South32 Illawarra Metallurgical Coal
PO Box 514
Unanderra NSW 2526

T +61 2 4286 3000

south32.net

26 April 2022

Jessie Evans
Director Resource Assessments
Department of Planning and Environment

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

Dear Jessie,

RE: DENDROBIUM MINE MODIFICATION – SUBMISSIONS REPORT

Overview

The New South Wales (NSW) Department of Planning and Environment (DPE) placed the Dendrobium Mine Modification 9 (the Modification) Modification Report on exhibition from Friday 4 March 2022 to Thursday 17 March 2022.

The Modification seeks 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 ventilation shafts and would allow the continuation of mining at the Dendrobium Mine at the existing production rate, allowing the existing employment of approximately 650 personnel at the Dendrobium Mine, royalties and other benefits to continue.

This Submissions Report has been prepared in consideration of the *State significant development guidelines – preparing a submissions report*.

Analysis of Submissions

In summary, 11 submissions were received on the Modification from public authorities and one from Wollongong City Council (WCC). One submission was received from a member of the public and one from an organisation.

All of the submissions were in the form of comments, with the exception of the public submission, which was an objection.

A submissions register is provided in Attachment 1.

Actions Taken Since Exhibition

Since the lodgement of the Modification Report, Illawarra Metallurgical Coal (IMC) has continued to consult with agencies regarding the Modification.

IMC met with WaterNSW, WCC, Department of Planning and Environment, and Fire and Rescue NSW on 10 March 2022 to discuss the Modification Report. Matters raised included greenhouse gas emissions, erosion and sediment control and hazard/risk matters and controls. IMC met with WaterNSW again on 8 April 2022 to discuss IMC's draft responses to matters raised in WaterNSW's submission.

Response to Submissions

Responses to issues raised in the Transport for NSW, Heritage NSW, Fire and Rescue NSW,NSW Rural Fire Service and Endeavour Energy submissions are provided in Attachment 1.

Responses to other issues raised are addressed in the following attachments:

- Attachment 2 Response to WaterNSW.
- Attachment 3 Response to EPA.
- Attachment 4 Response to EPA Matter 2 (Groundwater).
- Attachment 5 Response to EPA Matter 3 (Surface Water).
- Attachment 6 Response to BCD.
- Attachment 7 Response to DPE–Water.
- Attachment 8 Response to WCC.
- Attachment 9 Response to a member of the public.

Crown Lands, NSW Heritage Council and the Resources Regulator did not raise any specific concerns with the Modification and therefore these submissions have not been considered further.

Updated Evaluation of Merits

Consistent with the Modification Report, the Modification would allow the development of additional gas management infrastructure at the Dendrobium Mine. The Dendrobium Mine, when incorporating the Modification components, would be substantially the same as the existing/approved Dendrobium Mine. Therefore, 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 ventilation 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 llawarra Metallurgical Coal

List of Attachments

Attachment 1	Submissions Register
Attachment 2	Response to WaterNSW
Attachment 3	Response to EPA
Attachment 4	Response to EPA Matter 2 (Groundwater)
Attachment 5	Response to EPA Matter 3 (Surface Water)
Attachment 6	Response to BCD
Attachment 7	Response to DPE–Water
Attachment 8	Response to WCC
Attachment 9	Response to a member of the public

Attachment 1
Submissions Register

Table 1-1
Register of Submissions

Group	Name	Response or Section where issues addressed in Submissions Report
Public Authority	Transport for NSW	Transport for NSW has requested IMC obtain permits under the Heavy Vehicle National LAW (NSW) for the use of any OSOM vehicles on the public road network prior to their use. IMC would ensure their contractors obtain the relevant permit.
	Heritage NSW	Heritage NSW has recommended the implementation of the unexpected finds protocol outlined in Appendix 3 of the Modification Report. IMC would implement the relevant protocol in accordance with the Modification Report.
	Fire and Rescue NSW	1. The Dendrobium Mine and the Modification are not 'potentially hazardous industry' (as all potential hazards identified in The Modification Report are of acceptable risk), therefore HIPAP 1 and an Emergency Response Plan are not strictly applicable. However, IMC has internal Emergency Response Systems which would be reviewed and updated if necessary for the Modification. 2. An Emergency Services Information Package would be prepared in accordance with Fire and Rescue NSW fire safety guideline – Emergency services information package and tactical fire plans.
	NSW Rural Fire Service	NSW Rural Fire Service has requested the preparation of a Fire Management Plan, including development of appropriate asset protection zones (APZs) and construction standards to reduce potential for bushfire as a result of the Modification. A Bushfire Management Plan has been developed by Peterson Bushfire (2022) for the protection of the proposed infrastructure and any surrounding assets associated with the Modification (Attachment 2).
	WaterNSW	Attachment 2.
	EPA	Attachments 3, 4 and 5.
	Biodiversity Conservation Division	Attachment 6 includes an updated Biodiversity Development Assessment Report in response to Biodiversity Conservation Division comments, including: • Biodiversity credit requirements for Plant Community Types. • Assumed presence of two orchid species. • Updated hygiene protocols for protection of frog species.
	DPE–Water	Attachment 7.
Local Government Authority	Wollongong City Council	Attachment 8.

Table 1-1 (Continued)
Register of Submissions

Group	Name	Response or Section where issues addressed in Submissions Report
Organisation	Endeavour Energy	Endeavour Energy provided comments previously sent to the DPE in relation to the Preliminary Environmental Assessment for State Significant Development SSD 8194. Consultation with Endeavour Energy in relation to that project is described in Section 5 of the *Dendrobium Mine – Plan for the Future: Coal for Steelmaking – Environmental Impact Statement*: Endeavour Energy owns and maintains a number of low voltage (33 kV) aerial powerlines that cross the extent of the proposed underground mining areas. An initial prefeasibility application for a proposed ETL connection was submitted in March 2017, with a response received from Endeavour Energy in October 2017. Correspondence was sent to Endeavour Energy in September 2018, providing an overview of the Project and description of relevant Endeavour Energy assets, as well as an offer for a meeting. An application for technical review of the proposed ETL was submitted in February 2019, with a revised application, including proposed loading information, submitted early March 2019 (UIL5179). Further correspondence was provided in April 2019 on likely energy requirements for the Project.
Public		Attachment 9.

Note: Crown Lands, NSW Heritage Council and Resources Regulator did not raise any specific concerns with the Modification and therefore have not been considered further.

Attachment 2
Response to WaterNSW

Matter Raised

1. Fire Risk and Management
Based on a review of the Bushfire Management Plan, WaterNSW recommends the following additional measures be considered including:

- *increasing the inner APZ mapped to the North from 45m mark to fence line, progress east to corner (NE boundary corner) and potentially provide heat shielding to provide reduced radiant heat impact upon assets.*
- *increasing the inner APZ to West and NW of water tanks and provide heat shields to provide appropriate radiant heat potential for staff, contractor or fire fighters trying to access pumps and water supply.*
- *providing a refuge area using special fire protection standard (<10k/m2) for staff, contractors, and fire fighters, and*
- *treating and maintaining the remainder of the compound to an outer APZ standard.*

Response

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, which would be implemented to manage construction and operational activities associated with the Modification. The Bushfire Management Plan was conducted in accordance with the *Illawarra Bush Fire Risk Management Plan* and *Wollondilly/Wingecarribee Zone Bushfire Risk Management Plan* by David Peterson, a known expert in the field holding a Bachelor of Environmental Science (Hons 1) and a Graduate Diploma in Design for Bushfire Prone Areas. David is a Bushfire Prone Areas Design Level 3 accredited practitioner under the Fire Protection Association Australia accreditation scheme.

The objectives of the *Illawarra Bush Fire Risk Management Plan* are to:

- reduce the number of human-induced bush fire ignitions that cause damage to life, property and the environment;
- manage fuel to reduce the rate of spread and intensity of bush fires, while minimising environmental/ecological impacts;
- reduce the community's vulnerability to bush fires by improving its preparedness; and
- effectively contain fires with a potential to cause damage to life, property and the environment.

Accordingly, the risk treatments identified by Peterson Bushfire (2022) including APZ, ember and radiant heat protection, water supply for fire-fighting, access for fire-fighting and emergency response and evacuation planning reflect a balance between bushfire protection of IMC assets and assets owned by others (including WaterNSW) and environmental/ecological impacts associated with vegetation clearing.

Consequently, IMC believes the suite of mitigation measures proposed by Peterson Bushfire (2022) are adequate and do not require augmentation as requested by WaterNSW.

Notwithstanding, 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.

Matter Raised

WaterNSW notes the conceptual soil and water management plan (SWMP) presented in the modification report (Appendix 1 Surface Water Review by HEC (2022)) is in accordance with the Landcom (2004) and the Department of Environment and Climate Change (2008) guidelines. The conceptual SWMP proposes to enlarge the existing sediment basins to manage sediment laden runoff from the associated catchment areas.

WaterNSW recommends that any approval granted for the modification application shall include a condition or modify existing condition requiring the preparation of a SWMP for the site to incorporate measures proposed in the conceptual SWMP and be consistent with the cited guidelines. This is necessary to achieve a Neutral or Beneficial Effect (NorBE) on water quality of receiving waters.

Response

IMC agrees with the intent of the comment (to prepare an SWMP) and intends to consult further with WaterNSW during the preparation of the plan.

Matter Raised

The site is accessed via unsealed Fire Roads (6, 6C, 6F and 6K) within the Metropolitan Special Area, and is located approximately 12 km from the Picton Road entry to Cordeaux Dam. The indicative construction period is about 5 months. Heavy vehicle traffic movements (trucks, semi-trailers, agitators, construction cranes, 40-foot shipping container on semi-trailer etc.) and daily vehicular traffic for 35 construction staff is expected to the site.

WaterNSW notes that the modification report only commits to repair and maintain the fire roads (FR). It does not address impacts on the unsealed fire roads during construction of the gas drainage infrastructure.

WaterNSW reiterates that the road improvements and upgrades were a major issue for the SCA (now WaterNSW) during the construction of ventilation shafts 2 and 3. This required 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 roads prior to commencement of construction for the gas drainage works. This would be a key requirement of any protocol proposed by South32 for wet weather access during both construction and operation stages of the proposal.

WaterNSW recommends any approval granted for the modification application include a condition requiring South32 to prepare a Fire Roads Upgrade Works Plan in consultation with and to the satisfaction of WaterNSW. In preparing the Fire Roads Upgrade Works Plan, South32 must:

- *Conduct a site walkover and inspection with WaterNSW of the fire roads necessary for access to identify existing defects, creek crossings and drainage structures, and necessary erosion/sediment controls/upgrades necessary.*
- *Consider the following guidelines in review of soil, erosion, and water management structures along the fire roads:*
  - *Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads (Department of Environment & Climate Change NSW, 2008)*
  - *NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual (Soil Conservation Service, 2017)*

- *Conduct geotechnical investigations in relation to heavy vehicle and construction stage traffic impacts and necessary pavement add drainage design and/or reinforcement at identified locations.*
- *Design road upgrade works by suitable contractor to ensure pavement profile and drainage all function as intended.*
- *Ensure that all table and mitre drains can function throughout the life of the operation.*
- *Include maintenance and monitoring of table and mitre drains that are necessary to prevent stormwater scouring of pavement materials.*

Response

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 would 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 mitigate any impacts that have the potential to impact water quality within the WaterNSW Special Areas and manage impacts 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).

Accordingly, IMC agrees with the overall intent of WaterNSW's submission in this regard (i.e. to prepare a Fire Roads Upgrade Works Plan), however provides specific responses in respect of the specific requirements of the plan in Table 2-1.

Table 2-1
Fire Roads Upgrade Works Plan IMC Comments

WaterNSW Requirement	IMC Comment
• Conduct a site walkover and inspection with WaterNSW of the fire roads necessary for access to identify existing defects, creek crossings and drainage structures, and necessary erosion/sediment controls/upgrades necessary.	Agree, however it is noted that some maintenance issues pertaining to existing roads may be matters for WaterNSW rather than IMC.
• Consider the following guidelines in review of soil, erosion, and water management structures along the fire roads:	Agree.
- Managing Urban Stormwater – Soils and Construction – Volume 2C – Unsealed Roads (Department of Environment & Climate Change NSW, 2008)	Agree.
- NSW Rural Fire Service Fire Trail Design, Construction and Maintenance Manual (Soil Conservation Service, 2017)	Agree.
• Conduct geotechnical investigations in relation to heavy vehicle and construction stage traffic impacts and necessary pavement add drainage design and/or reinforcement at identified locations.	Clarification – geotechnical investigations are not proposed unless specific geotechnical issues are identified which could impact access to the site. A structural assessment and load test on the Sandy Creek bridge would be conducted.
• Design road upgrade works by suitable contractor to ensure pavement profile and drainage all function as intended.	Agree, however clarification that the intent of any road designs would be to maintain the existing function and purpose of the road (including access to the site).
• Ensure that all table and mitre drains can function throughout the life of the operation.	Agree, maintenance of table and mitre drains would be conducted by IMC in line with the existing WaterNSW Access Consent.
• Include maintenance and monitoring of table and mitre drains that are necessary to prevent stormwater scouring of pavement materials.	As above.

References

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

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

Attachment 3
Response to EPA

Matter Raised

Gas Management
The report states that forecast methane quantities in Area 3C exceed the dilution capacity of the ventilation circuit. The proposed methane management system involves post drainage collection and would allow some flaring to reduce greenhouse gas emissions (page 4). This would occur under conditions suitable for flaring (page 6).

The report states that consideration was given to adopting a gas turbine for power generation instead of flaring (page 5). However this was apparently discounted to avoid additional land disturbance, to avoid heavy industry (transmission lines and substations) in the drinking water catchment, and because of the short duration of gas supply – assuming the Dendrobium Mine Extension Project (State Significant Infrastructure [SSI]-33143123) is not approved.

The EPA notes that the project application includes installation of cooling towers, vacuum pumps, substations, water tanks, an upgrade of electricity transmission including poles and lines, modification to motors, drives and impellers at the site. It is unclear how installing a gas turbine would significantly increase the intended industrialisation of the previously cleared site.

The EPA requests that the following information be provided to support the assertion that power generation from a gas turbine and the resultant reduction in greenhouse gas emissions to atmosphere is not reasonable and feasible over the life of the project.

- *The mass/volume of gas expected to be generated overall and on an average daily basis from Area 3C and the mine expansion project.*
- *Comparison of gas supply from Area 3C and the extension project with volumes of gas produced and electricity generated at the Appin, Tower and Tahmoor methane gas plants.*
- *The expected timeframe of gas supply from Areas 3C and the mine extension project.*
- *A comparison of methane generation under option 1 (pre-drainage) and the preferred option 3 (post-drainage) in the report.*
- *A preliminary financial assessment of the feasibility of power generation at the site under options 1 and 3.*
- *An assessment of the comparative greenhouse gas emission (& reduction) under flaring, venting and power generation.*

In relation to the proposed vent/flare system, additional information is needed as follows.

- *What conditions would make flaring of gas unsuitable and result in venting?*
- *What will be done to optimise flaring of gas?*
- *What percentage of the gas generated will be flared and vented?*

Response

South32, owner of IMC, supports the objectives of the Paris Agreement in relation to carbon emission reductions and is committed to assisting in achieving these goals. Upon its inception in 2015, South32 announced its goal to achieve net zero carbon emissions by 2050, as well as a short-term target to keep its group-wide Scope 1 emissions below its FY15 baseline, which has been met. In 2021, South32 set a new company-wide decarbonisation target to achieve a 50% reduction in Scope 1 and 2 emissions by 2035 (South32, 2021a) and committed to the implementation of a range of mitigation measures and strategies to achieve its decarbonisation target. General mitigation themes currently being implemented by South32 include (South32, 2021a):

- reducing emissions through efficiency projects and low-carbon energy;
- applying low-carbon design to reduce carbon intensity; and
- trialling technology solutions for existing operations (e.g. VAMMIT trial at the Appin Mine).

In 2019, IMC lodged the Dendrobium Mine: Plan for the Future: Coal for Steelmaking (State Significant Development [SSD] 8194) EIS for an extension of the Dendrobium Mine into two new areas, namely Areas 5 and 6. Although recommended for approval by the DPE, the project was refused by the Independent Planning Commission in 2021.

In the EIS, it was described that in absence of approval of the Dendrobium Mine: Plan for the Future – Coal for Steelmaking, IMC would undertake further analysis regarding the feasibility of extraction of some portions of Area 3C. There would be significant time and costs associated with pre-drainage of gas from the coal measures (including the target Wongawilli Seam) in Area 3C to allow for the safe removal of the coal.

This scenario contemplated in the EIS has come to pass and 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 at the existing production rate, necessitating the capture and reticulation of post-drainage gas through new gas management infrastructure, instead of through the ventilation infrastructure as currently occurs. To illustrate this, the *in-situ* gas content within the Wongawilli Seam in Area 3C is predominantly carbon-dioxide at 5 to 16 cubic metres per tonne of run of mine coal (m^3/t ROM coal) (with the potential for small areas to be 18 m^3/t), whereas in Areas 3A and 3B the *in-situ* gas content was 0 to 3 m^3/t ROM coal. The threshold for gas drainage at the mine can be considered to be approximately 4 m^3/t ROM[1] (i.e. above this gas volume, reticulated drainage is likely to be required). As described above, this *in-situ* gas content means that alternative gas management infrastructure is needed to allow the continuation of mining at the Dendrobium Mine, allowing the existing employment of approximately 650 personnel at the Dendrobium Mine, royalties and other benefits to continue.

The infrastructure would also be used for pre-drainage of other LW blocks within the Area 3C domain and potentially for the newly proposed Dendrobium Mine Extension Project (State Significant Infrastructure [SSI]-33143123), if approved. At the time of writing, lodgement of an EIS for SSI-33143123 is pending.

In the context of South32's overall objective to decarbonise its businesses, greenhouse gas reduction is a key consideration of the gas drainage proposed for the Modification. As the Modification would allow for flaring of some of the gas using high efficiency enclosed flares, thereby converting some methane to carbon dioxide and lowering the global warming potential by a factor of 28, greenhouse gas emissions associated with mining operations at Dendrobium Mine would be reduced. IMC would use high efficiency enclosed flares that can flare gas with a methane content of 18% and over, which comprises approximately 25% to 35% of the gas to be drained from Area 3C. Accordingly, flaring of this gas, given the reduction in global warming potential of flared gas, would appreciably reduce overall Scope 1 greenhouse gas emissions.

The remaining gas with a methane content of less than 18% would be vented, consistent with existing practice. In this instance the gas is already at its lowest greenhouse gas potential technically viable with available flaring technologies.

[1] This depends on a number of variables, including the permeability of the seam, outburst threshold and from mine to mine based on local geology. Dendrobium Mine would typically apply gas drainage once gas content is above 4 m^3/t in areas where the seam gas is predominantly carbon dioxide (this would be slightly higher in areas where the seam gas is predominantly methane). Almost all gas within Area 3C is above a level that requires gas drainage, and as such the entire area is planned for gas drainage.

In the absence of the Modification, the same gas within Area 3C would be liberated from the mine via the ventilation system (albeit at an unviably slow mining rate to maintain safe gas conditions or if sufficient pre-drainage time was available prior to mining commencing), without the greenhouse gas reduction benefit of gas drainage and flaring as described above and in the Modification Report.

The potential to combust gas to generate electricity, rather than simply flaring has been considered. This would allow for further reductions in greenhouse gas emissions (i.e. if the electricity generated offsets electricity in the grid that would otherwise be produced by fossil fuel generators). While this technology is used at the Appin Mine, it requires a relatively homogenous gas resource at 75-95% methane and requires periodic gas enrichment from the state gas network to feed the electricity generation plant. By comparison, the Area 3C gas content is predominantly carbon dioxide with significantly lower methane content than Appin and is less homogenous. As such, gas drained from Area 3C could only be utilised for power generation with significant gas enrichment, which is not available in the Metropolitan Special Area and would dilute the objective of reducing GHG emissions. In addition, the Modification area (ML1566) is not considered suitable for power generation, as this activity requires a surface footprint (including for supporting infrastructure such as power reticulation) which would exceed the capacity of the existing site. Accordingly, this option is not considered viable for the Modification.

Matter Raised

Process Water and Fire Water
The EPA understands that the Vent shaft site is currently used for mine ventilation with ducts, fans, an electrical sub-station and a small quantity of tools and materials stored on site to service the equipment.

The water management component of the proposal is not fully described in the report but appears to involve the transport, storage and use of saline mine water. If that is the case, the proposal would be a change in the use of the site by introduction of a large volume of potentially polluting liquids adjacent to Cordeaux reservoir.

Page 19 the report states
"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."

Little information is provided about the water management system apart from the statement above. It is assumed that minewater will be used for cooling the vacuum extraction fans through an evaporative cooling system. Such systems generally have a blowdown waste product and use antiscaling and anti fouling additives. Risks come from storage, transport and use of chemicals and mine water in a site adjacent to the reservoir.

A full description of the cooling water system is needed to assess the level of risk presented. A listing of measures to minimise the risks is not provided except in a basic table in Attachment 2 of the report. Given the sensitivity of the site, a detailed consideration of factors is considered necessary.

No examination of alternative means for cooling the pumps is discussed such as dry cooling. There is also no holistic reasoning given for selection of the gas drainage option 3 over options 2 and 4 which may have lower catchment risks (on page 4). The report states the option was selected because "only option 3 is viable to deliver planned production rates."

In order to assess the possible risk of environment impact of the proposal, the EPA requests a full description the water management systems be provided. This should also include consideration of dry cooling or using catchment water as feed to the evaporative cooler. In addition, the EPA requests that following specific questions be addressed in relation to the proposal.

- *What is meant by process water supply?*
- *Why is minewater to be used for fire fighting & process water given it introduces an additional risk?*
- *How much minewater will be transported to the site and how much will be stored?*
- *What are the chemical and physical characteristics of water proposed to be used on site?*
- *What chemicals are to be stored on site and are they hazardous?*
- *How will they be stored and in what quantities?*
- *How will they be safely transported to the site?*
- *Will chemicals be added as anti-corrosion and anti-foulant in the cooling water?*
- *Where is blowdown water going to be stored and disposed?*
- *What measures will be taken to reduce risk of polluted water discharges to the catchment through accidental loss, bushfire and vandalism.*
- *How will leaks & spills will be detected, contained or treated given the remote location of the site?*
- *How will potentially contaminated stormwater be managed and disposed of?*
- *How will contaminated firewater be contained in the event of an incident?*

Response

The Modification seeks approval to secure a water supply by pumping water from the underground general purpose/fire water supply to two 250 kilolitre (kL) surface holding tanks. The capacity of these tanks has been sized to meet the fire water storage requirements for the site and provide a process water buffer in the event of a failure to the lift pump.

The tanks are located in the site's northern sediment pond stormwater catchment area and the capacity of the tanks is less than the detention volume of the sediment pond as a supplementary control against release of any mine general purpose/fire water off site.

The operation of the liquid ring vacuum pumps require a closed loop circulating supply of seal water. The seal water is integral to the function of the pumps and carries away waste heat from the compression process. The seal water passes through a settling chamber and directly through a cooling tower to reject waste heat through evaporation. Make up water is supplied from the surface storage tanks. The seal water circuit includes a chemical dosing system to manage water quality.

The seal water system requires periodic blow down primarily to manage accumulated particulates.

Water is returned to the underground reservoir via a borehole.

The IMC project team investigated heat pumps as an alternative to the cooling tower "dry cooling" however the additional energy demands and footprint required were found to be excessive. Responses to specific queries are provided in Table 3-1.

Table 3-1
Response to specific Questions

EPA Question	IMC Response
What is meant by process water supply?	Process water is the circulating seal water required to run the liquid ring vacuum pumps. The process water doubles as the cooling water.
Why is minewater to be used for fire fighting & process water given it introduces an additional risk?	In selecting the option to use mine general purpose water to supply the plant, consideration was given to alternatives including, trucking water to site, harvesting rainwater, harvesting groundwater and drawing water from the Cordeaux reservoir. General purpose mine water was selected to minimise external impacts while meeting the technical requirements of the plant.
How much minewater will be transported to the site and how much will be stored?	The total amount of mine general purpose water contained on site would be 500 kL in tanks with less than 50 kL circulating in the process at any time. No mine water would enter or leave site via the surface boundaries.
What are the chemical and physical characteristics of water proposed to be used on site?	Refer to Attachment 4.
What chemicals are to be stored on site and are they hazardous?	Refer to Table 3-2.
How will they be stored and in what quantities?	Refer to Table 3-2.
How will they be safely transported to the site?	All chemicals throughout the operation of the plant would be managed by a specialist contractor. Transport to site would be in accordance with the Australian dangerous goods code where required and in accordance with the WaterNSW access consent.
Will chemicals be added as anti-corrosion and anti-foulant in the cooling water?	Yes, refer to Table 3-2
Where is blowdown water going to be stored and disposed?	Blowdown water would be discharged directly underground into the underground storage reservoirs.
What measures will be taken to reduce risk of polluted water discharges to the catchment through accidental loss, bushfire and vandalism?	• Lined fire water tank design. • Routine plant inspections. • Remote operation and CCTV cameras. • Site security fencing. • Sediment pond sizing exceeding the maximum capacity of water stores on site. • Asset protection zones in place and maintained.
How will leaks & spills be detected, contained or treated given the remote location of the site?	Leaks would be detected via routine inspections (daily). CCTV would be monitored by the mines Control Room. The site would have spill kits available for first response.
How will potentially contaminated stormwater be managed and disposed of?	In the very unlikely events of: • a leak from the storage tanks, or • an uncontained spill exposed to a stormwater event. The sediment ponds can be evacuated via a suction truck.
How will contaminated firewater be contained in the event of an incident?	Per above (i.e. sediment pond sizing exceeding the maximum capacity of water stores on site)

Typical chemical storage at the site during operations would include (Table 3-2).

Table 3-2
Typical Chemical Storage Details

Name	Typical Use	Typical Storage
Sodium Hypochlorite	Prevent the growth of algae in cooling towers	1,000 litre Intermediate Bulk Containers (IBC)
Spectrus NX1104	Antimicrobial agent for treating the cooling water	1,000 litre IBC
Spectrus BD1500	Antimicrobial agent for treating the cooling water	20 kg polyboy
Genguard GN8115	Multi-functional corrosion, scale and deposit inhibitor	15 kg polyboy

All chemicals are stored in bunds which are suitable for Intermediate Bulk Containers. These would be standard hard cover type storage bunds that are securely fixed to ground.

Attachment 4 provides consideration of potential impacts on water quality associated with the use of the above chemicals within the mine water management system.

Matter Raised

Stormwater Management
The existing stormwater management system is to be used to capture sediment laden run-off from the construction site. Minor changes include a modified drain and possible enlargement of sediment basins A & B. The proposed method of stormwater treatment involved Type F retention basins in the Volume 1 and 2E of the Managing Urban Stormwater: Soils & Construction guideline.

The EPA request that the following points be addressed to provide more details of the stormwater system. The quoted page numbers refer to the report's Appendix 1 prepared by Hydro Engineering Consulting.

- *Figure 3, page 6: shows all run-off from sub catchment B going to Basin C. The diagram needs to be amended to show the separate flow path to Basin B.*
- *Section 5.3, page 9: evidence needs to be provided that the soil type corresponds to type F classification.*
- *Section 5.3, page 10: the report notes that available sediment pond capacity for basin A and B is approximately 0.7 ML but 0.9 ML volume is necessary to meet the guideline. The basins may be enlarged if needed.*
- *The EPA suggests that if modification of the basin surface area will result in significant additional vegetation clearance, the adopted sediment zone could be reduced in size and more frequent clean out considered. This might be considered acceptable given the relatively short construction time for the project.*
- *Section 5.3: a description of the discharge arrangement should be given as to whether the water will be pumped out or allowed to drain under gravity after the 5-day settling period.*
- *Section 5.4: during construction of the vent shaft in 2008, flocculants were found to be necessary to achieve acceptable water quality criteria within an acceptable time (goal for sensitive catchment release is <30 mg/L suspended solids or <60 NTU). An assessment should be made of need for flocculants and what type would be considered acceptable in the drinking water catchment. Alternatively, the use of mobile stormwater treatment facilities should be considered.*

Response

Refer to Attachment 5.

Reference

South32 (2021). *Sustainable Development Report 2021: For Future Generations.*

Attachment 4
Response to EPA Matter 2 (Groundwater)
(Response Prepared by Watershed HydroGeo)

20 April 2022

Watershed HydroGeo
ABN: 95 615 827 499
81 North St, Nowra N.S.W.
AUSTRALIA 2541
will.minchin@watershedhg.com

To: Gary Brassington
Manager Approvals
Illawarra Metallurgical Coal (IMC)

cc: Clive Berry (RS), Dave Leslie (IMC)

From: Will Minchin

Memorandum: Dendrobium Modification 9 – assessment of process water dilution and processing water characteristics

Your Ref: Request by IMC, 31/03/2022 Our Ref: IMC113–M040f

1 Introduction

Illawarra Metallurgical Coal (IMC) are in the process of modifying an existing consent (Modification 9) with regard to installing and operating gas drainage infrastructure at the Shafts 2-3 site (ML1566) above Dendrobium Mine Areas 2 and 3A. Government agencies have made submissions, and this letter provides a response to comments by New South Wales (NSW) Environment Protection Authority (EPA) (DOC22/167689-2, dated 16/03/2022) regarding the processing water and chemical additives.

Watershed HydroGeo ("WatershedHG") has addressed two items:

1. "What are the chemical and physical characteristics of water proposed to be used on site?"
   - This is addressed in Section 2 with a brief summary of water quality, and with attachment of reporting and analytical results (for IMC and by Sydney Water).
2. "Where is blowdown water going to be stored and disposed?"
   - This is addressed in Section 3, including by developing a water and chemical mass balance.

2 Water quality of water used on site

NSW EPA (2022) stated:

- "*The water management component of the proposal is not fully described in the report but appears to involve the transport, storage and use of saline mine water.*"
- "*What are the chemical and physical characteristics of water proposed to be used on site?*"

Samples are routinely collected by IMC staff from Dendrobium underground workings, inter-seam boreholes and flooded adjacent mine workings. Monthly water samples are taken from the main discharge points of the mine and from completed longwall panels. More than 3,400 water samples have been collected and analysed at Dendrobium Mine since 2004, providing an extensive database for ongoing characterisation of waters. Reporting of water quality is provided regularly to agencies (e.g. HGEO, 2022).

A broad summary of mine water quality is provided below.

Samples of mine inflow (via the goaf), which constitutes the majority of the water that would be used in the proposal, have compositions that are characteristic of groundwater from coal seams and coal measures. Total suspended solids are very low (typically below laboratory quantification limits).

Salinities are somewhat elevated (~800 to 3,000 microsiemens per centimetre [µS/cm]) relative to shallow groundwater and surface water and show strong enrichment of Na relative to Cl. Mine inflow water is dominated by Na and HCO_3 with near neutral to alkaline pH. Minor ions are Si, Ba, Sr, Mg and Li, which are derived from silicate weathering and carbonate dissolution.

3 Mass balance for seal water

As part of the operations at the surface at Shafts 2 and 3, IMC proposes to use mine water for processing (e.g. cooling, sealing). The chemical characteristics of the mine water were described in Section 2.

Processing will include a number of additives to the cooling system, such as for anti-fouling and to prevent scale. These are listed in Table 3-1.

Table 3-1 Proposed chemical additives

Chemical	Description	Feed rate/dose	Aquatic toxicology [mg/L]		
			Species	No effect (NOEL)	LC50
NX1104	Non-oxidising biocide (IBC)	Fed twice per week to 60 mg/L circulating concentration	Fathead minnow	1.0	2.9
			Daphnia magna	0.1	0.16
GN8115	Multifunctional corrosion/scale/ deposit inhibitor	110 mg/L, fed after blow-down/system bleed to achieve treatment residual	Rainbow trout	200	443
			Fathead minnow	500	502
			Daphnia magna	1000	2549
Spectrus BD1500	Biodispersant, biocide enhancer	10 mg/L, fed after blow-down/system bleed to achieve treatment residual	Rainbow trout	3000	-
			Fathead minnow	2000	>3000
			Daphnia magna	2000	-
Sodium Hypochlorite	Oxidising biocide (IBC)	0.5 ppm available chlorine as OCL. Continuous feed to match system consumption	"fish" (vertebrate)	-	0.07-5.9

Toxicity information from Material Safety Data Sheets (MSDS) obtained from https://www.ixom.com/sds-search
mg/L = milligrams per litre. LC50 = lethal dose for 50% of population.
Fathead minnow / rainbow trout = vertebrate species. Daphnia magna = invertebrate species.

This report describes a water and mass balance developed for the purpose of quantifying the mass and concentration of each additive from the point it is added to the processing water in the cooling system to its proposed and eventual discharge.

Figure 3-1 presents a schematic of the water balance, with water from the mine (Area 3A) being pumped to surface tanks near Shafts 2 and 3, and being used to fill (or top-up) the cooling water system. Water from the cooling system will be blown-down (discharged) from that system to a wastewater tank at the surface. From there, it will be re-introduced gradually to the water management system via the sump in the Area 3A underground workings, rather than as a single 'pulse' on the day that the blow-down occurs.

From this point in Area 3A, the blow-down water would be incorporated into the underground water management system (i.e. transferred between the areas via a series of sumps and pumps), being re-used/stored temporarily underground in the Kemira workings and discharged at Licensed Discharge Point (LDP) 5; either discharged directly from Area 1 or eventually in the case it is stored temporarily at Kemira. LDP5 is located on Allans Creek, which is joined just below the LDP by American Creek and Nudija Creek which have significant catchment areas, and then flows to Tom Thumbs Lagoon at Port Kembla.

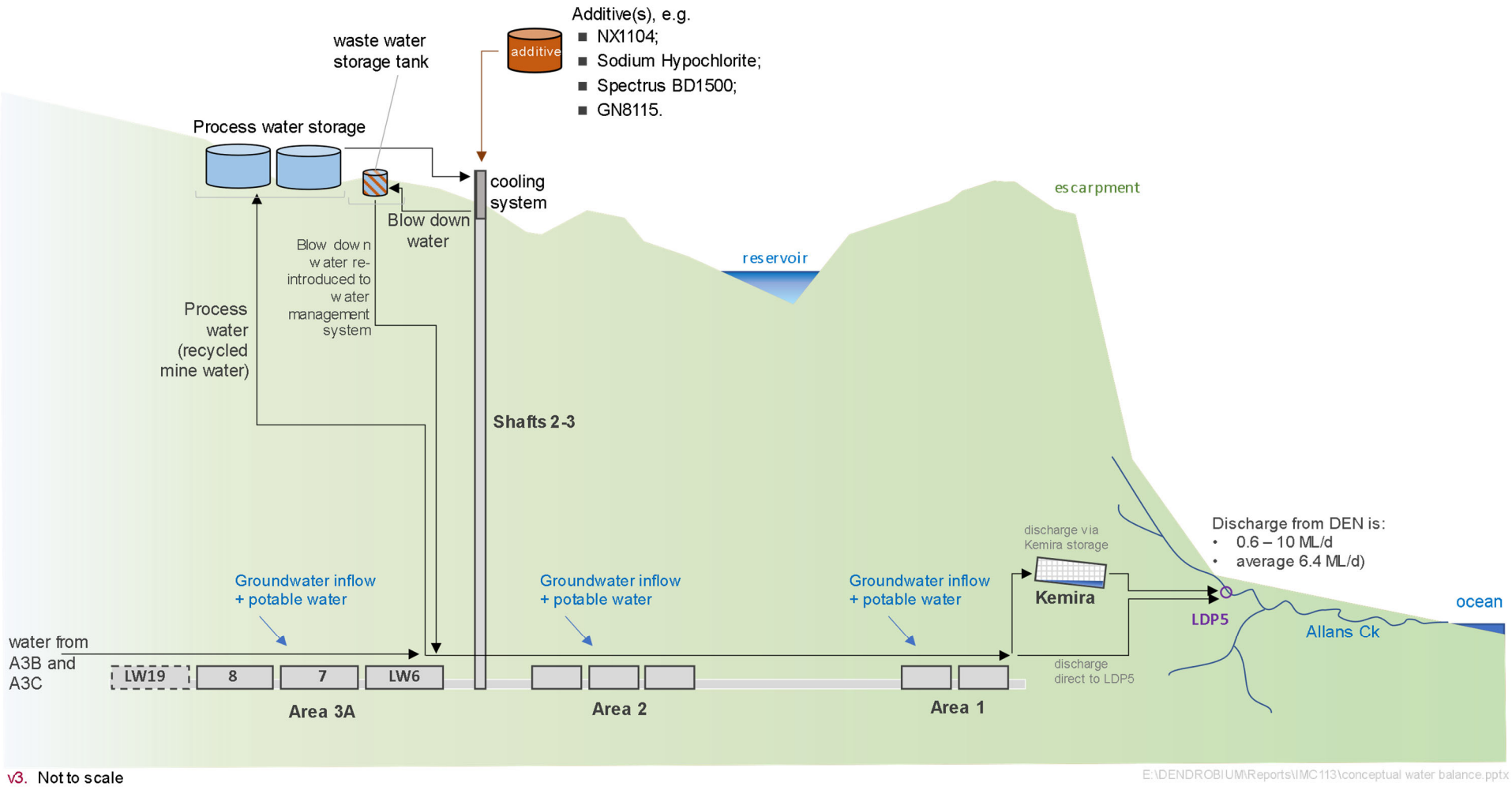


Figure 3-1 Conceptual schematic of the mass balance related to discharge of chemical additives

The assumptions (volumes and rates) for the water balance are listed in Table 3-2.

Table 3-2 Water balance assumptions

Component	Source	Value (range)
Cooling system (circulating) volume	Communication from Singleton Engineering Solutions (11/04/2022)	25 kilo litres (kL) = 25,000 litres (L)
Blow-down volume from cooling system.	Communication from Singleton Engineering Solutions (11/04/2022)	7.5 kL = 7,500 L (approx.) occurring every three weeks (i.e. 1 in 21 days), transmitted to wastewater tank
Re-introduction of wastewater (blow-down water) to water management system	Communication from IMC (19/04/2022) and dilution calculation	Blow-down volume re-introduced over 2 or more days after each blow-down event. Maximum daily volume of 4.5 kL, estimated to maintain concentration of NX1104 below stated ecotoxicological "no effect' thresholds
Replenishment of cooling system	Communication from Singleton Engineering Solutions (11/04/2022)	7.5 kL to replenish volume following blow-down
Pump-out from Area 3A	Daily record of gross pump-out from Dendrobium's water balance officer	Variable: ▪ average 6 mega litres per day (ML/d); ▪ range 1-11 ML/d*
Discharge from Dendrobium to LDP5	Daily record of discharge obtained from Dendrobium's water balance officer	Variable: ▪ average 6.4 ML/d; ▪ (range 0.6-10 ML/d)*
Flow in Allans Creek	Not available	Flow rate for Allans Creek is not known but has been estimated based on catchment size

* using statistics from 2018-2022 as likely values for water balance representing future operations

The water balance was simulated in a spreadsheet on a daily timestep for a year. The Area 3A pump-out and discharge to LDP5 rates were summarised from the daily record (upper chart on Figure 3-2) into a probability frequency distribution (lower chart on Figure 3-2).

This distribution was then applied on a daily basis in the water balance. The use of the variable rate gives an idea of dilution of the chemical additive across the range of discharge volumes. The water balance also assumes that the blow-down water moves as a pulse or slug through the system, maintaining peak load.

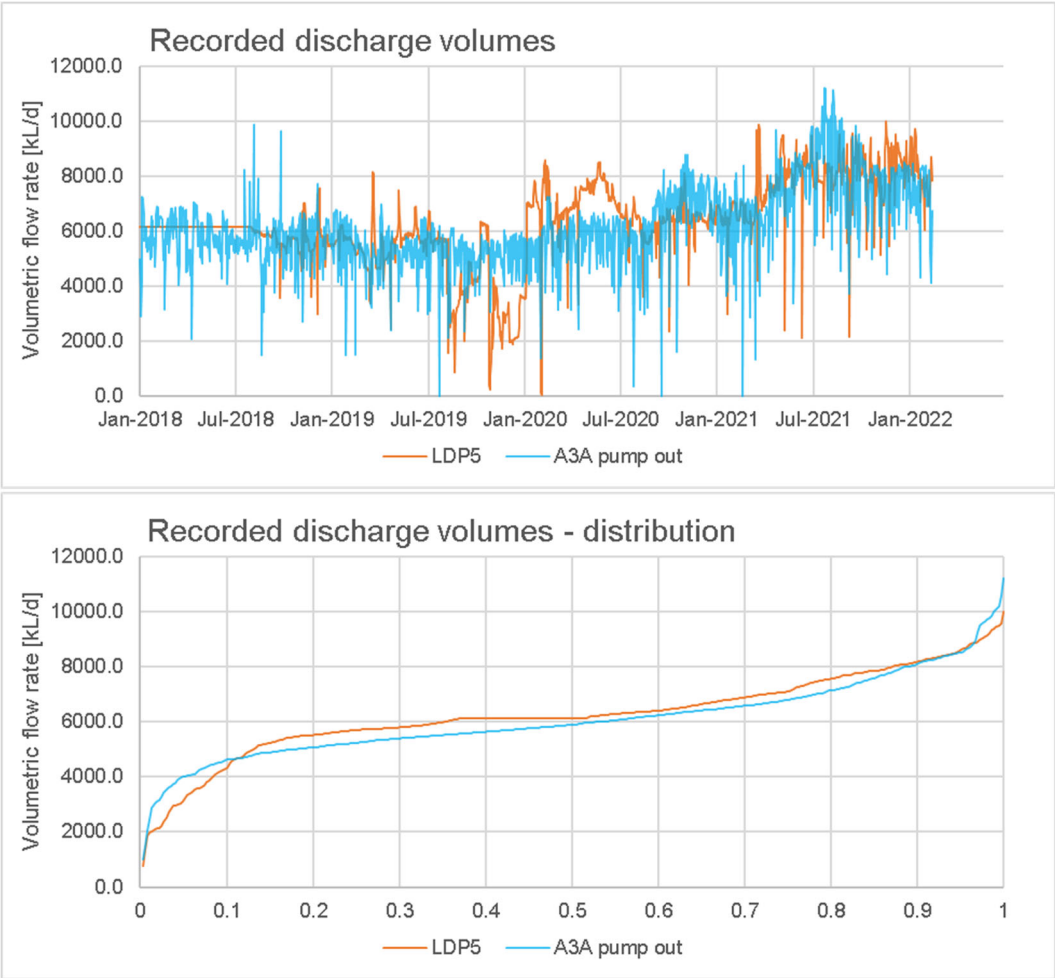


Figure 3-2 Historical discharge record and frequency distribution

Further assumptions regarding disposal are related to flow in Allans Creek (Section 3.1), degradation of chemical additives (Section 3.2).

The potential dilution in the water stored in Kemira workings is significant, with estimates of 300 ML of water stored in those workings. However, it is conservative to assume that the blow-down water may be discharged from Dendrobium directly to LDP5, so that is the basis of the mass balance.

3.1 Flow in Allans Creek

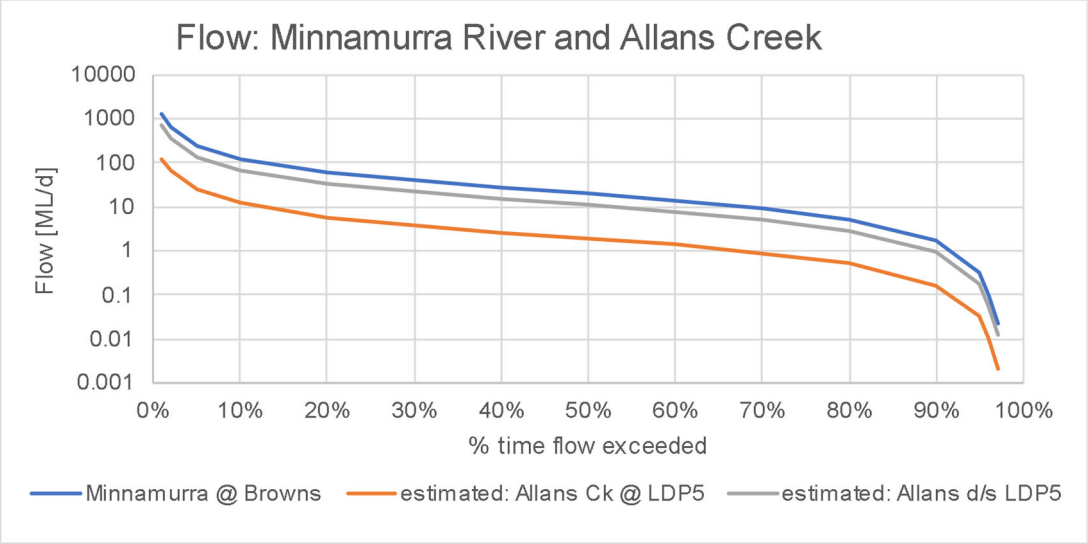
The flow rate in Allans Creek is not known (not monitored by IMC or by government) but this creek has a substantial catchment:

- 6 km^2 at LDP5;
- rising to 34 km^2 just 500 m downstream of LDP5, after the confluence with American Creek and Nudija Creek.

Flow gauging is conducted at Minnamurra River at Browns Lane (GS 214010), and data was obtained from this site from the WaterNSW website. This site is 20 km south of Allans Creek but is a geologically similar catchment flowing from the escarpment (land use is more urbanised in Allans Creek). Using the available flow record (for the period 2005-2022) for GS 214010 (catchment area 61 km^2), the flow in Allans Creek is estimated using catchment size. This is presented as a flow duration curve in Figure 3-3.

The dilution of chemical additives can only be calculated reliably as far as the LDP5 discharge.

The ultimate dilution in the creek would be greater, and an estimate has been made, but it is based on the estimated flow in the watercourse as outlined above. Further dilution would occur in the estuary / tidal zone – this has not been quantified.



E:\DENDROBIUM\Tech\SurfaceWater\WaterNSW\Minnamurra_Browns\[214010_Minnamurra at Browns.xlsx]214010

Figure 3-3 Measured flow in Minnamurra River and estimate flow in Allans Creek

3.2 Degradation of chemical additives

NX1104 is known to degrade or breakdown via hydrolysis (advice provided to IMC by Ixom). The MSDS indicate that the other additives also degrade. However, in the mass balance these additives are treated as conservative chemicals (i.e. do not degrade).

3.3 Results of mass balance

3.3.1 Dilution of NX1104

The mass balance results for NX1104 as it is discharged from Dendrobium's water management system at LDP5, and the subsequent dilution in Allans Creek, are summarised in Table 3-3. Higher concentrations correspond to the blow-down water being re-introduced and diluted in lower volumes of pump-out/discharge, and the lower concentrations correspond with higher total volumes of water being pumped out of the mine (or higher flow in the creek).

Table 3-3 Simulated concentrations at NX1104

Location	Catchment	Range (mg/L)	Median (mg/L)
Discharged from LDP5	Dendrobium underground	0.013 - 0.095	0.02
Allans Creek at LDP5	6 km^2	0.011 - 0.095	0.02
Allans Creek d/s American and Nudija Creeks	34 km^2	0.006 - 0.095	0.01

The charts on Figure 3-4 present the results along with the stated ecotoxicological thresholds from the MSDS. The charts summarise the simulated concentrations for:

a) a proportion of days on which the blow-down water is discharged, which is a small subset of all days (Table 3-2), and therefore a representation of the worst case; and

b) a proportion of all days.

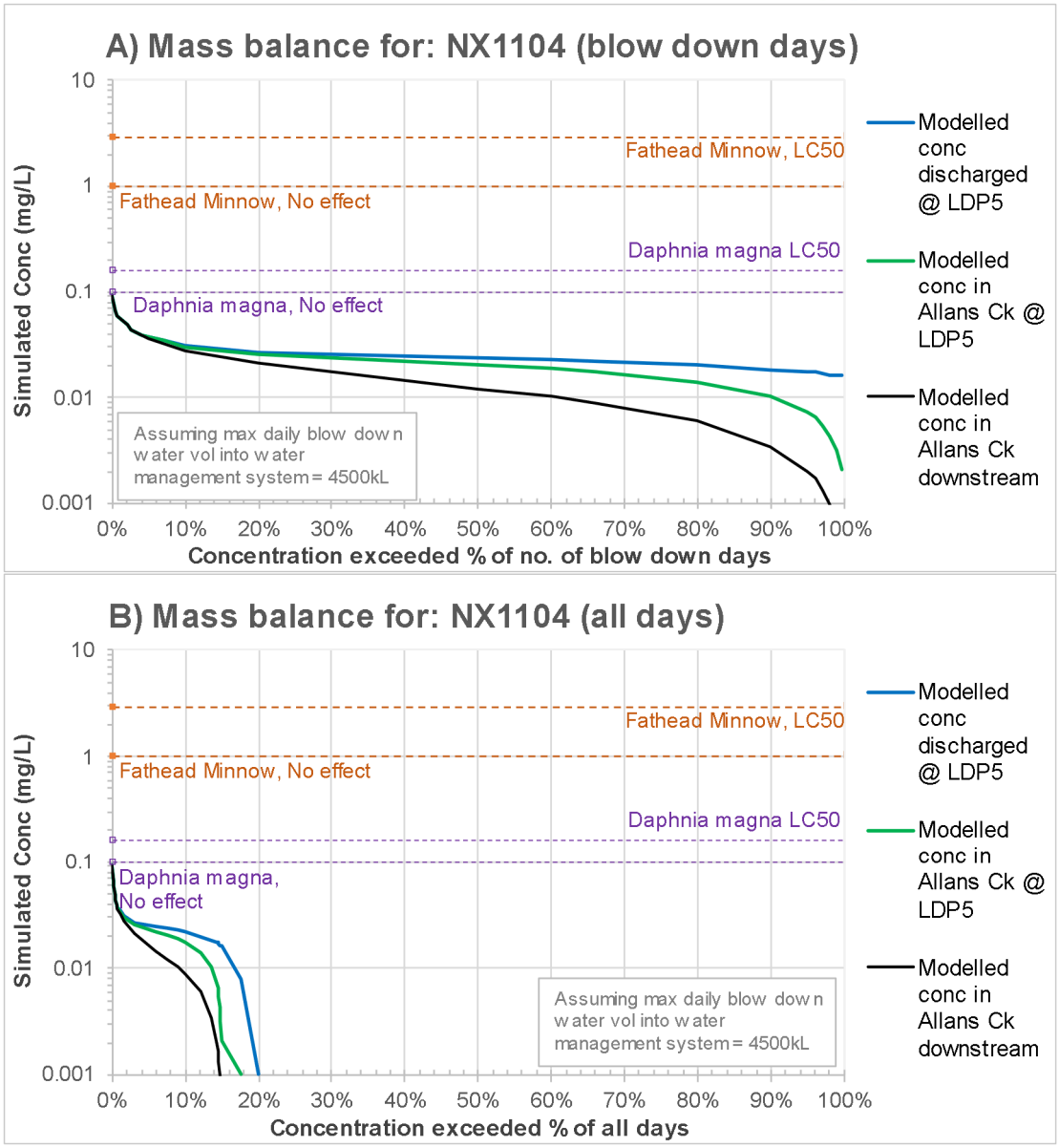


Figure 3-4 Simulated concentration of NX1104 at LDP5 and Allans Creek

In consideration of the periods where the pump-out and flow in the creek are low and the resultant dilution effect at its smallest, the results on Figure 3-4A suggests that following blow-down, NX1104 concentrations would be:

- consistently below the no effect level (NOEL) for Fathead Minnow, which is guide for aquatic vertebrate animal toxicity.
- consistently below the stated LC50 for *Daphnia magna* (invertebrate).
- consistently below the stated NOEL for *Daphnia magna*.

Considering that blow-down does not occur often (i.e. only on approximately 1 out of 21 days), then these concentration frequency percentiles drop considerably when considering all days, as shown on Figure 3-4B, which is the more realistic case.

In terms of sensitivity to assumptions, if the blow-down volume that is re-introduced to the water management system is lower than 4.5 kL (4,500 kL), e.g. the blow-down is introduced over 3 or more days, then estimated concentrations at LDP5 would decline even further than estimated.

3.3.2 Dilution of GN8115

The mass balance results for GN8115 as it is discharged from Dendrobium's water management system at LDP5, and the subsequent dilution in Allans Creek, are summarised on Figure 3-5.

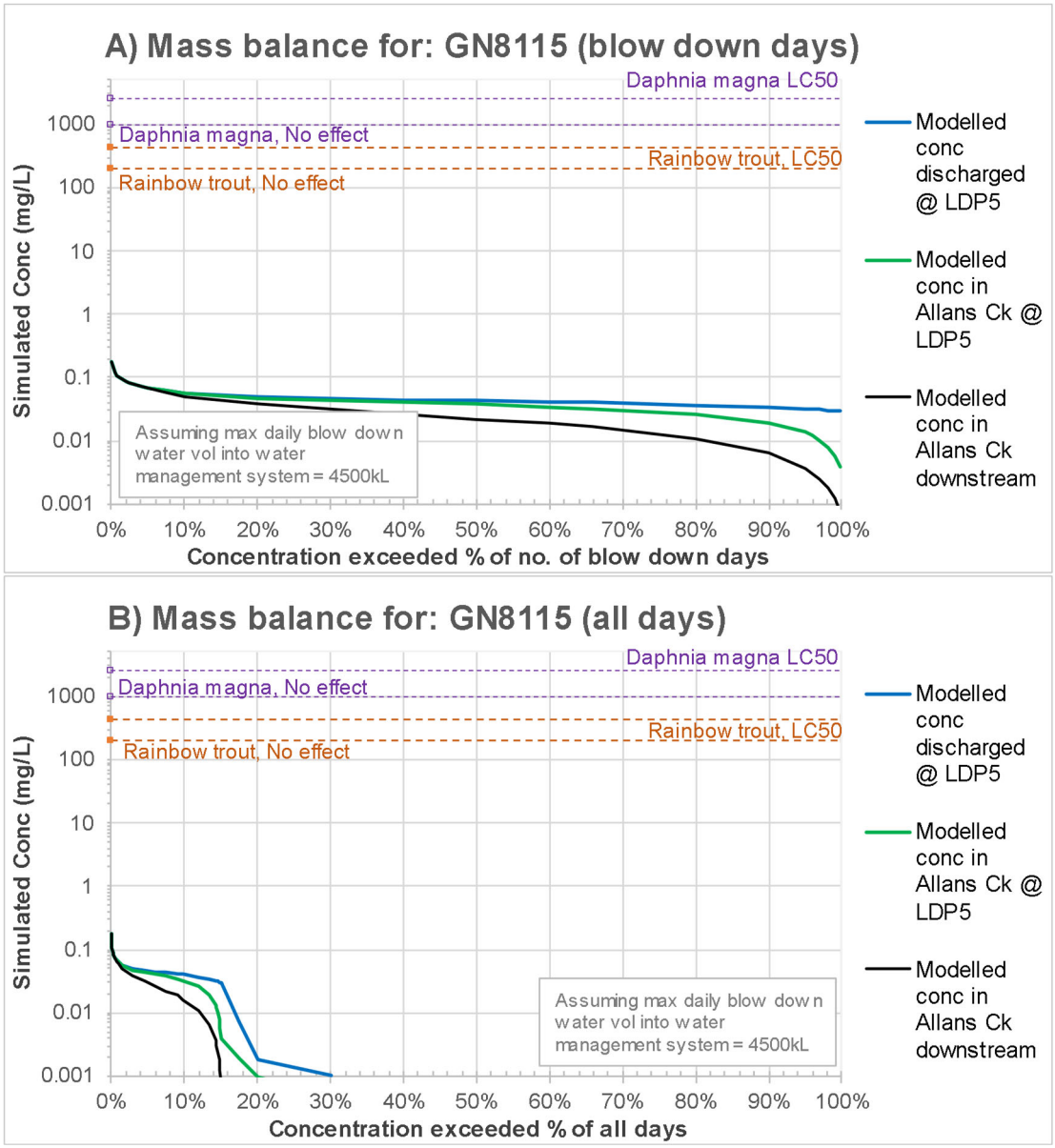


Figure 3-5 Simulated concentration of GN8115 at LDP5 and Allans Creek

This shows that the estimated GN8115 concentrations at LDP5 and in Allans Creek are significantly and consistently lower than the stated ecotoxicological thresholds, even without taking degradation into account.

3.3.3 Dilution of Spectrus BD1500

The mass balance results for GN8115 as it is discharged from Dendrobium's water management system at LDP5, and the subsequent dilution in Allans Creek, are summarised on Figure 3-6.

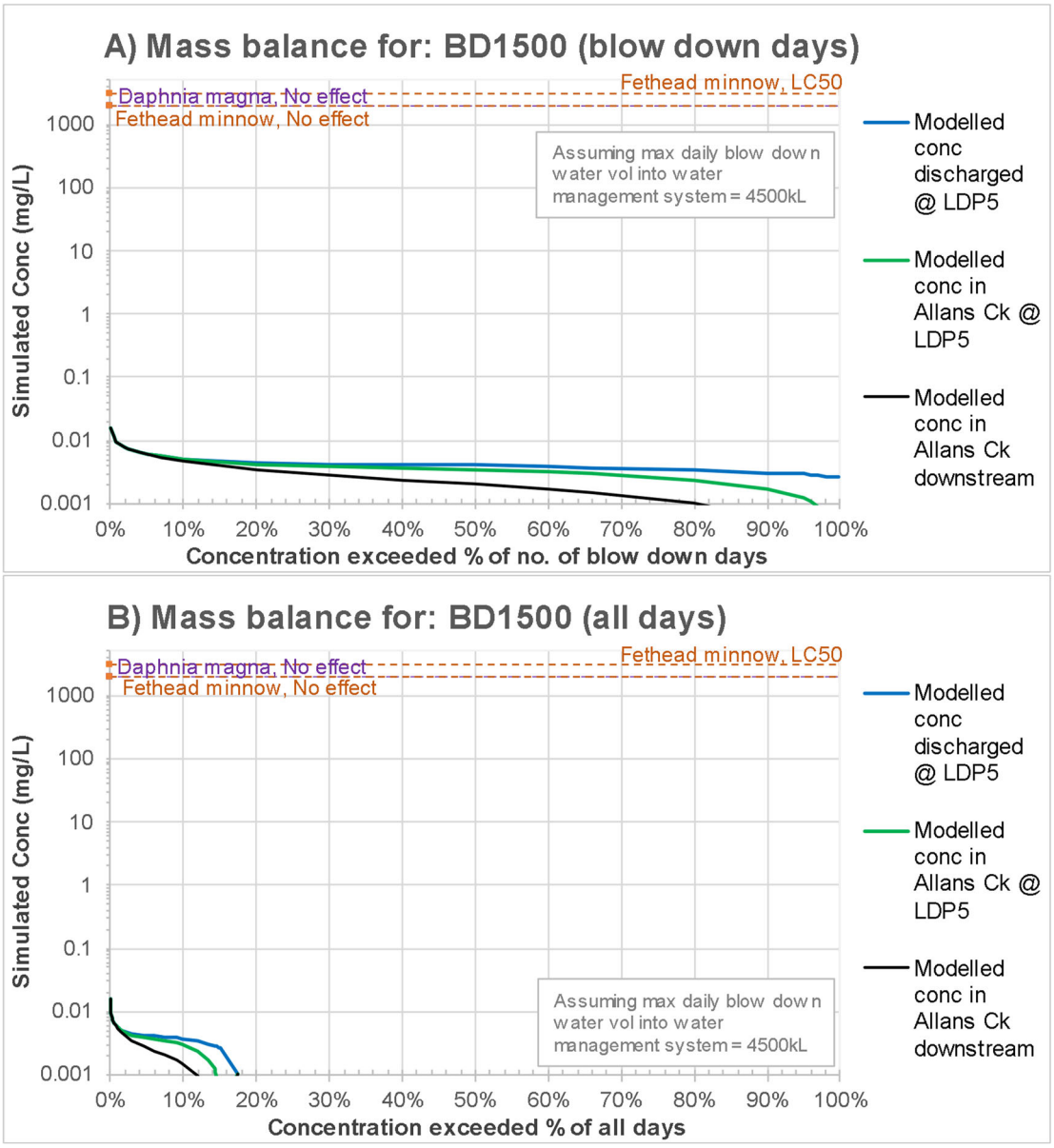


Figure 3-6 Simulated concentration of BD1500 at LDP5 and Allans Creek

This shows that the estimated Spectrus BD1500 concentrations at LDP5 and in Allans Creek are significantly and consistently lower than the stated ecotoxicological thresholds, even without taking degradation into account.

3.3.4 Dilution of Sodium Hypochlorite

The mass balance results for Sodium Hypochlorite as it is discharged from Dendrobium's water management system at LDP5, and the subsequent dilution in Allans Creek, are summarised on Figure 3-7.

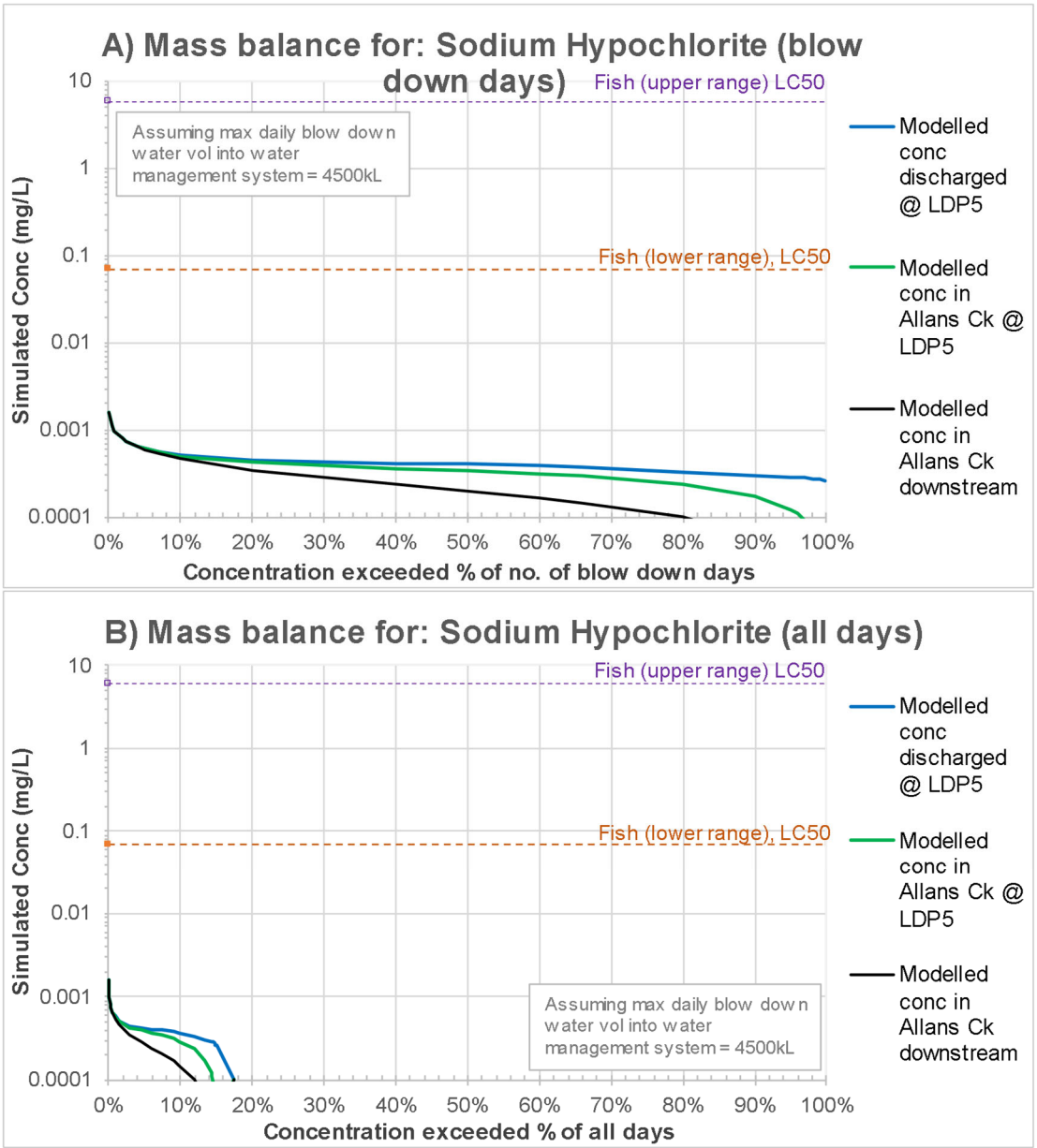


Figure 3-7 Simulated concentration of Sodium Hypochlorite at LDP5 and Allans Creek

This shows that the estimated Sodium Hypochlorite concentrations at LDP5 and in Allans Creek are significantly and consistently lower than the stated ecotoxicological thresholds, even without taking degradation into account.

3.4 Conclusions of mass balance

The concentrations of the latter three additives, GN8115, Spectrus BD1500 and Sodium Hypochlorite, are all estimated to be well below (i.e. two orders of magnitude or more) the stated ecotoxicological thresholds at the LDP5 discharge point.

The concentrations of NX1104, as it is discharged to the creek, calculated by a conservative mass balance outlined above, would be below the stated ecotoxicological thresholds provided that the blow-down volume (7.5 KL) is re-introduced back to the water management system over 2 or more days, with a maximum volume of 4.5 kL of blow-down water introduced and then discharged at LDP5 on any day.

Degradation of the NX1104 additive has not been quantified, but is stated to occur, and would likely reduce peak concentrations, as would the further dilution due to mixing through the water management system. Dilution in the tidal areas of Allans Creek and its estuary would reduce concentrations even further.

Your sincerely,

Will Minchin
will.minchin@watershedhg.com

4 References

HGEO, 2022. Monthly report on water quality sampling for Dams Safety NSW: March 2022. Report D21176, April 2022.

Attachment 5
Response to EPA Matter 3 (Surface Water)
(Response Prepared by Hydro Engineering and Consulting)

HYDRO ENGINEERING & CONSULTING PTY LTD

19 April 2022

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

Nicola,

Re: Dendrobium Mine Gas Management Infrastructure Modification – Assistance with Responses to EPA Comments

1. INTRODUCTION

Further to recent correspondence with Resource Strategies, we have undertaken additional works necessary to inform responses to the NSW Environment Protection Authority (EPA) comments[1] in relation to Appendix 1 of the Dendrobium Mine – Gas Management Infrastructure Modification Report (HEC, 2022)[2]. The following summarises the outcomes of these works.

2. EPA COMMENTS AND RESPONSES

The following comments and responses pertain to the 'Stormwater Management' section of the NSW EPA document[1].

Comment 1

Figure 3, page 6: shows all run-off from sub catchment B going to Basin C. The diagram needs to be amended to show the separate flow path to Basin B.

Response

Figure 1 herein presents a revised version of Figure 3 from HEC (2022). Indicative flow paths have been presented on Figure 1 to indicate the direction of catchment B surface water runoff to Sediment Basin B. No defined flow path is present in catchment B, rather surface water runoff travels as overland flow to Sediment Basin B.

[1] NSW EPA (2022). "EPA Comments on MOD 9 – Dendrobium Mine – Gas Management Infrastructure (DA60-03-2001-Mod-9)". Provided to NSW Department of Planning and Environment, 16/3/2022.
[2] HEC (2022). "Dendrobium Gas Management Infrastructure – Modification Surface Water Review". Prepared for Illawarra Metallurgical Coal, February.

Ground Floor, 16-20 Edmondstone Street
Newmarket QLD 4051
p (07) 3352 7222

A division of ATC Williams Pty Ltd
PO Box 3309
Newmarket QLD 4051
www.atcwilliams.com.au
ABN 64 005 931 288

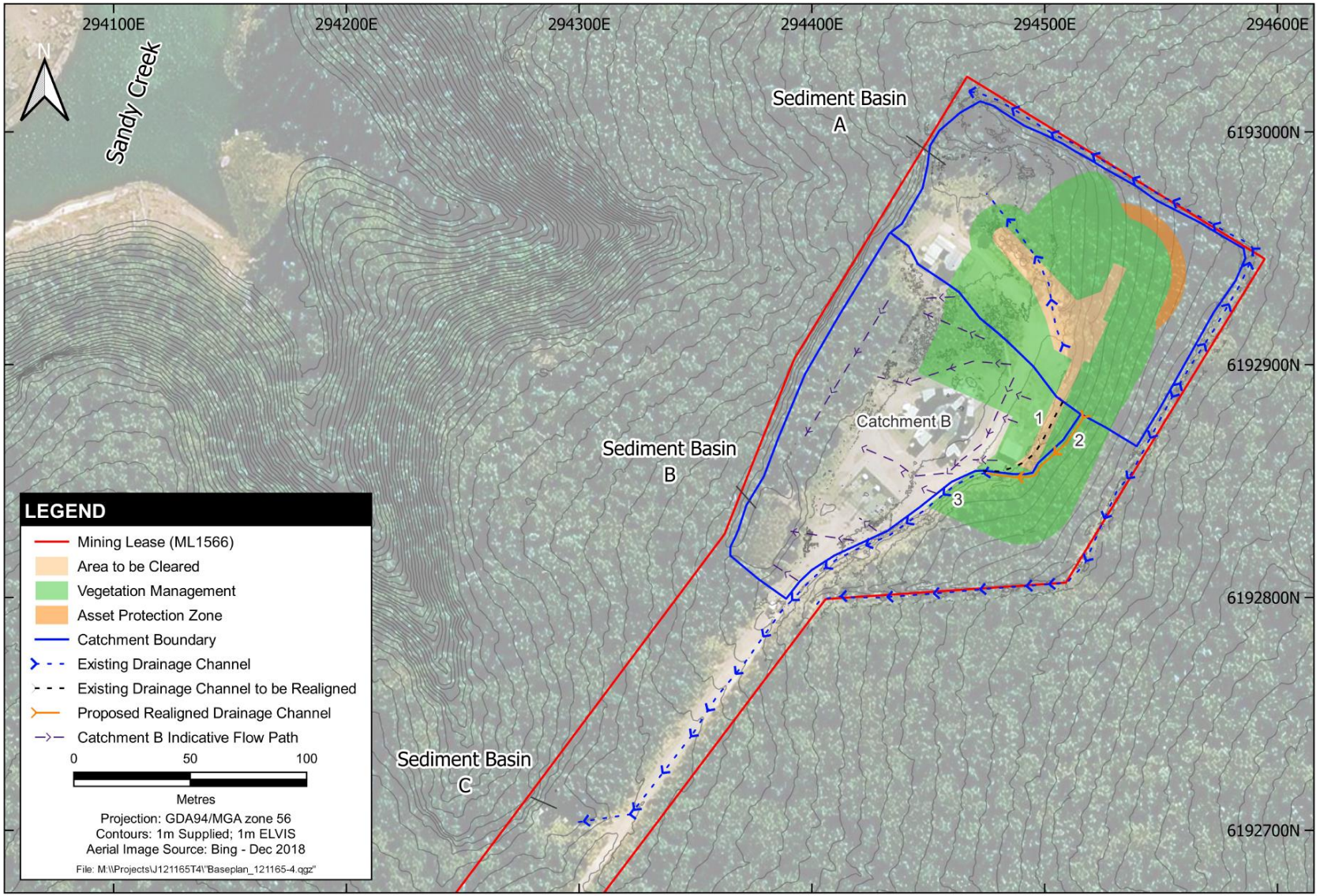


Figure 1 Modification Area Surface Water Management

Minor realignment of the existing drainage channel (shown as '1' in Figure 1) 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. The existing drainage channel (shown as '1' in Figure 1) would be realigned to the location of '2' in Figure 1 and connect to the existing drainage channel shown as '3' in Figure 1. The former drainage channel (shown as '1' in Figure 1) would be infilled and the surface graded such that surface water runoff is retained within catchment B and directed to Sediment Basin B. Only undisturbed area to the east of catchment B would be directed to Sediment Basin C.

Comment 2

Section 5.3, page 9: evidence needs to be provided that the soil type corresponds to type F classification.

Response

As indicated by the NSW Department of Planning and Environment eSPADE information system[3], the soil type of the Modification area is associated with the Warragamba lithology. The soils of the Warragamba on crests and ridges are defined as shallow to moderately deep (25 cm to less than 100 cm), rapidly drained Leptic Rudosols (Siliceous Sand and Lithosols) and well-drained Orthic Tenosols (Earthy Sands)[4].

On this basis, Type F soil classification was adopted (predominantly fine grained).

It is recommended that, during the detailed design stage, soil sampling is undertaken within the proposed disturbance area and that particle size analysis and dispersion testing is undertaken. It is noted that the design criteria are the same for sediment basins on Type D and Type F soils, as defined in Landcom (2004)[5], however the management approach differs (refer Comment 5).

Comment 3

Section 5.3, page 10: the report notes that available sediment pond capacity for basin A and B is approximately 0.7 ML but 0.9 ML volume is necessary to meet the guideline. The basins may be enlarged if needed.

The EPA suggests that if modification of the basin surface area will result in significant additional vegetation clearance, the adopted sediment zone could be reduced in size and more frequent clean out considered. This might be considered acceptable given the relatively short construction time for the project.

Response

Noted. As indicated in Section **Error! Reference source not found.** of HEC (2020), 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. It is not envisaged that enlargement of the existing sediment basins would require significant additional vegetation clearance, however, this will be assessed at the detailed design stage and the alternative approach of more frequent clean out would be considered.

[3] https://www.environment.nsw.gov.au/topics/land-and-soil/information/espade
[4] NSW Office of Environment and Heritage (2018). "Warragamba Lithology". Accessed from https://www.environment.nsw.gov.au/topics/land-and-soil/information/espade.
[5] Landcom (2004). "Managing Urban Stormwater: Soils and Construction Volume 1", 4th edition, March.

Comment 4

Section 5.3: a description of the discharge arrangement should be given as to whether the water will be pumped out or allowed to drain under gravity after the 5-day settling period.

Response

The sediment basins would be equipped with a siphon hose or small diameter pipe enabling the stored water to discharge by gravity after the 5-day settling period. Water drained from the sediment basins would be directed to a level spreader prior to discharging off-site to the adjacent bushland.

Comment 5

Section 5.4: during construction of the vent shaft in 2008, flocculants were found to be necessary to achieve acceptable water quality criteria within an acceptable time (goal for sensitive catchment release is <30 mg/L suspended solids or <60 NTU). An assessment should be made of need for flocculants and what type would be considered acceptable in the drinking water catchment. Alternatively, the use of mobile stormwater treatment facilities should be considered.

Response

The area to be cleared for the proposed Modification would be of a notably lesser extent than that cleared for construction of the original ventilation shaft infrastructure. As such, it is expected that the sediment load in surface water runoff during construction of the Modification infrastructure would be notably less than that during construction of the original ventilation shaft infrastructure.

Notwithstanding, it is recommended that, during the detailed design stage, soil sampling is undertaken within the proposed disturbance area and that particle size analysis and dispersion testing is undertaken. This would enable the soil type classification and the need for flocculation to be assessed. An assessment of acceptable flocculating agents for use in the Sydney drinking water catchment would also be undertaken at this stage.

3. CLOSURE

Thank you for the opportunity to be of continued 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

Attachment 6
Response to BCD
(Response Prepared by Niche Environment and Heritage)

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 | 20 April 2022

niche-eh.com

Excellence in your environment

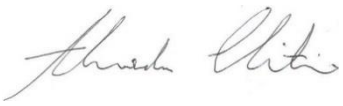
Project number	Client	Project manager/Accredited assessor	LGA
7066	South32 Illawarra Metallurgical Coal	Luke Baker (Accreditation No BAAS17033**)**. Sian Griffiths (Accreditation No. BAAS17066) Alex Christie (Accreditation No. BAAS18131)	Wollongong LGA

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)

Author	Review	Status	Date
Alex Christie	Luke Baker	Draft 1	17 January 2022
Alex Christie	Sian Griffiths	Final	31 January 2022
Alex Christie	Clive Berry	Final	4 February 2022
Alex Christie	Clive Berry	Final	8 February 2022
Alex Christie	-	Final	11 February 2022
Alex Christie	Sian Griffiths	Final	6 April 2022
Alex Christie	Alyssa Gorman	Final	19 April 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 12 kilometres (km) 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 hectares (ha) and the proposed activity would involve clearing/disturbance to less than 2 ha 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.

Two species of threatened orchid, Thick Lip Spider Orchid (*Caladenia tessellata*) and Bauer's Midge Orchid (*Genoplesium baueri*), could not be excluded as candidate species within the Subject land as survey was not conducted during the required survey period. Therefore, for the purposes of this BDAR, these species have been assumed present and species credits have been generated.

Two assessments of significance under the EPBC Act were required for threatened flora (*Caladenia tessellata* and *Genoplesium baueri*), which concluded a significant impact as a result of the Project was unlikely. No flora listed under the EPBC Act are considered affected species. 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 removal 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

A total of 17 ecosystem credits are required to offset impacts to *PCT 1083 – Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*. A total of 66 species credits are required to offset impacts to the following species:

- Thick Lip Spider Orchid (*Caladenia tessellata*) – 33 credits required.
- Bauer's Midge Orchid (*Genoplesium baueri*) – 33 credits required.

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

Table of Contents

List of Figures

List of Tables

List of Plates

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 12 km 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

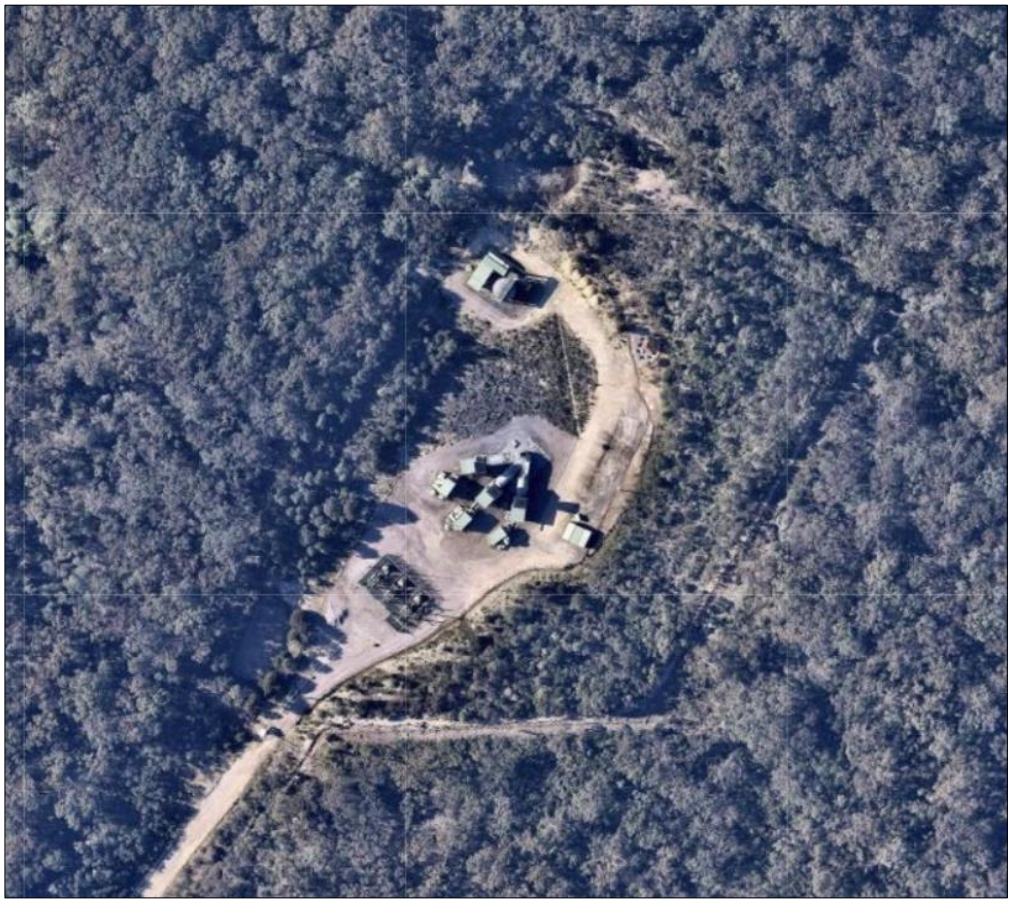


Plate 4: Aerial imagery of the Subject land from 2019

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 2 ha 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). • Saving Our Species Hygiene Guidelines: Protocols to protect priority biodiversity areas in NSW from *Phytophthora cinnamomic*, myrtle rust, amphibian chytrid fungus and invasive plants (DPIE 2020e).
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 6 km 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.	Figure 2

Landscape features	Description	Figure reference
	Woody vegetation cover The native vegetation extent and cover of woody vegetation was determined via aerial photography interpretation based on canopy cover. For woody vegetation 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
PCT1083_Moderate_Cleared	Proposed Infrastructure	Total clearing of vegetation	0.1	>101	88.7	62.1	58.1	68.4	0	-68.4
PCT1083_Moderate_APZ	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 (<30 cm).

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

Common Name	Scientific Name	BC Act*	Sensitivity to gain class	Vegetation Types
Little Bent-winged Bat	*Miniopterus australis*	V	High Sensitivity to Potential Gain	1083-Red Bloodwood - scribbly gum heathy woodland on sandstone 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, incidentally recorded during the field survey or are assumed present due to survey limitations are identified in Table 8.

Two species are assumed present within the Subject land:

- Thick Lip Spider Orchid (*Caladenia tessellata*).
- Bauer's Midge Orchid (*Genoplesium baueri*).

As detailed in Table 8, is it considered that these species are unlikely to occur, but could not be excluded as candidate species as targeted surveys could not be undertaken within the required period. Species polygons for these species are shown in Figure 6 and cover the entire Subject land where associated PCTs occur (PCT 1083), totalling 3.12 ha.

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%	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**	
					habitat 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.	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 unlikely this species would occur within the Subject land. This species also typically occurs in	Assumed present.

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	
										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 Subject land. However, as targeted surveys were unable to be conducted during the suitable survey period,	

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**	
										this species is assumed present for the purposes of this BDAR.	
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.	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 (completely parasitic on fungi and does not have the ability to	Assumed present.

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**	
										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. However, as targeted surveys were unable to be conducted during the suitable survey period, this species is assumed present for the purposes of this BDAR.	
Hygrocybe anomala var.	*Hygrocybe anomala* var.	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.

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**	
ianthinomarginata	*ianthinomarginata*										
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 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.
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.

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**	
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 7.

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.

Two threatened flora species listed under the EPBC Act could not be excluded as candidate species from the Subject land: Thick Lip Spider Orchid (*Caladenia tessellata*) and Bauer's Midge Orchid (*Genoplesium baueri*). The impact of the Project on these species has been assessed under the EPBC Act (Significant Impact Criteria) in Annex 7, which determined a significant impact was not likely.

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	

Impact	Extent of impact as a result of the Project
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 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

Impact	Extent of impact as a result of the Project
	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 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 NSW *Biodiversity Conservation Regulation 2017* (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.

Two SAII candidate species, *Caladenia tessellata* and *Genoplesium baueri*, could not be excluded as Candidate species within the Subject land as survey was not conducted during the appropriate survey period and therefore presence has been assumed for the purposes of this BDAR. All other candidate species identified in Table 8 have been excluded as candidate species.

Under the BAM, an assessor must provide information on a range of factors affecting the vulnerability of the species to SAII. These criteria are addressed for *Caladenia tessellata* and *Genoplesium baueri* in Annex 8. 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 (IMC 2015).

Table 11: Mitigation measures

Mitigation measure	Responsibility
Pre-construction	

Mitigation measure	Responsibility
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
Hygiene protocols are to be developed in line with Saving Our Species Hygiene Guidelines (DPIE 2020e) to mitigate the risk of spreading chytrid fungus to susceptible populations of Littlejohn's Treefrog located along the Sandy Creek. Hygiene protocols would be developed and implemented when working near areas of known amphibian habitat and would include adaptive management for any unexpected impacts that arise.	Project manager/Project Ecologist
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	

Mitigation measure	Responsibility
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. In addition, the current Mining Operations Plan addresses a range of measures designed to mitigate and address unexpected impacts to biodiversity.

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.

As discussed in Section 3.2.1, two threatened flora species listed under the EPBC Act could not be excluded as candidate species from the Subject land: Thick Lip Spider Orchid (*Caladenia tessellata*) and Bauer's Midge Orchid (*Genoplesium baueri*). The impact of the Project on these species has been assessed under the EPBC Act (Significant Impact Criteria) in Annex 7, which determined a significant impact was not likely. Therefore, 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

A total of 17 ecosystem credits are required to offset the impacts associate with the clearing of native vegetation as part of the Project (Table 12). The credit report is provided in Annex 6.

Table 12: Ecosystem credits required

PCT	Vegetation Zone/Project Stage	Cleared area (ha)	Vegetation Integrity Score	Future vegetation integrity score	Change in vegetation integrity score	Biodiversity risk weighting	Required credits
PCT 1083 - Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Total clearing of vegetation	0.1	68.4	0	-68.4	1.5	17
	Removal of trees, shrubs and fallen logs	0.74	68.4	17.2	-51.2		

4.2 Summary of species credits required

The results of the BAM-C species offset credit requirements are shown in Table 13 below. Threatened species assumed to be present within the development footprint generate a requirement of 66 species credits (Annex 6).

Table 13: Species credits required

Threatened species	Habitat impacted (ha)	Biodiversity risk weighting	Credits required
Caladenia tessellata	0.84	3	33
Genoplesium baueri	0.84	3	33
Total			**66**

5. Conclusion

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.

Two assessments of significance under the EPBC Act were required for threatened flora (*Caladenia tessellata* and *Genoplesium baueri*), which concluded a significant impact as a result of the Project was unlikely. No fauna listed under the EPBC Act are considered affected 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.

A total of 17 ecosystem credits are required to offset impacts to *PCT 1083 – Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*.

A total of 66 species credits are required to offset impacts to the following species:

- *Caladenia tessellata* (Thick Lip Spider Orchid) – 33 credits required.
- *Genoplesium baueri* (Bauer's Midge Orchid) – 33 credits required.

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 (2020e). Saving Our Species Hygiene guidelines - Protocols to protect priority biodiversity areas in NSW from *Phytophthora cinnamomi*, myrtle rust, amphibian chytrid fungus and invasive plants. 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 Planning, Industry and Environment (2022e) *Genoplesium baueri* - endangered species listing, NSW Scientific Committee - final determination. https://www.environment.nsw.gov.au/Topics/Animals-and-plants/Threatened-species/NSW-Threatened-Species-Scientific-Committee/Determinations/Final-determinations/2011-2012/Genoplesium-baueri-endangered-species-listing (accessed April 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).

Duncan, M. (2010) National Recovery Plan for the Thick-lip Spider-orchid Caladenia tessellata. Department of Sustainability and Environment, Melbourne.

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).

Jones DL (2006) A complete guide to native orchids of Australia including the Island Territories. Reed New Holland: Sydney.

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).

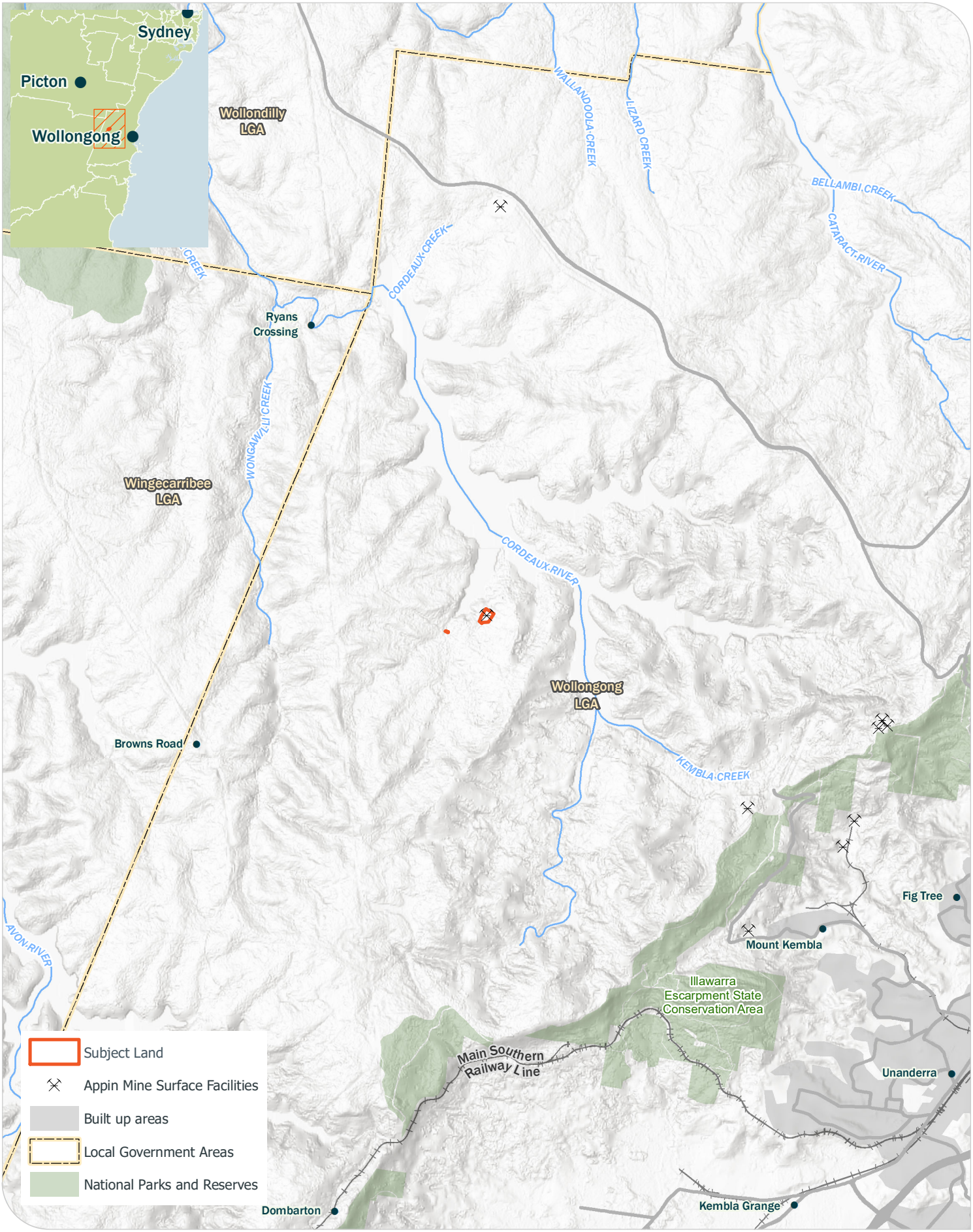
NSW Office of Environment and Heritage (2018) BAM Calculator User Guide. NSW Office of Environment and Heritage.

Riley, JJ., Banks, D.P. (2002) Orchids of Australia. University of New South Wales Press: Sydney.

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



niche Environment and Heritage

N

0 1.5

km

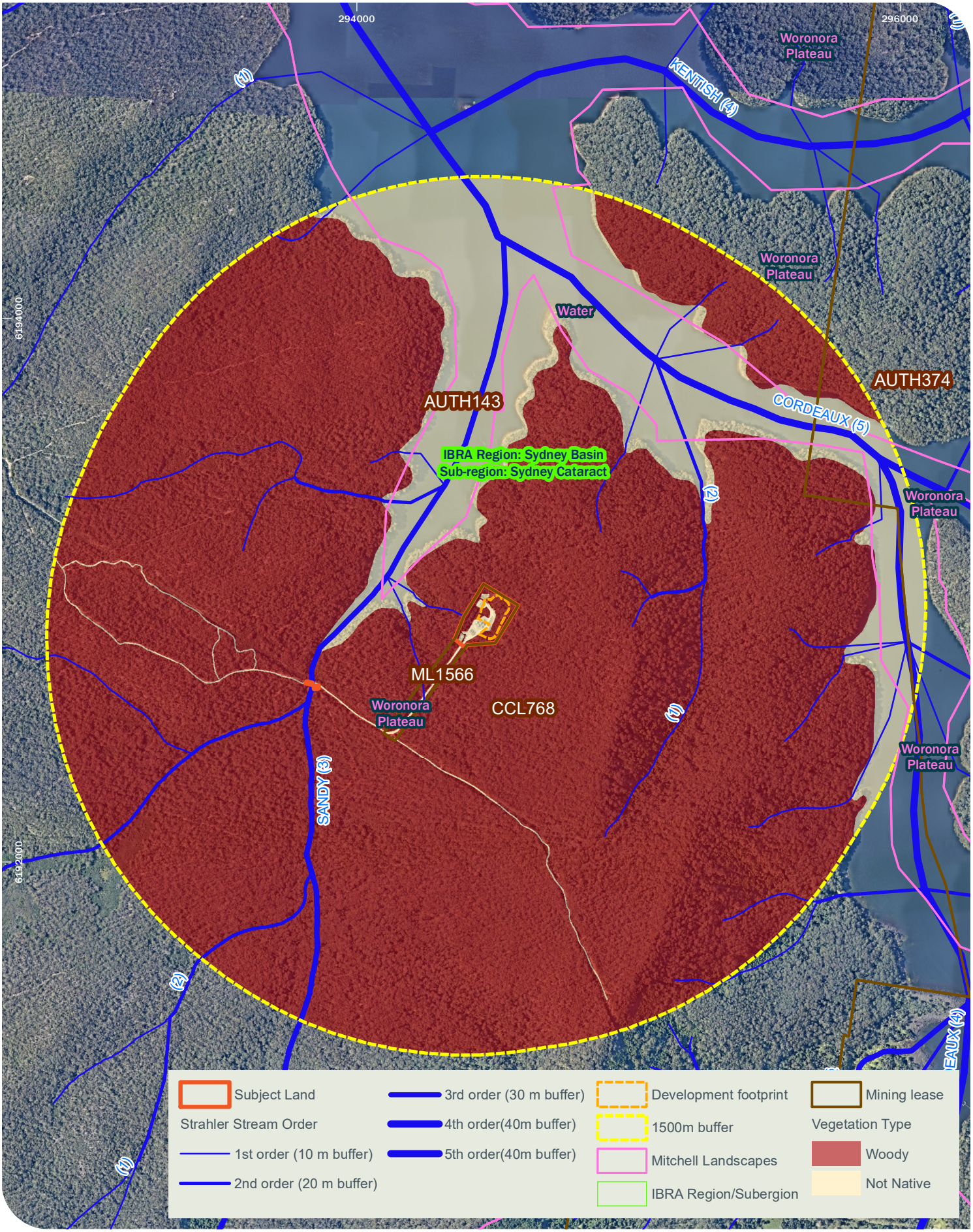
GDA 1994 MGA Zone 56

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



niche Environment and Heritage

0 300
m
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

niche Environment and Heritage

0 200
m
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

Drawn by: YH Last updated: 1/24/2022 5:38:11 PM File: T:\spatial\projects\a7000\a7066_DendrobiumGas_DD_NSW\Maps\report\BDAR\7066_Figure_3_SubjectLand.mxd

Drawn by: Neil/YH File: T:\spatial\projects\a7000\a7066_DendrobiumGas_DD_NSW\Mapsireport\BDAR\7066_Figure_4_VegZones.mxd Last updated: 4/5/2022 12:36:04 PM

niche Environment and Heritage

0 20
m

GDA 1994 MGA Zone 56

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

v2.0

Drawn by: YH Last updated: 1/31/2022 4:33:27 PM File: T:\spatial\projects\ia7000\a7066_DendrobiumGas_DD_NSW\Maps\report\BDAR\7066_Figure_5_ThreatenedSpecies.mxd

niche Environment and Heritage

0 200
m
GDA 1994 MGA Zone 56

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

Drawn by: NeilYH File: T:\spatial\projects\a7000\a7066_DendrobiumGas_DD_NSW\Mapsreport\BDAR\7066_Figure_6_SpeciesPolygons.mxd Last updated: 4/13/2022 12:33:03 PM

niche Environment and Heritage

0 20
m
GDA 1994 MGA Zone 56

Species polygons
Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

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

Figure 6

niche Environment and Heritage

N

0 20

m

GDA 1994 MGA Zone 56

Offsetting

Dendrobium Gas Infrastructure at No 2 and No 3 Vent Shaft

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

Figure 7

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	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
					heavy rains. The tadpoles are distinctive, being large and very dark 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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Ecosystem	Dusky woodswallows are widespread in eastern, southern and 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.	Low
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	Known. Recorded flying over Subject land. Subject land contains only marginal foraging habitat

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. 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.	and does not contain hollows suitable for 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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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 watercourses in otherwise open country.	Low
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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
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 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 cm 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	None

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					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.	
Mammals						
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 1000 m, 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 450 m 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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period.	
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 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.	Low
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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 within 15 km of the day roost although some individuals may travel up to 70 km.	Low
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 500 m of escarpment to find shelter during hotter parts of summer.	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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 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.	Low
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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					Grass-lilies are often not identified to variety level. Found in damp places in open forest on sandstone.	
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 linearifolius	Netted Bottle Brush	V	-	Species	Recorded from the Georges River to Hawkesbury River in the 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.	Low
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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 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.	Low
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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas.	
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, Metropolitan and Warragamba Catchments.	Low
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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					the eastern-most site. It is likely the seeds are wind dispersed. The fire response of H. *calvertianum* is unknown.	
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 River gorge, near Loftus and in Royal National Park. The southern population is mainly in the vicinity of Nowra.	Low
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	Low

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
					present as isolated individuals or very small populations. Probably killed by fire (as other Persoonia spp. are) but will regenerate from seed.	
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 brunnea	Brown Pomaderris	V	V	Species	The species is expected to live for 10 - 20 years, while the minimum 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.	Low
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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 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.	Low
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

Scientific Name	Common name	BC Act	EPBC Act	Class of credit	Habitat	Likelihood of occurrence
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/BAAS18131/21/00029833

Proposal Name
7066 Dendrobium Gas Drainage small area BDAR

BAM data last updated *
24/11/2021

Assessor Name
Alex Christie

Assessor Number
BAAS18131

BAM Data version *
50

Proponent Names
Gary Brassington

Report Created
13/04/2022

BAM Case Status
Finalised

Assessment Revision
2

Assessment Type
Part 4 Developments (Small Area)

Date Finalised
05/04/2022

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
Caladenia tessellata / Thick Lip Spider Orchid
Genoplesium baueri / Bauer's Midge Orchid

BAM Biodiversity Credit Report (Like for like)

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

BAM Biodiversity Credit Report (Like for like)

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, 1253, 1619, 1621, 1623, 1624, 1625, 1627, 1632, 1636, 1638, 1642, 1643, 1681	Sydney Coastal Dry Sclerophyll Forests <50%	1083_Moderate_Cleared	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, 1253, 1619, 1621, 1623, 1624, 1625, 1627, 1632, 1636, 1638, 1642, 1643, 1681	Sydney Coastal Dry Sclerophyll Forests <50%	1083_Moderate_APZ	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.

Species Credit Summary

BAM Biodiversity Credit Report (Like for like)

Species	Vegetation Zone/s	Area / Count	Credits
Caladenia tessellata / Thick Lip Spider Orchid	**1083_Moderate_Cleared, 1083_Moderate_APZ**	0.8	33.00
Genoplesium baueri / Bauer's Midge Orchid	**1083_Moderate_Cleared, 1083_Moderate_APZ**	0.8	33.00

Credit Retirement Options

Like-for-like credit retirement options

Caladenia tessellata / Thick Lip Spider Orchid	Spp	IBRA subregion
	Caladenia tessellata / Thick Lip Spider Orchid	Any in NSW
Genoplesium baueri / Bauer's Midge Orchid	Spp	IBRA subregion
	Genoplesium baueri / Bauer's Midge Orchid	Any in NSW

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00029832/BAAS18131/21/00029833	7066 Dendrobium Gas Drainage small area BDAR	24/11/2021
Assessor Name	Report Created	BAM Data version *
Alex Christie	13/04/2022	50
Assessor Number	BAM Case Status	Date Finalised
BAAS18131	Finalised	05/04/2022
Assessment Revision	Assessment Type	BOS entry trigger
2	Part 4 Developments (Small Area)	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.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion												
1	1083_Moderate_Cleared	Not a TEC	68.4	68.4	0.1	PCT Cleared - 17%	High Sensitivity to Potential Gain			1.50		3

2	1083_Moderate_APZ	Not a TEC	68.4	51.2	0.74	PCT Cleared - 17%	High Sensitivity to Potential Gain			1.50		14
											Subtotal	**17**
											Total	**17**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Caladenia tessellata / Thick Lip Spider Orchid (Flora)									
1083_Moderate_Cleared	68.4	68.4	0.1			Endangered	Vulnerable	True	5
1083_Moderate_APZ	51.2	51.2	0.74			Endangered	Vulnerable	True	28
								Subtotal	**33**
Genoplesium baueri / Bauer's Midge Orchid (Flora)									
1083_Moderate_Cleared	68.4	68.4	0.1			Endangered	Endangered	True	5
1083_Moderate_APZ	51.2	51.2	0.74			Endangered	Endangered	True	28
								Subtotal	**33**

Annex 7. EPBC Act Significant Impact Criteria Assessment

Assessments of Significance and supplementary information (where relevant) are presented for the following MNES in relation to the Project:

- Two threatened flora species:
  - *Caladenia tessellata*
  - *Genoplesium baueri*.

Caladenia tessellata	
Criteria for vulnerable species	***Likelihood***
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	
It is considered unlikely that the proposed action would lead to a long term decrease in the size of an important population of *Caladenia tessellata* as no known or previous records of the species will be impacted by the Project. It should be noted that no targeted surveys were undertaken for this species, however the species is considered unlikely to occur for the following reasons: • The lack of previous records within the locality (closest record >45km from the Subject land). • Total clearing and surface disturbance of the Subject land in 2005. • This species 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 Subject land.	None
Reduce the area of occupancy of an important population	
No known or previous records of the species would be impacted by the Project. Based on the habitat descriptions of the species and associated PCTs, 0.84 ha of vegetation in the Subject land could provide potential habitat for *Caladenia tessellata*. Given that the Subject land is not known habitat for the species, if we consider the extent of other potential habitat outside the Subject land and area of impact, then the removal of 0.84 ha comprises a negligible amount of the area identified as potential habitat. The Project is not likely to reduce the area of occupancy of the species.	Unlikely
Fragment an existing important population into two or more populations	
The Project will result in the removal of a negligible amount of habitat at a small location within a much larger area of better quality potential habitat, none of which presents a hostile barrier to the movement of pollinators or the dispersal of seed. Habitat for *Caladenia tessellata* would not be fragmented as a result of the Project.	None
Adversely affect habitat critical to the survival of a species	

Caladenia tessellata	
Criteria for vulnerable species	***Likelihood***
No critical habitat has been declared for *Caladenia tessellata*. Habitat critical to the survival of *Caladenia tessellata* is not likely to be impacted by the Project as no known or previous records would be impacted by the Project and the potential habitat in the Subject land is considered marginal at best.	Unlikely
Disrupt the breeding cycle of an important population	
Given the low occurrence of the species within the locality (no population records within 40 km of the Subject land), it is considered unlikely that the Project would result in the removal of any individuals of *Caladenia tessellata.* Further, given the Subject land has previously been completely cleared of vegetation in 2005, impacts to habitat for the species are unlikely. In addition, pollinators which are important for the reproduction of the species would persist in surrounding areas of habitat. Therefore, the action proposed is unlikely to have an adverse effect on the breeding cycle of an important population of *Caladenia tessellata*.	Unlikely
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	
The removal of 0.84 ha of native vegetation that represents potential habitat for the species is unlikely to have long-term negative consequences for *Caladenia tessellata* as the areas to be impacted have previously been subject to disturbance, and where possible infrastructure has been placed in areas where minimal vegetation would be removed. There is a very low chance that this species would occur in the locations to be impacted.	Unlikely
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	
The risk of introducing invasive species would be ameliorated through hygiene protocols. The Project is not likely to lead to the introduction of invasive species in *Caladenia tessellata* habitat.	Unlikely
Introduce disease that may cause the species to decline, or	
Whilst there is some potential for works plant and machinery to transport and disperse soil pathogens throughout the Subject land, this risk will be managed through the use of hygiene protocols. It is considered unlikely that the proposed action will introduce disease that may cause *Caladenia tessellata* to decline.	Unlikely
Interfere substantially with the recovery of the species.	
A draft recovery plan for *Caladenia tessellata* has been prepared which provides guidance on the recovery of the species and populations. The Project will impact <0.01% of potential habitat for *Caladenia tessellata* in the locality. Areas that are proposed to be impacted by the Project would be limited to clearly demarcated clearing limits, and the implementation standard hygiene, and sediment and erosion controls during the construction phase of the proposed works. The Project is not likely to interfere with the recovery of *Caladenia tessellata*.	Unlikely
Conclusion: The proposed action is unlikely to have a significant impact on *Caladenia tessellata*. Therefore, a Referral under the EPBC Act is not considered necessary.	

Genoplesium baueri	
Criteria for endangered species	***Likelihood***
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	

Genoplesium baueri	
Criteria for endangered species	***Likelihood***
It is considered unlikely that the proposed action would lead to a long term decrease in the size of an important population of *Genoplesium baueri* as no known or previous records of the species will be impacted by the Project. It should be noted that no targeted surveys were undertaken for this species, however the species is considered unlikely to occur for the following reasons: • The lack of previous records within the locality (closest record >20km from the Subject land) • Total clearing and surface disturbance of the Subject land in 2005. • 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). • This species is myco-heterotrophic (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.	None
Reduce the area of occupancy of the species	
No known or previous records of the species would be impacted by the Project. Based on the habitat descriptions of the species and associated PCTs, 0.84 ha of vegetation in the Subject land could provide potential habitat for *Genoplesium baueri*. Given that the Subject land is not known habitat for the species and the species is considered unlikely to occur as detailed above, if we consider the extent of other potential habitat outside the Subject land and area of impact, then the removal of 0.84 ha comprises a negligible amount of the area identified as potential habitat. The Project is not likely to reduce the area of occupancy of the species.	Unlikely
Fragment an existing population into two or more populations	
The Project will result in the removal of a negligible amount of habitat over a small area within a larger area of suitable better quality habitat, none of which present a barrier to the movement of pollinators or the dispersal of seed from the species. Habitat for *Genoplesium baueri* would not be fragmented as a result of the Project.	None
Adversely affect habitat critical to the survival of a species	
No critical habitat has been declared for *Genoplesium baueri*. Habitat critical to the survival of *Genoplesium baueri* is not likely to be impacted by the Project as no known or previous records would be impacted by the Project, and the species is considered unlikely to occur as detailed above.	Unlikely
Disrupt the breeding cycle of a population	
Given the low occurrence of the species within the locality (two population records within 20 km of the Subject land), it is considered unlikely that the Project would result in the removal of any individuals of *Genoplesium baueri.* Further, given the Subject land has previously been completely cleared of vegetation in 2005, impacts to habitat for the species are unlikely. In addition, pollinators which are important for the reproduction of the species would persist in surrounding areas of habitat. Therefore, the Modification is unlikely to have an adverse effect on the breeding cycle of an important population of *Genoplesium baueri*.	Unlikely
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	
The removal of 0.84 ha of native vegetation that represents potential habitat for the species is unlikely to have long-term negative consequences for *Genoplesium baueri* as the areas to be impacted have previously been disturbed and infrastructure has been placed in areas where minimal vegetation would be removed. There is a very low chance that this species would occur in the locations to be impacted, for reasons detailed above.	Unlikely
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	

Genoplesium baueri	
Criteria for endangered species	***Likelihood***
The risk of introducing invasive species would be ameliorated through vehicle hygiene protocols. The Project is not likely to lead to the introduction of invasive species in *Genoplesium baueri* habitat.	Unlikely
Introduce disease that may cause the species to decline, or	
Whilst there is some potential for works plant and machinery to transport and disperse soil pathogens throughout the Subject land, this risk will be managed through the use of vehicle hygiene protocols. It is considered unlikely that the proposed action will introduce disease that may cause *Genoplesium baueri* to decline.	Unlikely
Interfere with the recovery of the species.	
The Project will impact <0.01% of potential habitat for *Genoplesium baueri* in the locality. Areas that are proposed to be impacted by the Project would be limited to clearly demarcated clearing limits, and the implementation standard hygiene, and sediment and erosion controls during the construction phase of the proposed works. The Project is not likely to interfere with the recovery of *Genoplesium baueri*.	Unlikely
Conclusion: The proposed action is unlikely to have a significant impact on *Genoplesium baueri*. Therefore, a Referral under the EPBC Act is not considered necessary.	

Annex 8. Consideration of serious and irreversible impacts

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)
DPIE data accessed from TBDC	Principle 1 SAII: *species currently in a rapid rate of decline* = Yes, population reduction of ≥80% in 10 years or three generations Limited information Principle 2 SAII: – *species with a very small population size* = No Population = Limited information Extreme fluctuations = No information Principle 3 SAII: s*pecies with very limited geographic distribution* = Yes, known from <3 locations and/or an AOO <10km^2 or EOO <100 km^2 Limited information Principle 4 SAII: *species that is unlikely to respond to management and is therefore irreplaceable* = No Limited information
1. The assessor is required to provide further information in the BDAR or BCAR for any species at risk of an SAII, including the action and measures taken to avoid the direct and indirect impact on the species at risk of an SAII. Where these have been addressed elsewhere the assessor can refer to the relevant sections of the BDAR or BCAR.	No previous records of this species occur within the locality. Potential habitat for *Caladenia tessellata* is present within the Subject land within areas PCT 1083. The development footprint of the Project has been designed to avoid as much vegetation clearing as practical. Where vegetation clearing is required, infrastructure has been located in areas which have been previously cleared. In addition, clearing of the APZ would only require the removal of the shrub and canopy layer. Additional information on avoidance is provided in Section 3.1. Targeted surveys of the Subject land were unable to be conducted during the suitable months of survey to confirm the absence of this species. Therefore, *Caladenia tessellata* has been assumed present within the development footprint. However, the species is considered unlikely to occur within the development footprint for the following reasons: • The lack of previous records within the locality (closest record >45km from the Subject land).

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)
	• Total clearing and surface disturbance of the Subject land in 2005. • This species 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 Subject land. **The Project has the potential to disturb *Caladenia tessellata* habitat and potentially result in loss of individuals. However, given the Subject land has previously been completely cleared it is unlikely this species would occur with the development footprint.**
2. The assessor must consult the TBDC and/or other sources to report on the current population of the species including:	
a) evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) presented by an estimate of the: i. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer), or ii. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer) as indicated by: an index of abundance appropriate to the species; decline in geographic distribution and/or habitat quality; exploitation; effect of introduced species, hybridisation, pathogens, pollutants, competitors or parasites.	DPIE have determined that this species is at risk of SAII due to Principle 1 – rapid rate of decline. i. The decline in population of the species in NSW in the last 10 years cannot be accurately assessed at this time because: • The species information available in Bionet and other reliable/peer reviewed information about the species is limited and does not address this aspect. However, the National Recovery Plan notes "*The Thick-lip Spider-orchid was once relatively common and widespread in coastal areas between Newcastle in New South Wales and Westernport in Victoria, but has suffered a substantial decline in overall abundance. There are herbarium records of C. tessellata from Sydney and suburbs (Como, Loftus, Penshurst, Berowra, Sutherland, Caringbah, Castlecrag), Royal National Park, Queanbeyan, Heathcote, Huskisson, Ulladulla, Jervis Bay, Wyong (NSW); and Howe Range, Cann River, Sale/Stratford, Mt. Raymond and Port Albert (Vic). However, plants have not been seen at most of these sites for a number of years and the local populations may be extinct.*" (Duncan 2010). The species is known to be declining, as a result of the threats detailed below. ii. Key threats to the species, which are likely to have contributed to its decline are:

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)
	• Destruction of habitat, largely for urban and industrial development, is the cause of this historic decline. • Remaining populations of *Caladenia tessellata* are generally small and highly fragmented. There is a high risk of local extinction due to a small population size at many sites, and the highly disjunct distribution of the species. It is possible that some ecological functions such as conditions for the maintenance of pollinator and fungal activity have been adversely affected at many sites. • Disturbance caused by feral pig or deer, trampling and site disturbance from people, dogs, bicycles and track maintenance/fire protection activities and rubbish dumping. • The prolonged absence of fire or altered fire regimes (or other biomass reduction process such as mowing) may be detrimental as it reduces flowering and thus the ability of the populations to sustain themselves, leading to local extinctions. • Grazing by native or introduced herbivores. • Weed invasion. The Project is not likely to increase any of the above listed threats to the species, apart from the destruction of 0.84 ha of potential habitat. According to BioNet, there are no nearby records of *Caladenia tessellata* within 10 km of the Subject land, however, the species is highly cryptic. The species is generally found in grassy sclerophyll woodland on clay loam or sandy soils. Whist the vegetation within the Subject land is not grassy woodland, it does contain sandy soils which accounts for the entire 3.12 ha of the Subject land. Large areas of similar vegetation in better condition which would not be disturbed occur surrounding the Subject land.
b) evidence of small population size (Principle 2, clause 6.7(2)(b) BC Regulation) presented by: i. an estimate of the species' current population size in NSW, and ii. an estimate of the decline in the species' population size in NSW in three years or one generation (whichever is longer), and iii. where such data is available, an estimate of the number of mature individuals in each subpopulation, or the percentage of mature individuals in each subpopulation, or whether the species is likely to undergo extreme fluctuations	DPIE have determined that this species is not at risk of SAII due to Principle 2 – small population size. i. An estimate of *Caladenia tessellata* population size in NSW in 2010, is about 6 populations containing about 120 plants. Data on population size are likely to be underestimates, as flowering rates at some sites, especially those in thick heath or heathy woodland, may be suppressed in the absence of recent fire (Duncan 2010). **Population information for Caladenia tessellate (Duncan 2010)**

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)

Location	Pop. size	Extent	Land Mgr	Comments
New South Wales				
Morton National Park	~60 plants	<10 ha	DECCW	
Munmorah State Recreation Area	~20 plants	<10 ha	DECCW	Plants reported as 'scattered; not seen since 1999'
Braidwood (private property)	~10 plants	<1 ha	private	
South Pacific Heathland Reserve	~10 plants	<1 ha	DoL	Plants not seen since 2001
Wyrrabalong National Park	<10 plants	<2 ha	DECCW	Plants not seen since 1997
Porter Creek Wetland Reserve	<10 plants	<2 ha	WSC	Plants not seen since 1999

A response to b) ii cannot be provided because:

- The species information available in Bionet and other reliable/peer reviewed information about the species is limited and does not address these aspects.
- Bionet record data does not contain enough records to confidently identify a decline in the population over the last three years.

Bionet record data contains 58 records of the species, however this is in no way an indication of the current population size.

iii. The table from Duncan (2010) in response b) i above provides an indication of the estimated numbers of each population of *Caladenia tessellata.* There is insufficient data and information on the reproductive process of the species to determine whether the species population size would be likely to undergo natural fluctuations.

c) evidence of limited geographic range for the threatened species (Principle 3, clause 6.7(2)(c) BC Regulation) presented by:

   i. extent of occurrence;
   ii. area of occupancy;
   iii. number of threat-defined locations (geographically or ecologically distinct areas in which a single threatening event may rapidly affect all species occurrences); and
   iv. whether the species' population is likely to undergo extreme fluctuations.

DPIE have determined that this species is at risk of SAII due to Principle 3 – limited geographic range.

i. The *Caladenia tessellata* is endemic to mainland south-eastern Australia, where it is distributed from the central coast of New South Wales to the Westernport region of southern Victoria, in the South East Coastal Plain, South East Corner, and Sydney Basin bioregions. The species usually occurs on or near the coast, but in southern New South Wales, extends well inland to Braidwood (Duncan 2010).

ii. The species area of occupancy is limited within its known distribution. Little is known of the precise habitat requirements of *Caladenia tessellata*. In New South Wales, the species is generally found in grassy dry sclerophyll woodland on clay loam or sandy soils, less commonly in heathland on sandy loam soils. The population at Braidwood occurs in dry, low *Eucalyptus mannifera*, *Eucalyptus rossii* and Allocasuarina species woodland with a sparse understorey and stony soil. In Victoria, *Caladenia tessellata*

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)
	grows in heathland, heathy or grassy woodland, and grassy or sedgy open forests in well drained sand and clay loams (Duncan 2010). iii. Disturbance caused by feral pigs is a potential problem at the Braidwood (private property) site. Grazing by a range of introduced herbivores is also a problem at many sites: European Rabbit *Oryctolagus cuniculus* (Braidwood and Moormurng sites). Consumption of orchid tubers by bandicoots has been observed at Munmorah, Wyrrabalong and Porter Creek Wetland sites. The prolonged absence of fire (or other biomass reduction process such as mowing) may be detrimental as it reduces flowering and thus the ability of the populations to sustain themselves, leading to local extinctions. The timing of fire is also important, with the best time for orchids being late summer or early autumn, after seed dispersal but prior to new shoot growth. Fuel reduction burning of forests in spring and late autumn is considered to be a threatening process for many orchid species. An inappropriate fire regime or largescale disturbance by introduced herbivores may rapidly affect all individuals within a single location. iv. There is insufficient data and information on the ecology of *Caladenia tessellata* to determine whether the species population size would be likely to undergo extreme natural fluctuations. However, given the small population sizes and intermitted reproduction this species is unlikely to fit the boom/bust population model. Therefore, it's considered that if a sub-population lost a significant number of individuals, the recovery of the sub-population would be slow. Populations where habitat is subject to disturbance, grazing and inappropriate fire regimes, are likely to decline into the future or may lead to local extinctions.
d) evidence that the species is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation) because: i. known reproductive characteristics severely limit the ability to increase the existing population on, or occupy new habitat (e.g. species is clonal) on, a biodiversity stewardship site; ii. the species is reliant on abiotic habitats which cannot be restored or replaced (e.g. karst systems) on a biodiversity stewardship site; or	DPIE have determined that this species is not at risk of SAII due to Principle 4 – unlikely to respond to management. i. Little is known about the biology and ecology of *Caladenia tessellata*. The plants flower from late September to early November and the flowers remain open for a few days to a few weeks, depending on pollination and climatic conditions. Fruits usually take 5–8 weeks to mature following pollination, and plants reproduce solely from seed. The average longevity of *Caladenia tessellata* plants is not known. The species may be limited to certain areas as a result of their complex relationship with

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)
iii. life history traits and/or ecology is known but the ability to control key threatening processes at a biodiversity stewardship site is currently negligible (e.g. frogs severely impacted by chytrid fungus).	a mycorrhizal fungus. However, management of threats maintain populations and aid recruitment (Duncan 2010). ii. There is little information on the reproduction of *Caladenia tessellata* and whether plants can be cultivated and reintroduced to new areas. The species is reliant on a mycorrhizal fungus necessary for seed germination and providing some nutrients to the orchid. Whilst this is not an abiotic habitat it still may limit the ability to increase an existing population on a biodiversity stewardship site. iii. The life history traits and ecology of the *Caladenia tessellata* is not well known. Threats listed in response to 2) a) ii are for the most part controlled within a biodiversity offset site.
3. Where the TBDC indicates data is 'unknown' or 'data deficient' for a species for a criterion listed in Subsection 9.1.2(2.), the assessor must record this in the BDAR or BCAR.	Some of the questions in this consideration of SAII cannot be assessed at this time because: • The species information available in TBDC, Bionet and other reliable/peer reviewed information about the species is limited. • A lot of the information is not covered by scientific papers, and there are significant knowledge gaps. As such, we have noted the knowledge gaps in the TBDC and provided responses using information we have readily available. Items deemed data deficient by DPIE have been detailed at the start of this SAII assessment (DPIE data package).
4. In relation to the impacts from the proposal on the species at risk of an SAII, the assessor must include data and information on:	
a) the impact on the species' population (Principles 1 and 2) presented by: i. an estimate of the number of individuals (mature and immature) present in the subpopulation on the Subject land (the site may intersect or encompass the subpopulation) and as a percentage of the total NSW population; and ii. an estimate of the number of individuals (mature and immature) to be impacted by the proposal and as a percentage of the total NSW population; or iii. if the species' unit of measure is area, provide data on the number of individuals on the site, and the estimated number that will be impacted, along with the area of habitat to be impacted by the proposal.	i. Potential habitat for *Caladenia tessellata* was identified in the Subject land within PCT 1083. Targeted surveys of the Subject land were unable to be conducted during the suitable months of survey for this species. Therefore, *Caladenia tessellata* has been assumed present within the development footprint. ii. 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 unlikely this species would occur within the Subject land. However, surveys were not conducted to discount this species, it is not known if/how many individuals may be impacted by the Project.

Additional impact assessment provisions for species at risk of SAII	Thick Lip Spider Orchid (*Caladenia tessellata*)
	iii. The species unit of measure is area. The species polygon was based on the mapping of PCT 1083 (see Figure 6). The species polygon covers an area of 3.12 ha. Number of individuals on site is not known as targeted surveys were not conducted. The likelihood of occurrence of this species within the Subject land is low, therefore likelihood of impact on individuals is also likely to be low.
b) impact on geographic range (Principles 1 and 3) presented by: i. the area of the species' geographic range to be impacted by the proposal in hectares, and a percentage of the total AOO, or EOO within NSW. ii. the impact on the subpopulation as either: all individuals will be impacted (subpopulation eliminated); OR impact will affect some individuals and habitat; OR impact will affect some habitat, but no individuals of the species will be directly impacted. iii. to determine if the persisting subpopulation that is fragmented will remain viable, estimate (based on published and unpublished sources such as scientific publications, technical reports, databases or documented field observations) the habitat area required to support the remaining population, and habitat available within dispersal distance, and distance over which genetic exchange can occur (e.g. seed dispersal) and pollination distance for the species. iv. to determine changes in threats affecting remaining subpopulations and habitat if the proposed impact proceeds, estimate changes in environmental factors including changes to fire regimes (frequency, severity); hydrology, pollutants; species interactions (increased competition and effects on pollinators or dispersal); fragmentation, increased edge effects, likelihood of disturbance; and disease, pathogens and parasites. Where these factors have been considered elsewhere in relation to the target species, the assessor may refer to the relevant sections of the BDAR or BCAR.	i. The Subject land comprises 3.12 ha of vegetation that meets the potential area of habitat for the species, where species was unable to be excluded via survey (Figure 6). Exact areas of occupancy and percentages cannot be provided as there is insufficient data available for this species. The potential impacts to this species are considered to be low, therefore the Project is not likely to alter the species geographic range. ii. The impact on the sub-population(s) cannot be quantified, as there are also large areas of suitable habitat outside the Subject land. The potential impacts to this species are considered to be low, therefore the Project is not likely to impact a subpopulation of the species. iii. As noted above, we do not have enough information on the subpopulation if indeed present. Given the previous disturbance of the Subject land in 2005, it is likely that if a subpopulation occurred outside the Subject land that it would continue to persist. The secondary clearing of suitable habitat is unlikely to exacerbate previous fragmentation and lead to extinction of a subpopulation. Therefore, the Project is not likely to reduce the habitat area required to support a population of the species. iv. The Project is not likely to modify fire regimes. In addition, modification of the hydrology of drainage lines within the Subject land would not occur.
5. The assessor may also provide new information that can be used to demonstrate that the principle identifying the species as at risk of an SAII, is inaccurate.	Not applicable.

Additional impact assessment provisions for species at risk of SAII	Bauer's Midge Orchid (*Genoplesium baueri*)
DPIE data accessed from TBDC	Principle 1 SAII: *species currently in a rapid rate of decline* = No Limited information Principle 2 SAII: – *species with a very small population size* = Yes, <50 individuals or <250 individuals where threats are known Population = Limited information Extreme fluctuations = No information Principle 3 SAII: s*pecies with very limited geographic distribution* = No Number of locations = 20-30 Estimated AOO = 168 km2 Estimated EOO = 11,500 km2 Principle 4 SAII: *species that is unlikely to respond to management and is therefore irreplaceable* = No Limited information
1. The assessor is required to provide further information in the BDAR or BCAR for any species at risk of an SAII, including the action and measures taken to avoid the direct and indirect impact on the species at risk of an SAII. Where these have been addressed elsewhere the assessor can refer to the relevant sections of the BDAR or BCAR.	No previous records of this species occur within the locality. Potential habitat for *Genoplesium baueri* is present within the Subject land within PCT 1083. The development footprint of the Project has been designed to avoid as much vegetation clearing as practical. Where vegetation clearing is required, infrastructure has been located in areas which have been previously cleared. In addition, clearing of the APZ would only require the removal of the shrub and canopy layer. Additional information on avoidance is provided in Section 3.1. Targeted surveys of the Subject land were unable to be conducted during the suitable months of survey to confirm the absence of this species. Therefore, *Genoplesium baueri* has been assumed present within the development footprint. However, the species is considered unlikely to occur within the Subject land for the following reasons: • The lack of previous records within the locality (closest record >20km from the Subject land).

Additional impact assessment provisions for species at risk of SAII	Bauer's Midge Orchid (*Genoplesium baueri*)
	• Total clearing and surface disturbance of the Subject land in 2005. • 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). • This species is myco-heterotrophic (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. **The Project has the potential to disturb *Genoplesium baueri* habitat and potentially result in loss of individuals. However, given the Subject land has previously been completely cleared it is unlikely this species would occur with the Subject land.**
2. The assessor must consult the TBDC and/or other sources to report on the current population of the species including:	
a) evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) presented by an estimate of the: i. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer); or ii. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer) as indicated by: an index of abundance appropriate to the species; decline in geographic distribution and/or habitat quality; exploitation; effect of introduced species, hybridisation, pathogens, pollutants, competitors or parasites.	DPIE have determined that this species is not at risk of SAII due to Principle 1 – rapid rate of decline. i. The decline in population of the species in NSW in the last 10 years cannot be assessed at this time because: • The species information available in Bionet and other reliable/peer reviewed information about the species is limited and does not address this aspect. • Bionet record data exhibits a bias toward increased survey effort, resulting in an increase of species records within the last 10 years. However, the species is known to be declining, as a result of the threats detailed below. ii. Key threats to the species, which are likely to have contributed to its decline are (DPIE 2022e): • Destruction of habitat, largely for urban and industrial development, which continues to contribute towards a declining population. • Clearing of native vegetation' is listed as a Key Threatening Process. • Remaining populations of *Genoplesium baueri* are generally small and highly restricted making them more vulnerable to disturbance. • Disturbance caused by feral pig or deer, trampling and site disturbance from people, dogs, bicycles and track maintenance/fire protection activities and rubbish dumping. • Altered or inappropriate fire regimes.

Additional impact assessment provisions for species at risk of SAII	Bauer's Midge Orchid (*Genoplesium baueri*)
	The Project is not likely to increase any of the above listed threats to the species, apart from the destruction of 0.84 ha of potential habitat. According to BioNet, there are no nearby records of *Genoplesium baueri* within 10 km of the Subject land, however, the species is highly cryptic. The species grows in heathland to shrubby woodland (Riley & Banks 2002) or open forest, shrubby forest and heathy forest (Jones 2006). It usually occurs in sands or sandy loams (Riley & Banks 2002) or well-drained sandy and gravely soils (Jones 2006). This accounts for the entire 3.12 ha of the Subject land. Large areas of similar vegetation in better condition which would not be disturbed as a result of the Project occurs surrounding the Subject land.
b) evidence of small population size (Principle 2, clause 6.7(2)(b) BC Regulation) presented by: i. an estimate of the species' current population size in NSW; and ii. an estimate of the decline in the species' population size in NSW in three years or one generation (whichever is longer); and iii. where such data is available, an estimate of the number of mature individuals in each subpopulation, or the percentage of mature individuals in each subpopulation, or whether the species is likely to undergo extreme fluctuations.	DPIE have determined that this species is at risk of SAII due to Principle 2 – small population size. i. An estimate of *Genoplesium baueri* population size is about 20-30 populations (DPIE 2022e). A response to b) ii and b) iii cannot be provided because: • The species information available in Bionet and other reliable/peer reviewed information about the species is limited and does not address these aspects. • Bionet record data does not contain enough records to confidently identify a decline in the population over the last three years. Bionet record data contains 344 records of the species, however this is in no way an indication of the current population size.
c) evidence of limited geographic range for the threatened species (Principle 3, clause 6.7(2)(c) BC Regulation) presented by: i. extent of occurrence ii. area of occupancy iii. number of threat-defined locations (geographically or ecologically distinct areas in which a single threatening event may rapidly affect all species occurrences), and iv. whether the species' population is likely to undergo extreme fluctuations	DPIE have determined that this species is not at risk of SAII due to Principle 3 – limited geographic range. i. The extent of occurrence for *Genoplesium baueri* was estimated to be approximately 11,500 km^2. *Genoplesium baueri* is endemic to NSW and generally occurs within coastal areas of NSW from the Ulladulla area of the south coast to Port Stephens on the mid north coast. Most records are from areas between Ulladulla and northern Sydney. There are records for the species as far west as Woodford in the Blue Mountains and Penrose State Forest in the southern highlands (DPIE 2022e). ii. The species area of occupancy is estimated to be 168 km^2 (DPIE 2022e). iii. The prolonged absence of fire (or other biomass reduction process such as mowing) may be detrimental as it reduces flowering and thus the ability of the populations to sustain themselves, leading to local extinctions (DPIE 2022e). The timing of fire is also important,

Additional impact assessment provisions for species at risk of SAII	Bauer's Midge Orchid (*Genoplesium baueri*)
	with the best time for orchids being late summer or early autumn, after seed dispersal but prior to new shoot growth. Fuel reduction burning of forests in spring and late autumn is considered to be a threatening process for many orchid species (Duncan 2010). iv. There is insufficient data and information on the ecology of *Genoplesium baueri* to determine whether the species population size would be likely to undergo extreme natural fluctuations. However, given the small population sizes and intermitted reproduction this species is unlikely to fit the boom/bust population model. Therefore, it's considered that if a sub-population lost a significant number of individuals, the recovery of the sub-population would be slow. Populations where habitat is subject to disturbance, grazing and inappropriate fire regimes, are likely to decline into the future or may lead to local extinctions.
d) evidence that the species is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation) because: i. known reproductive characteristics severely limit the ability to increase the existing population on, or occupy new habitat (e.g. species is clonal) on, a biodiversity stewardship site; ii. the species is reliant on abiotic habitats which cannot be restored or replaced (e.g. karst systems) on a biodiversity stewardship site; or iii. life history traits and/or ecology is known but the ability to control key threatening processes at a biodiversity stewardship site is currently negligible (e.g. frogs severely impacted by chytrid fungus).	DPIE have determined that this species is not at risk of SAII due to Principle 4 – unlikely to respond to management. i. Little is known about the biology and ecology of *Genoplesium baueri*. The plants flower from December to April (DPIE 2022e). The species may be limited to certain areas as a result of their complex relationship with a mycorrhizal fungus. However, management of threats are likely to maintain populations and aid recruitment of the species. ii. There is little information on the reproduction of *Genoplesium baueri.* The species is reliant on a mycorrhizal fungus necessary for seed germination and providing some nutrients to the orchid. Whilst this is not an abiotic habitat it still may limit the ability to increase an existing population on a biodiversity stewardship site. iii. The life history traits and ecology of the *Genoplesium baueri* is not well known. Threats listed in response to 2) a) ii are for the most part controlled within a biodiversity offset site.
3. Where the TBDC indicates data is 'unknown' or 'data deficient' for a species for a criterion listed in Subsection 9.1.2(2.), the assessor must record this in the BDAR or BCAR.	Some of the questions in this consideration of SAII cannot be assessed at this time because: • The species information available in TBDC, Bionet and other reliable/peer reviewed information about the species is limited. • A lot of the information is not covered by scientific papers, and there are significant knowledge gaps. As such, we have noted the knowledge gaps in the TBDC and provided responses using information we have readily available.

Additional impact assessment provisions for species at risk of SAII	Bauer's Midge Orchid (*Genoplesium baueri*)
	Items deemed data deficient by DPIE have been detailed at the start of this SAII assessment (DPIE data package).
4. In relation to the impacts from the proposal on the species at risk of an SAII, the assessor must include data and information on:	
a) the impact on the species' population (Principles 1 and 2) presented by: i. an estimate of the number of individuals (mature and immature) present in the subpopulation on the Subject land (the site may intersect or encompass the subpopulation) and as a percentage of the total NSW population; and ii. an estimate of the number of individuals (mature and immature) to be impacted by the proposal and as a percentage of the total NSW population; or iii. if the species' unit of measure is area, provide data on the number of individuals on the site, and the estimated number that will be impacted, along with the area of habitat to be impacted by the proposal.	i. Potential habitat for *Genoplesium baueri* was identified in the Subject land within PCT 1083. Targeted surveys of the Subject land were unable to be conducted during the suitable months of survey for this species. Therefore, *Genoplesium baueri* has been assumed present within the development footprint. ii. Given the lack of previous records within the locality (closest record >20 km 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. However, surveys were not conducted to discount this species, it is not known if/how many individuals may be impacted by the Project. iii. The species unit of measure is area. The species polygon was based on the mapping of PCT 1083 (see Figure 6). The species polygon covers an area of 3.12 ha. Number of individuals on site is not known as targeted surveys were not conducted. The occurrence of this species within the Subject land is low, therefore likelihood of impact on individuals is also likely to be low.
b) impact on geographic range (Principles 1 and 3) presented by: i. the area of the species' geographic range to be impacted by the proposal in hectares, and a percentage of the total AOO, or EOO within NSW. ii. the impact on the subpopulation as either: all individuals will be impacted (subpopulation eliminated); OR impact will affect some individuals and habitat; OR impact will affect some habitat, but no individuals of the species will be directly impacted. iii. to determine if the persisting subpopulation that is fragmented will remain viable, estimate (based on published and unpublished sources such as scientific publications, technical reports, databases or documented field observations) the habitat area required to support the remaining population, and habitat available within dispersal distance, and distance over which genetic exchange can occur (e.g. seed dispersal) and pollination distance for the species.	i. The Subject land comprises 3.12 ha of vegetation that meets the potential area of habitat for the species, where the species was unable to be excluded via survey (Figure 6). Exact areas of occupancy and percentages cannot be provided as there is insufficient data available for this species. The potential impacts to this species are considered to be low, therefore the Project is not likely to alter the species geographic range. ii. The impact on the sub-population(s) cannot be quantified, as there are also large areas of suitable habitat outside the Subject land. The potential impacts to this species are considered to be low, therefore the Project is not likely to impact a subpopulation of the species. iii. As noted above we do not have enough information on the subpopulation if indeed present. Given the previous disturbance of the Subject land in 2005, it is likely that if a subpopulation occurred outside the Subject land that it would continue to persist. The secondary clearing of suitable habitat is unlikely to exacerbate previous fragmentation and

Additional impact assessment provisions for species at risk of SAII	Bauer's Midge Orchid (*Genoplesium baueri*)
iv. to determine changes in threats affecting remaining subpopulations and habitat if the proposed impact proceeds, estimate changes in environmental factors including changes to fire regimes (frequency, severity); hydrology, pollutants; species interactions (increased competition and effects on pollinators or dispersal); fragmentation, increased edge effects, likelihood of disturbance; and disease, pathogens and parasites. Where these factors have been considered elsewhere in relation to the target species, the assessor may refer to the relevant sections of the BDAR or BCAR.	lead to extinction of a subpopulation. Therefore, the Project is not likely to reduce the habitat area required to support a population of the species. iv. The Project is not likely to modify fire regimes. In addition, modification of the hydrology of drainage lines within the Subject land would not occur.
5. The assessor may also provide new information that can be used to demonstrate that the principle identifying the species as at risk of an SAII, is inaccurate.	Not applicable.

Annex 9. 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

Caladenia tessellata Species Polygon

Genoplesium baueri Species Polygon

niche-eh.com

Excellence in your environment

Contact Us

Niche Environment and Heritage
02 9630 5658
info@niche-eh.com

NSW Head Office – Sydney
PO Box 2443 North Parramatta
NSW 1750 Australia

QLD Head Office – Brisbane
PO Box 540 Sandgate
QLD 4017 Australia

Sydney
Brisbane
Cairns
Port Macquarie
Illawarra
Coffs Harbour
Central Coast
Gold Coast
Canberra

Our services

Ecology and biodiversity
Terrestrial
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)

Attachment 7
Response to DPE-Water
(Response Prepared by Watershed HydroGeo)

20 April 2022

Watershed HydroGeo
ABN: 95 615 827 499
81 North St, Nowra N.S.W.
AUSTRALIA 2541
will.minchin@watershedhg.com

To: Gary Brassington
Manager Approvals
Illawarra Metallurgical Coal (IMC)

cc: Clive Berry (RS), Dave Leslie (IMC)

From: Will Minchin

Memorandum: Dendrobium Modification 9 – assessment of groundwater take and effects

Your Ref: Request by IMC, 09/04/2022 Our Ref: IMC113–M041d

1 Introduction

Illawarra Metallurgical Coal (IMC) are in the process of modifying an existing consent (Modification 9) with regard to operation of gas drainage infrastructure at Shafts 2 and 3 above Dendrobium Mine Areas 2 and 3A. Government agencies have made submissions, and this document provides information in response to comments by DPE-Water (OUT22/2418, dated 07/04/2022) regarding the potential groundwater effects.

Watershed HydroGeo ("WatershedHG") has addressed the following:

1. "additional information to support the statement that there will be no change to groundwater water take as a result of the modification in accordance with the requirements of the NSW Aquifer Interference Policy (2012) (AIP).
2. Demonstration that sufficient entitlement can be acquired in the relevant water source unless an exemption applies, if additional groundwater take is required,
3. Provide a detailed and consolidated site water balance, if necessary.
4. Confirm the location of the proposed bores and any changes to the original impact assessment of the Dendrobium Mine. The updated impact assessment needs to address construction and operation impacts on the water source and water users, and the requirements of the AIP."

2 Response to DPE-Water

The following sub-sections address the items raised by DPE-Water.

2.1 Issue #1 - change to groundwater take

The three main features of the Modification 9 that could affect groundwater take are:

- Water make during the gas drainage process;
- Groundwater take during and following construction of bores to surface infrastructure; and
- Source of processing (cooling, sealing) water.

Area 3C is the mining domain that requires advance gas drainage and this would occur via in-seam boreholes. Some groundwater would be extracted as the seam is depressurised by the in-seam bores.

Groundwater take as a result of mining operations in Area 3C, including roadway development and subsequent longwall extraction has been approved (under DA60-03-2001).

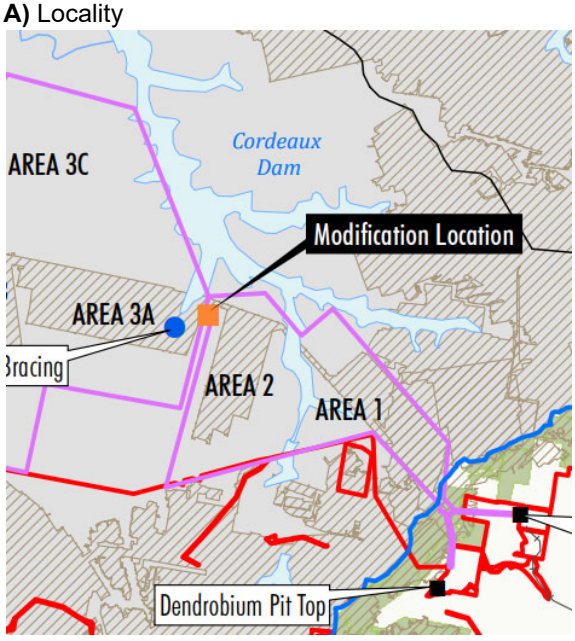
Advance drainage would mean that the timing of that groundwater take would occur slightly earlier (on the order of weeks or months) compared to the approved operation. However, the same or very similar volume of groundwater would be extracted. The approved take includes longwall operations, and it is the approved longwall extraction and associated goafing and fracturing, rather than the gas drainage or roadway development, that results in the significant majority of the groundwater take.

IMC's proposal for the Modification includes 3 boreholes:

- 600 mm gas riser (fully cased and grouted);
- 100 mm water supply (fully cased and grouted) (i.e. Area 3A workings to surface);
- 100 mm water return (fully cased and grouted) (i.e. flow from surface to underground workings).

The approximate location of these bores is marked on Figure 2-1, adjacent to Shafts 2 and 3.

A) Locality



B) Bore locations at Shaft 2-3 site

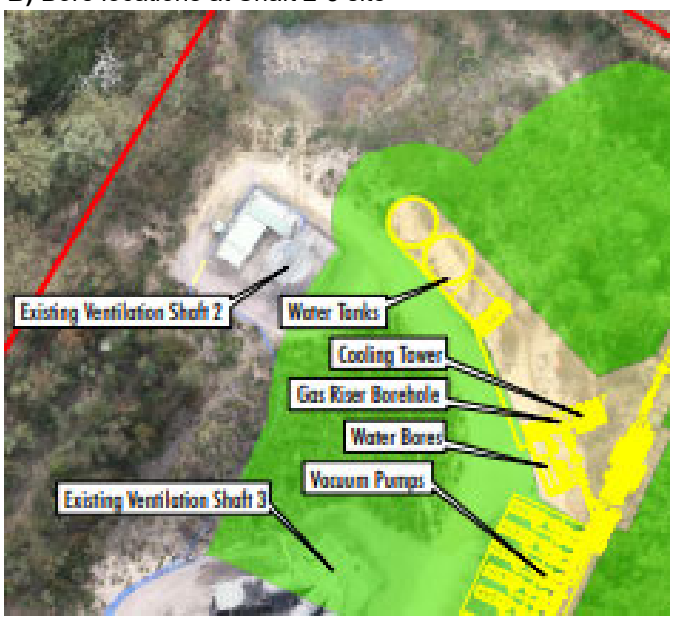


Figure 2-1 Modification 9 location and likely bore locations

As noted above, the bores would be fully cased, with lightning separation at seam level to prevent risk from lightning strikes. The casing would prevent groundwater ingress after construction, as well as preventing vertical movement of groundwater in the bore.

The source of processing water would be water collected in the normal operation of the mine. Dendrobium's water management system includes a network of pumps and sumps which collect groundwater and other operational water (e.g. water from potable supply) in the underground mine. Processing water consumption is anticipated to be 0-50 kL/day, with the water supply bore to the surface capable of transmitting approximately 5 L/s. This would be sourced from water already collected in a dam in Area 3A underground workings, where this water includes groundwater collected in Areas 3A, 3B and 3C and water from other sources as noted above. A water balance is presented in HEC (2022), as referred to in Section 2.3.

The overall take of groundwater related to the modified operation would be negligibly different to the approved take, which includes longwall extraction and associated dewatering. To re-iterate, no additional groundwater take is anticipated.

2.2 Issue #2 - sufficiency of groundwater entitlement

Dendrobium Mine, including the infrastructure related to the Modification, is located almost wholly within the Management Zone 2 (MZ2) of the Nepean Sandstone Groundwater Source (a Highly Productive groundwater source). Total groundwater entitlement for all users in this zone is approximately 31,446 shares, where one share usually correlates to one mega litre (ML) per year.

IMC holds the following Water Access Licences (WALs) for the MZ2 of the Nepean Sandstone Groundwater Source for its Dendrobium Mine operation:

- WAL 37464 = 300 shares
- WAL 37465 = 3,962 shares
- WAL 42386 = 3,653 shares; and
- WAL 42385 = 1,840 shares.
- **Total = 9,755 shares.**

As per the previous (#1), no additional groundwater take is anticipated. No changes to operations that would significantly increase groundwater take are planned for the near future.

Total groundwater extraction at Dendrobium Mine during the water year 2020-21 was **2,690 ML** (equivalent to 7.4 ML/d), which is 28% of Dendrobium's entitlement and 8.5% of the total entitlement held by all groundwater users in this MZ. The existing groundwater entitlement held by IMC is therefore clearly sufficient to meet demand at Dendrobium Mine. Water take for the Modification would be included in the groundwater take reported for the existing (approved) mine.

2.3 Issue #3 - site water balance

Section 6 of HEC (2022) presents the site water balance. HEC notes that “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”. As noted above, the overall take of groundwater related to the modified operation would be negligibly different to the approved take, which includes longwall extraction and associated dewatering.

2.4 Issue #4 - location of proposed bores and changes to original impact assessment

These 3 new bores (gas riser, water supply and water return boreholes) would be located within the Modification site (Figure 2-1) on the ridgeline between the Sandy Creek Arm and Cordeaux River Arm of Cordeaux Reservoir. The site is approximately 250 m west of the Sandy Creek Arm. The bores would be located on outcropping lower Hawkesbury Sandstone (which is thin on this ridgeline) and then the full geological sequence including the Bald Hill Claystone, Bulgo Sandstone and other Narrabeen Formation units and then the Illawarra Coal Measures including the Wongawilli Coal seam.

Because the bores would be fully cased (Section 2.1), other than during drilling and construction, there would be no drawdown around each bore. The effects of these would be negligible, especially in the context of the existing longwalls in Area 2 (east) and Area 3A (west) near to the Modification location.

There is no additional groundwater take (Section 2.1) as a result of the Modification, only a very slight change to the extraction of water from the coal seam, i.e. it would occur weeks to months earlier than anticipated in the original approval, coincident with advanced gas drainage.

As a result, consideration of effects as per the Aquifer Interference Policy (AIP) are summarised below:

- The groundwater is regulated by the Water Sharing plan for the Greater Metropolitan Region Groundwater Sources 2011. The Modification is within the Nepean Sandstone MZ2 of the Sydney Basin Porous Rock.
- No additional drawdown beyond the approved drawdown associated with longwall mining in the relevant mining domains (Areas 2, 3A and 3C).
- There are no registered bores within 6.5 km of the relevant areas.
- There are no High Priority Groundwater Dependent Ecosystems (GDEs) or High Priority Culturally Significant Sites, as listed in the relevant Water Sharing Plan, within 19 km of the relevant areas.
- There is no significant or measurable additional groundwater take associated with the Modification. In any case, IMC holds WALs with sufficient groundwater entitlement to cover any groundwater take.
- Accordingly, no impacts on water supply works are anticipated.
- There would be no changes to significant groundwater quality as a result of the Modification, especially when considering the longwall extraction in Areas 2, 3A and 3C that is approved (and has already occurred in Areas 2 and 3A).
- Processing water that would be used at surface is to be sourced from mine water. The water has a composition that is characteristic of groundwater from coal seams and coal measures. Total suspended solids are very low (typically below laboratory quantification limits). Salinities are somewhat elevated (~800 to 3,000 µS/cm) relative to shallow groundwater and surface water and show strong enrichment of Na relative to Cl. Mine inflow water is dominated by Na and HCO3 with near neutral to alkaline pH. Minor ions are Si, Ba, Sr, Mg and Li, which are derived from silicate weathering and carbonate dissolution.
- The Modification is not expected to change the beneficial use category for the beneficial use category of the groundwater source.
- Management of contamination risks (leaks and spills) are addressed in Table A2-1 of the main Modification report (IMC, 2022).

Accordingly, it is considered that the Modification would fall within the ‘Level 1 – Acceptable’ impacts identified in the AIP for water table, water pressure and water quality.

Your sincerely,

Will Minchin
will.minchin@watershedhg.com

3 References

HEC, 2022. Dendrobium Gas Management Infrastructure – Modification Surface Water Review. Dated 11/02/2022.

IMC, 2022. Dendrobium Mine Modification – Gas Management Infrastructure Modification Report (Modification 9). Dated 11/02/2022. https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=DA60-03-2001-MOD-9%2120220211T062853.705%20GMT

Attachment 8
Response to WCC

Matter Raised

Council considers that whilst the preferred option proposed could be perceived as facilitating ecologically sustainable development, as it may reduce Scope 1 greenhouse gas emissions via methane flaring (28 times global warming potential comparatively) being converted to CO2 with no significant change to the currently accepted environmental impacts, and not increase in the duration of existing impacts of the Project, further consideration is required of cumulative impacts should the same infrastructure be required assist with gas drainage from the proposed Dendrobium Mine Extension Project currently under assessment by the Department.

There may opportunity for the Department to encourage IMC towards exploring and further developing technology to both capture and reuse mine gas emissions for electricity production such as has been trialled at the Appin mine facility. In doing so future operations may better align with and assist Council's Global Covenant of Mayors for Climate and Energy (GCoM) emissions reduction target for the Wollongong Local Government Area, the Wollongong Climate Change Adaptation Plan and Our Wollongong 2028 Community Strategic Plan Goals.

Response

The potential to combust gas to generate electricity, rather than simply flaring has been considered. This would allow for further reductions in greenhouse gas emissions (i.e. if the electricity generated offsets electricity in the grid that would otherwise be produced by fossil fuel generators). While this technology is used at the Appin Mine, it requires a relatively homogenous gas resource at 75-95% methane content and requires periodic gas enrichment from the state gas network to feed the electricity generation plant. By comparison, the Area 3C gas content is predominantly carbon dioxide with significantly lower methane content than Appin and is less homogenous. As such, gas drained from Area 3C could only be utilised for power generation with significant gas enrichment, which is not available in the Metropolitan Special Area and would dilute the objective of reducing GHG emissions. In addition, the Modification area (ML1566) is not considered suitable for power generation, as this activity requires a surface footprint (including for supporting infrastructure such as power reticulation) which would exceed the capacity of the existing site. Accordingly, this option is not considered viable for the Modification.

The infrastructure would also be used for pre-drainage of other LW blocks within the Area 3C domain and potentially for the newly proposed Dendrobium Mine Extension Project (State Significant Infrastructure [SSI]-33143123), if approved. At the time of writing, exhibition of an EIS for SSI-33143123 is pending, however the EIS would give further consideration to the potential for power generation from mine waste gas in the future.

Further information is available in Attachment 3 – response to EPA submission.

Attachment 9
Response to a member of the public

Matter Raised

I note as an aside that the modification, while addressing existing needs for the safe operation of the mine, also considers possible future works that may be needed should the extension of the mine be approved by the Minister at a later date. I would ask the Department of Planning, Infrastructure and the Environment to assure themselves that the Modification does not exceed the purpose of meeting the safety requirements of the mine operation as it stands, as it would not be acceptable to progress a mine expansion that has not been through a full process of scrutiny before approval. Works required for the expansion of the mine should only be considered in the application for expansion.

Response

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 and potentially for the Dendrobium Mine Extension Project (State Significant Infrastructure [SSI]-33143123), if approved.

In summary, the gas drainage infrastructure is needed for existing approved longwall extraction and is required independent of the Dendrobium Mine Extension Project.

Matter Raised

My most serious concern in the case of this modification, however, is that works proposed are described as including
• "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."

As we have seen recently, water management and sediment controls at coal mines in the Illawarra have been associated with pollution of creeks and even beaches during heavy rainfall events, with South 32 having been fined by the EPA after a pollution incident where a tailings dam failed and polluted Brandy and Water Creek in Wollongong, and another company, Wollongong Coal, currently under investigation by the EPA in relation to another incident in which coal wash was observed in a creek. Any water management and sediment control, including plans for maintenance, supervision and monitoring, should take into account expected future extreme rainfall events.

I note that, in Appendix 1 of the modification proposal, the capacity of water management facilities is based on a 5 day duration rainfall event of 89.7mm, and that this volume of 89.7mm is based on past rainfall at Wollongong and Mittagong. Of course, we have recently seen a series of extreme rainfall events in the Illawarra, with average rainfall over a 5 day period exceeding 89.7mm, and we know that it is likely that extreme weather such as periods of heavy rain for several days, are likely to become increasingly frequent. For this reason, any modification to water management and sediment controls, especially in a catchment area, should take into account the increasing likelihood of these types of events.

The mining company's consultant's assessment and the consultation undertaken with Water NSW would have occurred prior to the extreme weather events that we have just seen in this region. It would therefore be prudent for the Department of Planning, Infrastructure and the Environment to revisit the matter of water management and the storage of coal wash and sediment traps in light of the experience that very recent extreme weather events have offered.

I hope that the Department of Planning, Industry and the Environment will take the time needed to look thoroughly at the matter of water management and sediment traps associated with this modification, in the light of the lived experience of the recent period of heavy rainfall. In a changing climate that includes more extreme rainfall events, sediment traps and coal wash storage require additional care in relation to capacity, monitoring and plans to ensure that bushland, waterways, and residential areas are not further impacted after periods of extreme rainfall. This is even more critical in the case of water management, coal wash storage and sediment traps that are within the water catchment.

Response

The required size of the sediment basins to manage runoff potentially containing sediment from the associated catchment areas has been determined by HEC (2022) in accordance with the Landcom (2004) and the Department of Environment and Climate Change (2008) guidelines (Appendix 1 of the Modification Report). These guidelines were used consistent with feedback from WaterNSW.

Consistent with the recommendations by HEC (2022):

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

In summary, the sediment dams would be actively managed to ensure the required capacities are maintained, including during sustained wet weather periods. In addition, the dams would be sized in consideration of the required capacities during the construction phase. These capacities would be maintained during the operational phase, even though disturbed areas would be progressively restored by rehabilitation. This would result in the sediment dam's capacities being in excess of requirements in the operational phase.

Implementation of the erosion and sediment control measures 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.

The submission makes reference to coal wash, which is not produced or stored/emplaced at the No. 2 and 3 shafts and is not proposed to be as part of the Modification.

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.

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

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