors;
  - hollow-bearing trees and stags;
  - rock ledges, shelters, caves, outcrops; and
  - logs and leaf litter.
- Permanent and ephemeral aquatic habitat.

2.4.3 Fauna and fauna habitats

Fauna species recorded in the Subject land are listed in Annex 5. No targeted surveys for threatened fauna were conducted, however, two candidate species, Gang-gang Cockatoo (*Callocephalon fimbriatum*) and Littlejohn's Tree Frog (*Litoria littlejohni*) were incidentally recorded within or near the Subject land during the field survey. Habitat survey was conducted during the vegetation assessment and used to identify likelihood of candidate species occurring within the Subject land.

The native vegetation present consists of regenerating native vegetation, both planted and natural regeneration. The Subject land consisted of overstorey and midstorey vegetation which is approximately 13 years old and lacks important habitat features. Given the age of the vegetation, no hollow bearing trees or large trees were recorded. Due to previous clearing and disturbance, the Subject land does not contain any surface rock and fallen timber recorded was minimal (<30cm).

Local fauna would utilise the Subject land for occasional foraging, however, the Subject land is located within the Sydney Catchment and is surrounded by large expanses of remnant high quality vegetation which is likely to be preferred by local fauna. Therefore, the Subject land is unlikely to provide suitable breeding habitat for threated fauna. The Subject land may provide limited foraging habitat for transient threatened fauna.

Aquatic habitat

The aquatic habitat within the Subject land consists of two retention basins located on the western side of the Subject land surrounding the vent shafts and Sandy Creek which flows through a small area of the Subject land to the west of the main Subject land. Installation and maintenance of sediment controls are approved activities for the vent shaft site.

The retention basins are shallow ephemeral dams which dry out during dry weather and have been established to retain potential sediment runoff from the vent shaft site. During rain events, water from these basins flow into the ephemeral drainage line to the west of the Subject land into Cordeaux Dam. These retention basins contain *Typha* sp. (Cumbungi) and may provide limited habitat for common amphibian species but are unlikely to provide suitable habitat for threatened species (see Plate **6**).

Habitat along Sandy Creek is in good condition and provides habitat for Littlejohn's Tree Frog which were recorded as tadpoles in a number of the pools either side of the crossing. Littlejohn's Tree Frog is listed as Vulnerable on both the BC and EPBC Acts. The surrounding mature, remnant vegetation provides suitable habitat for mature Littlejohn's Tree Frogs.

2.4.4 Threatened flora and fauna

Two species of threatened fauna, Gang-gang Cockatoo and Littlejohn's Tree Frog were incidentally recorded within or near the Subject land during the field survey (Figure 5). As identified in Table 8 the Gang-gang Cockatoo is a dual credit species, and the Subject land does not contain breeding habitat for the species.

2.4.5 Ecosystem credit species assessment

A list of ecosystem credit species predicted by the BAM-C to occur within the Subject land are shown below in Table 7. All ecosystem (predicted) credit species were assumed present within the Subject land for which they were predicted to occur.

Table 7. Predicted (ecosystem credit) threatened species

Common Name	Scientific Name	BC Act*	Sensitivity to gain class	Vegetation Types
Regent Honeyeater	*Anthochaera phrygia*	CE	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion

Common Name	Scientific Name	BC Act*	Sensitivity to gain class	Vegetation Types
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Varied Sittella	*Daphoenositta chrysoptera*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Spotted-tailed Quoll	*Dasyurus maculatus*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Little Lorikeet	*Glossopsitta pusilla*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Little Eagle	*Hieraaetus morphnoides*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
White-throated Needletail	*Hirundapus caudacutus*	-	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Broad-headed Snake	*Hoplocephalus bungaroides*	E	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Swift Parrot	*Lathamus discolor*	E	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Square-tailed Kite	*Lophoictinia isura*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Little Bent-winged Bat	*Miniopterus australis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone

Common Name	Scientific Name	BC Act*	Sensitivity to gain class	Vegetation Types
				plateaux of the Sydney Basin Bioregion
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Turquoise Parrot	*Neophema pulchella*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Powerful Owl	*Ninox strenua*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Eastern Osprey	*Pandion cristatus*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Yellow-bellied Glider	*Petaurus australis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Scarlet Robin	*Petroica boodang*	V	Moderate Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Koala	*Phascolarctos cinereus*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Golden-tipped Bat	*Phoniscus papuensis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
New Holland Mouse	*Pseudomys novaehollandiae*	-	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Masked Owl	*Tyto novaehollandiae*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
Rosenberg's Goanna	*Varanus rosenbergi*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion

* E – Endangered; V – Vulnerable; CE – Critically Endangered

2.4.6 Species credit species assessment

A total of 17 threatened fauna species were identified by the BAM-C as species credit species and/or incidentally recorded in the Subject land during the field survey (Table 8 and Annex 2). This included 15 species identified as candidate species by the BAM-C, an additional two species recorded during the field survey (Annex 2). Of the candidate species identified, 14 are species subject to serious and irreversible impacts (SAII).

In line with the 'Streamlined assessment module – Small area', candidate species credit species that are not at risk of an SAII and not incidentally recorded on the Subject land do not require further assessment. Candidate species credit species that are at risk of an SAII or incidentally recorded during the field survey are identified in Table 8.

Table 8: Candidate fauna species and habitat suitability assessment

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
Birds											
Regent Honeyeater	*Anthochaera phrygia*	Species/ Ecosystem	None	Yes. PCT 1083	10% or less habitat retained	< 5 ha	Yes	Yes	As per important area mapping.	No important areas mapped area within Subject land.	Not required.
Gang-gang Cockatoo	*Callocephalon fimbriatum*	Species/ Ecosystem	None	Yes. PCT 1083	Between 11 and 30 % habitat retained	< 5 ha	No	No	Hollow bearing eucalypts with hollows greater than 9 cm diameter.	Species recorded flying over Subject land. However, no suitable breeding hollows were recorded in the Subject land.	Not required.
Swift Parrot	*Lathamus discolor*	Species/ Ecosystem	None	Yes. PCT 1083	Between 11 and 30 % habitat retained	< 5 ha	Yes	Yes	As per important area mapping.	No important areas mapped area within Subject land.	Not required.
Mammals											
Little Bent-winged Bat	*Miniopterus australis*	Species/ Ecosystem	None	Yes. PCT 1083	Between 11 and 30 % habitat retained	< 5 ha	Yes	Yes	Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding within the Subject land. This includes species records in BioNet recorded within the Subject land.	Habitat constraints are not present within Subject land. No records have been identified near the Subject land.	Not required.

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	Species/ Ecosystem	None	Yes. PCT 1083	Between 11 and 30 % habitat retained	< 5 ha	No	No	Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding within the Subject land.	Habitat constraints are not present within Subject land.	Not required.
Large-eared Pied Bat	*Chalinolobus dwyeri*	Species	None	Yes. PCT 1083	Between 11 and 30 % habitat retained	< 5 ha	Yes	Yes	SAII threshold is potential breeding habitat and presence of breeding individuals. Potential breeding habitat is PCTs associated with the species within 100m of rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict	No potential breeding habitat was recorded within 100m of the Subject land. Cliffs do exist to the west of the Subject land, however these are greater than 100m from the Subject land.	Not required.

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
									concrete buildings.		
Amphibians											
Littlejohn's Tree Frog	*Litoria littlejohni*	Species	None	Yes. PCT 1083	intact (> 70% natural habitat retained)	< 5 ha	No	No	Breeding habitat consists of a range of still or slow-moving waterbodies including permanent streams, pools, ponds, swamps and dams, located within areas of suitable native vegetation.	Recorded in pools along Sandy Creek. The Subject land at Sandy Creek crossing contains suitable breeding habitat for this species, however, no vegetation disturbance or clearing would occur in these areas. Works would be limited to installing props on the sandstone to support the bridge. If undertaken following mitigation measures outlined in Section 3.2.5 the proposed works would not impact on this species. Habitat in the Subject land surrounding the vent shaft is not suitable for this species.	Not required
Reptiles											
Broad-headed Snake	*Hoplocephalus bungaroides*	Species/ Ecosystem	None	Yes. PCT 1083	Between 31 and 70% habitat	5 - 24 ha	Yes	Yes	Rocky areas including escarpments,	No suitable habitat was identified within the Subject land.	Not required

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
					retained				outcrops and pagodas within the Sydney Sandstone geologies.		
Flora											
Thick-leaf Star-hair	*Astrotricha crassifolia*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	No individuals were identified within the Subject land during the field survey. Given the conspicuous nature of this species, it is unlikely it would have remained undetected during the field survey if present. Therefore, this species is unlikely to occur within the Subject land.	Not required.
Thick Lip Spider Orchid	*Caladenia tessellata*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	Targeted surveys were unable to be conducted during the suitable survey period for this species. However, given the lack of previous records within the locality (closest record >45km from the Subject land) and total clearing and surface disturbance of the Subject land in 2005, it is highly	Not required.

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	Scientific name	Credit class	Subject land within species geographic constraints?	Species associated with PCT?	Vegetation cover required	Required patch size	SAII candidate (Y/N)?	Requires further assessment?	Habitat constraints	Subject land habitat condition suitability	
										unlikely this species would occur within the Subject land. This species also typically occurs in grassy sclerophyll woodland clay loam or sandy soils and less commonly in heathland on sandy loam soils. The Subject land is dry sclerophyll forest with sandy soils and unlikely to provide optimal habitat for this species. *Caladenia tessellata* grows in a complex relationship with a mycorrhizal fungus that is necessary for seed germination and provides nutrients to the orchid (DSE 2010). Given the extensive disturbance experienced during construction of the vent shaft, it is unlikely this species, or areas colonised by suitable mycorrhizal fungi which supports the species, would occur within the	

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
										Subject land.	
Deyeuxia appressa	*Deyeuxia appressa*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	The Subject land is outside the known distribution of this species.	Not required.
Bauer's Midge Orchid	*Genoplesium baueri*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	Targeted surveys were unable to be conducted during the suitable survey period for this species. However, given the lack of previous records within the locality (closest record >20km from the Subject land) and total clearing and surface disturbance of the Subject land in 2005, it is highly unlikely this species would occur within the Subject land. This species is known to be sensitive to drought and disturbance, with observations from current populations suggesting the species prefers moist, shaded microhabitats (Ecoplanning 2017). In addition, this species is myco-heterotrophic	Not required.

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
										(completely parasitic on fungi and does not have the ability to photosynthesize) making it completely dependent on mycorrhizal fungi for its survival (Ecoplanning 2017). Even if this species once occurred within the Subject land, it is highly unlikely that it still remains after the extensive disturbance of clearing, stockpiling of topsoil and respread 18 months later. If rhizomes still occurred within the topsoil during respread, it is unlikely mycorrhizal fungi would have had time to establish and support these individuals.	
Hygrocybe anomala var. *ianthinomarginata*	*Hygrocybe anomala* var. *ianthinomarginata*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	The Subject land does not contain suitable habitat for this species.	Not required.
Deane's Paperbark	*Melaleuca deanei*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	No individuals were identified within the Subject land during the	Not required.

Step 1: Identify threatened species for assessment									Step 2: Assess habitat constraints		Step3: Further assessment of candidate species
Common name	**Scientific name**	**Credit class**	**Subject land within species geographic constraints?**	**Species associated with PCT?**	**Vegetation cover required**	**Required patch size**	**SAII candidate (Y/N)?**	**Requires further assessment?**	**Habitat constraints**	**Subject land habitat condition suitability**	
										field survey. Given the conspicuous nature of this species it is unlikely it would have remained undetected during the field survey if present. Therefore, this species is unlikely to occur within the Subject land.	
Hairy Geebung	*Persoonia hirsuta*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	No individuals were identified within the Subject land during the field survey. Given the conspicuous nature of this species it is unlikely it would have remained undetected during the field survey if present. Therefore, this species is unlikely to occur within the Subject land.	Not required.
Sublime Point Pomaderris	*Pomaderris adnata*	Species	None	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	This Subject land is outside the known range of this species.	Not required.
Botany Bay Bearded Orchid	*Pterostylis* sp. *Botany Bay*	Species	Within 10 km of Kurnell Peninsula	Yes. PCT 1083	N/A	N/A	Yes	Yes	None listed.	The Subject land is outside the known distribution of this species.	Not required.

2.5 Prescribed impacts

Prescribed biodiversity impacts are impacts on biodiversity values in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. Potential for the prescribed impacts identified in Chapter 6 of the BAM (DPIE 2020a) which require consideration include impacts to:

- Karst, caves, crevices, cliffs, rocks or other geologically significant feature.
- Human-made structure.
- Non-native vegetation.
- Corridors and habitat connectivity.
- Hydrological process sustaining/interacting with rivers, streams or wetlands.
- Wind farm development.
- Vehicle strikes on threatened species.

The Subject land is located away from karsts, caves, and cliff lines. Such features would therefore not be impacted by the Project. Prescribed impacts that are applicable to the Subject land include vehicle strikes and water quality and hydrological processes.

Project specific prescribed impacts are detailed further in Section 3.2.3 and will be managed and mitigated via the measures detailed in Table 11.

3. Impact Assessment

The Impact Assessment forms Stage 2 of the BDAR as detailed in Section 8 of the BAM (DPIE 2020a).

3.1 Avoiding or minimising impacts on biodiversity values

In accordance with the BAM (DPIE 2020a), proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a project on biodiversity values. This section outlines the avoidance, management and mitigation measures that IMC have incorporated into the Project design or will employ during construction, operation or completion of the Project to reduce impacts on biodiversity values.

A summary of the avoidance and mitigation measures including action, outcome, timing and responsibility are provided in Section 3.1.1.

3.1.1 Avoidance measures (pre-construction)

Efforts to avoid and minimise impacts through siting and design of the Project are detailed below.

Location and design

The development footprint of the gas infrastructure has been designed to avoid as much vegetation clearing as practical. All vegetation removal would be limited to areas within the mining lease which were previously cleared in 2005 for the construction of the vent shaft. Vegetation clearance would be limited to a small area of direct clearing (0.1 ha) where placement of infrastructure is unable to be located within existing cleared areas. Infrastructure placement has been designed to avoid as much direct vegetation clearing as possible. The Project will also require the unavoidable partial clearing of 0.74 ha of regenerating vegetation surrounding the vent shaft. This clearing is necessary to establish suitable APZs to protect infrastructure in the event of a bushfire and to reduce the risk of an onsite ignition (Singleton Engineering Solutions 2020). The clearing of the APZ areas would only require partial clearing, limited to the removal of trees, shrubs and fallen logs. Remaining vegetation within the APZ area would be maintained through ongoing management of ground storey vegetation through slashing. This will ensure partial native vegetation cover is maintained within APZ areas and assist in future rehabilitation.

Prescribed impacts

Prescribed impacts relevant to the Project and relevant avoidance and mitigation measures are detailed in Section 3.2.3.

3.2 Impact summary

An assessment of the potential impact of the Project on biodiversity is provided below. It considers direct and indirect impacts as defined in the BAM (DPIE 2020a).

The Project would affect biodiversity, including threatened biodiversity, through both direct and indirect impacts. The areas subject to direct and indirect impact are discussed below.

3.2.1 Direct impacts

As discussed in Section 3.1.1, the area of direct impact has been defined as the area that will need to be cleared to accommodate the Project. The area of direct impact is presented in Figure 6.

The primary direct impacts are the removal of 0.84 ha (complete removal of 0.1 ha and partial removal of 0.74 ha) of PCT 1083 vegetation. This vegetation provides potential foraging resources for insectivorous, frugivorous and nectivorous fauna. Assessment of direct impacts is presented in Table 9.

These direct impacts cannot be further avoided or mitigated. As per the BAM (DPIE 2020a), Section 4 details the biodiversity credits required to offset the unavoidable impacts of the Project.

3.2.2 Indirect impacts

The area of indirect impact is largely limited to patches of regenerating vegetation present to the north-east within the Subject land. It should be noted that vegetation within the Subject land has previously been cleared for the construction of the vent shaft in 2005 and all remaining vegetation is either planted or natural regeneration from the seedbank. Indirectly impacted areas occur in a moderate condition and do not contain any important habitat features such as hollow bearing trees. Assessment of potential indirect impacts is presented in Table 9.

Table 9. Assessment of direct and indirect impacts

Impact	Extent of impact as a result of the Project
Direct impacts	
Removal or modification of native vegetation	Known: Approximately 0.84 ha of PCT 1083 vegetation would be removed. Only 0.1 ha of vegetation would be totally removed, 0.74 ha would be managed as an APZ requiring the removal of trees, shrubs and fallen logs only.
Loss of individuals of a threatened species	None: No threatened flora or fauna habitat were identified within the area of direct impact. No threatened species are likely to be harmed as part of the Project. Littlejohn Tree Frog tadpoles identified in the pools upstream and downstream of the Sandy Creek crossing are not likely to be impacted as no vegetation clearing is required in the vicinity of the species habitat.
Removal or modification of threatened species habitat other than native vegetation (micro-habitat features)	None: No threatened species habitat (excluding native vegetation) was identified on the Subject land. Habitat for Littlejohn's Tree Frog was identified along Sandy Creek, however, none of this habitat would be impacted as part of the Project.
Death through trampling or vehicle strike	Low: The Project is unlikely to cause death through trampling or vehicle strike. An ecologist would conduct a preclearing inspection prior to clearing or bridge works to ensure no fauna would be impacted as part of clear or construction.
Death through poisoning	Low: No poisons or chemicals are proposed to be used as part of the Project. Harmful substances used in construction would all be controlled as per required Australian Standards.
Fragmentation	Low: Approximately 0.84 ha of regenerating native vegetation would be modified. Given this vegetation has previously been cleared, it is not considered to contribute to fragmentation of remnant native vegetation in the locality.
Indirect impacts	
Predation by domestic and/or feral animals	Low: The Project is not likely to increase the presence of domestic or feral animals in the local area.
Loss of shade/shelter	Known: The removal of vegetation in the Subject land would result in a loss of approximately 0.84 ha of regenerating native vegetation which provides shade and shelter for local fauna. This This impact is considered low in magnitude as the area to be

Impact	Extent of impact as a result of the Project
	impacted is small and in a poorer condition to that of surrounding vegetation, providing minimal habitat. Vegetation to be removed is rehabilitation which is approximately from
Loss of individuals through starvation	Low: Removal of the habitat on the Subject land is not considered likely to cause loss of individuals through starvation. The habitat to be impacted is likely to be used seasonally as a foraging resource by insectivorous, frugivorous and nectivorous species occupying a much larger territory and relying on other resources throughout the rest of the year. No limiting habitat would be impacted by the Project.
Loss of individuals through exposure	Low: The small area of habitat (0.84 ha) to be removed in the Subject land has previously been cleared and is immediately surrounded by large areas of high quality vegetation. In addition, these areas would be rehabilitated at the end of the Projects life. Therefore, the Project is not considered likely to cause a loss of individuals through exposure.
Edge effects (noise, light, traffic)	Low: Given the area has been previously cleared and only contains regenerating vegetation and the proximity of the existing vent shafts, these areas and areas immediately surrounding the vegetation to be cleared are unlikely to provide suitable habitat for noise and light sensitive species. The area may experience some additional noise and traffic during the construction phase of the Project, however, this would only occur during the day and operational noise and traffic are unlikely to increase from current levels.
Traffic impacts	Low: Increased traffic within the Subject land, particularly during the construction period, has the potential to impact on locally occurring fauna that may be traversing the locality. Traffic on site will be confined to existing internal roads and hardstand areas with very low speed restrictions. Threatened species are unlikely to be subject to this impact.
Deleterious hydrological changes	Low: The Project will alter runoff flows throughout the Subject land. Any impacts beyond the Subject land during or after construction are expected to be minor and would be managed by standard sediment and erosion controls during construction and the incorporation of stormwater drainage into the Project design. In addition, the installation of props under the bridge at Sandy Creek Crossing is unlikely to alter flows in such a way it would impact on stream health or Littlejohn's Tree Frogs habitat.
Contamination of groundwater and surface water	None: Runoff and wastewater from site processes would be retained within the existing sedimentation retention basins and discharged into the ephemeral drainages which flow into Cordeaux Dam. The discharge will be in accordance with Landcom's Managing Urban Stormwater: Soils and Construction Manual (Landcom 2004). No transport of contaminants into the wider hydrological system of the area is likely.
Weed invasion	Low: Hygiene protocols are already in place as part of access to the Sydney Catchment Areas. Clearing and construction equipment will be washed down prior to entering the catchment

Impact	Extent of impact as a result of the Project
	to ensure the weeds cannot spread and establish.
Increased human activity within or directly adjacent to sensitive habitat areas	Low: Areas of vegetation beyond the Subject land are considered sensitive habitat areas containing high ecological value. Human activity would not increase within these areas as they are currently restricted areas and any increase in human activity experienced as part of the construction period would be contained to within the Subject land.

3.2.3 Prescribed impacts

Project specific prescribed impacts have been considered in Table 10. Prescribed impacts that are applicable to the Subject land include vehicle strikes and water quality and hydrological processes.

Prescribed impacts will be managed and mitigated via the measures detailed in Table 11.

Table 10: Prescribed impacts

Feature	Description of feature characteristics and location	Potential impact	Threatened species or community using or dependent on feature
Hydrological process sustaining/interacting with rivers, streams or wetlands	The bridge which crosses Sandy Creek requires an upgrade as part of the Project. Works would be limited to temporary bracing of the bridge using props at regular spacing to support the structure of the bridge. The props are to comprise stacked railway sleepers which will be placed on the watercourse rock outcrop to the height of the bridge undercarriage. The props/sleepers will be positioned above the normal water line and will not impact normal flows. If propping is required, it will be limited to less than 10% of the total 21m bridge span. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation). If mitigation measures are followed these works are highly unlikely to impact the health of the creek and amphibian population which it supports.	Chemicals used during the construction process may find their way into the creek. Inappropriate placement of sleepers may cause sleepers modify water flows and disturb Littlejohn's Tree Frog habitat. Trampling of Littlejohn's Tree Frog tadpoles during construction.	Sandy Creek provides habitat for Littlejohn's Tree Frog which were recorded as tadpoles in a number of the pools either side of the crossing. Surrounding vegetation also provides suitable habitat for mature Littlejohn's Tree Frogs. If appropriate procedures are followed as detailed in Section 3.2.5, the Project is highly unlikely to impact on threatened amphibians, namely the Littlejohn's Tree Frog.
Vehicle strikes on threatened species	Fire trail access and internal machinery/slashing.	Mortality or injury as a result of vehicle strike and slashing.	Ground-dwelling threatened species such as Koala, are unlikely to be using habitats in the Subject land. Staff will be made aware of the risks of wildlife crossing roads. Current speed limits have ensured there has been no reported wildlife death or injury within the catchment in recent years. The chance of vehicle strike is very low.

3.2.4 Potential serious and irreversible impacts (SAII)

The BC Act and the *Local Land Services Act 2013* (LLS Act) impose various obligations on decision-makers in relation to impacts on biodiversity values that are at risk of SAII. These obligations generally require a decision-maker to determine whether the residual impacts of a proposed development on biodiversity values (that is, the impacts that would remain after any proposed avoid or mitigate measures have been taken) are serious and irreversible (DPIE 2020b).

The BC Act and the BC Reg provide a framework to guide the consent authority in making a determination in relation to SAII. The framework consists of a series of principles defined in the BC Reg and supporting guidance, provided for under section 6.5 of the BC Act, to interpret these principles (DPIE 2019b). Criteria to interpret the principles is included in Table 1 of *Guidance to assist a decision-maker to determine a serious and irreversible impact* (DPIE 2019b). Namely, an impact is considered serious and irreversible under Part 6.7 of the BC Reg if it:

1. Will cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
2. Will further reduce the population size of the species that is currently observed, estimated, inferred or reasonably suspected to have a very small population size, or will further degrade or disrupt an ecological community that is already observed, inferred or reasonably suspected to be severely degraded or disturbed.
3. Impacts on the habitat of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.
4. Impacts on a species or ecological community that is unlikely to respond to measures to improve habitat and vegetation integrity and is therefore irreplaceable.

Under the BAM (DPIE 2020a), an assessor must provide information on a range of factors affecting the vulnerability of the species to SAII.

All SAII candidate species identified in Table 8 have been excluded as candidate species. The Project is considered unlikely to cause SAII to any of these threatened species.

3.2.5 Mitigation and management of impacts

Management and mitigation measures to be implemented during the construction and operational phases of the Project are detailed in Table 11. Many of these are already documented within the Mining Operations Plan (MOP) for Dendrobium Mine and Cordeaux Colliery as detailed in Section 3.2.7 (IMC 2015).

Table 11: Mitigation measures

Mitigation measure	Responsibility
Pre-construction	
Flagging to be erected prior to clearing to demarcate areas which are to be cleared, partial clearing and vegetation retention within the Subject land boundary.	Project manager
Pre-clearing inspection conducted by an ecologist to identify native wildlife which may need to be removed before clearing begins.	Project manager/Project Ecologist
Ensuring vehicles remain on designated roads and tracks and speed limits are enforced. Education drivers during the induction process and in on-going project discussions to reduce the likelihood of vehicle strikes impacting local fauna.	Project manager

Mitigation measure	Responsibility
Construction	
Implementation of erosion and sediment controls for the duration of construction works. IMC has previously prepared an Erosion and Sediment Control Plan for the construction of the vent shaft. This plan would be reviewed and amended where necessary. Regular maintenance of erosion and sediment controls during construction and until cleared areas are vegetated. This is detailed in the MOP.	Project manager
Ecologist to supervise clearing and remove and relocate native wildlife identified before or during clearing. If native fauna is identified during clearing all work must stop until fauna has been removed or left site. Where clearing trees and shrubs in the APZ area, care should be taken as to not disturb topsoil or groundstorey vegetation.	Project Ecologist
If props are to be installed under the bridge at Sandy Creek Crossing an ecologist should undertake an inspection prior to installing props. If Littlejohn's Tree Frog tadpoles are present within the pools surrounding the bridge during installation, supervision by an ecologist would prevent potential trampling of Littlejohn's Tree Frog tadpoles. Props should be placed in locations which do not impact on stream flow during normal flow conditions.	Project Ecologist
Branches and logs removed during clearing should be stockpiled and used for future rehabilitation.	Project manager
Appropriate spill kits would be carried and spill procedures following in the unlikely event of a spill. Machinery should be inspected and stored as far away from Sandy Creek as possible when not in use.	Project manager
Implement hygiene protocols to minimise the spread of weeds and pathogens by staff/machines/vehicles into areas of retained native vegetation and waterways.	Project manager
Minimise dust generation by minimising the extent and time that bare soil is exposed. Implement dust suppression activities when relevant through the Subject land.	Project manager
Post construction	
Management and removal of all waste from the Subject land.	Project manager
During operation	
Monitoring and maintenance of all erosion and sedimentation controls.	Project manager
Continue to enforce speed limits and maintain discussions with staff to ensure speed limits are followed.	Project manager

3.2.6 Adaptive management strategy

The mitigation measures provided in Table 11, Section 3.2.5 are considered adequate to reduce the potential impacts to terrestrial and aquatic environment as far as practicable for the Project. Therefore, it is considered that an adaptive management strategy is not required.

3.2.7 Dendrobium Mine Mining Operations Plan

The Mining Operations Plan (MOP) for Dendrobium Mine and Cordeaux Colliery (IMC 2015) includes the Dendrobium Mine Landscape Management Plan (IMC 2021), which outlines the following objectives:

- outline processes to comply with the Consent and other legislation with regards to land and vegetation management, rehabilitation and closure.
- minimise land clearing and disturbance footprints.
- maximise opportunities for progressive rehabilitation.
- provide preliminary criteria and standards for site closure.
- describe a monitoring, auditing and reporting system to measure performance against the land management objectives during the operation of Dendrobium Mine.

As detailed in the Landscape Management Plan, a Construction Management Plan is required for new large-scale construction activities which include specific land and vegetation practices to be complied with during the development. It is a requirement to minimise the disturbance footprint and maximise retention of remnant vegetation. Any construction activities are designed to be consistent with the requirements of the Managing Urban Stormwater: Soils and Construction Manual (Landcom 2004).

Existing Construction Management Plans are already in place for No. 2 & 3 Ventilation Shafts and outline appropriate erosion and sedimentation controls. These management plans would be reviewed prior to the commencement of construction to inform and manage various activities throughout the life of the Project in order to protect and manage important biodiversity values.

4. Quantifying Offset Requirements

The BAM (DPIE 2020a) identifies the BAM-C 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 biodiversity credits required due to ecological impacts associated with the Project has been undertaken using the BAM-C, app version 1.4.0.00, data version 50 (DPIE 2022a). The case has been finalised and submitted via the online BAM-C.

No threatened biodiversity listed on the EPBC Act are required to be offset for the Project, as the Project is not likely to impact any threatened biodiversity listed on the EPBC Act.

4.1 Summary of ecosystem credits required

According to Table 27 of the BAM, **Chapter 9 Thresholds for assessing and offsetting the impacts of the proposal**, impacts for TECs (no mention of PCTs) are required to detailed in the BDAR (small area). Therefore, it is understood that only impacts to TECs are required to be offset. The credit report in Annex 6 includes 17 ecosystem credits, however given the PCT in the Subject land is not associated with a TEC, it is understood that ecosystem credits are not required.

As the PCT recorded within the Subject land was not a TEC, offsets are not required for impacts associated with this vegetation in accordance with the BAM – Streamlined assessment module - Small area.

4.2 Summary of species credits required

The Project will not impact any species credit species at risk of SAII or incidentally observed during the site inspection. As such, no species credits are required to offset the Project in accordance with the BAM – Streamlined assessment module - Small area.

5. Summary

Impacts of the Project on ecological values are summarised as follows:

- Direct removal of 0.84 ha of regenerating native vegetation: 0.1 ha of vegetation totally removed, 0.74 ha managed as an APZ requiring the removal of trees, shrubs and fallen logs only.
- Removal of highly modified non-threatened fauna habitat (native vegetation).
- Removal of previously disturbed flora habitat.
- Potential impacts to water bodies, water quality and hydrological processes and potential vehicle strikes on threatened species.

As no threatened biodiversity listed under the EPBC Act are considered likely to be impacted by the Project, no assessment/s of significance under the EPBC Act were required. As such, there is no requirement for an EPBC Act Referral regarding Commonwealth threatened species, communities or populations.

IMC have aimed to avoid and minimise environmental impacts from the Project through detailed design and siting of the Project and implementation of actions aimed at mitigating and managing potential indirect impacts of the Project as detailed in Section 3.1.1.

No biodiversity offsets are required for this Project.

References

Department of Agriculture, Water and the Environment (2022a) Protected Matters Search Tool, Commonwealth Department of the Environment and Energy. https://www.environment.gov.au/epbc/protected-matters-search-tool (accessed January 2022).

Department of Agriculture, Water and the Environment (2022b) SPRAT Profiles, http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl (accessed January 2022).

Department of Planning, Industry and Environment (2012) Ramsar Wetlands of NSW, NSW Department of Planning, Industry and Environment, Sydney, NSW. https://datasets.seed.nsw.gov.au/dataset/ramsar-wetlands-of-nsw0c113 (accessed January 2022).

Department of Planning, Industry and Environment (2016) Illawarra Plant Community Type Vegetation Map, 2016. VIS_ID 4678. State of NSW and Department of Planning, Industry and Environment. https://datasets.seed.nsw.gov.au/dataset/illawarra-compiled-plant-community-type-map-2016-vis-id-4678 (accessed January 2022).

Department of Planning, Industry and Environment (2019a) Biodiversity Assessment Method Operational Manual Stage 2. State of NSW and Department of Planning, Industry and Environment. Dated September 2019.

Department of Planning, Industry and Environment (2019b) Guidance to assist a decision-maker to determine a serious and irreversible impact. State of NSW and Department of Planning, Industry and Environment.

Department of Planning, Industry and Environment (2020a) Biodiversity Assessment Method. State of NSW and Department of Planning, Industry and Environment.

Department of Planning, Industry and Environment (2020b) Biodiversity Assessment Method 2020 Operational Manual - Stage 1. State of NSW and Department of Planning, Industry and Environment.

Department of Planning, Industry and Environment (2020c) Biodiversity Assessment Method 2020 Operational Manual - Stage 3. State of NSW and Department of Planning, Industry and Environment.

Department of Planning, Industry and Environment (2020d) Surveying threatened plants and their habitats, NSW survey guide for the Biodiversity Assessment Method. State of NSW and Department of Planning, Industry and Environment.

Department of Planning, Industry and Environment (2022a) BAM Credit Calculator, app version 1.4.0.00, data version 50. https://www.lmbc.nsw.gov.au/bamcalc (accessed January 2022).

Department of Planning, Industry and Environment (2022b) BioNet Atlas of NSW Wildlife. http://www.bionet.nsw.gov.au/ (accessed January 2022).

Department of Planning, Industry and Environment (2022c) BioNet Threatened Species Database. http://www.bionet.nsw.gov.au/ (accessed January 2022).

Department of Planning, Industry and Environment (2022d) BioNet Vegetation Classification. https://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx (accessed January 2022).

Department of Sustainability and Environment 2010. National Recovery Plan for the Thick-lip Spider-orchid *Caladenia tessellata*. http://www.environment.gov.au/system/files/resources/f9bc9c67-5a06-4fc6-a39d-3d1571de142b/files/caladenia-tessellata.pdf (accessed January 2022).

Department of the Environment and Energy (2010). Directory of Important Wetlands in Australia, Commonwealth Department of the Environment and Energy, Canberra, ACT. https://datasets.seed.nsw.gov.au/dataset/directory-of-important-wetlands-in-australia (accessed January 2022).

Ecoplanning (2017) Expert Report for *Genoplesium baueri* - Lake Wollumboola Biobank Site Callala Bay. Prepared for Eco Logical Australia Pty Ltd by Brian Towle (Ecoplanning). August 2017.

Illawarra Metallurgical Coal (2015) Mining Operations Plan Dendrobium Mine And Cordeaux Colliery (DENMP0093). Illawarra Metallurgical Coal. https://www.south32.net/docs/default-source/illawarra-coal/dendrobium/mining-operations-plans/denmp0093-mining-operations-plan-dendrobium-and-cordeaux-colliery-fy15---fy22e3dca3addec94d34b30df5b7d212d740.pdf?sfvrsn=b50f401f_6 (accessed January 2022).

Illawarra Metallurgical Coal (2021) Dendrobium Mine Landscape Management Plan. Illawarra Metallurgical Coal. https://www.south32.net/docs/default-source/illawarra-coal/dendrobium/dendrobium-environmental-management-plans---surface-facilities/landscape-management-plan.pdf?sfvrsn=484997dc_12 (accessed January 2022).

Keith, D. (2004). Ocean Shores to Desert Dunes: The Native Vegetation of New South Wales and the ACT, NSW Department of Environment and Conservation, Sydney, NSW.

Landcom (2004) Managing Urban Stormwater: Soils and Construction Manual, 4th Edition. March 2004. https://www.landcom.com.au/assets/Uploads/managing-urban-stormwater-soils-construction-volume-1-fourth-edition-compressed.pdf.

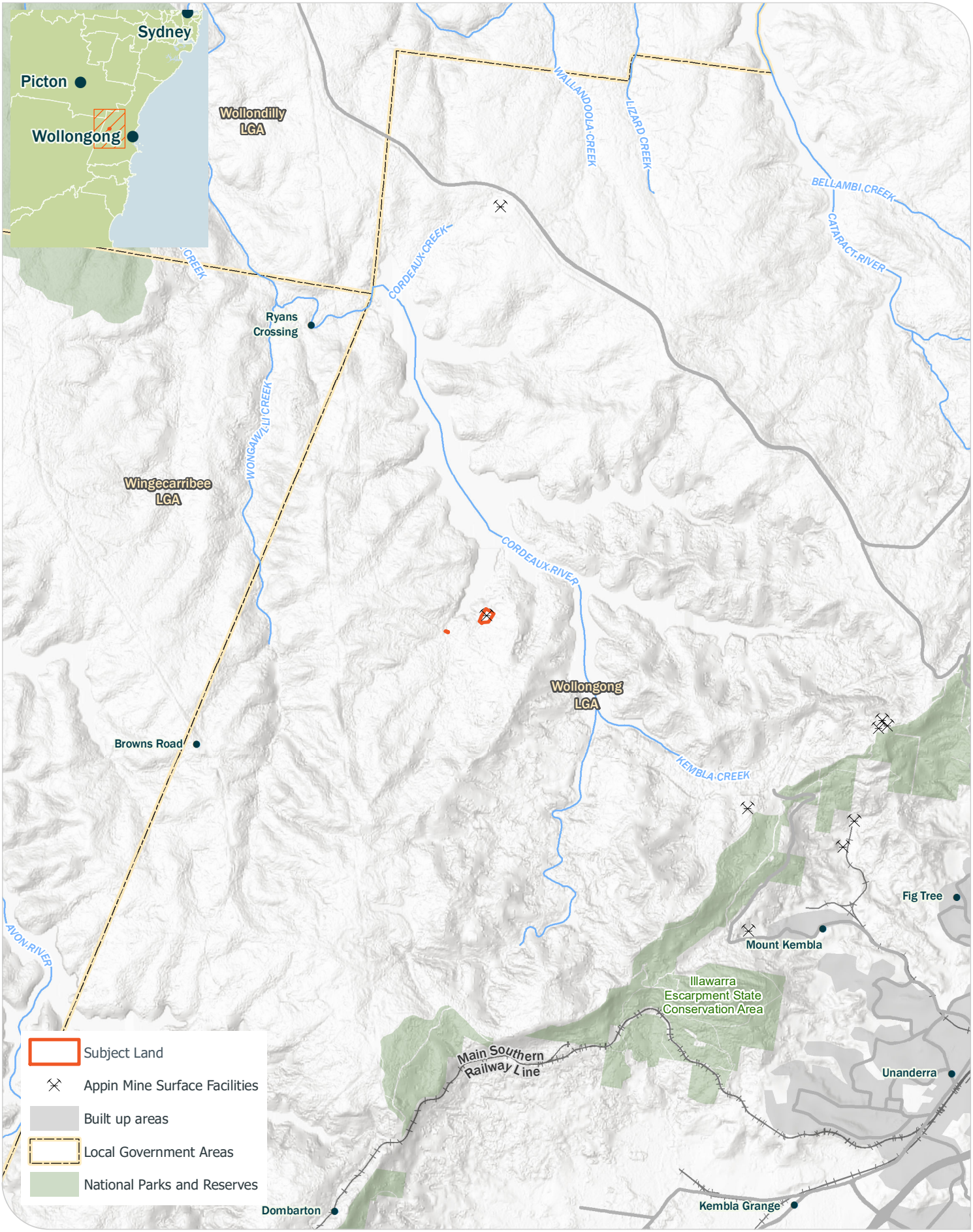
NSW Government (2010) Wollongong Local Environmental Plan 2009. NSW Government. https://legislation.nsw.gov.au/view/html/inforce/current/epi-2010-0076 (accessed January 2022).

NSW Office of Environment and Heritage (2018) BAM Calculator User Guide. NSW Office of Environment and Heritage.

Singleton Engineering Solutions (2020) Bushfire Management Plan - Dendrobium Ventilation Shaft 2 and 3 Gas Drainage Plant (Ref: 21149). Prepared 16 December 2020.

Strahler, A. (1957) Quantitative Analysis of Watershed Geomorphology. Transactions, American Geophysical Union, 38, 913-920.

Figures



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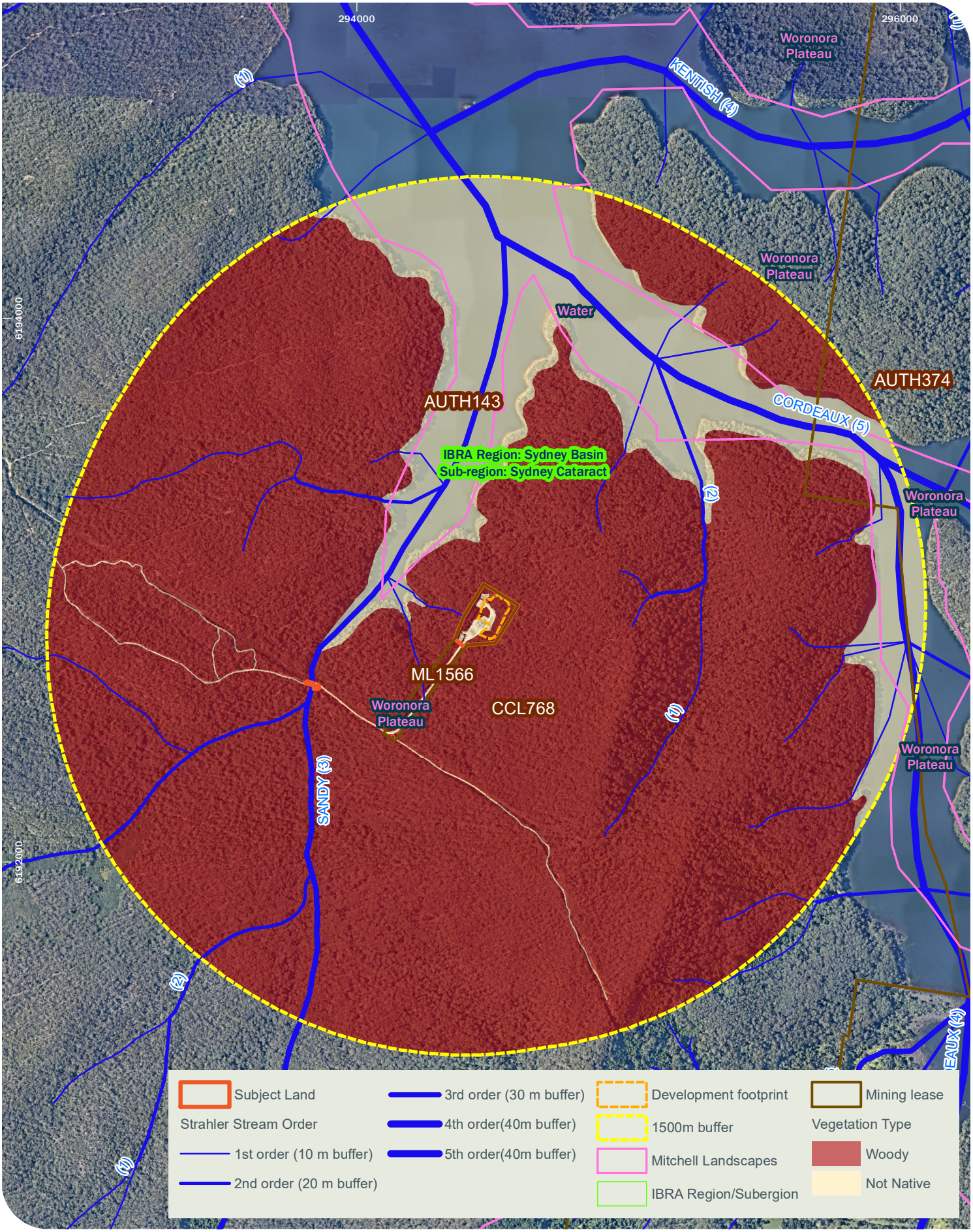
Regional Location

Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South32 Illawarra Metallurgical Coal

Figure 1



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GDA 1994 MGA Zone 56

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

Location Map

Dendrobium – Gas Infrastructure at No 2 and No 3 Vent Shaft

Figure 2

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GDA 1994 MGA Zone 56

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South32 Illawarra Metallurgical Coal

Development footprint
Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

Figure 3

Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

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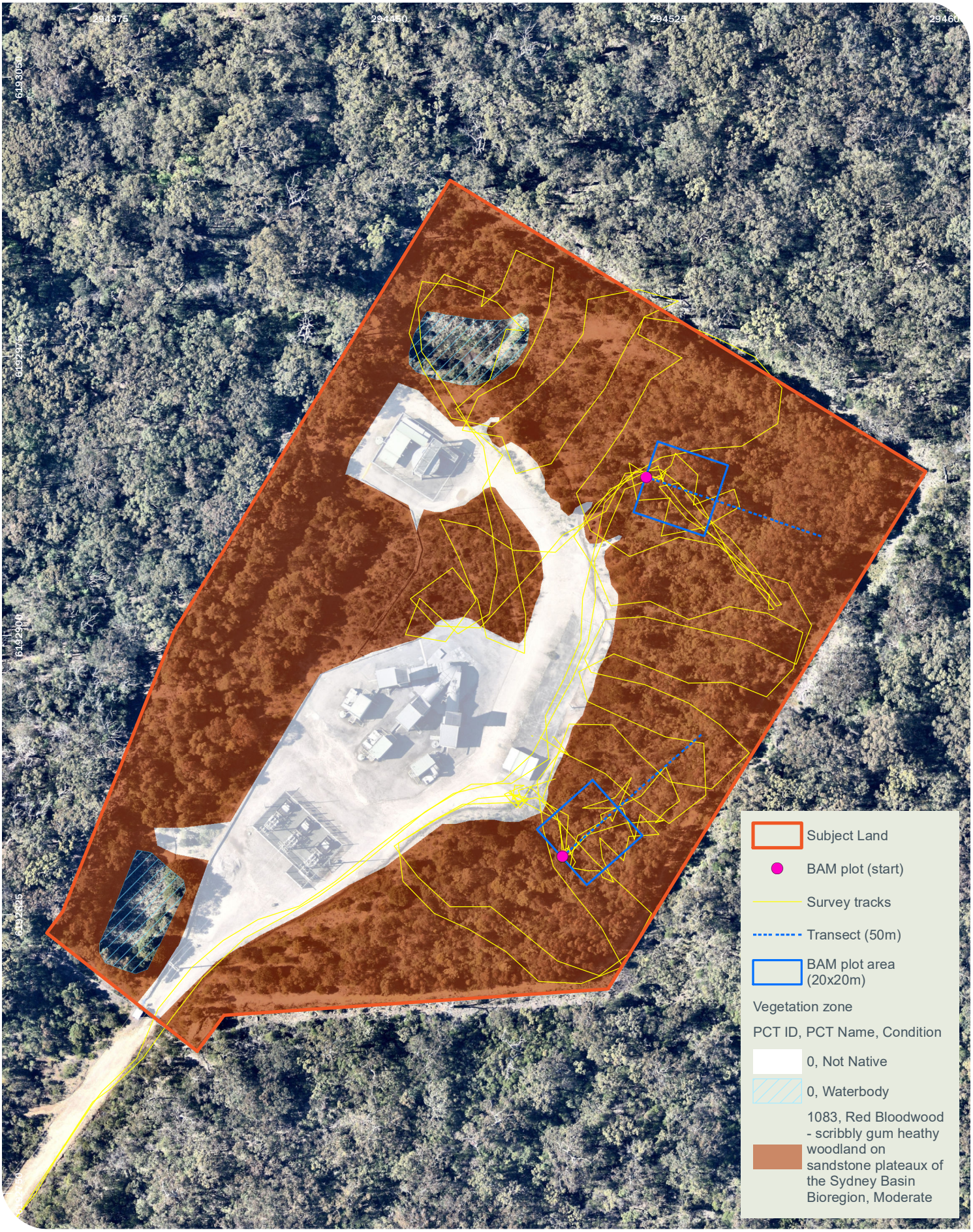

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Vegetation zones and plot locations

Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South32 Illawarra Metallurgical Coal

Figure 4

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Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South32 Illawarra Metallurgical Coal

Threatened species records
Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

Figure 5

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GDA 1994 MGA Zone 56

Impact areas

Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

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Client: South32 Illawarra Metallurgical Coal

Figure 6

Annex 1. Plant community description

PCT 1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion

Extent:

This PCT is distributed over a much larger area surrounding the Subject land. All vegetation recorded within the Subject land aligned to PCT 1083.

Condition and presence of weeds:

The area of PCT 1083 in the Subject land is in a moderate condition and was fully cleared of vegetation in 2009. Since this time the vegetation has regenerated through assisted revegetation and natural regrowth of species from the seed bank. Despite the heavily disturbed nature of the Subject land, the only exotic species recorded was *Hypochaeris radicata*.

Conservation status:

PCT 1083 in the Subject land does not align to a TEC listed under the BC Act or EPBC Act (refer to Section 2.3.6).

Characteristic species used for identification of PCT:

Characteristic species used to align the PCT include overstorey species such as *Corymbia gummifera*, *Eucalyptus racemosa*, *Eucalyptus sieberi* and *Eucalyptus piperita*. Characteristic species recorded as part of the midstorey consisted of *Acacia ulicifolia*, *Banksia ericifolia*, *Banksia serrata*, *Banksia spinulosa* and *Petrophile pulchella*. Common species recorded as part of the groundcover comprised of *Lepyrodia scariosa*, *Schoenus melanostachys*, *Lomandra longifolia* and *Baumea teretifolia*.

Justification of evidence used to identify the PCT:

PCT 1083 as described within the BioNet VIS (DPIE 2022d) is highly consistent with the geographic location and habitat of this PCT within the Subject land. The other PCT which was considered to potentially align to the vegetation within the Subject land was PCT 1250. While the Subject land contained three overstorey species, four midstorey species and two understorey species which matched with PCT 1250, PCT 1083 was a better fit, containing four overstorey species, five midstorey species and one understorey species. In addition, the description of PCT 1083 as low open forest with a diverse sclerophyll shrub layer and an open groundcover of sedges, as well as its occurrence on crests, ridges and exposed slopes on coastal sandstone plateaux, was also consistent with the vegetation recorded in the Subject land.

Photograph:

Plate 5. PCT 1083_moderate

Plate **6**. PCT 1083_moderate surrounding retention basin in the north west corner of the Subject land

Annex 2. Threatened species status and likelihood of occurrence

E = Endangered; V = Vulnerable, CE = Critically Endangered.

Unless otherwise stated, habitat information obtained from the BioNet Threatened Species Database (DPIE 2022c) and SPRAT Profiles (DAWE 2022b).

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
Amphibians						
Heleioporus australiacus	Giant Burrowing Frog	V	V	Species	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.	None
Litoria aurea	Green and Golden Bell Frog	E	V	Species	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.	Low
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Species	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	Known to occur within the Subject land along Sandy Creek. No suitable habitat to be cleared within the development footprint.

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					in colouration.	
Pseudophryne australis	Red-crowned Toadlet	V	-	Species	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs and usually contain leaf litter for shelter. Eggs are terrestrial and laid under litter, vegetation or rocks where the tadpoles inside will reach a relatively late stage of development before waiting for flooding waters before hatching will occur.	Moderate. No suitable habitat recorded within the development footprint.
Birds						
Dasyornis brachypterus	Eastern Bristlebird	E	E	Species	The distribution of the Eastern Bristlebird has contracted to three disjunct areas of south-eastern Australia. There are three main populations: Northern - southern Queensland/northern NSW, Central - Barren Ground NR, Budderoo NR, Woronora Plateau, Jervis Bay NP, Booderee NP and Beecroft Peninsula and Southern - Nadgee NR and Croajingalong NP in the vicinity of the NSW/Victorian border. Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW the habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of these vegetation types are fire prone.	Low
Pandion cristatus	Eastern Osprey	V	M, MA	Species/Ecosystem	Found right around the Australian coastline, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	None
Artamus	Dusky	V	-	Ecosystem	Dusky woodswallows are widespread in eastern, southern and	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
cyanopterus cyanopterus	Woodswallow				southwestern Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range. Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris.	
Anthochaera phrygia	Regent Honeyeater	CE	E, M	Species/Ecosystem	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. The distribution of the species has contracted dramatically in the last 30 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.	Low
Burhinus grallarius	Bush Stone-curlew	E	-	Species	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and, in the south-east, it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights.	Low
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	Species/Ecosystem	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas.	Known. Recorded flying over Subject land. Subject land contains only marginal foraging habitat and does not contain hollows suitable for

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger in eucalypts.	breeding.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Species/Ecosystem	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (A. *torulosa*) are important foods. Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.	Low
Daphoenositta chrysoptera	Varied Sittella	V	-	Ecosystem	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.	Low
Epthianura albifrons	White-fronted Chat	V	-	Ecosystem	Low vegetation in salty coastal and inland areas and crops. Runs along ground and is found in local flocks in Winter.	Low
Epthianura albifrons	White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	EP	-	Ecosystem	Low vegetation in salty coastal and inland areas and crops. Runs along ground and is found in local flocks in Winter.	Low
Glossopsitta pusilla	Little Lorikeet	V	-	Ecosystem	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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					eucalypts. Most breeding records come from the western slopes.	
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	M	Species/Ecosystem	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna.	Low
Hieraaetus morphnoides	Little Eagle	V	-	Species/Ecosystem	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.	Low
Hirundapus caudacutus	White-throated Needletail	-	M	N/A	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges.	Low
Ixobrychus flavicollis	Black Bittern	V	-	Ecosystem	Usually found on coastal plains below 200 m. Often found along timbered watercourses, in wetlands with fringing trees and shrub vegetation. The sites where they occur are characterized by dense waterside vegetation.	Low
Lathamus discolor	Swift Parrot	E	E	Species/Ecosystem	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.	Low
Lophoictinia isura	Square-tailed Kite	V	-	Species/Ecosystem	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, *Corymbia maculata*, E. *elata* or E. *smithii*. Individuals appear to occupy large hunting ranges of more than 100km2. They require large living trees for breeding, particularly near water with surrounding woodland - forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.	Low
Ninox connivens	Barking Owl	V	-	Species/Ecosystem	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					watercourses in otherwise open country.	
Ninox strenua	Powerful Owl	V	-	Species/Ecosystem	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 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.	Low
Numenius madagascariensis	Eastern Curlew	-	CE, MA, M	Species/Ecosystem	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.	None
Petroica boodang	Scarlet Robin	V	-	Ecosystem	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.	Low
Petroica phoenicea	Flame Robin	V	-	Ecosystem	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.	Low
Stictonetta naevosa	Freckled Duck	V	-	Ecosystem	The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits.	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
Tyto novaehollandiae	Masked Owl	V	-	Species/Ecosystem	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.	Low
Tyto tenebricosa	Sooty Owl	V	-	Species/Ecosystem	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.	Low
Fungi						
Hygrocybe anomala var. ianthinomarginata	-	V	-	Species	Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	None
Invertebrates						
Petalura gigantea	Giant Dragonfly	E	-	Species	The Giant Dragonfly is found along the east coast of NSW from the Victorian border to northern NSW. It is not found west of the Great Dividing Range. There are known occurrences in the Blue Mountains and Southern Highlands, in the Clarence River catchment, and on a few coastal swamps from north of Coffs Harbour to Nadgee in the south. Live in permanent swamps and bogs with some free water and open vegetation. Adults emerge from late October and are short-lived, surviving for one summer after emergence.	None
Mammals						

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
Petauroides volans	Greater Glider	-	V	Species	The Greater Glider occurs in eucalypt forests and woodlands. The Greater Glider occurs in eucalypt forests and woodlands. The species nests in hollows and are typically found in older forests. Generally, the home range for the greater glider is between 0.7-3 hectares and tends to have a population density of 0.01-5 individuals per hectare. The home ranges of females can overlap with males and females however for the males the home ranges never overlap.	Low
Phoniscus papuensis	Golden-tipped Bat	V	-	Ecosystem	The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to south of Eden in southern NSW. It is found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m, and is also recorded in tall open forest, Casuarina-dominated riparian forest and coastal Melaleuca forests. Bats will fly up to two kilometres from roosts to forage in rainforest and sclerophyll forest on mid and upper-slopes and are specialist feeders on small web-building spiders. They roost mainly in rainforest gullies on small first- and second-order streams in modified abandoned hanging nests of Yellow-throated Scrubwren and Brown Gerygone, and sometimes under thick moss on tree trunks, in tree hollows, dense foliage and epiphytes. Maternity roosts sometimes have been recorded up to 450m away from water sources.	Low
Cercartetus nanus	Eastern Pygmy-possum	V	-	Species	Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows but can also construct its own nest. Because of its small size it is able to utilise a range of hollow sizes including very small hollows. Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5 month period.	Low
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Species/Ecosystem	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					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.	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Ecosystem	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 roosting and foraging sites.	Low
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E	-	Species	Prefers sandy soils with scrubby vegetation and-or areas with low ground cover that are burn from time to time. A mosaic of post fire vegetation is important for this species.	Low
Micronomus norfolkensis	Eastern Freetail-bat	V	-	Ecosystem	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.	Low
Miniopterus australis	Little Bentwing-bat	V	-	Species/Ecosystem	Coastal north-eastern NSW and eastern Queensland. Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites. Little Bent-wing Bat has a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects.	Low
Miniopterus orianae oceanensis	Eastern Bentwing-bat	V	-	Species/Ecosystem	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.	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
Myotis macropus	Southern Myotis	V	-	Species	The Large-footed 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.	Low
Petaurus australis	Yellow-bellied Glider	V	-	Ecosystem	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.	Low
Petaurus norfolcensis	Squirrel Glider	V	-	Species	Generally, occurs in dry sclerophyll forests and woodlands but is absent from dense 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.	Low
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species	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.	None
Phascolarctos cinereus	Koala	V	V	Species/Ecosystem	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.	Low
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Species/Ecosystem	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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					within 15 km of the day roost although some individuals may travel up to 70 km.	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Ecosystem	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	Low
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Ecosystem	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches.	Low
Reptiles						
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Species/Ecosystem	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 within 500m of escarpment to find shelter during hotter parts of summer.	Low
Varanus rosenbergi	Rosenberg's Goanna	V	-	Ecosystem	This species is a Hawkesbury-Narrabeen sandstone outcrop specialist. Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests.	Low
Flora						
Acacia baueri subsp. aspera	-	V	-	Species	Occurs in low, damp heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					species have been made following fire, suggesting the species prefers early successional habitats. Restricted to the Sydney region, occurring on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mt. Keira district and at Wedderburn. May also occur on the escarpment-Woronora Plateau in the Flat Rock Junction and Stanwell Tops area of the Illawarra.	
Acacia bynoeana	Bynoe's Wattle	E	V	Species	Grows mainly in heath and dry sclerophyll forest in sandy soils. Mainly south of Dora Creek-Morisset area to Berrima and the Illawarra region, west to the Blue Mountains, also recorded from near Kurri Kurri in the Hunter Valley and from Morton National Park.	Low
Acacia pubescens	Downy Wattle	V	V	Species	Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland.	None
Astrotricha crassifolia	-	V	V	Species	Occurs near Patonga (Gosford LGA), and in Royal NP and on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (Lithgow LGA) and in Victoria. Occurs in dry sclerophyll woodland on sandstone.	Low
Caesia parviflora var. *minor*	Small Pale Grass-lily	E	Not listed	Species	This variety occurs uncommonly in Tasmania, southern Victoria and south-east South Australia with an outlying population in NSW, in Barcoongere State Forest, between Grafton and Coffs Harbour. This variety may be more common than currently known, as Pale Grass-lilies are often not identified to variety level. Found in damp places in open forest on sandstone.	Low
Caladenia tessellata	Thick-lip Spider Orchid	E	V	Species	The Tessellated 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.	Low
Callistemon	Netted Bottle	V	-	Species	Recorded from the Georges River to Hawkesbury River in the	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
linearifolius	Brush				Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest on the coast and adjacent ranges.	
Callitris endlicheri	*Callitris endlicheri* Woronora Plateau population	EP	-	Species	The population of *Callitris endlicheri* on Woronora Plateau, in the local government area of Wollongong, represents the coastal limit of the species' range and is disjunct from other known populations of the species. Throughout its range, the species is usually found on stony hills or ridges, common, from the plains to the coastal ranges. The Woronora Plateau population is restricted to a single outcrop of sandstone c. 2 ha in area. The soils at this site are skeletal sandy loams and the heathlands on sandstone outcrops in the area are restricted and highly distinctive.	None
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Species	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (E. *sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (C. *subulata*) and the Tartan Tongue Orchid (C. *erecta*).	Low
Deyeuxia appressa	-	E	E	Species	A highly restricted NSW endemic known only from two pre-1942 records in the Sydney area (Herne Bay, Saltpan Creek, off the Georges River, south of Bankstown and Killara, near Hornsby). Almost nothing is known about the species' habitat and ecology. Flowers spring to summer and is mesophytic (grows in moist conditions).	Low
Dillwynia tenuifolia	-	V	-	Species	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in western Sydney are	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					recorded from Voyager Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include: the Bulga Mountains at Yengo in the north, Kurrajong Heights and Woodford in the Lower Blue Mountains. In western Sydney, may be locally abundant particularly within scrubby-dry heath areas within Castlereagh Ironbark forest and Shale Gravel Transition forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	
Epacris purpurascens var. *purpurascens*	-	V	-	Species	Recorded from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. Found in a range of habitat types, most of which have a strong shale soil influence.	Low
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Species	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park. Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas.	Low
Genoplesium baueri	Bauer's Midge Orchid	E	E	Species	Grows in dry sclerophyll forest and moss gardens over sandstone. Flowers February to March. Has been recorded between Ulladulla and Port Stephens. Currently the species is known from just over 200 plants across 13 sites. The species has been recorded in Berowra Valley Regional Park, Royal National Park and Lane Cove National Park and may also occur in the Woronora, O'Hares,	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					Metropolitan and Warragamba Catchments.	
Grevillea parviflora subsp. *parviflora*	Small-flowered Grevillea	V	V	Species	Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	Low
Grevillea raybrownii	-	V	-	Species	All natural remnant sites occur within a habitat that is both characteristic and consistent between sites. Generally, occurs on ridgetops and, less often, slopes and benches of Hawkesbury Sandstone and Mittagong Formation. It occurs in Eucalyptus open forest and woodland with a shrubby understorey on sandy, gravelly loam soils derived from sandstone that are low in nutrients. Killed by fire and relies entirely on seed that is stored in the soil for regeneration. Recruitment appears to be promoted by fire or other disturbances.	Low
Helichrysum calvertianum	-	V	-	Species	*Helichrysum calvertianum* is endemic to New South Wales where it is currently only known from the Wingecarribee Shire. There are seven known populations. Only one population occurs within the reserve estate, in the northern part of Morton National Park. It occurs in dry sclerophyll forest and heathland with rock outcrops, predominantly on Hawkesbury sandstone soils. At altitudes between approximately 650 and 855 m. Rainfall ranges from 850 mm per annum at the western-most sites, to over 1500 mm at the eastern-most site. It is likely the seeds are wind dispersed. The fire response of H. *calvertianum* is unknown.	Low
Hibbertia puberula	*Hibbertia puberula*	E	-	Species	Occurs on sandy soil often associated with sandstone. Flowering time is October to November.	Low
Hibbertia stricta subsp. *furcatula*	-	E	-	Species	*Hibbertia stricta* subsp. *furcatula* (*Hibbertia* sp. nov. 'Menai') is known to occur in two populations, one in the southern outskirts of Sydney, and one near Nowra on the mid-South Coast of NSW. The Southern Sydney population occurs on both sides of the Woronora	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					River gorge, near Loftus and in Royal National Park. The southern population is mainly in the vicinity of Nowra.	
Leucopogon exolasius	Woronora Beard-heath	V	V	Species	Grows in woodland on sandstone. Restricted to the Woronora and Grose Rivers and Stokes Creek, Royal National Park.	Low
Leucopogon fletcheri subsp. *fletcheri*	*Leucopogon fletcheri* subsp. *fletcheri*	E	-	Species	Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs.	Low
Melaleuca deanei	Deane's Paperbark	V	V	Species	Grows in wet heath on sandstone in coastal districts from Berowra to Nowra.	Low
Persoonia acerosa	-	V	V	Species	Occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils. Recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area.	Low
Persoonia bargoensis	Bargo Geebung	E	V	Species	The Bargo Geebung occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravely soils.	Low
Persoonia hirsuta	Hairy Geebung	E	E	Species	Distributed from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west. A large area of occurrence, but occurs in small populations, increasing the species' fragmentation in the landscape. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. Usually present as isolated individuals or very small populations. Probably killed by fire (as other Persoonia spp. are) but will regenerate from seed.	Low
Pomaderris adnata	-	E	-	Species	Known only from one site at Sublime Point, north of Wollongong. Occurs near the edge of the plateau behind the Illawarra escarpment. Associated vegetation is silver-top ash - red bloodwood forest. Soil is a sandy loam over sandstone.	Low
Pomaderris	Brown	V	V	Species	The species is expected to live for 10 - 20 years, while the minimum	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
brunnea	Pomaderris				time to produce seed is estimated to be 4 - 6 years. Found in a very limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area. It also occurs at Walcha on the New England Tableland and in far eastern Gippsland in Victoria.	
Prostanthera densa	-	V	V	Species	Villous Mintbush is generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone, and rocky slopes near the sea.	Low
Prostanthera saxicola	*Prostanthera saxicola* population in Sutherland and Liverpool local government areas	EP	-	Species	Primarily in Eucalypt forest, heath and low shrubland, often in damp or moist sites. This population is restricted to the named local government areas (Liverpool and Sutherland) in the southern to south-western parts of Sydney. Recorded occurrences are mainly between Holsworthy station and Sutherland station, north from Lucas Heights and south of the Georges River. However, the population may extend beyond this into the adjacent parts of the relevant LGAs within the region (including the military reserve lands and the Royal and Heathcote National Parks). It occurs in eucalypt forest and heath in association with *Hakea dactyloides*, *Brachyloma daphnoides*, *Banksia spinulosa*, *Baeckea brevifolia*, *Epacris pulchella*, *Acacia myrtifolia* and *Acacia ulicifolia*. As well as, closed heath in association with *Allocasuarina nana* and *Lepidosperma viscidum* and heathy woodland of *Angophora hispida*, *Eucalyptus squamosa* and *Corymbia gummifera*, as a 'major component of the ground flora'. Found on rocky ridges and areas of outcrop.	Low
Pterostylis saxicola	Sydney Plains Greenhood	E	E	Species	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale-sandstone transition soils or shale soils.	Low
Pterostylis sp. *Botany Bay*	Botany Bay Bearded Orchid	E	-	Species	Restricted to the Sydney region where it is known from a small number of sites within Botany Bay National Park. The species was	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					first collected at Maroubra in 1908, although it has not been recorded at Maroubra since that time. Occupies moist level sites on skeletal sandy soils derived from sandstone. Associated vegetation is coastal heath and occurs in small localised populations, usually in areas within the heath where the canopy allows filtered light to reach the ground.	
Pultenaea aristata	-	V	V	Species	Grows in moist, dry sclerophyll woodland to heath on sandstone, specifically the drier areas of Upland Swamps. Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Keira above Wollongong.	Low
Rhodamnia rubescens	Scrub Turpentine	CE	-	Species	Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of R. *rubescens* typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	None
Solanum celatum	-	E	-	Species	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.	None
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Species	Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State forest. On the south coast the species occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities	None

Annex 3. Floristic plot data

Scientific name	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance
Acacia fimbriata	1	5	0.5	2
Acacia longifolia	2	5	0.1	2
Acacia parramattensis	2	5		
Acacia terminalis	1	5	0.5	5
Acacia ulicifolia			0.1	1
Allocasuarina littoralis	3	5	6	
Allocasuarina torulosa			0.5	1
Banksia ericifolia	2	5	0.5	5
Banksia serrata	2	2	0.5	1
Banksia spinulosa	0.1	1		
Bauera rubioides	0.5	5	0.1	5
Baumea teretifolia	2	50	0.2	50
Billardiera scandens			0.1	1
Callistemon citrinus	3	5	5	
Corymbia gummifera			8	
Cryptostylis erecta	0.1	2		
Cyperus spp.	1	50		
Dillwynia floribunda	0.5	10	0.1	1
Dodonaea triquetra	2	15	2	50
Drosera spatulata	2	200		
Entolasia marginata	0.1	1	0.1	5
Entolasia stricta			0.1	5

Scientific name	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance
Eucalyptus piperita	5	5		
Eucalyptus racemosa	5			
Eucalyptus sieberi			10	
Eurychorda complanata	2	40		
Gahnia sieberiana	8	15	0.1	1
Gleichenia dicarpa	0.5	50	0.5	15
Gonocarpus micranthus	0.1	50		
Gonocarpus teucrioides	0.5	100	1	100
Goodenia hederacea	0.1	5		
Hakea dactyloides	1	5	1	5
Hakea sericea	5		3	15
Hakea teretifolia	2	10		
Hibbertia spp.	0.1	1	0.1	5
Hypochaeris radicata	0.1	5	0.1	1
Kunzea ambigua	15		15	
Leptospermum juniperinum	2	10		
Leptospermum lanigerum	5	10	0.5	2
Leptospermum polygalifolium	8		8	
Lepyrodia anarthria	0.1	1		
Lepyrodia scariosa	0.1	10		
Lomandra longifolia	0.5	15	3	20
Melaleuca linariifolia			0.2	2
Melaleuca sieberi			1	5
Melaleuca squarrosa	2	5		

Scientific name	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance
Melaleuca thymifolia	0.1	1		
Microlaena stipoides var. stipoides	0.1	5		
Mitrasacme pilosa	0.2	25	0.1	5
Patersonia glabrata			0.1	2
Persoonia linearis	0.1	2	0.1	2
Petrophile pulchella	1	5	0.2	5
Pultenaea divaricata	0.1	5		
Pultenaea retusa	0.1	1	0.1	1
Schizaea bifida	0.1	1		
Schoenus melanostachys	5	15	5	
Selaginella uliginosa	1	50	0.5	50
Sprengelia incarnata	0.1	5		
Viminaria juncea	0.2	2	0.1	1
Viola sieberiana	0.1	50	0.1	15
Xanthosia tridentata	0.2	10	0.1	10
Xyris operculata	0.1	1		

Note: field data was collected in electronic format, therefore raw data sheets have not been provided.

Annex 4. Vegetation integrity transect scores

Plots	PCT	Composition						Structure						Function						Easting	Northing	50 m transect bearing
		TG	SG	GG	FG	EG	OG	TG	SG	GG	FG	EG	OG	NLT	TSSC	NTH	FL	LL*	HTW			
P1	1083	7	25	11	8	3	0	17.0	53.9	19.0	3.3	1.6	0.0	0	<5, 5-9, 10-29, 20-29	0	17.0	81.0	0	294496	6192841	50
P2	434	5	21	6	5	2	1	25.0	38.2	8.5	1.4	1.0	0.1	0	<5, 5-9, 10-29, 20-29	0	37.0	36.0	0	294519	6192943	115

Key to growth form groups: TG - Tree; SG - Shrub; GG - Grass and Grass-like; FG - Forb; EG - Fern; OG – Other; **Function codes:** NLT - Number of large trees; TSSC - Tree Stem Size Class; NTH - Number of trees with hollows; FL - Course Woody Debris (fallen logs); LL - mean leaf litter cover; HTW - High Threat Weeds

* 1 m^2 litter quadrats were placed at 5 m (left), 15 m (right), 25 m (left), 35 m (right) and 45 m (left) along the central 50 m transect, all positioned 5 m from the transect centreline and alternating to the left and right from the transect centreline (as indicated).

Note: field data was collected in electronic format, therefore raw data sheets have not been provided.

Annex 5. Fauna species list

Scientific name	Common name	BC Act	EPBC Act	Observation type
Aves				
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	O/W
Amphibia				
Litoria littlejohni	Littlejohn's Tree Frog	V	V	O

Key: W – heard; O – observed; P – scat, T – trace, A = Acoustic detector.

Note: field data was collected in electronic format, therefore raw data sheets have not been provided.

Annex 6. Ecosystem and species credits required (BAM-C Credit report)

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00029832/BAAS17066/21/00029833

Proposal Name
7066 Dendrobium Gas Drainage small area BDAR

BAM data last updated *
24/11/2021

Assessor Name
Sian Griffiths

Assessor Number
BAAS17066

BAM Data version *
50

Proponent Names

Report Created
11/02/2022

BAM Case Status
Open

Assessment Revision
0

Assessment Type
Part 4 Developments (Small Area)

Date Finalised
To be finalised

BOS entry trigger
BOS Threshold: Biodiversity Values Map and area clearing threshold

* 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.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		

Species
Nil

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Not a TEC	0.8	0	17	17

1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

	Sydney Coastal Dry Sclerophyll Forests This includes PCT's: 1083, 1138, 1156, 1181, 1183, 1250, 1253, 1619, 1620, 1621, 1623, 1624, 1625, 1627, 1632, 1636, 1638, 1642, 1643, 1681, 1776, 1777, 1778, 1780, 1782, 1783, 1785, 1786, 1787	Sydney Coastal Dry Sclerophyll Forests <50%	1083_Moderate	No	3	Sydney Cataract, Burragorang, Cumberland, Illawarra, Moss Vale and Pittwater. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Sydney Coastal Dry Sclerophyll Forests This includes PCT's: 1083, 1138, 1156, 1181, 1183, 1250, 1253, 1619, 1620, 1621, 1623, 1624, 1625, 1627, 1632, 1636, 1638, 1642, 1643, 1681, 1776, 1777, 1778, 1780, 1782, 1783, 1785, 1786, 1787	Sydney Coastal Dry Sclerophyll Forests <50%	1083_Moderate01	No	14	Sydney Cataract, Burragorang, Cumberland, Illawarra, Moss Vale and Pittwater. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

No Species Credit Data

Credit Retirement Options

Like-for-like credit retirement options

Annex 7. Digital files created for the BDAR

Subject land

Development footprint

1500m buffer boundary

Vegetation within 1500m buffer boundary

Strahler Stream Order

Construction footprint

BAM plots

Survey tracks

Vegetation mapping

Threatened species records

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Freshwater
Marine and coastal
Research and monitoring
Wildlife Schools and training

Heritage management
Aboriginal heritage
Historical heritage
Conservation management
Community consultation
Archaeological, built and landscape values

Environmental management and approvals
Impact assessments
Development and activity approvals
Rehabilitation
Stakeholder consultation and facilitation
Project management

Environmental offsetting
Offset strategy and assessment (NSW, QLD, Commonwealth)
Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)

APPENDIX 3

DENDROBIUM GAS INFRASTRUCTURE NO 2 AND 3 VENT SHAFT - ABORIGINAL OBJECTS DESKTOP DUE DILIGENCE ASSESSMENT (NICHE, 2022B)

Niche Environment and Heritage
PO Box 2443 North Parramatta NSW 1750
T 02 9630 5658 **F** 02 4017 0071
E info@niche-eh.com **ABN** 19 137 111 721

7 February 2022

Ms Nicola Curtis
Principal Mining Approvals
South32 Illawarra Metallurgical Coal

Dear Nicola,

Re: Dendrobium Gas Infrastructure No 2 and No 3 Vent Shaft – Aboriginal Objects Desktop Due Diligence Assessment (Niche ref: #7066)

Niche Environment and Heritage (Niche) have been engaged by South32 Illawarra Metallurgical Coal (IMC) to conduct an Aboriginal Objects Due Diligence Assessment (DD) for the proposed construction of new gas management infrastructure and ancillary infrastructure to facilitate management of gas from Area 3C at the site of the existing Dendrobium No 2 and 3 Shafts (hereafter referred to as the 'Activity Area A') and the proposed temporary shoring/bracing works of the bridge crossing at Sandy Creek on Fire Trail No 6C (hereafter referred to as the 'Activity Area B'.

The proposed works at Activity Area A would involve the following activities:

- Construction of new gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre-drainage gas from Area 3C at the site of the existing Dendrobium No 2 and 3 Shafts.
- Gas extraction from the underground mine via a borehole and vacuum pump, with associated infrastructure including a cooling water system incorporating cooling towers.
- Gas treatment using enclosed flares on the surface. Under conditions not suitable for flaring, gasses would alternatively be vented via a stack approximately 25 metres (m) high.
- Ancillary infrastructure, such as fencing, pumps, CO_2 tanks, condensate tanks and surface pipes.
- Additional water management infrastructure (e.g. sediment controls).
- Process/fire water system, including bores to pump water from and return water to the underground mine workings and pipes/tanks to convey and store this water.
- Installation and use of a transportable substation for electricity requirements.
- Upgrade of the three surface ventilation fans at the gas plant construction site, including upgraded fan impellers, shafts, drives and motors within the existing footprint.
- Minor upgrades of existing electricity transmission infrastructure, such as replacement poles and aerial conductors within mining lease (ML) 1566.

The proposed works at Activity Area B would involve the following activities:

- Temporary bracing of the 2-span Bailey bridge that is on the access trail (Sandy Creek crossing) using props at regular spacing to support the bridge's structure if heavy loads are to be transported across the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).

For the proposed works in Activity Area A, it is assumed that all construction activities would be located wholly within the previously approved and previously cleared area associated with the Dendrobium No 2 and 3 Shafts. Clearance of vegetation would occur within areas of revegetation that has occurred following the approved clearance activities to establish the existing ventilation shaft infrastructure.

For the proposed works in Activity Area B, there would be no surface disturbance outside of ML 1566. No removal of vegetation is required for the temporary bridge bracing.

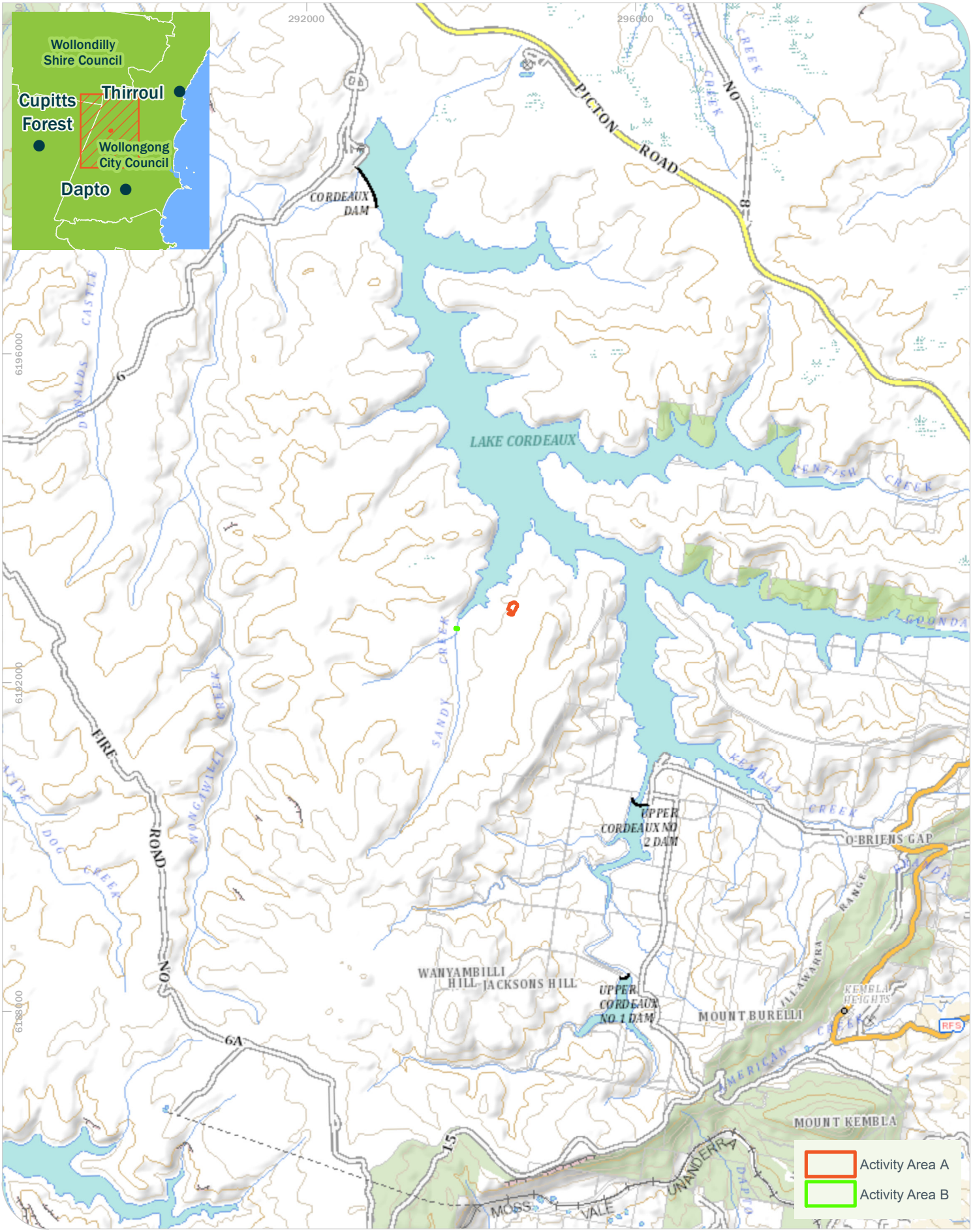
The location of Activity Area A and Activity Area B are shown on Figures 1 and 2.

Will the activity disturb the ground surface or any Aboriginal culturally modified (scarred) trees?

Yes.

The proposed activity involves earthworks and vegetation clearance.

No Aboriginal modified trees are located within Activity Area A or Activity Area B.



nicheEnvironment and Heritage

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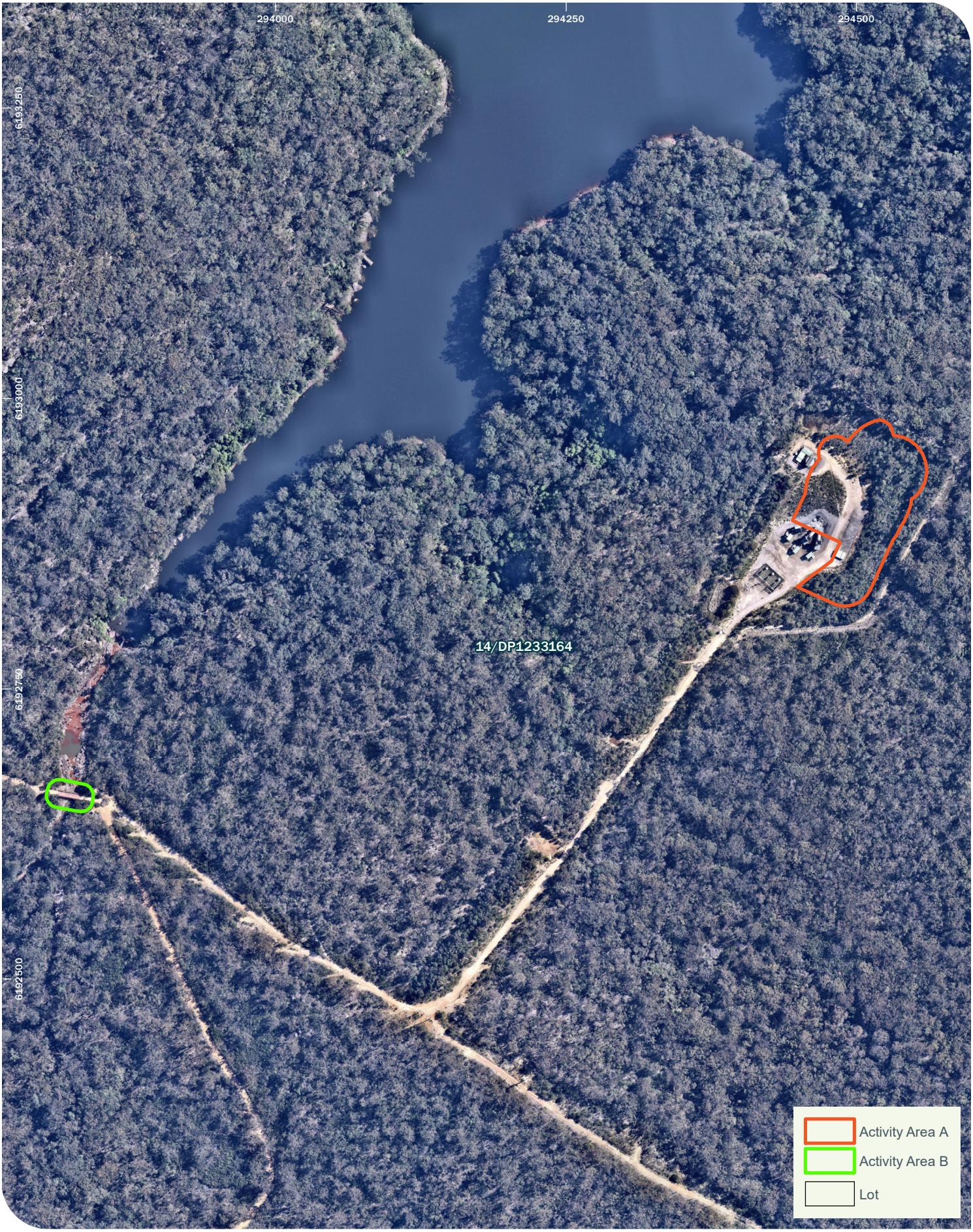
km
GDA 1994 MGA Zone 56

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

Location Map

Dendrobium - Gas Infrastructure at Nos 2 and 3 Shafts

Figure 1



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GDA 1994 MGA Zone 56

Location of the Subject Area

Dendrobium - Gas Infrastructure at Nos 2 and 3 Shafts

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

Figure 2

Is the activity exempt under legislation?

No.

The proposed activities associated with the construction of new gas management infrastructure and ancillary infrastructure are not exempt under the *National Parks and Wildlife Act, 1974* (NPW Act).

Is the activity subject to assessments or approval under the EP&A Act?

Yes.

The Dendrobium Underground Coal Mine Development Consent (DA 60-03-2001) was approved under the *Environmental Planning and Assessment Act, 1979* in 2001, with a modification approved in 2008. The proposed activity is to be assessed as a modification to the Consent under the *Environmental Planning and Assessment Act, 1979*.

The proposed activities are also assessed in accordance with the *NSW Minerals Industry Due Diligence Code of Practice for the protection of Aboriginal Objects* (NSW Minerals Council, 2010).

Step 1. Are there any relevant confirmed site records or other associated landscape feature information on AHIMS?

Yes.

An extensive Aboriginal Heritage Information Management System (AHIMS) search was completed on 24 November 2021 covering the Activity Areas and surrounds. The AHIMS search identified 8 Aboriginal cultural heritage sites and no Aboriginal Places surrounding the Activity Areas (Client ID # 641450). A second AHIMS search was completed on 30 November 2021 due to a discrepancy in basic and extensive search results. The extensive search identified 4 Aboriginal cultural heritage sites and no Aboriginal Places surrounding the Activity Areas (Service ID # 643428). It should be noted that the AHIMS search provides a general dot point location only and does not provide information regarding the size and extent of a specific Aboriginal cultural heritage site.

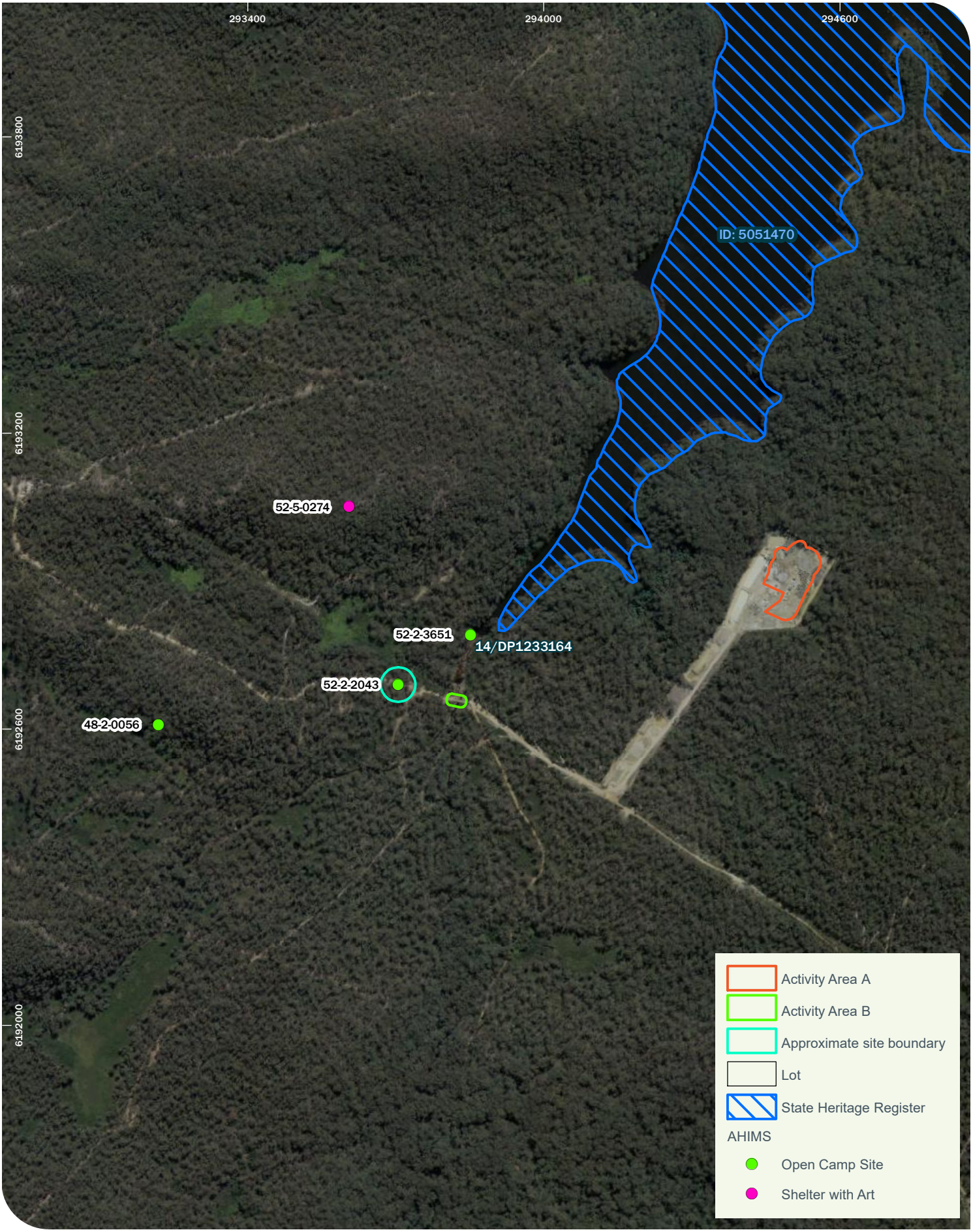
The search identified four Aboriginal cultural heritage sites within close proximity to the Activity Areas (Figure 3). For further information regarding the Aboriginal cultural heritage sites, see Table 1.

The site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) is a partially destroyed artefact site located within 100m of Activity Area B. The site is located in proximity to the bridge crossing over Sandy Creek, where proposed temporary shoring/bracing works are to be conducted. The site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) is an artefact scatter, originally recorded in 1996 by Caryll Sefton and re-recorded in 2000 by Navin Officer and further investigated by Biosis Research in 2006. A 'Consent to Destroy' was issued in 2005 to allow for the construction of an upgraded crossing of Sandy Creek (AHIMS permits 2211 and 2574). No further details are available for this consent to destroy at this stage.

Table 1: Details of AHIMS sites within search area

AHIMS ID	Site Name	Site Type	Status	Potential to be impacted by proposed works
52-2-3651	DM 23	Shelter with Artefacts	AHIMS: Valid	None
52-2-2043	Sandy Creek Road 28 (Cordeaux Catchment)	Open Camp Site	AHIMS: Partially Destroyed	None
52-2-0274	Sandy Creek Road 22	Shelter with Art	AHIMS: Valid	None
52-2-0056	DM 13	Shelter with Artefacts	AHIMS: Valid	None

It must be noted that care should be taken when using the AHIMS database to reach conclusions about site prevalence or distribution. Many of the Aboriginal cultural heritage sites within the local area are Shelters with Art, Shelters with Deposit and Axe Grinding Grooves. The majority of the Aboriginal sites identified by the AHIMS search appear to occur in areas of sandstone ridgelines. A more detailed, quantitative analysis may be appropriate to determine whether this reflects an occupation pattern or correlates the focus of surveys targeting ridgelines. Aboriginal sites are located across all landforms, but their frequency is over-represented in some landforms due to survey bias toward the mine developments. Therefore, the distribution of registered Aboriginal cultural heritage sites does not reflect patterns of occupation, but rather is often indicative of survey coverage and conditions.



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Location of AHIMS Sites and Heritage Items
Dendrobium - Gas Infrastructure at Nos 2 ands Shafts

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

Figure 3

v2.0

Step 2: Is the Activity a 'Low Impact Activity', as defined in the NPW Regulation?

No for Activity Area A and yes for Activity Area B (where there will be no ground disturbance or vegetation removal).

The activity at Area A is not a low impact activity as defined under section 58 of the *National Parks and Wildlife Regulation, 2019* ('the Regulation') because:

- It involves earthworks associated with construction and development; and
- It involves vegetation clearance.

The activity at Area B is a low impact activity as defined under section 58 of the *National Parks and Wildlife Regulation, 2019* ('the Regulation') because:

- There will be no ground disturbance or vegetation removal; and
- It involves maintenance of existing roads, fire and other trails and tracks,.

Step 3. Are there landscape features on undisturbed land that are likely to indicate the presence of Aboriginal objects?

Yes.

The following landscape features listed in the *NSW Minerals Industry Due Diligence Code of Practice for the protection of Aboriginal Objects* (NSW Minerals Council, 2010) signify a high potential for the presence of Aboriginal objects:

- Within 200 m of waters;
- Located within a sand dune system;
- Located on a ridge top, ridge line or headland;
- Located within 200 m below or above a cliff face; or
- Within 20 m of or in a cave, rock shelter, or a cave mouth.

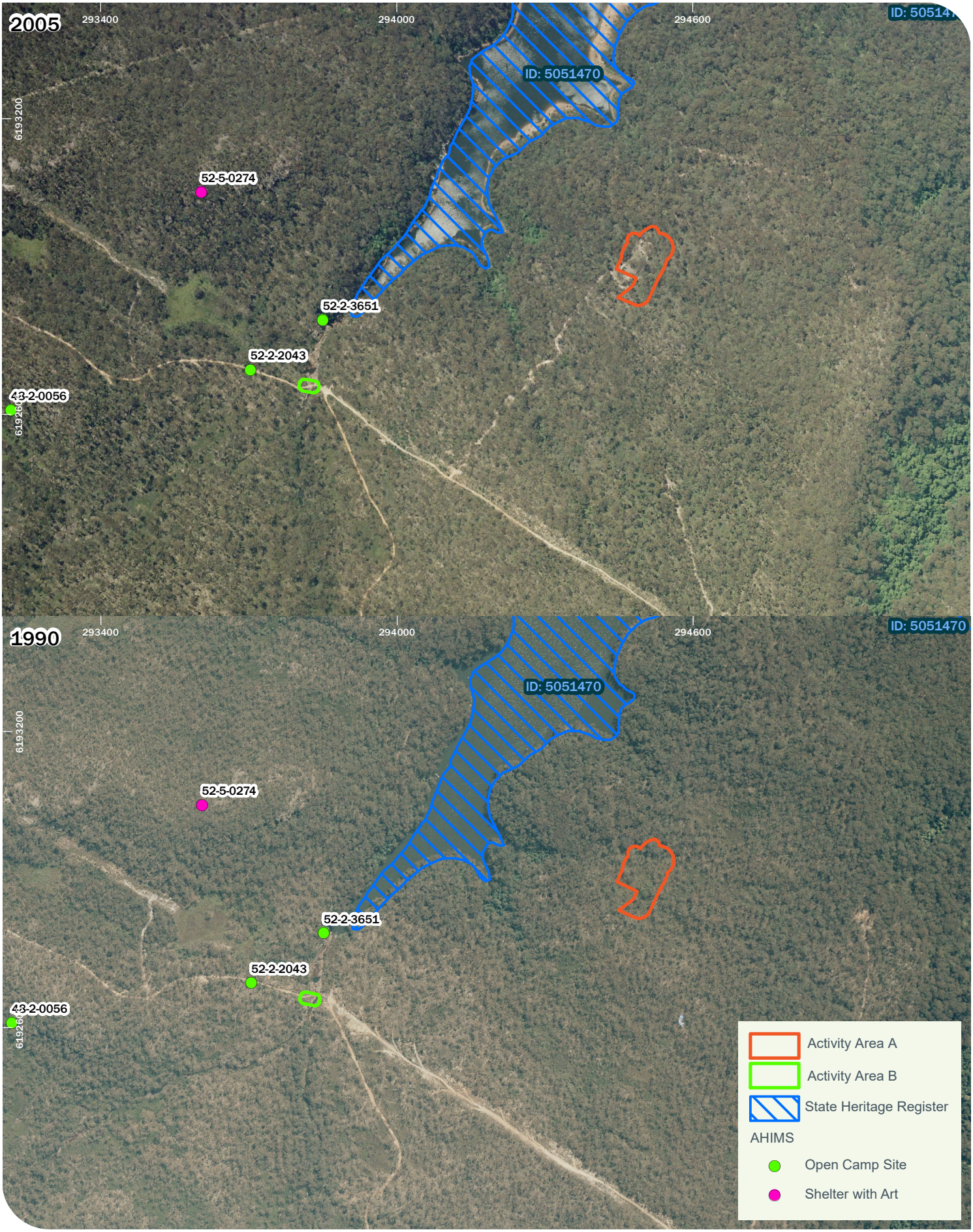
Based on the desktop assessment the Activity Areas contain the following landscape features that are likely to indicate the presence of Aboriginal objects, as identified by the Due Diligence Code:

- Within 200 m of waters.

The Activity Areas are located within 200 m of Sandy Creek, a tributary of the Cordeaux River. Sandstone platforms and outcrops are also present near the proposed activity. These landscape features are often associated with Aboriginal objects and sites, as demonstrated by the registered Aboriginal cultural heritage sites identified through AHIMS.

The soil profile within the Activity Areas (Figures 4a and 4b) has a low potential to preserve in situ traces of Aboriginal Objects due to shallow deposits, erosion and mass movement caused from natural processes (i.e. flooding). The Activity Areas are located within the Hawkesbury soil landscape (Figure 5). This soil landscape consists of steep ridges of the Woronora Plateau. Relief ranges between approximately 100 - 200 m and slopes generally have a gradient of 25% (Hazelton and Tille, 1990). The rises have narrow

crests, ridges and benches with broken scarps and boulders. Soils consist of shallow siliceous sands. Localised deep sands exist within joints and fractures. This soil profile experiences extreme soil erosion, mass movement and low fertility (Hazelton and Tille, 1990). Archaeological potential within this soil profile is low, due to erosion and mass movement of the soil profile. Axe Grinding Groves and Shelters with Art are common within this soil profile. Artefacts are often found in depositional sands within shelter sites.



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m
GDA 1994 MGA Zone 56

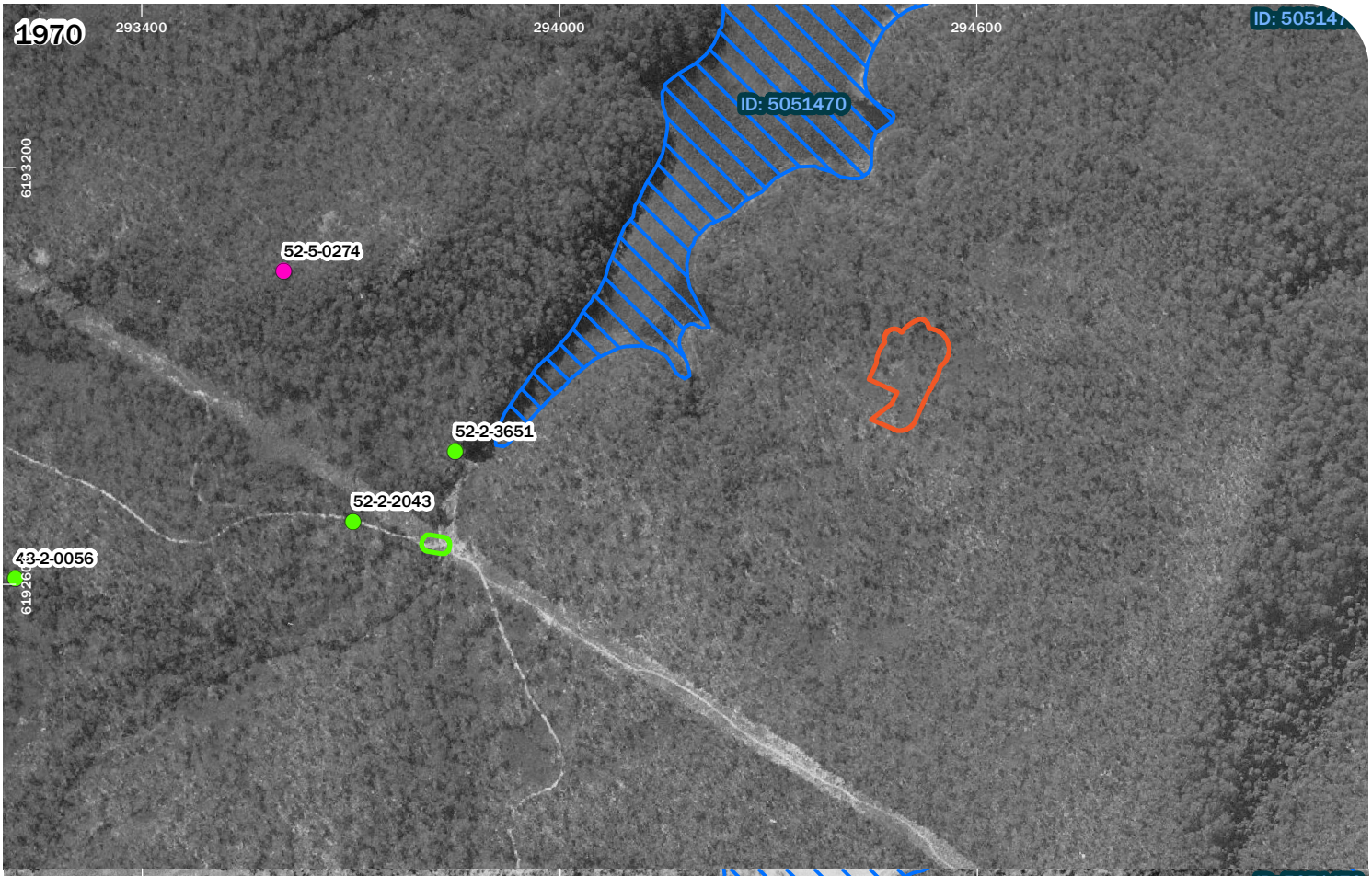
Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

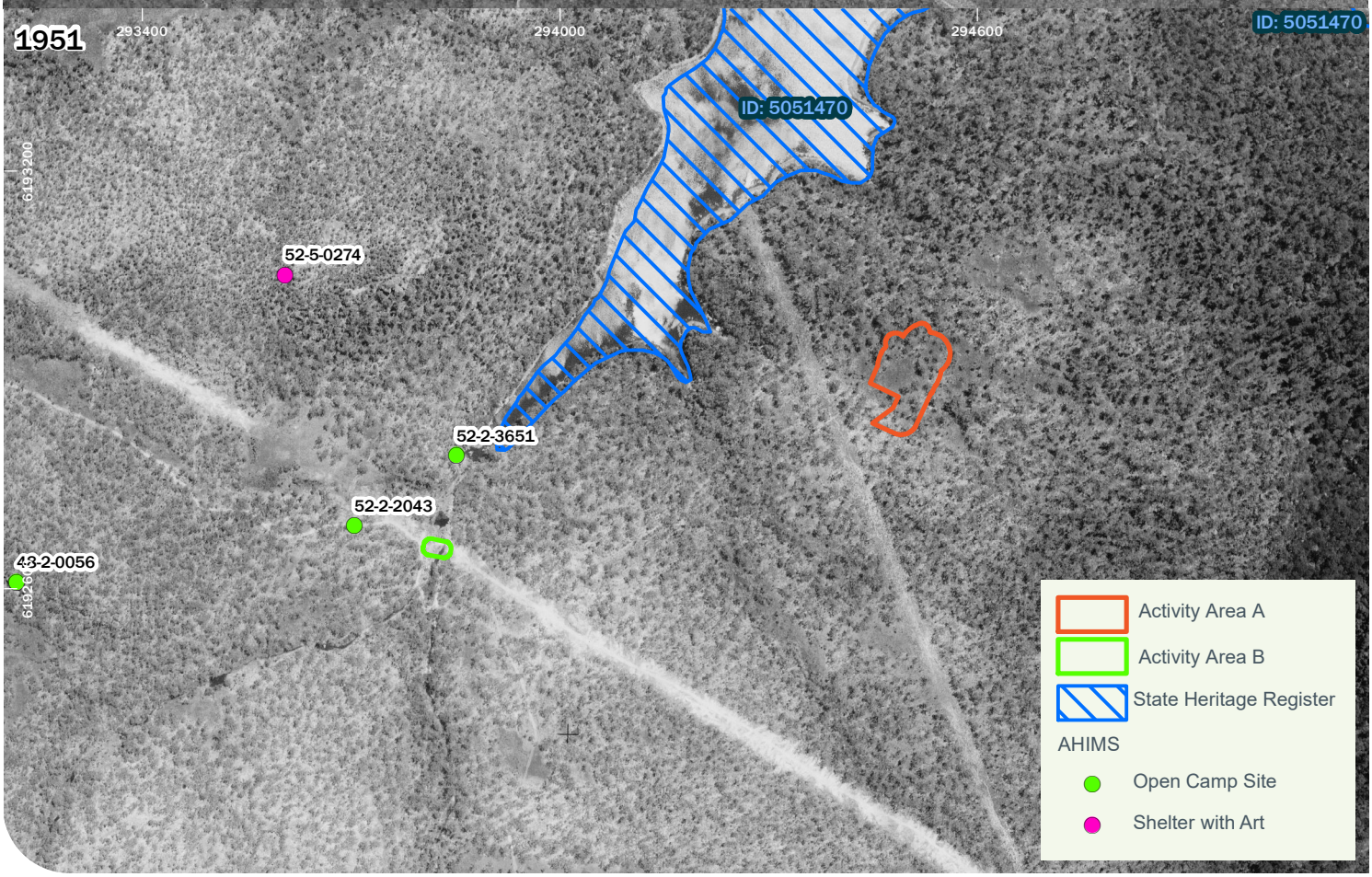
Historical Aerial Photographs

Dendrobium - Gas Infrastructure at Nos 2 and 3 Shafts

Figure 4a

v2.0





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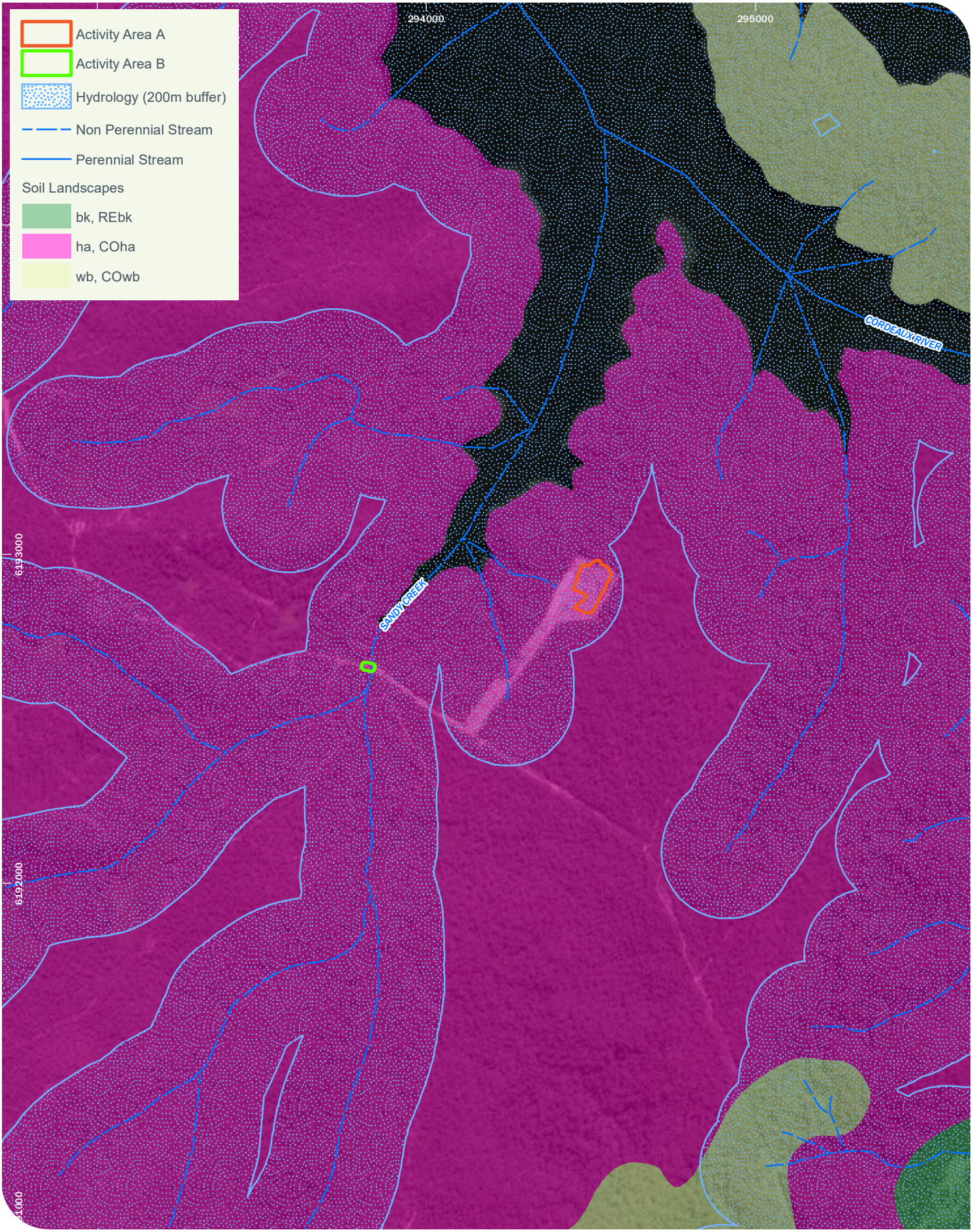
Historical Aerial Photographs

Dendrobium - Gas Infrastructure at Nos 2 and 3 Shafts

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

Figure 4b



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m
GDA 1994 MGA Zone 56

Soil landscapes and hydrology in the local area

Dendrobium - Gas Infrastructure at Nos 2 and 3 Shafts

Niche PM: Sian Griffiths
Niche Proj. #: 7066
Client: South 32

Figure 5

Niche Environment and Heritage
PO Box 2443 North Parramatta NSW 1750
T 02 9630 5658 **F** 02 4017 0071
E info@niche-eh.com **ABN** 19 137 111 721

Step 4. Does a desktop assessment confirm that there are Aboriginal objects or that they are likely?

Yes.

The desktop assessment concluded that Aboriginal Objects are likely to occur at Activity Area B due to the proximity to water and the location of AHIMS site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) within 100 m of Activity Area B.

This desktop DD assessment confirmed that Activity Area B has previously been surveyed for an Aboriginal Objects Due Diligence Assessment as part of a Review of Environmental Factors (REF) for environmental monitoring of Dendrobium Area 3C (Niche, 2021). The survey identified the partially destroyed Aboriginal cultural heritage site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) and provided recommendations to avoid impact to the site.

However, Aboriginal Objects are unlikely to occur within Activity Area A. Despite the proximity of Activity Area A to suitable landscape features, the area has been impacted by significant ground disturbances associated with vegetation clearance and the construction of existing infrastructure (i.e. access roads, ventilation shafts and electrical equipment) (Plate 1 and Plate 2).

Plate 1: General aerial photo of Activity Area A. Area of revegetation is visible.

Plate 2: General photo of Activity Area A, facing south-west.

Step 5. Can the activity be relocated away from the known/likely area of Aboriginal objects?

No.

The proposed works for Activity Area B cannot be relocated due to the existing location of the bridge crossing over Sandy Creek.

Regarding Activity Area A, relocating the activity is not warranted given the absence of Aboriginal objects and the minimal chance of Aboriginal objects existing subsurface due to the shallow and erosive soil profile associated with the Hawkesbury Sandstone landscape.

Are further investigations and impact assessments needed?

Activity Area A

No.

No Aboriginal heritage constraints were identified within or in proximity to Activity Area A.

IMC can proceed with the proposed activities at Dendrobium Colliery with the following recommendations:

- All site workers and contractors should be inducted to the area and informed of their obligations under the *National Parks and Wildlife Act, 1974.*
- In the unlikely event that any Aboriginal objects are found, all activities with the potential to impact the objects must stop. A temporary fence is to be erected around the Aboriginal cultural heritage site, with a buffer zone of at least 10 m around the known edge. An appropriately qualified archaeologist is to be engaged to assess the findings, and notification is to be provided to Heritage NSW. Works should not proceed without advice from Heritage NSW or an appropriately qualified archaeologist.
- In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact must cease immediately and:
  - The location, including a 10 m curtilage, should be secured using barrier fencing to avoid further harm;
  - The NSW Police must be contacted immediately;
  - No further action is to be undertaken until the NSW Police confirm the origin of the remains as non-human and provide a case number for South32's records;
  - If the skeletal remains are identified as Aboriginal, the Proponent or their agent must contact: Heritage NSW via the Environment Line on 131 555; and representatives of the Registered Aboriginal Parties (RAPs); and
  - No works are to continue until the Heritage NSW provides notification to the Proponent or their Agent.

Activity Area B

No.

Aboriginal heritage site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) is located in close proximity to Activity Area B. However, the proposed works will not involve vegetation clearing and will not impact the partially destroyed site.

IMC can proceed with the proposed activities at Dendrobium Colliery with the following recommendations:

- All site workers and contractors should be inducted to the area and informed of their obligations under the *National Parks and Wildlife Act, 1974.*
- No Ground surface disturbance should occur within proximity of Aboriginal heritage site Sandy Creek Road 28 (Cordeaux Dam) (AHIMS ID#52-2-2043) (see Figure 3)
- In the unlikely event that any Aboriginal objects are found, all activities with the potential to impact the objects must stop. A temporary fence is to be erected around the Aboriginal cultural heritage site, with a buffer zone of at least 10 m around the known edge. An appropriately qualified archaeologist is to be engaged to assess the findings, and notification is provided to Heritage NSW. Works should not proceed without advice from Heritage NSW or an appropriately qualified archaeologist.
- In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact must cease immediately and:
  - The location, including a 10 m curtilage, should be secured using barrier fencing to avoid further harm;
  - The NSW Police must be contacted immediately;
  - No further action is to be undertaken until the NSW Police confirm the origin of the remains as non-human and provide a case number for South32's records;
  - If the skeletal remains are identified as Aboriginal, the Proponent or their agent must contact: Heritage NSW via the Environment Line on 131 555; and representatives of the Registered Aboriginal Parties (RAPs); and
  - No works are to continue until the Heritage NSW provides notification to the Proponent or their Agent.

Yours sincerely,

Chelsea Freeman
Heritage Consultant - Niche Environment and Heritage

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E info@niche-eh.com ABN 19 137 111 721

References

Biosis Research, 2006. *Dendrobium Colliery Area 2, Longwalls 3 to 5, Impacts of Subsidence on Indigenous and Historical Archaeological Sites*. Report prepared for BHP Billiton Illawarra Coal.

Hazelton, P.A. and Tille, P.J., 1990. *Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet*. Soil Conservation Service of NSW, Sydney.

Navin Officer, 2000. *Dendrobium Coal Project Cultural Heritage Assessment*. Report to Olsen Environmental Consulting on behalf of BHP Coal Illawarra.

Niche Environment and Heritage, 2021. *Dendrobium Area 3C Environmental Monitoring Review of Environmental Factors - Aboriginal Objects Due Diligence Assessment*. Report prepared for South32 Illawarra Metallurgical Coal.

NSW Minerals Council, 2010. *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects.* NSW Minerals Council, Sydney, NSW.

Sefton, C., 1996. *Archaeological Investigation of Area 4, Appin Colliery*. Report prepared for Collieries Division, BHP Australia Coal.

Attachment 1 – AHIMS Extensive Search

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 7066

Client Service ID : 641450

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
52-2-3651	DM 23	GDA	56	293851	6192791	Closed site	Valid	Artefact : -		
	Contact	**Recorders**	Biosis Pty Ltd - Sydney					**Permits**	3081	
52-2-2043	Sandy Creek Road 28 (Cordeaux Catchment)	AGD	56	293600	6192500	Open site	Partially Destroyed	Artefact : -	Open Camp Site	4120,100453
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**	2211,2574	
52-5-0274	Sandy Creek Road 22;	AGD	56	293500	6192860	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	
	Contact	**Recorders**	Mrs.Caryll Sefton					**Permits**	3081	
48-2-0056	DM 13	GDA	56	293219	6192609	Closed site	Valid	Artefact : 3		
	Contact	**Recorders**	Biosis Pty Ltd - Sydney,Niche Environment and Heritage,Miss.Stella Quast					**Permits**	3081,4741	

**** Site Status**

Valid - The site has been recorded and accepted onto the system as valid

Destroyed - The site has been completely impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There is nothing left of the site on the ground but proponents should proceed with caution.

Partially Destroyed - The site has been only partially impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There might be parts or sections of the original site still present on the ground

Not a site - The site has been originally entered and accepted onto AHIMS as a valid site but after further investigations it was decided it is NOT an aboriginal site. Impact of this type of site does not require permit but Heritage NSW should be notified

Report generated by AHIMS Web Service on 24/11/2021 for Chelsea Freeman for the following area at Lat, Long From : -34.39, 150.75 - Lat, Long To : -34.38, 150.78. Number of Aboriginal sites and Aboriginal objects found is 4

Attachment 2 – Site Cards

Aboriginal Site Recording Form

AHIMS Registrar
PO Box 1967, Hurstville NSW 2220

Office Use Only

Site Number 48-2-0056

Date received / / Date entered into system 21/10/08 Date catalogued / /

Entered by (I.D.)

Information Access

☐ Gender/male ☐ Gender/female ☐ Location restriction ☐ General restriction ☐ No access

Office Use Only

For Further Information Contact:

☐ **Nominated Trustee**

Title | Surname | First Name | Initials

Organisation

Address

Phone number | Fax

Client on system ☐

☐ **Knowledge Holder**

Title | Surname | First Name | Initials

Organisation

Address

Phone number | Fax

Client on system ☐

Aboriginal Heritage Unit or Cultural Heritage Division Contacts

Geographic Location

Site Name DM 13

Easting 293219 Northing 6192609 AMG/GDA GDA

Mapsheet Wollongong

Zone Location Method Non-Differential GPS

Primary Recorder

Title | Surname | First Name | Initials

Mr | Rogerson | Scott

Organisation Biosis Research Pty Ltd

Address 18-20 Mandible St Alexandria

Phone number 02 9690 2777 Fax 02 9690 2577

Date recorded 8/5/07

Client on system ☐

NPWS Aboriginal Site Recording Form - Site Information

OPEN/CLOSE SITE Closed Site

Site Context

Landform

- [✓] Mountainous
- [✓] Plain
- [ ] Rolling hills
- [ ] Steep hills
- [ ] Undulating plain

Landform Unit

- [ ] Beach
- [ ] Coastal rock platform
- [ ] Dune
- [ ] Intertidal flat
- [ ] Lagoon
- [ ] Tidal Creek
- [ ] Tidal Flat
- [✓] Cliff
- [ ] Crest
- [ ] Flat
- [ ] Lower slope
- [ ] Mid slope
- [ ] Upper slope
- [ ] Plain
- [ ] Ridge
- [ ] Tor
- [ ] Valley flat
- [ ] Levy
- [ ] Stream bank
- [ ] Stream channel
- [ ] Swamp
- [ ] Terrace
- [ ] Terrace flat

Slope

[ ] degrees

Vegetation

- [ ] Closed forest
- [ ] Grasslands
- [ ] Isolated clumps of trees
- [ ] Open forest
- [ ] Open woodland
- [ ] Scrub
- [✓] Woodland
- [ ] Cleared
- [ ] Revegetated
- [ ] N/A

Land use

- [✓] Conservation
- [ ] Established urban
- [ ] Farming-intensive
- [ ] Farming-low intensity
- [ ] Forestry
- [ ] Industrial
- [ ] Mining
- [ ] Pastoral/grazing
- [ ] Recreation
- [ ] Semi-rural
- [ ] Service corridor
- [ ] Transport corridor
- [ ] Urban expansion
- [ ] N/A

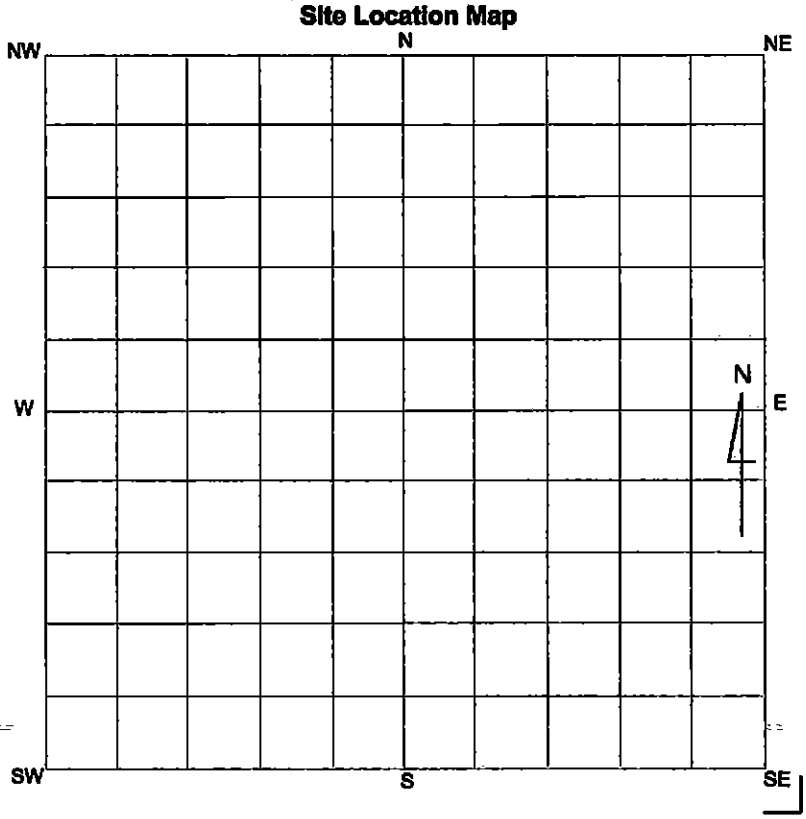
Water

Distance to permanent water source	150 metres
Distance to temporary water source	metres
Name of nearest permanent water source	Sandy Ck
Name of nearest temporary water	

Directions for Relocation

This shelter (cliff) with deposit is situated on the bottom cliff line on a significant ridgeline on the northern side of Sandy Creek. It is situated in the centre of a large, high sandstone cliff line, 150 m from the creek channel

Site Location Map



Current Land Tenure

- [✓] Public — National Park / other Government Dept.
- [ ] Private

Primary report I.D. [ ] (I.D. Office Use only)

Biosis Research (2007)Dendrobium Area 3 Proposed Longwall Mine – Archaeological and Cultural Heritage Assessment (Report to BHP Billiton)

NPWS Aboriginal Site Recording Form - Site Information

General Site Information

Closed Site

Shelter/Cave Formation

- [ ] Boulder
- [ ] Wind erosion
- [ ] Water erosion
- [ ] Rock collapse

Rock Surface Condition

- [ ] Boulder
- [ ] Sandstone platform
- [ ] Silica gloss
- [ ] Tessellated
- [ ] Weathered
- [ ] Other platform

Condition of Ceiling

- [ ] Boulder
- [x] Sandstone platform
- [ ] Silica gloss
- [ ] Tessellated
- [x] Weathered
- [ ] Other platform

Shelter Aspect

- [ ] North
- [x] North East
- [ ] East
- [ ] South East
- [ ] South
- [ ] South West
- [ ] West
- [ ] North West

Open Site

Site Orientation

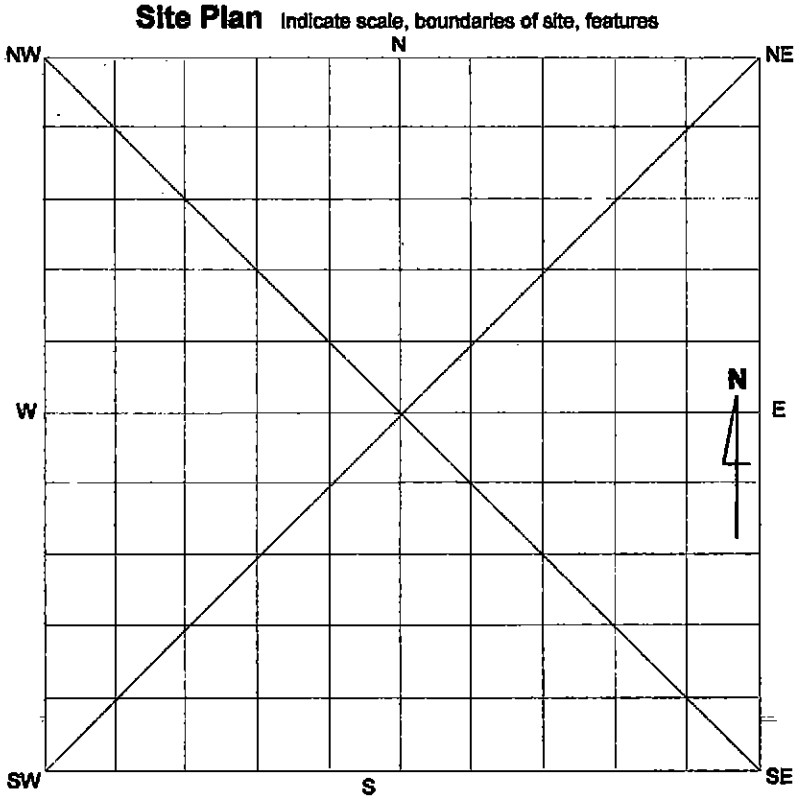
- [ ] N-S
- [ ] NE-SW
- [ ] E-W
- [ ] SE-NW
- [ ] N/A

Features

- [ ] 1. Aboriginal Ceremony & Dreaming
- [ ] 2. Aboriginal Resource & Gathering
- [ ] 3. Art
- [x] 4. Artefact
- [ ] 5. Burial
- [ ] 6. Ceremonial Ring
- [ ] 7. Conflict
- [ ] 8. Earth Mound
- [ ] 9. Fish Trap
- [ ] 10. Grinding Groove
- [ ] 11. Habitation Structure
- [ ] 12. Hearth
- [ ] 13. Non Human Bone & Organic Material
- [ ] 14. Ochre quarry
- [ ] 15. Potential Archaeological Deposit
- [ ] 16. Stone Quarry
- [ ] 17. Shell
- [ ] 18. Stone Arrangement
- [ ] 19. Modified Tree
- [ ] 20. Water Hole

Site Plan

Indicate scale, boundaries of site, features



Site Dimensions

Closed Site Dimensions (m)

- _____ Internal length
- _____ Internal width
- _____ Shelter height
- _____ Shelter floor area

Open Site Dimensions (m)

- _____ Total length of visible site
- _____ Average width of visible site
- _____ Estimated area of visible site
- _____ Length of assessed site area

Aboriginal Community Interpretation and Management Recommendations

Representatives of the following organisations were present during field work and agreed with report recommendations:

- Cubbitch Barta Native Title Claimants Aboriginal Corporation
- Illawarra Local Aboriginal Land Council
- Korewal Elouera Jerrungarugh

Preliminary Site Assessment

Site Cultural & Scientific Analysis and Preliminary Management Recommendations

The shelter is about 5.6m high and 23m long. A number of artefacts were found near a wombat hole located in the centre of the shelter. The artefacts consisted of:

- 3 quartz flakes
- One petrified wood fragment.
- One mudstone core

The deposit the artefacts were found in was approximately 30-40cm deep and of a medium yellow brown sand.

This section should only be filled in by the Endorsees

Endorsed by: ☐ Knowledge Holder ☐ Nominated Trustee ☐ Native Title Holder ☐ Community Consensus

Title	Surname	First Name	Initials

Organisation

Address

Phone number Fax

Attachments (No.)

- ☐ A4 location map
- ☐ B/W photographs
- ☑ Colour photographs
- ☐ Slides
- ☐ Aerial photographs
- ☐ Site plans, drawings
- ☐ Recording tables
- ☐ Other
- ☐ Feature inserts-No. ☐

Comments

See attached sheet of photo's.

NPWS FEATURE RECORDING FORM - ARTEFACT

Site I.D. | Site Name: DM 13

First recorded date: 08/05/2007

No. of instances: 5

Recorded by: Biosis

	Yes	No
Stone artefacts only		No
Artefacts collected		No
Permit issued		

Importance: Cannot be presently determined

- ☐ Contributed to primary site importance
- ☐ Contributes to secondary site importance
- ☐ Cannot be presently determined

Other Registration

- ☐ Register of the National Estate
- ☐ Heritage Register
- ☐ National Trust

Percentage of Non-stone Artefacts to Percentage of Stone Artefacts

0-9%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%
		☐	☐	☐	☐	☐	☐	☐	☐

Feature Context & Condition

Scatter No. | Easting | Northing

Density (Artefact count per square metre)

Dimensions: Length (m) | Width (m) | Depth (m)

	Yes	No
In situ		
Stratified		

Feature Condition

- ☐ Very good
- ☑ Good
- ☐ Poor

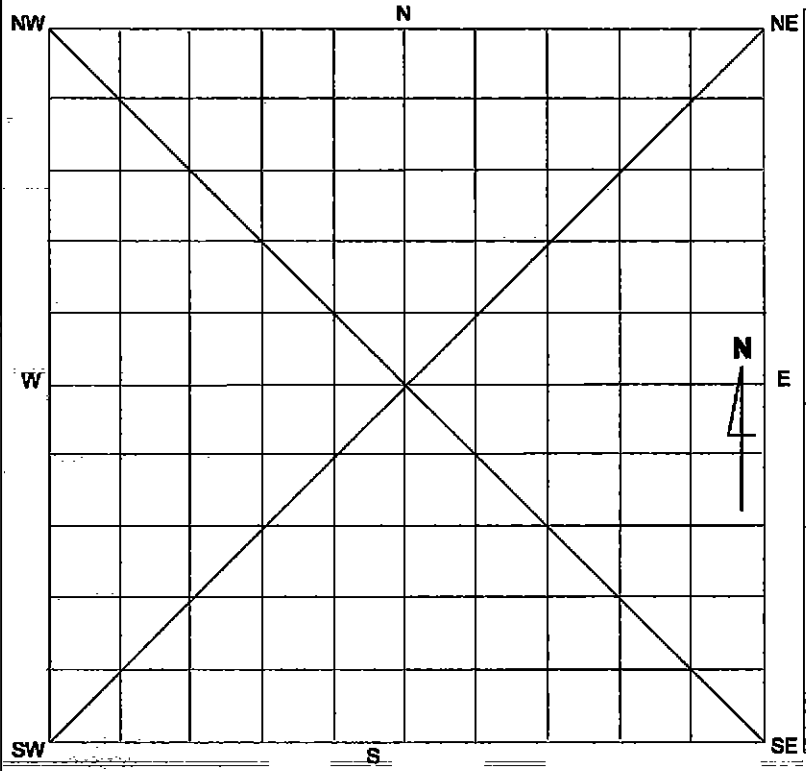
General Condition

- ☑ Weathered
- ☐ Vehicle damage
- ☐ Surface water wash
- ☐ Fire damage
- ☐ Erosion
- ☐ Stock damage
- ☑ Exposed archaeological material

Recommended Action

- ☐ Boardwalk
- ☐ Fencing
- ☐ Closure to public
- ☐ Continued inspection
- ☐ Fire hazard reduction
- ☐ Expert assessment
- ☐ Meeting with land manager
- ☐ Revegetation
- ☐ Signage
- ☐ Soil erosion control
- ☐ Track closure/re-routing
- ☐ Additional recording

Feature Plan (Indicate scale, location of instances)



Feature Environment

(Complete when *feature* environment differs to *site* environment, use attributes from cover card, p. 2)

- Land form
- Land form unit
- Slope
- Vegetation
- Land use

Water

Distance to permanent water source: metres

Distance to temporary water source: metres

Name of nearest permanent water source

Name of nearest temporary water

NPWS FEATURE RECORDING TABLE - ARTEFACT

Stone Artefact

Instance No.	Recording Date	Artefact Material	Artefact Type	Platform Surface	Platform Type	Termination	Cross Section	Length (mm)	Width (mm)	Thickness (mm)
1	08/05/2007	Silcrete	Other							
1	08/05/2007	Quartz	Flake							
1	08/05/2007	Quartz	Flake							
1	08/05/2007	Quartz	Flake							
1	08/05/2007		Flake							

Other Artefact Type

Instance No.	Recording Date	Artefact Material	Artefact Type	Description	Length (mm)	Width (mm)	Thickness (mm)

Material

Basalt
Chert
Fine grained siliceous
Granite
Quartz
Quartzite
Sandstone
Silcrete
Green glass
Amber glass
Amethyst glass
Clear glass
Ceramic
Porcelain
Tin can
Wire
Nail
Button
Shell
Bone
Wood
Resin

Artefact Description

Adze
Anvil
Axe
Backed blade
Blade
Core
Core tool
Cyclon
Distal fragment
Eloura
Flake
Flake tool
Flaked piece
Hammerstone
Manuport
Milling slab
Mortar
Muller
Nuclear tool
Pirri
Proximal fragment
Tula
Other diagnostic type
Modified
Unworked

Platform Surface

Cortex
Flake scar
More than one flake scar
Faceted
Ground
Indeterminate
Bipolar

Platform Type

Wide
Focal
Shattered
Indeterminate
Bipolar

Termination

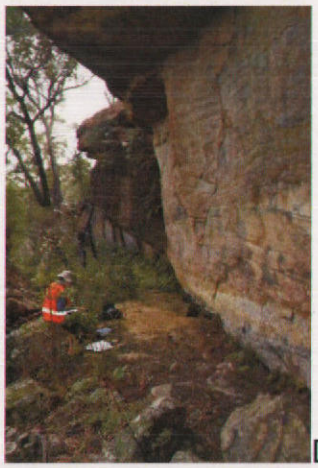
Feather
Hinge
Step
Outrepasse
Bipolar

Cross Section

High/strong
High/weak
Low/weak
Irregular

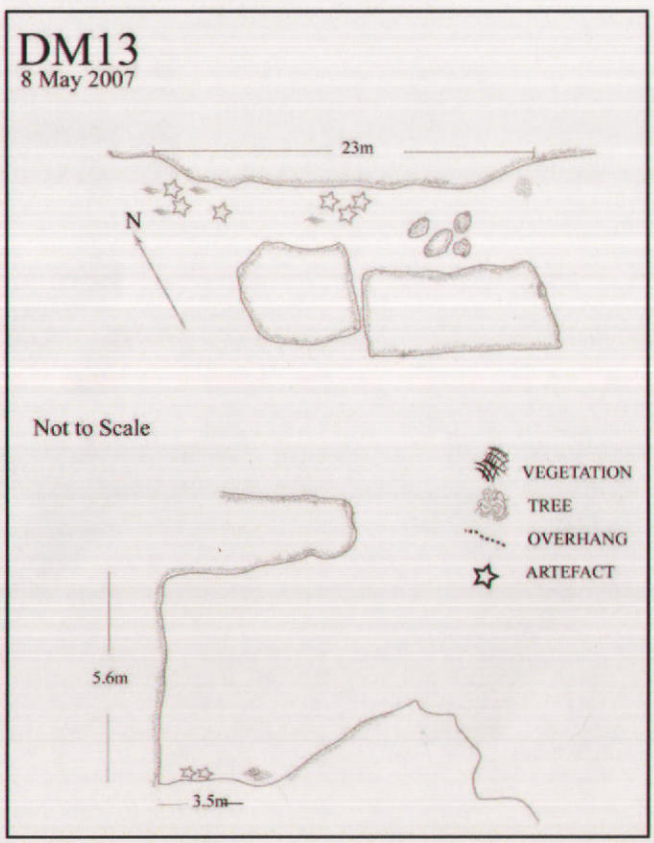
Comments:

Plates for Site DM 13



DM 13 View of Shelter

DM 13 Artefacts



DM 13 Floor Plan

Aboriginal Site Recording Form

AHIMS Registrar
PO Box 1967, Hurstville 2220 NSW

AHIMS site ID: 48-2-0056 **Date recorded:** 01-04-2021

Site Location Information

Site name: DM 13

Easting: 293219 **Northing:** 6192609 **Coordinates must be in GDA (MGA)**

Horizontal Accuracy (m): 3

Zone: 56 **Location method:** Non-Differential GPS

Recorder Information

(The person responsible for the completion and submission of this form)

Title	Surname	First name
Ms.	Quast	Stella

Organisation: Niche Environment and Heritage

Address: Level 4/460 Church St, Parramatta NSW 2150

Phone: 0458000903 **E-mail:** squast@niche-eh.com

Site Context Information

Land Form Pattern: **Land Use:**

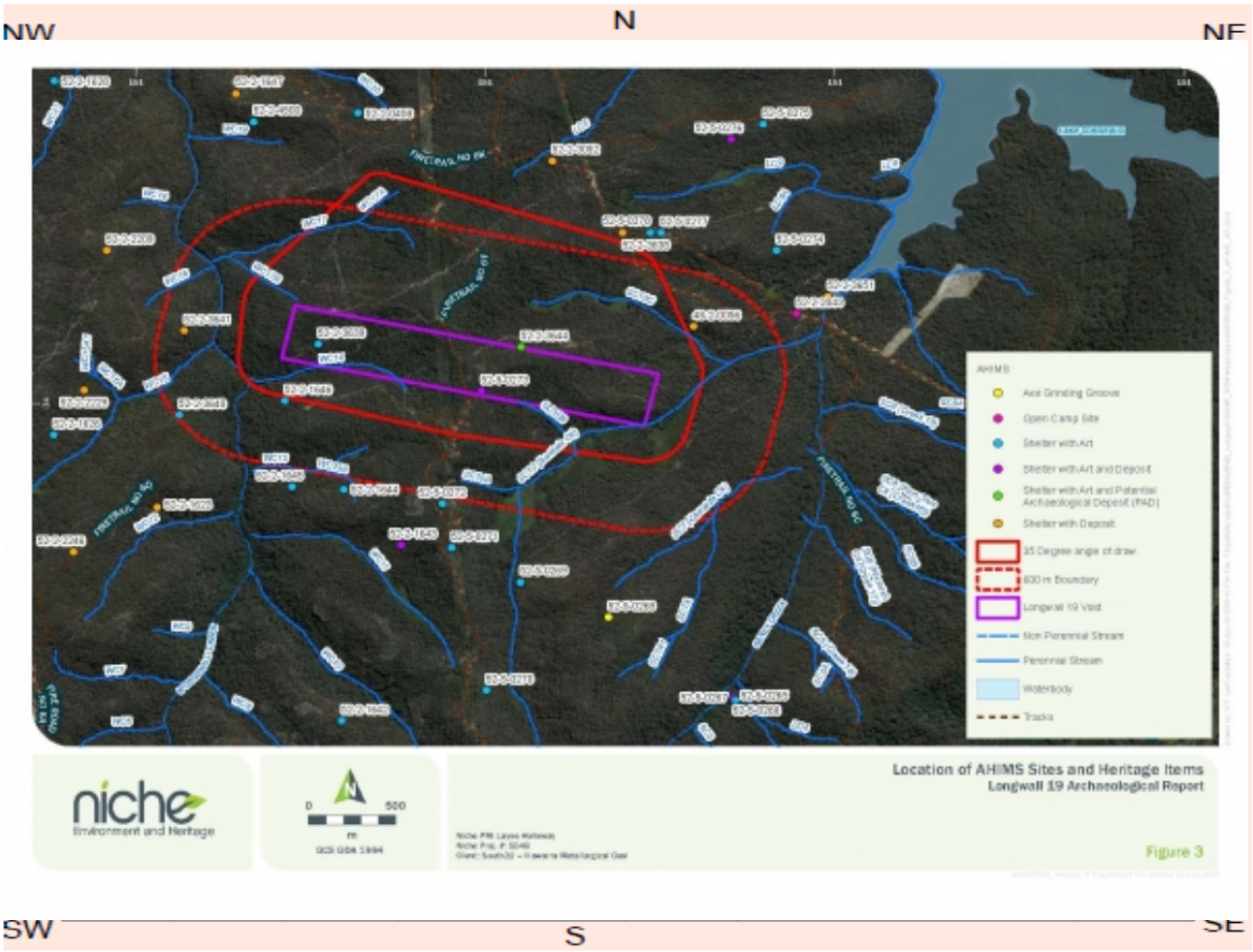
Land Form Unit: **Vegetation:**

Distance to Water (m): **Primary Report:**

How to get to the site:

Other site information: Large open shelter with limited overhang and large floor area of yellow brown silty sand deposit (3.5mx15m), located in mid-slope of continuous first ridgeline from the top, 170m south-west of Fire Road 6C and 150m north of SC10 tributary. Ridgeline 20m to the east is starting to collapse inwards.

Site location map



Site contents information

open/closed site: Closed

Site condition: Good

Features:

	Number of features	Length of feature(s) extent (m)	Width of feature (s) extent (m)	Scarred Trees: Scar Depth (cm)	Scarred Trees: Regrowth (cm)	Scarred Trees: Scar shape	Scarred Trees: Tree Species
1. Artefact	10	3	3				

Description:

10 Artefacts located on floor of shelter, to the right of the existing wombat burrow. 1 silcrete scraper with use-wear present, 2 partial chert flakes, 1 silcrete flake, 1 complete petrified wood flake, 1 quartz core, 1 quartz flake, 1 fine-grained siliceous flake, and quartz and silcrete debitage.

Features:

	Number of features	Length of feature(s) extent (m)	Width of feature (s) extent (m)	Scarred Trees: Scar Depth (cm)	Scarred Trees: Regrowth (cm)	Scarred Trees: Scar shape	Scarred Trees: Tree Species
2.							

Description:

Features:

	Number of features	Length of feature(s) extent (m)	Width of feature (s) extent (m)	Scarred Trees: Scar Depth (cm)	Scarred Trees: Regrowth (cm)	Scarred Trees: Scar shape	Scarred Trees: Tree Species
3.							

Description:

Features:

	Number of features	Length of feature(s) extent (m)	Width of feature (s) extent (m)	Scarred Trees: Scar Depth (cm)	Scarred Trees: Regrowth (cm)	Scarred Trees: Scar shape	Scarred Trees: Tree Species
4.							

Description:

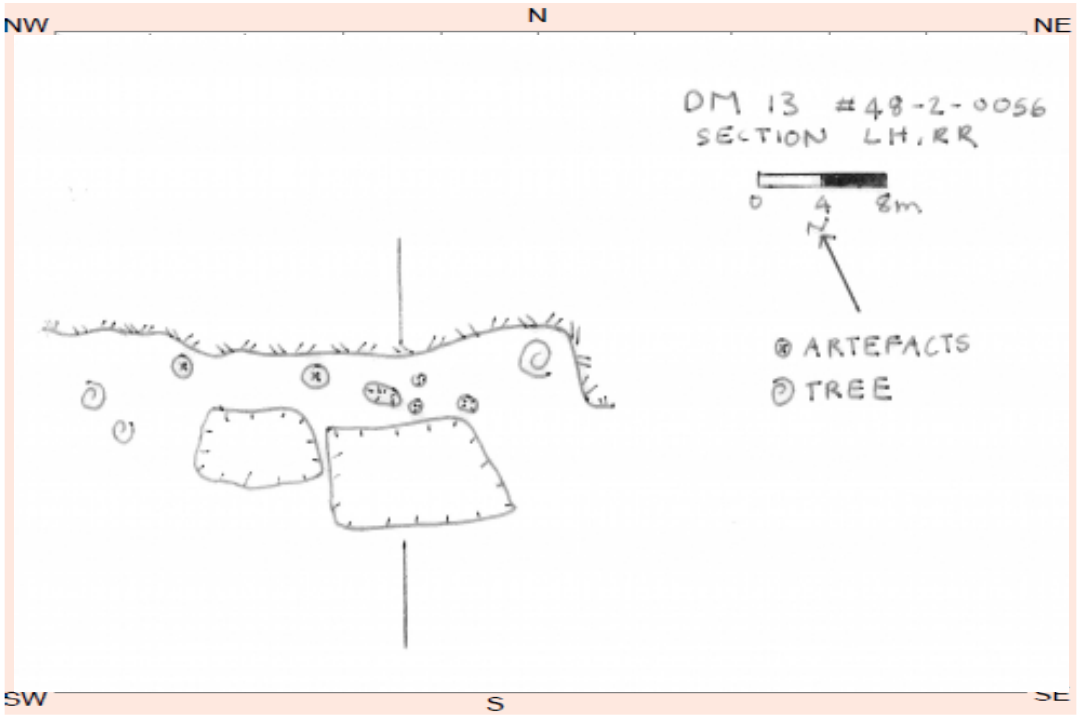
Features:

	Number of features	Length of feature(s) extent (m)	Width of feature (s) extent (m)	Scarred Trees: Scar Depth (cm)	Scarred Trees: Regrowth (cm)	Scarred Trees: Scar shape	Scarred Trees: Tree Species
5.							

Description:

Other Site Info: Large open shelter with limited overhang and large floor area of yellow brown silty sand deposit (3.5mx15m), located in mid-slope of continuous first ridgeline from the top, 170m south-west of Fire Road 6C and 150m north of SC10 tributary. Ridgeline 20m to the east is starting to collapse inwards.

Site plan

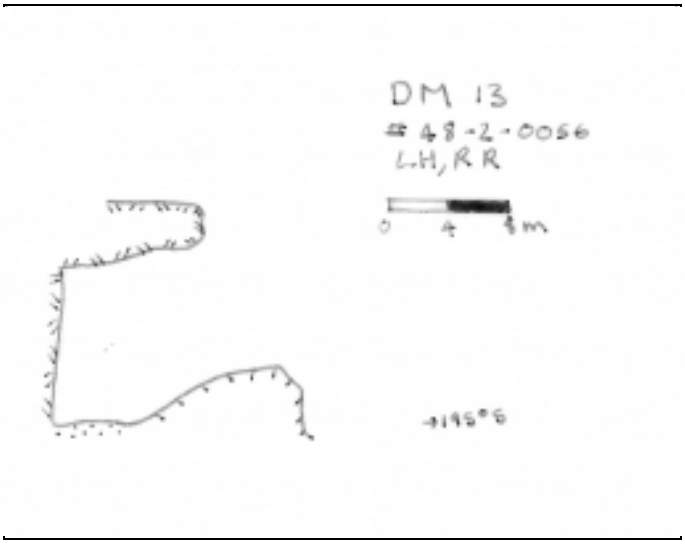


Site photographs

Description: General Photograph of DM 13 (AHIMS ID#48-2-0056) facing east.

Description: General photograph of DM 13 (AHIMS ID#48-2-0056) facing north west.

Description: Artefacts 1 to 5 (of 10) found on the deposit of DM 13 (AHIMS ID#48-2-0056).



Description: Section of DM 13 (AHIMS ID#48-2-0056). Note the considerable height of the shelter.

Site restrictions

Do you want to Restrict this site?: ☐

Restriction type: Gender ☐ General ☐ Location ☐

Why is this site restricted?:

Further information contact

Title	Surname	First name

Organisation:

Address:

Phone: **E-mail:**

[X] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 585 6444

Standard Site Recording Form Revised 3·88

24/1/97

1:250,000 map sheet: Wollongong NPWS Code 52

AMG Grid reference (Full reference - please include leading digits)

250K 250K

2 9 3 6 0 0 mE (25K) 6 1 9 2 5 0 0 mN (5/6 25K)

Scale of map used for grid reference (Please use largest scale available) [X] 25K, 50K (preferred) [ ] 100K [ ] 250K

1:25K, 50K, 100K map name: Wollongong

HEAD OFFICE USE ONLY:

NPWS Site no: 52-2-2043

Site types

Accessioned by: RS Date: 3-3-98

Data entered by: _____ Date: _____

Owner/Manager: Sydney Water

Address: PO Box 2 GUILDFORD

Site name: Sandy Creek Road 28 Locality/property name: Cordeaux Catchment

NPWS District: South Metrop. Region: Central

Reason for investigation

Archaeological survey for seismic lines

Portion no

Parish: Dendrobium

Photos taken? No

How many attached?

How to get to the site (refer to permanent features, give best approach to site eg from above, below, along cliff) (Draw diagram on separate sheet.)

The site is immediately adjacent to Fireroad 6C / Coxs Highway where it crosses Sandy Creek. It is on the eastern side of the creek and the northern side of the fire road.

Other sites in locality? Yes Site Types include: art shelters

Are sites in NPWS Register? Yes

Have artefacts been removed from site? No When?

By whom? Deposited where?

Is site important to local Aborigines? Yes

Give contact(s) name(s) + address(es): Jim Davis, Sites Officer, Illawarra Local Aboriginal Land Council, 484 Northcliffe Drive, Berkeley

Contacted for this recording? Yes

(Attach additional information separately) If not, why not?

Verbal/written reference sources (including full title of accompanying report)

Archaeological Survey of Five Seismic Lines, Cordeaux Catchment, for Elouera Colliery, BHP Coal.

NPWS Report Catalogue #

Checklist: surface visibility, damage/disturbance/ threat to site

Condition of site: Site disturbed by track construction and transmission line construction. Surface visibility is 90%.

Recommendations for management & protection (attach separate sheet if necessary)

See accompanying report.

52-2-2043

Site recorded by: C Sefton

Address/institution: 12 Chenhall Street WOONONA NSW 2517 Tel: 042-84 2004

Date: 20 December 1996

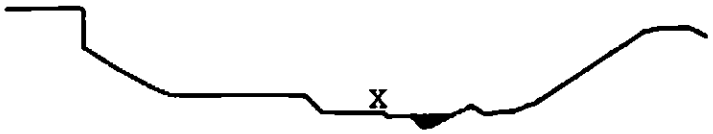
X

SITE POSITION & ENVIRONMENT

OFFICE USE ONLY: NPWS site no:

1. Land form a beach/hill slope/ridge top, etc: valley bottom b. site aspect: North c. slope: level

d mark on diagram provided *or* on your own sketch the position of the site. e. Describe briefly.



f Local rock type: Hawkesbury Sandstone g Land use/effect:

2. Distance from drinking water: at site Source: Sandy Creek

3 Resource Zone associated with site (estuarine, riverine, forest etc): open woodland

4 Vegetation: Eucalyptus racemosa, Hakea sp, Leptospermum sp., Banksia spenulosa, B. oblongifolia

5 Edible plants noted:

6 Faunal resources (include shellfish):

7 Other exploitable resources (river pebbles, ochre, etc):

Site type: surface scatter stone artefacts

DESCRIPTION OF SITE & CONTENTS.

Note state of preservation of site & contents. Do **NOT** dig, disturb, damage site or contents.

Cream-yellow sandy loam soil exposed by clearing adjacent to fire road and transmission line at creek crossing.

90% exposure on area 31 x 33 m.

Artefacts located:
black fossilised wood flake 42 x 39 x 17mm
red quartzite rejuvenation flake 5% cortex 44 x 44 x 23mm
grey silcrete flake 25 x 22 x 4mm
dark grey chert flake 22 x 17 x 6mm
dark grey chert flake 17 x 19 x 4mm
dark grey chert flake 50 x 38 x 20mm
grey silcrete flaked piece 38 x 22 x 6mm
grey chert flaked piece 20 x 12 x 5mm
grey chert bipolar core 15 x 17 x 4mm
grey silcrete flake 22 x 22 x 3mm
quartz bipolar core 10 x 14 x 5mm
quartz bipolar flake 26 x 20 x 3mm

CHECKLIST TO HELP: 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 surface decorated, motifs, colours, wet, dry pigment, technique of engraving, 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.

OTHER SITES EG structures (fish traps, stone arrangements, bora rings, mia mias), mythological sites, rock holes, engraved groove channels, contact sites (missions massacres cemeteries) as appropriate

Attach sketches etc. eg. plan & section of shelter, show relation between site contents, indicate north, show scale.

Attach annotated photos (stereo where useful) showing scale, particularly for art sites.

Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

New Recording ☐ Additional ✓

information ☐

Site name	SANDY CK RD 28	NPWS Site Number	52-2-2043
Owner/manager	SYDNEY CATCHMENT AUTHORITY		
Owner Address			
Location	FIRE ROAD 6C @ SANDY CREEK CROSSING.		
How to get to the site	The site is on the east side of Sandy Ck on the track and to its north		
1:250,000 map name	WOLLONGONG	NPWS map code	
AMG Zone	AMG Easting 293772	AMG Northing	6192496
Method for grid reference	HAND GPS	Map scale (if method = map) 1:25,000	Map name WOLLONGONG 9029-2-S
NPWS District Name (see map)	SOUTH METRO	NPWS Zone (see map)	56
Portion no.		Parish	
Site type(s)	OPEN CAMP SITE	Site type code (NPWS use only)	

Description of site and contents CHECKLIST: ed, length, wid, she, elen, gro, DEF, esti, con, cha, dist, type, AR, sur, wet, tech, size, BU, of b, ass, TRE, likel, posi, mar, QU, rec, perc

(NPWS Site No. 52-2-2043)
AMG reference (Hand GPS): 293772e; 6192496n

This site was originally recorded by Caryll Sefton in 1996 during a survey of seismic lines. The site is a surface scatter of stone artefacts and was named Sandy Creek Road 28.

The site is located immediately to the east of Sandy Creek and on and adjacent to Fire Road 6C. The site has been disturbed and exposed by road construction and use.

The site is located on the basal slope of a main ridge line located to its east. The aspect is to the north west and the gradient is low. Twelve artefacts were originally recorded as covering an area of 31m x 33m.

During the current re-recording 22 artefacts were located over an area which measured 30m x 24m. Raw materials included quartz, silcrete, chert, chalcedony, tuff and volcanics. Artefacts included flakes, modified flakes, cores and lithic fragments. One recognisable tool present was a thumbnail scraper.

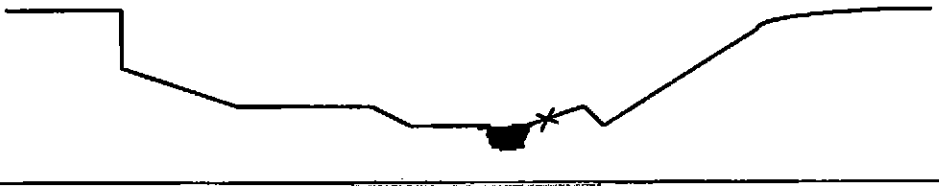
Areas adjacent to the site on both the north and south sides of the track are generally undisturbed by prior development and are assessed to be of moderate to high potential to contain undisturbed archaeologicial deposit. Accordingly, the site is assessed to be of moderate to high potential to contain more artefacts and be larger than recorded.

Attach photographs and sketches, eg. plan & section of shelter.
Do NOT dig, disturb or damage site or contents.

Aboriginal Sites Register of NSW

NPWS, PO Box 1967, Hurstville NSW 2220

Standard Site Recording Form

Land form	BASAL SLOPE OF BROAD RIDGE	Aspect	NW	Slope	LOW
Mark position of the site					
Local rock type	HAWK. SANDSTONE	Land use/effect	WATER CATCHMENT		
Distance from drinking water	@ SITE	Source	SANDY CK.		
Resource zone (eg. estuarine, river, forest)	FOREST	Vegetation			
Edible plants		Faunal resources (include shellfish)			
Other exploitable resources (eg. ochre)					
Are there other sites in the locality	YE	Are they in the Sites Register	YES	Other site types include	GRINDING GROOVES SHELTERS WITH ART

Site condition	DISTURBED		
Management recommendations			
Have artefacts been removed from site	NOT BY RECORDER	When	
By whom		Deposited at	
Consent applied for	☐	Consent issued	☐
Date of issue		Consent number	

Reason for investigation	DENDROBIUM COAL PROJECT EIS		
Were local Aborigines contacted or present for the recording	☐ Not contacted ☑ Contacted and present ☐ Contacted but not present	Names and addresses	SEAN SUDDERY ILLAWARRA L.A.L.C
Is the site important to local Aborigines			
Verbal/written reference sources	DENDROBIUM COAL PROJECT EIS DEC. 2000 NAVIN OFFICER	ASR report number(s) (or title)	C- C-
Photographs taken	YES	No. of Photos attached	—
Site recorded by	JULIE DIBDEN	Date of recording	OCT. 2000
Address/institution	NAVIN OFFICER 102 JERVOIS ST, DEAKIN, ACT		

Aboriginal Site Recording Form

AHIMS Registrar
PO Box 1967, Hurstville NSW 2220

Office Use Only

Site Number 52-2-36511

Date received / / Date entered into system 23/10/08 Date catalogued / /

Entered by (I.D.)

Information Access

☐ Gender/male ☐ Gender/female ☐ Location restriction ☐ General restriction ☐ No access

Office Use Only

For Further Information Contact:

☐ **Nominated Trustee**

Title | Surname | First Name | Initials

Organisation

Address

Phone number | Fax

Client on system ☐

☐ **Knowledge Holder**

Title | Surname | First Name | Initials

Organisation

Address

Phone number | Fax

Client on system ☐

Aboriginal Heritage Unit or Cultural Heritage Division Contacts

Geographic Location

Site Name DM 23

Easting | Northing | AMG/GDA GDA

Mapsheet Wollongong

Zone | Location Method Non-Differential GPS

Primary Recorder

Title | Surname | First Name | Initials

Mr | Rogerson | Scott

Organisation Biosis Research Pty Ltd

Address 18-20 Mandible St Alexandria

Phone number 02 9690 2777 Fax 02 9690 2577

Date recorded 15.5.07

Client on system ☐

b

NPWS Aboriginal Site Recording Form - Site Information

OPEN/CLOSE SITE Open Site

Site Context

Landform

- [x] Mountainous
- [x] Plain
- [ ] Rolling hills
- [ ] Steep hills
- [ ] Undulating plain

Landform Unit

- [ ] Beach
- [ ] Coastal rock platform
- [ ] Dune
- [ ] Intertidal flat
- [ ] Lagoon
- [ ] Tidal Creek
- [ ] Tidal Flat
- [x] Cliff
- [ ] Crest
- [ ] Flat
- [ ] Lower slope
- [ ] Mid slope
- [ ] Upper slope
- [x] Plain
- [ ] Ridge
- [ ] Tor
- [ ] Valley flat
- [ ] Levy
- [ ] Stream bank
- [ ] Stream channel
- [ ] Swamp
- [ ] Terrace
- [ ] Terrace flat

Slope

[ ] degrees

Vegetation

- [ ] Closed forest
- [ ] Grasslands
- [ ] Isolated clumps of trees
- [ ] Open forest
- [x] Open woodland
- [ ] Scrub
- [ ] Woodland
- [ ] Cleared
- [ ] Revegetated
- [ ] N/A

Land use

- [x] Conservation
- [ ] Established urban
- [ ] Farming-intensive
- [ ] Farming-low intensity
- [ ] Forestry
- [ ] Industrial
- [x] Mining
- [ ] Pastoral/grazing
- [ ] Recreation
- [ ] Semi-rural
- [ ] Service corridor
- [ ] Transport corridor
- [ ] Urban expansion
- [ ] N/A

Water

Distance to permanent water source [ ] metres

Distance to temporary water source [ ] metres

Name of nearest permanent water source

Name of nearest temporary water

Directions for Relocation

This site is a shelter with archaeological deposit, located directly below the Sandy Creek waterfall, near where Fire Road 6C crosses Sandy Creek.

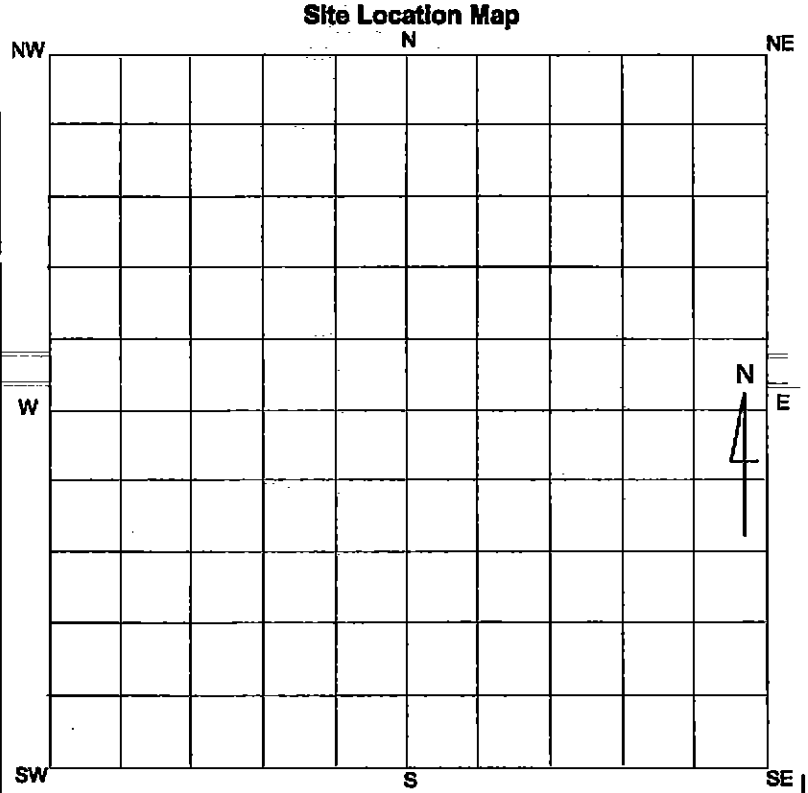
Current Land Tenure

- [x] Public — National Park / other Government Dept.
- [ ] Private

Primary report **I.D.** [ ] (I.D. Office Use only)

Biosis Research (2007) Dendrobium Area 3 Proposed Longwall Mine – Archaeological and Cultural Heritage Assessment (Report to BHP Billiton)

Site Location Map



NPWS Aboriginal Site Recording Form - Site Information

General Site Information

Closed Site

Shelter/Cave Formation

- [x] Boulder
- [x] Wind erosion
- [ ] Water erosion
- [ ] Rock collapse

Rock Surface Condition

- [ ] Boulder
- [ ] Sandstone platform
- [ ] Silica gloss
- [ ] Tessellated
- [ ] Weathered
- [ ] Other platform

Condition of Ceiling

- [ ] Boulder
- [ ] Sandstone platform
- [ ] Silica gloss
- [ ] Tessellated
- [x] Weathered
- [ ] Other platform

Shelter Aspect

- [ ] North
- [ ] North East
- [ ] East
- [ ] South East
- [ ] South
- [ ] South West
- [ ] West
- [ ] North West

Open Site

Site Orientation

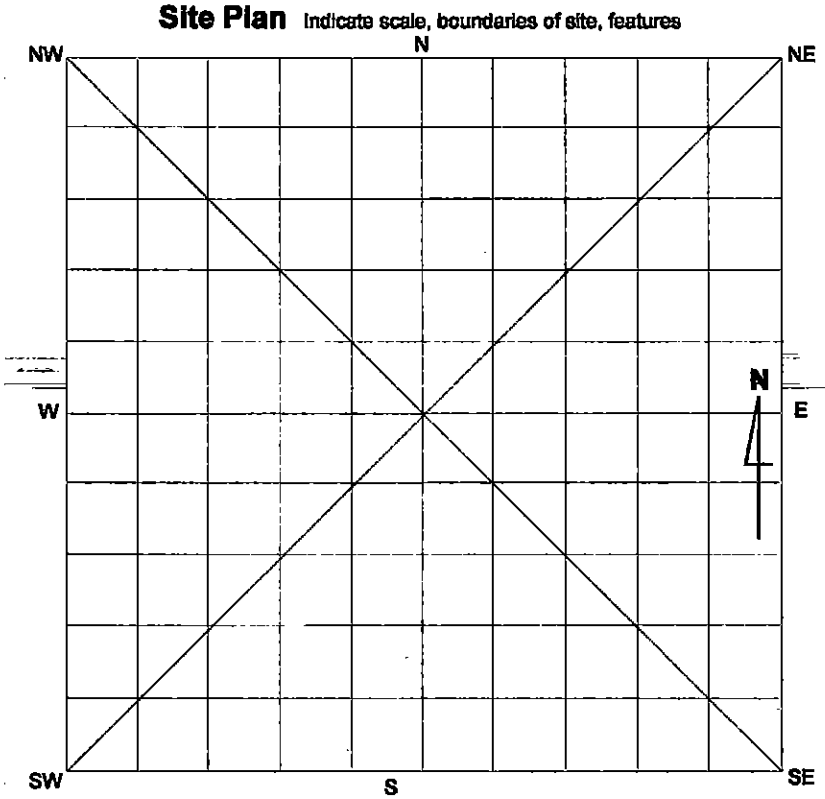
- [ ] N-S
- [ ] NE-SW
- [ ] E-W
- [ ] SE-NW
- [ ] N/A

Features

- [ ] 1. Aboriginal Ceremony & Dreaming
- [ ] 2. Aboriginal Resource & Gathering
- [ ] 3. Art
- [x] 4. Artefact
- [ ] 5. Burial
- [ ] 6. Ceremonial Ring
- [ ] 7. Conflict
- [ ] 8. Earth Mound
- [ ] 9. Fish Trap
- [ ] 10. Grinding Groove
- [ ] 11. Habitation Structure
- [ ] 12. Hearth
- [ ] 13. Non Human Bone & Organic Material
- [ ] 14. Ochre quarry
- [ ] 15. Potential Archaeological Deposit
- [ ] 16. Stone Quarry
- [ ] 17. Shell
- [ ] 18. Stone Arrangement
- [ ] 19. Modified Tree
- [ ] 20. Water Hole

Site Plan

Indicate scale, boundaries of site, features



Site Dimensions

Closed Site Dimensions (m)

- [ ] Internal length
- [ ] Internal width
- [ ] Shelter height
- [ ] Shelter floor area

Open Site Dimensions (m)

- [ ] Total length of visible site
- [ ] Average width of visible site
- [ ] Estimated area of visible site
- [ ] Length of assessed site area

Aboriginal Community Interpretation and Management Recommendations

Representatives of the following organisations were present during field work and agreed with report recommendations:

- Cubbitch Barta Native Title Claimants Aboriginal Corporation
- Illawarra Local Aboriginal Land Council
- Korewal Elouera Jerrungarugh

Preliminary Site Assessment

Site Cultural & Scientific Analysis and Preliminary Management Recommendations

This site is a shelter with archaeological deposit, located directly below the Sandy Creek waterfall, near where Fire Road 6C crosses Sandy Creek. The shelter measures 80 x 30 x 8m and has been formed by block fall on a large scale, with most of the shelter floor forming a steep slope and being strewn with very large angular boulders. However, the western end of the shelter contains approximately 20 m of reasonably flat floor, which has a well developed, though very damp deposit, of red soil . There were 6 artefacts, including cores and a retouched flake, located in the drip line and eroded parts of the deposit .

This section should only be filled in by the Endorsees

Endorsed by: ☐ Knowledge Holder ☐ Nominated Trustee ☐ Native Title Holder ☐ Community Consensus

Title	Surname	First Name	Initials

Organisation

Address

Phone number Fax

Attachments (No.)

- ☐ A4 location map
- ☐ B/W photographs
- ☑ Colour photographs
- ☐ Slides
- ☐ Aerial photographs
- ☐ Site plans, drawings
- ☐ Recording tables
- ☐ Other
- ☐ Feature inserts-No. ☐

Comments

See attached sheet of photo's.

NPWS FEATURE RECORDING FORM - ARTEFACT

Site I.D. [ ] Site Name DM 23

First recorded date [ ]

No. of instances 6

Recorded by [ ]

Importance Cannot be presently determined

- [ ] Contributed to primary site importance
- [ ] Contributes to secondary site importance
- [ ] Cannot be presently determined

Other Registration

- [ ] Register of the National Estate
- [ ] Heritage Register
- [ ] National Trust

[ ]

	Yes	No
Stone artefacts only	Yes	
Artefacts collected	No	
Permit issued		

Percentage of Non-stone Artefacts to Percentage of Stone Artefacts

0-9%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%

Feature Context & Condition

Scatter No. 1 Easting [ ] Northing [ ]

Density (Artefact count per square metre) [ ]

Dimensions [ ] Length (m) [ ] Width (m) [ ] Depth (m)

	Yes	No
In situ		
Stratified		

Feature Condition

- [ ] Very good
- [x] Good
- [ ] Poor

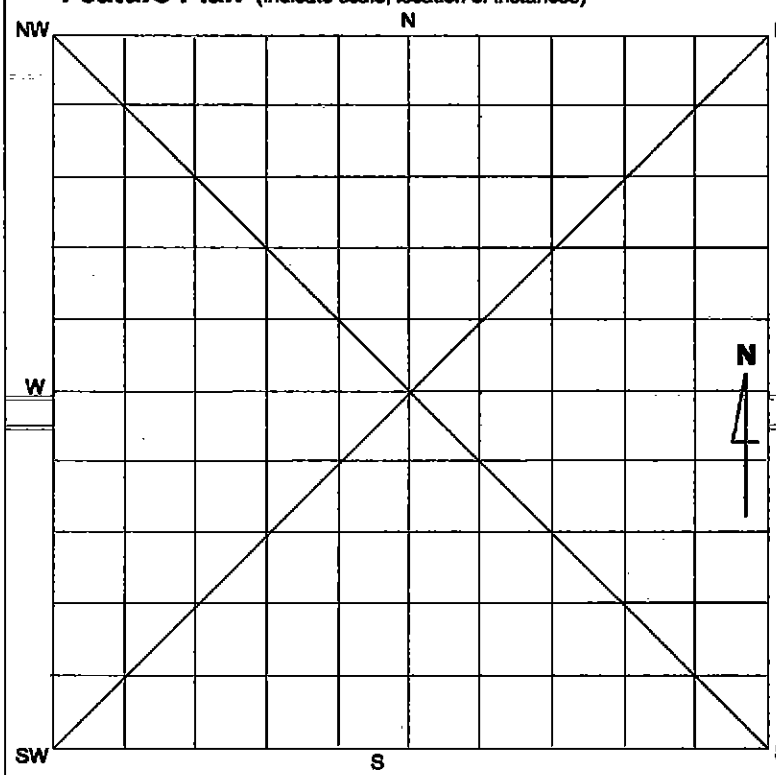
General Condition

- [ ] Weathered
- [ ] Vehicle damage
- [ ] Surface water wash
- [ ] Fire damage
- [ ] Erosion
- [ ] Stock damage
- [x] Exposed archaeological material

Recommended Action

- [ ] Boardwalk
- [ ] Fencing
- [ ] Closure to public
- [ ] Continued inspection
- [ ] Fire hazard reduction
- [ ] Expert assessment
- [ ] Meeting with land manager
- [ ] Revegetation
- [ ] Signage
- [ ] Soil erosion control
- [ ] Track closure/re-routing
- [ ] Additional recording

Feature Plan (Indicate scale, location of instances)



Feature Environment

(Complete when *feature* environment differs to *site* environment, use attributes from cover card, p. 2)

- [ ] Land form
- [ ] Land form unit
- [ ] Slope
- [ ] Vegetation
- [ ] Land use

Water

Distance to permanent water source [ ] metres

Distance to temporary water source [ ] metres

Name of nearest permanent water source [ ]

Name of nearest temporary water [ ]

Stone Artefact

Instance No.	Recording Date	Artefact Material	Artefact Type	Platform Surface	Platform Type	Termination	Cross Section	Length (mm)	Width (mm)	Thickness (mm)
1		Silcrete	Core							
1		Silcrete	Flake							
1		Silcrete								
1		Silcrete								
1		Silcrete								
1		Silcrete								

Other Artefact Type

Instance No.	Recording Date	Artefact Material	Artefact Type	Description	Length (mm)	Width (mm)	Thickness (mm)

Material
Basalt
Chert
Fine grained siliceous
Granite
Quartz
Quartzite
Sandstone
Silcrete
Green glass
Amber glass
Amethyst glass
Clear glass
Ceramic
Porcelain
Tin can
Wire
Nail
Button
Shell
Bone
Wood
Resin

Artefact Description
Adze
Anvil
Axe
Backed blade
Blade
Core
Core tool
Cyclon
Distal fragment
Eloura
Flake
Flake tool
Flaked piece
Hammerstone
Manuport
Milling slab
Mortar
Muller
Nuclear tool
Pirri
Proximal fragment
Tula
Other diagnostic type
Modified
Unworked

Platform Surface
Cortex
Flake scar
More than one flake scar
Faceted
Ground
Indeterminate
Bipolar

Platform Type
Wide
Focal
Shattered
Indeterminate
Bipolar

Termination
Feather
Hinge
Step
Outrepasse
Bipolar

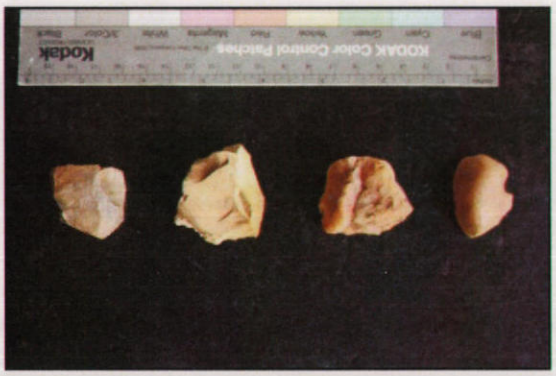
Cross Section
High/strong
High/weak
Low/weak
Irregular

Comments:

Plates for Site DM 23

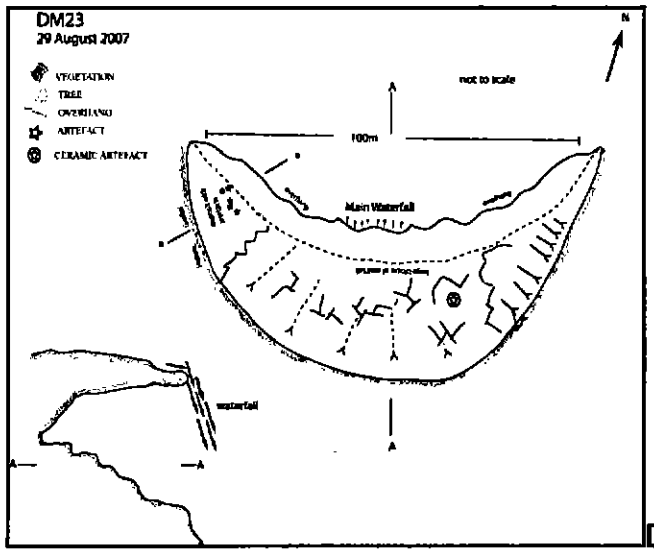
DM 23 Shelter

DM 23 Shelter



DM 23 Artefacts

DM 23 Artefact


DM23
29 August 2007
VEGETATION
TREE
OVERHANG
ARTEFACT
CERAMIC ARTEFACT
not to scale
N
100m
Main Waterfall
waterfall
A
A

DM 23 Plan

[ ] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 585 6444

Standard Site Recording Form Revised 5/88

52-5-0274

1:250,000 map sheet: WOLLONGONG NPWS Code L521

AMG Grid reference (Full reference - please include leading digits): 293500 mE 6192860 mN

Scale of map used for grid reference (Please use largest scale available): [X] 25K, 50K (preferred) [ ] 100K [ ] 250K

1:25K, 50K, 100K map name: **Wollongong**

HEAD OFFICE USE ONLY:

NPWS Site no: 52-5-274

Site types:

Accessioned by: AJK Date: 29 JAN 93

Data entered by: " Date: "

Owner/Manager: **Water Board**

Address: **Cordeaux Catchment Area**

Site name: **Sandy Creek Road 22**

Locality/property name:

NPWS District: South Metrop Region: Central

Reason for investigation

Routine survey by the Illawarra Prehistory Group

Portion no:

Parish:

Photos taken? **Yes**

How many attached?

How to get to the site (refer to permanent features, give best approach to site eg. from above, below, along cliff. (Draw diagram on separate sheet.)

The site is 0.4km north of the 6C firetrail.

Other sites in locality? Yes

Are sites in NPWS Register? Yes

Site Types include: Shelters, Grinding grooves

Have artefacts been removed from site? No When?

By whom? Deposited where?

Is site important to local Aborigines? Yes

Give contact(s) name(s) + address(es) Illawarra Local Aboriginal Land Council

Contacted for this recording? No

(Attach additional information separately) If not, why not?

Verbal/written reference sources (including full title of accompanying report). NPWS Report Catalogue #

Checklist: surface visibility, damage/disturbance/ threat to site

Condition of site:

Art is in very poor condition.
Deposit undisturbed.

Recommendations for management & protection (attach separate sheet if necessary):

Site recorded by: Caryll Sefton Date:

Address/institution: 12 Chenhall Street
WOONONA NSW 2517
Phone (042) 84 2004

SITE POSITION & ENVIRONMENT

OFFICE USE ONLY: NPWS site no:

1. Land form a. beach/hill slope/ridge top, etc: ridgetop b. site aspect: NE c. slope: gradual

d. mark on diagram provided *or* on your own sketch the position of the site:

e. Describe briefly:

f. Local rock type: Sandstone g. Land use/effect:

2. Distance from drinking water: 400m Source: Sandy Creek

3. Resource Zone associated with site (estuarine, riverine, forest etc): lov woodland

4. Vegetation: Eucalyptus gummifera, E. sieberi, E. eugenioides, Hakea dactyloides, Leptomeria acida, Hakea sericea.

5. Edible plants noted: Banksia galudesa, Kriostemon australiasies

6. Faunal resources (include shellfish):

7. Other exploitable resources (river pebbles, ochre, etc):

Site type: **Art Shelter**

CHECKLIST TO HELP: 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 surface decorated, motifs, colours, wet, dry pigment, technique of engraving, 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.

OTHER SITES EG. structures (fish traps, stone arrangements, bora rings, mia mias), mythological sites, rock holes, engraved groove channels, contact sites (missions massacres cemeteries) as appropriate

DESCRIPTION OF SITE & CONTENTS.

Note state of preservation of site & contents. Do NOT dig,disturb,damage site or contents.

Sandstone overhang: length 7.0m, width 2.8m, height 1.8m with a small living area 2m x 4m, formed by blockfall and cavernous weathering.

Deposit: 15cm yellow loamy sand which is undisturbed and formed by weathering and some slopewash.
Level area in front of the overhang is 10m x 4m.

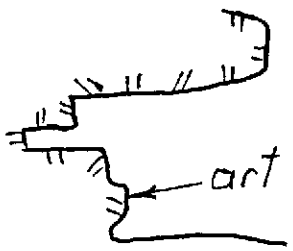
Art: located on the rear wall and consists of 3 charcoal indeterminate drawings in very poor condition.

Attach sketches etc, eg. plan & section of shelter, show relation between site contents, indicate north, show scale.
Attach annotated photos (stereo where useful) showing scale, particularly for art sites.

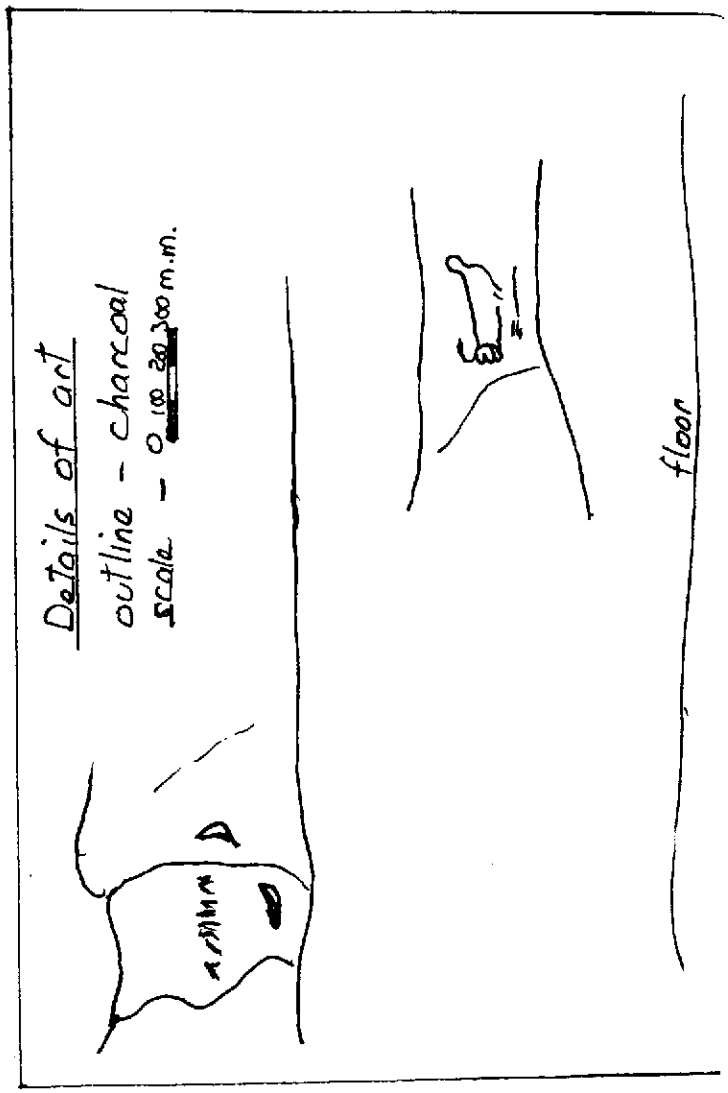
SANDY CREEK R.D. 22.

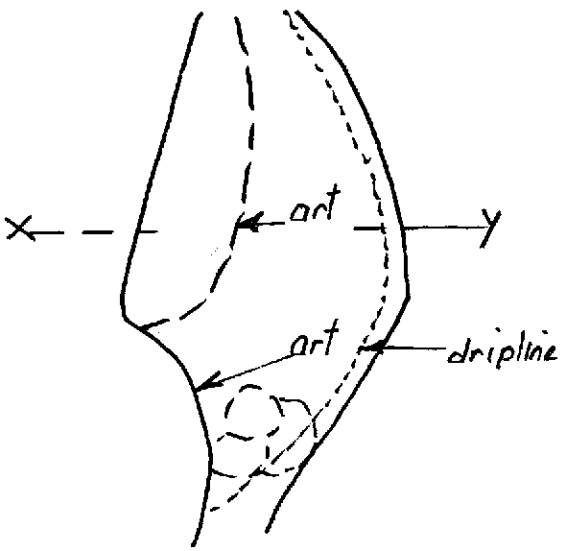
NW.

0 1 2 3 Metre



Profile X-Y





Plan of shelter

Drawn by D. Coles

0

APPENDIX 4

BUSHFIRE MANAGEMENT PLAN – DENDROBIUM VENTILATION SHAFT 2 AND 3 GAS DRAINAGE PLANT (PETERSON BUSHFIRE, 2022)

Bushfire Management Plan

Dendrobium Ventilation Shaft 2 and 3 Gas Drainage Plant

Singleton Engineering Solutions

3 February 2022

(Ref: 21149)

report by
david peterson

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FPA AUSTRALIA (NO.BPAD18882)
BPAD LEVEL 3 ACCREDITED PRACTITIONER
ABN 28 607 444 833

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1 Introduction

1.1 Background

Singleton Engineering Solutions engaged Peterson Bushfire to prepare a Bushfire Management Plan (BMP) for a proposed gas drainage plant for the South 32 Dendrobium mine (mining lease 1566) located at Cordeaux in the Wollongong local government area. The project involves the development of surface-based mine infrastructure for gas management of the Dendrobium coal mine.

South 32 has identified the need to prepare a BMP for the protection of the proposed infrastructure and any surrounding assets.

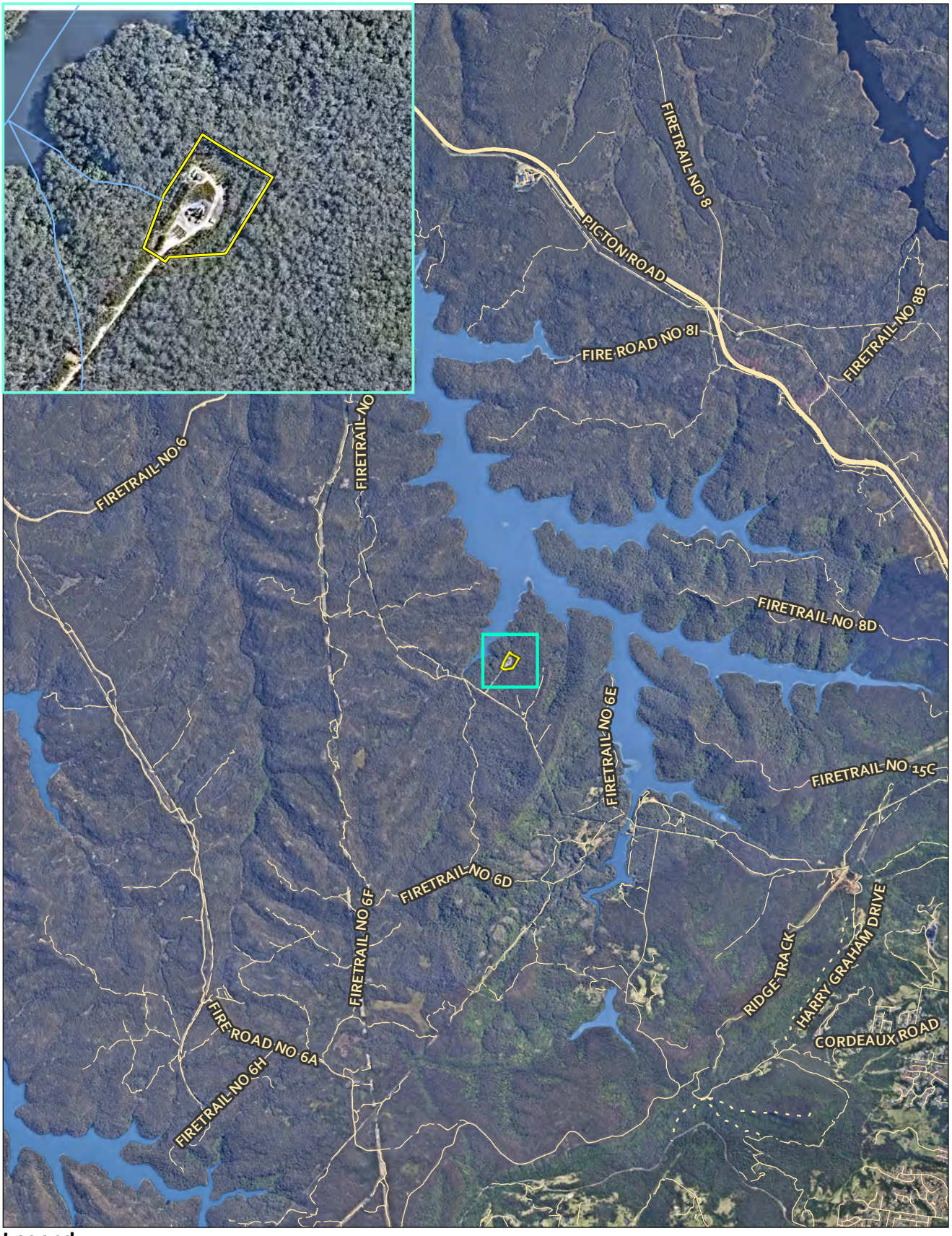
1.2 The subject site and development proposal

The subject site consists of the existing vent shaft site located within the Water NSW catchment lands off Firetrail No. 6C approximately 12 km in from the Picton Road as shown on Figure 1. The site is a cleared pad supporting Dendrobium underground coal mine Vent Shaft 2 and Vent Shaft 3 and various supporting infrastructure.

The proposal consists of the development of a gas drainage plant for the existing underground coal mine. Figure 2 shows the proposed layout.

The proposed infrastructure includes:

- Gas risers;
- Vacuum pumps;
- Compressors and filter station;
- Enclosed flares;
- Vent stack;
- Gas plant switch room;
- 2 x 250,000 L tanks dedicated to fire suppression;
- Fire-fighting pumps; and
- Relocatable substation.



Legend

Major Road
Minor Road
Path
Track-Vehicular
Waterbody
Subject Site

N

DKGIS

Date: 16/12/2021

0 0.5 1 2

Kilometers

Figure 1: The Location

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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Legend

Watercourse

Subject Site

N

DKGIS

Date: 16/12/2021

0 25 50 100

Metres

Figure 2: The Proposal

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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1.3 BMP objectives

This BMP is specific to the proposed development, and will be administrated under the generic BMP for the Dendrobium Mine (DENMP0034, June 2018) that was prepared to address the Dendrobium Pit Top, Kemira Coal Loading Facility, and Ventilation Shafts 1, 2 and 3.

The objectives are associated with the protection of life and property as listed below:

1. Protect human life (staff, contractors and community);
2. Protect built assets (buildings and infrastructure related to site operation as well as any surrounding assets); and
3. Maintain mine capability (minimise disruption to mine operations).

1.4 Legislative context

Bushfire management activities can be governed by numerous pieces of legislation, plans and guidelines. Those relevant to the objectives of protecting life and property at the site are summarised below and provide context to the assessment process and development of bushfire risk management strategies.

1.4.1 NSW Rural Fires Act 1997

The objectives of the *Rural Fires Act 1997* (RF Act) are to provide for:

- The prevention, mitigation and suppression of fires;
- Coordination of bushfire fighting and prevention;
- Protection of people and property from fires; and
- Protection of the environment.

The RF Act imposes obligations on land managers to take all reasonable measures to prevent the occurrence and spread of wildfire. The RF Act also places emphasis on cooperative fire management and wildfire suppression planning between the various organisations involved in fire management through the Bushfire Management Committees and by the preparation and implementation of a Bushfire Risk Management Plan.

1.4.2 District Bushfire Risk Management Plan

A Bushfire Risk Management Plan describes the level of bush fire risk across an area. The plan identifies assets within the community at risk from bushfire, assesses the level of risk to those assets and establishes treatment options to address the risk.

The subject site is within the Wollongong LGA and therefore covered by the 'Illawarra Bush Fire Risk Management Plan' (Illawarra Bush Fire Management Committee 2015). The plan addresses cooperative bushfire management across the local district. The Wingecarribee LGA is less than 4 km to the west, therefore both the Illawarra and Wollondilly/Wingecarribee

(Wollondilly/Wingecarribee Bush Fire Management Committee 2017) plans have been reviewed and considered in the preparation of this BMP.

1.4.3 Planning for Bush Fire Protection 2019

The NSW Rural Fire Service document 'Planning for Bush Fire Protection 2019' outlines the assessment process and required bushfire protection measures for new development in areas mapped as 'bush fire prone land'. The document focusses on the provision of Asset Protection Zones (APZ), Bushfire Attack Levels (BAL) and adequate access for residential development and vulnerable uses (such as schools, tourist accommodation and aged care facilities) however it also outlines vegetation management, access and water supply objectives for mining related proposals and similar infrastructure.

2 Bushfire environment

An analysis of the bushfire environment, or parameters that give rise to the bushfire threat, provides the foundation for a bushfire risk assessment. The parameters to be analysed are discussed below and include the bushfire hazard (comprising topography and vegetative fuels), knowledge of the weather and climatic patterns giving rise to bushfires, an account of fire history and known ignition sources, fire intensity patterns, and assets at risk.

2.1 Terrain

Figure 3 shows the pattern of the terrain surrounding the site. The predominant features in the landscape consist of the gullies and ridgelines associated with the creeks feeding into Lake Cordeaux generally to the east and north of the site. The gullies create steeply sloping land rising to the plateau areas further to the west.

More immediate to the site are steep slopes in the west direction leading down to where Sandy Creek enters Lake Cordeaux. The slopes continue upslope to west of the site.

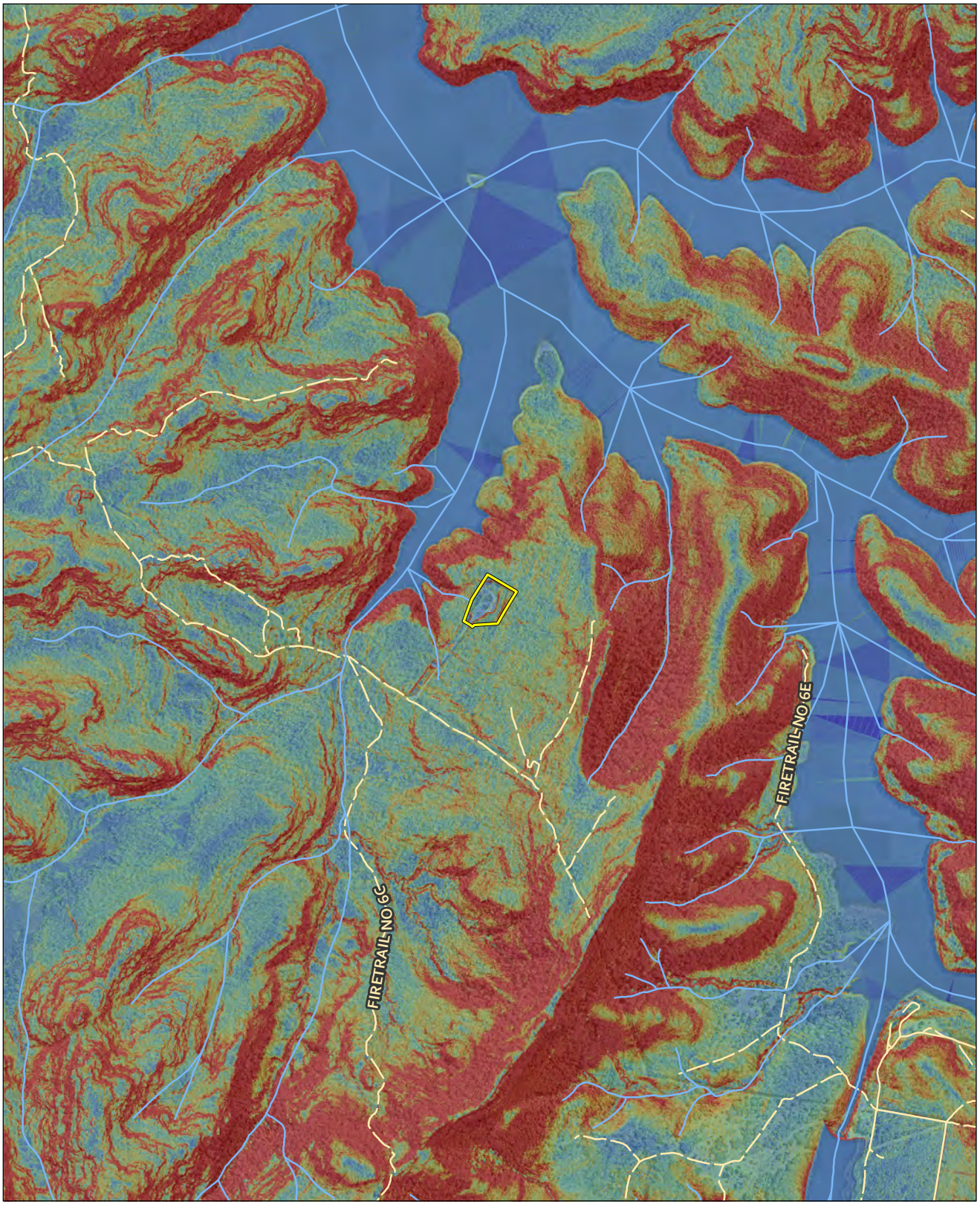
2.2 Vegetation and fuel

Vegetation communities known to occur throughout the area are mapped on Figure 4. Those communities immediately surrounding the site are listed in Table 1. The communities have been categorised into vegetation structural formations according to Keith (2004) in order to assign likely climax fuel loads following the RFS document *Comprehensive Vegetation Fuel Loads* (NSW Rural Fire Service 2019). The vegetation formations and likely climax fuel loads are shown in Figures 5 and 6 respectively.

Table 1 below shows that those communities immediately surrounding the site are forests with high climax fuel loads.

Table 1: Vegetation communities and corresponding structural formations and fuel loads

Vegetation community	Structural formation (Keith 2004)	Fuel load (NSW Rural Fire Service 2019)
Gully Gum – Sydney Peppermint – Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion	Southern Escarpment Wet Sclerophyll Forests	22/36.1 tonnes/hectare
Sydney Peppermint Smooth-barked Apple – Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	Sydney Coastal Dry Sclerophyll Forest	21.3/27.3 tonnes/hectare



Legend

- Minor Road
- Track-Vehicular
- Watercourse
- Subject Site

Slope

- Flat
- 0-5°
- 5-10°
- 10-15°
- 15-20°
- >20°

N

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Date: 16/12/2021

0 250 500 1,000

Metres

Figure 3: Terrain

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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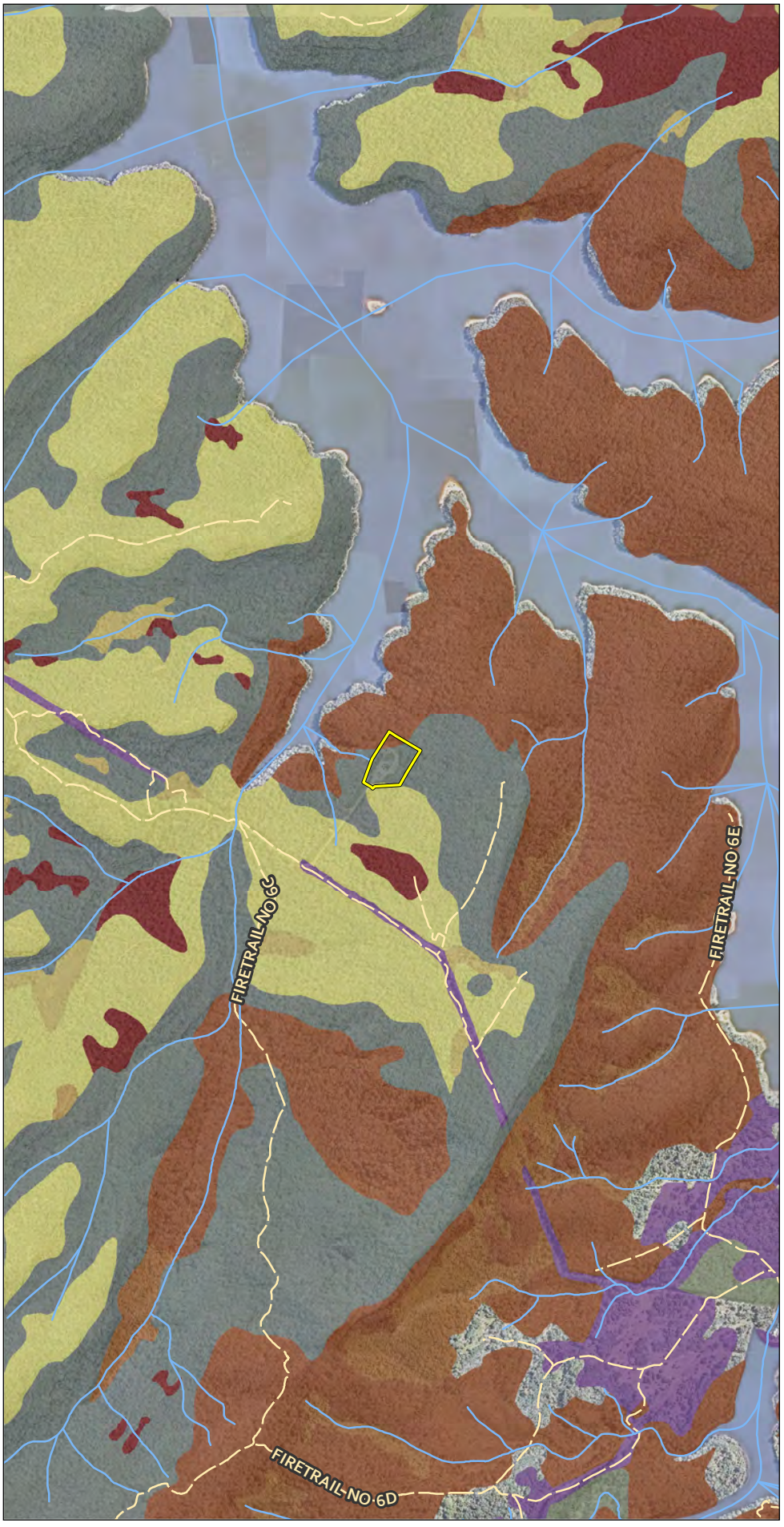

Legend

Track-Vehicular

Watercourse

Subject Site

Vegetation Community

Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin

Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion

Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion

Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin

Needlebush - Banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin

Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion

Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion

Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion

Unknown

N

DKGIS

Date: 16/12/2021

0 200 400 800

Metres

Figure 4: Vegetation Communities

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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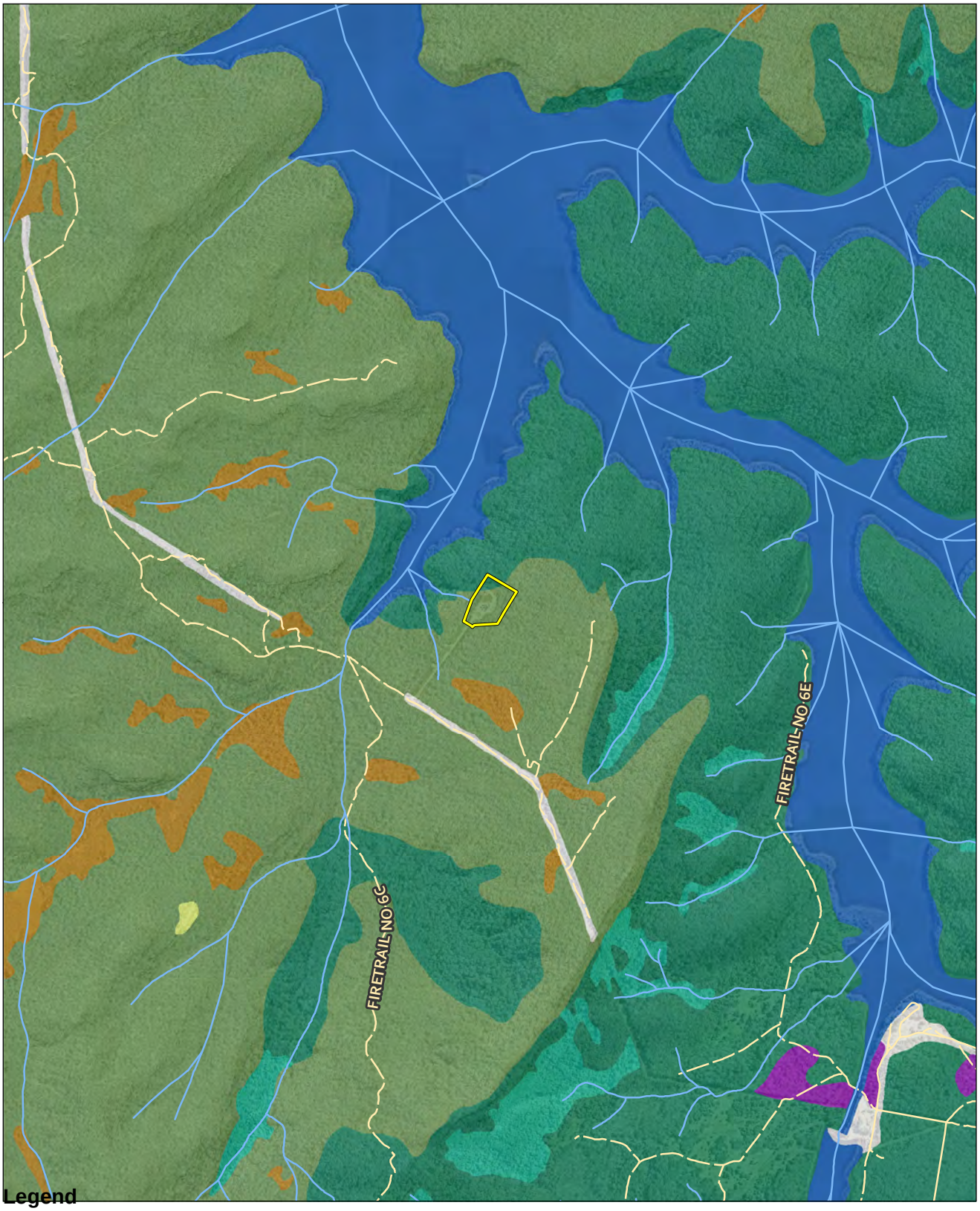

Legend

- Minor Road
- Track-Vehicular
- Watercourse
- Subject Site

Vegetation Formation

- Cleared
- Coastal Heath Swamps
- North Coast Wet Sclerophyll Forests
- Northern Warm Temperate Rainforests
- Southern Escarpment Wet Sclerophyll Forests
- Sydney Coastal Dry Sclerophyll Forests
- Sydney Coastal Heaths
- Water

N

DKGIS

Date: 16/12/2021

0 250 500 1,000

Metres

Figure 5: Vegetation Formations

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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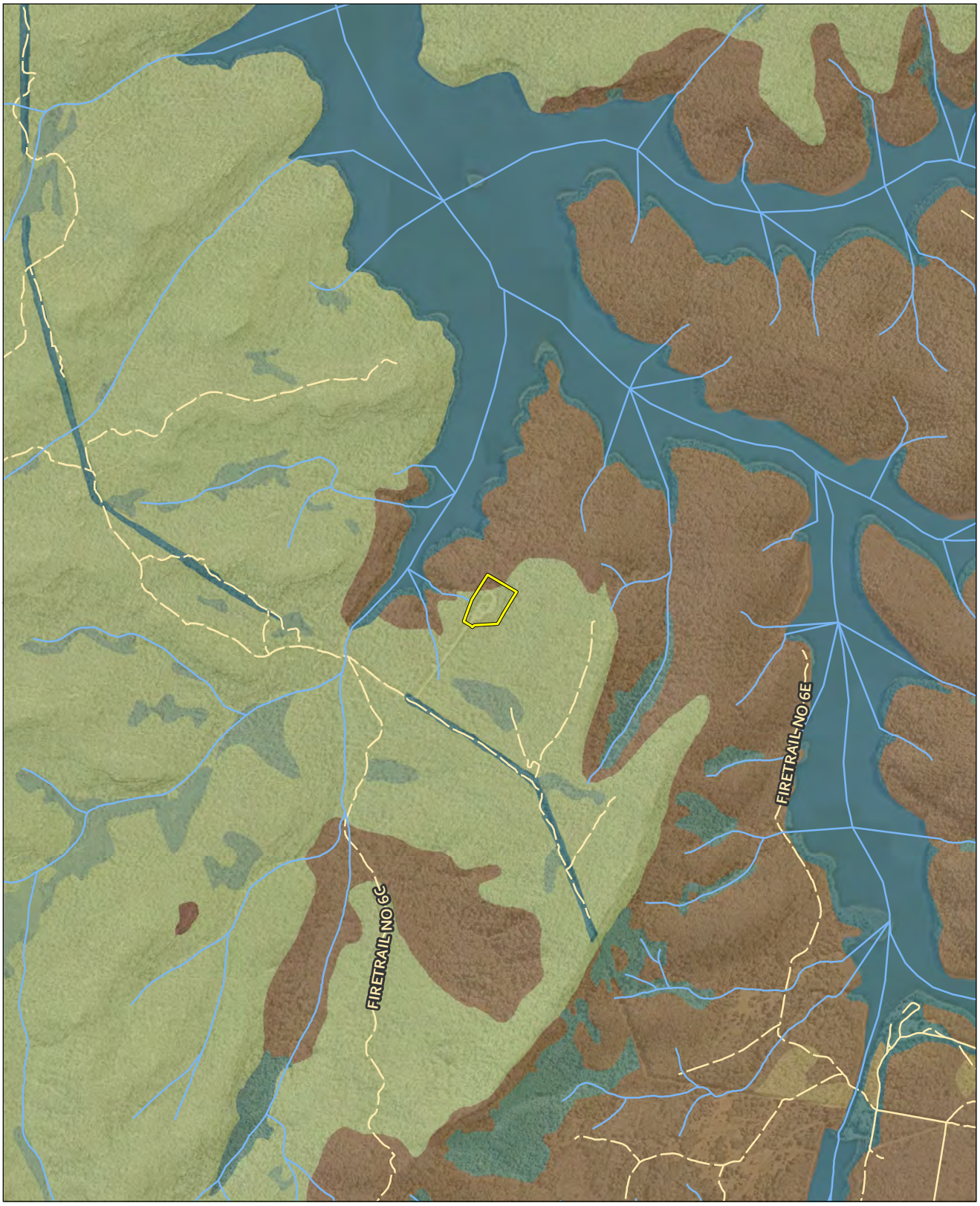

Legend

- Minor Road
- Track-Vehicular
- Watercourse
- Subject Site

Equilibrium Fuel Loads

- 0 t/ha
- 13.2 t/ha
- 15 t/ha
- 27.3 t/ha
- 35.98 t/ha
- 36.1 t/ha
- 36.9 t/ha

N

0 250 500 1,000

Metres

DKGIS

Date: 16/12/2021

Figure 6: Equilibrium Fuel Loads

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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2.3 Asset description

Bushfire can impact built assets through flame contact, radiant heat, burning debris (or ember attack), wind and smoke. Evidence indicates burning debris attack is responsible for most bushfire damage to buildings. Burning debris can cause spotting and ignite buildings well before an approaching fire. Radiant heat and flame contact are a threat to life and property and are also a major cause of damage or destruction of buildings. Bushfire attack via these varying modes also restrict fire-fighting operations, provide piloted ignition to building elements and threaten the health of occupants and their capacity to evacuate the area.

Bushfire protection planning should aim to prevent flame contact, reduce radiant heat to below the ignition thresholds for various elements of a building, and minimise the potential for embers to cause ignition.

Life and property assets have been divided between those associated within the proposal at the subject site and those external to the site as listed below. The internal assets are those that are proposed as part of the installation and are shown on Figure 2.

Due to the isolation of the site amongst the catchment lands, there are no external life and property assets within proximity. The closest built assets are those associated with the Cordeaux dam wall site which are located at least 5 km away to the north-west. The closest residential or community assets are located at least 6 km away to the south-east (Kembla Heights) or 13 km to the north-west (Wilton district).

2.4 Fire weather

The catchment lands above the Illawarra Escarpment have warm summers and with mild winters with rainfall being late summer dominated. Temperatures will commonly reach into the high 30's.

The fire season usually begins in early spring. The beginning of the fire season depends on the amount of rainfall that occurs during late winter and spring and the onset of strong north-west to south-west winds, which often prevail during October to November. The majority of serious bushfires occur from this period until the onset of summer rains, which normally start from December/January and continue through to autumn.

High fire danger periods typically have high temperatures associated with low humidity and moderate to strong westerly and northwesterly winds. Dangerous bushfire seasons are most commonly associated with a combination of two or more of the following factors:

- Occurrence of an extended drought period;
- Lower than average rainfall through winter and spring;
- Persistent north-west to south-west winds in spring;
- Prolific fuel occurrence from strong growing conditions during the previous summer; and
- Spring/summer thunderstorm activity in dry years.

2.5 Fire history and ignition sources

Information on fire history such as temporal and spatial pattern of fire spread is a useful factor in understanding bushfire risk. The 'Illawarra Bush Fire Risk Management Plan' (IBFMC 2017) states that there are, on average, 4 to 5 major fires each year across the district which is the total of the Wollongong, Shellharbour and Kiama LGAs combined.

Major fire activity has occurred every 6 years on average since 1939 when fires were first documented. The major fire activity occurs with the catchment lands west of the escarpment and to a lesser extent along the escarpment itself. Fires usually travel in an easterly direction under the influence of westerly winds, often flared-up by late afternoon sea breezes from the south and east.

The main sources of ignition are lightning strikes from 'dry' electrical storms during summer, escape from private properties, and arson (Wollondilly/Wingecarribee Bush Fire Management Committee, 2017).

The fire history mapping within the bush fire risk management plans shows that the site and surrounds has been subject to multiple fires over recent decades which is attributable to the vast expanse of forested lands surrounding the site associated with the catchment lands and National Parks estate.

The last fire to threaten the site was the 'Hall Road' fire in 2013 which initiated at Balmoral 23 km north-west of the site and travelled in an easterly direction under westerly winds crossing the Hume Motorway and eventually Picton Road. It was managed and contained using key fire trails within the catchment lands including Firetrail No. 6 which is 5 km to the north-west of the site, preventing further spread towards the site and the built-up areas associated with Wollongong.

2.6 Fire intensity analysis

The predicted fire intensity surrounding the site has been modelled using GIS (Figure 7). The map displays the intensity of a fire under the most problematic fire winds from the western sector by providing an understanding of rate of spread, risk to fire-fighters, fire control line feasibility and the relative bushfire risk across the landscape.

The GIS model is based on the fire behaviour formula of McArthur Mk 5 and utilised inputs of slope, vegetation (fuel load) and aspect as described below:

- Slope in degrees (Figure 3);
- Vegetation fuel loads (t/ha) based upon likely climax fuel loads (Figure 6) as specified by NSW Rural Fire Service (2019);
- Fire weather represented by a Fire Danger Index (FDI) of 100 (which is a day of 'catastrophic' fire weather on the fire weather warning system). This is the planning (design) level;

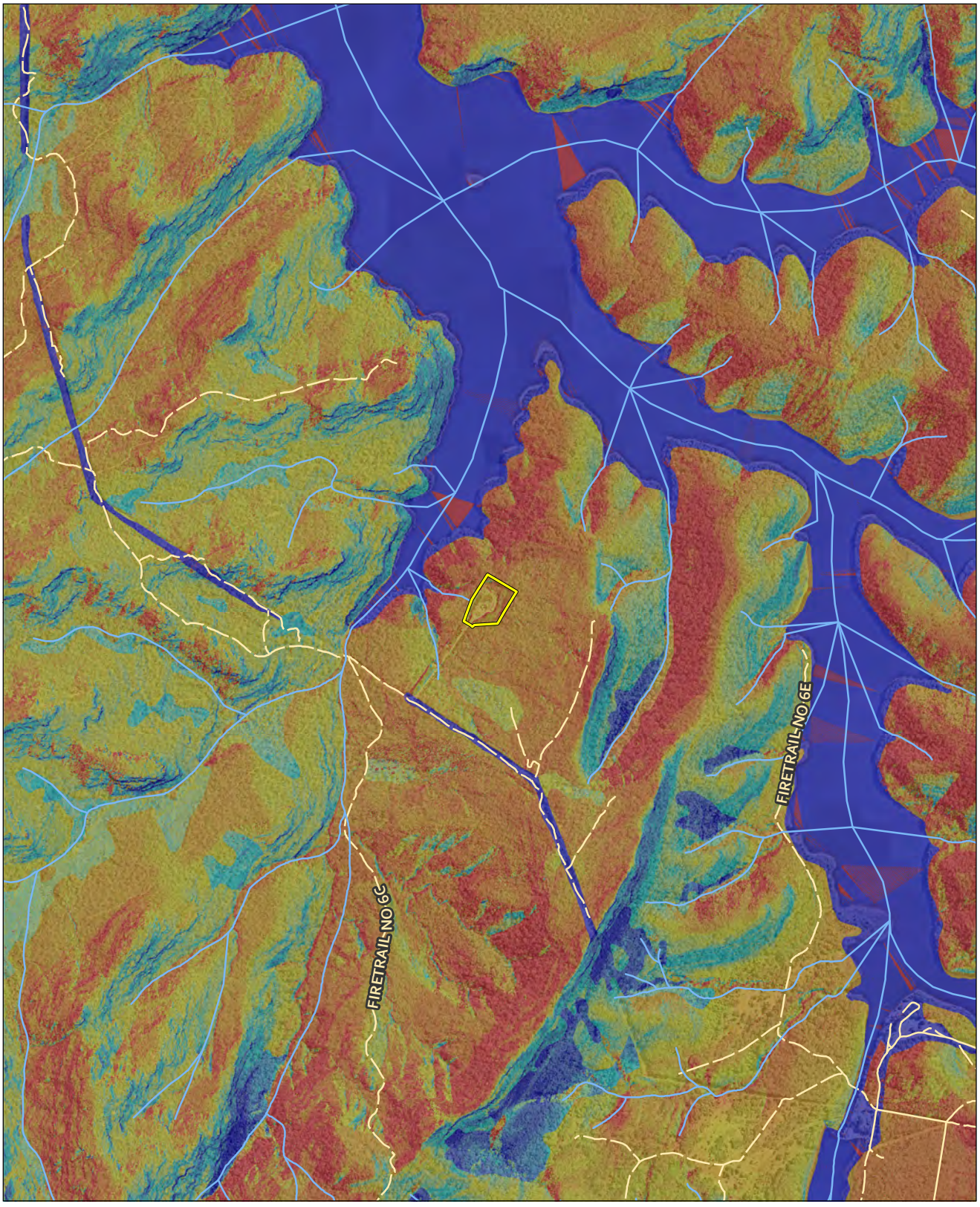
- A direction of fire spread under the influence of winds from the western sector when problematic bushfires occurs in the region.

The mapping of areas into varying degrees of intensity does not indicate how often an area will receive potentially damaging fires, however, it provides a useful comparative ranking across the landscape. Mapping intensity assists in understanding the potential behaviour of bushfires and fire pathways. For example, locations with an expanse of higher bushfire intensity running in a west to east direction may represent a potential wildfire path.

The intensity mapping highlights the exposure of the site to higher intensity fire for many kilometres. It is the steep, forested slopes of the surrounding gullies that highlight the highest fire intensity within the surrounding landscape. The mapping also highlights higher intensity areas to the immediate west of the site. These areas are a function of the steep downslopes which could generate high fire intensities under the influence of wind from the western sector.

2.7 Likely bushfire behaviour and bushfire threat

Based on the information provided in the preceding Sections 2.1 to 2.6, likely fire behaviour can be predicted. It is the combination of undesirable fire weather (i.e. hot and dry westerly winds during spring and early summer) combined with ignition somewhere within or adjacent the catchment lands (natural, accidental or arson) creating the potential for a bushfire to spread generally in a west to east direction to impact the site and proposed infrastructure or spread from the site towards communities to the east (e.g. suburbs of Wollongong). In addition, fire could impact from other directions depending on the wind direction at the time, however the rate of spread, intensity and general behaviour is typically less extreme.



Legend

Minor Road
Track-Vehicular
Watercourse
Subject Site

Fire Intensity (kW/m)

0 - 1,000
1,000 - 2,000
2,000 - 5,000
5,000 - 10,000
10,000 - 15,000
15,000 - 25,000
25,000 - 50,000
50,000 - 100,000
100,000 - 250,000
> 250,000

N

0 250 500 1,000
Metres

DKGIS
Date: 16/12/2021

Figure 7: Fire Intensity (kW/m)

Coordinate System: GDA 1994 MGA Zone 56
Imagery: © Nearmap

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3 Risk assessment

3.1 Methodology

The definition of bushfire risk is the chance of a bushfire igniting, spreading and causing damage to assets of value. The following sections assess the risk of a fire impacting the site.

The method of determining bushfire risk follows that used by NSW Rural Fire Service (BFCC 2008) in developing bushfire risk management plans across NSW. The method follows the procedures and considerations of *AS/NZS ISO 31000:2018 Risk management – Guidelines* and provides a risk classification scheme through qualitative scales to assess the likelihood and consequence of fire impact.

There are four possible likelihood ratings: unlikely, possible, likely and almost certain. An understanding of the bushfire environment (refer to Section 2) is used to determine the likelihood of a bushfire occurring. Where data is not available, subjective estimates may be used which reflect the degree of belief that a bushfire will occur. Table 2 outlines the process for determining likelihood.

Table 2: Likelihood ratings for assessing bushfire risk (NSW Rural Fire Service 2008)

	Fire are expected to spread and reach assets	**Fires are not expected to spread and reach assets**
Fires occur frequently	Almost certain	Possible
Fires occur infrequently	Likely	Unlikely

Source: *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008).

Consequence is the outcome or impact of a bushfire event. The assessment process for consequence is subjective and includes consideration of threat, vulnerability and other issues such as level of impact and recovery costs. There are four possible consequence ratings: minor, moderate, major and catastrophic. A description of each is provided in Table 3.

Table 3: Consequence ratings for assessing bushfire risk (NSW Rural Fire Service 2008)

Consequence rating	**Description**
Minor	• No fatalities • Some minor injuries with first aid treatment possibly required • No persons are displaced • Little or no personal support (physical, mental, emotional) required • Inconsequential or no damage to an asset • Little or no disruption to community and little to no financial loss

Consequence rating	Description
Moderate	• Medical treatment required but no fatalities. Some hospitalisation • Localised displacement of persons who return within 24 hours • Personal support satisfied through local arrangements • Localised damage to assets that is rectified by routine arrangements • Community functioning as normal with some inconvenience • Local economy impacted with additional financial support required to recover • Small impact on environment / cultural asset with no long term effects
Major	• Possible fatalities • Extensive injuries, significant hospitalisation • Large number of persons displaced (more than 24 hours duration) • Significant damage to assets that requires external resources • Community only partially functioning, some services unavailable • Local or regional economy impacted for a significant period of time with significant financial assistance required • Significant damage to the environment/cultural asset which requires major rehabilitation or recovery works • Localised extinction of native species
Catastrophic	• Significant fatalities • Large number of severe injuries • Extended and large number requiring hospitalisation • General and widespread displacement of persons for extended duration • Extensive resources required for personal support • Extensive damage to assets • Community unable to function without significant support • Regional or state economy impacted for an extended period of time • Permanent damage to the environment • Extinction of a native species in nature

Source: *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008).

The bushfire risk level is assessed by combining the likelihood and consequence to provide low, medium, high, very high or extreme levels of bushfire risk. This matrix is provided in Table 4.

Table 4: Matrix to determine level of bushfire risk (NSW Rural Fire Service 2008)

Consequence / Likelihood	Minor	Moderate	Major	Catastrophic
Almost certain	High	Very High	Extreme	Extreme
Likely	Medium	High	Very High	Extreme
Possible	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High

Source: *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees* (NSW Rural Fire Service 2008).

3.2 Assessing risk without risk treatments in place

To understand the baseline level of risk, the risk of bushfire impacting assets has been assessed without the application of specific bushfire protection controls (i.e. 'risk treatments'). This section outlines the risk assessment results and risk ratings.

The risk assessment has been split into the two scenarios of fire spreading to impact the site and fire spreading from the site to impact external assets/communities. Table 5 below outlines the risk assessment results for the baseline level of risk across both scenarios.

In response to the risk levels identified in Table 5 on the following page, a suite of risk treatments has been recommended in the following Section 4 – Risk Treatments. The treatments are designed to reduce the risk to an acceptable level (refer to Section 3.3 for discussion on acceptable level of risk).

A second risk assessment based on recommended risk treatments being in place is provided at Section 4.6 at the end of the list of proposed risk treatments.

Table 5: Assessment of level of bushfire risk without risk treatments in place

Fire scenario	Impact	Level of risk
Impact site	Likelihood = Almost certain Consequence = Major	Extreme • Dendrobium mine and vent shafts and other vent shaft sites in catchment lands are all rated 'major' consequence in the district risk plans. • History of landscape-wide fire. • Many ignition possibilities and scenarios within the district west of the site. • Exposure to landscape wide-fire and high bushfire behaviour potential. • Site isolation could delay operational response. • Fire impact could damage assets reducing mine capacity.
Impact external assets/communities	Likelihood = Possible Consequence = Moderate	Medium • Chances of ignition within site and spread into surrounding bushland not as prevalent as surrounding district. Ignition has not previously occurred in the Southern Coalfield. • More opportunities to control fire over long distances in the east direction prior to reaching community assets. • Landscape-wide fire could develop from point ignition.

3.3 Acceptable level of risk

Risk acceptability is typically defined and assessed by the asset owner using available guidelines on risk expectations provided by the local authorities and an understanding on the value placed on the asset. This risk assessment acknowledges that despite the risk treatments that are able to be put in place, some bushfire risk will remain (residual risk) and bushfires will continue to threaten assets. The concept of residual risk is inherent in all risk assessments and the level of risk is to some extent a compromise between the level of threat, significance or value of the asset, and costs involved in providing the protection.

The 'Illawarra Bush Fire Risk Management Plan' and 'Wollondilly/Wingecarribee Zone Bushfire Risk Management Plan' states that the level of acceptability for the area is 'high' due to a combination of risk priority and capacity to undertake works on a regional scale. Under the plans, areas of low to high risk are likely to be managed by routine procedures and do not require a specific application of resources. Items of very high and extreme risk will require the application of specific risk treatment planning and resources.

Nonetheless, South 32 should adopt a level of acceptability based on the guidance of a site-specific risk assessment (i.e. this plan), management objectives and resource capacity. The level of acceptability will differ between that of the region and that of a particular site or manager.

It is recommended that South 32 adopt the risk treatments in Section 4 of this report to address the risk of fire impact on the site and prevent the spread of fire from the site and potentially impacting on community assets.

4 Risk treatments

This section describes the bushfire protection measures recommended to treat the risk identified (see Section 3) in order to achieve the objectives (see Section 1). A suite of bushfire protection measures is required that in total provide an adequate level of protection for the project and surrounding communities. The measures range from separation of hazard from the asset by way of an Asset Protection Zone (APZ) through to providing fire-fighters with access and water for suppression operations. A 'measures in combination' approach is desired and is the framework of the local bush fire risk management plans and 'Planning for Bush Fire Protection 2019'.

The following subsections outline the recommended bushfire protection measures, which fall within the categories of:

- Asset Protection Zones (APZ)
- Ember and radiant heat protection
- Water supply for fire-fighting
- Access for fire-fighting
- Emergency response and evacuation planning

The bushfire protection measures are shown on Figure 8.

Legend

Watercourse
Subject Site
APZ for Vent Stack
APZ for infrastructure
Existing Access Road
Fire Fighting Infrastructure

N

DKGIS

Date: 16/12/2021

0 12.5 25 50

Metres

Figure 8: Risk Treatments

Coordinate System: GDA 1994 MGA Zone 56

Imagery: © Nearmap

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4.1 Asset Protection Zones (APZ)

4.1.1 Overview

An APZ is a buffer area between a bushfire hazard and an asset which minimises the impact of fire on that asset. The foremost significant treatment for reducing bushfire risk is the establishment of an APZ. This involves the continual management of vegetation to create a buffer zone that reduces the effect of flame contact and radiant heat on the asset as well as providing access for fire-fighting operations. An APZ also reduces the chances of fire escaping from a site by ensuring a fuel-reduced environment whereby fire cannot initiate and spread.

The dimension of the APZ is determined by the ability for fire-fighters to gain access between the hazard and the asset and the vulnerability of the asset that may be related to material combustion or threat to life. For example, the APZ dimensions specified by 'Planning for Bush Fire Protection 2019' for residential dwellings relate to a construction standard, or Bushfire Attack Level (BAL) of BAL-29.

No such standard exists for the development type proposed. Section 8.3.6 of 'Planning for Bush Fire Protection 2019' requires a nominal 10 m APZ around mining infrastructure which is considered to be insufficient to achieve the objectives of this BMP. A precautionary approach is therefore proposed.

4.1.2 APZ for the project

In line with the precautionary principle, the gas infrastructure components of the project should have an APZ to prevent exposure to a radiant heat flux greater than BAL-29 (i.e. 29 kW/m^2). BALs above BAL-29 are associated with high levels of radiant heat and flame contact.

The APZ distances required around the proposed gas infrastructure to ensure a rating no higher than BAL-29 are listed in Table 6 below and are shown on Figure 8. The APZ distances have been determined using Table A1.12.5 of 'Planning for Bush Fire Protection 2019'.

Table 6: Determination of recommended APZ

Direction	Vegetation [1]	Slope [2]	APZ to BAL-29 [3]
North	Forest	Downslope 10-15º	45 m
North-east	Forest	Upslope/ Flat	24 m
East			
South-east			
South			
West	Forest	Downslope 10-15º	45 m
North-west			

[1] Predominant vegetation classification over 100 m from proposed gas infrastructure components.

[2] Effective slope assessed over 100 m from proposed gas infrastructure components.

[3] APZ recommended to be maintained.

A second APZ has been provided around the vent stack where gas could become accidentally ignited such as from lightning strike. The vent stack will be located at the northern end of the site and will be elevated 25 m from ground level. The APZ proposed around the vent stack will be 30 m, compared to a minimum of 24 m for the remainder of the plant infrastructure. The 30 m APZ (refer to Figure 8) is a precautionary measure to ensure that any gas that may become accidentally ignited does not ignite the surrounding vegetation.

A study by Ramboll ('South 32 Area 3 Vent Shaft Dispersion and Radiation Study', 14 December 2021) modelled the expected temperature (ºC) and radiant heat (kW/m^2) that could be produced by the vent stack if ignited and concluded the following:

- Outside of the APZ, the highest temperature is 62 ºC, being at 26.4 m above ground level; and
- Outside of the APZ, the highest radiant heat is 2.63 kW/m^2, being at 26 m above the ground. The radiant heat drops to 1.85 kW/m^2 at 15 m above the ground and does not exceed 1.63 kW/m^2 at ground level.

The Ramboll study relies on the evaluation parameter that a radiant heat of 4.73 kW/m^2 should not be exceeded at any flammable material based on the requirements of Australian Standard 'AS 3814-2018 Industrial and commercial gas-fired appliances'. It is assumed by the study that the AS 3814 limit would protect both the plant infrastructure and the surrounding vegetation beyond the proposed APZ.

As concluded by the Ramboll study, the modelled temperature and radiant heat from an accidentally ignited vent stack should not ignite vegetation beyond the 30 m APZ. Ignition could only occur under such low levels of radiant heat if piloted such as by ember attack from an approaching bushfire at the same time.

4.1.3 Vegetation management within the APZ

The APZ shown on Figure 8 is to be maintained to achieve the performance requirement of an Inner Protection Area (IPA) as described by Appendix A4.1.1 of 'Planning for Bush Fire Protection 2019'. The following guide has been formulated to achieve an IPA standard for the project:

- Trees:
    - Trees at maturity should not touch, overhang or be within 2 m of assets;
    - Tree canopies should not be connected when at maturity. Gaps between crowns or groups of crowns are to be maintained at distances of 2 to 5 m, with the larger separation between small clumps of individuals that form a larger, collective crown.

- Shrubs:
    - Shrubs should not be within the APZ.
- Groundcovers:
    - Groundcovers should be maintained by regular slashing close to ground level;
    - Woody debris should be regularly removed; and
    - Organic mulch is not to be used within 5 m of an asset.

4.2 Ember and radiant heat protection

4.2.1 Overview

Building construction measures for the protection of embers and radiant heat, such as BALs, are typically applied to an enclosed building such as a dwelling. 'Planning for Bush Fire Protection 2019' does not require BALs to be applied to infrastructure buildings. Nonetheless, vulnerable elements of the gas drainage plant may be present and should be protected where practicable to increase the resilience of the structure.

4.2.2 Protection for the project

Enclosed spaces that house susceptible components can be screened to prevent the entry of embers and exposed cabling can also be protected from radiant heat. These components may be the first to succumb to excessive radiant heat compared to that of the steel components of the plant.

It is recommended to protect the following enclosed spaces from ember entry by installing metal mesh screens with maximum aperture of 2 mm over vents, air intakes and the like:

a) Gas plant switch room

b) Compressors and filter station

c) Enclosed flare housing

It is also recommended to enclose cabling by using cable trays or similar product to minimise impact of radiant heat.

4.3 Water supply for fire-fighting

4.3.1 Overview

An adequate supply of water and fire-fighting infrastructure is essential for fire-fighting purposes.

4.3.2 The project

Fire-fighting infrastructure has been designed into the proposal, featuring two 250,000 litre tanks and fire-fighting pumps.

4.4 Access for fire-fighting and evacuation

4.4.1 Overview

PBP requires safe operational access to structures and water supply for emergency services while occupants are seeking to evacuate the area.

4.4.2 The project

The site benefits from an existing internal access road that has the ability to support a Category 1 fire tanker and features a loop and ample space for turning and standing. The road also provides direct access to the proposed fire-fighting pumps and water supply.

The existing internal site road complies with the 'Planning for Bush Fire Protection 2019' design and construction standards for 'property access' roads as listed in Table 7 below.

Table 7: 'Planning for Bush Fire Protection 2019' standards for property access roads

Standard	Comment
Minimum 4 m carriageway. Some short constrictions in the access may be accepted where they are not less than 3.5 m wide, extend for no more than 30m and where the obstruction cannot be reasonably avoided or removed.	Achieved for the project
In forest, woodland and heath situations, rural property roads have passing bays every 200m that are 20m long by 2m wide, making a minimum trafficable width of 6m at the passing bay.	Achieved for the project
A minimum vertical clearance of 4m to any overhanging obstructions, including tree branches.	Achieved for the project
Property access must provide a suitable turning area.	Achieved for the project
Curves have a minimum inner radius of 6m and are minimal in number to allow for rapid access and egress.	Achieved for the project
The minimum distance between inner and outer curves is 6m.	Achieved for the project
The crossfall is not more than 10°.	Achieved for the project
Maximum grades for sealed roads do not exceed 15° and not more than 10° for unsealed roads.	Achieved for the project
A development comprising more than three dwellings has access by dedication of a road and not by right of way.	Not required

4.5 Emergency response and evacuation planning

4.5.1 Overview

All developments on bushfire prone land should have plans for responding to bushfire emergencies and the evacuation of people.

4.5.2 The project

Emergency response for fire-fighting operations and evacuation is addressed within the South 32 procedural documents:

- 'Dealing with a bushfire' DENP0093 (13/1/2020); and
- 'Dendrobium Mine Bushfire Management Plan' DENMP0034 (25/6/2018)

These documents specify the triggers and response mechanisms for alerting the emergency authorities and evacuating surface and underground operations including air ventilation management via the various shafts.

The access roads to the site from Picton Road consist of approximately 3 km of sealed road within a wide firebreak to Cordeaux Dam wall followed by approximately 10 km of unsealed fire trails amongst bushland. The site and access roads are isolated and within areas of high bushfire behaviour potential. However, it is not expected to have significant numbers of staff or contractors at the site when construction is complete. The above emergency procedures will address operational and evacuation issues.

4.6 Assessing risk with risk treatments in place

This section outlines the risk assessment results and risk ratings for the project based on the application of risk treatments as recommended within Sections 4.1 to 4.5 above.

Table 8 on the following page outlines the results using the same risk assessment methodology as presented in Section 3.

As shown in Table 8, the recommended risk treatments will reduce the risk of bushfire impacting the project from 'extreme' to 'very high' by a reduction of the consequence rating from 'major' to 'moderate'. The risk treatments will also reduce the risk of bushfire impacting external assets from 'medium' to 'low' by a reduction of the likelihood rating from 'possible' to 'unlikely'.

Section 3.3 discusses the concept of acceptable level of risk and residual risk. The residual level of risk to the project and external assets is acceptable within the context of the state bushfire risk management process. The risk treatments listed throughout Section 4 are designed to reduce the risk of fire impact on the site and prevent the spread of fire from the site to within acceptable limits.

Table 8: Assessment of level of bushfire risk with risk treatments in place

Fire scenario	Impact	Level of risk
Impact site	Likelihood = Almost certain Consequence = Moderate	Very High
Impact external assets/communities	Likelihood = Unlikely Consequence = Moderate	Low

5 Plan review

All plans and strategies must have mechanisms that show progress is being made in successfully completing the prescribed actions in order to achieve the objectives of the plan. A complete evaluation, review and updating of the plan should occur after five years at a minimum. The review should;

- Consider whether the plan has achieved the objectives;
- Re-assess the strategies and bushfire threat in light of current research and best practice; and
- Re-assess the strategies taking into account any legislative changes, financial constraints, and any changes in hazard and threat.

It is also important to review the effectiveness of the plan after a fire event. Other triggers for need of plan review within the 5 year interval may involve the introduction or construction of new assets or changes in legislation or policy.

References

Keith 2004. *Ocean Shores to Desert Dunes*. Department of Environment & Conservation, Sydney.

McArthur, A.G., 1962. *Fire behaviour in Eucalypt Forests.* Commonwealth Department of National Development, Forestry and Timber Bureau. Leaflet 107. Paper submitted to the Ninth Commonwealth Forestry Conference. India. 1968.

NSW Rural Fire Service 2008. *Bush Fire Risk Management Planning Guidelines for Bush Fire Management Committees*, Annexure B to Bush Fire Coordinating Committee policy No. 1/2008 Bush Fire Risk Management.

NSW Rural Fire Service (2019). Comprehensive vegetation fuel loads. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0005/97781/Comprehensive-vegetation-fuel-loads-Fact-Sheet-V8.pdf

NSW Rural Fire Service (2019). *Planning for Bush Fire Protection: A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners*. Australian Government Publishing Service, Canberra.

SAI Global (2018). *AS 3814-2018 Industrial and commercial gas-fired appliances*.

SAI Global (2018). *AS 3959-2018 Construction of buildings in bushfire-prone areas*. Incorporating Amendment 1, Fourth Edition.

South 32 (2018). *Dendrobium Mine Bushfire Management Plan* DENMP0034. 25th June 2018.

South 32 (2020). *Dealing with a bushfire* DENP0093. 13th January 2020.

Illawarra Bush Fire Management Committee (IBFMC) (2015). Illawarra Bush Fire Risk Management Plan. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0020/2378/Illawarra-BFRMP.PDF

Wollondilly/Wingecarribee Bush Fire Management Committee (WWBFMC) (2017). Wollondilly/Wingecarribee Bush Fire Risk Management Plan. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0019/2485/Wollondilly-Wingecarribee-BFRMP.pdf

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APPENDIX 5

ADDITIONAL GAS MANAGEMENT INFRASTRUCTURE AT DENDROBIUM NO. 2 AND 3 SHAFTS – NOISE REVIEW (RENZO TONIN & ASSOCIATES, 2022)

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Noise Review

28 January 2022

South32 c/- Resource Strategies

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1 Introduction

The Dendrobium Mine (the Mine) is an existing underground coal mine situated in the Southern Coalfield of New South Wales (NSW), approximately 8 kilometres (km) west of Wollongong. Illawarra Coal Holdings Pty Ltd (Illawarra Metallurgical Coal), a wholly owned subsidiary of South32 Limited (South32), is the owner and operator of the Mine. Renzo Tonin & Associates was engaged by South32, to conduct an assessment examining the potential noise impacts of the proposed modification of the Dendrobium Mine Development Consent DA 60-03-2001 to allow the development of additional gas management infrastructure at the Dendrobium Mine (the Modification).

Noise impacts are assessed in accordance with the following policies and guidelines:

- NSW *Interim Construction Noise Guideline* (ICNG) (Department of the Environment and Climate Change, 2009); and
- NSW *Noise Policy for Industry* (NPfI) (Environmental Protection Authority [EPA], 2017);

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project Overview

Illawarra Metallurgical Coal (IMC) is planning the extraction of approved longwall (LW) blocks LW21, and the proposed LW22 and LW23 in Area 3C of the Dendrobium Mine. The forecast gas quantities in Area 3C exceed the dilution capacity of the ventilation circuit, necessitating the capture and reticulation of post-drainage gas through new gas management infrastructure, instead of through the ventilation infrastructure as currently occurs. The infrastructure would also be used for pre-drainage of other LW blocks within the Area 3C domain.

The Modification would involve:

- Construction of new gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre-drainage gas from Area 3C at the site of the existing Dendrobium No 2 and 3 Shafts.
- Gas extraction from the underground mine via a borehole and vacuum pump, with associated infrastructure including a cooling water system incorporating cooling towers.
- Gas treatment using an enclosed flare on the surface. Under conditions not suitable for flaring, gasses would alternatively be vented via a stack approximately 25 metres (m) high.
- Ancillary infrastructure, such as fencing, pumps, CO2 tanks, condensate tanks and surface pipes.
- Additional water management infrastructure (e.g. sediment controls).
- Process/fire water system, including bores to pump water from and return water to the underground mine workings and pipes/tanks to convey and store this water.
- Installation and use of a transportable substation for electricity requirements.
- Upgrade of the three surface ventilation fans at the gas plant construction site, including upgraded fan impellers, shafts, drives and motors within the existing footprint.
- Minor upgrades of existing electricity transmission infrastructure, such as replacement poles and aerial conductors within mining lease (ML) 1566.
- Temporary bracing of the 2-span Bailey bridge that is on the access trail (Sandy Creek crossing) using props at regular spacing to support the bridge's structure if heavy loads are to be transported across the bridge. In addition, some steel structural elements of the bridge may require repair or strengthening (e.g. corrosion and/or paint removal, to enable suitable welding preparation).

The Modification would involve no change to:

- Approved LW mining.
- Surface disturbance outside of ML 1566 (i.e. the temporary bridge bracing would not require vegetation disturbance).

- Mine life, employment numbers, mining activities or other surface activities associated with the approved Dendrobium Mine.
- The quantity of gas required to be managed for the approved Dendrobium Mine.
- Groundwater take associated with the underground mine.

The Modification would involve no material change to employment numbers at the Dendrobium Mine.

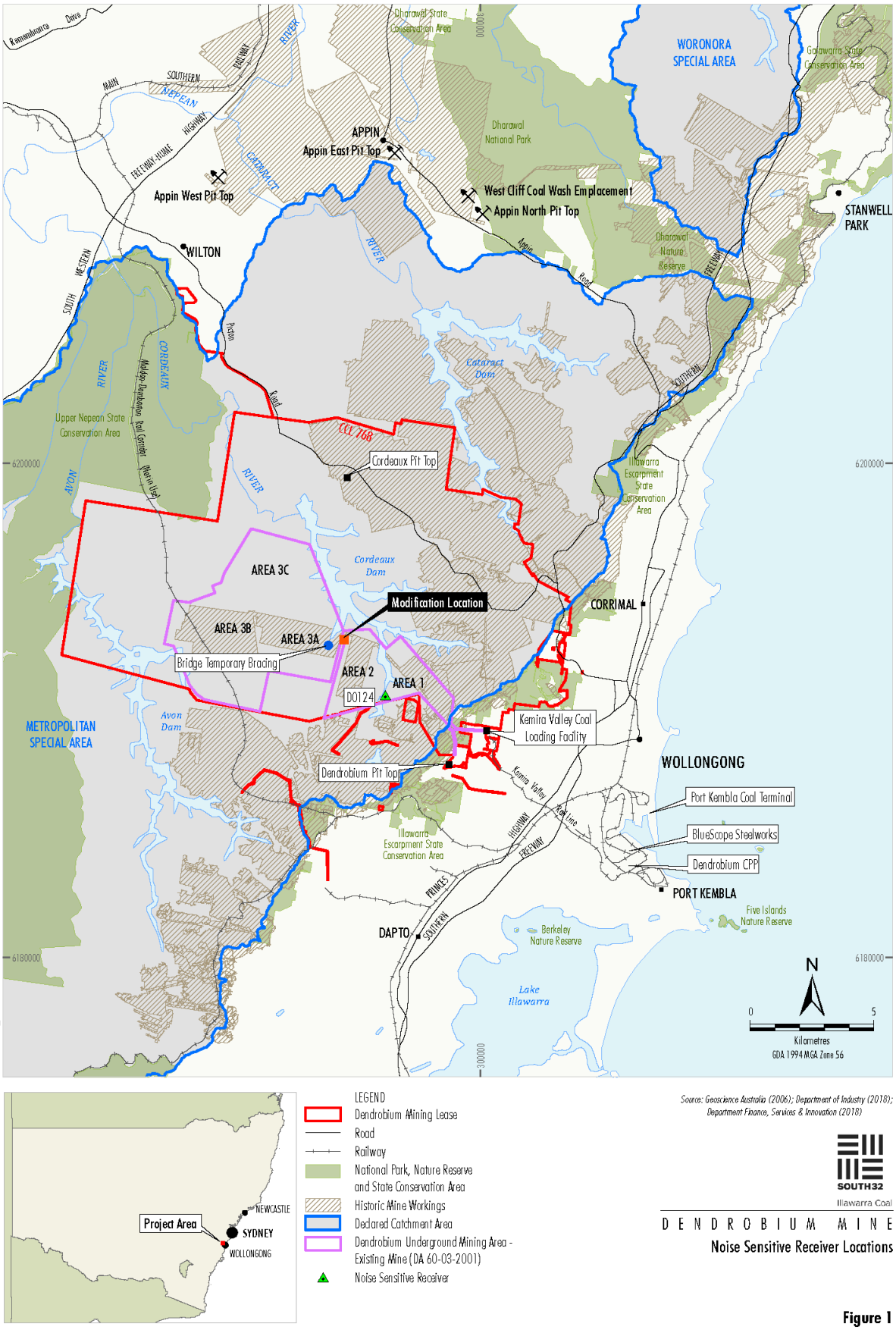
3 Noise Sensitive Receivers

Noise sensitive receivers for the Dendrobium Mine were previously identified in the acoustic assessment report "Dendrobium Mine – Plane for the Future: Coal for Steelmaking – Noise and Blasting Assessment" and prepared by Renzo Tonin & Associates (ref: TJ476-01F02, dated 10 July 2019) (Report). The nearest and potentially most affected noise sensitive receiver locations considered in this assessment are listed in Table 3.1 and shown on Figure 1.

Table 3.1 – Receiver Locations and Ownership Details

ID	Description	Easting	Northing	Category
D0124	Upper Cordeaux Lake No.2	296163	6190595	Caretaker's Quarters

Figure 1 – Noise Sensitive Receiver Locations



4 Established Noise Criteria

4.1 Construction Noise

Based on ICNG requirements, Table 4.1 presents the construction Noise Management Levels (NMLs) established for the nearest noise sensitive receiver in the previous Report.

Table 4.1 – Construction Noise Management Levels

Receiver	Noise Management Level $L_{Aeq(15min)}$			
	Day	Day Outside Recommended Standard Hours	Evening	Night
D0124	**45**	**40**	**35**	**35**

For this receiver location, a 'highly affected' noise objective of $L_{Aeq(15min)}$ 75dB(A) is also adopted.

4.2 Operational Noise

Based on NPfI requirements, Table 4.2 presents the operational Project Specific Trigger Levels (PSTLs) established for the nearest noise sensitive receiver in the previous Report.

Table 4.2 – Project Specific Trigger Levels

Receiver	Land Use	Intrusiveness, $L_{Aeq,15min}$, dB(A)			Amenity, $L_{Aeq,15min}$, dB(A)		
		Day	Evening	Night	Day	Evening	Night
D0124	Caretakers' Quarters (Rural)	N/A	N/A	N/A	**58**	**53**	**48**

5 Construction Noise Assessment

Construction of the additional infrastructure would occur from 7:00am to 5:00pm Monday to Saturday. Notwithstanding, critical construction and commissioning activities (e.g. drilling) would be undertaken up to 24 hours a day, 7 days per week. The construction works would occur in three phases as described in Table 5.1

Table 5.1 – Description of Construction Phases

Phase	Description	Typical Fleet	Estimated Period
Site Establishment / Civils	Initial vegetation clearance, earthworks and site preparation phase	Semi trailer equipment float, 150m grader, 20t excavator, skid steer loader	6 weeks
Drilling	Drilling and installation of gas and water boreholes	Semi trailer equipment float, drill rigs and specialty auxiliary drilling equipment	4 weeks
Gas Plant Construction	Installation of surface infrastructure including a portable substation, vacuum pumps, enclosed flares, vent stack and flame detector, piping, valves and instruments, seal water tank and associated equipment, cooling tower, compressed air, gas analysers, overflow	Semi trailer equipment float, rough terrain cranes	8 weeks

As the nearest receiver is located approximately 3 km away from the site, based on the proposed construction works, the estimated construction noise at the nearest receiver would be at least 5dB(A) below the most stringent construction NML presented in Table 4.1. Therefore, construction noise at the nearest receiver location is expected to comply with the construction NML comfortably and no further mitigation measures are required.

6 Operational Noise Assessment

The hours of operation of the additional infrastructure will be 24 hours per day, seven days per week. The new gas management infrastructure and ancillary infrastructure to facilitate management of post-drainage and pre- drainage gas from Area 3C at the site of the existing Dendrobium No 2 and 3 Shafts.

As the nearest receiver is located approximately 3 km away from the site, the estimated operational noise at the nearest receiver would be at least 10-15dB(A) below the most stringent PSTL presented in Table 4.2. Therefore, operational noise at the nearest receiver location is expected to comply with the PSTL comfortably and no further mitigation measures are required.

7 Conclusion

Renzo Tonin & Associates has completed a noise assessment for the construction and operation of additional gas management infrastructure at Dendrobium No 2 and 3 Shafts. Noise generated during construction and operational phases are expected to comply comfortably with the established noise criteria at the nearest affected receiver location.

References

1. Department of Environment and Climate Change (2009) *NSW Interim Construction Noise Guideline*.

2. Environment Protection Authority (2000) *NSW Industrial Noise Policy*.

3. Renzo Tonin & Associates (2019) *Dendrobium Mine – Plane for the Future: Coal for Steelmaking – Noise and Blasting Assessment*

APPENDIX A Glossary of Terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0 dB The faintest sound we can hear 30 dB A quiet library or in a quiet location in the country 45 dB Typical office space. Ambience in the city at night 60 dB CBD mall at lunch time 70 dB The sound of a car passing on the street 80 dB Loud music played at home 90 dB The sound of a truck passing on the street 100 dB The sound of a rock band 110 dB Operation of a jackhammer or chainsaw 120 dB Deafening
dB(A)	A-weighted decibels. The A-weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.

L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

ATTACHMENT 1

STATUTORY COMPLIANCE SUMMARY

Table A1-1
Summary Statutory Compliance for State Legislation

Relevant Legislation or Instrument	Mandatory Consideration	Relevant Section in Modification Report	Modified Project Compliance Status
Environmental Planning and Assessment Act, 1979 (EP&A Act)			
section 1.3	Relevant objects of the EP&A Act: • Promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources. • Facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment. • Promote the orderly and economic use and development of land. • Protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats. • Promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage). • Promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State. • Provide increased opportunity for community participation in environmental planning and assessment.	Section 4	✓
section 4.15	Relevant environmental planning instruments: • *State Environmental Planning Policy (SEPP) No 33: Hazardous and Offensive Development* (SEPP 33). • *State Environmental Planning Policy No.55 – Remediation of Land* (SEPP 55). • Any planning agreement or draft planning agreement that a developer has entered into under section 7.4 of the EP&A Act. • *Wollongong Local Environmental Plan 2009.* • The *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). The likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality; the suitability of the site for the	Section 4 and Table A1-2	✓

Relevant Legislation or Instrument	Mandatory Consideration	Relevant Section in Modification Report	Modified Project Compliance Status
	development; any submissions made in accordance with the EP&A Act or the EP&A Regulation; the public interest.		
EP&A Regulation			
Clause 115	An application for the modification of a development consent under sections 4.55(1), (1A) or (2) or 4.56(1) of the EP&A Act must contain information outlined in clause 115(1) and must satisfy clause 115(1A). Clause 115(2) also provides the notification requirements of clause 49 of the EP&A Regulation apply.	Modification Report – all sections	✓
Biodiversity Conservation Act 2016			
section 7.14(2)	With reference to clause 30A, Sections 1(a) and 2(c) of the *Biodiversity Conservation (Savings and Transitional) Regulation, 2017*, the Modification could potentially increase impacts on biodiversity values and therefore a Biodiversity Development Assessment Report is required.	Section 6 and Appendix 2	✓
Protection of the Environment Operations Act 1997 (POEO Act)			
section 43	The approved Dendrobium Mine is currently licensed under Environment Protection Licence (EPL) 3241 to conduct "mineral waste generation" and "mineral processing" as defined in Schedule 1 of the PoEO Act. It is not anticipated that any specific conditions of EPL 3241 would require modification as a result of the Modification.	This attachment.	✓
National Parks and Wildlife Act 1974 (NPW Act)			
section 90	The Modification does not seek to change the approved surface development extent for the and would not involve additional potential impacts on Aboriginal cultural heritage to those previously assessed. Notwithstanding, IMC will continue to manage Aboriginal cultural heritage in accordance with Aboriginal Heritage Impact Permits granted under the *National Parks and Wildlife Act, 1974*.	Section 6 and Appendix 3	✓

Table A1-2
Summary Statutory Compliance for Environmental Planning Legislation

Relevant Legislation or Instrument	Mandatory Consideration	Relevant Section in Modification Report	Modified Project Compliance Status
SEPP 33			
clause 13	A consent authority must consider current circulars or guidelines published by the DPE relating to hazardous or offensive development, whether to consult with relevant public authorities regarding any environmental or land use safety requirements, a preliminary hazard analysis prepared by the applicant, feasible alternatives to the development and likely future use of surrounding land. A preliminary hazard analysis has been completed to address this.	Section 6 and Attachment 2	✓
SEPP 55			
clause 7(1)	A consent authority must consider whether the land is contaminated and be satisfied that, if the land is contaminated, the land is suitable in its contaminated state (or will be suitable after remediation) for the purpose of the Modification.	The Modification disturbance areas are wholly located within ML 1566 therefore there is no 'change of use' of these areas	✓
State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011			
clause 11A	As the Modification has the same or lesser impact on water quality than that of the existing development, the Modification will have a neutral effect to water quality in accordance with clause 11A	Section 6 and Appendix 1	✓
Wollongong Local Environmental Plan 2009			
clause 2.1	The Modification has regard to the aims of the Wollongong LEP, as: • The Modification has been developed in a manner that considers the impacts, mitigation measures and management measures required for effective land use and rehabilitation activities. • The Modification would facilitate local and regional employment and economic development opportunities.	This attachment	✓

ATTACHMENT 2

HAZARD IDENTIFICATION AND ANALYSIS

Table A2-1
Hazard Identification and Analysis

Project Component	Incident Type	Scenario	Existing and Proposed Treatment Measures	Likelihood[1]	Consequence[2]	Risk[3]
Construction/ Development Activities	Spill/Leak	Spill of diesel, oils, chemicals, sewage, construction materials or untreated water, leading to impacts on surrounding watercourses.	• Fuels, oils and lubricants stored in accordance with relevant standards and legislation. • Dangerous goods register (SDS). • Construction-specific environmental controls. • Site runoff control (i.e. drains and sumps). • Operator training and operational procedures. • Spill management equipment (i.e. spill kits), procedures and training. • Emergency Response Systems. • Water Management Plan. • Waste Management Plan. • Pollution Incident Response Management Plan.	1	3	3
	Fire	Poor storage of chemicals/fuel results in fire, leading to off-site bushfire.	• Fuels, oils, lubricants and chemicals stored in accordance with relevant standards and legislation. • Removal of hazardous items and regular cleaning around the site. • Firefighting equipment and spill kits located in on-site vehicles. • Regular inspections and maintenance of firefighting equipment. • Regular maintenance of fire breaks to slow fire spread. • Operator training and operational procedures. • Emergency Response Systems. • Liaison with Rural Fire Service for quick response. • Bushfire Management Plan.	0.3	10	3

Table A2-1 (Continued)
Hazard Identification and Analysis

Project Component	Incident Type	Scenario	Existing and Proposed Treatment Measures	Likelihood[1]	Consequence[2]	Risk[3]
Construction/ Development Activities (Cont.)	Fire (Cont.)	Vehicle Fire or electrical fire leading to off-site bushfire.	• Regular inspections and maintenance of firefighting equipment. • Regular inspections and maintenance of site infrastructure, equipment and machinery. • Firefighting equipment and spill kits located in on-site vehicles and infrastructure where required. • Regular maintenance of fire breaks to slow fire spread. • Operator training and operational procedures. • Liaison with Rural Fire Service for quick response. • Bushfire Management Plan.	0.3	10	3
	Explosion	Malicious act, operator error or lightning strike ignites storage chemicals/fuel/ gas cylinders.	• Appropriate storage of fuel, gas, explosives, chemicals, and dangerous substances as required by relevant standards and legislation. • Access only for authorised personnel with appropriate licence, and display of restricted area signage. • Firefighting equipment and spill kits located in on-site vehicles. • Operator training and operational procedures. • Emergency Response Systems. • Liaison with Rural Fire Service for quick response. • Bushire Management Plan.	0.1	30	3

Table A2-1 (Continued)
Hazard Identification and Analysis

Project Component	Incident Type	Scenario	Existing and Proposed Treatment Measures	Likelihood[1]	Consequence[2]	Risk[3]
Construction/ Development Activities (Cont.)	Theft	Theft of construction material or equipment, leading to an off-site event causing injury.	• Perimeter fencing to reduce ease of access to construction sites. • Restricted access to authorised personnel. • Installation of adequate lighting around construction activities. • Site security procedures (i.e. restricted access).	1	3	3
	Uncontrolled/ Unauthorised Movement	Unauthorised access to site, leading to personal injury.	• Perimeter fencing to reduce ease of access to construction sites. • Restricted access to authorised personnel. • Installation of adequate lighting around construction activities. • Site security procedures (i.e. restricted access).	1	3	3

Table A2-1 (Continued)
Hazard Identification and Analysis

Project Component	Incident Type	Scenario	Existing and Proposed Treatment Measures	Likelihood[1]	Consequence[2]	Risk[3]
Underground Mining Operations	Fire	Malfunction of gas management/ flaring facilities, resulting off-site fire-related impacts.	• Use of enclosed flares. • Maintenance of sufficient fire breaks around gas flares. • Regular inspections and maintenance of site infrastructure and equipment. • Regular inspections and maintenance of firefighting equipment. • Operator training and operational procedures. • Dedicated on-site fire response equipment and team. • Emergency Response Systems. • Bushfire management Plan.	0.3	10	3
	Release of Noxious Gases to Atmosphere	Failure of gas drainage/ ventilation infrastructure or an underground fire/explosion produces emissions, causing off-site impacts.	• Adequate gas testing and design of ventilation and gas management infrastructure. • Regular inspections and maintenance of site infrastructure and equipment. • Continuous monitoring of gas/levels/alarm. • Pollution Incident Response Management Plan.	0.3	3	0.9
Other Infrastructure and Supporting Systems	Leak/Spill	Leak or spill from water management system leading to impacts on surrounding watercourses.	• Design of water management structure in accordance with relevant standards and guidelines. • Regular inspections of water containment structures and pipelines for structural integrity, effectiveness and maintenance to maintain their function. • Operator induction and ongoing training. • Water Management Plan. • Pollution Incident Response Management Plan.	1	3	3

Table A2-1 (Continued)
Hazard Identification and Analysis

Project Component	Incident Type	Scenario	Existing and Proposed Treatment Measures	Likelihood[1]	Consequence[2]	Risk[3]
Other Infrastructure and Supporting Systems (Cont.)	Fire	Malfunction of on-site power reticulation resulting in off-site fire.	• Power reticulation designed to Australian Standards and legislation – including security measures. • Removal of hazardous items and regular cleaning around the site. • Power usage monitoring and alarms. • Firefighting equipment and spill kits located in on-site vehicles and infrastructure where required. • Regular inspections and maintenance of firefighting equipment. • Operator induction and ongoing training. • Dedicated on-site fire response equipment and team. • Liaison with Rural Fire Service for quick response. • Bushfire Management Plan.	0.3	10	3

Source: Appendix N of the Dendrobium Mine – Plan for the Future: Coal for Steelmaking – Preliminary Hazard Analysis (South32, 2019).

[1] Refer to Table A2-2.

[2] Refer to Table A2-3.

[3] Refer to Table A2-4.

Table A2-2
Qualitative Measures of Probability

Event	Likelihood	Description
10	Almost Certain	Could be expected to occur more than once during the study or project. Could occur once per year.
3	Likely	Could easily be incurred and has generally occurred in similar studies or projects. Could be incurred in 1 to 2 years.
1	Possible	Incurred in a minority of similar studies or projects. Could be incurred within a 5 year strategic budget period.
0.3	Unlikely	Known to happen, but only rarely. Could be incurred within a 5 to 20 year timeframe.
0.1	Rare	Has not occurred in similar studies or projects, but could. Could be incurred in 20 to 50 years.
0.03	Very Rare	Conceivable, but only in extreme circumstances. Has not happened in industry in the last 50 years.

Source: Appendix N of the Dendrobium Mine – Plan for the Future: Coal for Steelmaking – Preliminary Hazard Analysis (South32, 2019).

Table A2-3
Qualitative Measures of Maximum Reasonable Consequence

Estimated Level of Consequence	Area of Effect			
	Harm to People	Environmental	Community	Financial
1	Low-level short-tern subjective symptoms or inconvenience. No medical treatment.	Low-level impact to land, biodiversity, ecosystem services, water resources or air.	Single low-level community health, safety or security impact, low-level inconvenience <2 weeks, minor, low-level disturbance to a single house or structure.	<US$500,000 loss or production delay.
3	Objective but reversible impairment. Medical treatment, injury or illness.	Minor impacts (<3 months) to land, biodiversity, ecosystem services, water resources or air.	Minor community health, safety or security impacts (<10 households) or human rights infringements, inconvenience to livelihoods <6 months, moderate damage to <50 houses or community infrastructure.	US$5,000,000 to >US$500,000 loss or production delay.
10	Permanent impairment <30% of body to one or more persons.	Moderate impacts (<1 year) to land, biodiversity, ecosystem services, water resources or air.	Moderate community health, safety or security impacts (<50 households). Single allegation of human rights violations, moderate disruption to people's lives (<50 households).	US$25,000,000 to >US$5,000,000 loss or production delay.
30	Single fatality. Permanent impairment >30% of body to one or more persons.	Major impacts (<5 years) to land, biodiversity, ecosystem services, water resources or air.	Serious community health, safety or security impacts (<50 households). Multiple allegations of human rights violations, extended disruption to people's lives (>50 households).	US$100,000,000 to >US$25,000,000 loss or production delay.

Table A2-3 (Continued)
Qualitative Measures of Maximum Reasonable Consequence

Estimated Level of Consequence	Area of Effect			
	Harm to People	Environmental	Community	Financial
100	2-20 fatalities. Permanent impairment >30% of body to more than 10 persons.	Serious or extensive impacts (<20 years) to land, biodiversity, ecosystem services, water resources or air.	Serious community health, safety or security impacts (>50 households) or human rights violation, extended disruption to people's lives (>200 households).	US$250,000,000 to >US$100,000,000 loss or production delay.
300	>20 fatalities. Permanent impairment >30% of body to more than 100 persons.	Severe impacts (>20 years) to land, biodiversity, ecosystem services, water resources or air.	Extensive community health, safety or security impacts (>200 households) or human rights violations, extended serious disruption to people's lives (>1000 households).	>US$250,000,000 loss or production delay.

Source: Appendix N of the Dendrobium Mine – Plan for the Future: Coal for Steelmaking – Preliminary Hazard Analysis (South32, 2019).

Table A2-4
Risk Ranking Table

Likelihood	Consequence					
	Low 1	Minor 3	Moderate 10	Significant 30	Major 100	Catastrophic 300
10 Almost Certain	10	30	100	300	1,000	3,000
3 Likely	3	9	30	90	300	900
1 Possible	1	3	10	30	100	300
0.3 Unlikely	0.3	0.9	3	9	30	90
0.1 Rare	0.1	0.3	1	3	10	30
0.03 Very Rare	0.03	0.09	0.3	0.9	3	9

Source: Appendix N of the Dendrobium Mine – Plan for the Future: Coal for Steelmaking – Preliminary Hazard Analysis (South32, 2019).