Dendrobium Mine Extension Project

State Significant Development SSD-8194

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Cover image: Upland coastal swamp above Dendrobium Mine *Courtesy of Howard Reed*

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Glossary

Abbreviation	Definition
ACHA	Aboriginal Cultural Heritage Assessment
AQGGA	Air Quality and Greenhouse Gas Assessment
BAR	Biodiversity Assessment Report
BC Act	*Biodiversity Conservation Act 2016*
BCD	Biodiversity Conservation Division, Department of Planning, Industry and Environment
BOS	Biodiversity Offset Strategy
BVT	Biometric Vegetation Type
Catchment Panel	Independent Expert Panel on Mining in the Catchment
CO_2-e	Carbon dioxide-equivalent
CPP	Coal Preparation Plant
CWE	Coal Wash Emplacement
DAWE	Commonwealth Department of Agriculture, Water and the Environment
Department	Planning & Assessment Group, Department of Planning, Industry and Environment
DPIE - Water	Water Group, Department of Planning, Industry and Environment
DSNSW	Dams Safety NSW
EA	Economic Assessment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPI	Environmental Planning Instrument
EPL	Environment Protection Licence
ESD	Ecologically Sustainable Development

GHGEs	Greenhouse Gas Emissions
HHA	Historic Heritage Assessment
IESC	Commonwealth Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development
KVCLF	Kemira Valley Coal Loading Facility
LEP	Local Environmental Plan
LW	Longwall
MEG	Minerals Energy and Geoscience Group, Department of Regional NSW
Mining Panel	Independent Advisory Panel for Underground Mining
Mining SEPP	*State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*
Minister	Minister for Planning and Public Spaces
MNES	Matters of National Environmental Significance
ML/day	Megalitres per day
Mt	Million tonnes
Mtpa	Million tonnes per annum
MZ	Management Zone
NBA	Noise and Blasting Assessment
NPWS	National Parks & Wildlife Service, DPIE
PCT	Plant Community Type
RMS	NSW Roads and Maritime Services
ROM	Run-of-Mine
RTS	Response to Submissions
SA	Subsidence Assessment
SocIA	Social Impact Assessment
Secretary	Planning Secretary of the Department
SEPP	State Environmental Planning Policy
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011*
SSD	State Significant Development

TEC	Threatened Ecological Community
Upland swamps	Coastal Upland Swamps of the Sydney Basin Bioregion TEC
WCC	Wollongong City Council
WiSC	Wingecarribee Shire Council
WoSC	Wollondilly Shire Council

Executive Summary

Illawarra Coal Holdings Pty Ltd, a subsidiary of South32 Limited (South32) owns and operates the Dendrobium Mine, an underground coal mine located around 8 kilometres (km) west of Wollongong in the Southern Coalfield of NSW. The mine produces metallurgical coal for steelmaking in Australia and overseas. Development consent for the mine was granted in 2001, allowing the extraction of up to 5.2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal to December 2030. Coal is extracted using longwall mining methods.

The consent permits mining from five approved underground mining areas, which are shown in **Figure ES1**. Coal extraction is complete in Areas 1 and 2, largely complete in Area 3A and well underway in Area 3B. Extraction from Area 3C has not yet commenced as the coal seam in that area contains high levels of gas that must first be drained over a period of years before mining can safely occur.

South32 is seeking development consent for the Dendrobium Mine Extension Project (the Project) to allow it to extract an additional 78 million tonnes (Mt) of ROM coal from two new mining areas (Areas 5 and 6, shown in **Figure ES1**), and to extend the life of the mine until December 2048. The Project has a capital investment value of nearly $1 billion and is expected to increase the existing mine workforce from around 400 to 500 personnel.

The Project would use the existing mine infrastructure with minor upgrades and extensions. Coal handling and processing would be integrated with existing operations such that the Project would effectively be a continuation of the existing mine. Key existing surface facilities at Dendrobium Mine would continue to be used for the Project but some additional surface infrastructure would be required, including four new ventilation shafts and upgrades to the existing Cordeaux Pit Top, which is currently decommissioned.

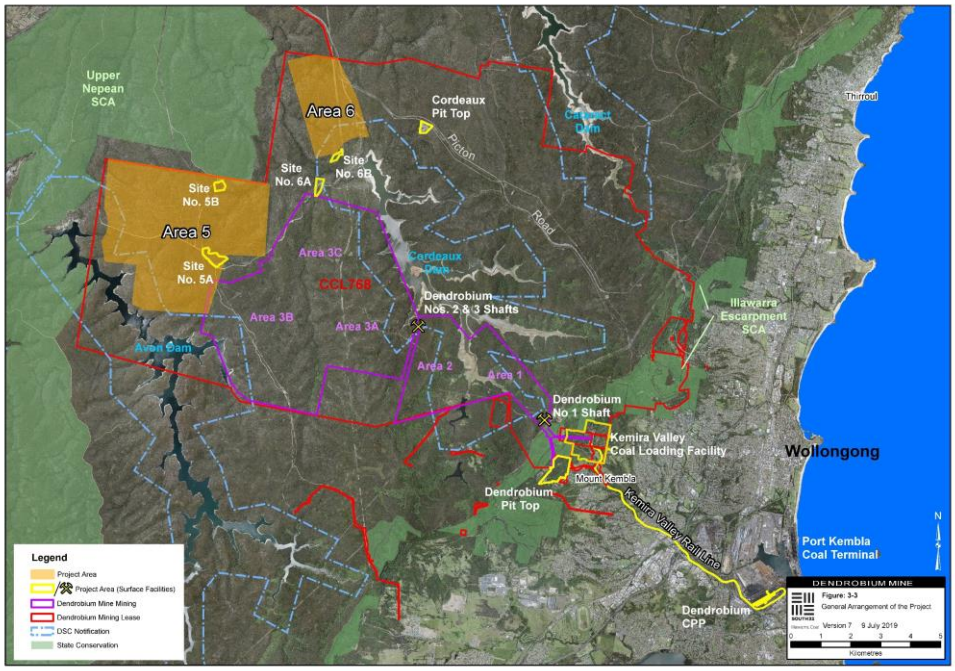


Figure ES1| Local Context and Existing Mine and Project General Arrangement
(Source: EIS)

Strategic Context

Dendrobium Mine is part of an integrated coal mining and steel making complex located in the Illawarra Region of NSW.

Coal from the Dendrobium Mine and South32's nearby Appin Mine is blended to produce premium quality coal blend used for steel making. The coal is supplied directly to the BlueScope Steelworks in Port Kembla, or to the Port Kembla Coal Terminal (PKCT) for seaborne transport to the Whyalla Steelworks in South Australia or for international export.

With an annual production capacity of approximately 3.0 Mtpa, the BlueScope Steelworks is the largest steel production facility in Australia and one of only two Australian primary steelmaking facilities (the other being Whyalla Steelworks).

BlueScope directly employs approximately 3,000 people in Port Kembla, indirectly supports an estimated 10,000 jobs in the Illawarra Region, and contributes approximately $1.9 billion per annum to the economy.

The proximity of the Southern Coalfield coal mines is a major factor in BlueScope's ability to make steel economically. South32 currently supplies BlueScope with 60% of its overall coal needs. Importing this coal from further afield would add significant transport and logistics costs and also require a substantial capital investment in additional unloading infrastructure at Port Kembla.

The continued supply of coal from the Dendrobium Mine to the BlueScope Steelworks would avoid these additional costs to BlueScope's steelmaking operation and contribute to its ongoing economic viability and associated socio-economic benefits for the region and State.

Engagement

During the public exhibition of the Project, the Department received 775 public submissions, including 39 from special interest groups, business entities or other organisations. Most of these submissions (81%) supported the Project because of the ongoing and additional employment opportunities that would be provided at the mine itself, and because of the importance of the Project for the continuation of the BlueScope Steelworks.

The main issues raised in objections relate to potential surface water losses from water supply catchments, as the new mining areas are located in the Metropolitan Special Area, a declared water catchment area for Sydney' drinking water supply which protects the catchments of the Avon and Cordeaux Rivers and the stored waters in Avon and Cordeaux Dams.

Other key issues raised include the project's potential impacts on watercourses and upland swamps, biodiversity impacts, impacts on Aboriginal and non-Aboriginal heritage and greenhouse gas emissions.

The Department also received advice from 13 government agencies and associated entities (including WaterNSW) and from the three local councils directly affected by the project (Wollongong City Council, Wollondilly Shire Council and Wingecarribee Shire Council). Key issues raised were water losses from the catchment, impacts on upland swamps and potential risks to the two dams.

Key Assessment Issues

As the Project is an extension of an existing mine, the key assessment issues focus around the proposed expansion of the underground mining footprint, its location within the Metropolitan Special Area and the economic consequences for the Illawarra Region if the Project is not approved. The critical issues revolve around the:

- proposed mine design, particularly the proposed longwall void width of 305 metres (m);
- anticipated impacts on water catchment values and security of water supply for the Sydney and Wollongong areas and whether these impacts can be acceptably minimised and/or offset;
- potential impacts on WaterNSW's water supply assets (particularly the walls and floors of Cordeaux and Avon Dams); and
- economic and social costs and benefits, including the likely economic and social costs if the Project does not proceed.

In undertaking its assessment, the Department sought independent expert advice from the:

- Commonwealth Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) on water resource impacts;
- Government's newly-established Independent Advisory Panel for Underground Mining (Mining Panel) on mine subsidence related issues;
- BAEconomics, on the Project's potential downstream economic costs and benefits on BlueScope Steel and PKCT; and
- MineCraft Consulting Pty Ltd, on the likely economic impacts of reducing longwall widths to both South32 and to the State.

It has also sought to apply the recommendations of the Independent Expert Panel on Mining in the Catchment (the Catchment Panel), which submitted its two-part Final report to Government in October 2019.

Mine Design

South32 has sought to avoid or minimise surface subsidence impacts primarily through applying minimum separation distances between the longwall voids and key surface features. These include a minimum setback of 1,000 m from the walls of Avon and Cordeaux Dams, a setback of 300 m from the full supply levels of their reservoirs, setbacks of 50 m from 57 identified 'key stream features' (increased to 100 m if mining on more than one side of the feature) and setbacks from the four major watercourses to limit subsidence induced streambed cracking.

However, above the two mining areas, subsidence impacts would be significant. The major surface features impacted would be *Coastal Upland Swamps of the Sydney Basin Bioregion* (upland swamps), which are a threatened ecological community, and a large number of small and relatively small ephemeral watercourses which feed the larger streams and the water storages. South32 has sought to substantially reduce potential impacts on upland swamps by not seeking consent to develop another mining area known as Area 4, which is overlain by a much larger aggregation of upland swamps.

Of the 21 proposed longwall panels, 18 have a void width of 305 m. This width is such that subsidence cracking would extend from the mine to the surface over (at least) the major proportion of the two mining areas. This cracking would cause infiltration of surface water from both upland swamps, watercourses and the water table. A significant proportion of this water would continue to

infiltrate through fractured rock strata and reach the mine. Many agencies and public submitters proposed that the longwall width be reduced substantially in order to reduce subsidence impacts at the surface.

South32 provided additional expert consideration of subsidence impacts resulting from narrower longwall voids. This advice indicated that, although the severity of impacts would be reduced, narrower panels (even at an uneconomic width of 150 m) would not prevent surface subsidence impacts. While cracking resulting from 'conventional' subsidence would reduce with narrower longwall voids, cracking would still result from 'non-conventional' subsidence impacts on watercourses and upland swamps.

The Department sought advice on this and other issues from the Government's new Mining Panel. The Panel agreed that longwall void width is not the best mine design control to manage environmental impacts on surface features at Dendrobium Mine, as surface cracking due to valley closure begins to plateau at void widths reported to be uneconomic at the Dendrobium Mine. That is, even void widths of 150 m would cause substantial surface cracking and drainage of watercourses and upland swamps. Substantial reductions in panel width would produce very limited environmental benefits at the surface.

MineCraft Consulting provided a detailed assessment of the costs of reducing longwall void widths. In broad terms, every 25 m reduction in void width would come at a cost of $100 million (NPV). These costs result from lower and less efficient recovery of coal, higher operating costs for South32, a lower net present value for the Project, and lower royalty income for the State. They would accrue not only to South32, but also to the regional community and the State.

The Department therefore considers that incremental reductions in environmental impacts as a result of narrowing longwall void widths would come at an unsustainable economic cost.

Surface Water

While the Project involves two new mining domains (Areas 5 and 6), the nature and scale of its anticipated impacts on the overlying catchment are no different to those that have previously taken place in the existing mining areas. For example, the same longwall void width (305 m) is being used in Area 3B and Area 3C and was previously used in part of Area 3A. Mining at Dendrobium has taken place for many years without any significant impacts on Sydney's drinking water supply, as was confirmed by the Catchment Panel in its Final Report.

Anticipated subsidence impacts include fracturing of streambeds and diversion of surface water underground; losses from the reservoirs due to increased permeability in the solid rock mass separating them from longwall voids; and impacts on surface water quality, including an increase mobilisation of metals such as iron. Stream function would be impacted due to cracking of creek beds, loss of pool holding capacity and loss of baseflow reporting to streams from upland swamps and near-surface aquifers.

South32's approach has been to recognise and accept these impacts; to incorporate conservative assumptions into its groundwater modelling and surface water modelling; to provide for specific limits on impacts in the case of the four major watercourses and 57 key stream features; and to provide for remediation of impacts on these features It has also proposed to offset the surface water losses (in terms of both quantity and quality) and also to offset related ecosystem and fauna species losses.

In terms of surface water losses, South32 has proposed to make annual payments to the Government for the Project's actual annual surface water take, which would be spent on important strategic water supply capital works to enhance Sydney's overall water supply. It would also provide a single up-front payment to cover the modelled water take that would continue from the fractured surface post-mining. South32 has calculated that this would total $103.1 million in current dollars, made up of $86.4 million in annual payments during longwall mining and a $16.7 million upfront payment.

While South32 would make these payments in respect of all modelled surface water losses, the critical figures for the people of Sydney are the predicted reductions in inflows to the water storages. The modelled reductions in an average rainfall year are approximately 0.55% (1.05 megalitres/day (ML/day)) for Lake Avon and 0.39% (2.84 ML/day) for Pheasants Nest Weir. These figures include leakages directly from Lake Cordeaux and Lake Avon towards the new mining voids, which are modelled to be approximately 0.1 ML/d from Lake Cordeaux and approximately 0.36 ML/d from Lake Avon.

The median annual yield from Avon Dam is 70,111 ML and the median annual yield from Pheasants Nest Weir (which receives regulated flows from Avon, Cordeaux and Nepean Dams) is 276,400 ML. The EIS estimates that, on an annual basis, the Project would have a maximum surface water take of 1,935 ML, which is 0.7% of annual inflows to Pheasants Nest Weir. This figure is the major component of Dendrobium Mine's overall surface water licensing requirement of 3,300 ML/year.

South32 has also proposed an offset package to address its water quality impacts, which includes transferring 28.5 hectares (ha) of land owned by South32 in the Metropolitan Special Area to the ownership of WaterNSW, and a package of fire management, maintenance of unsealed roads and installation and maintenance of barriers and fencing at least equivalent to WaterNSW's annual expenditures on these management issues.

The Department has recommended a range of conditions for monitoring and management of surface water including:

- setting strict performance measures (including negligible environmental consequences for Avon River and Cordeaux River);
- requiring additional offsets for any exceedances of these performance measures;
- obtaining approval of Extraction Plans for the management of all longwall mining operations, including surface and groundwater impact assessment criteria and trigger levels for investigating potentially adverse impacts on water resources or water quality;
- a surface water monitoring program to monitor and report on stream flows and water quality, stream and riparian vegetation health, and channel and bank stability;
- a plan to respond to any exceedances of the surface water and groundwater assessment criteria; and
- a program to update the development's surface water and groundwater models, to improve their integration and compare monitoring results with modelled predictions.

WaterNSW Assets

South32 has committed to ensuring no damage to the dam walls, no loss of either safety or serviceability for the dams, and negligible additional risk to public safety. Based on a 1,000 m setback from the Avon and Cordeaux dam walls, absolute subsidence movements at the dam walls are expected to be very small and differential movements are expected to be negligible. Dams Safety

NSW, the key body with responsibility for managing dam safety, has accepted South32's risk assessment and mitigation measures, subject to ongoing detailed consideration through the Extraction Plan process.

The Department considers that residual risks can be managed through requirements for detailed assessment of risks to dam structures in all relevant Extraction Plans, and through any necessary adaptive management.

Groundwater

The Project's EIS includes a large-scale regional groundwater model which was used to estimate the magnitude of water inflows to Areas 5 and 6, stream flow and swamp losses above the mine, impacts on Lake Avon and Lake Cordeaux and mining-induced drawdowns for regional groundwater users. The model built on previous groundwater modelling undertaken for Dendrobium Mine over the past decade. The model is based on a series of conservative assumptions, the most significant of these is that surface to seam cracking has been assumed over all longwalls with a void width of 305 m.

On this basis, mine inflows to Area 5 are predicted to rise to a maximum of about 18 ML/day in 2033 and 2037, averaging approximately 12 ML/day during the life of mining in that area. Inflows to Area 6 are predicted to rise to a maximum of almost 4 ML/day in 2047, averaging approximately 3 ML/day during the life of mining in that area. The maximum annualised inflow to the entire mine, including Areas 5 and 6, is predicted to be approximately 26 ML/day occurring around 2032 and 2036. This would be a significant increase over recent mine inflows of around 10 ML/day recorded at Dendrobium.

Surface water losses would comprise approximately 25-35% of the predicted total mine inflows, although that prediction is conservative because the model assumes all surface water is permanently lost to the groundwater system, whereas in reality a significant proportion of the water is likely to re-emerge downstream and not report to the mine workings. There is a very low risk of a greater than 2 m drawdown (the minimal impact requirements of the *NSW Aquifer Interference Policy*) at any water supply work within a 40 km^2 area surrounding the mining areas.

The IESC, the Department's Water Group (DPIE Water) and the Mining Panel made a number of criticisms of the EIS's groundwater model and made recommendations to further develop it and thereby improve the confidence of its predictions, particularly regarding surface water losses. However, these recommendations generally related to improvements that could be undertaken during the life of the Project and no real concerns were raised about the general soundness, whether its assumptions were sufficiently conservative, or its reliability for assessment purposes.

The Department is recommending conditions to require regular review of the groundwater model for the development, including:

- review within two years from any grant of consent and every three years thereafter throughout the life of the development in consultation with DPIE Water and WaterNSW;
- careful consideration of all comments received regarding the groundwater model and surface water model included in the EIS from DPIE Water, the IESC and the Mining Panel;
- implementation of the Mining Panel's recommendations which relate to review and development of the groundwater model and surface water model;
- independent peer review if requested by the Department's Secretary; and
- comparison of monitoring results with modelled predictions.

Biodiversity

There are 46 upland swamps lying partly or wholly within 600 m of the Project's proposed longwall voids. Twenty-five of these swamps are located directly above or within 60 m of the proposed longwall voids. It is expected that mine subsidence would cause surface cracking in 25 swamps, which would lead to reduced length of time in which they were waterlogged following heavy rainfall events. In turn, this may lead to vegetation changes to either a drier swamp community or in some places to a non-swamp woodland. Some swamps may also be at greater risk of erosional scour and gullying or even burning out during bushfires in very dry periods.

South32 has accepted that the Project would impact on the full extent of the 25 swamps located directly above or within 60 m of its longwall voids and has proposed to offset those impacts in accordance with the requirements of the applicable *Biodiversity Offset Policy for Major Projects* and *Framework for Biodiversity Assessment*.

Up to 28.5 ha of native vegetation would be cleared for new surface infrastructure (mainly the ventilation shafts and associated infrastructure). Most of this area comprises two relatively common (ie non-threatened) vegetation communities on sandstone plateaus in the Sydney Basin Bioregion. However, 0.55 ha of Shale Sandstone Transition Forest Threatened Ecological Community would be affected by new electricity transmission lines. The vegetation clearing would impact habitat for three threatened fauna species (Rosenberg's Goanna, Eastern Pygmy-possum and Koala). There are also five threatened fauna species that would be affected by subsidence impacts (Broad-headed Snake, Giant Dragonfly, Littlejohn's Tree Frog, Giant Burrowing Frog and Red-crowned Toadlet). South32 would retire the required species credits for each of these species.

The Department has proposed conditions requiring South32 to:

- retire ecosystem credits (within 24 months of approval of Project) that are equivalent to its anticipated impact on 21.6 ha of upland swamps;
- carefully monitor the condition of all upland swamps within the study area prior to, during and following undermining and also monitor a suitable suite of control swamps; and
- retire any additional offsets required should, at any time during the life of the Project or for 10 years following cessation of mining in Areas 5 and 6, impacts on upland swamps exceed the predictions found in the EIS.

Mine Closure

The Mining Panel was critical of the level of detail regarding mine closure planning in the EIS, which was finalised before the recommendations of the Catchment Panel became publicly available. The Mining Panel recommended that significant additional work in this area is undertaken early in the Project's life, should it be approved.

In particular, the Mining Panel recommended that South32 be required to develop a Mine Closure Plan early in the Project's life, so that it could fully identify and assess potential hazards associated with mine closure. The Mining Panel recommended that this plan should include consideration of options to safely seal Dendrobium Mine and options for managing residual risks. While the Department notes that this is an existing issue for the current mining operations, it fully supports these recommendations and has recommended conditions accordingly.

Amenity Impacts

The Project would involve continued use of most of the major infrastructure at the mine, with no significant changes to the operation of these facilities.

One residence is predicted to experience operational noise levels up to 3 dB(A) above the relevant trigger level *Noise Policy for Industry*, and consequently would qualify for at-home noise mitigation under the State's *Voluntary Land Acquisition & Mitigation Policy*.

South32 uses trains to move Dendrobium Mine's ROM coal from its Kemira Valley Coal Loading Facility along the Kemira Valley Rail Line to its Dendrobium Coal Preparation Plant at Port Kembla. The Project involves a continuation of the existing approved level of ROM coal production, rail traffic and rail operating hours. Consequently, there would be no change in rail noise impacts along the Kemira Valley Rail Line.

Short-term construction noise for minor new infrastructure at the Dendrobium Pit Top (including a carpark extension) would be managed by South32 in accordance with the *Interim Construction Noise Guideline*. Construction of the proposed ventilation shafts and related infrastructure would occur 24 hours per day, seven days per week. However, there are no nearby private receivers.

The Project does not propose any changes to the existing mine's rates of ROM coal production and transport. Consequently, dust and related emissions are unlikely to change. The Dendrobium Mine has no existing air quality management issues.

Greenhouse Gas Emissions

South32 proposes to minimise the Project's direct (ie Scope 1) greenhouse gas emissions (GHGEs) through flaring of drained pre-mining and post-mining gas wherever feasible. Depending on the proportion of gas that is recovered and flared, total Scope 1 emissions over the life of the Project would be approximately 17 to 22 Mt of carbon dioxide-equivalent (CO_2-e). This includes fugitive and/or flaring emissions associated with already-approved mining in Areas 3B and 3C that would occur until 2030.

Scope 3 emissions from the combustion of product coal by third party consumers (ie customers such as BlueScope Steelworks, Whyalla Steelworks or international steelworks) were modelled to be about 235.9 Mt CO_2-e over the life of the Project, or an average of about 8.1 Mt CO_2-e per annum.

These emissions are accounted for under the *Commonwealth National Greenhouse and Energy Reporting Act 2007* and the Paris Agreement as the Scope 1 and 2 emissions of the entities actually burning that coal.

The Department notes that there is no current alternative to the use of coking coal for the large scale, economic production of iron and steel. It also notes that the NSW and Commonwealth Government's current policy frameworks do not promote restricting private development as a means for Australia to meet its commitments under the Paris Agreement or the long-term aspirational objective of the NSW Government's Climate Change Policy Framework.

As only Scope 1 and Scope 2 emissions are within the control of an entity, the Department's view is that the key areas for active management of greenhouse gases within the development assessment and approval process for new projects in NSW are reductions in direct (ie Scope 1) emissions and improved energy efficiency (ie reduction and efficiency in the use of fuels and bought-in electricity).

Recommended conditions include a requirement for South32 to prepare and implement an Air Quality and Greenhouse Gas Management Plan, which must include:

- a description of measures to ensure capture of methane and its flaring or beneficial use;
- a description of measures to ensure best practice management (including in respect of minimisation of greenhouse gas emissions and energy efficiency); and
- provisions for a detailed feasibility study of options for beneficial use of methane, to be completed within 2 years of commencing second workings.

Aboriginal Heritage

No Aboriginal heritage sites would be disturbed for the construction of new surface infrastructure for the Project. However, the EIS identified 58 Aboriginal heritage sites in the area directly above the proposed new mining areas and within the larger boundary representing their predicted 20 mm subsidence contours. These sites include 23 axe grinding groove sites, 34 sandstone shelters with art and/or archaeological deposits and a single isolated artefact.

All sites have a risk of being impacted by subsidence, however it is not expected that all sites *would* be impacted. Fifteen of the 58 sites are outside the 35^0 'angle of draw' of the longwall voids and therefore have a relatively low risk of impact. Twenty-three of the rock shelters and nine grinding groove sites were predicted to experience less than 20 mm of vertical subsidence, which is the accepted minimum for reliable measurement. Significantly, nine of 10 shelters predicted to experience more than 100 mm of vertical subsidence were judged as having low scientific significance.

The Department's Biodiversity Conservation Division proposed changes to South32's mine design to avoid impacts on six Aboriginal heritage sites. One of these has been substantially protected by South32's revision of its Project design to reduce the western extent of one longwall by 290 m. The five remaining sites are all located centrally above longwall panels. Given the limited risks of impacts, the Department does not consider that the scientific or cultural benefit of avoiding the risk of impacts is warranted.

Economic Value and Risks

The EIS's Economic Assessment calculated that the Project would provide a net benefit to the community of NSW of around $1,073.2 million in net present value (NPV) terms, comprising $497.8 million in direct benefits and $583.4 million in indirect benefits.

The majority of direct benefits would flow to State and local Governments, with $272 million (NPV) in royalties, payroll tax and Council rates. Nearly $151 million (NPV) would come to NSW as Commonwealth company income tax apportioned to NSW. About $75 million (NPV) would come to NSW shareholders of South32 as distributions from the producer surplus.

Indirect benefits would accrue either to NSW workers employed by the Project ($365.8 million (NPV)) or to NSW suppliers of goods and services to the Project ($217.6 million (NPV)).

The Project's operational workforce would be in the order of 500 full-time equivalent personnel, including both direct South32 employees and on-site contractors, while construction and development would require up to approximately 207 additional personnel in the first year of the Project. Other construction activities would be undertaken at other times over the life of the Project, with smaller associated construction workforce peaks.

The Economics Assessment calculated that projected direct employment would lead to gross income for the NSW economy of $1,802.3 million (NPV) and an associated increase in worker benefit of $365.8 million (NPV).

Approximately 75% of the mine's current and expected suppliers are currently based in NSW. Their supply of goods and services to the Project would result in a net supplier benefit (ie producer surplus) for the NSW economy of $217.6 million (NPV). The projected increase in gross state product for NSW is $2,285.8 million (NPV). The Local Effects Analysis shows an estimated net benefit of $116.1 million (NPV) to the local area over the life of the Project, and a net benefit to the greater Wollongong area or around $431.3 million (NPV).

South32 primarily sells a blended coking coal product comprising Bulli Seam coal from its Appin Mine and Wongawilli Seam coal from its Dendrobium. BAEconomics reported that Dendrobium is a low cost mine with high production while Appin is a high cost mine with lower production. Without ongoing coal production from Dendrobium Mine, BAEconomics considered that South32 would not be able to average its costs across the two mines and could not produce its blended product. The Appin Mine may also not be able to remain economically viable.

BlueScope sources around 88% of its coking coal from the Southern Coalfield, with around 68% of that proportion coming from South32. BlueScope's blast furnace is optimised to use coke with characteristics the same or very similar to that produced from the coal blend provided by South32.

Around 70% of the coal shipped through PKCT is supplied by South32. BAEconomics reported that a total loss of Dendrobium coal exports would result in a very significant increase in PKCT's loadout costs per tonne, making that operation economically marginal under average conditions in the global coal market. Closure of both South32 mines would therefore also possibly lead to closure of PKCT. This in turn could threaten the viability of the other coal mines in the Southern Coalfield.

According to BAEconomics, the worst-case scenario would be for closure of South32's two mines to lead to a cessation of coal exports through PKCT and the production of primary steel at BlueScope. This would lead to direct job losses estimated to be about 6,586 workers. It would also result in an estimated direct loss of annual output of $3.89 billion per year for the domestic economy, and a total output loss for the economy, including flow-on effects, or around $10.7 billion per year.

Conclusion

The Department has carefully weighed the environmental impacts of the Project against the significance of the Project's identified coking coal resource and the wider socio-economic benefits associated with continued operation of the Dendrobium Mine for a further 25 years.

The Project would provide major economic and social benefits for Wollongong and its surrounding region and to NSW. The Department considers that South32 has designed the project in a manner that achieves a good balance between maximising the recovery of a coal resource of State significance and minimising the potential impacts on the water resource, biodiversity values and other environmental values of the Metropolitan Special Area.

The Department has accepted all 14 recommendations of the Mining Panel regarding assessment and ongoing management of the Project.

The Department has recommended a comprehensive and precautionary suite of conditions to ensure that the Project complies with contemporary criteria and standards, that the impacts remain consistent

with those predicted by South32, and that residual impacts are effectively minimised, managed and/or compensated for. These conditions reflect the recommendations of the Mining Panel.

In essence, the Project is the continuation of current mining practices at Dendrobium Mine in two new mining areas. Most of the Mine's impacts on the community and environment would remain unchanged from those currently experienced. The key change is not in mining or other operational practices or the scale of operations, but that two new mining areas would be impacted.

However, South32 has proposed additional limitations on its operations in order to reduce expected environmental impacts below those of its existing operations. These include:

- formalising a 300 m setback from stored waters and a minimum 1,000 m setback from the walls of Avon and Cordeaux Dams;
- reducing impacts on major named creeks, such as Donalds Castle Creek;
- increased offsetting of its impacts on upland swamps;
- implementing substantial impact mitigation and remediation measures for 57 key stream features; and
- very substantial offset payments to compensate for its surface water take, with these payments able to be used by Government for capital projects to enhance Sydney's water supply.

The existing development consent and other regulatory arrangements have provided a robust management framework to limit the Mine's environmental impacts. In particular, the Department's current performance measures, requirements for Extraction Plans and Trigger Action Response Plans and offsets have been effective in this respect.

However, the Department has also recommended strengthening a number of key consent conditions, including:

- performance measure of negligible environmental consequences for Avon and Cordeaux Rivers;
- requiring early preparation and regular review of a Mine Closure Plan, which would contain a detailed mine closure strategy for Dendrobium Mine;
- rehabilitation objectives to include:
  - remediation of physical damage as soon as reasonably practicable (unless the environmental impacts of remediation exceed the environmental benefits) in four unnamed third order streams, as well as the four major named watercourses and all identified key stream features;
  - negligible environmental consequences from any mine water discharges that occur after Project completion;
- improved monitoring of upland swamps; and
- regular review of the groundwater model for the development.

On balance, the Department believes that the Project's benefits significantly outweigh its residual costs, and that it is in the public interest and is approvable, subject to the recommended conditions.

1 Introduction

1.1.1 Illawarra Coal Holdings Pty Ltd, a subsidiary of South32 Limited (South32) is the owner and operator of the Dendrobium underground coal mine, located some 8 kilometres (km) west of Wollongong in the Southern Coalfield of NSW. South32 is seeking development consent for the Dendrobium Mine Extension Project (the Project), known by the company as *Dendrobium Mine – Plan for the Future: Coal for Steelmaking*.

1.1.2 The existing mine received development consent in 2001, has been extracting coal by longwall methods since April 2005 and has approval to extract coal until 31 December 2030.

1.1.3 The regional location of the existing Dendrobium Mine is shown in **Figure 1**. A more local context for the Mine and the Project is shown in **Figure 2**.

1.1.4 The Dendrobium Mine currently extracts coal from the Wongawilli Seam and primarily produces hard coking (ie metallurgical) coal, used for steelmaking. The mine is approved to mine up to 5.2 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal and is primarily regulated under development consent DA 60-03-2001 (as modified) and Consolidated Coal Lease (CCL) 768. The mine is also regulated under a number of approvals under other State legislation and also has a Commonwealth approval (EPBC 2001/214).

1.1.5 ROM coal from the mine is washed (ie processed) at the Dendrobium Coal Preparation Plant (CPP) to produce saleable coal products. The general arrangement of the approved Dendrobium Mine is shown in **Figure 2**. Key existing surface facilities at the Dendrobium Mine include the:

- Dendrobium Nos 1, 2 and 3 Shafts, which are ventilation shafts connecting the underground mine to the overlying surface;
- Dendrobium Pit Top facilities;
- Kemira Valley Coal Loading Facility (KVCLF);
- Kemira Valley Rail Line;
- Dendrobium CPP, located within the BlueScope Steelworks in the Port Kembla industrial precinct; and
- West Cliff Stage 3 Coal Wash Emplacement (CWE).

1.1.6 The Dendrobium Mine currently has five approved underground mining areas. Coal extraction is complete in Areas 1 and 2, largely complete in Area 3A, well underway in Area 3B and yet to commence in Area 3C.

1.1.7 Exploration in the remaining undeveloped extraction area (Area 3C) has determined that the coal in this area has a high level of contained gas (principally carbon dioxide). The high level of gas makes it unsafe to mine this coal unless the gas is first drained via underground boreholes. The amount of drilling required and the time taken for the gas to drain from the workings means that the majority of Area 3C cannot be mined for many years, perhaps 2032.

1.1.8 Unless a longwall mine maintains continuous production of longwall coal, its running costs far outweigh its revenue. For this reason, South32 needs to identify and gain approval to mine other sources of longwall coal, until the drainage of gas from Area 3C is completed.

1.1.9 The Project focuses on the development of two new longwall mining domains at the Dendrobium Mine known as Area 5 and Area 6, from which South32 proposes to recover 78

million tonnes (Mt) of ROM coal. Development of Areas 5 and 6 would extend the life of the Dendrobium Mine from 2030 until 2048. The spatial relationships between the currently approved mining areas and the proposed Areas 5 and 6 is shown in **Figures 1** and **2**.

1.1.10 Should the Project be approved, South32 proposes to complete mining in Area 3B (together with a small remaining longwall block in Area 3A), then extract two small longwall blocks from the southern fringes of Area 3C, then initiate and complete extraction of the Project's Area 5 and then undertake extraction of the remainder of Area 3C. Following this, South32 would initiate and complete extraction of Area 6. This sequence of coal extraction is intended to provide South32 with a continuous (or near continuous) supply of longwall coal until 2048.

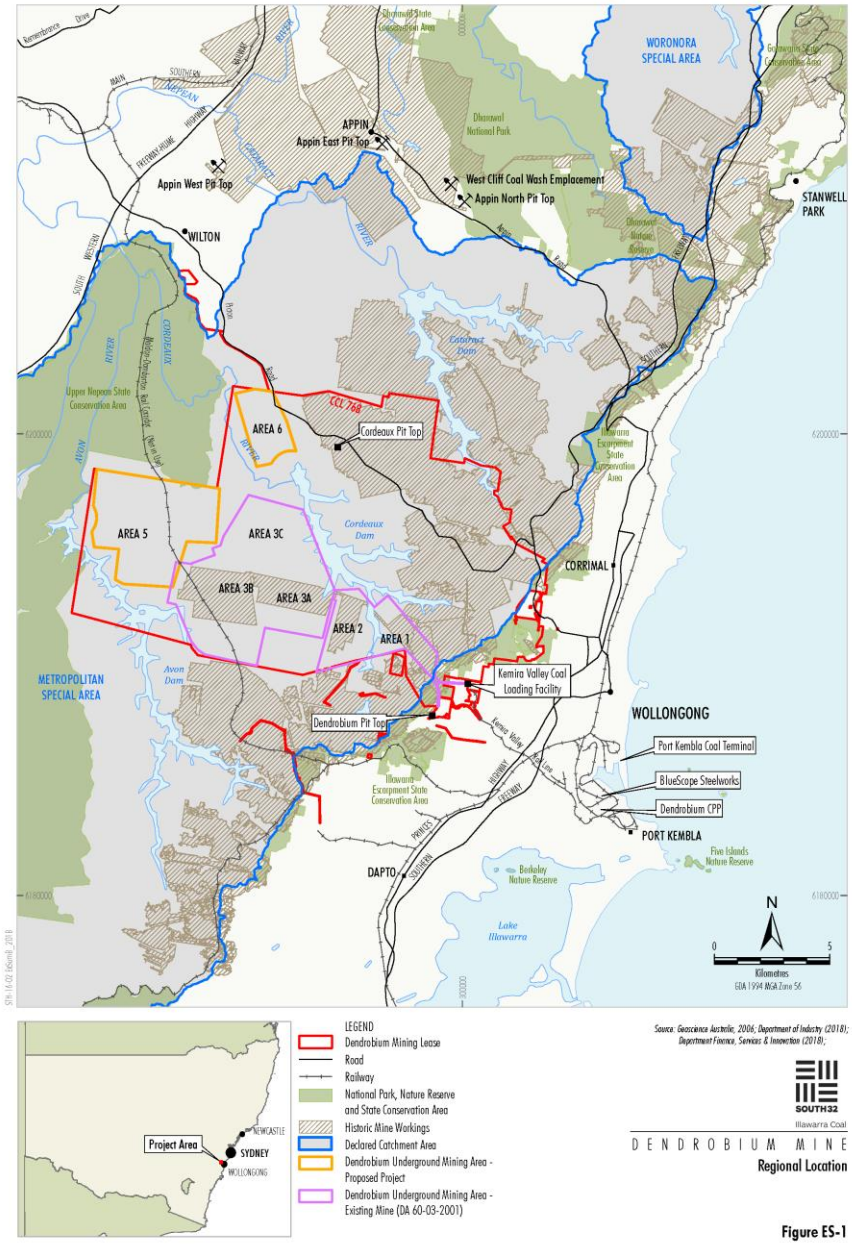


Figure 1 | Regional Context Map *(Source: EIS)*

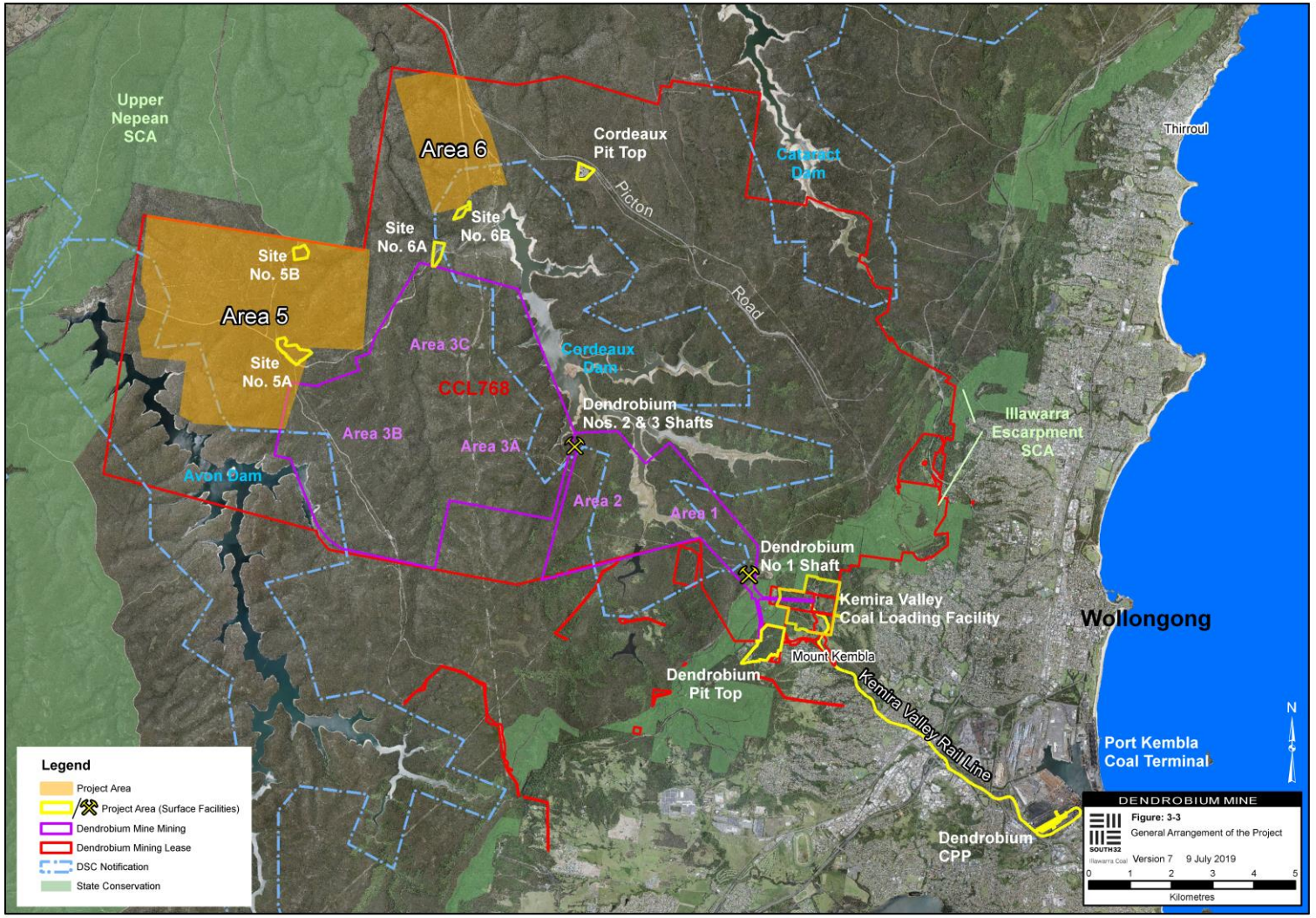


Figure 2 | Local Context and Existing Mine and Project General Arrangement
(Source: EIS)

1.1.11 The Project does *not* include underground mining operations in Areas 1, 2, 3A, 3B and 3C and associated surface activities such as monitoring and remediation. These operations would continue to be regulated under the existing consent DA 60-03-2001. South32 does not have approval to extract its identified Area 4 and no approval to do so is sought under the Project, since it is overlain by a significant number of upland swamps.

1.1.12 In essence, the Project is the continuation of coal mining at the existing Dendrobium Mine, based on the underground extraction of coal from two new mining areas. South32 is proposing that the two new mining areas together with all existing surface operations and all new and existing underground mining roads would be managed under a fresh development consent. These are the primary components of the Project. However, the existing approved mining areas would continue to be managed under the old development consent DA 60-03-2001. Consequently, the two consents would overlap in both area and effect for some time as South32 is not proposing to surrender its existing consent and has not yet lodged an application to align DA 60-03-2001 with any new consent granted for the Project.

1.1.13 The Project's Areas 5 and 6 are located within the catchments of the Avon and Cordeaux Rivers, and the associated Avon and Cordeaux Dams, which are part of Greater Sydney's water supply system. These catchments are included within the Metropolitan Special Area, which is a 'Special Area' declared under the *WaterNSW Act 2014* and managed by WaterNSW (see **Figure 1**).

1.1.14 In the absence of the Project, South32 has indicated that it expects longwall mining at Dendrobium Mine would be discontinued in 2024. That is, unless approval to extract (at least) Area 5 is obtained, mining of the great majority of Area 3C would not proceed, owing to the extended discontinuity in longwall production until that Area can be adequately drained of underground gas.

1.1.15 The Project underground mining areas would be located wholly within South32's existing mining lease CCL 768. No additional mining leases are required for the Project.

2 Project

2.1 Project Overview

2.1.1 As set out in its Environmental Impact Statement (EIS, see **Appendix A**), the Project would include the following development:

- longwall mining of the Bulli Seam in a new underground mining area (Area 5);
- longwall mining of the Wongawilli Seam in a new underground mining area (Area 6);
- development of underground roadways within the Bulli Seam, Wongawilli Seam and other strata required to access these two mining areas;
- use of existing underground roadways and drifts for personnel and materials access, coal clearance, ventilation, dewatering and other ancillary activities related to Areas 5 and 6;
- development of surface infrastructure associated with mine ventilation and gas management and abatement, water management, and other ancillary infrastructure;
- handling and processing of up to 5.2 Mtpa of ROM coal;

- use of the existing Dendrobium Pit Top, KVCLF, Dendrobium CPP and Dendrobium Ventilation Shafts with minor upgrades and extensions;
- transport of sized ROM coal from the KVCLF via the Kemira Valley Rail Line to the Dendrobium CPP;
- use of the Cordeaux Pit Top for mining support activities to reduce underground travel time for workers and delivery of materials while underground development and longwall mining occurs in Area 6;
- augmentation of mine access arrangements, including upgrades to, and the use of, the existing Cordeaux Pit Top;
- delivery of product coal from the Dendrobium CPP to the BlueScope Steelworks at Port Kembla for domestic use or to the Port Kembla Coal Terminal (PKCT) for export or for seaborne transport to the Liberty Primary Steel Whyalla Steelworks at Whyalla;
- transport of coal wash by road to customers for engineering purposes (eg civil construction fill), for other beneficial uses and/or for emplacement at the West Cliff CWE Stages 3 and 4;
- development and rehabilitation of the West Cliff Stage 3 CWE;
- progressive development of sumps, pumps, pipelines, water storages and other water management infrastructure;
- controlled release of excess water in accordance with the conditions of Environmental Protection Licence 3241;
- monitoring, rehabilitation and remediation of subsidence and other mining effects; and
- other associated infrastructure, plant, equipment and activities.

2.1.2 The Project would continue to make use of the existing Kemira Valley Rail Line, which connects the KVCLF directly to the Dendrobium CPP. The Project was independently estimated in March 2019 to have an overall capital investment value of $956 million.

2.1.3 The Project would use existing pit tops and supporting infrastructure. Additional infrastructure and upgrades to existing infrastructure required to support the Project would be progressively developed in parallel with ongoing mining operations, including:

- development of underground roadways, coal clearance infrastructure and other ancillary infrastructure required to access and support the two new underground mining areas;
- underground mining machinery replacement and upgrades;
- development and augmentation of mine ventilation infrastructure;
- additional gas management and abatement infrastructure;
- upgrades to the Dendrobium Pit Top and decommissioning and removal of redundant infrastructure;
- upgrades to the Cordeaux Pit Top and decommissioning and removal of redundant infrastructure to facilitate workers and materials access during development and mining operations in Area 6;
- ongoing maintenance and upgrades of the Kemira Valley Rail Line and water management infrastructure;
- upgrades and replacement of infrastructure at the Dendrobium CPP and removal of redundant infrastructure; and
- minor augmentations and upgrades of other surface facilities.

2.1.4 Construction would generally occur 7.00 am to 5.00 pm Monday to Sunday. Some construction and development works (eg drilling and construction of ventilation shafts, and underground development activities) would occur on a 24 hour per day basis.

2.1.5 Additional mobile equipment would be required for periods during construction and development activities; including drill rigs, mobile cranes, excavators, loaders and delivery trucks.

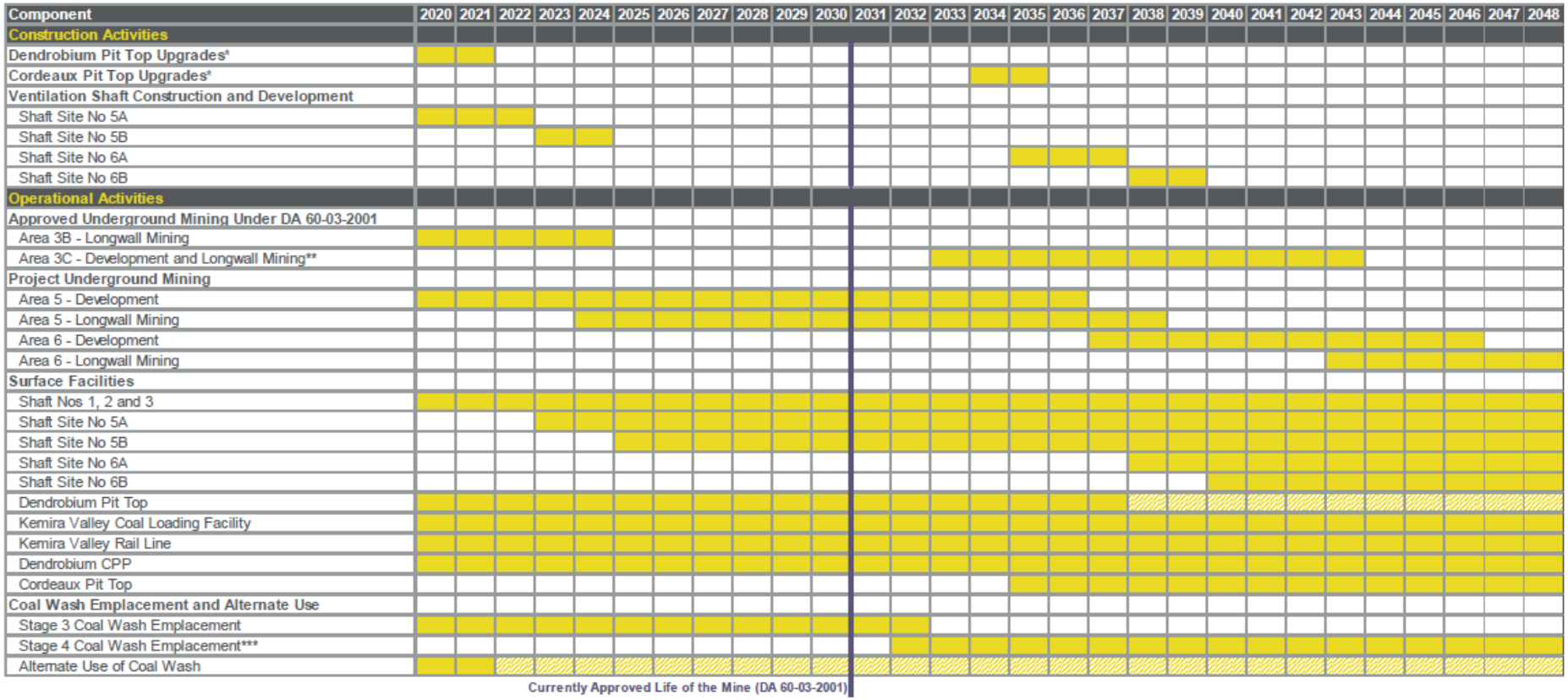
2.1.6 A summary of the main components of the Project, compared with those of the existing approved operations at Dendrobium Mine, is set out in **Table 1**. An indicative project schedule is set out in **Table 2**.

Table 1 | Main Components of the Project, Compared with Existing Approved Operations

Aspect	Existing Dendrobium Mine	Project
Mine Life	Until 31 December 2030	Until 31 December 2048
Mining Method	Underground extraction using longwall mining methods	No change
Resource	Mining of the Wongawilli Seam in Areas 1, 2, 3A, 3B and 3C	Mining of the Bulli Seam in Area 5 and the Wongawilli Seam in Area 6
Annual Production	Handling and processing of up to 5.2 Mtpa of ROM coal	No change
Resource Recovered	Approximately 35 Mt of ROM coal, as at 1 July 2019	Approximately 78 Mt of additional ROM coal
Coal Handling and Processing	Transport of coal from underground workings via an underground conveyor network to the KVCLF for sizing and stockpiling ROM coal transport to the Dendrobium CPP via the Kemira Valley Rail Line Processing of up to 5.2 Mtpa of sized ROM coal at the Dendrobium CPP	No change
Management of Mining Waste	Transport of up to approximately 1.1 Mtpa of coal wash by road from the Dendrobium CPP to Stages 3 and 4 of the West Cliff CWE Development and rehabilitation of the West Cliff Stage 3 CWE Coal wash supply to customers for civil construction fill or other beneficial use	Transport of up to approximately 1.6 Mtpa of coal wash by road from the Dendrobium CPP to Stages 3 and 4 of the West Cliff CWE No change No change

Aspect	Existing Dendrobium Mine	Project
General Infrastructure	Dendrobium Pit Top Kemira Valley Coal Loading Facility (KVCLF) Kemira Valley Rail Line Dendrobium CPP Dendrobium Ventilation Shafts Nos 1, 2 and 3	Continued use of existing infrastructure with minor upgrades and extensions Augmentation of mine access arrangements, including upgrades to and use of the existing Cordeaux Pit Top Development of ancillary infrastructure including surface infrastructure associated with mine ventilation and gas management
Product Coal Transport	Delivery from Dendrobium CPP to BlueScope Steelworks (primarily by conveyor) or to PKCT (by trucks using a private road)	No change
Water Management	Water management infrastructure to separate clean, oily and dirty water Use of a combination of recycled treated mine water and potable water purchased from Sydney Water in underground and surface operations Release of excess water in accordance with the conditions of EPL 3241	Augmentations and use of existing water management infrastructure Continued use of a combination of recycled treated mine water and water purchased from Sydney Water Continued release of excess water in accordance with the conditions of EPL 3241. Release volumes and release infrastructure to be modified as required based on mine inflow rates
Workforce	Current workforce of approximately 400 personnel (including South32 staff and on-site contractor personnel)	At full development, employment of c. 500 operational personnel (including South32 staff and on-site contractor personnel) Up to c. 200 contractor personnel required for surface facility construction and development of underground gateroads and infrastructure to support longwall mining
Hours of Operation	Operated on a continuous basis, 24 hours per day, seven days per week Trains do not travel on the Kemira Valley Rail Line between 11.00 pm and 6.00 am, unless written approval is obtained for emergency use	No change No change

Table 2 | Indicative Construction and Operational Schedule *(Source: EIS)*



* The construction timeframes specified (i.e. 2-year periods) represent a likely construction window, with the majority of construction activities occuring intermittently within the 2-year period

** Subject to separate assessment and approval of an extension of Development Consent DA 60-03-2001 from 31 December 2030 to 31 December 2048

*** Subject to separate assessment and approval of an extension of Project Approval 08_0150 from 31 December 2041 to 31 December 2048

2.2 Underground Mining

Mine Design

2.2.1 The Project involves the development of longwall panels of up to 305 metres (m) void width, with tailgate chain pillar widths generally of 44 or 45 m.[1] Extraction heights in the Bulli Seam in Area 5 would be up to 3.2 m, and up to 3.9 m in the Wongawilli Seam in Area 6. Mining in Area 5 would occur at depths of 250 to 390 m below the surface, and 375 to 460 m below the surface in Area 6.

2.2.2 Areas 5 and 6 are two distinct (ie non-adjoining) mining domains with differing major constraints. Area 5 is constrained by the extent of CCL 768 to the west and north and the extent of the approved Area 3 to the east. Area 5 is also constrained by igneous intrusions to the east and the Avon Dam and Avon River to the south and south-west. Area 6 is constrained by Cordeaux Dam and Cordeaux River to the south and west, the extent of CCL 768 to the north and a fault zone to the east.

2.2.3 South32 has also incorporated three sets of key longwall design setbacks in the mining layout for Areas 5 and 6 to reduce potential environmental impacts. South32's EIS states that this is *"in consideration of previous mining experience in Dendrobium Mine Area 3B and key stakeholder feedback"*. These three key self-imposed design constraints (see **Figure 11**) are:

- longwall setbacks from both the Avon and Cordeaux Dam walls (minimum setback distance of 1,000 m);
- no direct undermining of the existing Avon and Cordeaux Dam waterbodies, with a minimum 300 m longwall setback from their existing Full Supply Level (FSL); and
- longwall setbacks from named watercourses (ie Cordeaux River, Avon River and Donalds Castle Creek) to achieve 200 millimetres (mm) or less of predicted Project-related valley closure as a result of subsidence.

2.2.4 South32 then imposed additional constraints within the remaining layout to protect what it termed 'key stream features' (see **Figure 11**). South32 considered these to be any permanent pool >100 cubic metres (m^3) in volume and any waterfall or step >5 m in height and with a permanent pool at the base, as identified during South32's site investigations.

2.2.5 South32 has committed to avoid direct undermining of all such features and also to longwall panel setbacks of:

- 50 m when mining occurs on one side of the 'key stream feature'; and
- 100 m when mining occurs on more than one side of the 'key stream feature'.

2.2.6 The EIS's resulting proposed longwall layout is shown in **Figure 3**.

2.2.7 It is important to note, however, that the EIS specifically states that this proposed layout is not fixed or final. The EIS describes its proposed longwall layout as the 'Base Plan Longwalls' and then states that, *"There are a number of alternative longwall layouts that would also meet these same Project constraints and, therefore, achieve the same environmental outcome"*.

[1] Longwall (LW) 515 and LW 516 are proposed to have void widths of 280 and 285 m, respectively, and LW 512 is proposed to have a void width of 205 m over the last 800 m of its length. Tailgate chain pillar width is proposed to be 35 m for LW 511 and LW 512.

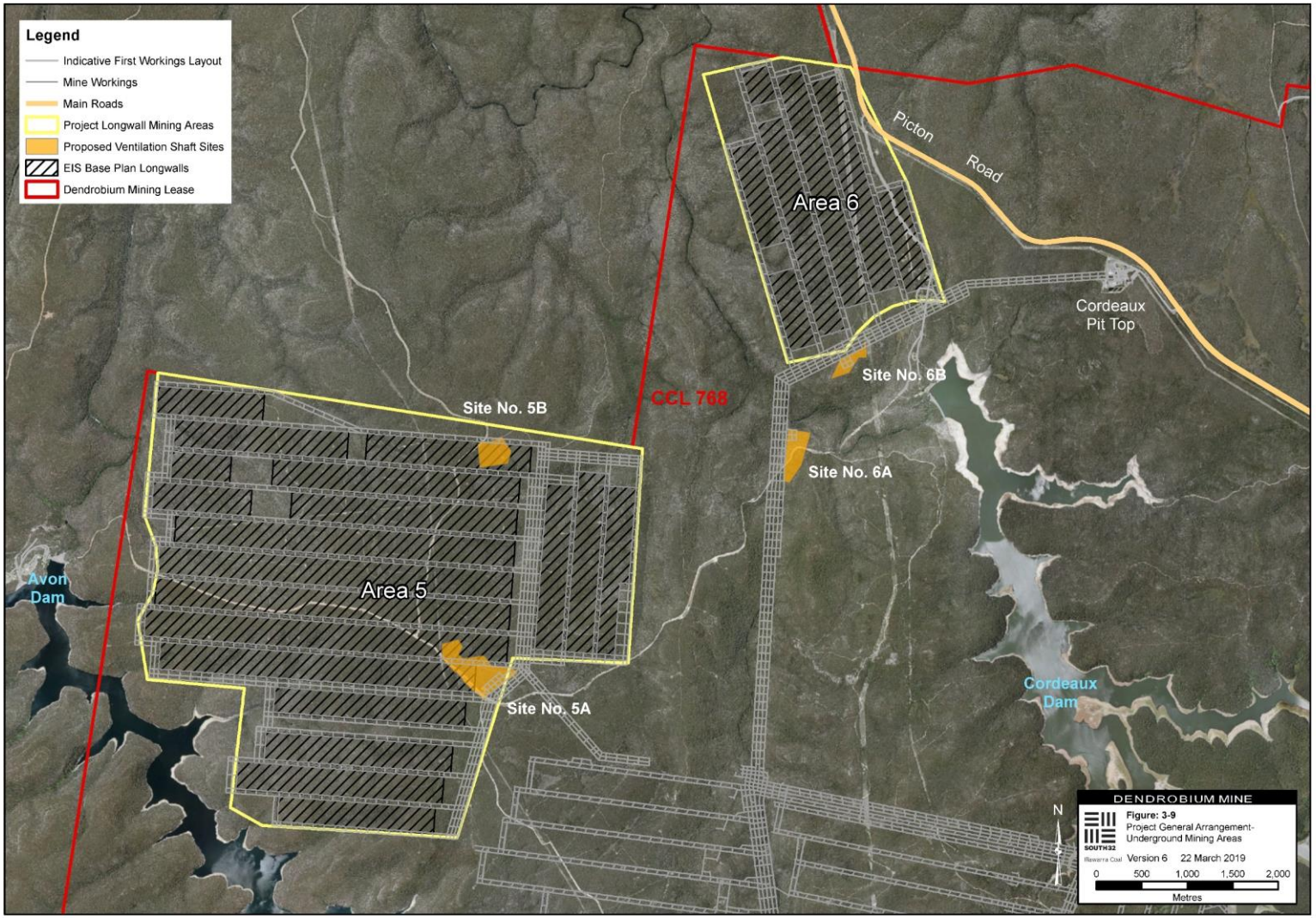


Figure 3 | EIS's 'Base Plan' Longwall Layout
(Source: EIS)

2.2.8 The EIS proposes that these design constraints are 'referenced' (ie as performance measures or other limits) in any consent granted for the Project and also proposes that *"Final Project longwall layouts would be subject to review and approval as a component of future Extraction Plans developed in consultation with the relevant authorities and to the satisfaction of the Secretary."*

2.2.9 Consistent with current regulatory practice, South32 has committed to implement an 'adaptive management' approach to achieve all subsidence performance measures imposed by any consent which it receives. Adaptive management would involve monitoring and periodic evaluation of environmental consequences against the performance measures. If necessary, mitigation measures, mine design and/or mining extent would be adjusted to achieve the performance measures.

2.2.10 The EIS's indicative mining schedule for the Project is presented in **Table 3**. As with any major underground project, Tthe EIS indicates that actual timing and mining sequence may vary for a number of reasons, including in response to localised geological features or coal quality characteristics, detailed mine design requirements, overall mine economics, market volume requirements, and/or adaptive management requirements.

Table 3 | Indicative Mining Schedule - Project and Area 3 *(Source: EIS)*

Project Year	ROM Coal Production (Mt)		Project ROM Coal Handling and Processing (Mt)		
	Approved Dendrobium Mine Mining (Area 3) (DA 60-03-2001)*	Project Underground Mining Areas (Areas 5 and 6)	Total ROM Coal	Coal Wash (Wet)	Total Product Coal
1	4.7	0.2	4.9	1.3	3.7
2	4.4	0.1	4.5	1.2	3.4
3	3.8	0.2	4.0	1.0	3.1
4	3.2	0.4	3.6	0.9	2.7
5	2.0	1.2	3.2	0.8	2.6
6	-	3.4	3.4	0.5	3.0
7	-	5.2	5.2	0.8	4.6
8	-	4.9	4.9	0.7	4.4
9	-	4.4	4.4	0.6	3.9
10	-	4.3	4.3	0.6	3.8
11	-	3.7	3.7	0.5	3.3
12	-	3.8	3.8	0.5	3.4
13	0.0	4.1	4.1	0.5	3.7
14	0.2	3.8	4.0	0.5	3.5
15	0.3	3.3	3.6	0.5	3.1
16	0.3	2.9	3.2	0.5	2.7
17	0.3	3.2	3.5	0.6	3.0
18	0.2	3.6	3.8	0.7	3.2
19	0.2	3.5	3.7	0.6	3.1
20	3.1	0.5	3.6	0.9	2.7
21	3.6	0.3	3.9	1.1	2.8
22	3.7	0.3	4.0	1.1	3.0
23	3.3	0.3	3.6	1.0	2.7
24	1.4	2.3	3.7	1.2	2.6
25	-	3.6	3.6	1.2	2.6
26	-	4.3	4.3	1.5	3.1
27	-	4.7	4.7	1.6	3.2
28	-	4.7	4.7	1.6	3.3
29	-	0.4	0.4	0.1	0.3

Note: The combined total of product coal and coal wash is greater than total ROM coal due to changes in moisture content. Other totals may not add exactly due to rounding.

* ROM coal extraction in Area 3 would continue to be conducted in accordance with Development Consent DA 60-03-2001.

Underground Mine Development

2.2.11 Underground roadways would be developed to support the Project's two underground mining areas in respect of access, ventilation and coal clearance.

2.2.12 Underground infrastructure for coal clearance would be installed for the two new mining areas. Existing coal clearance infrastructure would also be upgraded or augmented progressively throughout the life of the Project through replacement or upgrade of conveyors, sizers, drives, winders and supporting systems. Other ancillary infrastructure required to support the Project underground mining areas includes infrastructure for electricity distribution, communication systems, water management, services and service delivery (eg boreholes to the surface).

2.2.13 Underground mining operations would be conducted on a continuous basis, 24 hours per day, seven days per week.

2.3 Surface Development

New Ventilation Shafts

2.3.1 The Project would involve construction and use of the following ventilation shaft infrastructure (see **Figure 3**):

- an additional ventilation shaft site to support Area 5 (Site No 5A), with a maximum disturbance area of approximately 7.5 hectares (ha);
- an optional additional ventilation shaft site to support Area 5 (Site No 5B), with a maximum disturbance area of approximately 3 ha; and
- two additional ventilation shaft sites to support Area 6 (Site No 6A and Site No 6B), with maximum disturbance areas of approximately 4 ha each.

2.3.2 Construction of ventilation shaft sites for the Project would involve:

- improvement of existing tracks and construction of new tracks to allow access, as necessary;
- development of concrete-lined or steel-lined ventilation air shaft(s);
- installation of ventilation fan(s) if the site would be used as an upcast ventilation shaft;
- installation of transmission lines and power supply and associated electrical switchroom, transformer and ancillary infrastructure for these ventilation fans;
- installation of appropriate security (ie fencing) to prevent unauthorised access to the ventilation shaft sites;
- construction of sumps for the containment of drilling process water (pending its disposal underground or off-site);
- installation of erosion and sediment control infrastructure, where required;
- installation of an access/egress winder at the ventilation shaft sites to facilitate emergency transportation to/from underground mining operations; and
- other minor associated works.

2.3.3 South32 expects that the shafts would be constructed from the surface down to the underground workings. Using this method, the shaft construction would take place in advance of development workings, with material from the excavation being removed from the top of the shaft.

2.3.4 The EIS proposes that excavated material resulting from the construction of the shafts is used as engineered fill and for construction of sediment dams. Any excess material is proposed to be stockpiled on the shaft sites, revegetated and used for future rehabilitation of the shaft site (ie infilling) on decommissioning.

2.3.5 Excavation of the shafts would occur 24 hours per day, seven days per week, while the remainder of construction activities associated with the ventilation shafts (eg installation of surface infrastructure) would generally be limited to daytime hours.

2.3.6 Some of the ventilation shaft sites would also be used for the installation of 'service boreholes' to deliver electricity, compressed air, diesel, and clean water required for the advancing longwall operations or for ventilation.

2.3.7 The Project would also involve continued use of existing Dendrobium Ventilation Shafts Nos 1, 2 and 3 (see **Figure 2**). Ventilation fans, electrical infrastructure and other infrastructure at the existing Dendrobium Shafts may be upgraded or replaced during the life of the Project. The ventilation fans at Dendrobium Shaft No 3 may also be removed during the life of the Project and the site converted to a downcast ventilation shaft.

Management of Mine Gas

2.3.8 As is currently the case, South32 is proposing that mine gas would be flared or else vented to the atmosphere (if the gas was too low in methane content for flaring or for other operational reasons).

2.3.9 The EIS proposes that any new mine gas management infrastructure would be constructed at the two upcast ventilation shaft sites. Gas management infrastructure would be fully fenced, and may include flares, pumps, nitrogen tanks, gas monitoring equipment, water collection, surface pipes and other ancillary infrastructure.

Dendrobium Pit Top

2.3.10 Upgrades at the Dendrobium Pit Top would include:

- construction of additional car parking facilities on the southern side of Cordeaux Road, including an additional intersection with Cordeaux Road;
- extension and relocation of bathhouses (eg change rooms), locker facilities and administration buildings; and
- additional electricity distribution infrastructure.

2.3.11 Other minor upgrades and augmentations would occur within the current disturbance footprint. Existing infrastructure at the Dendrobium Pit Top that is no longer required (eg demountable buildings) may be decommissioned and removed.

Cordeaux Pit Top

2.3.12 Upgrades to the mothballed Cordeaux Pit Top would be necessary to allow it to be used for the proposed personnel and materials access to underground mining operations in Area 6. These upgrades would include:

- upgrades to existing shafts, and development of new shafts and/or drifts to facilitate access to, ventilation of, and provision of services to the underground workings in Area 6;
- development of new buildings, and extension of existing buildings, within the existing surface lease to provide additional bathhouse facilities (eg change rooms), locker facilities, administration facilities and workshop areas;
- upgrades to existing water management infrastructure and development of new water management infrastructure; and
- upgrades to electricity distribution infrastructure.

2.3.13 Other minor upgrades and augmentations would occur within the existing surface lease area and current disturbance footprint. Existing infrastructure that is no longer required (eg the existing coal bins) may be decommissioned and removed.

Kemira Valley Rail Line

2.3.14 A rail control room would be developed for the Kemira Valley Rail Line during the life of the Project. Additional water management and ancillary infrastructure may also be installed within the Kemira Valley Rail Line easement. Components of the Kemira Valley Rail Line would be replaced, upgraded or augmented during the life of the Project, including track work, culverts, crossings, signalling, fencing and screening.

Dendrobium CPP

2.3.15 A new conveyor from the Dendrobium CPP to the washed coal stockpile would be developed during the life of the Project.

2.3.16 Existing components of the Dendrobium CPP would be replaced, upgraded or augmented during the life of the Project, including (but not necessarily limited to) conveyors, surge bins, storage bins, tanks, sumps, filters, centrifuges, thickeners, chutes, skirts, scrapers, sprays and electrical infrastructure.

2.3.17 Existing infrastructure at the Dendrobium CPP that is no longer required (eg coal bins that are no longer in use) may be decommissioned and removed.

Water Management System Upgrades

2.3.18 Development of the two new mining areas and related underground headings would lead to a substantial increase in groundwater inflows to the mine, which would increase the volume of water to be transferred off-site for licensed discharge. The EIS anticipates that this may require augmentation or duplication of some water management infrastructure.

2.3.19 In particular, the EIS anticipates that the existing excess water pipeline that follows the Kemira Valley Rail Line to the licensed discharge point (LDP5) at Allans Creek in Unanderra would need to be upgraded, replaced or duplicated. Any duplicated pipeline would run parallel to the existing 7 km excess water pipeline from Kemira Valley storage tank to LDP5. The anticipated diameter of the duplicated pipeline is similar to that of the existing pipeline and would be located within the existing infrastructure corridor.

Other Surface Facilities

2.3.20 Upgrades to other supporting facilities (such as the KVCLF) during the life of the Project would be within current disturbance footprints and would involve replacement, upgrade or addition of existing components.

2.4 Related Developments

2.4.1 The **BlueScope Steelworks** at Port Kembla was originally developed due to its proximity to the coal mines of the Southern Coalfield. With an annual production capacity of approximately 3.0 Mtpa, the BlueScope Steelworks is the largest steel production facility in Australia and one of only two Australian primary iron and steelmaking facilities. South32 currently supplies the BlueScope Steelworks with around 52% of its overall metallurgical coal purchases of 2.9 Mtpa, or around 60% of its overall coking coal purchases.[2]

2.4.2 **PKCT** is a coal export and import terminal located at Port Kembla which is owned by a consortium of six equal shareholders, which are all coal mining companies operating in the NSW Southern and Western Coalfields. The consortium comprises:

- Illawarra Metallurgical Coal (owned by South32);
- Centennial Coal Company Ltd (owned by Banpu Public Company);
- Wollongong Coal (owned by Jindal Steel and Power);
- Tahmoor Coal Pty Ltd (owned by SIMEC Mining);
- Metropolitan Collieries (owned by Peabody Energy Australia); and
- Oakbridge Coal (owned by Glencore Pty Ltd, but not currently sending coal to PKCT).

2.4.3 South32 operates the terminal on behalf of the consortium.

2.4.4 PKCT receives coal from coal mines operated by these companies via both public and private road and by rail. PKCT has two bulk handling facilities, Berths 101 and 102. Berth 102 is dedicated to the loading of coal.

2.4.5 The great majority of product coal from the Project that is not delivered from the Dendrobium CPP to BlueScope by conveyor would be trucked to PKCT via private road, where it would be stockpiled for seaborne transport to Liberty Primary Steel Whyalla Steelworks, or for international export.

2.4.6 South32 also operates another major underground coal mine in the Southern Coalfield, known as the **Bulli Seam Operations** or the Appin Mine (see **Figure 1**). This mine has two operating pit tops (Appin East and Appin West) which are located just south of and west of the township of Appin, which in turn is 16 km south of Campbelltown. The Bulli Seam Operations also encompass a further, non-operating mine (the former West Cliff Colliery), at which South32 operates a coal preparation plant (the West Cliff CPP) which is used to upgrade the quality of the ROM coal produced by the Bulli Seam Operations.

2.4.7 The waste products from coal washing at both the Dendrobium CPP and West Cliff CPP are emplaced in a landfill also located at West Cliff Colliery (the West Cliff CWE). Development

[2] BlueScope requires about 2.5 Mtpa of coking coal and 0.4. Mtpa of 'Pulverised Coal Injection' (PCI) coal, both of which are used in its blast furnace to make liquid iron. 2.2 Mtpa of this coking coal and 0.2 Mtpa of this PCI coal comes from coal mines in the Southern Coalfield. PCI coal used for metallurgical purposes and the various types of coking coal are together known as 'metallurgical coal'.

and rehabilitation of Stage 3 of this emplacement is currently managed under the Dendrobium Mine's DA 60-03-2001, whereas the development and rehabilitation of Stage 4 of this emplacement is managed under the consent for the Bulli Seam Operations (MP 08-0150).

2.4.8 It is proposed that future *development and rehabilitation* of Stage 3 of the West Cliff CWE would be undertaken as part of the Project, rather than under DA 60-03-2001. However, development and rehabilitation of Stage 4 would continue to be managed under MP 08-0150. The trucking of coal washery waste from the Dendrobium CPP to both Stages 3 and 4 would be managed as part of the Project. Trucking from the West Cliff CPP is undertaken under MP 08-0150.

2.4.9 The **Cordeaux Colliery** (also owned by South32) was approved in 1974 with first coal being produced in 1980. Coal production ceased in March 2001 and the Colliery has since been in care and maintenance.

2.4.10 As noted above, the Project would include adaptive re-use of the Cordeaux Pit Top (located south of Picton Road and northeast of the Cordeaux Dam wall, see **Figure 2**) to reduce travel time for workers and materials while development and mining operations occur in Area 6.

2.4.11 **Figure 4** is a schematic plan showing the relationships between all key elements of the Project and the related but external elements that would continue to be managed under DA 60-03-2001 or MP 08-0150. The figure also shows the transport of ROM coal to the Dendrobium CPP, product coal to BlueScope Steelworks and PKCT and coal washery waste from Dendrobium CPP to the West Cliff CWE.

3 Strategic Context

3.1 Introduction

3.1.1 The Dendrobium Mine is part of an integrated coal mining, coke making, iron and steel making and coal and coke export complex located in the Illawarra Region of NSW. As set out in Section 2.4, South32 operates two large underground coal mines, which extract coal from beneath the Illawarra Plateau to the west of Wollongong in the Southern Coalfield. The company's Bulli Seam Operations are approved to extract up to 10.5 Mtpa of ROM coal. This Bulli Seam coal is prepared ('washed') to remove stony material at the West Cliff CPP. The Dendrobium Mine is approved to extract up to 5.2 Mtpa of ROM coal from the Wongawilli Seam, which is washed at the Dendrobium CPP.

3.1.2 A large proportion of the product coal from the two seams is blended to produce optimum quality coal which is used to make coke for steel making purposes. Blending takes place at Dendrobium CPP, prior to delivery to BlueScope Steelworks for coke making or to PKCT for shipping to the Liberty Primary Steel Whyalla Steelworks or for international export.

3.1.3 The following sections provide key background information on this strategic setting. However, the Department also sought expert advice on the downstream economic benefits of the existing Dendrobium Mine and the economic costs to the region should the Project not be approved. This critical information is set out in **Section 6.10**.

3.2 BlueScope Steelworks

3.2.1 Large quantities of metallurgical (primarily coking) coal are an essential raw material in the large scale (ie economic) production of iron and steel. Coal (in the form of coke) is introduced to a blast furnace together with pelletised iron ore and a flux (generally limestone). Molten iron is the product of this process. Approximately 770 tonnes (t) of coal is used to make 600 t of coke, which in turn is used to create 1,000 t of steel. There is no currently no economically viable alternative to the use of metallurgical coal as a reducing agent in a blast furnace (ie the method employed at the BlueScope Steelworks) at a commercial scale.

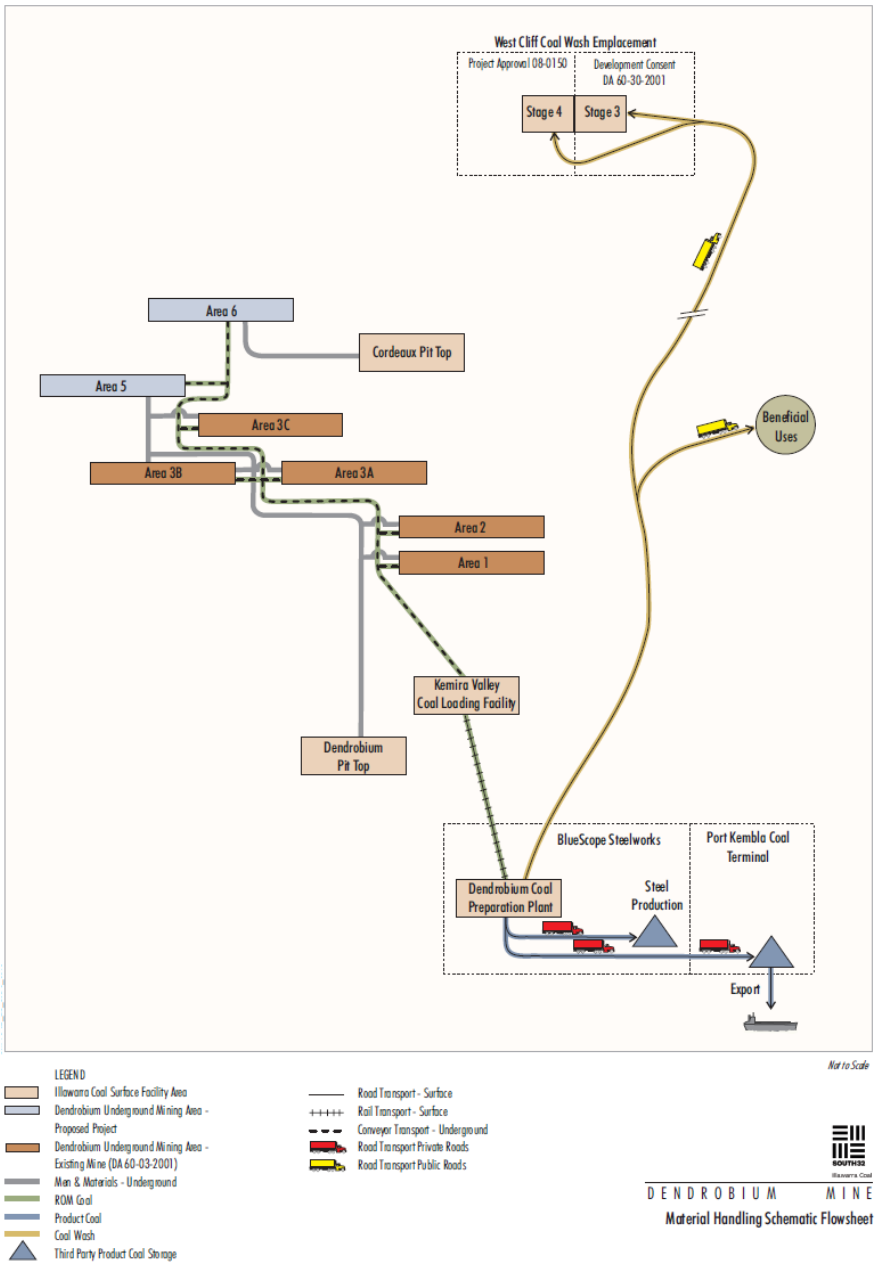


Figure 4 | Relationships between Key Project Elements and Key External Elements *(Source: EIS)*

3.2.2 The Port Kembla steelworks was first developed by Australian Iron and Steel Limited (AIS) in 1928 due to its proximity to the coking coal mines of the Southern Coalfield. BHP took over

AIS in 1935 and later formed the business unit known as BHP Steel. BlueScope was de-merged from BHP Billiton in 2002 to form a stand-alone public company.

3.2.3 BlueScope Steel is Australia's only producer of flat steel and manufactures various products in all mainland States. BlueScope also supplies products through its Lysaght division which include fencing; roof and wall cladding; rainwater products; steel house framing; structural products such as flooring systems, walkways and meshes; and home improvement products.

3.2.4 In FY19, BlueScope sold nearly 3 Mt of steel products, of which 0.864 Mt was exported to international markets from Port Kembla. BlueScope also produces a substantial amount of coke which is additional to its own needs. In FY19, BlueScope exported about 0.7 Mt of coke for use in metallurgical purposes overseas.

3.2.5 The company's sales revenue in FY19 was a little over $12.5 billion and its reported net profit after tax was over $1 billion. BlueScope employs over 6,100 employees across Australia.

3.2.6 The Project's EIS reports that the BlueScope Steelworks at Port Kembla:

- directly employs approximately 3,000 people;
- is estimated to indirectly support about 10,000 jobs in the region (with the Illawarra Business Chamber noting in its submission to the Report that the multiplier effect of the steel industry is 3 to 5 indirect jobs for every direct job generated by the industry); and
- is estimated to contribute approximately $1.9 billion per annum to the economy, based on analysis conducted by Wollongong City Council (without considering any multiplier effect).

3.2.7 The EIS reports that steel remains a fundamental material for a variety of construction and manufacturing industries, and that domestic steelmaking is a strategically valuable asset for Australia's economic security and prosperity.

3.2.8 The importance of Australian steelmaking is described in a Commonwealth Senate inquiry report titled *Australia's Steel Industry: Forging Ahead* (2017), which outlines the economic significance of the steel industry to the Australian economy and regional economies where steelmaking facilities are located.

3.2.9 Over the six months, there has been increasing public discussion over the possibility of Australia developing a so-called 'green steel' industry. This industry would be based on using hydrogen (produced by electrolysis of water, using low-cost renewable wind or solar electricity) to reduce iron ore and produce molten steel. Any such industry is more likely to develop close to large iron ore mines (for example, in Western Australia's Pilbara region), rather than close to metallurgical coal mines, which would not be required for the process.

3.2.10 The Department considers that any such development is likely to be (at the very least) several years in the future. While ever BlueScope Steel remains in production at Port Kembla, a local supply of hard coking coal will be necessary. For that matter, while ever there remains a substantial international demand for hard coking coal, Soth32's premium hard coking coal blend is likely to command a premium over similar products available elsewhere.

3.3 Importance of Southern Coalfields Coal Supply to BlueScope

3.3.1 The EIS states that the steelmaking industry is highly trade exposed, with Australian steelmakers competing against suppliers across the globe. Maintaining low production costs is therefore critical to the competitiveness and viability of the Australian steelmaking industry.

3.3.2 Coal from the Southern Coalfield is supplied to the BlueScope Steelworks on a 'just-in-time' arrangement via conveyor deliveries (from Dendrobium CPP) and road deliveries (from West Cliff CPP). Coal stockpiles for feed to the Dendrobium CPP and BlueScope are depleted on a weekly basis.

3.3.3 South32 currently supplies the BlueScope Steelworks with about 60% of its overall coking coal requirements, about 1.5 Mtpa of the total 2.5 Mtpa. In FY19, South32 supplied BlueScope Steel with 0.505 Mt of coking coal from the Dendrobium Mine, together with 0.945 Mt from its Bulli Seam Operations.

3.3.4 BlueScope does receive a limited amount of ship-borne Queensland coal directly (ie not via PKCT), via what are known as the BlueScope Bulk Stevedoring Berths. BlueScope indicated in its submission that any increase in seaborne coking coal supply to the steelworks (ie increased shipments from the Queensland mines via Queensland coastal ports) would require substantial capital investment in additional port facilities at Port Kembla (estimated to be at least $150 m) and stockpiling facilities, with its additional annual logistics costs estimated to be between $50 M and $100 M.

3.3.5 The EIS states that the proximity of the existing Southern Coalfield mines, including Dendrobium Mine, to BlueScope Steel's facilities at Port Kembla is a factor in BlueScope Steel's ability to make economically competitive steel. BlueScope has previously noted that without local metallurgical coal suppliers it may struggle to remain economically viable at Port Kembla.

3.3.6 The fundamental reason for this is that locally-sourced coal offers a key competitive advantage. BlueScope has indicated that the shipping and related costs to bring coking coal from the central Queensland mines via associated coastal ports such as Abbot Point and Hay Point would be about A$40 per tonne (or a total of c. $100 M per annum to replace its existing 2.4 Mtpa of locally-sourced metallurgical coal).

3.3.7 In July 2019, BlueScope's General Manager of Manufacturing said to the local media that *"South32 being able to their extend their next mining domain is very important. ... What would we do if we didn't have access to local metallurgical coal for our coking process in the Illawarra here? We would have to import it into the steelworks across our berths which they aren't designed to do. … High quality coal, stable supply, just-in-time supply, enables us to remain internationally competitive."*

3.3.8 BlueScope has coking coal supply contracts with South32 which extend until 2032, with an option to renew for a further 5 years. While this a commercial matter between the parties, it is expected that the existing contract will be reviewed and renewed prior to 2032.

3.3.9 The continued supply of coal from the Dendrobium Mine to the BlueScope Steelworks would avoid these additional costs to the BlueScope steelmaking operation and contribute to its ongoing economic viability and associated socio-economic benefits.

3.3.10 BlueScope's advantage in respect of locally sourced coal with integrated delivery systems (particularly from Dendrobium CPP) is a key factor (possibly the key factor) in its ability to remain economically viable, particularly in times of economic downturn and low steel prices. These issues are explored further in **Section 6.10**.

3.4 Interaction with PKCT

3.4.1 As noted above, nearly all coal from the Project that is not sold to BlueScope would be transported from Dendrobium CPP to PKCT via private road,[3] where it is stockpiled primarily for international export or else for seaborne transport to Liberty Primary Steel's Whyalla Steelworks. Coal throughput at PKCT during FY19 was 7.29 Mt, which is well below the Port's maximum capacity of 16 Mtpa. The EIS reports that coal from South32's two mining operations currently accounts for the majority of throughput at PKCT.

3.4.2 In FY19, 1.7 Mt of metallurgical coal and 1.2 Mt of energy coal from Dendrobium Mine was trucked from Dendrobium CPP to PKCT for loading and shipping to a variety of international export markets (2.51 Mt), Liberty Primary Steel (0.22 Mt) or delivery to other domestic consumers (0.165 Mt). In FY19, the international export markets for Dendrobium Mine's metallurgical coal were (in order of sales totals) India, Vietnam, China, Taiwan, South Korea, Japan and the European Union. The international markets for energy coal were India, Vietnam and China.

3.4.3 In addition, 1.940 Mt of metallurgical coal and 0.124 Mt of thermal coal from the Bulli Seam Operations was trucked from West Cliff CPP to PKCT.

3.4.4 PKCT is a privately-owned company which does not produce annual public operating accounts. However, its annual cost of operations is apportioned solely between the coal mining companies which use it to ship their products, on a per-tonne basis. Operating costs at PKCT are generally considered to be relatively inelastic, ie lower throughput leads to higher costs per tonne, limiting the profit margin of all mining companies which use the facility (being Peabody's Metropolitan Mine, SIMEC's Tahmoor Coal Mine, Wollongong Coal's Russell Vale Mine (currently not operating) and Centennial Coal). PKCT operates under a lease over its site which extends until 2030.

3.4.5 The loss of coal throughput sourced from either or both the Dendrobium and Bulli Seam Operations would have a very major impact on the economics of PKCT and the three remaining mines which together send relatively small volumes of coal through the facility. These issues are explored further in **Section 6.10.**

3.5 South32's Bulli Seam Operations

3.5.1 South32 has publicly stated that its Bulli Seam Operations have substantially higher operating costs than the Dendrobium Mine. This is partly because of the need to truck ROM coal from the two pit tops to the West Cliff CPP and then to truck product coal down the Illawarra Escarpment (Mount Ousley) to the BlueScope Steelworks or to PKCT. However, the Bulli Seam Operations mine also has a much larger footprint, with three surface facilities and 6

[3] In addition, in FY19, 0.135 Mt of energy coal was trucked from Dendrobium CPP to Boral Cement's cement kiln at Berrima.

ventilation shafts. It also operates at greater depths, which leads to higher costs for gas management and strata control. Overall, the Bulli Seam Operations have more than twice the number of employees and contractors as Dendrobium (1,218 vs 654, as at June 2020) and its operating costs per tonne are more than twice as high.

3.5.2 The Bulli Seam Operations are intended to operate as two separate longwalls in two different mining domains on an ongoing basis. However, South32 was not able to operate two longwalls at this mine for some time, owing to strata control and gas problems, but returned to two-longwall production in late April 2020, with the start of LW 708B.

3.5.3 South 32's Illawarra Metallurgical Coal business was highly profitable in FY19 (underlying earnings before income tax (EBIT) was US$359 M on sales revenue of US$1.135 billion).

3.5.4 In FY19, South32's total product coal production from its two Illawarra mines was nearly 6.65 Mt. 80% of its sales volume of 6.31 Mt was metallurgical or coking coal, and 20% was the lower quality energy (ie thermal) coal. Average realised sales price for its metallurgical coal was US$209/tonne. Average realised sales price for energy coal was US$66/tonne. Two thirds of its sales (by volume) were export sales. A little more than half of total production came from the Dendrobium Mine, following very poor production performance at the Bulli Seam Operations in FY18.

3.5.5 South32's general blend of Wongawilli Seam and Bulli Seam coals from its Dendrobium and Bulli Seam Operations (its 'Illawarra Coking Coal' blend) is based on a preferred 65:35 ratio (weighted average). The Wongawilli Seam coal provides increased fluidity and coke strength and a consequent price margin over Bulli Seam coal alone. BlueScope's preferred blend of coal from South32's two mines is 70:30; however, it has taken more coal from Dendrobium in recent years owing to the lower production profile at the Bulli Seam Operations over that time.

3.6 Sydney's Drinking Water Catchment

3.6.1 The Dendrobium Mine extracts coal from beneath Sydney's drinking water catchment. For this reason, it has been controversial since before its approval in 2001. A significant section of the community is either opposed to or concerned about longwall mining of coal beneath the Special Areas of the catchment. The mine's Areas 1, 2, 3A, 3B and 3C are all located within the Metropolitan Special Area, a Special Area declared under the *WaterNSW Act 2014* and managed by WaterNSW (see **Figure 1**).

3.6.2 The Project's Areas 5 and 6 are located within the catchments of the Avon and Cordeaux Rivers, and the associated Avon and Cordeaux Dams, which are part of Greater Sydney's water supply system. They are also located within the Metropolitan Special Area.

3.6.3 South32 has sought to avoid any impacts on the concrete walls of the Avon and Cordeaux Dams by developing a mine plan for Areas 5 and 6 which includes a separation of at least 1,000 m between any longwall and the dam walls. It has also sought to limit impacts on the dam's reservoirs and the major watercourses within their catchments by committing to:

- no direct undermining of the existing Avon and Cordeaux Dam waterbodies, with a minimum 300 m longwall setback from their FSL; and

- longwall setbacks from 'named watercourses' (ie Cordeaux River, Avon River and Donalds Castle Creek) to achieve 200 mm or less of predicted Project-related valley closure within those watercourses.

3.6.4 While South32's commitments are significant, its existing longwall mining operations at Dendrobium have led to significant impacts on watercourses (see paras 3.8.1 – 3.8.4).

3.7 Independent Expert Panel on Mining in the Catchment

3.7.1 In November 2017, the NSW Government established the Independent Expert Panel for Mining in the Catchment (the Catchment Panel) to provide expert advice on the impact of coal mining activities in the Greater Sydney Water Catchment Special Areas, with a particular focus on risks to the quantity of water in the Catchment available for water supply.

3.7.2 The Catchment Panel was established following the release during 2017 of two key reports which provided detailed recommendations about future mining within the Sydney drinking water catchment. These were a Height of Cracking Study at the Dendrobium Mine and a regular triennial independent audit of Sydney's drinking water catchment, undertaken for WaterNSW.

3.7.3 The Height of Cracking Study concluded that further work should be carried out to improve prediction and management of water impacts at the mine, while the Catchment Audit Report recommended 6 broad measures to reduce mining risks and impacts in the Special Areas.

3.7.4 The Catchment Panel's key functions were to:

- undertake an initial review of current mining in the catchment;
- review and update the findings of the 2008 Southern Coalfield Inquiry; and
- strengthen assessment of the ongoing operation of approved mines and new applications for mining within the Special Areas of the catchment by providing advice.

3.7.5 The Catchment Panel submitted its Initial Report in November 2018, focusing on activities at the Dendrobium and Metropolitan mines. It also provided initial observations and sought comment through a consultation and submission process on a number of issues.

3.7.6 The Catchment Panel's Final Report was released in October 2019. The Initial Report was updated in light of feedback and now forms Part 1 of the Panel's Final Report. Part 2 of the Final Report provides a review of developments since the 2008 Southern Coalfield Inquiry as well as risks to water quantity, environmental consequences for swamps, cumulative impacts and measures to improve the way the effects, impacts and consequences of mine subsidence are assessed and managed in relation to water quantity.

3.7.7 The two reports contained 50 recommendations, with key recommendations addressing:

- establishment of a new expert panel to provide advice on future mining applications and performance outcomes;
- establishment of an inter-agency working group to identify acceptable water losses;
- reducing the risk of surface to seam fracturing through appropriate mine design;
- ensuring mining companies hold sufficient water licences;
- provision for offsets for catchment water losses associated with mining;
- improved management of and access to environmental data;

- independent peer reviews of groundwater and surface water assessments prepared in support of mining applications;
- improved, more objective performance measures;
- improved monitoring of water flows and water quality;
- a future study to inform mine closure planning; and
- further research into the height of fracturing above longwall voids, the impacts of geological structures on subsidence effects and impacts and the hydrological and ecological impacts of mining on upland swamps.

3.7.8 On 31 October 2019, the Minister for Planning and Public Spaces announced that the Government would review and respond to the Catchment Panel's 50 recommendations in due course and that *"In the interim, no new development applications for mining in the Special Areas will be determined"*. This commitment prevented determination of the Project until the Government's response was announced.

3.7.9 On 18 April 2020, the Minister announced that the Government had accepted all 50 of the Catchment Panel's recommendations and had established an interagency taskforce to implement an action plan to:

- ensure there is a net gain for the metropolitan water supply by requiring more offsetting from mining companies;
- establish a new independent expert panel to advise on future mining applications in the catchment;
- strengthen surface and groundwater monitoring;
- improve access to and transparency of environmental data;
- adopt a more stringent approach to the assessment and conditioning of future mining proposals to minimise subsidence impacts;
- review and updating current and potential future water losses from mining in line with the best available science;
- introduce a licensing regime to properly account for any water losses; and
- undertake further research into mine closure planning to reduce potential long-term impacts.

3.7.10 The Government's temporary moratorium on determination of development applications ended with this announcement.

3.8 Panel Findings Specific to Dendrobium Mine

3.8.1 The Catchment Panel gave very careful consideration to the impacts of the existing Dendrobium Mine on the drinking water catchment. The Catchment Panel's key conclusions in its Part 1 report with respect to the mine were:

- water inflow into all four existing mining areas (Areas 1, 2, 3A & 3B) exhibits some correlation with rainfall, ranging from weak in Area 3B to strong and rapid for Area 2;
- it is very likely that the high rate of influx is associated with a connected fracture regime that extends upwards to the surface (ie 'surface-to-seam cracking');
- it is plausible that an average of around 3 megalitres/day (ML/day) of surface water and seepage from reservoirs is currently being diverted into the mine workings; and

- faulting, basal shear planes[4] and lineaments[5] need to be very carefully considered and risk assessed in the future, especially when planning for further longwall panels to the south of LW 16 (in Area 3B).

3.8.2 The Catchment Panel's Part 2 report contained a second figure for its estimate of surface water loss from above Dendrobium mine. In considering data relating to surface water flow into the mine, leakage from the reservoir into the mine, and loss of baseflow to streams due to depressurisation, the Panel considered that the "upper limit of recent loss rate … is less than 5 ML/day".[6]

3.8.3 The Catchment Panel's Part 2 report also gave particular consideration to water flow losses in Wongawilli Creek (a 'named watercourse', within the context of the Project's EIS). By August 2018, when mining of LW 13 in Area 3B had been completed, a 1,543 m length of Wongawilli Creek was showing zero or discontinuous flow. The Catchment Panel agreed with South32's interpretation that the loss of flow in this length of the Creek most likely reflected a combination of two factors, being:

- low streamflow rates due to an extended period of well-below average rainfall; and
- loss of baseflow (ie regular leakage of near-surface groundwater to the stream channel) due to broadscale groundwater depressurisation resulting from mine subsidence in Areas 3A and 3B.

3.8.4 More straightforwardly, the wide longwall panels at Dendrobium (305 m void width) caused extensive cracking in the rocks above the panels, which reached the surface in some places. These cracks provided a pathway across much of the mining area for drainage of near-surface groundwater to lower strata. When Wongawilli Creek's streamflow (from further upstream) reduced substantially during an extended drought, there was insufficient near-surface groundwater remaining to support continued flow in the Creek. Therefore, the Creek stopped flowing and in places dried up.

3.8.5 This interpretation was supported by South32's groundwater model, which predicted baseflow loss from Wongawilli Creek.

3.9 Strategic Planning Documents

Strategic Statement on NSW Coal

3.9.1 The NSW Government's *Strategic Statement on NSW Coal* (2014) provides the following relevant objectives to guide the growth and performance of the NSW coal sector:

- ***co-existence*** – land use decisions do not exclude other potential uses without considering the benefits and consequences for other land users and all NSW residents;
- ***transparency*** – decisions are open, transparent and evidence-based, to minimise corruption risks;
- ***sustainability*** – decisions are governed by triple bottom line considerations, to promote comprehensive and balanced decision-making;

[4] A 'basal shear plane' is not a geological feature as such, but a planar opening or weakness that develops adjacent to the base of a valley as the overlying land moves towards the open valley during valley closure movements.
[5] Geological lineaments are strongly linear surface features such as joints where there is no associated surface movement of geological strata (ie faulting). Major lineaments are usually recognised from maps and aerial photos. They may be associated with valley development and commonly represent locations of increased surface water infiltration.
[6] See Table 3 in the Part 2 report, and related text.

- ***safety*** – coal exploration and production risks are managed through consultation and safe systems, to achieve zero fatalities in the mining industry;
- ***best practice and leading technologies*** – regulation of the coal sector promotes the adoption of best practices and world-leading technologies;
- ***achieving value for the economy and adequate returns for taxpayers*** – coal development prioritises the highest value resources, and generates financial returns for the Government by capturing an appropriate share of that value; and
- ***regional economic development*** – support opportunities and economic development in the region of a resource.

3.9.2 The four objectives which are most relevant to the decision on whether to grant development consent for the Project are *co-existence*, *sustainability*, *regional economic development* and *achieving value for the economy and adequate returns for taxpayers*.

3.9.3 Consideration of the Project in respect of these objectives is provided in **Section 6**, particularly **Sections 6.3, 6.4, 6.10 and 6.11**.

WaterNSW's Policy Framework

3.9.4 WaterNSW has developed a policy framework for managing activities within the Special Areas of Sydney's drinking water catchment, which includes two key documents.

3.9.5 The *WaterNSW Principles for Managing Mining and Coal Seam Gas Impacts in Declared Catchment Areas* are focused on six key principles to protect the catchments, being:

- protection of water quantity;
- protection of water quality in Declared Catchment Areas;
- protection of human health in Declared Catchment Areas;
- protection of water supply infrastructure;
- protection of ecological integrity in Special Areas; and
- sound and robust evidence regarding environmental impacts.

3.9.6 The *Special Areas Strategic Plan of Management 2015 (SASPoM)* was developed by WaterNSW and the then Office of Environment & Heritage to provide the strategic framework for the planning, delivery and reporting of land management activities within the Special Areas, in order to secure high quality water for the storages, maintain ecosystem integrity and manage cultural values. The SASPoM governs the actions of WaterNSW and BCD within the Special Areas. It contains nine key strategic management objectives, five of which are of particular relevance to the Project, as follows:

- **pollutants** are controlled so that impacts on water quality and natural and cultural values are minimised;
- surface and groundwater sources and their interactions will be better understood so decisions are made that seek to minimise impacts on Special Areas' **hydrological integrity**;
- measures are in place to minimise the impacts of **built assets** within the Special Areas on water quality, ecological integrity and cultural values;
- **ecological integrity** including threatened plant and animal species, endangered populations, endangered ecological communities, geodiversity and other natural values are maintained; and
- management of Special Areas is supported by appropriate **policy, planning and evaluation**.

NSW Climate Change Policy Framework

3.9.7 The Government's 2016 *NSW Climate Change Policy Framework* (CCPF) committed NSW to an 'aspirational long-term objective' of achieving net-zero emissions by 2050. The framework addresses actions to limit emissions which are by or on behalf of the Government. However, this document does not control or directly relate to actions by private entities (such as South32) and does not control decision-making under the *Environmental Planning & Assessment Act 1979* (EP&A Act).

3.9.8 In March 2020, the Government announced a new 10-year plan to help it achieve the CCPF's objective of achieving net-zero emissions by 2050, the *Net Zero Plan Stage 1: 2020-2030*. This Plan aims to enhance the prosperity and quality of life of the community, while helping the State to deliver a 35% cut in emissions by 2030, compared to 2005 levels. The Plan's four priorities are to:

- drive uptake of proven emissions reduction technologies;
- empower consumers and businesses to make sustainable choices;
- invest in the next wave of emissions reduction innovation; and
- ensure the NSW Government leads by example.

3.9.9 As part of the Plan, the NSW and Commonwealth Governments will invest almost $2 billion over 10 years to reduce emissions in NSW. The Plan will support a range of initiatives targeting electricity and energy efficiency, electric vehicles, hydrogen, primary industries, coal innovation, organic waste and carbon financing.

3.9.10 In respect of coal innovation, the Plan first notes that:

"New South Wales' $36 billion mining sector is one of our biggest economic contributors, supplying both domestic and export markets with high quality, competitive resources. Mining will continue to be an important part of the economy into the future and it is important that the State's action on climate change does not undermine those businesses and the jobs and communities they support."

3.9.11 The Plan then focuses on limiting the fugitive emissions of methane that come from coal mining, through capture and combustion. The NSW Government will invest in a 'Coal Innovation Program' to reduce emissions from the mining and use of coal. This program has been prioritised for bilateral funding with the Commonwealth.

3.9.12 The Coal Innovation Program will focus on providing:

- coal operators with direct, strategic incentives to capture and re-use methane released during mining; and
- research and industry partnerships with funding to commercialise emerging technologies to reduce emissions at hard-to-mitigate mine sites.

Other Strategic Planning Documents

3.9.13 Attachment 6 of the EIS lists a number of other strategic planning documents which may be considered to have some relevance to the Project. Amongst these documents is WCC's *Wollongong 2022: Our Community Strategic Plan 2012-2022*, which provides a future direction for the community within the Wollongong LGA. Two of that Plan's six goals are to "value and protect our environment" and for "an innovative and sustainable economy".

3.9.14 South32 considers that the Project is generally consistent with this Plan, as the Project:

- incorporates a range of strategies to manage and minimise potential impacts on the surrounding environment;
- would be developed by South32's subsidiary Illawarra Coal, which is a local company operating in the region for over 80 years;
- would continue to benefit the economy through the development of employment opportunities and regional expenditure; and
- would be developed in a manner that incorporates community engagement through a consultation program.

4 Statutory Context

4.1 State Significance

4.1.1 The Project is declared to be State significant development (SSD) under section 4.36 of the EP&A Act by virtue of the operation of clause 8 of the *State Environmental Planning Policy (SEPP) (State and Regional Development) 2011.* As the Project is 'development for the purposes of coal mining', it falls within the scope of clause 5(1)(a) of Schedule 1 of that SEPP.

4.2 Permissibility

4.2.1 The Project area is within the Wollongong, Wingecarribee and Wollondilly Local Government Areas (LGAs), which are covered, respectively, by the:

- *Wollongong Local Environmental Plan 2009* (Wollongong LEP);
- *Wingecarribee Local Environmental Plan 2010* (Wingecarribee LEP); and
- *Wollondilly Local Environmental Plan 2011* (Wollondilly LEP).

4.2.2 The Project area includes land zoned under the Wollongong LEP as:

- Zone RU1 (Primary Production);
- Zone RU2 (Rural Landscape);
- Zone E1 (National Parks & Nature Reserves);[7]
- Zone E2 (Environmental Conservation);
- Zone E3 (Environmental Management);
- Zone E4 (Environmental Living); and
- Zone SP2 (Infrastructure).

4.2.3 The Project area includes land zoned under the Wingecarribee and Wollondilly LEPs as:

- Zone E2 (Environmental Conservation); and
- Zone SP2 (Infrastructure).

[7] The Project would involve some activities located well beneath the depth of reservation of two State conservation areas (eg continued use of the Dendrobium and Kemira Valley Tunnels). However, the development application area excludes all lands that are included in those State conservation areas. Nonetheless, the zoning extends to the centre of the Earth.

4.2.4 In the absence of the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007* (the Mining SEPP), underground mining would be prohibited under the Wollongong, Wingecarribee and Wollondilly LEPs in these zones.

4.2.5 However, clause 5(3) of the Mining SEPP provides that that SEPP prevails over other environmental planning instruments (EPIs) made under the EP&A Act, such as these LEPs. Clause 7(1) of the Mining SEPP provides that 'underground mining carried out on any land' is permissible with development consent. That is, notwithstanding any prohibition in the Wollongong, Wingecarribee and Wollondilly LEPs, development for the purposes of the underground mining may be carried out with consent. This permissibility extends to facilities for the processing and transportation of coal.

4.2.6 The Dendrobium CPP and a portion of the Kemira Valley Rail Line are located within Zone IN3 (Heavy Industrial) under the *State Environmental Planning Policy (Three Ports) 2013*. Port facilities and heavy industries are permissible with consent within this zone.

4.3 Independent Planning Commission

4.3.1 In accordance with section 4.5 of the EP&A Act and clause 8A(1) of *SEPP (State and Regional Development) 2011*, the Independent Planning Commission of NSW (the Commission) is the consent authority for the Project and must determine the development application, as more than 50 public submissions in the nature of objection were received. The submission from Wollondilly Shire Council, which is partly affected by the Project and objected to it until such time as the *"potential impacts on water sources (eg drinking water) and supplies are addressed to the satisfaction of WaterNSW"*, might also require the Project to be considered by the Commission.

4.3.2 On 23 September 2020, the Minister for Planning and Public Spaces requested under section 2.9(1)(d) of the EP&A Act that the Commission hold a public hearing into the carrying out of the Project. The terms of the Minister's request are as follows:

1) Conduct a public hearing into the carrying out of the Dendrobium Extension Project (SSD 8194) prior to determining the development application for the project under the EP&A Act, paying particular attention to:

a) the Department of Planning, Industry and Environment's assessment report, including any recommended conditions of consent;

b) key issues raised in public submissions during the public hearing; and

c) any other documents or information relevant to the determination of the development application.

2) Complete the public hearing and make its determination of the development application within 12 weeks of receiving the Department's assessment report in respect of the project, unless the Planning Secretary agrees otherwise.

4.4 Mandatory Matters for Consideration

Introduction

4.4.1 The Department of Planning, Industry and Environment's (the Department's) assessment of the Project has given careful consideration to all necessary statutory requirements. These include the:

- objects of the EP&A Act, set out in section 1.3 of the Act; and
- matters listed under section 4.15(1) of the EP&A Act, including applicable EPIs and regulations.

4.4.2 Apart from considering the statutory requirements in their own right, the Department has carefully considered Section 4 of the EIS and Attachment 6 to the EIS, where the Applicant has considered applicable legislation and environmental planning instruments in detail.

4.4.3 The Department has considered all statutory requirements in its assessment of the Project and has provided a summary of this consideration in respect of the objects of the EP&A Act and a general overview of the applicable EPIs below. Further consideration of particular provisions of the EP&A Act and applicable EPIs can be found in **Appendix G**.

Objects of the EP&A Act

4.4.4 The objects of the EP&A Act are the underpinning principles for all decision making under the Act. They must be considered by the consent authority when determining a development application under the Act. The Department has assessed the Project against the objects found in section 1.3 of the EP&A Act. **Table 4** summarises how these objects have been considered.

Table 4 | Consideration of the Project against the objects of the EP&A Act

Object	Consideration
(a) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources;	• The Project is built around development of the State's mineral resources (ie publicly-owned coal), while making substantial provision for protection of the publicly-owned water resources within the Special Areas and Sydney's drinking water supplies. • The Project would provide ongoing socio-economic benefits to the people of NSW through the provision of coal royalties and other taxes and a substantial number of ongoing permanent employment opportunities for members of the regional community, as well as construction jobs.
(b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment;	• The Department considers that the Project can be carried out in a manner that is consistent with the principles of ESD. The Department's assessment has sought to integrate all significant environmental, social and economic considerations. • The Department has further considered the principles of ESD in **Appendix G1**.
(c) to promote the orderly and economic use and development of land;	• The Project involves the expansion of an existing coal mine and can be largely carried out using existing site and transport infrastructure.

		• The Project involves a permissible land use and the recovery of a large and important coal resource.
(e)	to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats;	• The Department considers that the Project has been designed to minimise potential environmental impacts where practicable, including the incorporation of setbacks from dams and water storages, named watercourses and 'key stream features'. • The Project would result in the loss of a limited amount of existing native vegetation and habitat. However, the Department considers that the proposed offset would maintain or enhance biodiversity values in the long-term. • The Department considers that the impacts on threatened species and habitats can be managed and/or mitigated through appropriate conditions of consent that require strict performance measures (ie limits on potential subsidence impacts), biodiversity offsets and appropriate rehabilitation strategies.
(f)	to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage);	• The Project would have limited impacts on the cultural and built heritage of the site, including Aboriginal heritage.
(i)	to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State;	• The Department notified and consulted with the three affected Councils and NSW government authorities over the Project and carefully considered all responses in its assessment.
(j)	to provide increased opportunity for community participation in environmental planning and assessment.	• The Department publicly exhibited the proposal and made the development application, EIS and other relevant documents publicly available on its website (see **Section 5**). • All public submissions have been considered by South32 and the Department during the assessment process.

Environmental Planning Instruments

4.4.5 The consent authority must take into consideration the provisions of EPIs (including draft instruments), when determining development applications. A number of EPIs apply to the Project, including the:

- Mining SEPP;
- *SEPP (Infrastructure) 2007* (Infrastructure SEPP);
- *SEPP (State and Regional Development) 2011 (SRD SEPP)*;
- *SEPP (Sydney Drinking Water Catchment) 2011*;
- *SEPP No. 33 – Hazardous and Offensive Development*;
- *SEPP No. 44 (Koala Habitat Protection)*;
- *SEPP No. 55 – Remediation of Land*;
- Wollongong LEP;
- Wingecarribee LEP; and
- Wollondilly LEP.

4.4.6 South32 has considered each of these EPIs in its EIS (see the EIS's Section 4 and Attachment 6). The Department has considered the Project against the relevant provisions of these instruments (see **Appendix G2**). Based on this assessment, the Department considers

that the Project can be carried out in a manner that is consistent with the aims, objectives and provisions of these instruments.

4.5 Biodiversity Assessment

4.5.1 Section 7.9(2) of the *Biodiversity Conservation Act 2016* (BC Act) generally requires all applications for SSD to be accompanied by a Biodiversity Development Assessment Report (BDAR). However, clause 28(1) of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* provides that *'The former planning provisions continue to apply … to the determination of a pending or interim planning application."*

4.5.2 In March 2018, the Department advised South32 that the Project is a 'pending or interim planning application' under this Regulation. As a result, although the *Threatened Species Conservation Act 1995* (TSC Act) was repealed by the BC Act, some provisions of the TSC Act that would be in force if it had not been repealed (such as assessment guidelines) continue to apply to the Project.

4.5.3 For this reason, the EIS contains a Biodiversity Assessment Report (BAR) and Biodiversity Offset Strategy (BOS) prepared in accordance with the 2014 *Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects* (FBA), rather than a BDAR.

4.6 Commonwealth Matters

4.6.1 On 6 March 2017, a delegate of the Commonwealth Minister for the Environment and Energy determined that the Project is a 'controlled action' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to its potential impacts on Matters of National Environmental Significance (MNES), specifically:

- listed threatened species and communities (sections 18 & 18A of the EPBC Act); and
- a water resource, in relation to a large coal mining development (sections 24D and 24E).

4.6.2 Under the current Bilateral Agreement between the Commonwealth and NSW governments, the Commonwealth has accredited the NSW assessment process under the EP&A Act for the controlled action (EPBC 2017/7855), to enable a single integrated assessment of the Project. However, the Commonwealth's decision-maker maintains a separate approval role, which will be exercised following the Commission's determination of the development application.

4.6.3 Following clarification of the then Commonwealth Department of Environment and Energy's assessment requirements, the Department issued revised Secretary's Environmental Assessment Requirements (SEARs) for the Project, including an attachment covering the Commonwealth's matters. The Department has assessed the potential impact of the Project on the applicable MNES in accordance with the requirements of the Bilateral Agreement. These matters are addressed briefly in **Section 6.6.** A more complete report will be provided separately to the Commonwealth once the application has been determined for the purposes of NSW under the EP&A Act.

4.7 Integrated and Other NSW Approvals

4.7.1 Under section 4.41 of the EP&A Act, a number of approvals are integrated into the SSD approval process, and consequently are not required to be separately obtained for the Project. These include:

- various approvals relating to fisheries under the *Fisheries Management Act 1994*;
- various approvals relating to heritage required under the *National Parks and Wildlife Act 1974* and the *Heritage Act 1997*; and
- certain approvals under the *Water Management Act 2000.*

4.7.2 Under section 4.42 of the EP&A Act, a number of other approvals (if required) cannot be refused and must be granted in terms substantially consistent with any development consent for the Project. These include:

- Environment Protection Licences (EPLs) under the *Protection of the Environment Operations Act 1997*; and
- consents under section 138 of the *Roads Act 1993* for the re-alignment of public roads, intersection upgrades and mining beneath public roads.

4.7.3 The Project would require variations to two existing EPLs, being EPL 3241 and EPL 611.

4.7.4 The Project would require approvals under section 138 of the *Roads Act 1993* in respect of:

- construction of an additional access road and intersection with Cordeaux Road at the Dendrobium Pit Top to service new parking facilities as well as an associated pedestrian tunnel or crossing underneath or across Cordeaux Road;
- mining beneath public roads; and
- a possible upgrade of the Picton Road intersection at Cordeaux Pit Top, based on future traffic levels.

4.7.5 No additional mining leases or exploration licences under the *Mining Act 1992* are required for the Project.

4.7.6 The Department has consulted with the relevant government authorities responsible for the integrated and other approvals and considered their advice in its assessment of the Project.

5 Engagement

5.1 Department's Engagement

5.1.1 Under Section 89F of the EP&A Act, the Secretary is required to publicly exhibit the EIS for the Project for at least 30 days. Due to the high level of public interest in the Project, the Department extended the exhibition period to 56 days.

5.1.2 After accepting the EIS, the Department publicly exhibited it from 25 Jul 2019 until 18 September 2019. The Department notified relevant government agencies and Wollongong, Wollondilly and Wingecarribee Councils and advertised the exhibition in the:

- Illawarra Mercury;

- Sydney Morning Herald;
- Daily Telegraph; and
- The Australian.

5.1.3 The EIS was exhibited at the offices of the Wollongong, Wollondilly and Wingecarribee Councils, the Wollongong City Library, Unanderra Library and Warrawong Library. The EIS could be viewed electronically at the Department's office and on its website, at Service NSW Centres and at the office of the Nature Conservation Council.

5.1.4 In undertaking these processes, the Department has satisfied the requirements of clause 9 of Schedule 1 of the EP&A Act, the Mining SEPP, the Infrastructure SEPP and the local LEPs.

5.1.5 The Department also met with representatives of the Dendrobium Mine Community Consultative Committee on 6 May 2019 concerning the Project and other matters. A Departmental officer also participated in a catchment inspection in Area 3B on 21 August 2019 with representatives of South32 and WaterNSW.

5.1.6 The Department has engaged regularly with representatives of South32 and its principal consultant throughout the assessment process. The Department is familiar with the existing operations at Dendrobium Mine as well as the sensitive environment in which it operates, having participated in many site visits and inspections over the past 10 to 15 years.

5.2 Summary of Submissions

5.2.1 During and following the EIS exhibition period, the Department received a total of 775 submissions on the proposal. Of this total, 13 were from Government agencies and related entities and three were from the Councils of the LGAs directly affected by the Project (see **Appendix E**), whereas 39 were from special interest groups and 720 were from the members of the community (see **Appendix B**).

5.2.2 603 submissions supported the Project, 154 submissions objected to the Project and 18 submissions simply provided advice or comments.

5.2.3 The following subsections provide an overview of submissions received from agencies, special interest groups and the general public.

Agencies & Councils

5.2.4 Advice was received from 13 Government agencies and associated entities and the three local Councils (see **APPENDIX E**) directly affected by the Project, being the:

- Commonwealth Independent Expert Scientific Committee (IESC);
- WaterNSW;
- Biodiversity and Conservation Division (BCD), part of the Department of Planning, Industry & Environment;
- Water Group (DPIE - Water), part of the Department of Planning, Industry & Environment;
- NSW Dams Safety Committee, now Dams Safety NSW (DSNSW);
- Environment Protection Authority (EPA);
- Division of Resources & Geoscience (now the Minerals, Energy and Geoscience group, or MEG), part of the Department of Regional NSW;
- NSW Resources Regulator, part of the Department of Regional NSW;

- Heritage Council of NSW;
- NSW Health;
- NSW Roads and Maritime Services, Southern Region (RMS);
- NSW Rural Fire Service (RFS);
- Subsidence Advisory NSW (SA NSW);
- Wingecarribee Shire Council (WiSC);
- Wollondilly Shire Council (WoSC); and
- Wollongong City Council (WCC).

5.2.5 Two of these agencies (WaterNSW and WoSC) objected to the Project. All others provided advice, commonly in the form of requests for further information but also in respect of concerns over particular aspects of the Project. These matters are addressed in **Section 5.3** below.

Special Interest Groups

5.2.6 Submissions were received from a total of 39 special interest groups, business entities or other organisations. Of this total, 20 supported the proposal, 17 objected and 2 provided comments (see **APPENDIX B**). These groups are set out in **Table 5** below.

5.2.7 The 20 organisations which supported the Project are dominated by business entities that are either suppliers to or customers of South32. These include major business entities like BlueScope Steel, PKCT, NSW Ports and Pacific National. Six other major representative bodies for local industry and labour unions also made submissions in support. These were the Illawarra Business Chamber, the Illawarra Innovative Industry Network, the Port Kembla Chamber of Commerce, the Illawarra branch of Regional Development Australia and the South Western District of the CFMMEU's Mining and Energy Division.

5.2.8 Submissions were also received from three former Government entities which operate key infrastructure assets that may be affected by the Project. NSW Ports, privatised in 2013, holds a long-term lease over Port Kembla and supported the Project. Transgrid (privatised in 2015) and Endeavour Energy (majority privatised in 2017) operate electricity transmission and distribution grids, respectively, in and adjacent to the Project area. Both these infrastructure operators provided comments on the Project.

5.2.9 Of particular interest is that one environmental group (the Singleton Shire Health Environment Group) made a submission in support of the Project. The basis of this submission was that this group supports underground coal mining over open cut coal mining, due to the latter's substantially greater air quality impacts.

5.2.10 The 17 special interest groups which objected to the Project are principally representative or advocate environmental groups or else community environmental groups (see **Table 5**). These groups have a variety of special interest focuses, including:

- opposition to coal mining and/or coal seam gas production;
- climate change and reduction of anthropogenic greenhouse gas emissions (GHGEs);
- national parks and nature conservation;
- protection of water resources; and
- general environmental protection and advocacy.

Table 5 | Summary of Special Interest Group Submissions

Special Interest Group	Submissions	Position
360 HR Recruitment	1	Support
AI Group	1	Support
Ampcontrol	1	Support
BlueScope Streel	1	Support
CFMMEU Mining and Energy Division, South Western District	1	Support
Foreshore Shipping Container Services	1	Support
Highland Drilling Pty Ltd	1	Support
Highland Water Solutions	1	Support
Illawarra Business Chamber	1	Support
Illawarra Innovative Industry Network	1	Support
NSW Ports	1	Support
Nexus Mining	1	Support
Oliver Taylor	1	Support
Pacific National	1	Support
Port Kembla Chamber of Commerce	1	Support
Port Kembla Coal Terminal	1	Support
Project Portfolio Management	1	Support
Regional Development Australia – Illawarra	1	Support
Singleton Shire Health Environment Group	1	Support
South Coast Equipment Pty Ltd	1	Support
Endeavour Energy	1	Comment
Transgrid	1	Comment
Australian Youth Climate Coalition Wollongong	1	Object
Beyond Zero Emissions	1	Object

Special Interest Group	Submissions	Position
Doctors for the Environment Australia Inc	1	Object
Georges River Environmental Alliance	1	Object
Greens Northern Beaches	1	Object
Illawarra Local Aboriginal Land Council	1	Object
Illawarra Residents for Responsible Mining Inc	1	Object
Lane Cove Coal and Gas Watch	1	Object
Lock the Gate Alliance	1	Object
National Parks Association	5	Object
Nature Conservation Council	1	Object
Protect our Water Alliance	1	Object
Sutherland Shire Environment Centre	1	Object
Total Environment Centre	1	Object

General Public

5.2.11 Submissions were received from 720 members of the general public (see **APPENDIX B**). Of this total, 583 supported the proposal, 135 objected and 2 provided comments.

5.2.12 A slim majority (51%) of community members who made submissions live locally to the Project's key surface facilities, ie in the Wollongong LGA. Only 6% of submissions came from the two other LGAs affected by the Project footprint, including its longwall footprint. 18.6% of submissions came from Shellharbour LGA, which neighbours Wollongong LGA to the south, and a further 6% of submissions came from the Kiama and Shoalhaven LGAs, both of which are located south of Shellharbour LGA. 10% of submissions came from the Sydney Metropolitan area.

5.2.13 Less than 10% of submissions were received from other areas of NSW (including the Central Coast, Hunter Valley and Newcastle) or from interstate (including Victoria, Queensland and Western Australia).

5.2.14 Of all public submissions, 81% supported the Project and 19% opposed it. Breaking down public submissions in terms of support and opposition from different geographic areas reveals some interesting patterns (see **Table 6**). The level of community support for the Project was very high in the LGAs most affected by it – 82% in Wollongong and 91% in Wollondilly and Wingecarribee (combined). Community members in the other local LGAs close to the Project

also expressed strong support for it – 97% in Shellharbour and 93% in Kiama and Shoalhaven (combined).

5.2.15 Only in the Sydney Metropolitan Area did a relatively narrow majority of public submissions oppose the Project (57%). When combined, all other areas of the State and interstate submissions, also had substantial support for the Project (69%).

Table 6 | Summary of Public Submissions

Local Government Area	Total submissions received	Support (%)	Object
Wollongong	367	303 (82)	63 (17)
Shellharbour	134	130 (97)	4 (3)
Wollondilly & Wingecarribee	46	42 (91)	4 (9)
Kiama & Shoalhaven	43	40 (93)	3 (7)
Sydney Metropolitan Area	78	32 (41)	45 (57)
Other	52	36 (69)	16 (31)
Total	**720**	**583 (81)**	**135 (19)**

5.3 Key Issues Raised in Submissions

5.3.1 The frequency with which all issues was raised across all submissions (ie public and agency, whether supporting, objecting or commenting) is displayed in **Figure 5**.

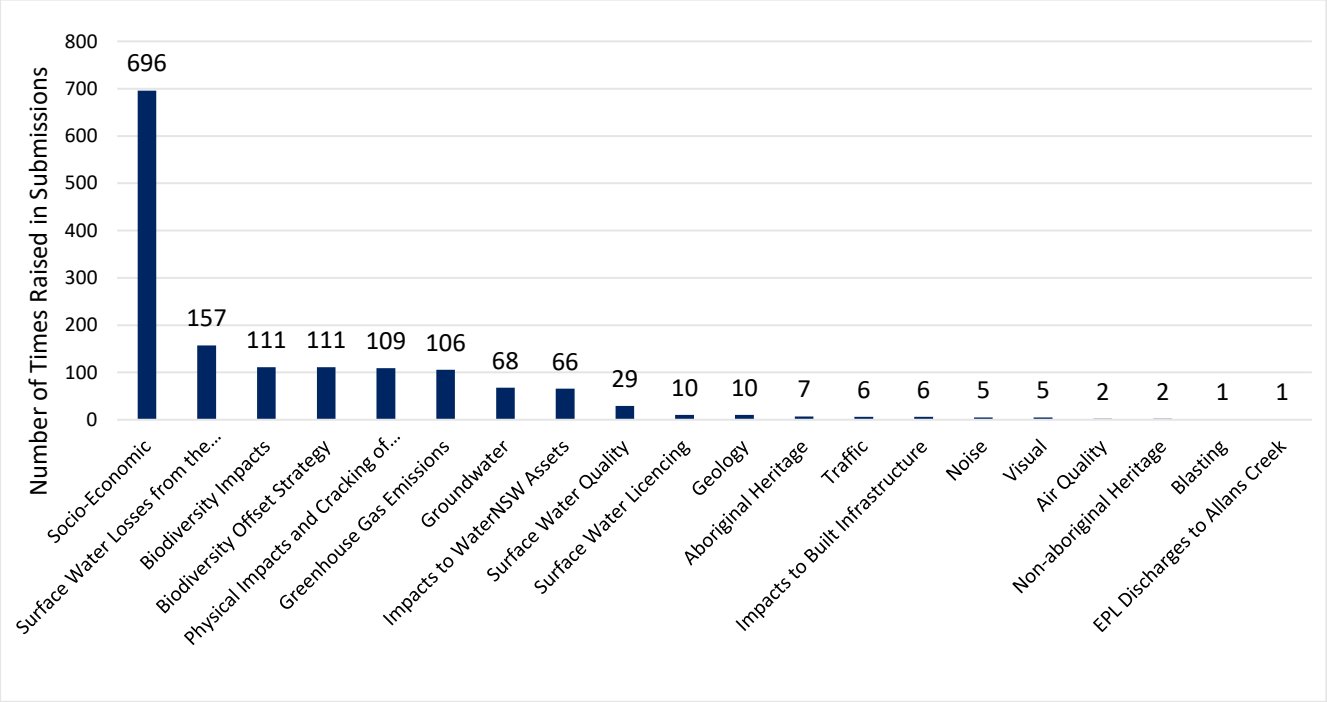


Figure 5 | Frequency of Issues Raised in All Public and Agency Submissions *(Source: South32)*

5.3.2 The key message from **Figure 5** is the degree to which socio-economic issues dominated submissions. Given that only 87 submissions raised negative socio-economic issues (see **Figure 6**), it is apparent that the dominant issue raised across the totality of submissions was the positive socio-economic benefits of the Project, noted in 613 submissions.

5.3.3 **Figure 5** gives some indication of the issues of most significance to objectors. More detail can be found in paras 5.3.72 – 73 and in **Figure 6**.

Agency Advice

5.3.4 Only one NSW Government agency *objected* to the Project – WaterNSW. A number of the other 12 submissions from Government agencies and similar entities expressed concerns over particular aspects of the Project or the EIS. For the most part, agency submissions provided advice and/or comments.

5.3.5 The key issues and matters of concern raised by Government agencies and similar entities in their advice in response to the EIS are set out in brief summary form below. They are then addressed in more detail under the relevant headings and subheadings in **Section 6**.

Proposed Longwall Layout & Geometry

5.3.6 The principal agencies that expressed concerns relating to the proposed longwall layout and its geometry (primarily the proposed 305 m width of the longwall voids) were WaterNSW, the IESC, BCD and DPIE - Water.

5.3.7 For example, WaterNSW stated that:

> *"… there is a fundamental problem in the project design as it does not sufficiently take into account a 'paradigm shift' in scientific understanding and policy settings that has occurred since the last mine was approved in the Special Areas. In particular, the project has not been designed to reduce the height of fracturing and associated groundwater depressurisation."*

5.3.8 WaterNSW recommended that the Department:

> *"requests the mining company provide information about alternative mine designs that have been considered that would avoid or reduce environmental impacts, including:*
> - *reducing the mining dimensions (eg narrower longwalls with wider pillars) in order to prevent 'surface-to-seam fracturing', and*
> - *increasing the setbacks from key infrastructure and environmental features."*

5.3.9 WaterNSW also recommended that the Department refers the project to the Catchment Panel or a similar technical panel of experts (including a mine subsidence expert, groundwater expert, surface water expert and dams engineer) for advice on the mine design and potential impacts.

Subsidence Assessment

5.3.10 The principal agencies that expressed concerns relating to the EIS's Subsidence Assessment were WaterNSW and BCD.

5.3.11 WaterNSW and BCD both drew attention to the fact that the EIS's Subsidence Assessment did not apply a recent revision by South32's subsidence consultant of vertical subsidence

predictions in Areas 3A and 3B (an increase of 30%) to the proposed mining in Area 5, albeit that it did to the proposed mining in Area 6. South32's RTS reported that the increased predictions only apply to mining in the Wongawilli Seam (ie Area 6) and not the Bulli Seam (Area 5), owing to different coal pillar behaviour in the two seams.

5.3.12 The IESC considered that:

> "*the subsidence assessments have been completed to a good standard, particularly with respect to the use of existing observations of impacts at other areas of the Dendrobium Mine."*

Surface Water Losses

5.3.13 The key agencies that expressed concerns relating to predicted or potential surface water losses from the catchment were WaterNSW, DPIE - Water and BCD.

5.3.14 WaterNSW expressed concern that the EIS identified that the Project would 'take' up to 3.3 gigalitres/year (GLpa) of surface water from its drinking water catchment. This water take would comprise water loss from nine major watercourses (3rd order or above) and over 100 smaller tributaries.

5.3.15 WaterNSW drew attention to the estimates in the EIS's Surface Water Assessment that "in a dry year [ie 10th percentile climatic conditions] this may reduce the yield of the Avon Reservoir catchment by 3.9% and the Pheasant's Nest Weir catchment by 2.9%". Further, that it predicts a 100% reduction in stream flow to the Avon Reservoir and a 67% reduction in stream flow to Pheasants Nest Weir, from that portion of the catchment directly overlying Area 5, in a dry year.

Surface Water Licensing

5.3.16 The key agencies that expressed concerns relating to surface water licensing were WaterNSW and DPIE - Water. Both agencies drew attention to the fact that, as at the time of their submissions, there was no existing policy mechanism by which South32 can acquire the necessary entitlements for surface water losses in the Special Areas.

Impacts on Stream Function

5.3.17 The key agencies that expressed concerns relating to loss of stream function were DPIE - Water and BCD.

5.3.18 DPIE - Water stated that:

> *"The impact of subsidence on the geomorphology of watercourses is significant noting subsidence will not affect all watercourses at the same level. The submission lacks explanation on criteria used to assign significance to watercourses and on the assignment of setback distances. … We are concerned about the criteria used to assign significance to watercourses overlying or adjacent to the predicted subsidence zone for Dendrobium Areas 5 and 6. The EIS does not provide geomorphic or hydrologic justification for the use of the 'Key' stream features of pools with holding capacities greater than 100m^3 capacity or waterfalls greater than 5 m height. These criteria may reduce any obligation to reduce longwall lengths to avoid direct subsidence of overlying swamps and connected watercourses."*

5.3.19 BCD considered that the setbacks from significant stream features proposed in the EIS *"assume that subsidence impact will not occur in areas with <200mm of valley closure, a threshold that is not supported from previous experience in the Southern Coalfields".*

5.3.20 The IESC considered that the surface water assessments had been "completed to a high standard."

Surface Water Quality

5.3.21 The principal agencies that expressed concerns relating to surface water quality in the catchment were WaterNSW and the IESC.

5.3.22 WaterNSW considered that mobilisation of metals (eg iron) due to extensive fracturing of streambeds would likely lead to an increase in metals within streams across the catchments of the two reservoirs. This issue could become a greater concern post-mining, as groundwater pressure recovers, leading to surface seeps of iron-enriched waters.

5.3.23 WaterNSW also considered that the EIS did not contain an adequate assessment against the 'Neutral or Beneficial Effect' (NorBE) test in respect of loads or concentration of metals in streams or reservoirs, as required under the *SEPP (Sydney Drinking Water Catchment) 2011.* WaterNSW stated that it had 'serious concerns' that the Project would not meet this test.

5.3.24 The IESC considered that one of the key potential impacts of the Project was 'adverse impacts on water quality of inflows to water supply storages associated with the expected changes in the upland environment. Such water quality impacts are likely to include changes in turbidity, nutrient loads and pathogens.' The IESC also sought further consideration of "potential long-term changes to surface water quality as groundwater levels recover post-mining, as well as the mechanisms which cause water quality changes to occur."

Surface Water Discharges

5.3.25 The principal agency that expressed concerns relating to surface water discharges was the EPA, which considered that the EIS did not fully assess pollutant loads for the proposed increased discharge of mine water at LDP5 in Allans Creek and the need to revise the site's existing EPL 3241.

5.3.26 These matters were addressed to EPA's satisfaction in South32's RTS.

Groundwater Impacts

5.3.27 The principal agencies that expressed concerns relating to predicted or potential groundwater impacts were WaterNSW, the IESC and DPIE - Water.

5.3.28 Generally speaking, the IESC considered that the EIS contained *"a detailed assessment to characterise groundwater resources within the project area [which] builds on previous site models, using site-specific data and geological mapping, and data from the Illawarra Coal bore database."* However, the IESC had a number of particular concerns over the groundwater assessment. These included that:

> *"The groundwater model … is focused on simulating regional groundwater flows under the assumptions inherent in an equivalent porous media model. This model does not adequately incorporate the impacts of surface cracking and near-surface ground movement. This means the groundwater model does not address what is likely to be the main impact pathway on baseflow in nearby watercourses, and this has implications for assessing likely impacts on aquatic biota and ecological function. Accordingly, the IESC has a low level of confidence in the … estimates of mining impacts on surface water-groundwater interactions."*

"The IESC also has limited confidence in the current groundwater model predictions … given the risk of potential impacts to groundwater assets."

"The groundwater model has not adequately simulated the dynamic changes in hydraulic properties associated with mining-induced ground movement under streams."

5.3.29 WaterNSW considered that the groundwater model may have resulted in underestimates in the EIS of mine water inflows, surface water losses, water quality impacts and swamp impacts, due to uncertainties in some of its key input data. These uncertainties relate to increases over a number of years in South32's modelled predictions of surface water loss; the proportion of surface water diversion modelled as reporting to mined voids and modelled predictions of leakages from the reservoirs.

5.3.30 DPIE - Water first identified that "*The reported modelling work is highly sophisticated and largely compliant with the Australian Groundwater Modelling Guidelines"*. However, it also identified a number of technical concerns relating to model parameterisation, model calibration, model predictions, calibration of model inflows, sensitivity analysis and uncertainty analysis. These are addressed in more detail in **Section 6.5**. DPIE - Water proposed a number of improvements to the groundwater model *"to ascertain the predicted impacts with better certitude. For example, the model needs to improve its estimation of drawdown effects on water users, infrastructure and the environment."*.

Geological Risks and Hazards

5.3.31 The principal agencies that expressed concerns relating to inadequate assessment of geological risks and hazards in the EIS were WaterNSW and DSNSW.

5.3.32 WaterNSW considered that the extent and possible impacts of geological structures (including faults, dykes, and 'basal shear planes') had not been fully investigated and simulated in the subsidence predictions, particularly faults trending northeast-southwest.

5.3.33 DSNSW expressed similar concerns in respect of geological influences on potential far-field subsidence effects on the walls of Cordeaux Dam and Avon Dam. Its concerns related to the assessment of risks associated with two igneous dykes shown in the Subsidence Assessment as extending beneath the wall of Cordeaux Dam, and also the potential for the activation of basal shear planes in the geological strata outcropping in the valleys in which the dam walls are built.

Potential Impacts to WaterNSW Assets

5.3.34 The principal agencies that expressed concerns relating to potential impacts on WaterNSW assets (principally the walls of Cordeaux Dam and Avon Dam) were WaterNSW and DSNSW.

5.3.35 Both agencies sought an increase in South32's proposed setback of 1,000 m between the dam walls and any longwall void, to a minimum of 1,500 m. WaterNSW considered that the EIS did not adequately consider the potential for differential far-field horizontal movements (ie movements that were greater at one end of the dam wall than at the other).

5.3.36 DSNSW addressed this issue in much more detail. It pointed to a figure in the Subsidence Assessment that suggests that the difference in movement at each end (ie the 'abutments') of the Avon and Cordeaux dam walls may be as much as 10 mm and 16 mm, respectively.

5.3.37 It also considered that the additional movement on the Cordeaux Dam wall projected to occur as a result of the approved (but delayed) extraction of Area 3C had not been taken into account. Because Area 6 and Area 3C are located at opposite ends of this dam wall, regional ground movement towards the resulting longwall goaf would 'pull' the dam wall in opposite directions. DSNSW considered that these two movements could total as much as 120 mm.

Biodiversity Impacts

5.3.38 The principal agencies that expressed concerns relating to predicted biodiversity impacts were BCD, WaterNSW and the IESC.

5.3.39 BCD's advice was particularly extensive and detailed. BCD concluded that, while the area of vegetation that would be directly cleared is relatively small, the likelihood of subsidence over a much more extensive area is high and this is *"predicted to have a significant impact on multiple threatened Coastal Upland Swamps and other water dependent ecosystems and threatened species".*

5.3.40 Among other matters, BCD considered that the EIS did not adequately demonstrate that the key biodiversity assessment principle of first seeking to 'avoid' the potential impact has been met. It considered that the Project is likely to have a significant impact on NSW and Commonwealth-listed water-dependent threatened ecological communities (TECs) and species, including Coastal Upland Swamps of the Sydney Basin Bioregion ('upland swamps'), Littlejohn's Tree Frog, Giant Burrowing Frog and Giant Dragonfly.

5.3.41 WaterNSW's advice in respect of biodiversity matters focused on the expected impacts to 26 endangered upland swamps due to fracturing of the bedrock beneath the swamps, which WaterNSW considered would "make them more fire-prone and change their ecological functioning".

5.3.42 The IESC's advice on the same matter was more extensive. The IESC concluded that:

> *"Key potential impacts of the Project [include] major changes to water regimes and drying severity in swamps. Twenty six swamps will be directly undermined and impacted by subsidence with an additional 20 potentially impacted as these are located partially or wholly within 600 m of planned longwall panels;*
>
> *irreversible changes will occur in EPBC-listed swamps, instream and riparian environments (including major changes in important ecological processes such as organic matter decomposition and microbial activity in the hyporheic zones) and water-dependent flora and fauna, such as the state-listed Giant Dragonfly (Petalura gigantea), resulting from the above mentioned changes to flows and water regimes in streams and swamps."*

Biodiversity Offset Strategy

5.3.43 The principal agencies that expressed concerns relating to the Project's proposed Biodiversity Offset Strategy were BCD and the IESC.

5.3.44 BCD's key concerns were that:

- the Framework for Biodiversity Assessment (FBA) was incorrectly applied in calculating the maximum predicted offset liability for the Project in respect of upland swamps. BCD's Upland Swamp Offset Policy requires calculation against a 'worst-case scenario' for

swamps, which under the predictions in the EIS includes significant erosion and scouring, equating to total loss of swamps; and
- the FBA was incorrectly applied in calculating offsets for loss of Koala habitat and other threatened species through clearing for surface infrastructure.

5.3.45 While the IESC noted that potential subsidence-related impacts to swamps are proposed by South32 to be offset "consistent with government policies", it considered that "further clarification is required, as many swamps contain endemic species and the impacts relate to an extensive area that is greater than the sum of its individual assets. Clarification is required on which swamps are proposed to be offset, and how their attributes compare to swamps that are likely to be impacted."

Impacts to Other Built Infrastructure

5.3.46 The only agency that expressed significant concerns relating to predicted or potential impacts on built infrastructure (other than WaterNSW's assets) was the RMS.

5.3.47 While the EIS contained appropriate modelling of future intersection loading related to the Project, RMS sought additional modelling based on current traffic loads, to better understand the significance of the proposed increase in construction and operational traffic, particularly near the Cordeaux Pit Top, at the intersection of the pit top access road with Picton Road.

5.3.48 This matter was addressed to RMS's satisfaction in South32's RTS.

Greenhouse Gas Emissions

5.3.49 No agency expressed significant concerns relating to greenhouse gas emissions.

Other Air Quality Impacts

5.3.50 The only agency that expressed any concern relating to other air quality impacts (primarily dust emissions) was the EPA. The EPA considered that it needed further information from South32 to support its analysis of the EIS's air quality assessment.

5.3.51 These matters were addressed to EPA's satisfaction in South32's RTS.

Noise and Blasting Impacts

5.3.52 The only agency that expressed significant concerns relating to predicted and potential noise and blasting impacts was the EPA. The EPA sought additional information and justification regarding:

- inconsistencies between the noise limits in the existing development consent and the proposed Project Trigger Noise Levels and predicted outcomes at some receivers;
- selection and justification of 'reasonable and feasible mitigation' under the *Noise Policy for Industry*;
- validity of the operational noise model and the sound power levels applied to particular equipment; and
- clarification of the blasting assessment criteria used in the EIS's Noise and Blasting Assessment and specific consideration of potential impacts from small and infrequent underground blasts on built infrastructure (specifically the walls of Cordeaux and Avon Dams).

5.3.53 Each of these matters was addressed to the EPA's satisfaction in South32's RTS.

Aboriginal Heritage Impacts

5.3.54 The only agency that expressed significant concerns relating to predicted or potential Aboriginal heritage impacts was BCD.

5.3.55 BCD considered that mine subsidence from the Project "*is likely to harm multiple Aboriginal cultural heritage sites. [BCD is] particularly concerned that the current longwall design will harm sites that have high Aboriginal cultural and scientific significance."* BCD sought a number of variations to the Project's longwall layout to *"reduce harm to a minimum or imperceptible level"* at a number of key sites.

Non-Aboriginal Heritage Impacts

5.3.56 The only agency that expressed concerns relating to predicted or potential impacts on non-Aboriginal heritage was the Heritage Council.

5.3.57 The Heritage Council sought reductions in the size of both Area 5 and Area 6 such that they do not overlap with the heritage curtilage of the Avon and Cordeaux Dams, as listed in the State Heritage Register. The Heritage Council considered that subsidence and surface fracturing could potentially "radically alter" the landscapes and built elements within the curtilages.

5.3.58 It also sought further information on potential visual impacts of the proposed new ventilation shaft infrastructure from the viewpoints of access roads and other viewpoints within the curtilage areas, not just for viewers walking on the walls of the Avon and Cordeaux Dams.

Traffic Impacts

5.3.59 No agency expressed concerns over predicted or potential traffic impacts, other than the RMS in respect of modelled intersection performance (see para 5.3.47).

Visual Impacts

5.3.60 The only agency that expressed concerns relating to predicted or potential visual impacts was the Heritage Council (see para 5.3.58).

Negative Socio-Economic Impacts

5.3.61 No agency expressed significant concerns relating to negative socio-economic impacts arising from the Project.

Positive Socio-Economic Benefits

5.3.62 The principal agency that provided comments concerning the positive socio-economic benefits flowing from the Project was MEG.

5.3.63 In summary, MEG considered that the Project would:

- ensure continued operations at the Dendrobium Mine until 2048;
- improve resource recovery and be an efficient use of resources;
- produce 77.6 Mt of ROM coal over 23 years;
- provide the State of NSW with A$680 million in revenue from royalties (current dollars);
- generate total revenue (value of coal produced) of A$10.4 billion (current dollars);
- support continued employment for up to 500 full time operational jobs at the existing Dendrobium Mine; and

- continue to supply the majority (along with blended coal from the Bulli Seam Operations) of the coking coal to the nearby BlueScope Steelworks.

5.3.64 MEG also pointed out that, if the Project is not approved, production at Dendrobium Mine would cease in about 2024, with the consequent loss of 500 jobs and the loss of royalty revenue to the State and the loss of other local and regional economic benefits.

Council Advice

5.3.65 The three affected councils all provided submissions in response to exhibition of the Project's EIS.

5.3.66 Area 6, Ventilation Shaft Sites 6A and 6B and the West Cliff CWE are all located within Wollondilly LGA. **WoSC** first recognised the "*economic benefits of the … Project in terms of both employment and importance of the continued operations of the Port Kembla Steelworks"*. Notwithstanding, WoSC formally *objected* to the Project, until such time as the *"potential impacts on water sources (eg drinking water) and supplies are addressed to the satisfaction of WaterNSW"*.

5.3.67 While WoSC drew attention to a number of other matters, the key concerns of the Council and its community focused on *"potential impacts to water sources and the availability of potable water supplies"*.

5.3.68 It should be noted that the West Cliff CWE already has development consent until the end of 2030 (under the existing Dendrobium consent) or until the end of 2041 (in the case of that part of the CWE regulated under MP 08_0150).

5.3.69 **WCC's** submission recognised the *"importance of this project to the Illawarra economy and to local steel production. … Council also notes that there are a range of aspects of the proposal which should be reviewed and modified to mitigate adverse environmental and social impacts. This is particularly important given the size of the mine expansion and the sensitive water catchment areas involved."*

5.3.70 WCC was principally concerned about the extent of subsidence related impacts on watercourses, upland swamps and Aboriginal heritage sites due to the current proposed mine layout, especially the 305 m widths of the proposed longwall voids. It was also specifically concerned about the cumulative loss of water to reservoirs, creeks and upland swamps in the Greater Sydney Water Catchment due to mining activities. WCC sought a review of South32's mine plan to limit impacts on upland swamps, watercourses, Aboriginal heritage and threatened frog fauna found in swamps.

5.3.71 Area 5 and Ventilation Shaft Sites 5A and 5B are located within Wingecarribee LGA. The **WiSC** submission simply reported that Wingecarribee Council has had a policy position of opposing any longwall or other coal mining anywhere within the Wingecarribee LGA because of its concerns over potential impacts on groundwater, water catchments, agricultural land and tourism. The WISC submission did not offer any other comment on the EIS or the Project.

Public Submissions in Objection

5.3.72 The key issues raised in submissions from the 135 members of the public and 17 special interest groups which objected to the Project were:

- surface water losses from the catchment;
- anthropogenic GHGEs;
- biodiversity impacts and the biodiversity offset strategy;
- physical impacts and cracking of streambeds;
- adverse socio-economic impacts;
- impacts to WaterNSW's assets;
- groundwater impacts; and
- surface water quality.

5.3.73 **Figure 6** (below) shows the frequency of issues raised in objecting submissions from the general public and special interest groups. Given that nearly 88% of objecting submissions came from members of the public, **Figure 6** also provides a clear indication of which issues were of most concern to public objectors.

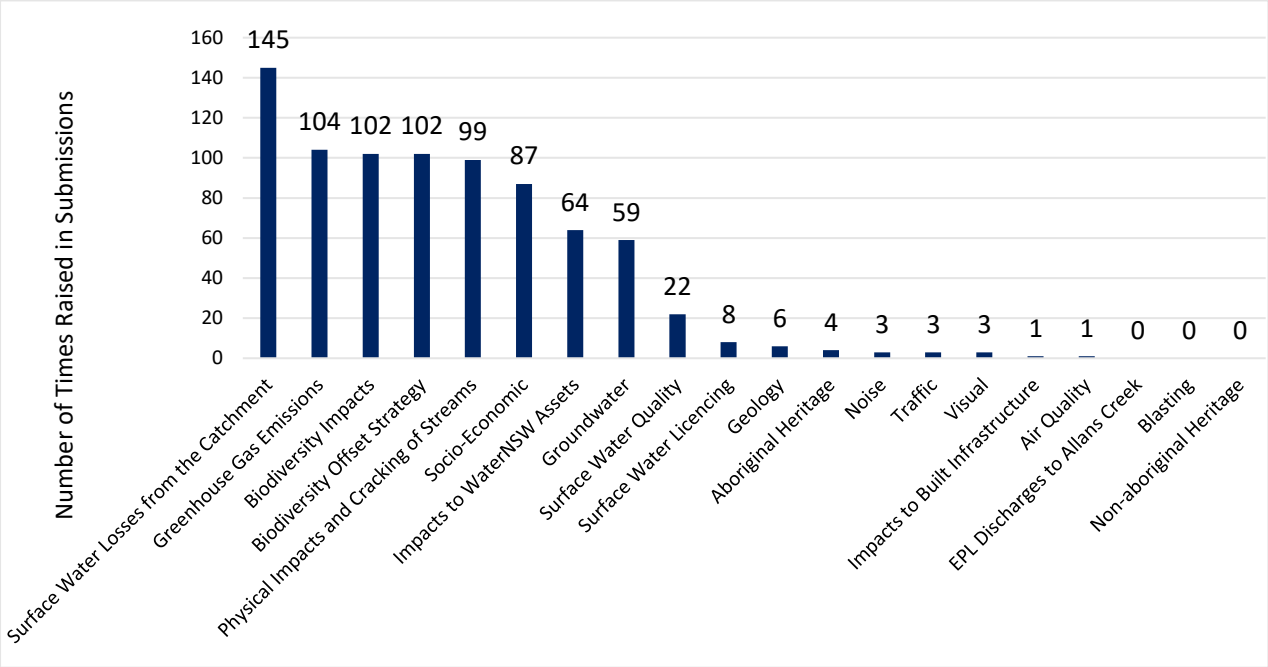


Figure 6 | Frequency of Issues Raised in Public and Organisational Objections *(Source: South32)*

Public Submissions in Support

5.3.74 The issues raised in all submissions from the 20 organisations and 583 members of the public who supported the Project related to its positive socio-economic benefits, especially:

- continuation of employment for the existing Dendrobium Mine workforce;
- significant additional employment opportunities at the Dendrobium Mine; and
- importance of the Project to continuation of the BlueScope Steelworks.

5.3.75 There is little point in presenting a chart showing this information (due to its unanimity), however the degree to which this issue dominated all submissions can be seen in **Figure 5**.

5.4 Response to Submissions

5.4.1 On 3 October 2019, the Department requested that South32 prepare responses to the issues raised in submissions (a 'Response to Submissions', or RTS). On 5 December 2019, the

Department requested that South32 identifies within its RTS which recommendations in the reports of the Catchment Panel the company proposes to adopt or otherwise reflect in the current application and/or during the undertaking of the mining proposed in the application.

5.4.2 On 13 February 2020, South32 lodged its RTS with the Department (see **Appendix C**). The RTS provided:

- analysis of and response to the issues raised in all submissions received during the public exhibition period (including advice from government agencies and the Commonwealth's IESC);
- a summary of actions taken by South32 since lodgement of the EIS;
- South32's changes to its proposed mitigation measures and an updated justification for the Project; and
- a response to the Department's request that South32 advise which of the Catchment Panel's recommendations the company proposes to adopt in its application or otherwise implement during the proposed mining.

5.4.3 The RTS contained some key changes over the Project as exhibited. Firstly, South32 reported purchase of a property which could provide a substantial number of upland swamp ecosystem credits to meet the Project's offset liability.

5.4.4 South32 also expanded the EIS's statements that the Project had an "objective" for beneficial re-use of mine water in the Port Kembla industrial precinct, as follows:

> *"South32 commits to implement or fund works such that the Project results in net neutral or net beneficial effects to Sydney's drinking water supplies from subsidence-related surface water losses from the Metropolitan Special Area. This would include beneficial use of mine water to reduce existing demands on the drinking water system, and/or funding or implementing works that reduce existing losses (eg pipe losses or evaporation)."*

5.4.5 However, this commitment has since been overtaken by later developments (see ***Offsetting*** in **Section 6.3**). The RTS also reported that, since lodging the EIS, South32 has continued to consult with Government, Councils, industry and community members regarding the Project.

5.4.6 The RTS was forwarded to affected agencies on 19 February 2020. Further submissions were received from WaterNSW, BCD, EPA, MEG, RR, the Heritage Council, NSW Health and WCC (see **Appendix C**). These further submissions were provided to South32 on 13 March 2020.

5.4.7 On 20 April 2020, the Department asked South32 to give more consideration to the original submissions (and further submissions) provided by the IESC, WaterNSW, DSNSW, BCD, the Heritage Council, DPIE - Water and WCC. The Department also sought further information regarding South32's revised commitment for *"net neutral or net beneficial effects to Sydney's drinking water supplies from subsidence-related surface water losses"* (see para 5.4.4).

5.4.8 Between early May and early July 2020, South32 provided additional, more detailed responses in respect of the submissions from each of these agencies (see **Appendix C**). South32 also initiated meetings with the affected State agencies (ie WaterNSW, DSNSW, BCD, the Heritage Council and DPIE - Water) to discuss its responses and any remaining issues.

5.4.9 Importantly, in its response to the Department, South32 also further revised its commitment regarding surface water offsets in the following terms: *"South32 commits to implement (ie*

"direct" offset) or fund (ie "indirect" offset) works such that the Project results in a net gain to metropolitan water supplies."

5.4.10 The detailed content of South32's RTS and its additional responses are addressed in more detail under the relevant headings and subheadings in **Section 6** below.

5.5 Amended Development Application

5.5.1 Clause 55 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) provides that an applicant may, with the agreement of the consent authority, amend or vary a development application at any time before its determination.

5.5.2 On 18 August 2020, South32 duly submitted an Amendment Report for the Project to the Department. On the same day, a delegate of the Commission agreed to the amendment of the development application for the Project and the Amendment Report was lodged by South32 on the Department's web portal, as required by clause 55 (see **Appendix D**).

5.5.3 The Amendment Report sets out three significant but relatively minor amendments to the Project. In summary, these are:

- delineation of the location of certain ancillary infrastructure – in response to BCD's submission, further design works were undertaken to delineate fixed locations for the proposed electricity transmission line needed to provide power to the four new ventilation shaft sites and the proposed new service boreholes site (now to be added to Shaft Site 5A). There is no change to the total native vegetation disturbance of 28.5 ha assessed in the EIS but additional fauna and flora survey work was undertaken to recalculate ecosystem and species credits;
- refinement of the FSL for Avon Dam and the associated longwall setback – more detailed surface contour data was obtained by South32 which led to a small expansion to its FSL mapping for Avon Dam. As a result, LW 516 would be shortened to maintain the proposed 300 m longwall setback from the FSL. Consequently, there is a small reduction of c. 0.4 Mt of ROM coal to be produced from Area 5; and
- confirmation of South32's surface water offset commitments for a "net gain" to Metropolitan drinking water supplies – details of South32's revised commitment (see para 5.4.9) and proposals as to how this could be achieved.

5.5.4 The Amendment Report indicated that its proposed amendments would lead to:

- a small reduction of the Project's total ROM coal resource from c. 77.6 Mt to c. 77.2 Mt;
- a resulting small reduction in net economic benefits to NSW;
- a resulting small reduction in indirect greenhouse gas emissions (ie Scope 3);
- no change to the total native vegetation disturbance of 28.5 ha assessed in the EIS; and
- refining the Biodiversity Offset Strategy and offset requirements commensurate with delineating the native vegetation disturbance footprint.

5.5.5 The amendments would lead to no change in the Project's mine life, workforce, peak production rate, hours of operation and longwall setback commitments. There would be no additional environmental impacts beyond those assessed in the EIS (eg for surface water, groundwater and biodiversity) and not require any changes to the monitoring, mitigation and management measures set out in the EIS.

5.6 Review by Independent Advisory Panel for Underground Mining

5.6.1 Two of the Catchment Panel's 50 recommendations proposed the establishment of a new independent subsidence advisory panel to provide advice to Government regarding new underground coal mining proposals and subsidence-related performance outcomes under mining approvals. This new panel (the Independent Advisory Panel for Underground Mining, or the 'Mining Panel') was established on 21 August 2020. The Mining Panel is chaired by Emeritus Professor Jim Galvin, who also chaired the Catchment Panel.

5.6.2 On 26 August 2020, the Department wrote to Prof Galvin seeking the Mining Panel's advice concerning the Project, particularly *"longwall void widths for the two proposed mining domains (Area 5 and 6), and the relative environmental costs and benefits associated with different longwall widths, including whether a reduction in the void widths would materially reduce the environmental impacts of the project."*

5.6.3 Subsequently, the Scope of Works was broadened to include a focus on subsidence impacts associated with the specific mine layout on which the EIS is based.

5.6.4 The Mining Panel provided its advice to the Department on 20 October 2020 (see **Appendix F**). The Mining Panel's advice contained 45 conclusions and 14 recommendations regarding the Project. These recommendations are set out in full below.

Project Assessment

It is recommended that the assessment of the [Project] give consideration to the following:

1. *As a matter of due diligence, the consent authority should confirm the scope and appropriateness of the selected key stream features.*
2. *In respect of stream classification, whether any of the streams impacted by the proposed mining warrant classification as being of special significance.*
3. *The adoption of a risk assessment approach for evaluating the nature and scale of environmental impacts, the appropriateness of the limits selected for environmental impacts, the reliability of setback distances of longwall panels proposed for preventing these limits being exceeded, and the suitability of the mine layout to adaptive management as a control for preventing exceedances of predicted impacts.*
4. *In respect of surface water losses in the context of mine closure, whether the approach to assessment of compensation is appropriate or warrants future review.*

Project Approval Conditions

Should the [Project] be approved in its current form, it is recommended that the approval conditions make provision for:

5. *A suite of Management Plans to support Extraction Plans as per contemporary practice but taking into account the recommendations of the [Catchment Panel] that:*
    i. *consent conditions that make provision for meeting the requirements of performance measures by avoidance, mitigation or remediation need to be quite specific about the scope of attributes that have to be avoided, mitigated or remediated and the verification standards that avoidance, mitigation and remediation measures have to satisfy.*
    ii. *TARP triggers for surface and groundwater should be based on meaningful indicators developed in consultation with relevant agencies and authorities with oversight and regulatory responsibilities for mining.*
6. *The development of a Mine Rehabilitation and Closure Plan (MRCP) within a stipulated period to support the Extraction Plan.*

i. *The stipulated period could be of the order of 3 to 5 years.*

ii. *The MRCP should be based on a robust risk assessment that includes input from key stakeholders and independent third party specialists in mine closure in order to fully and objectively identify the potential hazards associated with mine closure, the likelihood and consequences associated with these hazards materialising, the extent to which consequences can be controlled should the hazards materialise, and the residual risks after control measures have been put in place.*

iii. *The MRCP should be peer reviewed by mine closure specialists on an annual basis during its development and every three years after development*

iv. *Consideration should be given to making continuing approval of the Extraction Plan during development of the MRCP conditional on demonstration on an annual basis of satisfactory progress in developing this management plan.*

7. *The MRCP to include provision for:*

    i. *Establishing the practicality of effectively and safely sealing Dendrobium Mine and those other mines that may directly or indirectly be connected hydraulically to Dendrobium Mine.*

    ii. *Improved modelling of points of groundwater outflow and water quality, and identification of potential needs for treatment*

    iii. *Options for managing residual risks, such as mine water discharge in perpetuity, should Dendrobium Mine not be able to be effectively sealed and, conversely, contaminated leakages should it be effectively sealed.*

8. *Government ensuring the provisioning and guaranteeing of adequate funding to cover both mine closure and all potential residual risks after mine closure.*

Project Residual Risks

Ground engineering is characterised by gaps in knowledge bases and pervasive uncertainty and so there is always a degree of residual risk and opportunities for improvement in time to come that require any project approval to be underpinned by a suite of robust risk management plans. Should the project be approved, the Extraction Plans should be supported by management plans that make provision for the following:

Surface water assessment

9. *The impacts and consequences predictions presented by the Proponent are not necessarily worst-case despite the use of a range of conservative assumptions. This is due to limitations of the predictive models employed. It seems unlikely that these limitations can be resolved in the short term. So, in addition to developing applicable TARPs for surface water, progressive model updating and refinement of surface water monitoring should be required.*

10. *The methods, criteria and thresholds used by the Proponent to determine key stream features, the absence of features of special significance, and the likelihood of impacts to rivers and named creeks should be regularly reviewed and the outcomes should be used to update the assessment of mining impacts to inform Extraction Plans.*

11. *Work should continue to be undertaken on water loss accounting methods and monitoring to more reliably inform surface water loss compensation.*

Groundwater assessment

12. *Groundwater modelling should continue to be reviewed and updated and further reports on the model outputs prepared in relation to the following matters:*

    a. *Re-evaluation of the spatial distribution of hydraulic properties of the geological formations to ensure that the property distributions represent the best conceptual understanding of the geological and hydrogeological setting and are not numerical artefacts of the chosen methods of property assignment and data averaging.*

b. *Extension of the sensitivity analysis to ensure that the calibration of the model is adequately examined as part of the analysis and that uncertainties in the key outputs of the modelling, such as mine inflows and surface losses are appropriately assessed and kept up to date.*

c. *Incorporating mine closure planning properly into the modelling of groundwater impacts after the end of mining.*

13. *The model should be updated regularly considering both new information from ongoing monitoring and considering further development of the subsurface mine closure plans. Updates should occur at intervals no longer than every three years. The modelling updates should undergo peer review.*

14. *In preparing reports on the groundwater modelling, effort should be made to improve the presentation of the modelling results by adopting mapping scales that allow detailed interrogation of spatial outputs by a reviewer. A5 scale maps are inadequate. As the majority of impacts are at the mine area scale, it would be beneficial for a greater focus on the mining areas when reporting outputs such as local water balances and for increased use of temporal plots to present information for the mine areas.*

5.6.5 South32 reviewed the Mining Panel's advice and provided a response to the Department on 22 October 2020. This response accepted all of the Mining Panel's recommendations, while noting that some were directed to the consent authority, rather than the company. The Department also accepts and supports all recommendations. Individual recommendations, key conclusions and other matters raised in the Mining Panel's advice are addressed in **Sections 6.2, 6.3 and 6.5 to 6.7**.

5.6.6 The Mining Panel's advice has been carefully taken into account by the Department in finalising its assessment.

6 Assessment

6.1 Introduction

6.1.1 This is a somewhat unusual assessment report for a resource assessment project in that there are only a few critical issues which are likely to determine whether to grant consent to the development application or not. Apart from these critical issues, there is a larger number of second and third order issues that require assessment but are not considered likely to be critical to this primary decision.

6.1.2 The key reason why there is a larger number of second and third order issues is that the Project represents the continuation of an existing underground mining operation which first commenced coal extraction by longwall methods over 16 years ago. There are no changes to the proposed rate of coal extraction or processing and very limited changes to the mine's key surface facilities. Impacts on the surrounding communities have generally been previously assessed and many measures to control or reduce impacts on these communities are already in place.

6.1.3 For this reason, the key assessment issues focus around the expansion of the underground mining footprint, its location within the Metropolitan Special Area and the economic

consequences for the Illawarra Region if the Project is not approved. The critical issues are therefore considered to revolve around the Project's:

- proposed mine plan, particularly the proposed longwall void width of 305 m, which is a considered to be a threshold issue;
- anticipated impacts on water catchment values and security of water supply for the Sydney and Wollongong areas and whether these impacts can be acceptably minimised and/or offset;
- potential impacts on WaterNSW's water supply assets (particularly the walls and floors of Cordeaux and Avon Dams) and their minimisation; and
- economic and social costs and benefits, including the likely economic and social costs if the Project does not proceed.

6.1.4 This section of the report is structured to first fully ventilate and assess these critical issues, prior to considering the remaining issues and impacts. For this reason, this section of the report does not follow the usual structure of the Department's reports for resource assessment projects.

6.1.5 In undertaking its assessment, the Department has carefully considered each requirement of the EP&A Act and the following key documents and information:

- South32's EIS;
- all submissions received from the IESC, State agencies and local councils;
- all submissions received from special interest groups and the general community;
- South32's RTS and other information provided in response to the Department's requests;
- South32's Amendment Report;
- reports of the Catchment Panel and advice received from the Mining Panel; and
- independent expert reports commissioned by the Department in respect of the Project's proposed mine plan and the economic consequences if the Project does not proceed.

6.1.6 The Department has also given consideration to the terms of the existing development consent for the Dendrobium Mine, the history of community complaints regarding its operations and its relationships with its local and regional community.

6.2 Proposed Mine Design

Introduction

6.2.1 The key facts regarding South32's proposed mine design are set out in **Section 2.2**. There are a number of major constraints, both at the surface (eg extent of mining leases, location of dams and reservoirs) and underground (location of major in-seam igneous intrusions, fault zones and Area 3C), which limit the overall size and general location of Areas 5 and 6. Apart from these major constraints, the three major limitations on the proposed mine design are those which South32 has chosen in order to limit subsidence impacts, these being:

- longwall setbacks from both the Avon and Cordeaux Dam walls (minimum setback distance of 1,000 m);
- no direct undermining of the existing Avon and Cordeaux Dam waterbodies, with a minimum 300 m longwall setback from their existing FSLs; and

- longwall setbacks from named watercourses (ie Cordeaux River, Avon River and Donalds Castle Creek) to achieve 200 mm or less of predicted Project-related valley closure as a result of subsidence.

6.2.2 The adequacy of each of these major limitations to protect the features in question is addressed in **Sections 6.3 and 6.4**. The major purpose of **Section 6.2** is to address the critical question of the Project's proposed longwall width.

Longwall Geometry

Introduction

6.2.3 As noted above, the proposed longwall geometry is considered to be a threshold issue for assessment of the Project. This is particularly the case because the Catchment Panel expressed concerns over reducing the risk of surface to seam fracturing through appropriate mine design. The Catchment Panel's Part 2 report stated the Panel's view "*that it would be wise to adopt a precautionary approach and base mine design on preventing the height of free drainage in the Special Areas from extending to the surface or interacting with surface fracture networks.*" Nonetheless, there were no recommendations to give specific effect to this view.

6.2.4 In addition, a number of key agencies expressed concerns over the proposed longwall geometry (primarily the proposed 305 m width of the longwall voids), including WaterNSW, the IESC, BCD and DPIE - Water.

6.2.5 The Department therefore considers that the first issue to be carefully considered is the proposed geometry of the Project longwalls.

6.2.6 Apart from the general location of a longwall mining domain, such as the proposed Area 5 or Area 6, the geometrical factors of the proposed mining act as dominant controls on subsidence effects (and therefore subsidence impacts and environmental consequences at the surface). These key geometrical factors, in general order of significance, are the:

- longwall void width;
- height of longwall extraction;
- depth from the surface to the extracted seam;
- width of the solid coal pillars remaining between longwall voids (generally called tailgate chain pillar width); and
- longwall void length.

6.2.7 In simple terms, if longwall width and/or the height of extraction is increased, or if the depth from surface to seam is decreased, then subsidence effects will increase. That is, if a longwall void is wider or taller or closer to the surface, then measured subsidence effects are greater.

6.2.8 Inter-panel chain pillar width then varies these simple relationships. Broadly speaking, a wider chain pillar will reduce subsidence effects at the surface by providing a stronger foundation to support the overlying rock mass. However, this is not a simple linear relationship, and South32 provided a letter report from its subsidence consultants, Mine Subsidence Engineering Consultants (MSEC), dated 18 February 2016, that indicated that chain pillars of 60 m width were no more effective than chain pillar widths of 45 m in reducing maximum predicted vertical subsidence, tilt or surface curvature.

6.2.9 A coal seam is also fixed in position and cannot be moved further from the surface of the land above it. In addition, it is generally considered inefficient to leave good quality coal in the roof of a mine by limiting the height of extraction, once the opportunity to extract that coal has been gained. Finally, the other key geometric parameter (longwall length) will be considered in terms of specific risks and impacts to specific sites and features.

6.2.10 Consequently, the key factor in longwall mine design which may be readily varied to reduce overall subsidence effects is the width of the proposed longwall void.

6.2.11 However, even this is not a straightforward decision because varying the longwall width comes at a significant economic cost to the mining company. This is because all elements of construction and operation of a longwall mine are uneconomic in themselves. Each is an investment in the opportunity to extract coal by longwall methods.

6.2.12 This includes the roadways which are developed to delineate every longwall block. Each longwall block has a given number and length of roadways (maingate and tailgate roads, etc). The cost of developing these roadways is therefore largely fixed. These costs are then amortised against the rapid, low-cost recovery of coal from the longwall block. If the block is narrower, it follows that the development costs are higher, per tonne of coal produced.

Reduced Longwall Width and Resulting Subsidence Effects

6.2.13 The relationship between longwall void width and subsidence effects is not always a simple linear one. A particularly narrow longwall panel (say <50 m) will generally leave enough integrity in the overlying strata that its subsidence effects at the surface are almost imperceptible. However, as the void width increases, the overlying strata are less able to 'arch' over the goaf and the surface rocks begin to sag (ie subside). At a particular void width (for any given height of extraction and depth from the surface), a limit is reached where no arching support remains available and maximum vertical subsidence occurs. This limiting void width is referred to as the 'critical width'. If a longwall void exceeds critical width, then there is no resulting increase in subsidence effects as the maxima have already been reached. The overall effect at the surface is simply that the remaining arched strata (over the longwall chain pillars) are farther apart. However, the maxima for vertical subsidence, tilts and compressive and tensile strains have already been reached. Only between the point at which surface subsidence over a narrow longwall void is initiated and the point at which critical width is reached are the relationships between longwall width and subsidence effects broadly linear.

6.2.14 In the Southern Coalfield, the critical width occurs at a longwall width-to-depth ratio of approximately 1.4. The width-to-depth ratios for the proposed longwalls vary between 0.78 ~ 1.1 (average of 0.85) in Area 5 and vary between 0.66 ~ 0.81 (average of 0.70) in Area 6 The proposed longwalls in Areas 5 and 6 therefore have void widths less than the critical width. This means that reasonably linear relationships exist between longwall void width and subsidence effects. MSEC has provided a letter report, dated 30 September 2019, which demonstrates these relationships clearly (see **Figures 7, 8 and 9**).

6.2.15 **Figure 7** shows that the maximum predicted vertical subsidence in Area 5 is less than for Area 6. MSEC states that this results from the lower mining height in the Bulli Seam. The shapes of the curves for Area 5 and Area 6 also differ somewhat as a result of the proposed mining geometry. The proposed longwalls in Area 5 are at shallower depths of cover (360 m average) compared with the depths of cover in Area 6 (440 m average), whereas the

proposed mining heights in Area 5 are lower (2.5 m to 3.2 m in the Bulli Seam) compared with the proposed mining heights in Area 6 (3.9 m in the Wongawilli Seam).

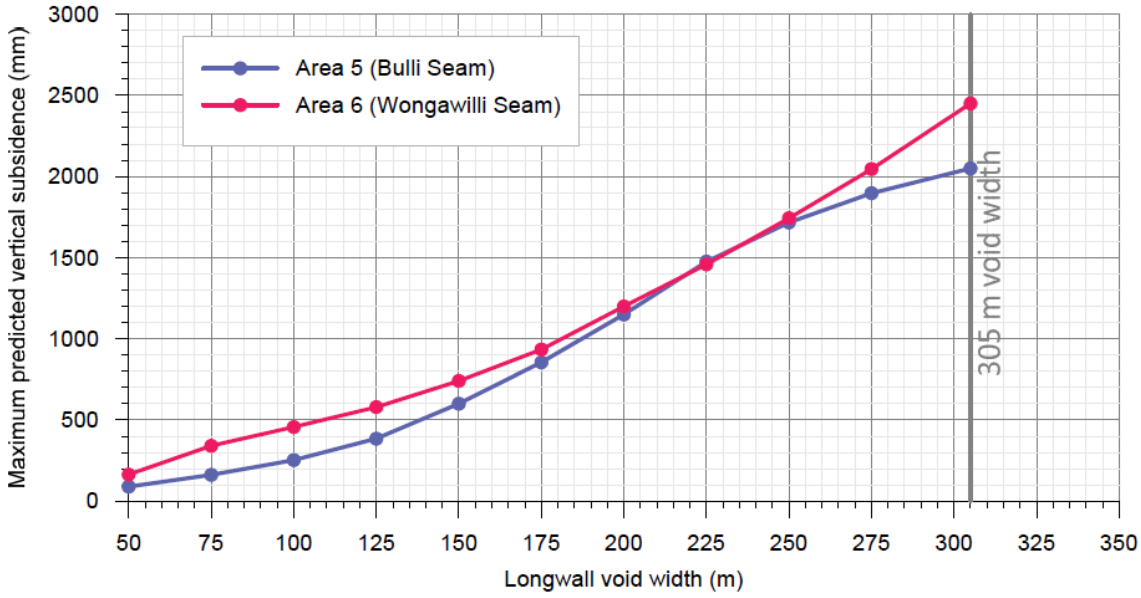


Figure 1 Maximum predicted vertical subsidence versus longwall void width

Figure 7 | Maximum Predicted Vertical Subsidence versus Longwall Void Width *(Source: MSEC)*

6.2.16 **Figure 7** shows that maximum predicted vertical subsidence decreases as longwall void width reduces. The maximum predicted vertical subsidence, as percentages of the maximum predicted value for the 305 m wide longwalls, are approximately 70 % to 80 % for 250 m longwalls, 50 % to 60 % for 200 m wide longwalls and 30 % for 150 m longwalls. However, the potential for physical impacts (ie surface cracking and rock fracturing) is not dependent on absolute vertical subsidence. Physical impacts develop due to differential movements within and between rocks, which are the result of curvature and resultant strain.

6.2.17 **Figures 8 and 9** show the relationships between longwall width and convex ('hogging') curvature at the land surface and resultant tensile strains (**Figure 8**) and concave ('sagging') curvature at the land surface and resultant compressive strains (**Figure 9**), albeit that there are some differences between Areas 5 and 6, again as a result of the different mining geometry in the two seams.

6.2.18 **Figures 8 and 9** also show the values for tensile and compressive strain that are the generally accepted threshold values for the initiation of surface cracking in rocks and soils in the Southern Coalfield. These are where tensile strains are predicted to be at least 0.5 mm/m or compressive strains are predicted to be at least 2 mm/m. **Figures 7, 8 and 9** are based on MSEC's comprehensive database of subsidence impacts in the Southern Coalfield and the application of the generally accepted Incremental Profile Method of prediction subsidence effects. Application of this data and method suggest that:

- tensile strains sufficient to cause surface cracking will result from longwall void widths as low as 65 m; and
- compressive strains sufficient to cause surface cracking will result from longwall void widths as low as 135 m.

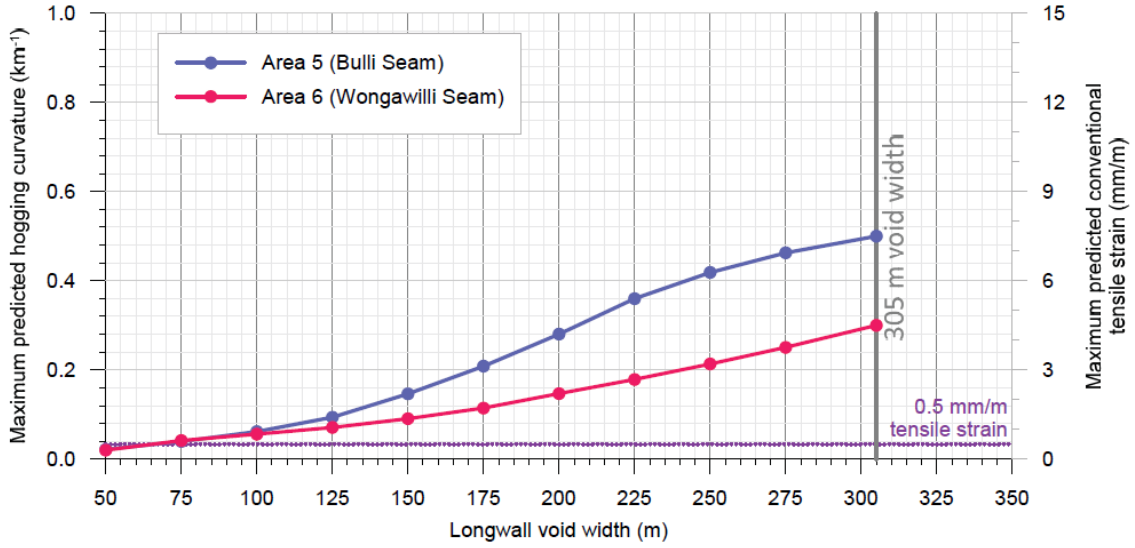


Figure 2 Maximum predicted hogging curvature and conventional tensile strain versus longwall void width

Figure 8 | Maximum Predicted Hogging Curvature and Conventional Tensile Strain versus Longwall Void Width *(Source: MSEC)*

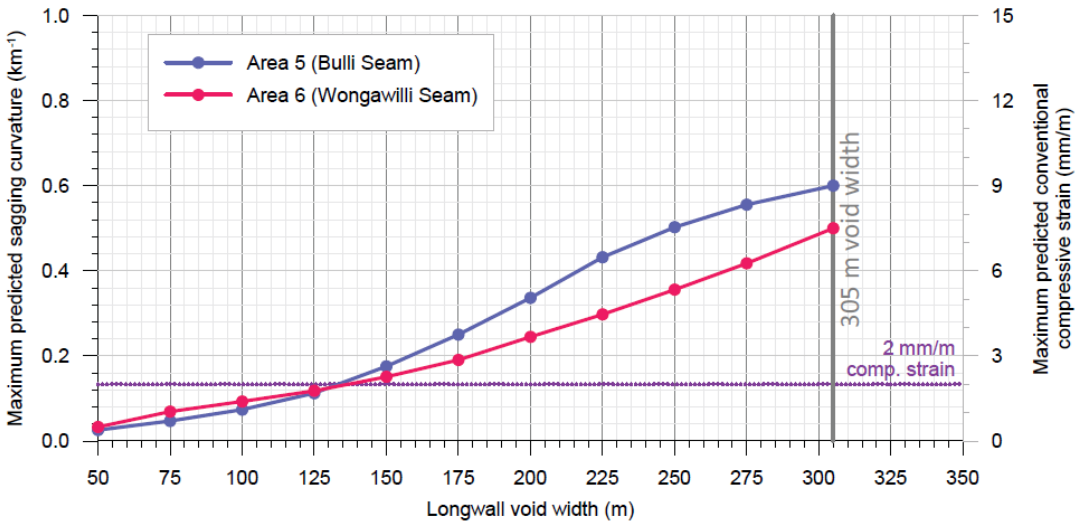


Figure 3 Maximum predicted sagging curvature and conventional compressive strain versus longwall void width

Figure 9 | Maximum Predicted Sagging Curvature and Conventional Compressive Strain versus Longwall Void Width *(Source: MSEC)*

6.2.19 However, the extent and magnitude of physical surface impacts would be expected to decrease with reducing longwall width, as such impacts are directly related to the amount of tensile or compressive strain. As MSEC states:

"Surface cracking and rock fracturing are generally not observed in the Southern Coalfield where the predicted tensile strains are less than 0.5 mm/m and the predicted compressive strains are less than 2 mm/m. The predicted conventional strains for the 150 m through to 305 m wide longwalls are greater than 0.5 mm/m tensile and 2 mm/m compressive. Whilst the predicted strains and, hence, the potential for physical impacts decrease with narrower longwall widths, the strains are still of sufficient magnitude

to result in the fracturing of bedrock. These physical impacts will be visible at the surface where the bedrock is shallow (i.e. surface cracking in the overlying soils) or where it is exposed."

6.2.20 The overall result of MSEC's analysis of longwall width and conventional tensile and compressive strains is that reducing longwall width would reduce surface impacts, but not avoid them. Even at a longwall void width of 150 m, tensile strains of between 1.2 - 2.3 mm/m and compressive strains of between 2.3 - 2.7 mm/m could be expected, which would be expected to cause surface cracking on a flat overlying surface.

6.2.21 However, valley closure effects and resulting impacts (as might be anticipated in watercourses) are even more sensitive and more difficult to control. The MSEC letter report also contains detailed analysis of potential valley closure effects, which it summarises as follows:

"4. Valley related effects are influenced less by longwall width. The maximum measured compressive strain due to valley related effects decreases as longwall void width reduces. However, longwall void width has less influence on valley closure strain when compared with the conventional subsidence effects (i.e. vertical subsidence, curvature and conventional strain);

5. Measured strains sufficient to fracture bedrock due to valley related effects are clearly seen at narrow longwall widths. The measured compressive strains due to valley related effects directly above the previously extracted longwalls in the Southern Coalfield, with void widths ranging between 125 m and 175 m, were greater than 2 mm/m in 66 % of cases. That is, the majority of the measured strains are still considered to be sufficient to result in the fracturing of bedrock in the bases of the streams and similarly bedrock under swamps; and

6. Valley related effects are clearly seen at narrow longwall widths. The predicted valley related effects for the 150 m through to 305 m wide longwalls are considered to be sufficient to result in fracturing, shear, dilation and buckling of the strata in the bases of valleys. This is supported by the observation that adverse impacts were observed along the Waratah Rivulet above Metropolitan Colliery, where the longwall void widths were 163 m. Similar impacts would be expected to the streams located directly above Dendrobium Areas 5 and 6 at similar longwall void widths."

6.2.22 The Department accepts the position of South32 and MSEC that reducing longwall void width would not *prevent* the most critical surface subsidence impacts (ie cracking of watercourses and/or the floors of swamps). While reductions in void width would be expected to *reduce* the number and severity of impacts, including these key impacts, the potential benefit of a small reduction in void width (say to 275 m or even 250 m) is likely to be illusory. Even at void widths of 200 m or 150 m, significant cracking of watercourses and swamps would be expected to occur and the need for South32 to either remediate or offset such impacts would arise.

Reduced Longwall Width and Economic Impacts

6.2.23 As noted above, in paragraphs 6.2.11-12, reductions in longwall width come at a significant economic cost to the mining company. However, the actual extent of these costs is not well set out in South32's EIS. For this reason, the Department sought expert advice from a respected mine design consultant (MineCraft Consulting Pty Ltd) on the likely economic impacts of reducing longwall widths to both South32 and to the State.

6.2.24 The terms of reference for MineCraft's review, as requested by the Department, were as follows:

a. recast the EIS's proposed mine plan for both Areas 5 and 6 based on longwall void widths of 150 m, 175 m, 200 m, 225 m, 250 m, 275 m and 305 m;

b. in respect of each of these options, examine and report on the:

   i. extent of additional gateroad development and the need for additional continuous miners and crews arising;

   ii. extent of any additional requirements for management of underground gas;

   iii. potential implications for "development float", mine sequencing and continuity of mining; and

   iv. changes in total coal recovery (see section 3.1 of the EIS); and

   v. changes in the Project's rate of return on capital and NPV and income to the State of NSW (see the EIS's Appendix L).

c. report on the potential to either increase or reduce mining height, particularly in respect of the Wongawilli Seam; and

d. make recommendations for any additional information required to inform the comprehensive assessment of the Project's proposed mine plan.

6.2.25 MineCraft provided a draft report to the Department in early February 2020 and a final report in July 2020 (see **Appendix F**). MineCraft's adopted methodology was to:

- using AutoCAD, draw the mine layout design for longwall panel width of 300 m and then recast it for widths of 275 m, 250 m, 225 m, 200 m, 175 m and 150 m (centre distances);[8]
- calculate the ROM coal reserve within each layout, using MineCraft's Scheduling Module;
- calculate longwall productivity key performance indicators (KPIs) for the base 300 m layout, using MineCraft's Longwall Productivity Module, and then calculate the relevant KPIs for the alternate mine layouts;
- create a mining schedule for the base 300 m layout using the derived longwall productivity KPIs and other parameters based on industry typical performance;
- apply the base mining schedule to the alternate mine layouts using the derived longwall productivity KPIs and adjust heading development (ie first workings) requirements to ensure ongoing longwall continuity;
- collate the production output KPIs for each alternate mining schedule;
- establish the operating cost framework for the base layout, using MineCraft's Operating Cost Module and industry benchmark costs as input data, and then develop an annual operating cost profile for the base case;
- using the alternate production schedules, establish annual operating cost profiles for the alternate mining schedules; and
- calculate the net present value of the annual cash flow from each case.

6.2.26 MineCraft's report contained the following important caveats:

"This review was conducted as a desktop exercise and is considered a comparative review rather than an absolute review. In this context it is acknowledged that the base case assumptions may not precisely match the actual mine data in terms of performance and costs, however they are expected to be sufficiently approximate to allow a comparison of the economic impact from alternate mine plans.

The review included the calculation of net present value (NPV) which is based on estimated cash flows from the Project. It is highlighted that the NPV values shown in this report are not expected to be a reflection of the actual Project NPV as the information used is not sufficiently precise. Rather they are used to demonstrate a comparison between options. Several inputs to the cash flows have been kept

[8] The 'centre distance' for a longwall panel is the distance between the centres of the installation headings on either side of the actual longwall. Seeing as each heading for the Project is c. 4.5 m in width, it follows that the total longwall void is the centre distance + 4.5 m.

constant across all options including capital cost and sales price. It is acknowledged that different panel width configurations could cause capital cost variations and different sales volumes may cause average sales prices to vary. However, it was not considered feasible in this review to apply more accuracy in these regards and also the impact would be expected to be low.

NPV is highly sensitive to several factors including coal prices, marketing agreements, foreign exchange rates, taxation rates, etc for which exact details are not known. Therefore, a consistent approach to this data has been used across all options."

6.2.27 The Department notes in particular MineCraft's acknowledgement that its *"base case assumptions may not precisely match the actual mine data in terms of performance and costs, however they are expected to be sufficiently approximate to allow a comparison of the economic impact from alternate mine plans… It is highlighted that the NPV values shown in this report are not expected to be a reflection of the actual Project NPV as the information used is not sufficiently precise. Rather they are used to demonstrate a comparison between options."*

6.2.28 That is, the MineCraft report does not seek to provide a precise assessment of the costs to South32 of each alternative mine layout. The strength of MineCraft's report is in providing a comparative, rather than absolute, analysis. Consequently, the Department's analysis below focuses on differences and relativities, rather than absolute numbers.

6.2.29 A summary of MineCraft's analysis with respect to the key impacts on the Project's productivity from incrementally reducing longwall panel width from 300 m to 150 m is:

- increased total gateroad development from 190 km to 294 km;
- increased main headings development from 52 km to 67 km;
- increased total development (ie gateroads plus main headings) from 242 km to 361 km;
- increased annual development from 14 km to 17 km per year;
- reduced total ROM coal produced from 78.3 Mt to 71.6 Mt;
- increased development ratio (dev km/LW kilotonnes (kt))[9] from 3.4 to 5.9;
- reduced longwall productivity from 101 kt to 82 kt per week;
- reduced annual production ranging from 4.4 Mtpa to 3.4 Mtpa; and
- increased mine life ranging up to five years (20 years to 25 years, based on calculated production scheduling).

6.2.30 The resulting key impacts to the Project's economics include:

- reduced revenue from sales, as annual production decreases; and
- increased mine operating costs (up to $20 million per year).

6.2.31 The consequential impacts of lower overall coal production and an extended Project life for State coal royalties include:

- reduced total royalty income (gross) from $626 million to $572 million; and
- reduced total royalty (NPV) from $305 million to $260 million.

6.2.32 MineCraft then calculated the NPV of the Project's estimated cash flows taking into account estimated production profiles, operating costs, distribution costs, capital costs, royalty payments and company taxation. As might be expected, reducing the panel width has a negative impact on Project NPV, as set out in **Table 7** below. Columns two and four in that Table demonstrate that NPV value is highly sensitive to coal sales pricing. However, the NPV

[9] Development ratio is a key measure of longwall productivity.

difference between various panel width cases remains fairly constant at approximately $100 million per 25m reduction in panel width. At panel widths less than 200 m, the NPV is shown to rapidly decrease and is substantively negative for MineCraft's assumed base case coal sales price.

6.2.33 The Department provided MineCraft's final draft report to South32 for factchecking. South32's response was *"We have no material comments. In our opinion, the Report adequately demonstrates the relative negative impact on Project economics from reductions in longwall width, and supports that the Project is not economically feasible with narrow panels."* South32 also endorsed the report's qualification that its NPV calculations "*are not expected to be a reflection of the actual Project NPV as the information used is not sufficiently precise. Rather they are used to demonstrate a comparison between options."*

Table 7 | Project Net Present Value – Panel Width vs Coal Sales Price *(Source: MineCraft report)*

Panel Width	NPV_7 -10%	NPV_7	NPV_7 (+10%)
300 m	$329 M	$667 M	$1,002 M
275 m	$238 M	$568 M	$897 M
250 m	$139 M	$464 M	$785 M
225 m	$45 M	$368 M	$687 M
200 m	-$73 M	$244 M	$556 M
175 m	-$304 M	$27 M	$328 M
150 m	-$496 M	-$125 M	$173 M
Average Sales Price	**(-10%)**	**Base**	**(+10%)**
USD/t	99	110	121
AUD/t	141	157	173

Notes: NPV_7 means NPV at an annual discount rate of 7%

6.2.34 The Department considers that the MineCraft report provides valuable assistance in understanding the economic costs of reducing Project longwall void widths. The report's fundamental outcome is the conclusion that reducing panel width is an inefficient approach to recover coal. Reductions in panel width would necessarily lead to:

- less overall recovery of ROM coal, ie a less efficient recovery of the overall State-owned coal resource (which must be considered by the consent authority under clause 15 of the Mining SEPP);
- higher operating costs for South32;
- lower NPV for the Project; and
- lower royalty income for the State.

6.2.35 These outcomes are not to say that reducing panel width should not be further considered, but the associated costs must be clearly appreciated.

Balancing Environmental Benefits with Economic Costs

6.2.36 The Department sought the additional information from South32 and MineCraft in an endeavour to identify (if possible) whether there was a "sweet spot" where the Project's environmental impacts could be substantially lessened while not impinging too significantly on its economic value. There is a consequential need to integrate the outcomes of the MineCraft report with the additional advice provided by South32 on reductions in subsidence effects and impacts associated with reductions in panel width.

6.2.37 The Department's view is that the costs of reducing panel width are such that it should only be adopted as a measure to avoid, reduce or minimise subsidence impacts if the evidence supports the view that the resulting environmental benefits outweigh the economic costs.

6.2.38 However, in this case, there appears to be no such evidence. **Tables 8 and 9** demonstrate that tensile and compressive strains above longwalls would still be high enough to cause surface cracking (and therefore surface water losses) even at a panel width of 150 m. At this width, MineCraft estimates the Project NPV to be substantially negative, ie South32 would not commit to the necessary capital expenditure and therefore the Project would not proceed. Further, MSEC's advice is that cracking and surface water losses as a result of valley closure and upsidence would continue to be likely at panel widths of 150 m. This conclusion is confirmed by experience at the Metropolitan Mine, where significant amounts of surface cracking in important watercourses has continued to occur at void widths of 163 m.

6.2.39 The community members, special interest groups and a number of State agencies that have called for reductions in longwall void width at Dendrobium have generally done so in order to reduce the likelihood and extent of surface impacts above the mining domains.

6.2.40 The Department considers that the evidence put forward by MSEC demonstrates that there would be little environmental benefit by reducing longwall void widths by 25 m, 50 m or 75 m. While, there would be some limited benefit by reducing void widths to 200 m or less, such reductions would not achieve the outcomes that many submitters have hoped for.

6.2.41 While reductions in panel width to 200 m or less would be expected to significantly reduce the extent of connective cracking between the mining void and the surface, they would not eliminate surface cracking (just the connectivity between this cracking and cracking extending upwards from the mining goaf). Thus, the greatest environmental benefit of reduced longwall void width would simply be reductions in drainage from groundwater held in the upper third of the geological strata between the surface and the coal measures.

6.2.42 The essence of consolidating the conclusions of the MSEC letter report together with those of the MineCraft report is that very substantial reductions in panel width would produce only limited environmental benefits, but at great economic cost. Minor reductions in panel width produce no appreciable environmental benefit at all.

Subsidence Assessment

6.2.43 The EIS contains a Subsidence Assessment (SA) for the Project, prepared by Mine Subsidence Engineering Consultants (MSEC). The SA was commissioned by South32 to:

- prepare subsidence predictions for all proposed longwalls in Areas 5 and 6;
- identify the natural and built surface features close to each of these proposed longwalls;
- provide subsidence predictions for each of these surface features;
- prepare impact assessments, in conjunction with other specialist consultants, for each of the natural and built features; and
- recommend management strategies and monitoring measures.

6.2.44 The SA is a comprehensive document which addresses each of these matters in detail. In many respects, it is the 'heart' of the EIS.

6.2.45 The principal agencies that expressed concerns in their submissions relating to particular aspects of the SA were WaterNSW and BCD. The issue raised by these agencies was addressed in South32's RTS (see **Appendix C**) and neither agency pursued this issue in their later correspondence. The IESC stated in its advice: *"the subsidence assessments have been completed to a good standard, particularly with respect to the use of existing observations of impacts at other areas of the Dendrobium Mine"*.

6.2.46 The Department has no residual concerns over the accuracy or comprehensiveness of the SA or its adequacy to underpin assessment of the anticipated and potential subsidence impacts of the Project. However, particular aspects of the SA, including its predictions, are discussed in **Sections 6.3 – 6.6** and **Section 6.12**, insofar as they relate to impacts on the environmental and cultural heritage values addressed in those sections.

Geological Risks and Hazards

6.2.47 The principal agencies that expressed concerns relating to assessment of geological risks and hazards in the EIS (particularly in the SA) were WaterNSW and DSNSW. The issues raised by these agencies were addressed in South32's RTS and its later detailed responses in respect of the submissions from these agencies (see **Appendix C**). Neither agency pursued these issues in their later correspondence.

6.2.48 The Department considers that the assessment of geological risks and hazards in the SA and other elements of the EIS (for example, its Appendix P – Geological Structures Review) is adequate for the assessment and determination of the Project.

6.2.49 However, it is clear that additional information concerning geological structures (eg igneous dykes and sills, faults and major surface lineaments) would be required prior to the approval of individual Extraction Plans. It is a normal part of mine development for an increasing amount of exploration (particularly in-seam (ie horizontal) drilling) to be undertaken while longwall layouts are being refined. It is in a mining company's interests to undertake this work rather than to define a longwall footprint and construct development headings (which are expensive in both time and money) without the benefit of this critical information.

6.2.50 The Department is therefore confident that this additional information would be provided in a timely manner (ie in association with applications for approval of Extraction Plans).

6.2.51 The issue of adequate understanding of geological structures and associated risks and hazards is particularly important in respect of maintaining the integrity of the walls of Cordeaux and Avon Dams. This issue is addressed in **Section 6.4**.

Advice from the Mining Panel

6.2.52 The first 20 conclusions in the Mining Panel's advice all have direct or indirect bearing on South32's mine design and the SA. However, the key conclusions with respect to mine design are:

> 8. *[South32's] approach, effectively, appears to be: 1) deciding which natural surface features warrant a level of protection from mining-induced impacts; 2) nominating the tolerable levels of impacts for these features; 3) avoiding exceedance of these levels through a combination of setback distances and remediation; and, 4) maximising economic returns by offsetting and compensating for environmental impacts to a range of other surface features and all subsurface features, notwithstanding that these impacts may not fully materialise, if at all, in Areas 5 and/or 6.*
>
> 9. *In respect of the Department's initial request for the Panel to provide advice on the relative environmental costs and benefits associated with different longwall widths, including whether a reduction in the void widths would materially reduce the environmental impacts of the project, the Panel cannot provide this advice. This is because the EIS and supporting documentation, including the Proponent's responses to some of the Panel's questions, do not provide the necessary information and analysis to enable the impact of different longwall panel widths to be fully and adequately assessed.*
>
> 10. *EIS Appendix A, Subsidence Assessment, constitutes an assessment of surface subsidence and not of subsurface subsidence, notwithstanding that it does touch on some limited aspects of mining-induced subsurface ground movements.*
>
> 11. *The methodologies for predicting mining-induced subsidence effects (movements) on the surface are adequately described in the EIS, are appropriate to the [Project] and have been diligently applied in the defined Study Area, with deviations from predicted subsidence effects capable of being adequately managed through established approval conditions.*
>
> 4. *Environmental impacts associated with conventional subsidence are of both a surface and subsurface nature and include the height of connective fracturing. Environmental impacts due to conventional subsidence are particularly sensitive to changes in longwall panel width and extraction height, as well as some parameters over which there is limited control, such as depth of mining.*
>
> 1. *At Dendrobium Mine, longwall panel width is not the key control when considering environmental impacts on natural surface features due to mining-induced non-conventional subsidence, in particular, valley closure. This is because environmental impacts due to non-conventional surface subsidence start to plateau at longwall panel widths that are reported to be too narrow to be economic at Dendrobium Mine.*
>
> 2. *Rather, the key control for limiting environmental impacts on natural surface features due to non-conventional subsidence is, as reflected in the mine layout proposed for Areas 5 and 6, the setback distance of longwall panels from natural surface features.*
>
> 3. *Therefore, in respect of non-conventional subsidence, project assessment needs to have a focus on the rigour in identifying the nature and scale of environmental impacts, the appropriateness of the limits selected for environmental impacts, the reliability of setback*

distances of longwall panels proposed for preventing these limits being exceeded, and the suitability of the mine layout to adaptive management as a control for preventing exceedances of predicted impacts.

6.2.53 The Department agrees with the Mining Panel's key conclusions with respect to mine design and the subsidence assessment.

6.2.54 In particular, the Mining Panel has confirmed the Department's view that the key control over surface cracking of watercourses is non-conventional subsidence (ie valley closure). It is expected that most watercourses would experience some cracking and reduced pool holding capacity even with longwalls of an uneconomically narrow width. Similarly, even with narrow panels there would be enough surface cracks within most swamps for water retention following large rainfall events to also be reduced. As Conclusion 1 states, narrowing longwall void width is unlikely to significantly reduce the severity of impacts on the key surface features located above and adjacent to the two mining areas (ie the network of drainage channels and watercourses and the upland swamps). Whereas setbacks (of sufficient size) from key features would work, narrowing panel width would not.

6.2.55 The Mining Panel has also not identified any changes to the mine plan which would significantly reduce environmental impacts. However, it has identified a method by which key stream features can be subject to more detailed consideration. This issue is addressed within **Section 6.3**.

6.2.56 Importantly, while highlighting matters for consideration in the assessment process, the Mining Panel has made no recommendations with respect to either the mine plan or the SA.

Conclusion

6.2.57 The Department concludes that the Project's mine plan has passed the threshold test that it set in para 6.1.3. All parties are clear that the Project would lead to significant environmental impacts to the key surface features (ie watercourses and upland swamps). South32's approach has been to accept this level of impact and to offer substantial offsets to compensate for them.

6.2.58 Many submitters (and some agencies) have sought to reduce the Project's environmental impacts, largely by calls to reduce longwall void width. The Department concludes that reducing longwall void width is not an effective means of reducing, much less eliminating, the environmental impacts of the Project. This position is confirmed by the Mining Panel's conclusions.

6.3 Surface Water Resources

Introduction

6.3.1 The EIS contains a Surface Water Assessment (SWA) for the Project, prepared by Hydro Engineering and Consulting (HEC), which includes a description of the Dendrobium Mine's surface water management system and associated site water balance. It also assesses potential Project-related impacts to surface water features from subsidence and surface facilities, including:

- reduction in water yield;
- effects to water quality;
- changes to erosion potential;
- changes to swamp size and swamp vegetation;
- impacts to water storage in Avon and Cordeaux Dams; and
- volumes and quality of surface water discharges.

6.3.2 The SWA used as its basis the following key guidelines:

- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000);
- *National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC/ARMCANZ, 2000);
- *Using the ANZECC Guideline and Water Quality Objectives in NSW* (DECC, 2006).
- *Draft Upland Swamp Environmental Assessment Guidelines – Guidance for the Underground Mining Industry Operating in the Southern Coalfield* (OEH, 2012); and
- *Neutral or Beneficial Effect on Water Quality Assessment Guideline* (WaterNSW, 2015).

6.3.3 The SWA also includes a stream risk assessment in consideration of the methodologies recommended by the previous Planning Assessment Commission during its assessments of the Metropolitan Mine and Bulli Seam Operations.

6.3.4 The SWA was subject to a peer review (initiated by South32) by Emeritus Professor Tom McMahon. Prof McMahon considered five versions of the SWA, including the final version, and confirmed that his recommended changes had been appropriately addressed by HEC. Prof McMahon concluded that the SWA was *"completed in a professional and detailed manner, and the conclusions in the Report are appropriately supplemented by suitable modelling studies carried out by the consultant."*

6.3.5 As set out in **Section 6.1**, the Department considers that the impacts of the Project on surface water resources are a critical issue for the Project's assessment. Key issues and advice relating to the SWA and surface water impacts are assessed below.

6.3.6 The Mining Panel considered that the SWA's technical quality was *"good overall, and the report is generally clear regarding the data and methods used and their limitations. Some of the outcomes of the [Catchment Panel] have been addressed, including those relating to: independent peer review; baseline monitoring; co-location of flow and quality monitoring; and swamp water balance analysis."*

Advice from the IESC

6.3.7 The Commonwealth's IESC provided extensive advice regarding surface water resources. The IESC noted that the Project would increase the area at Dendrobium Mine affected by subsidence, including undermining upland swamps and first, second and third order streams. This would result in considerable changes to surface water flows and water regimes within the impacted stream reaches and swamps.

6.3.8 Consequently, the IESC concluded that *"the primary impacts from the proposed project will be to water-dependent ecosystems on-site"*. This position is important as it identifies that the Project's impacts are largely focused on the two sites proposed for mining, rather than to Sydney's overall drinking water catchment or its drinking water supplies. On this basis, the IESC considered that the key potential impacts of the Project are:

- surface impacts from subsidence, including vertical subsidence, fracturing of streambeds and the base of upland swamps, and diversion of surface water underground;
- permanent changes to the flow regimes of numerous first, second and third order stream reaches that would considerably decrease streamflows and increase the number of low and no flow days under all rainfall scenarios;
- major changes to water regimes and drying severity in upland swamps, 26 of which would be directly undermined. An additional 20 upland swamps are located partly or wholly within 600 m of the proposed longwalls;
- irreversible changes would occur in EPBC-listed upland swamps, instream and riparian environments and in water-dependent flora and fauna, resulting from changes to flows and water regimes; and
- adverse impacts on water quality of inflows to water supply storages, likely to include changes in turbidity, nutrient loads and pathogens.

6.3.9 The IESC considered that the EIS's surface water assessments had been completed to a 'high' standard and that its subsidence assessments had been completed to a 'good' standard. However, further information and quantitative analysis should be provided on options for variations to the proposed mine plan, such as setbacks from upland swamps, or variations to longwall width (or other aspects of mine design and geometry) as these appear to be the only viable options which could reduce predicted impacts.

6.3.10 The IESC sought further investigation of irreversible impacts associated with near surface cracking and near surface ground movement, including additional monitoring, field investigations and analyses.

Surface Water Modelling

6.3.11 The SWA used the Australian Water Balance Model (AWBM) to assess the impact of subsidence on streamflow in catchments directly above and otherwise affected by the Project. The AWBM required modifications to account for non-swamp deep drainage using drainage estimates provided in the groundwater modelling and swamp seepage losses due to changes in horizontal and vertical drainage from predicted subsidence. Emeritus Professor Tom McMahon, who peer reviewed the SWA in May 2019, was satisfied with the adopted modelling approach and the SWA's changes to the AWBM model.

6.3.12 To assess potential impacts on the hydrology and water balance of undermined upland swamps, the SWA applied the VADOSE/W model which is a finite element, two-dimensional, unsaturated/saturated groundwater seepage model. Professor McMahon considered that this *"model appears to be a suitable model to assess the impact of the proposed Project on horizontal and vertical drainage beneath the potentially affected swamps and I am satisfied with the adopted values of the model parameters."*

6.3.13 The Mining Panel made no particular criticisms of the SWA's approach to modelling, stating that *"The AWBM modelling is an appropriate way of translating predicted groundwater losses into approximate changes in surface flow regimes. Accuracy is limited primarily by the accuracy of the estimated groundwater losses and by the absence of suitable calibration flow data at time of modelling. Accuracy may also be improved by using longer sequences of input rainfall and analysis of inter-annual variability of the outputs."*

6.3.14 However, the Mining Panel was more critical of the data underpinning the model and considered that much of the SWA is *"preliminary due to the limited data sets available for*

Areas 5 and 6 at the time of the analysis. The impacts of water take on the flow regime are modelled using catchment models (… AWBM) that are not yet calibrated using locally obtained data, the baseline flow data not being sufficient at that time. The swamp infiltration and soil moisture modelling is a welcome contribution to impacts assessment and has provided provisional estimates of infiltration rates and loss of baseflow from swamps. As further data become available the models should be refined."

Surface Water Losses

6.3.15 The SWA's surface water impact modelling covers 14 small catchments across Areas 5 and 6 and predicts large impacts on flow regimes in the watercourses directly undermined. The SWA's calculation of anticipated surface water losses resulting from the Project relies on the groundwater modelling, which was considered to be more capable of providing an accurate estimate than the modelling programs used in the SWA.

6.3.16 The GA provides estimates of water capture (ie 'take') from stream flow and storage in the catchment for the periods 2000 to 2018 (ie before the Project) and 2018 to 2070 (generally during and following the Project). The GA's estimates are based on its conservative assumptions, in particular in relation to seam to surface fracturing.

6.3.17 The GA's calculations of predicted surface water losses during 2016 to 2018 were 10 - 20% of total Dendrobium Mine inflows over that time. For Areas 5 and 6, the surface water take is predicted to be 25% of total mine inflow following completion of mining in Area 6, peaking at 35% during mining of Area 5.

6.3.18 Based on these simulations, the SWA concluded that, under a median rainfall scenario, there is *"an immeasurably small and likely indiscernible impact to Lake Avon inflow"* and *"an immeasurably small and likely indiscernible impact to Pheasants Nest Weir inflow"*. The estimated reductions are approximately 0.55% (1.05 ML/day) and 0.39% (2.84 ML/day) for Lake Avon and Pheasants Nest Weir, respectively. Professor McMahon concurred with this assessment, stating *"based on my experience of uncertainty estimates in stream gauging and in water balance analysis, the values are not within the accuracy band that can be measured in the field or by water balance analysis and, in my judgement, are not statistically different from zero."*

6.3.19 Similarly, the IESC considered that *"These impacts are unlikely to be of material concern even in drought years or under expected future climate projections".*

6.3.20 The Mining Panel did not dispute the reasonableness of the SWA's calculations and considered that "*The method of calculation is reasonable given current model and data limitations."* It also agreed that a 0.55% loss in a median rainfall year is likely indiscernible.

6.3.21 The median annual yield from Avon Dam is 70,111 ML and the median annual yield from Pheasants Nest Weir (which receives regulated flows from Avon, Cordeaux and Nepean dams) is 276,400 ML. The GA estimates that, on an annual basis, the Project would have a maximum surface water take of 1,935 ML, which is 0.7% of annual inflows to Pheasants Nest Weir. This figure is the major component of Dendrobium Mine's overall surface water licensing requirement of 3,300 ML/year.

6.3.22 No party has criticised the SWA's approach of relying on the GA's modelling. However, this approach has inevitably focused extra attention on the GA. The Mining Panel concluded that the SWA's estimates of surface water loss were affected by the same limitations and uncertainties that it had identified in the GA's groundwater model.

6.3.23 In particular, the Mining Panel expressed concerns at how the groundwater model treated diffuse recharge (ie infiltration following rainfall). Diffuse recharge is based on a combination of recharge to the subsurface and extraction of groundwater from the water table by evapotranspiration. Modelling of shallow groundwater tables over much of the area led to a high percentage of available recharge being captured and returned to the atmosphere by groundwater-fed evapotranspiration. The GA suggests that more than 80% of otherwise available recharge is returned to the atmosphere by this means.

6.3.24 The Mining Panel considered this to be an *"important element of the model [that] has received little attention in considering flows to streams, impacts of mining on surface flow processes, inflows to the mine and model sensitivity. There is a need for a better understanding of the impact of this choice for recharge modelling on each of the major flow terms. The risk is that the model is underestimating the total groundwater flows by underestimating the hydraulic properties of the formations and that the calibration approach, which has been largely based on head calibration and mine inflow calibrations, is desensitised by this selection of a self-balancing recharge model across the majority of the modelled area."*

6.3.25 The Mining Panel also expressed concerns at how the groundwater model treated interactions between surface waters and the subsurface, stating:

"The parameterisation of the surface/subsurface flow exchanges is important for estimating the surface water losses in the catchment. In order to gain better appreciation of these exchanges, a more complete understanding of the model representations of the near surface interactions and an assessment of the sensitivity of these to the model's parameterisation are required. The necessary information is not presented in the report and sensitivity analysis of the surface components of the model has not been performed. It is not possible, at this stage, to be comfortable that the worst-case losses from the surface water regime have been identified. Stream depletion can arise from combinations of reductions in overland and groundwater flow to the streams and increases in stream losses to the groundwater. The changes in losses will be a function of changes in the groundwater heads around and along the stream profiles. These will depend on enhancements in the hydraulic properties of the geological formations and the depth of the enhancements as well as the depletion of the shallow groundwater by deep percolation to the mine. Further investigation of these features of the groundwater model is desirable to gain greater insight into the uncertainties in the estimation of loss of stream flows."

6.3.26 The Department concurs with these comments and agrees that they require additional consideration as the groundwater model is further developed.

6.3.27 The Mining Panel made three recommendations concerning the SWA and the ongoing refinement of the modelling of surface water losses, in the following terms:

9. *The impacts and consequences predictions presented by [South32] are not necessarily worst-case despite the use of a range of conservative assumptions. This is due to limitations of the predictive models employed. It seems unlikely that these limitations can*

be resolved in the short term. So, in addition to developing applicable TARPs for surface water, progressive model updating and refinement of surface water monitoring should be required.

10. *The methods, criteria and thresholds used by [South32] to determine key stream features, the absence of features of special significance, and the likelihood of impacts to rivers and named creeks should be regularly reviewed and the outcomes should be used to update the assessment of mining impacts to inform Extraction Plans.*

11. *Work should continue to be undertaken on water loss accounting methods and monitoring to more reliably inform surface water loss compensation.*

6.3.28 The Department supports these recommendations and has recommended conditions of consent that require not only regular and ongoing review and development of the groundwater model but also that South32 give careful consideration to all comments made by the Mining Panel (and the IESC and DPIE – Water) and implement the Panel's recommendations regarding review and further development of the groundwater and surface water models.

Losses from Reservoirs

6.3.29 South32 has proposed a 300 m setback between the footprints of longwall voids within Areas 5 and 6 and the FSL of the reservoirs of Avon Dam and Cordeaux Dam, respectively. The groundwater model has modelled likely losses from the reservoirs as a result of cracking above and adjacent to the longwall footprints and consequent increased permeability of the rock mass between the reservoirs and the longwall voids.

6.3.30 For Cordeaux Reservoir, the groundwater model predicts a maximum loss of approximately 0.29 ML/day due to the entire Dendrobium Mine (ie Areas 1,2, 3A, 3B, 3C, 5 and 6). This is predicted to occur in about 2050, just after completion of extraction in Area 6. The incremental loss from Areas 5 and 6 is estimated to be up to approximately 0.1 ML/d, due primarily to mining in Area 6.

6.3.31 For Avon Reservoir, the model predicts a maximum loss of 0.48 ML/day for the whole of the Dendrobium Mine. The maximum incremental loss from Areas 5 and 6 is estimated to be up to approximately 0.36 ML/d, due primarily to mining in Area 5.

6.3.32 The model also predicts very minor losses for the rather distant Nepean Reservoir for the Mine, with a maximum loss of 0.02 ML/day. This modelled loss is considered to be negligible.

6.3.33 The modelling also applied sensitivity scenarios and uncertainty bands. Eight of the 11 different sensitivity scenarios predicted losses of <0.4 (Cordeaux), <0.6 ML/day (Avon) and 0.06 ML/day (Nepean).

6.3.34 The modelled losses from reservoirs are a component of the surface water take considered under ***Surface Water Losses*** above, rather than additional amounts. The Mining Panel did not separately consider losses from reservoirs, but treated them as a component of overall surface water losses.

6.3.35 The Department considers that the groundwater model's predictions of losses from reservoirs related to the Dendrobium Mine and the Project are careful and reasonable and can be relied

upon for assessment purposes. South32 has committed to both purchase and offset the modelled loss of stored waters by the Project.

Impacts on Stream Function

Introduction

6.3.36 It is apparent that one of the Project's key environmental impacts would be impact on stream function owing to cracking of creek beds, loss of pool holding capacity and loss of baseflow reporting to streams from upland swamps and near-surface aquifers.

6.3.37 South32's approach has been to recognise and accept this, to incorporate conservative assumptions into the groundwater modelling and surface water modelling, to provide for particular limits on impacts in the case of named watercourses and key stream features, to provide for some degree of remediation of impacts on these features, and to account for residual impacts by way of compensatory offsets for surface water losses and related ecosystem and fauna species losses.

6.3.38 The Department considers that this issue is best assessed by considering three classes of watercourses that may be impacted by the Project (see **Figure 10**), being the:

- four named watercourses (ie the Avon and Cordeaux Rivers (5th order streams) and Donalds Castle and Wongawilli Creeks (3rd order streams);
- four short reaches of unnamed 3rd order streams; and
- large number of unnamed 2nd and 3rd order streams.[10]

6.3.39 In addition, key stream features are also given separate consideration (see **Figure 11**).

Named Watercourses

6.3.40 As might be expected, both the SA and the SWA paid greater attention to the four most significant watercourses, which are all large enough to have been given a formal geographic name.

6.3.41 For example, the SA includes assessment of valley closure for Avon River, Cordeaux River and Donalds Castle Creek, with Wongawilli Creek considered to be too distant from Area 5 to warrant this additional attention. The two mining areas have been set back from these watercourses to reduce the likelihood and severity of any subsidence impact.

6.3.42 The key mine design constraint in this respect has been the SA's valley closure predictions. The setbacks from named watercourses are such as to prevent more than "200 mm of *additional* valley closure" *(emphasis added)*. In the case of the Avon and Cordeaux Rivers, no closure additional to the Project is anticipated, and so these predictions are absolute. However, Donalds Castle Creek and Wongawilli Creek are planned to be impacted by valley closure resulting from the forthcoming extraction of the remainder of Area 3B and also (in the case of Wongawilli Creek) Area 3C.

[10] The Strahler classification of streams provides that a 1st order stream has no upstream tributaries (ie is a headwater stream); a 2nd order stream occurs downstream of the confluence of two 1st order streams, a 3rd order stream occurs downstream of the confluence of two 2nd order streams, and so on.

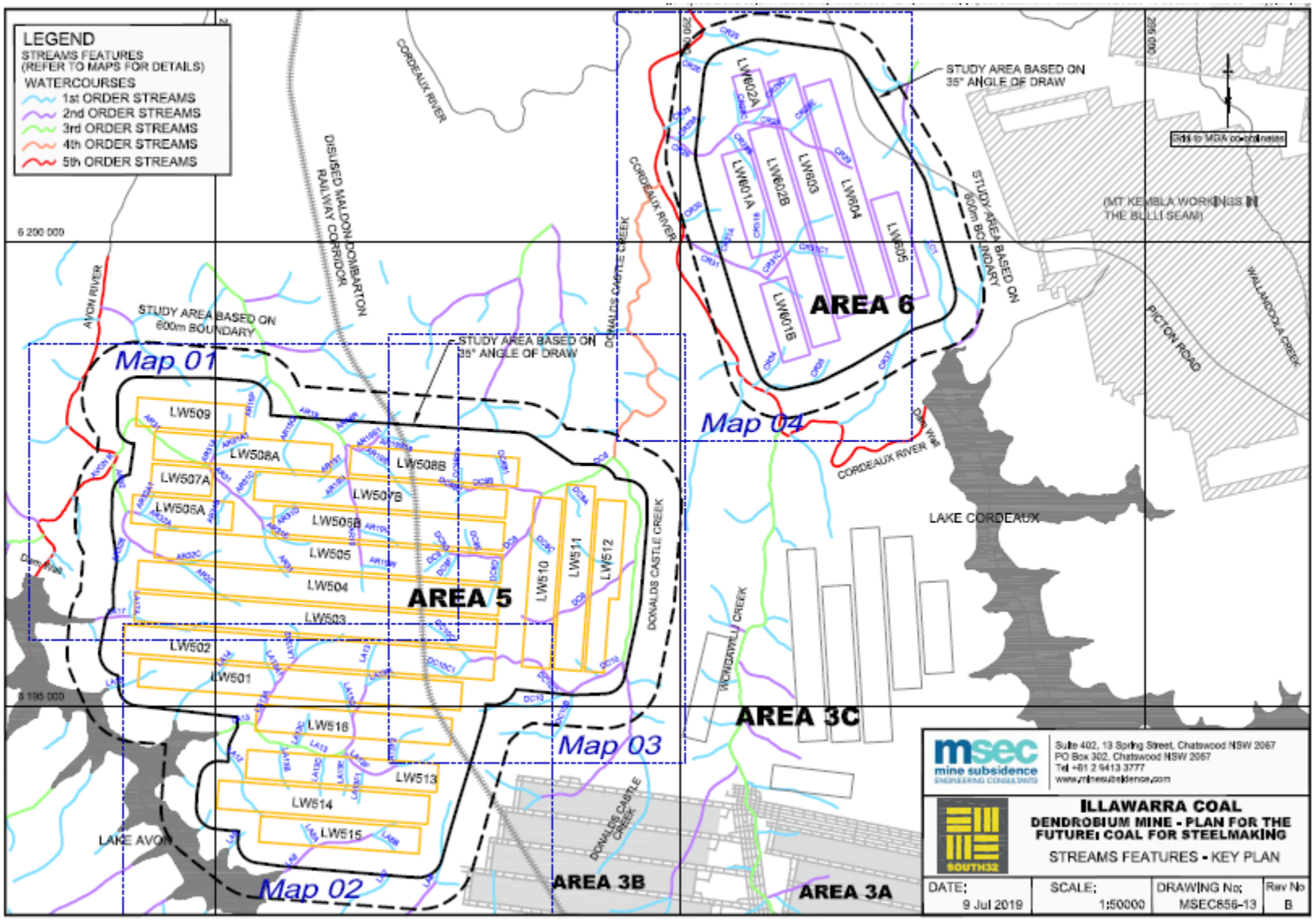


Figure 10 | Watercourses by Stream Order *(Source: SA)*

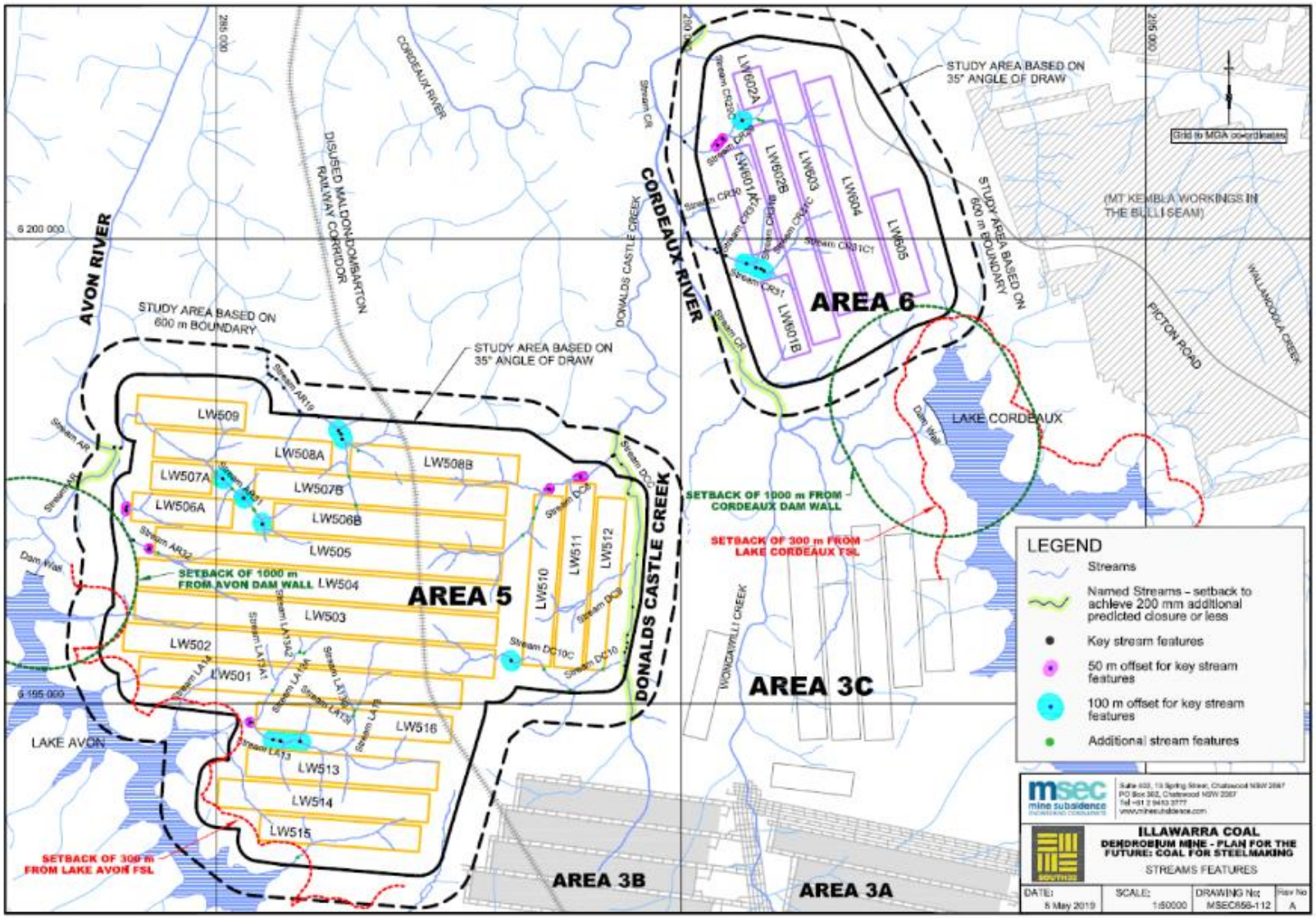


Figure 11 | Project Design Constraints for Dam Walls, Named Watercourses and Key Stream Features *(Source: EIS)*

6.3.43 The maximum additional valley closure predicted by the SA for the named watercourses is as follows:

- 200 mm for the Avon River, at a minimum distance of 360 m from LW 509;
- 80 mm for the Cordeaux River, at a minimum distance of 360 m from LW 601B
- 210 mm for Donalds Castle Creek, at a minimum distance of 340 m from LW 511 and 50 m from LW 512, noting that additional closure is 200 mm with the remaining 10 mm to result from extraction of existing and approved longwalls in Areas 3B and 3C; and
- <20 mm for Wongawilli Creek, at a minimum distance of 700 m from LW 601B.

6.3.44 Because Wongawilli Creek is so distant from the proposed mining Areas, it was not considered in as much detail as the other three named watercourses in the SA and other parts of the EIS. Consequently, it does not require further consideration below.

6.3.45 Notwithstanding the proposed setbacks to achieve <200 mm additional closure, the SA identifies a small statistical probability of Type 3 subsidence impacts in each of the first three of these named watercourses, based on MSEC's rock bar impact model. So-called Type 3 impacts are defined as *"fracturing which has resulted in pool water levels dropping more than expected after considering the rainfall and groundwater flow conditions"* and are considered to be the most serious impacts on watercourses, although some such impacts are of greater scale and significance than others.

6.3.46 MSEC's rock bar impact model is a database of all previously known impacts on watercourses associated with longwall mining in the Southern Coalfield, which is constantly updated with additional data. While at the time of the Southern Coalfield Inquiry in 2008, no Type 3 impacts had been recorded on streams where predicted valley closure was <200 mm, additional data has indicated that 93% of such impacts occur at ≥200 mm closure and some 7% occur below this value. Generally speaking, there is a straight-line relationship between Type 3 impacts and predicted valley closure, however such impacts are now known at a level of 80 mm of predicted closure (see Figure 3 in the Mining Panel's advice).

6.3.47 On this basis, the EIS predicts the following likelihood of Type 3 impacts for named watercourses where they are located within 400 m of proposed longwalls:

- 7% for pools and channels along a 400 m section of the Avon River;
- 5% for pools and channels along a 250 m section of the Cordeaux River; and
- 9% for pools and channels along a 2.9 km section of Donalds Castle Creek.

6.3.48 While these likelihoods are very low, the Mining Panel took some issue with the way in which MSEC had applied its model to derive the predictions. Fundamentally, this concern relates to MSEC treating all streams (and all rockbars) alike. That is, MSEC's predictions were based on a statistical interpretation of its database, rather than any consideration of the actual nature of the pools and rockbars on the affected reaches of the watercourses. While MSEC's approach is useful, a more accurate prediction (whether higher or lower) could be made with more detailed consideration of the actual features present in the affected stream reaches.

6.3.49 Nonetheless, the key issue is not so much the accuracy of the SA's predictions (as there is always some degree of uncertainty), but what would be done if Type 3 impacts (as well as subsidence impacts of lesser significance) occur in any of the named watercourses. The EIS contains the following commitment in respect of remediation of named watercourses:

"South32 would implement remediation measures to mitigate physical damage to the streams where it is practicable to do so."

6.3.50 South32 has clarified that the practicality element of this commitment means: *where the environmental benefits of remediation are not exceeded by additional environmental impacts*.

6.3.51 The Department has recommended that any consent granted for the Project include a rehabilitation objective that requires achievement of this commitment.

6.3.52 However, the Department also considers that there is a material difference in stream significance between the Avon and Cordeaux Rivers and the other two named watercourses. In correspondence dated 22 October 2020, South32 has accepted this position.

6.3.53 To reflect this difference, the Department considers that remediation should be undertaken to a higher standard in the Avon and Cordeaux Rivers. Consequently, it has proposed a Project performance measure of not greater than "negligible environmental consequences" within these watercourses. South32 has also accepted this proposal.

Unnamed 3rd Order Streams

6.3.54 There are four additional 3rd order streams overlying or immediately adjacent to Area 5 which are not large enough to have been given geographic names. Within the EIS, these are labelled as DC8 (a tributary of Donalds Castle Creek); AR 19 and AR 31 (tributaries of the Avon River, below the Avon Dam); and LA13 (a stream which flows directly into Lake Avon). With the exception of AR 31, no 3rd order stream is directly undermined, although short sections of LA13 and DC8 are very close to the proposed longwall void footprint. Each of the affected stream reaches is relatively short, with a total of around 2 km within the SA's Study Area (a distance of 600 m from longwall voids). Less than 750 m of AR31 is underlain by LW 508A and LW 509. There are no 3rd order streams overlying Area 6.

6.3.55 There are no proposed setbacks from longwalls to any unnamed 3rd order stream. Instead, South32 proposes setbacks to what it has termed 'key stream features' (see the following subsection). For this reason, no detailed impact assessment has been undertaken in either the SA or the SWA for the unnamed 3rd order streams (or, for that matter, for 2nd and 1st order streams). Potential impacts on the 3rd order section of LA13 have been lessened by the proposed shortening of LW 516 by 300 m.

6.3.56 The only 3rd order stream which was given a focus by the Mining Panel is AR19, which flows into the Upper Nepean Conservation Area shortly after exiting Area 5. The Panel considered this stream to be *"important ecologically in supplying flow to the south-eastern section of [this reserve]"*. However, the Panel did not recommend any special treatment for this stream.

6.3.57 South32 did not propose any remediation of subsidence impacts to 3rd order streams, except in the case of impacts to 'key stream features' (see following subsection). However, the Department considers that each of these streams is significant, while admittedly not reaching the level of significance of the four named watercourses.

6.3.58 For this reason, the Department considers that its proposed rehabilitation objective for named watercourses should be extended to 3rd order streams subject to subsidence impacts. That is, any consent granted should require South32 to remediate physical damage as soon as

reasonably practicable, unless the environmental impacts of remediation exceed the environmental benefits.

Key Stream Features

6.3.59 As set out in **Section 2.2**, one of the constraints which South32 applied to its mine design was to protect what it termed 'key stream features'. South32 considered these to be any permanent pool >100 m^3 in volume and any waterfall or step >5 m in height and with a permanent pool at the base.

6.3.60 Both DPIE - Water and the Mining Panel questioned the appropriateness of South32's criteria for identification of key stream features. The Mining Panel noted that they were South32's criteria, rather than being set by Government or by some independent process and made the following recommendation in respect of finalising the Project's assessment:

> *1) As a matter of due diligence, the consent authority should confirm the scope and appropriateness of the selected key stream features.*

6.3.61 South32 responded to the Panel's recommedation by stating that *"Justification for the selection of the Key Stream Features is transparently described in Section 6.6.3 of the EIS, and the Stream Risk Assessment".* While the EIS indeed contains a straightforward description of South32's adopted hierarchy for watercourses and its identification of key stream features, that is not the same as to undertake and then describe a process which justifies the selection of key stream features on a scientific or environmental level.

6.3.62 The Department has not been presented with any evidence that suggests that South32's threshold definitions for key stream features are not reasonable or acceptable.

6.3.63 Nonetheless, there are additional important issues to consider. These include the question of whether some key stream features are more important than others and therefore deserve a higher level of protection. The second is the level of protection to these features offered by South32's mine plan.

6.3.64 South32 has identified a total of 57 key stream features across Area 5 and Area 6. Of this total, 12 are located in Area 6 and the remaining 45 are located in Area 5. A full list is shown in **Table 8**. The Department notes that most of these features are actually large pools, rather than waterfalls or steps.

Table 8 | Key Stream Features *(Source: EIS and SA)*

Stream	Stream Order	Identified Features
Donalds Castle Creek	3rd	12 pools
DC8	3rd	2 pools, 2 steps
DC10C	2nd	1 pool
LA13	3rd	4 pools
AR19	3rd	13 pools

AR31	2nd	4 pools, 1 step
AR32	2nd	3 pools, 1 step
CR29	2nd	4 pools
CR31	2nd	8 pools

6.3.65 Some of these features are located on 3rd order streams, and thereby would lead to some measure of protection to both Donalds Castle Creek and the unnamed 3rd order streams considered in the preceding subsection. However, a number are located on 2nd order streams. South32 points out that stream features located on 2nd order streams have not previously been subject to any specific protective measures in the catchment area. Indeed, it considers that its approach of identifying key stream features is "more sophisticated" than past approaches of only protecting 3rd or higher order streams.

6.3.66 South32 has committed to avoid direct undermining of all key stream features and also to longwall panel setbacks of:

- 50 m when mining occurs on one side of the feature; and
- 100 m when mining occurs on more than one side of the feature.

6.3.67 These setbacks have led to South32 committing to 5 intra-panel solid coal pillars (for LW 506, LW 507, LW 508 in Area 5 and LW 601 and LW 602 in Area 6). It has also led to it proposing three wider chain pillars between LW 510 and the longwalls to the west, between LW 501 and LW 516 and between LW 513 and LW 516 (see **Figure 3**). However, these setbacks and increased chain pillar widths are not intended to fully protect the key stream features from subsidence impacts.

6.3.68 As the Mining Panel points out *"The identification of the selected key stream features and the setback of longwall panels by either 50 m or 100 m from these features is not intended to assure the full protection of the key features from subsidence impacts. Rather, as stated in the EIS, the purpose of the setbacks is to reduce potential subsidence impacts on the key stream features. It is the Panel's understanding that remediation is confined to re-establishing the site-specific functionality of these features, where practicable. Remediation is not intended to and will not restore the function and values of the stream system and the loss of baseflow due to groundwater depressurisation."*

6.3.69 As with named watercourses, South32 has proposed that it would implement remediation measures to mitigate physical damage to key stream features where it is practicable to do so (ie where the environmental benefits of remediation are not exceeded by additional environmental impacts).

6.3.70 The Mining Panel paid particular attention to key stream features. As an illustrative exercise, it applied the SA's rock bar impact model to estimate that about 10 of 37 rockbars associated with key stream features were likely to be subject to Type 3 impacts and require remediation by South32.

6.3.71 The Mining Panel also put forward a simple means of identifying larger and therefore possibly more significant features (see Tables 1 and 2 in the Mining Panel's advice). On the basis of

greater pool length (≥30 m), greater pool volume (≥300 ML) and a likelihood measure of greater risk of impact (≥150 mm predicted valley closure), it has identified four large pools on Donalds Castle Creek (DCC_P26, DCC_P36, DCC_P40 and DCC_P43) which are at a potentially higher risk of impact. Similarly, it has identified two large pools on LA13 (LA13_P4 and LA13_P17) in the same category.

6.3.72 The Department has given careful consideration to the six larger pools identified by the Mining Panel. LA13_P4 and LA13_P17 sit centrally above a 200 m wide barrier pillar which South32 has proposed between LW 513 and LW 516 for the specific purpose of protecting them, as well as LA13_P9. Even so, being located between two longwalls, valley closure is predicted to be 600 mm and 700 mm at these two locations. A very wide barrier pillar (probably in excess 600 m) would be required to lead to a low likelihood of Type 3 impacts.

6.3.73 In the case of the four large pools on Donalds Castle Creek, three of them (DCC_P36, DCC_P40 and DCC_P43) are adjacent to the southern half of LW 512, where South32 has reduced the longwall void width to 205 m, for the specific purpose of reducing impacts on the entire reach of Donalds Castle Creek (as a named watercourse), not just these pools. Only DCC_P26 is opposite the northern section of LW 512, which has a planned void width of 305 m.

6.3.74 The Mining Panel also clearly stated that it is *"not necessarily advocating the adoption of the threshold values it chose to illustrate a risk management approach to assessing environmental impacts. But, it is advocating the concept of risk management zones and risk assessment for objectively assessing environmental impacts on watercourses, as have other Panels over the past decade."*

6.3.75 The Department considers that there is not enough information currently available on pool values (eg presence of key fish habitat) to advocate larger setbacks to increase the measure of protection offered to particular key stream features, including any of the six identified by the Mining Panel as larger in size and at a higher risk of impact.

6.3.76 It should also be noted that the Mining Panel's choice of threshold for valley closure (≥150 mm predicted valley closure) equates to a 4% chance of a Type 3 impact, using MSEC's rock bar impact model and there is no high degree of certainty that any of the six pools would be impacted under the current mine plan. For example, DCC_P26 has a 6% chance of developing a Type 3 impact, based on predicted closure of 180 mm.

6.3.77 In any case, as South32 has pointed out, all 57 of its identified key stream features are subject to its commitment to remediate any physical damage as soon as reasonably practicable, unless the environmental impacts of remediation exceed the environmental benefits.

6.3.78 The Department proposes that additional information is provided in conjunction with Extraction Plans. This information is required in order to inform decisions regarding the practicality of remediation. That is, it is necessary to know what the environmental benefits of remediation would be before an informed decision can be taken as to whether the environmental impacts of remediation activities would outweigh the environmental benefits.

Unnamed 2nd and 1st Order Streams

6.3.79 There are a large number of unnamed 2nd and 3rd order streams overlying and directly adjacent to both Area 5 and Area 6. South32 has not proposed any measures to protect these

streams, other than in respect of the key stream features located in some 2nd order streams. Instead, its approach has been to recognise the subsidence impacts (particularly streambed cracking) that would result from the Project and to compensate for the surface water lost from the catchment.

6.3.80 It is a given that any economic mine plan within Areas 5 and 6 would significantly impact 2nd and 1st order streams, just as it would impact upland swamps. This is particularly the case since the controlling factor on streambed cracking appears to be valley closure, rather than conventional compressive and tensile strains.

6.3.81 The Mining Panel gave limited attention to these streams. It did state that: *"While the 'largely ephemeral drainage lines' across Areas 5 and 6 do not contain key fish habitat and 'consist largely of disconnected pools', they do 'provide habitat for some native species' such as macroinvertebrates including crayfish, galaxiids and frogs"* and considered that drainage of these pools was likely to lead to changes in the abundance of macroinvertebrates.

6.3.82 The Department agrees with this position and accepts that the Project would result in residual impacts on 2nd and 1st order streams above and immediately adjacent to Area 5 and Area 6.

Stream Significance and Risk Assessment

6.3.83 The Mining Panel made a recommendation in respect to formal consideration in the assessment process of stream significance, as follows:

> 2. *In respect of stream classification, whether any of the streams impacted by the proposed mining warrant classification as being of special significance.*

6.3.84 The concept of "special significance" in regard to both watercourses and upland swamps was first raised by the Commission's predecessor (the Planning Assessment Commission) in considering the Metropolitan Coal Project in 2009 and then again in considering the Bulli Seam Operations Project in 2010. However, the concept has not since been defined for watercourses or otherwise pursued by DPIE – Water or other agencies.

6.3.85 The term "special significance" has also not been used in the EIS or SWA. Nonetheless, the level of significance attached to various watercourses within the EIS (ie named watercourses vs unnamed watercourses and key stream features vs other stream features) provides some measure of discrimination in respect to significance.

6.3.86 The Department has taken this further, adopting the following hierarchy for watercourses that may be affected by the Project:

- Avon River and Cordeaux River (5th order);
- named 3rd order watercourses (ie Donalds Castle Creek and Wongawilli Creek);
- other unnamed 3rd order watercourses; and
- unnamed 2nd and 1st order watercourses.

6.3.87 The Department considers that this hierarchy is a good representation of the significance of these watercourses and has identified rehabilitation objectives and/or performance measures which reflect this hierarchy.

6.3.88 South32's identification of key stream features is a useful complement to this hierarchy. While South32's criteria are self-selected, no party has proposed any replacement for them, on

either scientific or other grounds. The Department considers they provide a sound basis for assessing and limiting the impacts of the Project.

6.3.89 The Mining Panel made a further recommendation regarding increased use of formal risk assessment processes, as follows:

> *3. The adoption of a risk assessment approach for evaluating the nature and scale of environmental impacts, the appropriateness of the limits selected for environmental impacts, the reliability of setback distances of longwall panels proposed for preventing these limits being exceeded, and the suitability of the mine layout to adaptive management as a control for preventing exceedances of predicted impacts.*

6.3.90 The Panel supported this position in two of its Conclusions, in the following terms:

> *26. Although the EIS is supported by a document titled Stream Risk Assessment [this] does not constitute a risk assessment that is consistent with the intent of recommendations over the past decade of a number of Panels concerned with mining in the Southern Coalfield or with Australian and international standards and guidelines for risk assessment (such as MDG-1010 (2011) and ISO 31000 (2009)). This is because it does not objectively identify the likelihood of the hazards materialising, the consequences should they materialise, and the residual risk after implementing the controls. Rather, the Stream Risk Assessment is a useful tabulation of information on stream features, the threshold values used by South32 to determine key stream features, debateable likelihood predictions confined to only rivers and named creeks, and the remediation and offset provisions for features deemed to be at risk.*

> *27. A risk assessment approach provides an objective basis for assessing the scale and acceptability of environmental impacts on watercourses. The Panel has tested the concept of a risk management approach along the lines recommended by Southern Coalfield Inquiry (DoP, 2008) and developed in the PAC report for the Metropolitan Coal Project (DoP, 2009) and considers that its application would provide considerable assistance in this matter in assessing the likelihood and consequences of environmental impacts and deciding on acceptable threshold values that then inform mine design.*

6.3.91 The Department has given careful consideration to this recommendation, which is founded on the use of formal risk assessment (ie consequence and likelihood rankings) such as that applied by the Mining Panel in order to identify larger pools which are at higher risk of impact.

6.3.92 However, there is a substantive difference between methodological approach and the quality or reliability of outcomes. The Mining Panel is here advocating a different methodological approach, rather than saying that the outcomes of the SWA's Stream Risk Assessment are unreasonable or unreliable. It is also suggesting that this approach is used in mine design by mining companies and not just in development assessment.

6.3.93 The Department supports more rigorous, quantified and transparent assessment of environmental impacts and considers that the Mining Panel's recommendation has value in the design and assessment of future mining projects, particularly projects with substantial opportunities and requirements to limit environmental impacts, such as underground mines in the Southern Coalfield.

Surface Water Quality

Impacts During Mining

6.3.94 Both WaterNSW and the IESC expressed concerns over the potential impacts of the Project on water quality within streams but more particularly within the stored waters held in lake Avon and Lake Cordeaux.

6.3.95 WaterNSW considered that mobilisation of metals from underlying geological strata (eg iron) due to extensive fracturing of streambeds would likely lead to an increase in metals within streams across the catchments of the two reservoirs. The IESC considered that one of the key potential impacts of the Project was *"adverse impacts on water quality of inflows to water supply storages associated with the expected changes in the upland environment. Such water quality impacts are likely to include changes in turbidity, nutrient loads and pathogens."*

6.3.96 The Mining Panel gave detailed consideration to water quality issues. With respect to the EIS's assessment of impacts taking place during the Project's life, the Panel considered that *"A satisfactory water quality baseline analysis and review of potential short-term consequences have been conducted."*

6.3.97 The Mining Panel also considered that: *"The baseline water quality data presented in summary provides a good basis for water quality impacts assessment. The Panel notes the exceedance of applicable targets for some parameters both in mine-affected and unaffected catchments. It is noted that the established water quality and flow monitoring are reasonably well co-located, which provides a basis for understanding water quality spikes and variations in contaminant loads. This will be valuable for ongoing assessment of cumulative impacts to water resources."*

6.3.98 The Mining Panel also agreed with South32 that *"there is no evidence to date of deterioration of water quality due to the Dendrobium Mine that is significant at catchment scale or detected in reservoirs, except visual impacts due to staining that are expected to reduce over time."*

6.3.99 The Department agrees with this position. The principal impact on surface water quality associated with longwall mining is so-called "iron staining" within watercourses. This staining results from subsidence-induced cracking of bedrock below watercourses and across the landscape. This cracking causes increased infiltration of surface water, which in turn leaches unoxidised iron from freshly exposed rock surfaces within these cracks. The surface water commonly returns to the surface further down-gradient in the watercourse. When it does so, the dissolved iron is rapidly oxidised within the water column to form insoluble iron oxides and hydroxides. This is apparent as a milky suspension within the water, which soon precipitates to the stream bed where it forms a hard orange/red/brown deposit.

6.3.100 Iron is a very common metal in soils, clays and rocks and its presence as insoluble deposits of oxides and hydroxides on stream beds is very common. Nonetheless, the iron deposits caused by mine subsidence are a change to the existing aquatic environment and may have temporary impacts on aquatic biota. However, their greatest impact is a visual one.

6.3.101 These iron precipitates may stain stream beds for dozens or hundreds of metres (even a kilometre or more) down gradient from longwall mining domains. However, the very fact that the iron minerals are precipitating demonstrates that the dissolved iron is coming out of dissolution and is no longer generally available to aquatic biota.

6.3.102 For this reason, very limited amounts of dissolved iron and related metals are expected to reach the stored waters in Lake Avon and Lake Cordeaux. They are not expected to lead to any water quality issues which inhibit the use of those waters for their principal purpose, which is the provision of safe, clean and crystal-clear drinking water for the people of Sydney and Wollongong.

Impacts Following Mining

6.3.103 One reason why it is expected that the Project would have limited impacts on surface water quality during mining is that the groundwater modelling is based on a significant amount of surface water percolating through fractured geological strata to the mine, from whence it would be removed by the mine water collection and discharge system. However, this circumstance will not remain forever, and when Dendrobium Mine is eventually closed, the groundwater systems will eventually recover.

6.3.104 Both WaterNSW and the IESC drew attention to this issue. WaterNSW's advice stated that water quality could become a greater concern post-mining, as groundwater pressure recovers, leading to the potential for surface seeps of iron-enriched waters. The IESC also sought further consideration of *"potential long-term changes to surface water quality as groundwater levels recover post-mining, as well as the mechanisms which cause water quality changes to occur."*

6.3.105 The Mining Panel gave great emphasis to this issue, as had the Catchment Panel before it (albeit in general terms for all underground coal mines in the Southern Coalfield, rather than for Dendrobium Mine *per se*).

6.3.106 The Mining Panel drew the following conclusion:

> 31. *"The assessment of potential for adverse consequences on stream and reservoir water quality lacks consideration of long term cumulative contaminant loads, including emergence of contaminated shallow and deep groundwater post-closure. It is not sufficient to assume, as the EIS does, that the current lack of evidence of water quality consequences will continue long term."*

6.3.107 The Panel's advice also contained the following:

> *"The Panel is concerned by the absence of analysis of long-term risks to water quality, including:*
>
> - *Cumulative effects on reservoir water quality (which, due to large volume in the reservoir and limited monitoring that can be undertaken, are not yet expected to be detected, but may be in the future).*
> - *Potential for increased loads to reservoirs and Pheasants Nest Weir following re-pressurisation should the mine be sealed, including contaminant loads emanating from deep and shallow groundwater.*
> - *Potential for significant localised ecological and visual impacts at points of groundwater emergence following re-pressurisation, should the mine be sealed."*

6.3.108 In its response to the Mining Panel's advice, South32 made the following points in reply:

> - *"Of the Project longwall areas, only a small portion of Area 5 is within the catchment of the reservoirs. The remaining Project areas are downstream of the dam walls (i.e. no potential for accumulation of contaminant loads in the reservoirs).*

- *Given mining in the catchment has occurred for >100 years, the current lack of observed adverse impacts to water quality provides a reasonable basis for the EIS conclusions.*
- *South32 would accept a performance measure for negligible impact to reservoir water quality, with this to be monitored over the life of the Project.*
- *Additional analysis undertaken following the EIS and provided to [the Department] indicates there is a low risk of adverse impacts to water quality in the Special Catchment Areas following groundwater recovery post-mining."*

6.3.109 The Mining Panel's recommendations in respect of mine closure planning included the following:

> 7. *[Mine closure planning] to include provision for …. improved modelling of points of groundwater outflow and water quality, and identification of potential needs for treatment.*

6.3.110 The Department agrees with the Panel's recommendation. Should the Project be approved, then improvements in the groundwater model (see **Section 6.5**) are critical to strong management of the Project, including in respect to robust mine closure planning. Sound modelling and monitoring of aquifer repressurisation must be an integral part of the developing groundwater model and robust mine closure planning.

6.3.111 At the current time, there are no known water quality impacts associated with aquifer repressurisation and mine closure following completion of the Project. Instead, much of the necessary knowledge can only be gathered as the Project begins to extract coal by longwall methods in both Area 5 and Area 6.

6.3.112 The essential reason for this is that the groundwater model has been largely based on ongoing percolation of surface waters to the mined voids until the end of the life of the Project, at which time pumping from the mine is modelled to cease and groundwater levels would begin to repressurise. However, there is some likelihood of a solid rock remaining between the surface fracture zone and the height of connected cracking (see ***Surface to Seam Cracking*** in **Section 6.5**). Such a 'constrained zone' acts not only to prevent or limit the percolation of surface waters to the mine but also acts to prevent or limit repressurised coal seam aquifers from rising to the surface, where they may discharge.

6.3.113 The Department is satisfied that there is no known and significant threat to water quality associated with mine closure following the Project. However, this will be a key issue for the ongoing development of the Project, should it be approved. It is also an issue for Dendrobium Mine and the other operating coal mines in the Southern Coalfield, regardless of whether the Project is approved.

6.3.114 The Department is satisfied that the potential issue of water quality impacts following mine closure is best dealt with as a 'post-approval' matter, as recommended by the Mining Panel.

Neutral or Beneficial Effects

6.3.115 The *SEPP (Sydney Drinking Water Catchment) 2011* (the Drinking Water SEPP) requires the consent authority for the Project (ie the Commission) to be satisfied that the carrying out of the proposed development would have a 'neutral or beneficial effect' on water quality, commonly known as the NorBE test.

6.3.116 WaterNSW's advice stated that the EIS did not contain an adequate assessment against the NorBE test in respect of loads or concentration of metals in streams or reservoirs. South32

addressed WaterNSW's concerns in its RTS and in later correspondence dated 15 June 2020 to the Department. However, WaterNSW expressed continuing concerns.

6.3.117 Changes to the Drinking Water SEPP in October 2017 clarified the standard that a development such as the Project must meet in order to satisfy the NorBE test. Since that date, the SEPP has provided for 'continuing development'. Clause 11A(2) provides that:

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

6.3.118 The Department considers that the Project passes the 'likelihood' test that is embedded in this provision and accepts that the Project is continuing development under the Drinking Water SEPP. In this regard, the Department notes that South32's current mining lease (CCL 768) is very much larger than the area for which it received development consent coal in 2002 (see **Figure 4**). The coking coal resources within CCL 768 have been known as a large scale and valuable resource since well before the grant of CCL 768 under the *Coal Mining Act 1973*.

6.3.119 Clause 11A(3) provides that *"the carrying out of the proposed development will have a neutral or beneficial effect on water quality if it will have the same or a lesser adverse impact on water quality when compared to the adverse impact that the continuing development would have if it were extended or expanded under similar conditions as the existing development consent."*

6.3.120 In simple terms, clause 11A(3) requires that any new development consent to extract coal in Area 5 and Area 6 must be granted under conditions that do not cause a greater impact on water quality than the existing conditions of DA 60-3-2001. This test must be met in the context of an "extension or expansion", as set out in clause 11A(2).

6.3.121 The Project involves an extension of the existing Dendrobium Mine, using the same extraction methods (ie longwall mining involving void widths of up to 305 m). No evidence has been provided by any agency or submitter to suggest that the proposed extraction would lead to different or greater water quality impacts than those associated with the existing mine.

6.3.122 Even if that were to be the case, the test required by the Drinking Water SEPP is not the nature, scale or extent of the water quality impacts (either during mining or following mine closure), but rather that the conditions of consent which apply to the existing mine must be (at least) maintained for the expansion or extension. That is, while consent conditions governing water quality may be maintained or strengthened, they cannot be weakened.

6.3.123 The existing consent for Dendrobium Mine (as modified) contains particular performance measures relating to water quality. Condition 3 of Schedule 2 of the consent requires that:

"The Applicant must ensure the development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows to Lake Cordeaux or Lake Avon or surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek, to the satisfaction of the Secretary."

6.3.124 The Department is recommending conditions that have the same effect.

6.3.125 The existing consent also contains a number of other conditions that govern water quality in relation to limitations on impacts to Wongawilli Creek and Sandy Creek, content of Extraction

Plans, management of swamp impacts, end of panel reporting and groundwater monitoring. The Department is satisfied that the suite of conditions which it has recommended for the Project are either equivalent to or else strengthen the requirements of the existing consent in respect of water quality.

6.3.126 The existing consent contains a further condition, which required that South32 provide the then Sydney Catchment Authority (now WaterNSW) with a suitable offset package for *(inter alia)* loss of water quality or loss of water flows to water storages caused by mining and related operations, with this offset package to be submitted to the Department by April 2009.

6.3.127 South32 has proposed an offset package to address the potential water quality impacts of the Project. This package includes the transfer of 28.5 ha of land owned by South32 in the Metropolitan Special Area to the ownership of WaterNSW and a package of fire management, maintenance of unsealed roads and installation and maintenance of barriers and fencing at least equivalent to WaterNSW's annual expenditures on these management issues.

6.3.128 The water quality offset package is intended to improve management of the Special Area and in particular to reduce erosion as a cause of sediment entering WaterNSW's storages. The package (as proposed by South32) has the following purpose: "*Additional catchment management measures and transfer of land to WaterNSW to improve water quality in the Special Catchment Areas (and achieve net neutral or beneficial effects to water quality as a result of the Project)".*

6.3.129 The package is similar in scale and nature to that required under the existing consent. However, it is more focused, in that it only addresses water quality issues, rather than the other matters also addressed by the existing consent condition. In that respect, the proposed condition of consent to require implementation of the offset package offered by South32 as part of a Planning Agreement with the Minister for Planning and the Minister for Water is stricter than the parallel condition in the existing consent.

6.3.130 The Department is therefore satisfied that the Project meets the NorBE test.

Surface Water Discharges

6.3.131 South32 currently discharges excess mine water from Dendrobium Mine into Allans Creek, a watercourse which flows into the much larger American Creek and thence into the Port Kembla harbour. This discharge and the discharge point (LDP5) are licensed by the EPA under the *Protection of the Environment Operations Act 1997.* EPL 3241 contains a variety of water quality limits addressing metals, pH, turbidity and oils and grease but no volume limit. Current discharges are about 10 ML/day but are modelled to increase as the Project develops and to exceed 20 ML/day in 2026 and thereafter for the life of the Project and beyond (see **Figure 14**). The discharge pipeline which runs from the Dendrobium Pit Top to Allans Creek along the Kemira Valley Rail Line corridor would need to be duplicated to carry the additional volume of mine water to be discharged.

6.3.132 All matters concerning mine water discharges raised in the EPA's advice following exhibition of the EIS were addressed to its satisfaction in South32's RTS.

6.3.133 The Department is confident that the duplication of the existing pipeline to LDP5 can be undertaken with a minimal environmental impact. Review and any necessary amendment of EPL 3241 is a matter for the EPA.

6.3.134 South32's revised surface water offsetting proposals (see ***Offsetting*** below) as set out in its Amendment Report involved construction and operation of a small (5 ML/day) water treatment facility at Port Kembla, close to LDP5, with this capacity sized to treat the proportion of its mine water that was equivalent to its maximum modelled Project surface water take (not the existing mine). This proposal is no longer part of the proposed development.

Surface Water Licensing

6.3.135 The EIS states that: *"Due to existing restrictions on the availability of licences in the water sources that the Project is not physically located within, South32 is reliant on the NSW Government creating additional licences or entitlements available to facilitate the development of the Project in the applicable adjoining Water Sharing Plan management areas and zones."*

6.3.136 As noted in **Section 3.8**, in April 2020 the Government publicly announced that it was committed to implementing all of the Catchment Panel's 50 recommendations. This included *"introducing a licensing regime to properly account for any water losses"* within the Special Areas.

6.3.137 The design of this new licensing regime has recently been approved by the NSW Cabinet. The key components are:

- imposing conditions on development consents requiring mining companies operating in the Special Areas to minimise surface water losses from new mining proposals and to pay the full cost associated with offsetting these surface water losses;
- collecting and administering all offset payments from mining companies in a dedicated offset fund under the EP&A Act; and
- giving the Minister for Water, Property and Housing the authority to spend these funds (as required) on priority water projects to increase the drinking water supply of the Sydney metropolitan area.

6.3.138 The new regime requires mining companies to:

- fully offset all surface water losses of their project for the full duration of water take (rather than simply the project's mining life);
- pay the Long Run Marginal Cost (LRMC) for all water taken, as set by the Independent Pricing and Regulatory Tribunal (IPART) determination for retail water prices; and
- bring forward the payment of these offsets as much as possible, to account for the time value of money and ensure that funds are available for early expenditure on water supply capital works.

6.3.139 The new regime will be supported by amendments to *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* which would allow WaterNSW to enter into dealings with mining companies and trade water allocations to them.

6.3.140 In essence, mining companies operating in the Special Areas must first obtain a surface water license under the *Water Management Act 2000* and then purchase a water allocation from WaterNSW (which currently holds essentially all water allocations within the Special Areas).

Consent conditions would then require an additional payment to reflect the LRMC of all surface water taken.

6.3.141 The changes to the surface water licensing regime were developed in the knowledge that they may be applied to the Project and, if necessary, to other mines operating in the Special Areas, such as Metropolitan Colliery and Russell Vale Mine.

Offsetting

6.3.142 South32 has put forward a number of offset proposals to account for the Project's anticipated surface water take. Both the EIS and RTS proposed annual payments to WaterNSW for surface water take during the life of the Project, based on the regular IPART determinations for WaterNSW's bulk water price to local Councils. This would have led to payments to WaterNSW of up to $100,000 per annum in today's dollars during the Project's life. South32 also committed to beneficially using mine water produced by the Project and/or funding or implementing works that would reduce existing losses such that there would be no net loss to Sydney's drinking water system.

6.3.143 In April 2020, the Department sought further detailed information from South32 concerning its water offset proposals. When it responded to these queries on 2 June 2020, South32 substantially increased its offer of annual payment for surface water take to Sydney Water's retail price (rather than its bulk water purchase price), which is also set regularly by IPART. This proposal was based on current retail prices equivalent to $2,300/ML ("base scenario") and $3,120/ML ("drought scenario"). South32 would provide this funding to Government to be used for projects that result in net gains to metropolitan water supplies. South32 also committed to build and operate a water treatment facility (at a projected cost of up to $34 million) to remove salt and metals from the Project's mine water, and gift this facility to the Government at the end of the Project's life. Alternately, if the water treatment facility was not built (ie if a market for the treated water could not be identified), then South32 would give the Government $34 million (in 2020 prices) at the end of the Project's life in (expected to be in 2048). The terms of this offer were also set out in South32's Amendment Report.

6.3.144 Notwithstanding the very substantial increases in South32's offer, there were a number of aspects of this proposal which were not acceptable, in particular the lack of offsetting of surface water losses which would continue following completion of the Project (ie post mine closure). The Department therefore continued to discuss offsetting arrangements with South32. On 7 October 2020, South32 amended its surface water offsetting proposal to deal more explicitly and comprehensively with offsetting the surface water losses which would continue following mine closure. The key terms of this offer are as follows:

- *annual payments during mine life*, based on the actual surface water loss due to the Project for each water year (ie financial year), to be calculated at the end of each water year and priced at the actual IPART retail price for that water year, which would vary over time to reflect inflation and drought/non-drought year prices. Current IPART retail prices are $2,350/ML (base) and $3,180/ML (drought); and
- *a single up-front payment of $16.7 million to cover post-mining water take*, made upon approval of the first Extraction Plan for the Project (ie payment linked to when surface water losses from subsidence would be authorised to commence), with this amount based on the NPV of modelled post-mining losses and IPART prices, assuming drought price applies for 1 year in 10.

6.3.145 South32 has calculated that its projected payments during mine life would total $86.4 million in real terms ($22.6 million NPV) based on its currently predicted annual surface water losses. Thus, the total payment is projected to be $103.1 million in real terms.

6.3.146 On this basis, an amount of $16.7 million (indexed to CPI – General) would become available to Government for expenditure on important strategic water supply capital works sometime before late 2024, when longwall operations are projected to commence. Annual payments of between $100,000 and $8.19 million (in real terms) would be added to this figure each year from 2023 to 2048 (see **Table 9**).

Table 9 | South32's Final Surface Water Offset Offer *(Source: South32 letter of 7-10-20)*

Project Year	Surface Water Offsets[1]		
	During Mining (Indicative Annual Payment)[2]		Post-mining (Actual Up-front Payment)[3,4]
	Real	NPV	
2021	-	-	$16,700,000
2022	-	-	-
2023	*$100,636*	*$76,775*	-
2024	*$203,328*	*$144,970*	-
2025	*$281,728*	*$187,727*	-
2026	*$773,043*	*$481,412*	-
2027	*$589,673*	*$343,195*	-
2028	*$1,229,021*	*$668,506*	-
2029	*$980,455*	*$498,413*	-
2030	*$1,896,860*	*$901,184*	-
2031	*$2,854,900*	*$1,267,610*	-
2032	*$3,192,243*	*$1,324,668*	-
2033	*$2,052,884*	*$796,144*	-
2034	*$3,734,948*	*$1,353,717*	-
2035	*$2,571,473*	*$871,047*	-
2036	*$2,806,442*	*$888,448*	-
2037	*$3,047,401*	*$901,616*	-
2038	*$5,509,572*	*$1,523,443*	-
2039	*$3,496,890*	*$903,663*	-
2040	*$6,002,934*	*$1,449,787*	-
2041	*$3,761,884*	*$849,107*	-
2042	*$6,402,386*	*$1,350,563*	-
2043	*$3,972,603*	*$783,185*	-
2044	*$6,972,025*	*$1,284,590*	-
2045	*$4,605,552*	*$793,055*	-
2046	*$8,192,032*	*$1,318,347*	-
2047	*$5,727,364*	*$861,408*	-
2048	*$5,468,191*	*$768,624*	-
Total	*$86,426,469*	*$22,591,205*	$16,700,000

[1] Surface water offsets are in addition to provision of annual payments to compensate WaterNSW for lost revenue and South32 holding appropriate groundwater and surface water licences (refer letter dated 2 June 2020).

[2] The annual payments for surface water losses during the mine life have been calculated based on the predicted surface water losses for the Project in the EIS. South32's offer is based on annual payments during mining which would be calculated annually based on actual surface water loss at the end of each water year (i.e. reflect real surface water losses) and varying IPART prices.

[3] The up-front payment for post-mining losses (in net present value terms) is based on predicted post-mining surface water losses.

[4] Up-front payment to be made upon approval of the first Extraction Plan for the Project.

6.3.147 It must be noted that South32's commitment for annual payments is based on 'actual surface water losses' as calculated using the Project's groundwater model (which would be annually recalibrated with all available new monitoring data), rather than the predictions made in the EIS and GA. Actual surface water losses may therefore vary substantially from the EIS's predictions based on improved groundwater modelling, revised assumptions or modelling for surface to seam cracking, mining delays, changed mine inflows, reduced longwall void width/s or other changes to the mine plan.

6.3.148 The Department considers that South32's position concerning payments for 'actual losses' is appropriate. However, such a position requires that the conditions of any consent provide for a detailed (and mining area-specific) program of monitoring of rainfall, evapotranspiration, stream flow, infiltration and mine inflows and regular review of the groundwater model and improvements to its interface with the surface water model (as proposed by the Mining Panel) to ensure that each annual calculation of surface water losses is as robust and reliable as possible. Conditions to support these outcomes have been proposed in the draft consent for the Project.

6.3.149 The Department also notes that there are a number of years prior to the planned commencement of longwall extraction and that this time can be applied to improve the groundwater and surface water models and ensure that an adequate monitoring regime is in place, together with all necessary baseline information.

6.3.150 The Mining Panel made one recommendation to be considered during the assessment process concerning offsetting of post-mining surface water take, as follows:

> *4. In respect of surface water losses in the context of mine closure, whether the approach to assessment of compensation is appropriate or warrants future review.*

6.3.151 The Department notes that the offset calculation includes modelled post-mining losses from 2048 until the year 2319 (171 years), using the NPV of a weighted non-drought and drought price for water, with drought pricing applying for one year in ten.

6.3.152 The Department is satisfied that this methodology is appropriately conservative. In addition, the proposal for it to be an up-front payment (and therefore accessible for early capital works) limits the opportunity for future review. Notwithstanding, should actual surface water losses exceed those currently modelled, then it could be expected that this might lead to additional mine closure costs for South32. In turn, these additional closure costs would be expected to be reflected in the security deposit required by MEG under South32's mining lease.

6.3.153 Finally, the Department notes that 'beneficial re-use' of mine water is no longer part of South32's surface water-take offsetting proposals, having been overtaken by the financial commitments set out above. While South32 remains open to such beneficial re-use, it would require either a large-scale water treatment opportunity or other appropriate market to arise. Any such proposal would be the subject of a separate development or modification application.

6.3.154 Given the above, the Department considers that South32's water offsetting proposal is substantial (more than $100 million) and appropriately reflects the importance of Sydney's drinking water catchment and the recommendations of the Catchment and Mining Panels.

6.3.155 The draft conditions of consent make provision for both South32's water take and water quality offsetting offers to be delivered by way of a Planning Agreement, to be entered into by South32 with the Secretary and the Minister for Water, Property and Housing under Division 7.1 of Part 7 of the EP&A Act, within six months of commencing development under the consent.

Monitoring and Management

6.3.156 The Department has standard conditions for monitoring and management of surface water resources affected by underground coal mining. These conditions are focused on:

- setting strict performance measures;
- requiring additional offsets for any exceedances of these performance measures;
- obtaining approval of Extraction Plans for the management of all longwall mining operations; and
- including within every Extraction Plan a component Water Management Plan, Biodiversity Management Plan, Land Management Plan, Subsidence Monitoring Program, Swamp Monitoring Program, Trigger Action Response Plan/ and Contingency Plan.

6.3.157 The Department recommends that these standard conditions are applied to any consent granted for the Project. In respect of surface water resources, the key component plan would be the Water Management Plan. Standard conditions contain detailed requirements for:

- obtaining and including detailed baseline data;
- preparing surface and groundwater impact assessment criteria, including trigger levels for investigating potentially adverse impacts on water resources or water quality;
- a surface water monitoring program to monitor and report on stream flows and water quality, stream and riparian vegetation health, and channel and bank stability;
- a description of adaptive management practices to guide future operations in the event of greater than predicted impacts on aquatic habitat; and
- a plan to respond to any exceedances of the surface water and groundwater assessment criteria.

6.3.158 The Mining Panel made a recommendation regarding Extraction Plans and their component management plans, in the following terms:

5. *A suite of Management Plans to support Extraction Plans as per contemporary practice but taking into account the recommendations of the [Catchment Panel] that:*
    i. *consent conditions that make provision for meeting the requirements of performance measures by avoidance, mitigation or remediation need to be quite specific about the scope of attributes that have to be avoided, mitigated or remediated and the verification standards that avoidance, mitigation and remediation measures have to satisfy.*
    ii. *TARP triggers for surface and groundwater should be based on meaningful indicators developed in consultation with relevant agencies and authorities with oversight and regulatory responsibilities for mining.*

6.3.159 The Department considers that its standard conditions give effect to this recommendation.

6.3.160 In addition, the Department is recommending further requirements for the Water Management Plan to strengthen the standard conditions and reflect the unique circumstances of the Project. These are:

- a program to continually improve and refine modelling of surface water losses, including provision for annual recalibration of the development's groundwater model to incorporate

all new relevant data (eg groundwater pressures, surface water flows, rainfall, evaporation and mine inflows); and
- a program to update the development's surface water and groundwater models, to improve their integration and compare monitoring results with modelled predictions.

6.3.161 The Department is also recommending that stricter performance measures apply to the two most significant watercourses which may be affected by the Project (notwithstanding South32's mine design which substantially limits the likelihood of any such impacts). The Department recommends that the Avon River and Cordeaux River are subject to a performance measure of "negligible environmental consequences", where "negligible is defined to mean "small and unimportant, such as to be not worth considering".

6.3.162 In other respects, the proposed performance measures for all watercourses require that all subsidence impacts and environmental consequences do not exceed those predicted in the EIS (including the SA, SWA and GA).

6.3.163 Requirements for remediation of subsidence impacts within watercourses are included in the proposed conditions setting out rehabilitation objectives and requirements for a Rehabilitation Management Plan. The proposed standard applies to each of the four named watercourses, to all unnamed 3rd order streams and to all key stream features (as defined within the EIS).

6.3.164 For all such features, the proposed condition requires that South32 "remediate physical damage as soon as reasonably practicable, unless the environmental impacts of remediation exceed the environmental benefits".

6.3.165 The Department considers that its proposed requirements regarding monitoring, management and remediation of the subsidence impacts resulting from the Project are robust, reasonable, scalable, comprehensive and appropriate.

6.4 Potential Impacts to WaterNSW Assets

Existing Assets

6.4.1 As set out in **Section 6.1**, the Department considers that the potential for impacts from the Project on WaterNSW's water supply assets (particularly the walls and floors of Cordeaux and Avon Dams) and minimising the risk of such impacts are critical issues for the Project's assessment.

6.4.2 The principal agencies that expressed concerns relating to such impacts were WaterNSW and DSNSW (see paras 5.3.34 – 5.3.37). DSNSW provided the most detailed submission setting out its concerns. The Department considers that this submission was one of the most important received in response to exhibition of the EIS.

6.4.3 South32 addressed the issues raised by DSNSW in its RTS (see that document's pp 66-72). However, the Department sought further information on these issues which was provided by South32 in its letter of 29 May 2020 (subsequently revised on 15 June 2020, following a meeting with DSNSW representatives on 3 June 2020).

6.4.4 The RTS reiterated the EIS's statements that South32's proposed setback distance between its longwall voids and the walls of Avon and Cordeaux Dams was a "minimum" of 1000 m (see

Figure 11). The RTS also stated that *"South32 is not seeking to damage or compromise the Avon Dam or Cordeaux Dam walls, and as such, agrees with stakeholder comments about the importance of protecting this infrastructure."*

6.4.5 However, in its later response, South32 went further and made the following commitment: *"South32 commits to achieving a subsidence performance measure such that the safety and serviceability of the Avon and Cordeaux dam walls is always maintained, and that there is negligible additional risk to public safety as a result of the Project."*

6.4.6 This commitment mirrors a condition of consent that in any case the Department would recommend as part of a suite of measures to protect the dam walls.

6.4.7 South32 also acknowledged the concerns raised by DSNSW in regard to the minimum setback distance from the walls of Avon and Cordeaux dams. It reported that its subsidence consultant MSEC considers that *"based on currently available information, **absolute** subsidence movements at both the Avon and Cordeaux dam walls at 1,000 m from secondary extraction are expected to be very small, **differential** movements are expected to be negligible and within the range of survey tolerance (i.e. are not anticipated to be measurable) and that a monitoring and adaptive management approach be developed." (emphasis added)*

6.4.8 Further, MSEC considers that *"this conclusion would remain the same if the minimum setback distance to the dam walls was revised to 1,500 m (i.e. **differential** movements would be negligible and within the range of survey tolerance, and recommend an adaptive management approach be developed)." (emphasis added)*

6.4.9 Finally, South32 stated that *"the ultimate setback distance from the dam walls to the Project longwalls will be determined by the requirement to achieve South32's additional commitment, as well as the performance measures in any development consent for the Project."*

6.4.10 In essence, South32's current commitments are:

- no damage to the dam walls;
- no loss of either safety or serviceability for the dams; and
- negligible additional risk to public safety.

6.4.11 The Department endorses South32's commitments and considers that they are an appropriate framework for approval of the Project. The key residual issue is how to guarantee their achievement, ie how best to frame strong and enforceable conditions of consent.

6.4.12 MSEC's position on 'absolute' and 'differential' horizontal movements at distances of 1,000 m and 1,500 m (ie 'far-field') from longwall voids is also accepted. The Department notes that the landmass surrounding a longwall void expands a small amount in the direction of the void. There is no particular point at which this expansion cuts out – it just reduces exponentially, as shown in the SA's Figure 4.4. Consequently, the amount by which the landmass moves towards the void is not greatly different at substantial distances, such as 1.0 km or 1.5 km.

6.4.13 Further, it is differential (rather than absolute) far-field movements that are critical to maintaining surface infrastructure such as dam walls. Put simply, it is not of great importance if both ends of a dam wall, together with the land beneath it and adjacent to its abutments, all move collectively towards the void. However, it is much more important if one end of the dam wall moves substantially more or less than the other. Possible reasons for significant

differential movements (which was the basis for the DSNSW's original concerns) might include, for example, a major lineament defining the valley in which the dam is constructed.

6.4.14 Far-field differential movements of a scale that may be of concern cannot be predicted precisely without detailed knowledge of site-specific conditions at the local scale. In any case, the key 'avoidance' measure that could be applied at this stage (ie setback distance) is also not particularly effective at the distances in question.

6.4.15 Therefore, the Department agrees with MSEC's recommendation that development and application of an adaptive management approach is the most appropriate means of avoiding damage to the walls of the two dams from far-field horizontal movements. This adaptive management regime must include detailed assessment of the risks of far-field impacts on the dam structures in the Extraction Plan for any longwall with any potential to affect the structures, as well as regular and detailed monitoring and reporting.

6.4.16 DSNSW raised a number of other related issues that may have implications for the safety and serviceability of the dam walls and limiting losses of stored waters through subsidence impacts beneath the reservoirs' FSLs. These included:

- implications of the extraction of Area 3C (already approved) on the wall of Cordeaux Dam, when considered cumulatively with extraction within Area 6;
- risks associated with geological features (eg two inferred igneous dykes which may run beneath the wall of Cordeaux Dam);
- risks of movements in the dam walls or their foundations associated with development and/or activation of shearing at the base of the impounded valley ('basal shear planes');
- risks associated with uplift of the valley floor (ie 'upsidence') beneath the dam walls; and
- risks of increased loss of stored waters through leakage via basal shear planes or other mechanisms caused or exacerbated by subsidence.

6.4.17 South32 addressed each of these matters in its later response. The general tenor of this response was not to reject DSNSW's issues, but to accept them as issues of uncertain scale or significance and then to state that the most appropriate means and time to quantify them and address them would be in the Extraction Plan process. South32 also agreed with a number of DSNSW's positions, including its recommendation to conduct a risk assessment focused on the safety of the dams and security of the stored waters, with input from a qualified dams engineer. South32 proposed that this take place during the Extraction Plan process.

6.4.18 The remaining questions for the Department are whether:

- South32 has responded adequately to the issues raised by DSNSW;
- sufficient information has been presented to support approval of the Project in the form proposed; and
- if so, whether the residual risks and uncertainties are of sufficiently limited scale and significance that they can be adequately managed by conditions of consent (in particular application of strict performance measures and the Extraction Plan process).

6.4.19 The Department considers that South32's later response addresses well the issues raised by DSNSW. This is reflected in DSNSW's later letter to the Department, dated 22 July 2020, in which it notes South32's additional commitment to ensure negligible additional risk to public safety as a result of the Project and makes a single request regarding performance measures in conditions of consent: *That the Applicant ensure that there is no mining-induced cracking of the Avon and Cordeaux dam walls and their associated grout curtains.*

6.4.20 The implication of this limited request is that DSNSW considers that, subject to this single but important performance measure (and South32's existing commitments), risks related to the dam walls can be appropriately managed by the Department's Extraction Plan process.

6.4.21 The Department agrees with this position and notes that its Extraction Plan process includes requirements for careful and regular delineation and assessment of all subsidence-related risks as well as ongoing monitoring and adaptive management. It proposes conditions of consent to:

- set strict performance measures to ensure:
  - no mining-induced cracking of the dam walls and their associated grout curtains;
  - no loss of either safety or serviceability for the dams and reservoirs; and
  - no additional risk to public safety; and
- apply the Department's standard conditions regarding the Extraction Plan process; and
- add to these conditions requirements to assess and manage risks associated with:
  - cumulative impacts of the extraction of Area 3C on the wall of Cordeaux Dam;
  - geological features, such as sills, dykes and faults;
  - development and/or activation of basal shear planes and/or upsidence for the dam walls and their foundations; and
  - loss of stored waters through leakage via basal shear planes or other mechanisms.

6.4.22 Based on application of these conditions, the Department considers that the risks of subsidence-related impacts to WaterNSW's built assets are adequately understood and can be well managed.

6.4.23 The Department notes that the Mining Panel made no substantive comment on potential subsidence risks to the dam walls. It considered this highly specialised area of mine subsidence engineering to be outside the expertise of the Panel's four members. In this respect, DSNSW has both responsibility and expertise. The Department is confident that DSNSW would continue to give high priority to the protection of the dam walls, during development and approval of Extraction Plans and through detailed ongoing subsidence monitoring while longwall panels are being extracted.

Potential Future Assets

6.4.24 In its submission, WaterNSW drew attention to the potential for both proposed mining areas to overlap with an area that WaterNSW has considered for a possible future dam and associated reservoir (the "Lower Cordeaux Dam") and would likely cause substantial leakage from the floor of this reservoir, if the dam is constructed.

6.4.25 South32 addressed this issue in its RTS and advised that WaterNSW had also raised it during preparation of the Project EIS. WaterNSW did not further address this issue.

6.4.26 The RTS advises that the Lower Cordeaux Dam is one of WaterNSW's long-term water supply options. The identified dam wall location is on the Cordeaux River, approximately 2.8 km west of the proposed Area 6 longwalls and approximately 3.7 km north of the proposed Area 5 longwalls. Even if a dam wall were to be constructed prior to mining taking place, these distances are such that measurable far-field horizontal or valley-related effects are unlikely.

6.4.27 However, the FSL of the potential reservoir could overlap small portions of the Area 5 and Area 6 longwall footprint. The RTS advises that these areas are limited as a result of the

setbacks between longwalls for named watercourses and key stream features, as proposed by South32. The RTS also advises that the FSL of the potential reservoir would flood a number of features that the Project seeks to protect (eg sections of Wongawilli Creek and Donalds Castle Creek). Further, the FSL would overlap other previously mined areas (ie parts of South32's Area 2 and Area 3 as well as other historic mining operations).

6.4.28 These issues are important, but the Department considers that they do not carry great weight for determination of the Project. Instead, they are critical issues to be considered by any consent or determining authority in assessing any future planning proposal to construct the Lower Cordeaux Dam. This is because there is no requirement in planning law for a consent authority considering a particular development application to take into account other potential developments that do not pass a test of being "likely", or to take into account potential future land uses that do not pass the test of being a "likely" future preferred use of land.[11]

6.4.29 The Department considers that WaterNSW's identified Lower Cordeaux Dam option does not pass either of these tests. The option's undoubtedly significant environmental impacts (in particular drowning many hundreds of hectares of native vegetation and threatened species habitat and inundating a large number of Aboriginal heritage sites) have not yet been assessed or otherwise considered. The option has not been subject to cost benefit evaluation and has not been evaluated against other major water supply options, such as constructing one or more additional seawater desalination plants in Sydney or the Illawarra. It seems beyond doubt, even at this early stage, that the environmental impacts of constructing and filling such a dam would be much greater than those of the Project.

6.4.30 The Department considers that there are a number of highly uncertain and contingent possibilities that affect the "likelihood" of this competing development. These include the possibility that WaterNSW would seek planning approval; the possibility that it would receive Government endorsement for the required capital expenditure; the possibility that it would receive a sufficient level of public support; and the possibility that it would receive development consent or other planning approval.

6.4.31 On this basis, the Department considers that the possibility of development of the Lower Cordeaux Dam is not "likely", nor that the use of that site is a "likely" preferred use of land. Therefore, the Department considers that the possibility that the Lower Cordeaux Dam would be built is not of great weight in the decision on whether or not to grant development consent to the Project. That is, consent for the Project should stand or fall on its own merits.

6.5 Groundwater Resources

Introduction

6.5.1 The EIS contains a Groundwater Assessment (GA) for the Project, prepared by HydroSimulations. The GA's purpose was to "conceptualise, model, assess and document the likely groundwater impacts" of the Project.

6.5.2 In preparing the GA, HydroSimulations took into consideration various recent reports by the Commission's predecessor (ie the Planning Assessment Commission), the IESC's published

[11] The requirements of clause 12 of the Mining SEPP are considered in Appendix G2.

information requirements and previous IESC advice on a similar project. It also sought to apply 12 recent relevant recommendations and comments, primarily from the Catchment Panel's reports (see paras 3.7.1 to 3.8.5) but also from the Height of Cracking Study (see paras 3.7.2 to 3.7.3).

6.5.3 The principal agencies that expressed concerns relating to predicted or potential groundwater impacts were WaterNSW, DPIE - Water and the IESC (see paras 5.3.27 to 5.3.30). Most concerns expressed by these agencies related to HydroSimulation's groundwater model, rather than the impacts of the project on groundwater resources as such.

6.5.4 Advice from the Mining Panel is considered under the relevant sub-headings below.

Groundwater Modelling

6.5.5 The GA details the development and application of a single regional groundwater model to address the impacts of mining on the groundwater and surface water system around Dendrobium Mine both during mining and for a period of 150 years following completion of the Project around 2048. The model is based on the MODFLOW-USG software. This software allows spatial refinement of the model in critical areas and makes it easier to use the model for a range of purposes without the need for the creation of sub-models.

6.5.6 The main purposes of the groundwater modelling were to investigate the magnitude of water inflows to Areas 5 and 6, stream flow and swamp losses above the mine, impacts on Lake Avon and Lake Cordeaux and mining-induced drawdowns for regional groundwater users.

6.5.7 To develop this groundwater model, HydroSimulations first undertook a detailed data analysis in order to conceptualise the local and regional groundwater systems. Both this data and the conceptualisation then underpinned the design of the GA's groundwater model.

6.5.8 The groundwater model built on previous groundwater modelling undertaken for Dendrobium Mine over the past decade. The Department notes that the Catchment Panel's report observes:

"There has been a major effort over the last decade by Metropolitan Mine and Dendrobium Mine to employ up-to-date 3-dimensional groundwater models and best practice modelling methods undertaken by suitable experts, with expert peer review."

6.5.9 The model's domain accounts for historic stresses in the groundwater system (ie other underground coal mines and the voids and subsidence that they create) by adopting a regional scale (40 km x 40 km) and incorporating all historical, current and proposed mining operations. The model 'grid' has greater fineness in areas where groundwater stresses could occur, such as around longwall panels, or where sensitive features are located (eg reservoirs, watercourses, upland swamps and registered bores).

6.5.10 The groundwater modelling was subject to a peer review, initiated by South32 but undertaken by Kalf and Associates, which concluded that the modelling was "fit for purpose". This peer review also identified key issues relating to the groundwater modelling and predicted groundwater impacts and proposed ongoing monitoring and regular model review, should the Project be approved.

6.5.11 As noted above, the principal agencies that expressed concerns relating to the groundwater model were the DPIE – Water, the IESC and WaterNSW. The Mining Panel has also expressed a number of concerns, many of which are related to those raised by the first two of these agencies.

6.5.12 DPIE – Water's advice focused on a number of technical concerns over HydroSimulation's groundwater model. These concerns related to model parameterisation, model caibration, model predictions, mismatches between model calibrated inflows and calibration targets, and sensitivity analysis and uncertainty analysis.

6.5.13 The IESC sought further information as follows:

- consideration of the limitations of using equivalent porous medium (EPM) groundwater modelling (fundamentally an averaging approach) in a highly disturbed or fractured area;
- further information regarding groundwater impact predictive scenarios and sensitivity analysis to allow comparison of predicted results between the proposed and a revised mine plan; and
- further consideration of characterisation of geological structures and lineaments to fully understand potential impacts to nearby water assets and allow development of appropriate TARPs.

6.5.14 WaterNSW's advice concerning the groundwater model focused on its predictions of surface water take. WaterNSW noted that previous iterations of the model had predicted surface water take at the existing Dendrobium Mine and that these predictions had increased 5-fold in the 5 years since 2014 (now 1372 ML/year). Solely on this basis, WaterNSW questioned the reliability of the current model's predictions.

6.5.15 South32 addressed these issues in its RTS (see that document's pp 118 - 126). However, the Department sought further detail in respect of issues raised by each of these agencies which was provided by South32 in individual letters dated 15 June 2020, 22 June 2020 and 26 June 2020. South32 also met with representatives of DPIE - Water on 15 July 2020 and WaterNSW on 7 August.

6.5.16 On 16 September 2020, DPIE - Water provided its final advice stating that it did not accept that the *"groundwater model has the capability to adequately predict impacts and so require a detailed plan from the proponent to describe how the model will be upgraded.*" While the additional information provided by South32 had addressed some of its concerns, it still considered that *"there remain matters that the proponent must resolve. Most importantly, a clear plan is required for model updating, including acceptable methodologies for data QA/QC for modelling purposes and model parameterisation."*

6.5.17 The Department first notes that groundwater modelling is a highly specialised and technical discipline, seeing as it is based on a single, integrated, computerised mathematical representation of a very complex system, comprising (at least) the:

- landscape, with its terrain and permanent and ephemeral waterbodies;
- underlying geological layers ('strata') at least as deep as the coal seam to be mined, together with known information about geological faults and igneous intrusions;
- known (or predicted):
  - rainfall, evaporation, transpiration and infiltration rates across the landscape;
  - hydrological properties of each of the strata and other geological features;

- hydrological behaviour in response to the creation of underground voids by the mining process (as well as existing voids caused by other mining activities);
- hydrological behaviour in each of the overlying strata as they respond to subsidence and rock collapse above the larger of these voids (ie the longwall panels);

- manner in which all these features and values interact hydrologically; and
- rates at which these interactions change over time, until the disturbed hydrological system once again reaches a stable ('steady') state.

6.5.18 Because of these complexities, together with the continuing increases in computing power and the regular changes in groundwater modelling programs that result, modelling of very complex systems (like the model's 40 km x 40 km domain) can result in different practitioners and even experts having different opinions as to how best to undertake such tasks.

6.5.19 Consequently, there are a number of questions that can be directed towards a groundwater model in a development assessment context, which include:

- is the modelling as good as it can be?
- if not, is the modelling sound and 'fit for purpose'?
- given that mathematical modelling of such complex systems can never be wholly precise, is the modelling sufficiently accurate to gain a sufficiently reliable understanding of likely impacts and risks?
- if there are residual doubts about accuracy and precision, is the model based on 'conservative' assumptions, such that any deviations from accuracy and precision are likely to be in favour of the environment or other parties, rather than the developer?
- can the modelling and its resultant accuracy and precision be significantly improved? and
- do these improvements need to be implemented for assessment purposes or only for project management purposes?

6.5.20 The Department considers that the key questions to consider regarding the groundwater model for assessment of the Project are whether the model is sound and 'fit for purpose', does it provide a sufficiently reliable understanding of the likely impacts and risks, and whether its assumptions are conservative.

6.5.21 The Department has considered the issues raised by agencies through this prism. The key assessment issues that can be elucidated by groundwater modelling are predictions of:

- losses of surface water (and near-surface water) from catchment flows;
- losses of groundwater and surface water to the mine;
- losses of stored waters from reservoirs;
- consequent surface and groundwater 'take' that would require to be licensed; and
- recovery times in respect of groundwater impacts.

6.5.22 The only agency that has raised concerns about the actual outputs of the model for any of these issues is WaterNSW, which considered that previous increases in modelled surface water losses was sufficient cause for concern over the reliability of the current model's outputs. However, none of the water modelling experts at the IESC nor DPIE - Water raised any concerns about the reasonableness or accuracy of the model's key numerical outputs. Many issues raised by these agencies relate to model inputs and (on this basis) the precision of its outputs. That is, additional detailed review and possible changes to the model's inputs would lead to greater precision in its outputs. The Department agrees with this position.

6.5.23 Other criticisms by agencies related to adopting a different approach in undertaking key aspects of the modelling. A good example is the IESC's concerns over the use of an

equivalent porous medium (EPM) approach to model high levels of disturbance or fracturing in the areas above longwalls. EPM is a modelling approach where an applied change in the porosity of the affected area of a modelled layer is used to indirectly reflect increased fracturing. That is, the model does not directly contain two porosities in the affected area (the original porosity plus narrow zones of highly increased porosity to represent fracturing), but rather one porosity which attempts to 'average' the changes resulting from fracturing across both fractured and unfractured rock.

6.5.24 The IESC's advice stated:

"The groundwater model … is focused on simulating regional groundwater flows under the assumptions inherent in an equivalent porous media model. This model does not adequately incorporate the impacts of surface cracking and near-surface ground movement. This means the groundwater model does not address what is likely to be the main impact pathway on baseflow in nearby watercourses, and this has implications for assessing likely impacts on aquatic biota and ecological function. Accordingly, the IESC has a low level of confidence in the … estimates of mining impacts on surface water-groundwater interactions."

6.5.25 The IESC made a number of other comments which were related to this position. However, no concerns over the use of EPM were raised by any other agency, including DPIE - Water. South32 also disagreed with the IESC's position and quoted in response Section 4.3.3 of the Australian Groundwater Modelling Guidelines (AGMG), which states that *"Fractured rock aquifers are commonly modelled as equivalent porous media and this assumption is usually valid for large-scale groundwater flow models"*.

6.5.26 South32 also referenced a recent research paper by Turnadge, Mallants and Peeters (2019), which held the position that EPM simulation is appropriate for representing fracturing, and that explicit dual porosity simulation is uncommon and typically only applied in specific applications (ie coal seam gas applications). On this basis, South32 considered that the use of EPM methods was appropriate, particularly at the very large scale which had been adopted for the groundwater model's domain.

6.5.27 The Department considers that the critical question regarding these different approaches to modelling is not which approach is preferred, but whether the results are sufficiently reliable. In this case, the question is whether the averages applied in EPM modelling are appropriate (or conservative). Neither the IESC nor any NSW agency has suggested that they are not.

6.5.28 The Mining Panel's assessment of the GA focused on the groundwater model and its strengths and weaknesses. The Mining Panel's high-level summary of the model was that:

"The development of the groundwater model presented in the report from conception through calibration to implementation is generally of a high standard. The selection of the MODFLOW-USG software for development of the model provides a high degree of functionality for representing complex geological settings for conditions where continuous porous media assumptions can be assumed and where the impacts of under-saturation on flow and storage can be simplified to equivalent saturated flow approximations. The software allows hydraulic properties to be varied in time as well as in space. In general, the approach to modelling is well suited to the assessment of regional impacts of longwall mining while dewatering of the mine voids continues.

The approach to development and calibration of the model is generally good but there are limitations to the modelling that make it generally difficult to assess the reliability of the model outputs and also difficult to assess whether further model development in the short term and sensitivity testing of alternative mine plans would provide greater confidence in the model outputs for the purposes of reducing groundwater controlled impacts.

6.5.29 The Mining Panel made a number of criticisms of the Groundwater Model at a more-detailed level, however, essentially found it to be 'fit for purpose' for predicting the Project's impacts during its life on the overlying surface water environment and regional groundwater users, as demonstrated by its Conclusions # 21 and 22. However, the Mining Panel raised a number of concerns about the model's assessment of post-mining groundwater recovery. These issues are considered under ***Mine Inflows***, below.

6.5.30 The Department accepts that the groundwater model is based on a series of conservative assumptions, particularly in regard to the prediction of surface water losses (as raised by WaterNSW). The most significant of these is that surface to seam cracking has been assumed over all longwalls with a void width of 305 m and the Tammetta equation[12] has been applied to estimate the height of cracking in the other three cases[13] (see discussion below).

6.5.31 In addition, depth of surface cracking has been assumed to be 10 times the expected extraction height (ie 22 to 32 m in Area 5 and 39 m in Area 6). This is greater than in most other recent applications in the Southern Coalfield, where generally 10 – 20 m has been assumed. Related to this, all surface water draining to the subsurface has been assumed to migrate vertically, ie no allowance has been made for horizontal flow at or below the base of the network of surface cracks with some subsequent degree of reemergence in streams further down drainage lines. Finally, surface drainage lines (whether permanent or ephemeral) have been modelled as 'constantly flowing'[14], which allows for continual drainage of surface waters even when (in actuality) ephemeral drainage lines would have ceased to flow.

6.5.32 South32 has advised that, on this basis, the groundwater model estimates that 25 – 35% of mine groundwater inflows would be derived from surface waters. When the same modelling is applied to Areas 1, 2, 3A and 3B, it has a tendency to overpredict historic 30-day average mine total inflows (ie groundwater *plus* surface water) by approximately 20%.

6.5.33 In respect of the Department's key questions regarding the groundwater model, no agency has raised a significant concern that it is:

- not sound and 'fit for purpose';
- does not lead to a sufficiently reliable understanding of likely impacts and risks, and
- is not based on sufficiently conservative assumptions.

6.5.34 The Department concludes that the groundwater model passes these critical tests and that it can therefore be relied upon for the purposes of the assessment. The Department considers that the model does not require any further changes or adjustments prior to determining the Project. The Mining Panel is in general agreement with this position.

[12] The 'Tammetta equation' is the more conservative of the two mathematical equations used recently to estimate the height of cracking above subsided longwall panels. Its continued use has been encouraged by the Catchment Panel.
[13] Two proposed longwalls (LW 515 and LW 516) would have a void width of 295 m. Part of one longwall (LW 512) would have a void width of 205 m. All other 18 longwalls would have a void width of 305 m.
[14] Ephemeral flow in surface watercourses is difficult to incorporate into groundwater models.

6.5.35 This is not to conclude that the groundwater model is as good as it can be or that it should not be kept under regular review and improved on an ongoing basis, for adaptive management purposes.

6.5.36 The great majority of DPIE – Water's recommendations about improving the precision of the groundwater model were cast as "post-approval recommendations" (see its advice dated 16 September 2020). The Department agrees with the advice of both DPIE - Water and Kalf and Associates that the model should be regularly reviewed. DPIE - Water proposed that the first review be completed within two years of any development consent granted to the Project and then every three years following that. The Department agrees with this proposal and notes that no underground mining causing subsidence is proposed until 2024, which would mean that the first review would have been completed prior to longwall operations commencing.

6.5.37 Similarly, the Mining Panel has made a number of recommendations (#12 - #14) for further development and continuous improvement of the groundwater model. These recommendations have been accepted by South32 and are also supported by the Department.

6.5.38 The Department's standard conditions for underground coal mines require development of a Water Management Plan which includes a "program to periodically validate the groundwater model for the development". The Department has proposed additions to this condition to implement DPIE - Water's proposed schedule for review. It has also proposed that conditions require that South32 carefully consider all comments on the groundwater modelling received from DPIE – Water, the IESC and the Mining Panel and implement the recommendations of the Mining Panel. Finally, the Department is proposing that each review of the groundwater model take place in consultation with both DPIE – Water and WaterNSW, to ensure that DPIE – Water's proposals for changes to the model are satisfactorily addressed and that WaterNSW's interests (particularly in regard to modelling of surface water losses) are adequately catered for.

6.5.39 Subject to these important additions to standard conditions, the Department accepts that the groundwater model is fit for purpose, appropriately conservative, adequately informs assessment of the Project and can be relied upon for the ongoing adaptive management of the Project.

Surface to Seam Cracking

6.5.40 Over recent years, a number of studies and other investigations have considered how best to ascertain or estimate the 'height of cracking' which extends upwards towards the surface of the land from the collapsed strata ('goaf') above an extracted longwall void. In particular, the 2017 Height of Cracking Study addressed this matter in detail. The Catchment Panel also considered this issue at length and compared two competing mathematical approaches to estimating this height. The Catchment Panel questioned elements of both approaches and did not fully endorse either. However, it did state:

"Notwithstanding that uncertainty is associated with both the Tammetta and the Ditton height of complete drainage equations, it is recommended to err on the side of caution and defer to the Tammetta equation until:

- *field investigations quantify the height of complete drainage at the Dendrobium Mine and Metropolitan Mine, and/or*
- *alternative geomechanical modelling of rock fracturing and fluid flow is utilised to inform the calibration of groundwater models."*

6.5.41 The Mining Panel confirmed this position in its following conclusion:

> 6. *There continues to be much conjecture and uncertainty as to both how to predict the height of connective fracturing and how to confirm this height in the field.*

6.5.42 Importantly, the GA and the groundwater model have sought to address this issue by:

- in the first instance, applying pre-existing geomechanical modelling (as proposed by the Catchment Panel) to the great majority of the proposed longwalls, which produces even more conservative results than the Tammetta equation;
- as a consequence, assuming surface to seam cracking above the 18.5 longwalls with a proposed void width of 305 m; and
- applying the Tammetta equation to the 2.5 longwalls with a proposed void width of either 285 m, 280 m[15] or 215 m.

6.5.43 The geomechanical modelling applied in the GA is known as FLAC2D. In 2017 and 2018, South32 obtained reports from its consultant SCT for Areas 5 and 6, respectively, based on application of this conservative approach to modelling. The conclusion in each report was: *"This modelling suggests that fracturing would extend from seam to surface in most of the cases modelled by SCT."*

6.5.44 The Mining Panel considered this approach to be both conservative and pragmatic, as set out in its following conclusion:

> 7. *The conservative approach by [South32] to assume connective fracturing to surface and to utilise offsets and compensatory provisions for impacts in the Sydney Water Catchment is a pragmatic means of setting performance measures that are consistent with the recommendation of the IEPMC (OCSE, 2019b) that "Government should seek opportunities to improve the effectiveness of performance measures, especially for watercourses and swamps, by specifying them in unambiguous, quantifiable and measurable terms."*

6.5.45 Nonetheless, it is valuable to consider the predicted height of fracturing based on application of the Tammetta equation across all of Areas 5 and 6. **Figure 12 (A)** shows the modelled degree of overlap or separation between the groundwater model's surface cracking zone and the height of fracturing extending upwards from longwall voids, as estimated using the Tammetta equation. **Figure 12 (B)** shows the modelled interaction between this height of fracturing and the groundwater model's geological strata layers, each of which represents different aquifer properties.[16].

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[15] The GA used a void width of 285 m for LW215, while the SA is based on a void width of 280 m, as proposed by South32. Thus, the GA's assessment of LW 515's impacts (including its Tammetta equation calculation) is slightly conservative.

[16] It should be noted that Figure 12 (A) & (B) vary somewhat from similar figures included in the EIS and GA. The principal variations were included in the RTS. South32 advised that these were to incorporate:

- an allowance for the surface cracking zone (being 10 x the height of in-seam extraction) in Figure 12 (A); and
- proposed actual height of in-seam extraction across Area 5 within both figures, rather than proposed maximum height of extraction.

The proposed actual height of extraction in Area 5 varies from 2.2 m to 3.2 m, according to seam thickness, with an average of 2.7 m. The figures included in the EIS were based on the maximum height of extraction (3.2 m). Proposed height of extraction in Area 6 is constant at 3.9 m, because the Wongawilli Seam is always thicker than this. Figures 10 (A) & (B) vary further from those in the RTS, in that (at the Department's request) they include equivalent data for Areas 1, 2, 3A, 3B and 3C, as was also present in the EIS and GA.

6.5.46 The areas coloured light orange, orange and red on **Figure 12 (A)** indicate where the modelled distance between the surface cracking zone and the underlying connected fracturing is < 50 m. The great majority of Area 6 falls into this category, whereas much smaller parts of Area 5 are similarly affected. This is largely because the greater height of extraction in Area 6 (fixed 3.9 m) compared with Area 5 (variable 2.2 - 3.2 m) makes a very significant difference in the Tammetta equation.

6.5.47 The Department considers that there is a *high* risk of surface to seam drainage *wherever* the modelled separation between the surface cracking zone and connected fracturing zone is < 20m (ie areas coloured orange or red on **Figure 12 (A)**), owing to model errors and the likely existence of strata jointing and faulting. Such joints and faults are likely to provide 'leaky cracks in the bathtub' even if most of the 'bathtub' remained solid.

6.5.48 Where the modelled separation between the two zones is > 20m but < 50 m (ie coloured light orange), the Department considers that there is *significant risk of some* surface to seam drainage in *some* areas, for the same reasons.

6.5.49 Where the modelled separation between the two zones is > 50 m (ie coloured yellow or green), the Department considers that there is a *moderate risk of limited* surface to seam drainage in *some* areas, again for the same reasons. Put more simply, it does not take very many cracks to drain a bathtub. It is only where the water flowing into the bathtub exceeds the quantity draining out that the bathtub remains full.

6.5.50 Even so, it is important to consider whether there may be greater or lesser impacts than in existing mining areas at Dendrobium, particularly those which have been subject to extraction at an equivalent void width, ie Area 3B. It is also valid to compare the predictions with those for the already approved Area 3C, which is proposed to have an equivalent void width.

6.5.51 **Figure 12 (A)** clearly indicates that the risk of surface to seam drainage is significantly less in Area 5 and, to a lesser extent, in Area 6 than is the case in any existing mining area. The Tammetta equation predicts connective cracking extending to the surface or connecting with the surface cracking zone across all or nearly all of Areas 1, 2, 3B and 3C and roughly half of Area 3A. In order of importance, the reasons underpinning the lower predictions for the Project longwall domains are the:

- much lower proposed height of extraction in Area 5 (only 2.2 – 3.2 m in the Bulli Seam);
- deeper average depth of cover for Area 6 than any existing mining area – significantly deeper than Areas 3A, 3B and 3C and much deeper than Areas 1 and 2; and
- lower proposed height of extraction in Area 6 (3.9 m in the Wongawilli Seam) than was the case in some parts of Areas 3B.

6.5.52 **Figure 13** depicts the results of the FLAC2D geomechanical modelling of rock deformation and fracturing and resultant increases in vertical hydraulic conductivity for Area 6. The GA's peer reviewer made the following observations regarding this modelling and its results:

"It is to be noted that the vertical fractures and vertical hydraulic conductivity shown, in the FLAC2D simulations … does not propagate upward at high elevations in a midway position and in a direct vertical direction above the panels shown, but in preferred directions along the edges of the parabolic fracture zones. It should also be noted that there is no horizontal fracture zone observed in these figures that are due to tensile forces that are typically 10 to 30m below the ground surface. It is understood that the FLAC2D code does not simulate these horizontal fractures … It is quite possible that in reality that

the presence of the horizontal shallow fracturing zone would still allow in part flow downstream and likely re-emergence outside of the mining zone with a proportion of inflow migrating down to the mining zone through vertical fracture zone as depicted …."

6.5.53 It is also worth noting that post-mining drilling and hydrological testing in 2015 of the rock strata above the 305 m void of LW9 in Area 3B did *not* conclusively demonstrate vertical connectivity between the surface and the mine. Depth of cover for this longwall varied between 314 m and 409 m (average 381 m). Drainage appeared to extend upwards to the Lower Hawkesbury Sandstone (where a bore demonstrated depressurisation), but aquifers remained perched in the Upper Hawkesbury Sandstone. Tracer tests did not find evidence of vertical connectivity between the lower Hawkesbury Sandstone and the stratigraphically lower Bulgo Sandstone. Six months after mining was completed, tracer chemicals had not been detected in the principal outflow from the longwall panel. Instead, much of the 2.5 m dilation in the rockmass measured using extensometers appeared to have been taken up by increased horizontal cracking and dilation of pre-existing bedding planes, leading to an increase of horizontal hydraulic conductivity of up to 3 orders of magnitude. These increases in horizontal conductivity were greater below the base of the Hawkesbury Sandstone. Speaking simply, it appears that the upper strata beneath the surface cracking zone sagged, opening up horizontal bedding planes and fractures, rather than cracking vertically through to the surface.

6.5.54 Despite there being no tracer chemicals detected in the water accumulating in the mine workings, the Height of Cracking Study concluded that, because packer testing results indicated the presence of fractures and bedding separation through the whole geological sequence, there was seam-to-surface connectivity. That is, it assumed vertical connections linking the horizontal fracture network to the underlying zone where vertical fractures were readily apparent.

6.5.55 Nonetheless, as noted above, South32 has addressed any uncertainty as to where and how much surface to seam drainage would occur by assuming it would occur generally across the mining domains and then propose that the resulting modelled loss of water is fully offset.

6.5.56 It is also important to re-iterate that surface to seam drainage is not the key determinant of environmental consequences for the surface environment. The key determinant is the extent of *surface cracking*, which is related mostly to valley closure effects and then to *conventional compressive and tensile strains*. *Surface to seam cracking* is instead the key determinant of loss of surface water, via percolation of infiltrating surface water through the column of cracked geological strata to the mine below.

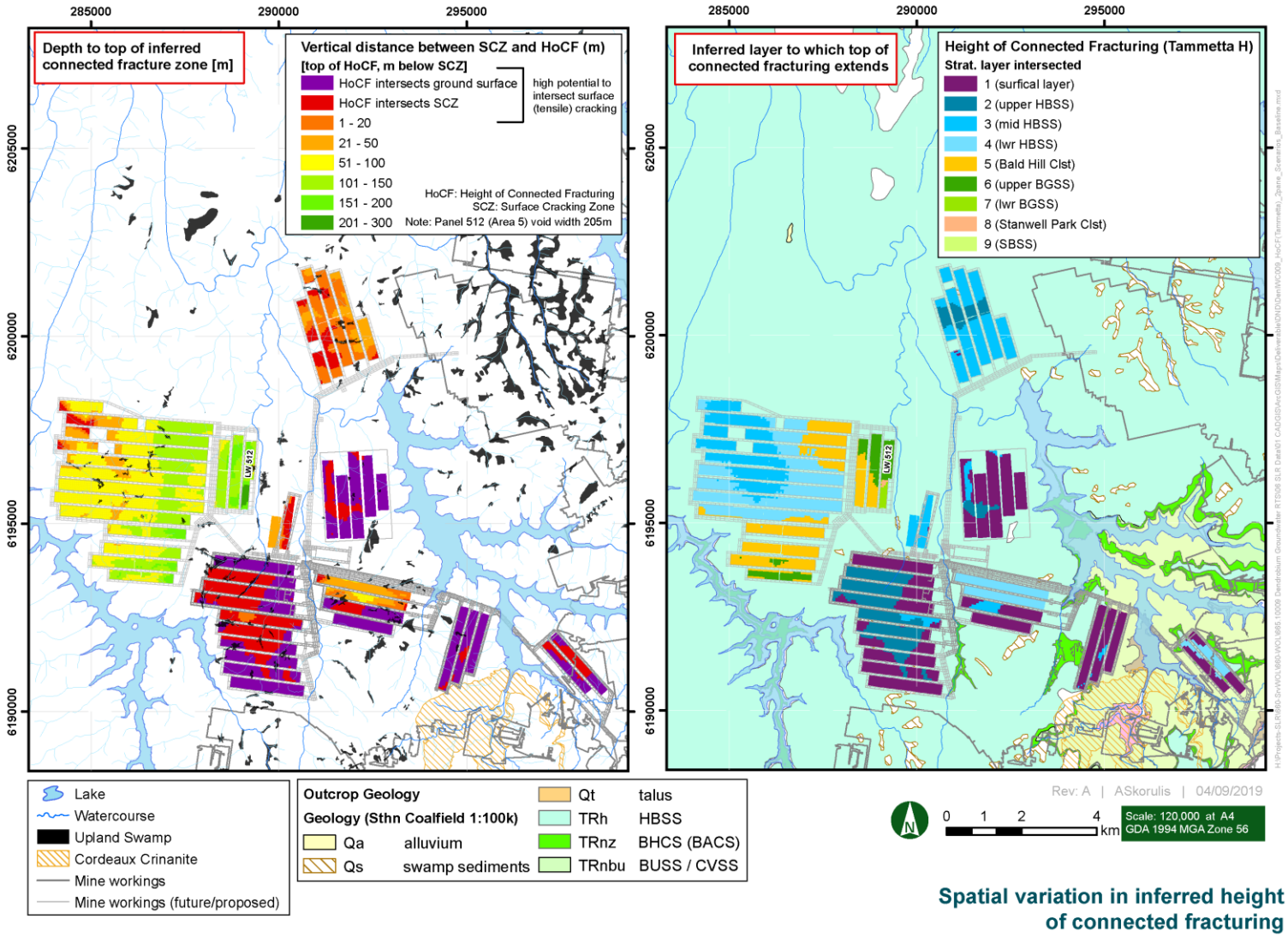

Figure 12| (A) Modelled Distance between Surface Fracture Zone and Connected Fracture Zone and (B) Modelled Groundwater Layer Intercepted by Connected Fracture Zone *(Source: South32, August 2020)*

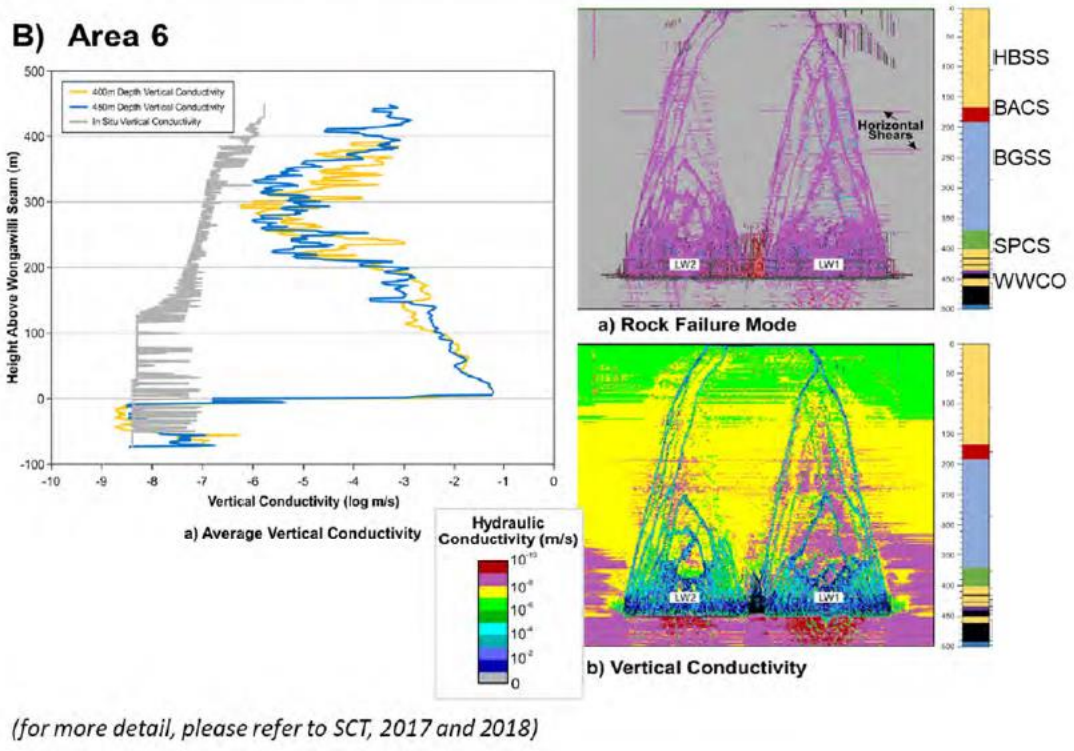

Figure 13 | Summary of FLAC2D Modelled Fracturing, Deformation and Hydraulic Conductivity for Area 6 *(Source: GA, after SCT 2018)*

Aquifer Depressurisation and Repressurisation

6.5.57 South32's assumption of surface to seam cracking does not mean that water would be not retained within the rock strata between the surface and the mine. Water would be constantly infiltrating at the surface, either through rainfall or streamflow. Water would percolate downwards to the extracted longwall voids at an increased rate, but not so fast as to fully drain the overlying rock strata, particularly the upper strata. That is, the predictions and modelling of surface to seam cracking could be characterised as 'partial' or 'constrained' surface to seam cracking, rather than 'complete' or 'unconstrained' cracking.

6.5.58 Consequently, the groundwater model provides estimates of predicted groundwater levels in various aquifers and how these are affected over the life of the Project, and beyond. The fall in aquifer level as a result of development of the mining void and associated collapsed roof strata ('goaf') is known as drawdown.

6.5.59 The GA reports that the groundwater model was interrogated to predict drawdown at four representative locations: at a monitoring bore location immediately above LW 502 in Area 5, at a monitoring bore location above the eastern edge of LW 601B in Area 6, at a location adjacent to the Cordeaux River, 400 m north of Area 6 and at a location adjacent to the Avon Dam wall (900 m from Area 5). As might be expected, predicted drawdowns are greater in the lower strata, which are directly affected by goafing or else connected to the goaf by vertical fracturing. They are also greater directly above the longwalls than at their edges and reduce with lateral distance from the longwall domain footprints.

6.5.60 The GA contains hydrographs displaying existing groundwater levels, modelled drawdowns and modelled post-mining recovery for 14 model layers (from the regolith down to the

Wongawilli Seam) over the period required for post-mining recovery in groundwater levels to stabilise. In the case of Area 5, this is a 100-year period (1990 to 2090) and in the case of Area 6, it is a 200-year period (1990 to 2190).

6.5.61 Above Area 5, all strata up to the Bald Hill Claystone are predicted to experience significant drawdown (>100 m). Recovery to pre-mining levels is predicted by ~2100. Drawdown within the Hawkesbury Sandstone is predicted up to 80 m and drawdown in the water table of up to 70 m. Although the model simulates recovery of lower Hawkesbury Sandstone water levels to greater than pre-mining levels, it also simulates incomplete recovery in the water table by about 15 m.

6.5.62 At the edge of LW 601B, the Bulgo Sandstone is predicted to experience drawdown of between 140-180 m, and more in the lower Bulgo. These units are predicted to recover over > 50 years to higher than pre-mining levels due to changes in hydraulic conductivity in and above the goaf, and continued surface infiltration. Drawdown in the Hawkesbury Sandstone is predicted to be 10 m to 40 m, with greatest drawdown in the lower horizons.

6.5.63 At the location 400 m from Area 6, drawdown of 80 m is predicted in the Bulgo Sandstone. Recovery of water levels to pre-mining levels would take about 100 years. The lower Hawkesbury Sandstone is predicted to experience ~25 m of drawdown, with recovery predicted to above pre-mining water levels. Drawdown of 4 m is predicted for the mid-Hawkesbury Sandstone.

6.5.64 At the location 900 m from Area 5, all layers up to the Bald Hill Claystone are predicted to experience significant drawdown, with recovery to pre-mining levels by ~2080-2120. Drawdown in the lower Hawkesbury Sandstone is predicted to be about 2-3 m, with about half of that to recover. The model predicts drawdown of 0.9-1.8 m in the upper and middle Hawkesbury Sandstone and less in the regolith.

6.5.65 The GA also contains groundwater level contour maps derived from the groundwater model for four key aquifer layers – the water table, the lower Hawkesbury Sandstone, the upper Bulgo Sandstone and the Wongawilli Seam. These maps suggest that water levels in the lower Hawkesbury and upper Bulgo Sandstone would eventually recover to close to or above pre-mining levels and that the water table would recover to pre-mining levels in some areas. However, permanent drawdown of the water table is predicted in some locations above and around the two longwall domains.

6.5.66 The Department considers that the groundwater model's predictions of groundwater drawdown, including in the water table, the regolith and the three layers modelled in the Hawkesbury Sandstone, are reasonable and can be relied upon for assessment purposes.

6.5.67 However, the Mining Panel in two of its conclusions cast doubt on the reliability of the model in the post-mining period, ie during repressurisation of sub-surface aquifers, as follows:

23. *The groundwater modelling of the post mining period is not based on a clear, technically feasible description of mine sealing. As a consequence, it is not possible to assess the risks and impacts of groundwater recovery on the surface water environment or on the pattern of discharges of mine water and potential contamination from the mine at this time.*

24. *There are uncertainties associated with groundwater pressure recovery and mine outflow volumes and quality following mine closure, which are not addressed in the EIS and which require considerable*

investigation and planning, including analysis of the feasibility of sealing Dendrobium Mine, whether or not the Dendrobium Extension Project is approved.

6.5.68 The Mining Panel considered that these uncertainties and model improvements could be dealt with at the post-approval stage, through development of detailed mine closure planning and ongoing review and development of the groundwater model. The Department agrees with this position. This is discussed in more detail in **Section 6.7.**

Mine Inflows

6.5.69 The quantities of water from various sources that enter the mine can only be directly accounted for as a combined figure, being the total mine inflow. This figure in turn is derived from the mine's overall underground water balance, which is based on the quantities of water pumped into and out of the mine, minus water leaving the underground entrained in ROM coal or evaporated via mine ventilation air. The total mine inflow is made up of water derived from various sources, being the water derived from the coal seam being mined, water derived from both overlying and underlying rock strata, and water percolating down to the mine from the surface.

6.5.70 The groundwater model provides predictions regarding total inflow. **Figure 14** shows the model's predicted calibrated 'base case' daily rate of total inflow to the existing approved Dendrobium Mine and the Project, from 2005 until the proposed end of mining under the Project (~2049). The model is conservative, when compared with historic groundwater inflows to the Dendrobium Mine, as it overpredicts these inflows by approximately 20%.

6.5.71 The GA reports that inflow to Area 5 is predicted to rise to a maximum of about 18 ML/day in 2033 and 2037, averaging approximately 12 ML/day during the life of mining in that area. Inflow to Area 6 is predicted to rise to a maximum of almost 4 ML/day in 2047, averaging approximately 3 ML/day during the life of mining in that area.

6.5.72 The substantial difference of inflow between Areas 5 and 6 is primarily due to total longwall area. The lower inflow in Area 6 is also consistent with greater cover depth.

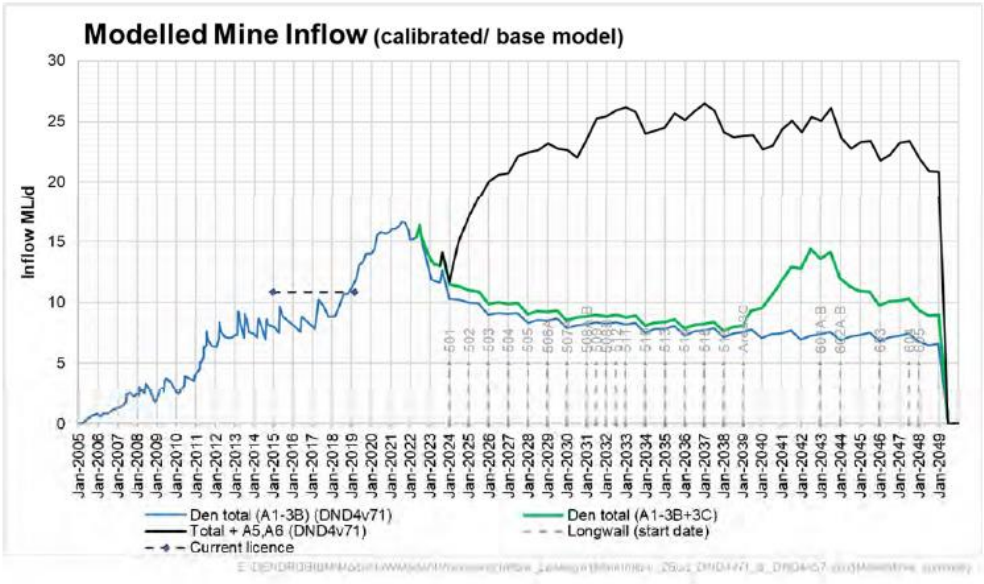

Figure 14 | Predicted Total Mine and Project Inflow *(Source: GA)*

6.5.73 The model indicates that total inflows would rise from the current rate (about 11 ML/day) until the end of mining in Area 3B, with a maximum inflow of just over 13 ML/day. After that, a small peak would occur in Area 3A (LW 19) of up to 4 ML/day, and then relatively small rates of inflow into Area 3C (LW 20 and LW 21) of up to 2 ML/day. At about 2039 and during the 2040s, development of Area 3C could see a second, larger peak of up to 7 ML/day.

6.5.74 The results, particularly those for Area 5, represent a significant increase compared to recent inflows recorded at Dendrobium. The maximum annualised inflow to the entire mine, including Areas 5 and 6, is predicted to be approximately 26 ML/day or 9,490 ML/year, occurring around 2032 and 2036 (both during Area 5) and a slightly lower peak of about 25.5 ML/day in 2043 (early during Area 6). The average modelled inflow for the period 2023-2049 is 22 ML/day (of which about 10 ML/day is predicted to be due to inflow to approved Areas 1-3C.

6.5.75 The groundwater model also makes predictions as to the amount of water entering the mine which is derived from surface waters and the amount which is derived from subterranean strata (ie the coal seam and the overlying and underlying rock strata). South32 has advised that the model predicts that surface water losses would comprise approximately 25-35% of predicted total mine inflows. South32 considers that these predictions are "*likely to be conservative given the conservative nature of assumptions adopted in the groundwater model (eg assuming surface water is 'permanently' lost to the groundwater system, whereas in reality, portions are likely to re-emerge downstream and not report to the mine workings).*"

6.5.76 In respect of mine inflows, the Mining Panel concluded that: "*The estimated rates of inflow are stated to be conservative (i.e. at the high end of the possible range). The level of conservatism cannot be determined from the available modelling but the inflows appear to be an acceptable first estimate of the likely impacts. Therefore, the figures provided should be adopted in determining any approval for the mine."*

6.5.77 The Department agrees with this position and notes that the regular review and development of the groundwater model will address these areas of uncertainty.

6.5.78 As surface water and groundwater are treated separately for licensing and offsetting purposes, they are treated separately in this report (see **Section 6.3** and below).

Assessment Against the Aquifer Interference Policy

6.5.79 The GA contained an assessment of the predicted impacts of the Project against the requirements of the *NSW Aquifer Interference Policy* (AIP). The water sources within which the Dendrobium Mine and Project are located are managed under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. The Mine and Project lie almost completely within Management Zone 2 (MZ2) of the *Sydney Basin Porous Rock (Nepean Sandstone and Sydney Basin – South Groundwater Sources)* (see **Table 10**). This Management Zone is classified as 'Highly Productive' under the AIP.

6.5.80 Groundwater modelling indicates that there is a "very low risk" of drawdown in excess of the minimal impact criterion of a maximum of 2 m drawdown at any water supply work (ie privately owned bores) to be caused by the Project in the 40 km x 40 km domain of the model. The sensitivity scenario analysis supports this conclusion, with the median estimate also being zero. Under the worst-case sensitivity scenario up to 5 water supply works would be affected

by >2 m. However, each of bores are predicted to experience greater than 2 m drawdown due to historic and/or cumulative mining that is not associated with Dendrobium.

6.5.81 The GA concludes that the Project meets the minimal impact requirements of the AIP. The Department accepts this conclusion as does DPIE - Water.

Groundwater Licensing

6.5.82 Groundwater licensing requirements for the Project were estimated using the groundwater model, consistent with the AIP's requirements that *"predictions should be based on complex groundwater modelling and conducted in accordance with the Australian Groundwater Modelling Guidelines"*.

6.5.83 The EIS reports that South32 already holds licensed groundwater allocation sufficient to account for the peak predicted groundwater inflow to both the existing Dendrobium Mine and the Project. However, South32 holds no licensed allocation in MZ 1, and would require a transfer of licences from other management zones to account for this take (see **Table 10**).

Table 10 | Groundwater Licensing Requirements for Dendrobium Mine, including the Project *(Source: EIS)*

Water Source (Management Zone)	Allocation held by South32	Maximum licensing requirement (ML/year)	Maximum project increment
Sydney Basin – Nepean (MZ2)	9,455	6,700	5,700
Sydney Basin – Nepean (MZ1)	-	32	7
Sydney Basin – South	75	4	3

6.5.84 The EIS states that: *"Due to existing restrictions on the availability of licences in the water sources that the Project is not physically located within, South32 is reliant on the NSW Government creating additional licences or entitlements available to facilitate the development of the Project in the applicable adjoining Water Sharing Plan management areas and zones."*

6.5.85 The new licensing arrangements set out under ***Surface Water Licensing*** will also make provision for transfer of groundwater licence allocations between management zones.

Monitoring and Management

6.5.86 The EIS states that the GA's recommendations regarding ongoing groundwater monitoring would be adopted by South32. South32 would:

- continue to undertake ongoing monitoring supporting calculation of groundwater inflow to the Dendrobium Mine;
- continue to undertake analysis of water reporting to mine workings (eg water quality 'finger-printing') to determine the proportionate sources of this water (ie coal seams, overburden, surface water or upward flow from underlying strata). Water quality sampling

would target electrical conductivity, pH and tritium (as an indicator of the presence of modern water);
- continue to operate the extensive groundwater monitoring network currently in place in Areas 5 and 6, including monitoring of groundwater levels in the deep and shallow strata;
- further review this monitoring network, including consideration of the Catchment Panel's recommendations regarding the period of baseline data (eg installing additional monitoring sites to facilitate recording of sufficient baseline data); and
- undertake pre-mining and post-mining packer and permeability monitoring testing, focusing on hydraulic conductivity in the Hawkesbury Sandstone, Bald Hill Claystone and upper Bulgo Sandstone.

6.5.87 South32 would also continue to review and progressively update its groundwater model over the life of the Project to account for additional monitoring data, hydraulic property testing and knowledge about geological structures. Consistent with Kalf & Associates' recommendations, a full review of the groundwater model would be conducted every 3 to 5 years, including comparison of monitoring data against predictions and recalibration of the model if necessary.

6.5.88 The Department supports South32's proposals in respect of ongoing groundwater monitoring and regular review of the groundwater model. The critical data inputs to provide assurance of the amount of surface water taken by the Project (and therefore compensation and offset requirements) are ongoing quantification of water inflows to different parts of the mine, regular chemical analysis (particularly tritium analysis and other 'finger-printing') of this water to determine origin and regular review of modelled surface water diversions and mine inflows.

6.5.89 The Department has proposed conditions regarding a groundwater monitoring, regular review of the groundwater model (taking into account the comments of DPIE – Water and the IESC and the comments and recommendations of the Mining Panel) and a Water Management Plan which are based on its standard conditions, with particular emphases to ensure that this critical data is regularly collected and reported.

6.6 Biodiversity

Introduction

6.6.1 The EIS contains a combined Biodiversity Assessment Report (BAR) and Biodiversity Offset Strategy (BOS) for the Project, prepared by Niche Environment and Heritage (Niche), which includes assessment of the:

- ecological values of the area impacted by the Project;
- potential impacts from the Project to biodiversity values, particularly threatened biodiversity (ie TECs, threatened flora and threatened fauna) listed under the BC Act; and
- potential impacts from the Project to biodiversity values listed as MNES under the EPBC Act.

6.6.2 As set out in **Section 4.5**, the BAR and BOS were undertaken in accordance with the:

- *Biodiversity Offset Policy for Major Projects* (the NSW Offset Policy) (OEH, 2014); and
- *Framework for Biodiversity Assessment* (FBA) (OEH, 2014).

6.6.3 Flora and fauna baseline surveys of the Project area and surrounds (ie the Dendrobium Pit Top and directly above and within 600 m of the proposed longwalls) were conducted by Niche.

These surveys targeted threatened species and communities, focusing on proposed vegetation disturbance areas and landscape features susceptible to subsidence impacts. A total of 241 flora species and 116 fauna species (comprising 58 bird, 32 mammal, 14 reptile and 12 amphibian species) were recorded by Niche.

6.6.4 South32 provided a Supplementary BAR in August 2020 as part of its Amendment Report.

6.6.5 The Project's potential impacts on biodiversity are considered in the following subsections.

Direct Clearing

6.6.6 Underground coal mining has much lower impacts on biodiversity than open cut coal mining because it does not involve large-scale clearing and excavation of the landscape. Direct clearing is limited to the relatively small areas required for the main surface facilities (including workers and materials access and ROM coal egress) and other smaller surface facilities such as ventilation shafts and service boreholes. In the case of the Project, the major surface facilities are already in existence and so direct biodiversity impacts are further reduced.

6.6.7 The Project elements associated with surface development are identified in **Section 2.3**. South32's Amendment Report revises and clarifies the Project's projected biodiversity impacts resulting from direct clearing. The Amendment Report put forward fixed locations (and therefore clearly identified impacts) for some infrastructure which, at the time of completion of the EIS, had been specified as required but with no fixed location. This infrastructure is the proposed service borehole sites and routes for the electricity transmission lines (ETLs) required to service the ventilation shaft sites. As now proposed, the Project elements that would cause direct clearing of native vegetation are:

- Ventilation Shaft Site 5A and an associated service boreholes site (15 ha);
- Ventilation Shaft Site 5B (0.5 ha);
- Ventilation Shaft Site 6A (4.3 ha);
- Ventilation Shaft Site 6B (4.0 ha);
- Pit Top Carpark Extension (0.2 ha); and
- ETLs to Ventilation Shaft Sites (4.5 ha).

6.6.8 The Amendment Report did not change the total amount of clearing required for these surface facilities (ie 28.5 ha) but specified the location of this clearing. The affected native vegetation communities subject to clearing, sites affected, hectares involved and resulting ecosystem credit requirements are set out in **Table 11**, below.

6.6.9 The total number of ecosystem credit requirements associated with direct clearing (1,165) is less than previously indicated in the EIS (1,228), due to reductions in intended clearing within Plant Community Types (PCTs) 1395 and 1250 as a result of defining the ETL alignments and services borehole site.

6.6.10 Nearly all clearing (>94%) involves a native vegetation community which is relatively common on sandstone plateaus in the Sydney Basin Bioregion (PCT 1083). Clearing associated with works at the Mine's existing surface facilities on the moist lower slopes of the Illawarra Escarpment is limited to 0.2 ha, affecting PCT 1245.

6.6.11 The ETL alignment commences from an existing Endeavour Energy ETL located about 200 m northwest of Cordeaux Dam Wall. The ETL alignments have been designed to avoid clearing

where practical by utilising existing road verges and fire breaks. An easement width of 18 m has been assumed, consistent with design advice from Endeavour Energy. Initial clearing of canopy, mid canopy and shrubs would be required across this easement for access and asset protection purposes, as well as ongoing slashing for maintenance purposes.

6.6.12 It is proposed that the branch ETL to Ventilation Shaft Site 6B would be trenched and cabled underground within an existing 330 kV Transgrid easement to avoid vegetation clearing.

Table 11 | Native Vegetation Impacts from Direct Clearing *(Source: Amendment Report)*

BVT Name	BVT Code	PCT Code	Sites Affected	Ha Affected	Ecosystem Credits Required
Red Bloodwood - Scribbly Gum heathy woodland on sandstone plateaux, Sydney Basin Bioregion	HN566	1083	All four ventilation shaft sites and ETL alignment	26.9	1,051
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion*	HN556	1395	ETL alignment (only)	0.55	40
Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion	HN651	1250	ETL alignment (only)	0.85	68
Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion	HN597	1245	Pit top carpark extension (only)	0.2	6
Total				**28.5**	**1,165**

** Also known as Shale Sandstone Transition Forest Threatened Ecological Community*

Threatened and Endangered Species

Threatened Ecological Communities

6.6.13 The proposed locations of the ventilation shaft sites were selected to avoid threatened flora species and, as far as practical, limit clearance of Shale Sandstone Transition Forest Threatened Ecological Community (PCT 1395).

6.6.14 Impacts on PCT 1395 are limited to 0.55 ha. These impacts are all located where the branch ETL to Ventilation Shaft Site 5B (which follows an existing fire road) traverses small areas of this community.

Threatened Flora Species

6.6.15 The initial surveys undertaken by Niche for the BAR did not identify any threatened flora species in the areas proposed to be subject to direct clearing. However, the additional surveys undertaken for the Supplementary BAR identified two threatened flora species which might be impacted by construction of the ETLs. These species are:

- Bynoe's Wattle *(Acacia bynoeana)*: A total of 86 plants were recorded within slashed/maintained vegetation in the existing easement of Fire Road 6. This area is managed by WaterNSW on a periodic basis to ensure that the height of the vegetation remains below approximately 0.5 m, and thus acts as a fire break. These existing management practices may have contributed to the plants' establishment given the species is known to prefer disturbed sites such as trail margins; and
- Port Jackson Heath *(Epacris purpurascens var. purpurascens)*: Three plants were recorded within 5 m of the proposed ETL to Ventilation Shaft Site 6, all located within an existing Transgrid ETL easement consisting of low shrubs and native ground cover.

6.6.16 The Supplementary BAR considers that neither species would be impacted by the Project because:

- both populations occur within existing easements subject to regular trimming/slashing regimes. The proposed ETL would not alter or increase these management regimes;
- transmission line poles would be sited so as to avoid individuals of the two species, thus avoiding direct impacts;
- the three Port Jackson Heath plants occur adjacent to the proposed ETL easement, rather than within it;
- the plants would be marked by an ecologist prior to construction works, to protect the species during construction; and
- contractors would be made aware of the plants prior to construction activities.

6.6.17 Given both species are considered unlikely to be impacted, the Supplementary BAR considers that no biodiversity offset is required for them. The Department accepts this position.

Koala Habitat

6.6.18 The Koala *(Phascolarctos cinereus)* is listed as vulnerable under both the BC Act and the EPBC Act.

6.6.19 Mapping by Niche in 2016 identified Koalas in both Area 5 (four records) and Area 6 (two records). Based on native vegetation communities, Niche mapped the two mining domains as being about 3% 'core Koala habitat' (c. 125 ha) and about 20% 'potential Koala habitat' (816 ha, primarily in Area 5). The four ventilation shaft sites proposed in the EIS and considered in the BAR avoided all mapped core and potential Koala habitat, and therefore sought to avoid direct clearing that might impact on Koalas.

6.6.20 The BAR's consideration of Koalas was based on the requirements of *SEPP No. 44 - Koala Habitat Protection* (SEPP 44), as it stood at the time of finalising the EIS. However, BCD's advice pointed out that SEPP 44 was under review and that Hard-leaved Scribbly Gum (*Eucalyptus sclerophylla)*, which is found within PCT 1083 and therefore across the four ventilation shaft sites, was likely to be added to the list of Koala feed trees. On this basis, BCD's advice sought Koala species offsets for the full extent of this clearing.

6.6.21 SEPP 44 has since been replaced by *State Environmental Planning Policy (Koala Habitat Protection) 2019* (Koala SEPP) which commenced on 1 March 2020. While Hard-leaved

Scribbly Gum has been added to the Koala SEPP's list of Koala feed trees, clause 15 of the SEPP provides that: *"A development application made, but not finally determined, before the commencement of this Policy in relation to land to which this Policy applies must be determined as if this Policy had not commenced."*

6.6.22 That is, there is no legal requirement for native vegetation communities containing Hard-leaved Scribbly Gum to be considered as potential Koala habitat, and thus there is no legal requirement for offsetting of impacts on Koalas associated with the clearing of the four ventilation shaft sites.

6.6.23 The Supplementary BAR contained additional survey effort by Niche for Koalas along the newly-confirmed ETL alignment. There were two additional Koala sightings along the ETL alignment between Ventilation Shaft Sites 5A and 5B, within PCT 1395. However, the BAR had already made an allowance for assumed impacts on Koala in both PCT 1250 and PCT 1395 as a result of the ETL. The confirmation of the ETL's location led to confirmation of these assumed impacts. The Supplementary BAR therefore did not vary the BAR's previously identified impacts on Koala (ie 0.45 ha of PCT 1395, 0.85 ha of PCT 1250 and 0.2 ha of PCT 1245, see **Table 11** above).

6.6.24 South32's position throughout the progress of its development application has been that it is not required to offset for impacts on Koalas, other than in respect of this 1.51 ha, where Koala feed trees listed under SEPP 44 are present. Nonetheless, BCD has continued to seek offsets for the clearing of PCT 1083 on the four ventilation shaft sites (an additional 26.9 ha) and on 4 September 2020 provided South32 with additional information regarding Koala habitat and Koala sightings on the Woronora Plateau and the use by Koalas of Hard-leaved Scribbly Gum in this area as a feed species. That information underpinned BCD's conclusion that PCT 1083 is likely to support a "low density" of Koalas, estimated by it at one individual per 50 ha.

6.6.25 South32 responded to the Department on 8 September 2020. South32 accepted BCD's position that Hard-leaved Scribbly Gum is a Koala feed tree species on the Woronora Plateau. However, it noted that this species occurred in PCTs additional to PCT 1083 and considered that Koala records in this tree species should be considered in the context of the prevailing PCT, soil type and other factors. In this respect, South32 also referred to Table 10 of *A review of Koala tree use across New South Wales* (OEH, 2018) which indicates that Koala use of Hard-leaved Scribbly Gum in different locations in NSW is highly variable.

6.6.26 South32 also noted that the Koala is currently listed under the Biodiversity Assessment Methodology (BAM) as both a 'species' and 'ecosystem' credit species and considered that the reason for this was to reflect high and low density Koala habitat, so as to allow offsets to be made on an equivalent basis (ie high quality habitat offsets for impacts in high quality habitat). Otherwise a perverse outcome would result, where impacts on high quality habitat could be offset with low quality habitat.

6.6.27 The Department finds this line of reasoning to be persuasive, notwithstanding the fact that there is no legal requirement for offsets under the applicable EPI (ie SEPP 44) in respect of PCTs containing Hard-leaved Scribbly Gum. It stands to reason that the quality of habitat should be a key factor when assessing offset requirements. The Department can see no reason why PCT 1083 should be offset in the same manner as PCTs 1395, 1250 and 1245 for Koala impacts, even if the Koala SEPP's listing of Hard-leaved Scribbly Gum had application.

6.6.28 The Department considers that the Project is consistent with the aims, objectives and requirements of SEPP 44. South32 has prepared a Koala Plan of Management for the Project. Subject to the adoption and implementation of this management plan and the retirement of Koala species credits as set out in **Table 12** and under **Biodiversity Offset Strategy**, below.

6.6.29 Nevertheless, as requested by BCD, the Department's recommended conditions include that South32 undertake additional surveys for Koalas during that species' breeding season, across the areas of PCT1083 proposed to be cleared and provide any necessary additional offsets.

Other Threatened Fauna Species

6.6.30 BCD's advice was that the BAR contained inadequate survey effort in respect of Eastern Pygmy-possum *(Cercartetus nanus)* and had also assessed Rosenberg's Goanna *(Varanus rosenbergi)* as not requiring species credits and that therefore additional survey effort was required in respect of both species. BCD also requested additional survey effort for Powerful Owl *(Ninox strenua)* and its breeding habitat (ie large tree hollows).

6.6.31 Niche undertook this additional survey effort and the Supplementary BAR newly identified both species as being impacted by direct clearing. **Table 12** below sets out the impacts of direct clearing on threatened fauna and the species credits required to offset these impacts.

Table 12 | Threatened Fauna Impacts from Direct Clearing *(Source: Amendment Report)*

Species	Sites Affected	Ha Affected	Species Credits Required
Rosenberg's Goanna	Ventilation shaft sites and ETL alignment	27.05	893
Eastern Pygmy-possum	Pit Top Carpark Extension, ventilation shaft sites and ETL alignment	27.25	545
Koala	Pit Top Carpark Extension and ETL alignment	1.51	39

6.6.32 Given that BCD has accepted the Supplementary BAR's assessment of impacts of direct clearing on other threatened fauna species, The Department also accepts this assessment as being appropriate and sufficient.

Subsidence Impacts

6.6.33 Although direct clearing would be limited to a small fraction (perhaps 5%) of that involved in a large-scale open cut coal mine, BCD's advice in respect of the potential impacts of subsidence on biodiversity was extensive. BCD concluded that, while the area of vegetation that would be directly cleared is relatively small, the likelihood of subsidence over a much more extensive area is high and this is *"predicted to have a significant impact on multiple threatened Coastal Upland Swamps and other water dependent ecosystems and threatened species"*.

Avoidance of Impacts

6.6.34 The *NSW Biodiversity Offsets Policy for Major Projects* contains a hierarchy of actions ('avoid, minimise, offset') to reduce impacts on biodiversity. Proponents are required to first seek to

avoid and minimise impacts before proceeding to use the Policy's offset provisions. Much of BCD's advice related to its concerns over the proposed longwall void width and whether the Project adequately avoided or minimised impacts on biodiversity. For example, BCD's submission in response to South32's RTS stated that: *"Avoidance of impacts could be achieved by not undermining swamps or by narrowing longwall panel widths to reduce subsidence effects below the surface cracking thresholds."*

6.6.35 The Department notes that South32 has sought to avoid impacts on water resources (and therefore, to some degree, biodiversity) through setbacks from the walls of Cordeaux and Avon Dams, the FSL of their reservoirs, three major named watercourses and listed 'key stream features'. South32 estimates that these setbacks together prevent potential access to some 25 Mt of ROM coal within its existing mining lease adjacent to Area 5, which it estimates to be worth some $3.58 billion and $222 million in associated royalties to the State.

6.6.36 South32 also sought to avoid and minimise impacts on upland swamps by pursuing mining in Areas 5 and 6, as against its other potential mining area (Area 4), which has a greater proportion of its area affected by swamps (see **Figure 15**). It has also proposed to site its surface infrastructure in Areas 5 and 6 (ie the four ventilation shaft sites and the ETL) at locations so as to avoid any direct disturbance of any upland swamp. The application of the Project setbacks discussed above would also avoid direct undermining of at least six additional upland swamps (Den124, Den115, Den131, Den132, Den119 and Den134).

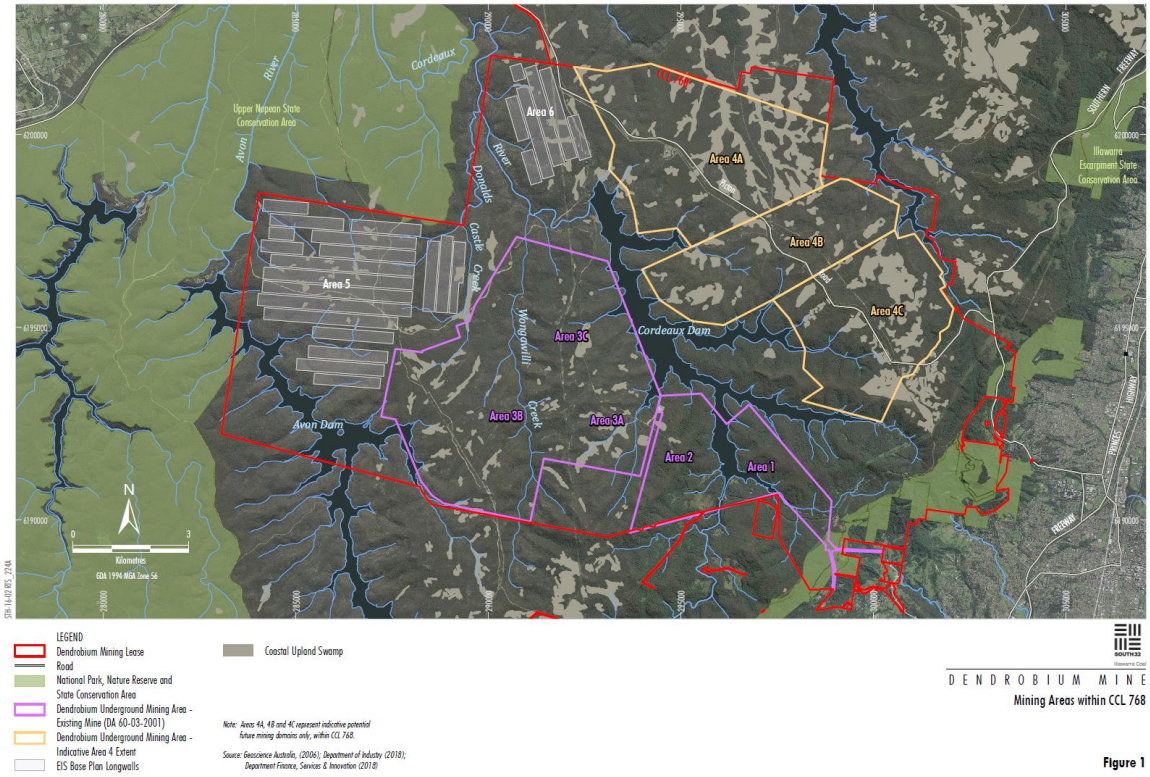

Figure 15 | Potential mining areas within Dendrobium Mine's CCL 768: existing (Areas 1, 2, 3A, 3B and 3C), proposed (Areas 5 and 6) and other (Areas 4A, 4B and 4C) *(Source: South32 letter of 08/09/2020)*

6.6.37 The EIS also gave some consideration to a longwall mine design what it termed the 'minimum case', which avoided all upland swamps within Area 5 and Area 6. Both the minimum case and the EIS's Project layout are shown in **Figure 16**.

6.6.38 It can be seen that the minimum case would lead to a substantial loss of longwall length, particularly in the centre and west of Area 5 and, to a lesser extent, in the centre and north of Area 6. The EIS briefly quantifies these losses and reports that the minimum case would result in a further reduction of 21.2 Mt of ROM coal (of a remaining coal resource of 77.2 Mt), worth some $3 billion and $186 million in associated royalties to NSW and an overall reduction in net benefits to NSW of approximately $220 million (NPV). South32 later advised that: *"This longwall layout is not considered economically feasible, and is therefore considered unreasonable…"*.

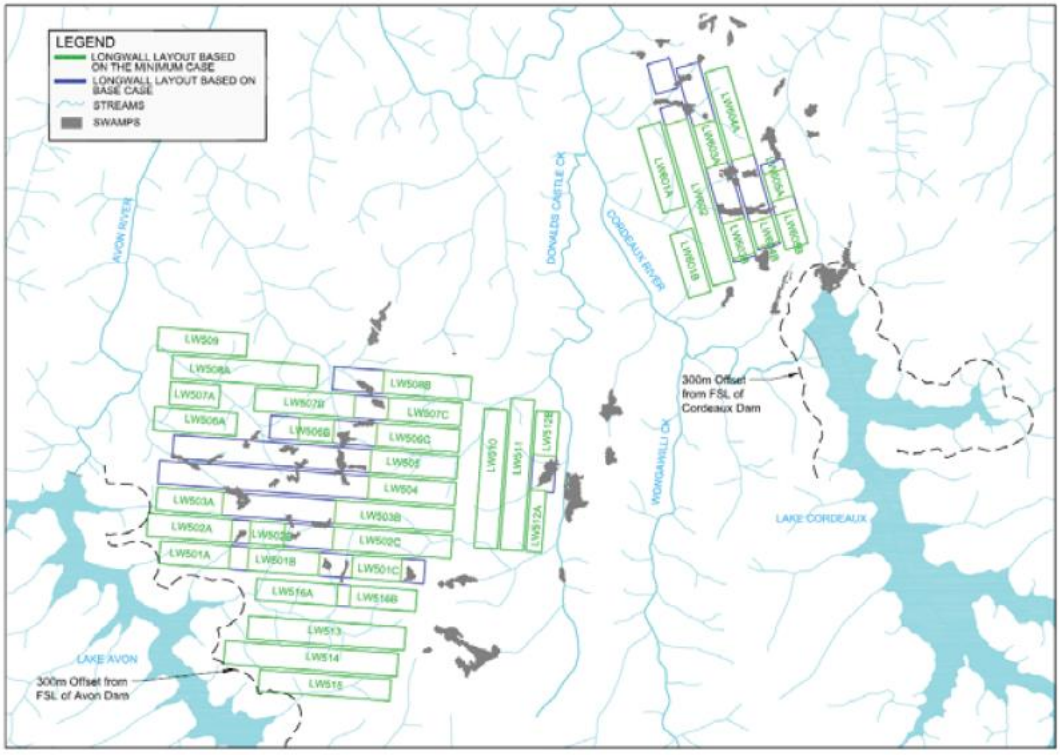

Figure 16 | Comparison between the Project (blue) and Minimum Case (green) *(Source: SA)*

6.6.39 In addition, this revised longwall layout would offer little benefit to watercourses and ultimately to catchment flows, since it continues to be based on 305 m longwall voids, albeit that the length of most longwalls would be shortened. The SA reports that the minimum case layout is predicted to result in *"similar vertical subsidence and closure at named watercourses and the drainage lines that overlie the longwalls"*.

6.6.40 Importantly, the EIS and SA consider whether narrower longwall void widths would reduce impacts on upland swamps. They report that *"no material difference in the potential for impacts to upland swamps associated with alternative longwall layouts is expected."* That is, a significant surface cracking zone would be expected to develop over a mining domain based on any longwall void width from 150 m to 305 m and this would be sufficient to cause a significant amount of drainage of upland swamps. Put another way, the only avoidance

measure that can largely protect upland swamps is setbacks from longwall voids (of any width). Undermining at a narrower void width would not protect upland swamps.

6.6.41 Based on the above, the Department is satisfied that South32 has adequately addressed the requirements of the *NSW Biodiversity Offsets Policy for Major Projects* to avoid and minimise impacts on biodiversity.

Upland Swamps

6.6.42 Coastal Upland Swamps of the Sydney Basin Bioregion ('upland swamps') are a native vegetation community listed as endangered under both the BC Act and EPBC Act. The EIS contains consideration of upland swamps in the SA, GA, SWA, BAR and BOS.

6.6.43 There are 46 upland swamps lying partly or wholly within 600 m of the Project's proposed longwall voids. Of these, 27 are partly or wholly located directly above the proposed voids or within 60 m of those voids, with 22 of these in Area 5 and five in Area 6.

6.6.44 Within the Project area, two types of upland swamp can develop on Hawkesbury Sandstone near-surface bedrock as follows:

- headwater swamps, which can develop on relatively low-sloped areas near catchment divides where near-surface bedrock with relatively low permeability leads to a locally perched water table; and
- valley in-fill swamps, which can occur in depositional environments in the valleys of second or third order streams (eg where pools behind rock bars fill with sediment and peat over time). In such depositional environments, the rates of sedimentation must exceed the scouring forces associated with occasional high flows.

6.6.45 Not all upland swamps are constantly wet. In most cases, the perched water table within a swamp naturally recedes during extended dry periods and recovers during prolonged rainfall events. Some valley infill swamps have a continually-high water table, but many swamps (particularly headwater swamps) are better characterised as being 'regularly waterlogged' following high rainfall events, rather than constantly wet. This regular waterlogging favours particular species (eg sedges and tea-trees) and prevents the seeds or seedlings of other species (particularly eucalypts) from surviving. Many such swamps can survive regular periods of dryness.

6.6.46 The EIS reports that there are more than 1,400 upland swamps in the Woronora and Metropolitan Special Areas. Flow from the down-gradient outlets of upland swamps contributes to flows within watercourses and therefore to overall catchment flows. Community groups and agencies have regularly characterised these upland swamps as being like 'sponges', which soak up rainfall and slowly release this water as baseflow to streams. This delayed contribution to stream flow is said to contribute to overall reservoir inflows, albeit that it is actually more likely to be of biodiversity value than water runoff value.

6.6.47 Upland swamps on the Woronora Plateau comprise four separate vegetation communities, being:

- Coastal Upland Swamps: Banksia Thicket (MU42);
- Coastal Upland Swamps: Tea-tree Thicket (MU43);
- Coastal Upland Swamps: Sedgeland-Heath Complex (MU44);[17] and

[17] This complex includes Sedgeland (MU44a), Restioid Heath (MU44b) and Cyperoid Heath (MU44c).

- Coastal Upland Swamps: Fringing Eucalypt Woodland (MU45).

6.6.48 These four different communities reflect local differences in the constancy of waterlogging, depth of soil to bedrock, and slope. Only the first three of these communities fall within the "endangered" listings for upland swamps under the BC Act and EPBC Act. That is, MU45 is not listed as a TEC.

6.6.49 The BAR reports that the upland swamps within its Study Area are predominantly the drier vegetation types, being Eucalypt Fringing Woodland (49%), Restioid Heath (32%) and Banksia Thicket (5%). The wetter swamp communities are represented by Tea-tree Thicket (10%), Cyperoid Heath (3.5%) and Sedgeland Complex (0.4%). On this basis, just 51% (by area) of the upland swamps in the Study Area fall within the "endangered" listings and 86% (by area) are already the drier vegetation communities.

6.6.50 The BAR also identified that two of the 27 affected swamps partly or wholly located above or within 60 m of proposed longwalls contain only Fringing Eucalypt Woodland (MU45), being Den107 and Den114. Consequently, there are only 25 upland swamps which satisfy the TEC listing and which require to be offset.

6.6.51 As noted above, BCD considered that the Project is likely to have a significant impact on upland swamps. WaterNSW's advice in respect of biodiversity matters also focused on the expected impacts to upland swamps due to fracturing of the bedrock beneath them, which WaterNSW considered would *"make them more fire-prone and change their ecological functioning"*.

6.6.52 The IESC considered that:

> *"Key potential impacts of the Project [include] major changes to water regimes and drying severity in swamps. … irreversible changes will occur in EPBC-listed swamps, instream and riparian environments (including major changes in important ecological processes such as organic matter decomposition and microbial activity in the hyporheic zones)".*

6.6.53 The IESC sought further information as follows:

- given the evidence for irreversible impacts on upland swamps, further information and evidence to support the predicted likely success of proposed remediation measures for upland swamps and streams (eg grouting and flow dispersion structures); and
- further investigation and discussion of potential impacts from localised changes on ecological components of water resources to enable development of appropriate monitoring, management and mitigation measures, including how predicted changes to water regimes would alter water quality; and
- further consideration of the potential risk of increased bushfire impacts on dried upland swamps, both individually and at the landscape scale, given that 25 upland swamps would be undermined and therefore at higher risk of drying.

6.6.54 In regard to swamp rehabilitation, South32 reported that it is undertaking research into swamp rehabilitation in accordance with approval conditions governing coal extraction in Area 3B. However, its response focused on its proposed offsets to impacts on upland swamps, rather than rehabilitating them.

6.6.55 South32 agreed with the IESC's comment about further investigation of impacts from changes on ecological components of water resources and said that it would develop appropriate monitoring, management and mitigation measures for aquatic ecology in consultation with

relevant agencies. In regard to water quality, the relevant elements of the Mine's existing Watercourse Impact, Monitoring, Management and Contingency Plan would be reviewed and updated for the Project.

6.6.56 The Mining Panel made three key conclusions with respect to swamps, as follows:

> *37. Approval of any viable mine plan in Area 5 or 6 will require some proportion of the upland swamps to be undermined.*
>
> *38. The swamps are predicted to experience impacts and consequences due to the cracking of the underlying sandstone and subsequent increased drainage of the swamp. The [Project] envisages undermining within 60 m of 25 swamps (19 in Area 5, 6 in Area 6), deeming this necessary to achieve an economically viable mine. [South32] has provided for offsets to compensate for the consequences of mining over the full area of the [upland swamp TEC].*
>
> *39. The risks of permanent loss of swamps due to the combination of mining impacts and severe bushfire need to be further considered in the context of the impacts of the 2019-2020 bushfires observed at other locations.*

6.6.57 The Department agrees with this assessment.

6.6.58 In respect of bushfire risks to swamps, the RTS stated that South32 would continue its existing bushfire risk management activities, in accordance with the Mine's existing Bushfire Management Plan and consult with WaterNSW. The Department considers that Swamp Monitoring Programs (required as a component of each Extraction Plan) should pay special attention to the risk of erosional scour, gullying and risk of peat burns (see para 6.6.72).

6.6.59 Mine subsidence can cause small changes to the slope of the land surface. For upland swamps, changes in slope (particularly at or near the swamp outlet) can increase the risk of erosion. Once a 'knickpoint' develops in the thalweg[18] of a swamp (where overland flow runs during storms), it can continue to erode further up-slope, leading to gullying.

6.6.60 However, a much greater risk to upland swamps is serious cracking of the bedrock beneath them, which can lead to much faster drainage of the waterlogging which results from large rainfall events.

6.6.61 It is generally agreed that changes to the hydrology of a swamp will eventually lead to changes in the vegetation community/ies within it, although the time frame over which this change may occur is uncertain. However, different parties have differing views as to the likely extent of the changes in the vegetation community/ies. For example, will a wet vegetation community be replaced by a drier community that still fits within the definition of the TEC? Will an affected community transition to MU45, which falls outside of that definition but remains part of an upland swamp? Will an affected community transition to a healthy but non-swamp vegetation community? Or will it transition to a non-healthy and degraded non-swamp community? Will the changed community be more fire-prone? Does it contain peat deposits that can catch alight and burn out in a bushfire? Many of these questions can only be answered reliably by detailed research taking place over many years and considers all four

[18] 'Thalweg' is a term for the line joining the lowest points along the long profile of a valley, stream or watercourse.

swamp vegetation communities in a variety of sites which are subject to varying degrees of subsidence impact. This work has not been completed.

6.6.62 The EIS and BAR reference a 2007 study by Richardson and Ryan which found that more than 500 upland swamps in the Southern Coalfield had been directly undermined (by longwall, bord and pillar and other methods), with additional swamps located within various offset distances from longwall extraction. Of these 500 swamps, only three (0.6%) were considered by those authors to be subject to significant visual changes from scour and/or erosion.

6.6.63 South32 has undertaken monitoring of upland swamps within 400 m of longwalls at Dendrobium Mine since 2003, as well as monitoring of relevant control swamps. This monitoring initially focused on vegetation change (floristic plots and photo monitoring) however has been augmented more recently to include piezometer water level data and Airborne Laser Survey of surface contours.

6.6.64 This monitoring program collects data for approximately 20 upland swamps. Review of water level data generally indicates that upland swamps overlying longwall panels experience changes in surface hydrology, such as increased rates of water recession following rainfall events and increased duration of dry periods between rainfall events. However, the EIS and BAR reference a review by Biosis for South32 in 2017 of data collected over the previous 11.5 years in Area 2, 7.5 years in Area 3A and 4.5 years in Area 3B. This review did not find a 'strong link' between subsidence effects and upland swamp vegetation response. That is, over the timeframes studied, swamp vegetation is more or less persistent, notwithstanding the changes the reduction in the number and persistence of waterlogging episodes.

6.6.65 The key conclusions of this Biosis report were that:

- swamp size and extent of groundwater dependent swamp sub-communities, mapped using LiDAR data, showed a universal decrease across both impact and control swamps;
- all upland swamps (impact and control) continue to show a trending decline in Total Species Richness (TSR);
- statistically significant yearly and, occasionally, seasonal trends in species composition were detected at most sites, regardless of mining area or treatment. Such widespread trends are indicative of natural turnover of species within upland swamps in response to seasonal and annual variability in climate, competition, disturbance and edaphic factors, including nutrient availability;
- species composition was changing (increasing or decreasing at sites) every year at both impact and control sites, and this change is statistically significant at most sites;
- photo monitoring did not detect any conclusive differences between impact and control sites; and
- Swamp 15B and Swamp 1A show a small, but statistically significant, decline in TSR following mining.

6.6.66 The EIS and BAR also contained recent and historic monitoring photos of Swamp 15B to provide visual support for the view that swamp vegetation can persist despite significant impacts on hydrology due to subsidence cracking of the underlying bedrock. Swamp 15B was undermined by Longwall 8 (part of Area 3A) in 2012. This longwall had a void width of 305 m, an average cutting height of 3.5 m and an average depth to seam of 321 m, and so is comparable in most respects to the extraction proposed in both Areas 5 and 6. Two of the 12 pairs of before-and-after photos included in the BAR are shown in **Figure 17**, below.

6.6.67 Some changes to vegetation are apparent, however, they are not so major as to lead to the view that the swamp has changed to a non-swamp community. Nonetheless, as suggested above, it may take a longer period of time for strong vegetative responses to become clear. Or, it may be that some significant event (for example a bushfire, either alone or in concert with a serious drought, such as that experienced in 2018 - 2020) may be required to 'trigger' more significant change.

6.6.68 Despite there being substantial ongoing uncertainty about the extent of the long-term impacts caused by an extensive network of surface cracking to overlying upland swamps, South32 has accepted that the Project would impact on the full extent of all such swamps located above or within 60 m of proposed longwalls and has proposed to offset those impacts. The nature of these offsets and their sufficiency is addressed under Biodiversity Offset Strategy, below.

Figure 17 | Pre-Mining and Post-Mining Photos, Swamp 15b above Longwall 8 *(Source: BAR)*

6.6.69 The BAR also sought to identify which of its identified 46 upland swamps are valley infill or headwater swamps. According to the BAR, just seven of the 25 swamps expected to be impacted by the proposed mining are valley infill swamps, of which four are located above or adjacent to Area 5 (Den98, Den104, Den108 and Den111) and three are located above or adjacent to Area 6 (Den118, Den121 and Den128). The identified TEC components of most of these valley infill swamps are small (0.5 ha or less). However, one (Den98) is relatively large (2.9 ha, of which 2.2 ha is TEC) and this swamp also overlies the northern (wider section) of proposed LW 512 and is therefore predicted to be subject to substantial upsidence, valley related closure and conventional closure movements.

6.6.70 Den98 is also the only one of the 25 swamps in the Study Area overlying or within 60 m of a proposed longwall which the BAR considers to satisfy the criteria for 'swamps of special significance' in *Upland Swamp Environmental Assessment Guidelines: Guidance for the Underground Mining Industry Operating in the Southern Coalfield* (USEAG, OEH, 2012).[19] For this reason, the BAR indicates that it would be subject to "additional monitoring". South32 has since stated that the nature of this additional monitoring would be detailed in the relevant Extraction Plan and may include subsidence, flora transects and plot data, shallow piezometers and soil moisture analysis against relevant control/reference swamps.

6.6.71 The BAR's identification of valley infill and headwater swamp characteristics was done solely using 'desktop' means. The BAR states that GIS analysis was used to identify valley infill swamps as those occurring in *"incised depressions with clearly identified drainage lines"* and headwater swamps as those *"that did not occur within creeklines, or, were elevated above first order streams on relatively flat terrain"*. Review of the SA's detailed topographic maps suggests that there may be a number of opportunities to refine this analysis, both in re-assessing valley and headwater swamp characteristics and also identifying swamps with a hybrid character. For example, it appears that Den98 is actually a hybrid swamp, in that the greater proportion appears to be a headwater swamps although it also contains two incised drainage lines, one at its centre and one on its southern flank.

6.6.72 The Department considers that a much more careful and field-tested identification of valley infill and headwater swamp characteristics is required. Valley infill swamps are more likely to include relatively deep accumulations of peaty sediments and are therefore more likely to be subject to erosion (scour and/or gullying events from heavy rainstorms) or possible peat burns ignited by bushfires. The results of these studies should be used to underpin and otherwise inform the required upland swamp monitoring program. The Department considers that this program should pay particular attention to the valley infill components of the upland swamps and has proposed conditions to this effect, including special consideration of swamps likely to be at increased risk of erosional scour, gullying or peat burns during bushfires.

Threatened and Endangered Species

Threatened Ecological Communities

6.6.73 No TECs would be impacted by subsidence except for upland swamps, which are separately considered above.

Threatened Flora Species

6.6.74 The surveys undertaken by Niche and reported in the BAR did not identify any threatened flora species in the Study Area, located overlying and within 600 m of Areas 5 and 6. However, four threatened flora species have been previously recorded within the Study area, namely Prickly Bush-pea *(Pultenaea aristata)* and Woronora Beard-heath *(Leucopogon exolasius)*, both listed as vulnerable under the BC Act and EPBC Act; Rufous Pomaderris *(Pomaderris brunnea)*, listed as endangered under the BC Act and vulnerable under the EPBC Act; and Port Jackson Heath (*Epacris purpurascens var. purpurascens)*, listed as vulnerable under the BC Act. The surveys undertaken for the Supplementary BAR confirmed

[19] the Department notes that the reason for this classification as a 'swamp of special significance' is solely that this swamp is located just inside the far northwestern perimeter of the USEAG's "North Pole" cluster of upland swamps. Beyond that, Den98 is not more or less special than many other swamps overlying Area 5 and Area 6.

the presence of Port Jackson Heath and Bynoe's Wattle, but both populations of these species were well away from the subsidence footprint.

6.6.75 The BAR also listed four other threatened flora considered to have a moderate to high likelihood of occurrence within the Study Area, being Bynoe's Wattle, White-flowered Wax Plant *(Cynanchum elegans)*, Small-flower Grevillea *(Grevillea parviflora ssp. Parviflora)* and Hairy Geebung *(Persoonia hirsuta)*.

6.6.76 All eight species have relatively extensive habitat throughout the Study Area.

6.6.77 The BAR considered that only three of these eight species (Port Jackson Heath, Prickly Bush-pea and Rufous Pomaderris) were 'highly likely' or 'moderately likely' to occur within habitat types sensitive to subsidence. The first two are known to occur within upland swamps in the Southern Coalfield and the second of these is also known to occur in ephemeral drainage lines. However, the third species (Rufous Pomaderris) has a sole record dating to the 1950s and no other record closer than the Bargo area (some 12 km distant) has since been found.

6.6.78 The records of Woronora Beard Heath are much more recent (2016 and 2018) but are located on the upper slopes of the valleys of watercourses above and close to Area 5. The BAR considers that these locations are not "sensitive to subsidence" in the same way that upland swamps and ephemeral drainage lines are.

6.6.79 In summary, all previously and recently recorded threatened flora species are located either outside the subsidence footprint or above it but in habitats not sensitive to subsidence. While two species are known to occur within upland swamps (ie Prickly Bush-pea and Port Jackson Heath), they were not found in the swamps examined by Niche in the Study Area.

6.6.80 The BAR concludes that the key impact mechanisms in the habitats where key threatened flora species are likely to occur (ie dieback due to the release of strata gas, loss of habitat due to hydrological change and loss of individuals due to rock falls or earth slippages) are 'unlikely' to affect any threatened flora species. BCD has not raised any concerns over this assessment and the Department also accepts it as being sufficient.

Other Threatened Fauna Species

6.6.81 Apart from those previously considered (ie Koala, Rosenberg's Goanna and Eastern Pygmy-possum), 12 threatened fauna species were recorded by Niche during baseline surveys for the Project, being a glider, seven bat species, three bird species and a frog, as follows:

- Greater Glider *(Petauroides volans)*;
- Eastern Bentwing-bat *(Miniopterus schreibersii oceanensis)*;
- Eastern False Pipistrelle *(Falsistrellus tasmaniensis)*;
- Eastern Freetail-bat *(Mormopterus norfolkensis)*;
- Golden-tipped Bat *(Kerivoula papuensis)*;
- Greater Broad-nosed Bat *(Scoteanax rueppellii)*;
- Little Bentwing-bat *(Miniopterus australis)*;
- Yellow-bellied Sheathtail-bat *(Saccolaimus flaviventris)*;
- Scarlet Robin *(Petroica boodang)*;
- Varied Sittella *(Daphoenositta chrysoptera)*;
- White-bellied Sea-Eagle *(Haliaeetus leucogaster)*; and
- Littlejohn's Tree Frog *(Litoria littlejohni)*.

6.6.82 The BAR considered that an additional eight threatened species have a high likelihood of occurrence within the Project area, being a snake, a bat, three bird species, an insect and two amphibian species, as follows:

- Broad-headed Snake *(Hoplocephalus bungaroides)*;
- Grey-headed Flying-fox *(Pteropus poliocephalus)*;
- Gang-gang Cockatoo *(Callocephalon fimbriatum)*;
- Glossy Black-Cockatoo *(Calyptorhynchus lathami)*;
- Powerful Owl *(Ninox strenua)*;
- Giant Dragonfly *(Petalura gigantean)*;
- Giant Burrowing Frog *(Heleioporus australiacus)*; and
- Red-crowned Toadlet *(Pseudophryne australis)*.

6.6.83 The EIS and BAR considered that the Project may have a significant impact (and therefore require species credit offsets) on five of these threatened fauna species, as follows:

- Broad-headed Snake;
- Giant Dragonfly;
- Littlejohn's Tree Frog;
- Giant Burrowing Frog; and
- Red-crowned Toadlet.

6.6.84 In its advice following exhibition of the EIS, BCD requested additional survey effort in respect of a number of species. While this did identify additional threatened fauna species impacts resulting from direct clearing, it did not identify any additional impacts arising from subsidence.

6.6.85 **Table 13** below sets out the impacts of subsidence on threatened fauna and the species credits required to offset these impacts.

Table 13 | Threatened Fauna Impacts from Subsidence *(Source: Amendment Report)*

Species	Habitat Affected	Ha Affected	Species Credits Required
Broad-headed Snake	Cliff lines	0.28	9
Giant Dragonfly	Upland swamps	13.93	1073
Littlejohn's Tree Frog	Upland swamps and streams	32.74	851
Giant Burrowing Frog	Upland swamps and streams	32.74	426
Red-crowned Toadlet	Streams	7.21	94

6.6.86 BCD has accepted South32's assessment of the impacts of subsidence on threatened fauna species in the BAR and Supplementary BAR.

Aquatic Ecology

6.6.87 The EIS contains an Aquatic Ecology Assessment (AEA) for the Project, prepared by Cardno, which includes the results of baseline studies and an assessment of the impacts of the Project on aquatic ecology. The AEA took into account the results of the SA, GA and SWA.

6.6.88 Monitoring of aquatic habitat, macroinvertebrates and fish in Dendrobium Mine Areas 1, 2, 3A and 3B has been undertaken by Cardno since 2000, including watercourses within the Wongawilli, Native Dog, Donalds Castle and Sandy Creek catchments.

6.6.89 This monitoring indicates that aquatic habitat and fauna within the Dendrobium Mine area is largely undisturbed. Riparian vegetation is generally in very good condition with few introduced species. Aquatic vegetation is relatively sparse and found primarily in the Avon and Cordeaux Rivers. The fish assemblage is in good condition and no invasive fish have been identified in the Wongawilli Creek and Donalds Castle Creek catchments.

6.6.90 Baseline aquatic ecology surveys were undertaken in Spring 2016 at seven sites in the Avon River, Cordeaux River and Donalds Castle Creek. The surveys included characterisation of aquatic habitat; surveys of aquatic flora, macroinvertebrates and fish; and targeted surveys for Macquarie Perch *(Macquaria australasica)*, which is listed as an endangered species under the *Fisheries Management Act 1994* (FM Act) and the EPBC Act. The Project area does not contain any critical aquatic habitat listed under either of these Acts.

6.6.91 Key Fish Habitat (KFH) was identified through desktop mapping of stream order and field validation during the surveys. First and second order ephemeral streams overlying Areas 5 and 6 generally comprise disconnected pools, some separated by waterfalls, providing barriers to fish movement and limiting habitat value for fish. They do not constitute KFH.

6.6.92 The named watercourses affected by the Project (ie Avon and Cordeaux Rivers and Donalds Castle Creek) and the two major reservoirs are all Type 1 - Highly Sensitive KFH.

6.6.93 Within Area 5, there are six relatively short reaches of third order stream, which are categorised as Type 2 - Moderately Sensitive KFH habitat. Two of these reaches were surveyed.

6.6.94 Macroinvertebrate assemblages sampled were somewhat impaired according to the Australian River Assessment System (AUSRIVAS) model. These assemblages were comparable to those previously sampled by Cardno and the AEA considers that they probably reflect natural water quality and naturally low pH. Three common and widespread native fish species (Flathead Gudgeon, a Galaxid species and Australian Smelt) and a Freshwater Crayfish species were caught in the Avon River, Cordeaux River and Donalds Castle Creek surveys.

6.6.95 No threatened aquatic ecology species listed under either the FM Act or the EPBC Act were recorded during the surveys. However, Macquarie Perch have been previously recorded within the Dendrobium Mine area, in Wongawilli Creek. Although there are no known records of Adam's Emerald Dragonfly *(Archaeophya adamsi)* or Sydney Hawk Dragonfly *(Austrocordulia leonardi)* in the Project area, the AEA considered that potentially suitable micro-habitat for these species does exist.

6.6.96 The EIS states that direct disturbance of aquatic habitat would be avoided wherever possible. The minor works that may be required (eg maintenance of stream crossings along access roads) would have a negligible impact on aquatic ecology.

6.6.97 Due to the Project's setbacks from named watercourses, there would be a low likelihood of subsidence-related fracturing resulting in diversion of flow in the short sections of the Avon and Cordeaux Rivers and Donalds Castle Creek located within 400 m of the proposed

longwalls. Wongawilli Creek is a minimum of 700 m from the proposed longwalls and would not be impacted (and is consequently not listed as a 'named watercourse').

6.6.98 The EIS considers that the expected loss of ephemeral aquatic habitat above and immediately adjacent to the proposed longwalls would not result in any significant impacts to aquatic ecology, due to the limited value of this habitat and its abundance in the wider catchment. In addition, the Project's setbacks from key stream features (particularly the pools, which are mostly but not entirely located within third order stream reaches) is a significant mitigation measure to reduce impacts on aquatic ecology.

6.6.99 The AEA predicts that stygofauna occur within the shallow fractured Hawkesbury sandstone aquifer as well as upland swamp aquifers. However, potential impacts to stygofauna habitat would be minor relative to the extent of similar habitat across the entire Hawkesbury sandstone aquifer (which covers about 20,000 square km) and mapped swamp habitat within the Woronora, O'Hares and Metropolitan Catchments (which totals about 4,500 ha).

6.6.100 The AEA concludes that the Project is unlikely to result in a significant impact on any threatened aquatic species listed under the FM Act or the EPBC Act. The Project consequently would not require biodiversity offsets for threatened aquatic species.

6.6.101 DPIE - Water expressed a number of concerns in its advice over the strength of the AEA, as follows:

- appropriateness of the model used to assess macroinvertebrates;
- survey methods for Macquarie Perch;
- identification of the Freshwater Crayfish only to genus level;
- loss of fish habitat over the mining area;
- potential for impacts downstream of the two mining areas;
- improved design in the monitoring programs for macroinvertebrates;
- improved monitoring of Macquarie Perch in the Avon and Cordeaux Rivers; and
- water level monitoring throughout the mine life at all key downstream sites.

6.6.102 South32 responded to these comments in its RTS and (as requested by the Department) at more length in its later additional response to DPIE - Water's advice. South32 noted that four of its seven survey sites were located remote from or upstream of historical mine workings, and the remainder were in Donalds Castle Creek.

6.6.103 Macroinvertebrate sampling was undertaken in accordance with the AUSRIVAS Rapid Assessment Protocol and results were assessed against AUSRIVAS modelling software. Aquatic ecology surveys for the Project were undertaken consistent with relevant guidelines and methodologies, including targeted surveys of Macquarie Perch. However, South32 acknowledged DPIE - Water's comments regarding the use of additional survey methodologies for this species, and would continue to consult with DPIE - Water regarding survey effort for both Macquarie Perch and macroinvertebrates during the Project. South32 stated that details of proposed monitoring and management measures for Macquarie Perch would be detailed in Extraction Plans and other relevant management plans.

6.6.104 South32 also noted that it maintains an extensive surface water monitoring and management program for the approved Dendrobium Mine (including both surface water flow and quality monitoring). The existing program includes stream flow monitoring of a number of ephemeral

drainage lines proximal to Area 5, Area 6 and Donalds Castle Creek. These surface water monitoring networks would be expanded and augmented for the Project.

6.6.105 South32 also considered that its BOS would provide protection for fish habitat similar to that affected by the Project, notwithstanding that no necessity for offsets for impacts on aquatic ecology arises for the Project.

6.6.106 The Department considers that the Project's impacts on aquatic ecology are limited, owing to the key setbacks incorporated in the Project's mine design (ie setbacks from the FSL of the two reservoirs, setbacks from the Avon and Cordeaux Rivers and Wongawilli and Donalds Castle Creeks and setbacks from key stream features). Known habitat for Macquarie Perch is at least 400 m from the Project's two mining areas and no Macquarie Perch were found during the baseline surveys for the AEA.

6.6.107 The Department also considers that the impacts on watercourses within and adjacent to the two mining areas (principally first and second order streams with a limited length of third order streams) are unavoidable should the Project proceed. There is no evidence that the existing Dendrobium Mine has impacted on aquatic ecology other than in respect of the loss of habitat arising from the cracking of pools and rockbars, again principally in respect of first and second order streams. The Department considers it very unlikely that the Project would cause impacts to aquatic ecology greater than those associated with the existing Dendrobium Mine.

6.6.108 DPIE – Water's advice in response to the RTS raised no ongoing concerns with the AEA and instead proposed a number of recommendations regarding post-approval aquatic ecology monitoring, as follows:

- time series graphs for key water quality parameters (including pH, EC and heavy metals), should be developed and used in future aquatic ecology assessments;
- a region-specific AUSRIVAS model should be used, if available;
- macroinvertebrates should be identified to genus level, particularly for sensitive taxa from the families Ephemeroptera, Plecoptera and Trihoptera, to allow for more detailed assessment of macroinvertebrate community sensitivity;
- *Euastacus* sp. should be identified to the species level; and
- additional sampling effort for Macquarie Perch and identification of the closest Macquarie Perch population to the two mining areas.

6.6.109 The Department considers that these recommendations are best taken into account and applied during development of key management plans for the Project (particularly Extraction Plans and their component Biodiversity Management Plans). Proposed conditions require South32 to consult with both BCD and DPIE - Water during preparation of these plans.

Biodiversity Offset Strategy (BOS)

6.6.110 As a result of the delineation of the location of ancillary surface infrastructure and the associated and other additional surveys undertaken for the Supplementary BAR, South32 has amended the BOS proposed for the Project within the EIS. The Project's key biodiversity impacts and South32's proposed BOS, as set out in the Amendment Report (see **Appendix D**), are summarised in **Table 14**, below.

Table 14 | Summary of South32's Identified Ecosystem and Fauna Impacts and Offset Requirements *(Source: Amendment Report)*

Vegetation Community	Impact Mechanism	Ha Affected	Ecosystem Credits Required	Credits/ha
HN566/PCT 1083	Direct Clearing	26.9	1,051	39.1
HN556/PCT 1395	Direct Clearing	0.55	40	72.7
HN651/PCT 1250	Direct Clearing	0.85	68	80.0
HN597/PCT 1245	Direct Clearing	0.2	6	30.0
HN560/PCT 978 (upland swamp, Banksia Thicket)	Subsidence	16.3	227	13.9
HN662/PCT 1804 (upland swamp, Tea Tree Thicket)	Subsidence	4.6	78	17.0
Species	**Impact Mechanism**	**Ha Affected**	**Species Credits Required**	**Credits/ha**
Koala	Direct Clearing	1.51	39	25.8
Rosenberg's Goanna	Direct Clearing	27.05	893	33.0
Eastern Pygmy-possum	Direct Clearing	27.25	545	20.0
Broad-headed Snake	Subsidence	0.28	9	32.1
Giant Dragonfly	Subsidence	13.93	1073	77.0
Littlejohn's Tree Frog	Subsidence	32.74	851	26.0
Giant Burrowing Frog	Subsidence	32.74	426	13.0
Red-crowned Toadlet	Subsidence	7.21	94	13.0

6.6.111 Most of the proposed offset requirements are uncontroversial. However, BCD has not accepted South32's proposals regarding offsets of impacts on upland swamps or Koala habitat. Consequently, impacts on these values are separately considered below.

Upland Swamps

6.6.112 BCD disagrees with South32's proposals to offset its impacts on upland swamps. South32 has consistently proposed a 'partial offset', as it considers that upland swamps impacted by subsidence would retain significant biodiversity values. BCD maintained that South32 should provide a complete offset (equivalent to upland swamps being cleared for construction of, say, a ventilation shaft or freeway) and further stated that this is a requirement of its *Addendum to NSW Biodiversity Offsets Policy for Major Projects - Upland Swamps Impacted by Longwall Mining Subsidence* (the Upland Swamp Offset Policy, OEH, 2016).

6.6.113 BCD maintains that the FBA was incorrectly applied in the EIS and BAR in calculating the 'maximum predicted offset liability' for the Project in respect of upland swamps. It considers that the Upland Swamp Offset Policy requires calculation against a 'worst-case scenario' for

swamps, which includes significant erosion and scouring, equating to total loss of all undermined swamps.

6.6.114 In its final response to BCD's position (dated 8 September 2020), South32 states its position as follows. The proposed offsets for upland swamps have been calculated in accordance with the NSW Offset Policy, supporting FBA and associated *Credit Calculator for Major Projects and Biobanking* (BBCC). The BBCC allows amendment of site value scores to reflect a "partial impact" (ie predicted hydrological impacts to swamps would not result in a complete loss of value, compared with clearing). As the Upland Swamp Offset Policy forms part of the NSW Offset Policy, the BBCC is available for calculating potential impacts to swamp vegetation.

6.6.115 The Department notes that the Upland Swamp Offset Policy is expressed as an "Addendum" to the overarching NSW Offset Policy and states in its Introduction that:

*"This policy will **operate as an addendum** to the Biodiversity Offsets Policy for Major Projects (BOP). It must be **read in conjunction with** the BOP and the Framework for Biodiversity Assessment (FBA), which underpins the BOP by **setting out the process for assessing biodiversity impacts and determining offset requirements** for those impacts….*

*This addendum **extends the BOP** to the calculation and provision of biodiversity offsets for the subsidence impacts of longwall coal mining on upland swamps and associated threatened species." (emphasis added)*

6.6.116 The Upland Swamp Offset Policy further states that:

*"If it is predicted that upland swamps are likely to experience **greater than negligible environmental consequences** as a result of mining subsidence, conditions of consent will require that, on the approval of an extraction plan, a proponent must demonstrate a legal ability to secure offsets for the swamps to be undermined in that extraction plan, **as calculated using the FBA**."* …

*"The offset liability should be assessed as a potential maximum (i.e. **worst case scenario**), given the uncertainty in the prediction of subsidence and consequent high likelihood of significant environmental impacts for upland swamps." (emphasis added*

6.6.117 That is, a calculation using the FBA and its associated BBCC must be applied when calculating offset liabilities and this calculation must reflect a worst-case scenario.

6.6.118 Therefore, it appears that this issue centres around the question of just what is the 'worst-case scenario', rather than whether the FBA and BBCC should be used to undertake this calculation. BCD has stated that its worst-case scenario is *"significant erosion and scouring, equating to total loss of [all 25 undermined] swamps."* However, South32's worst-case scenario is the partial loss of swamp vegetation as set out in the BAR.

6.6.119 It would seem that the answer to this question is evidentiary, rather than a matter of interpreting policy.

6.6.120 The Department first notes that the requirement for South32 to assess its upland swamp offset liability is triggered by its predicted changes in swamp hydrology, which may well take place across the full extent of the 25 undermined swamps. Indeed, it is prudent and precautionary for both South32 and Government agencies to assume that all parts of these swamps would be affected by "greater than negligible" changes in hydrology. But this trigger

does not lead automatically to the position that all vegetation (or even all swamp vegetation) would be lost. Instead, it leads to the requirement to undertake a worst-case scenario assessment, using the applicable policy instruments (ie the FBA and BBCC).

6.6.121 While BCD's advice contains statements regarding the possibility of significant scour events in undermined swamps and refers to the recent total loss of two upland peat swamps (Carne West and Gang Gang) above the Springvale Coal Mine on the Newnes Plateau in the Western Coalfield, following a sequence of undermining, drainage, desiccation, drought and bushfire; it has not made out the case that all upland swamps undermined by the Project (or indeed elsewhere at Dendrobium Mine or in the Southern Coalfield) are likely to suffer the same fate. On the other hand, South32 has presented evidence regarding the persistence of good quality swamp vegetation for at least ten years following undermining and reported the 2007 study by Richardson and Ryan which found that, of >500 undermined upland swamps, only three (0.6%) were subject to significant visual changes from scour and/or erosion (see paras 6.6.58 – 67 and **Figure 17**). South32's BAR also contains two Appendices which address in substantial detail the previous impacts of underground mining on upland swamps (the BAR's Appendices 8 and 9).

6.6.122 The Department considers that the BAR's position that the 'worst-case scenario' in upland swamps is partial loss of vegetation is reasonable and supported by the evidence. Further it considers that the BAR's numerical quantification (using the BBCC) of this partial loss of biodiversity value is also reasonable. BCD has not questioned the accuracy or reasonableness of this quantification, only whether the Upland Swamp Offsets Policy (and associated NSW Offsets Policy, FBA and BBCC) provide the opportunity to apply it.

6.6.123 The Department also notes that the Upland Swamp Offsets Policy covers circumstances where impacts to upland swamps are greater than predicted. Any such case would require a revised calculation of the offset liability under the FBA.

6.6.124 The Project is predicted to impact on 21.6 ha of upland swamps located within 60 m of proposed longwalls. South32 has stated that it proposes to relinquish approval to impact swamp Den02 (0.7 ha), which has already been offset via its existing Maddens Plains BioBank site and that this offset should therefore be 'reapplied' to the Project, leading to a net area of upland swamp to be offset of 20.9 ha.

6.6.125 The Department first notes that the Maddens Plains Biobank Site is no longer being applied in respect of the Project (see para 6.6.137). In addition, notwithstanding that South32 now predicts that the reduced boundary for extraction of Area 3C would mean that Den02 would not be impacted by subsidence from that domain, at its closest point, Den02 is only about 330 m from the expected void of LW 512. While this means that it is well outside the 60 m limit where the SA considers that conventional subsidence impacts are likely, the SA also indicates that the valley containing Den02 has an effective valley height of 30 m, and that therefore some significant upsidence (50 mm) and valley closure (90 mm) is anticipated.

6.6.126 Consequently, the Department must recommend conditions requiring the offset of all 21.6 ha of potentially affected upland swamps, subject to this requirement being able to be reduced if the existing approval to impact Den02 (pursuant to conditions under DA 60-3-2001) is actually relinquished at some point in the future.

6.6.127 South32 has calculated that its anticipated 'net' offset requirement for 20.9 ha of upland swamps (under its partial loss scenario) under the FBA is 305 FBA credits, which have a reasonable equivalent under the current BAM of 196 BAM credits.

6.6.128 South32 proposes to satisfy this offset liability by forming a Stewardship Agreement over its new Project biodiversity offset property – which contains approximately 51.3 ha of Coastal Upland Swamp TEC (most recently estimated by Niche to provide 398 BAM credits).

6.6.129 South32 has also offered to support conditions of consent requiring an offset sooner than would be required under the Upland Swamp Offsets Policy, which recommends satisfying swamp offset liabilities over the life of a Project (ie for each successive Extraction Plan). South32 has said that it would accept a condition requiring the Project's swamp offset liability (based on its partial loss scenario) to be satisfied early in the Project life so that the benefits of securing offsets can be realised immediately. Most recently, South 32 has proposed that, within one year of Project commencement, it would make an application to form a Stewardship Agreement over the new Project offset property and subsequently retire all ecosystem credits associated with upland swamps within that property.

6.6.130 The Department supports South32's proposals regarding offset of its predicted impacts on upland swamps and has proposed conditions requiring South32 to:

- retire BAM credits (within 24 months of approval of Project) that are equivalent to its anticipated impact on 21.6 ha of upland swamps, providing that this equivalence can be reduced should South32 succeed in relinquishing its approval to impact swamp Den02;
- carefully monitor the condition of all upland swamps within the BAR's study area prior to, during and following undermining and also monitor a suitable suite of control swamps;
- continue to apply the Upland Swamp Offset Policy, NSW Offsets Policy and FBA; and
- retire any additional offsets required should, at any time during the life of the Project or for 10 years following cessation of mining in Areas 5 and 6, impacts on upland swamps exceed the predictions found in the BAR.

Koala Habitat

6.6.131 BCD also disagrees with South32's proposals to offset its impacts on Koala habitat. BCD's view remains that South32 needs to provide offsets for all Koala habitat directly impacted, which includes the full extent of all native vegetation containing any eucalypt listed as a feed tree species under the new Koala SEPP that is proposed to be cleared for surface infrastructure (primarily the four ventilation shaft sites). In its response to South32's RTS, BCD stated its reasoning in support of this position, as follows:

"SEPP 44 has been revised to reflect improved understanding of regional koala habitat use trees in the new [Koala] SEPP. Scribbly Gum (E. sclerophylla) is recognised as a key Koala habitat use tree in this region (OEH 2018 – A review of Koala tree use across NSW…) and PCTs with this as a dominant species, including PCT 1083, must be included in calculations for koala habitat. Koala was recorded during surveys for the EIS and is known to be present.

The proponent has not confirmed that the Koala is not present or unlikely to be present at the development site, as required by s6.5.1.11 of the FBA. We therefore maintain that all Koala habitat must be offset."

6.6.132 However, as set out in paras 6.6.18-29 and **Appendix G2**, the Project must satisfy the requirements of SEPP 44, rather than the new Koala SEPP.

6.6.133 While the Department notes the approach put forward by BCD, it is required to reflect the policy which applies to assessment of the Project. It considers that South32's proposal to offset Koala species credits in respect of 1.51 ha of land to be cleared by the Project is consistent with the requirements of SEPP 44.

Other Threatened Species and Communities

6.6.134 BCD has accepted the Supplementary BAR's assessment of the Project's impacts on all other native vegetation communities (including Shale Sandstone Transition Forest Threatened Ecological Community) and all other threatened fauna species. Consequently, the Department also accepts those assessments and the calculation of the required ecosystem and species credit offsets required.

BOS Mechanisms

6.6.135 The EIS stated that South32 had a number of options for retirement of the ecosystem and species credits for the Project, including:

- existing South32 Appin West and Douglas Park BioBank sites have sufficient residual credits to address all offset requirements for HN556 and the Koala;
- existing South32 Cataract River BioBank site contains sufficient residual credits to address all offset requirements for HN556;
- existing South32 Maddens Plains BioBank site contains identified habitat for the Giant Burrowing Frog, Littlejohn's Treefrog and Red-crowned Toadlet within upland swamps;
- existing South32 landholdings on the Illawarra Escarpment with more than 1,000 ha of native vegetation, including at least 100 ha of HN566, 100 ha of HN651 and 200 ha of HN597;
- additional recently-purchased Project offset property on Maddens Plains containing 51.3 ha of upland swamp TEC and additional Fringing Eucalypt Woodland;[20]
- payment into the Biodiversity Conservation Trust's (BCT's) Biodiversity Conservation Fund (BCF);
- possible rehabilitation works within upland swamps within land owned by WaterNSW and BCD; and
- other direct or supplementary measures.

6.6.136 BCD raised concerns over some of these proposals, in particular the further use of the existing Maddens Plains BioBank site to generate species credits in addition to the ecosystem credits already used to offset impacts on upland swamps in Areas 3B and 3C.

6.6.137 In correspondence dated 2 October 2020 (see **Appendix D**), South32 confirmed that it is now proposing to satisfy its biodiversity offsetting requirements by a combination of the following:

- retirement of FBA credits through existing South32 BioBank sites (eg Appin West, Douglas Park and Cataract River);
- establishment of Stewardship Agreements over South32 landholdings and/or privately-owned property (eg eastern portion of its Illawarra Escarpment landholdings, existing Maddens Plains Strategic Offset, recently-purchased Project offset property); and
- payment into the BCF.

6.6.138 South32 further advised that the final Project Offset Strategy remains subject to detailed post-approval cost benefit analysis, in particular payments into the BCF versus identifying and

[20] As advised in the RTS, South32 has purchased a group of four land parcels located some 18 km northeast of Area 6 on Maddens Plain, which is also part of the Woronora Plateau upland swamp complex. The parcels are adjacent to upland swamps reserved within Dharawal National Park.

securing additional offset properties. The use of South32's existing BioBank sites is also subject to the reasonable equivalence conversion process between BBAM and BAM credits.

6.6.139 South32 is no longer proposing possible rehabilitation works within upland swamps or other direct or supplementary measures. The use of the existing Maddens Plains offset property to generate additional species credits also is no longer proposed.

6.6.140 South32 has stated that it would liaise with BCD to identify available credits at its recently-purchased Project offset property, however, its most recent calculations suggest that the site would:

- fully satisfy the required BAM credits for upland swamps; and
- satisfy a significant portion of the required credits for two amphibian species, being Giant Burrowing Frog (364 of 426 credits required) and Littlejohn's Tree Frog (364 credits of 851 credits required);

6.6.141 South32 has also proposed that conditions of any consent granted for the Project allow for staging of its BOS requirements, as follows:

- *upland swamps* – full ecosystem credit liability to be satisfied "early in the Project life" by applying for a Stewardship Agreement over the Project offset property and retiring all required BAM credits;
- *surface disturbance* – staged retirement of ecosystem and species credits, with liabilities calculated for each draft Mining Operations Plan (or equivalent) that includes surface disturbance of native vegetation using the credit/ha ratios set out in **Table 14** above, with retirement of credits within 1 year of approval of that Plan (or earlier); and
- *other subsidence* – staged retirement of species credits, with liabilities calculated for each draft Extraction Plan using the credit/ha ratios set out in **Table 14** above, with retirement of credits within 1 year of approval of that Plan (or earlier).

6.6.142 The Department considers that there are good reasons to support staging in the retirement of offsets. For example, construction of the two pairs of Ventilation Shaft sites is expected to be undertaken about 15 years apart and the construction of Shaft Site 5B is not yet certain. Construction of the carpark extension and Ventilation Shaft Site 5A are on South32's 'critical path' for development of the Project. In addition, subsidence is expected to take place over some 24 years and may involve the approval of 10 or more Extraction Plans.

6.6.143 However, the Department considers that retirement of credits for surface disturbance should be directly tied to the requirements of the consent, rather than to a Mining Operations Plan, the development and approval of which is a requirement of conditions of mining leases granted under the *Mining Act 1992*. The Department also considers that the retirement of species credits according to each proposed Extraction Plan is an inefficient and unduly protracted approach.

6.6.144 The Department therefore proposes that conditions of any consent granted for the Project allow for some limited staging of BOS requirements, as follows:

- *upland swamps* – full ecosystem credit liability to be satisfied by South32 applying for a Stewardship Agreement over the Project offset property and retiring all required BAM credits within 24 months of grant of any consent;
- *surface disturbance* – staged retirement of ecosystem and species credits, with liabilities calculated using the credit/ha ratios set out in **Table 14**, with relevant credits retired:

- within 12 months of commencing construction of the carpark extension and Shaft Site 5A (including the service boreholes site); and
- prior to commencing construction for each of Shaft Sites 5B, 6A and 6B;

- *other subsidence* – staged retirement of species credits, with liabilities separately calculated for Area 5 and Area 6 using the credit/ha ratios set out in **Table 14**, with relevant credits retired prior to commencing longwall extraction in each mining area.

6.6.145 The Department has also proposed conditions requiring that all credits are retired in accordance with the requirements of the NSW Offset Policy, Upland Swamp Offset Policy and FBA. Subject to these conditions, is confident that South32 can satisfy its offset requirements.

Biodiversity Matters of National Environmental Significance

6.6.146 The Project requires approval under the EPBC Act due to its impacts on MNES, including Commonwealth-listed TECs and species (see **Section 4.6**). Not all TECs and threatened flora and fauna listed under the BC Act are listed under the EPBC Act. The BAR states that it has addressed the Commonwealth requirements for assessment set out in the SEARs and provides a BOS that satisfies the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (Commonwealth Policy, DSEWPAC 2012) and its eight Offset Principles.

6.6.147 Under the Commonwealth Policy, only those entities that are i) listed as threatened under the EPBC Act and ii) likely to be "significantly impacted" by the Project are required to be offset. The Commonwealth Policy contains the following key considerations that must be addressed:

- offsets are measures that compensate for 'significant residual adverse impacts on the environment' affecting MNES;
- the associated 'offsets assessment guide' (which uses a balance sheet approach to measure impacts and offsets) must be used to assess the suitability of offset proposals;
- at least 90% of the impact should be directly offset (subject to certain exceptions) and offsets should be implemented prior to or at the time of the impact occurring; and
- up to 10% (or more if an exception applies) of impacts may be indirectly offset through compensatory measures such as research, monitoring, education programs etc.

6.6.148 The Commonwealth Department of Agriculture, Water and the Environment (DAWE) also requires biodiversity offset sites to be secured under a legally binding conservation covenant and actively managed under a fully funded plan. There are a variety of NSW mechanisms for achieving this, including the Biodiversity Offsets Scheme under the BC Act and use of conservation agreements or the dedication of land to the conservation estate under the *National Parks and Wildlife Act 1974*.

Threatened Flora Species

6.6.149 No threatened flora listed under the EPBC Act were recorded during Niche's surveys of the surface infrastructure disturbance areas or habitats that may be susceptible to subsidence impacts.

6.6.150 However, the BAR included assessments of significance for the purposes of the EPBC Act for each of three Commonwealth-listed flora species – Prickly Bush-pea, Rufous Pomaderris and Woronora Beard-heath. These assessments found that the Project was "unlikely" to have a significant impact on these species, on any of the nine relevant tests.

Threatened Fauna Species

6.6.151 The BAR included assessments of significance for the purposes of the EPBC Act for each of five Commonwealth-listed fauna species – Littlejohn's Tree Frog, Giant Burrowing Frog, Koala, Grey-headed Flying-fox and Greater Glider. These assessments found that the Project was "unlikely" to have a significant impact on the latter three of these species, on any of the nine relevant tests. However, it was "likely" to have a significant impact on Littlejohn's Tree Frog and Giant Burrowing Frog under three of these tests.

6.6.152 The Supplementary BAR did not disturb or add to this assessment, since the additional threatened fauna species that it identified in the direct disturbance sites (Eastern Pygmy-possum and Rosenberg's Goanna) are not listed under the EPBC Act.

6.6.153 The BAR's conclusion is that Commonwealth offsets are required in respect of disturbance of 32.74 ha of swamp and creek habitat for Littlejohn's Tree Frog and Giant Burrowing Frog.

Threatened Ecological Communities

6.6.154 The BAR included assessments of significance for the purposes of the EPBC Act for two Commonwealth-listed TECs – Coastal Upland Swamps and Shale Sandstone Transition Forest. In the case of Shale Sandstone Transition Forest, the assessment found that the Project was "unlikely" to have a significant impact on the TEC on any of eight relevant tests, because the extent of the proposed clearing was so limited (and was further reduced in the Amendment Report to 0.55 ha). However, in the case of upland swamps, the indirect impacts associated with subsidence cracking and disturbance of the hydrological profile were "likely" to lead to a significant impact under four of the eight relevant tests.

Commonwealth Offset Requirements

6.6.155 The BAR concludes that the Project requires offsets for the purposes of the EPBC Act for its significant impacts on:

- Coastal Upland Swamps TEC (21.6 ha);
- Littlejohn's Tree Frog (32.74 ha); and
- Giant Burrowing Frog (32.74 ha).

6.6.156 Assessment of the Commonwealth offset liability under the EPBC Act for the Project is undertaken under NSW's planning regime (ie this assessment process), in accordance with the Bilateral Agreement between NSW and the Commonwealth. On 24 March 2020, this Bilateral Agreement was amended to fully endorse NSW's Biodiversity Offsets Scheme (a legislative scheme established under the BC Act), which includes the BAM and payments into the BCF.

6.6.157 The amended Bilateral Agreement therefore allows South32 to pay into the BCF to fully satisfy its offset requirements for Commonwealth-listed threatened species and communities. The BCT is required to meet the Commonwealth offset requirements in a 'like-for-like' manner.

6.6.158 The Commonwealth Minister for the Environment will consider the Department's assessment report prior to making a final decision under the EPBC Act.

6.7 Mine Closure Planning

6.7.1 The Mining Panel paid particular attention to the issue of mine closure planning for the Project. Its relevant conclusions are:

41. *The consideration given to mine closure planning in the EIS is simplistic and lacks engineering design and risk assessment.*

42. *Some important aspects of the EIS have a reliance on being able to effectively seal the mine at the completion of mining so that it floods, groundwater levels and pressures recover, and water is not diverted from the catchment in perpetuity.*

43. *The EIS does not question whether it is physically feasible to seal the mine. This needs careful consideration as a basis for assessing the feasibility of some important controls associated with managing mine water inflow after mine closure, including the type, magnitude, longevity and cost of offsets and compensatory provisions for impacts on water quantity and water quality in the catchment in perpetuity.*

44. *Offset and compensatory provisions should have regard to the consequences of not being able to seal the mine effectively, should that possibility materialise.*

45. *The extraction of Areas 5 and/or 6 is unlikely to change the existing legacy of past mining operations at Dendrobium Mine and in surrounding mines in respect of sealing Dendrobium Mine at the end of mining operations and how this impacts on managing mine water inflow in perpetuity. It could increase the scale of the legacy impacts that will need to be managed after mine closure.*

6.7.2 The Department accepts these conclusions and notes that this issue was also raised by the Catchment Panel in its Final Report, dated October 2019. The Catchment Panel made five key recommendations for improved consideration of mine closure in the assessment process and during mining operations.

6.7.3 However, South32's EIS was completed and exhibited prior to publication of the Catchment Panel's Final Report. South32 did (at the Department's request) consider and respond to all of the Catchment Panel's recommendations in an attachment to its RTS, wherein South32 expressed its agreement with the intent of all five recommendations.

6.7.4 Importantly, the Mining Panel, did not express any concerns that the incomplete nature of mine closure planning for the Project (or, for that matter, for the existing Dendrobium Mine) was such as to stand in the way of completing assessment of the Project and its determination by the Commission.

6.7.5 Instead, the Mining Panel recommended that this issue was dealt with following determination, by way of conditions of consent. The Mining Panel made two detailed recommendations that consent conditions make provision for:

6. *The development of a Mine Rehabilitation and Closure Plan (MRCP) within a stipulated period to support the Extraction Plan.*

    i. *The stipulated period could be of the order of 3 to 5 years.*

ii. *The MRCP should be based on a robust risk assessment that includes input from key stakeholders and independent third party specialists in mine closure in order to fully and objectively identify the potential hazards associated with mine closure, the likelihood and consequences associated with these hazards materialising, the extent to which consequences can be controlled should the hazards materialise, and the residual risks after control measures have been put in place.*

iii. *The MRCP should be peer reviewed by mine closure specialists on an annual basis during its development and every three years after development*

iv. *Consideration should be given to making continuing approval of the Extraction Plan during development of the MRCP conditional on demonstration on an annual basis of satisfactory progress in developing this management plan.*

7. *The MRCP to include provision for:*

i. *Establishing the practicality of effectively and safely sealing Dendrobium Mine and those other mines that may directly or indirectly be connected hydraulically to Dendrobium Mine.*

ii. *Improved modelling of points of groundwater outflow and water quality, and identification of potential needs for treatment*

iii. *Options for managing residual risks, such as mine water discharge in perpetuity, should Dendrobium Mine not be able to be effectively sealed and, conversely, contaminated leakages should it be effectively sealed.*

6.7.6 The Department supports these recommendations and has recommended conditions to give them effect. The conditions require development of a Mine Closure Plan in addition to a Rehabilitation Management Plan. It should be noted that the Mine Closure Plan would have to address closure of the entire Dendrobium Mine, rather than simply the Project. This is an necessary and appropriate measure to consider closure of the entire Mine in an integrated fashion.

6.7.7 The Mining Panel also noted the importance of Government holding a sufficient security deposit to guarantee the costs of both mine closure and any residual risks, by way of the following recommendation:

8. *Government ensuring the provisioning and guaranteeing of adequate funding to cover both mine closure and all potential residual risks after mine closure.*

6.7.8 The *Mining Act 1992* contains comprehensive requirements regarding security deposits, which are required to be lodged (by way cash, a bond or other guarantee) with MEG by the titleholder of any mining lease or other authority granted under that Act.

6.7.9 MEG reviews the security deposits lodged on behalf of mining projects on a regular basis. It can be expected that MEG will take a considerable interest in both the Rehabilitation Management Plan and the Mine Closure Plan prepared for the Project, should it be approved.

6.7.10 The Department is confident that MEG would set the size of the security deposit for Dendrobium Mine fully commensurate with the scale of the necessary rehabilitation and the residual risks associated with mine closure.

6.7.11 Based on the proposed requirements for early and comprehensive mine closure planning (which give full effect to the Mining Panel's recommendations) and the requirements of the *Mining Act 1992* in respect of an appropriately scaled security deposit, the Department is satisfied that the requirements of the EP&A Act regarding adequate impact assessment of the Project have been met in respect of mine closure. In this respect, the Department further notes the Mining Panel's final conclusion, that *"The extraction of Areas 5 and/or 6 is unlikely to change the existing legacy of past mining operations at Dendrobium Mine and in surrounding mines in respect of sealing Dendrobium Mine at the end of mining operations and how this impacts on managing mine water inflow in perpetuity. It could increase the scale of the legacy impacts that will need to be managed after mine closure."*

6.8 Noise

Introduction

6.8.1 The EIS contains a Noise and Blasting Assessment (NBA) for the Project, prepared by Renzo Tonin, which includes assessment of:

- operational noise from existing surface facilities that would continue to be used;
- rail traffic noise from existing rail infrastructure that would continue to be used;
- construction noise; and
- road traffic noise.

6.8.2 The NBA was undertaken in accordance with the:

- *Noise Policy for Industry* (NPfI) (EPA, 2017);
- *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013);
- *Road Noise Policy* (RNP) (DECCW, 2011);
- *Interim Construction Noise Guideline* (ICNG) (DECC, 2009); and
- *Voluntary Land Acquisition and Mitigation Policy - For State Significant Mining, Petroleum and Extractive Industry Developments* (VLAMP) (NSW Government, 2018).

6.8.3 Following consideration of South32's RTS, the EPA expressed satisfaction that the NBA had been carried out appropriately.

Operational Noise

6.8.4 It is first noted that Dendrobium Mine's surface facilities are significant industrial facilities that have been operating in the local area for many years. The Project would involve continued use of the Dendrobium Pit Top, KVCLF, Kemira Valley Rail Line, Dendrobium CPP and three existing Dendrobium ventilation shafts. The Project would not involve significant changes to the operation of these facilities, with minor upgrades occurring progressively over the life of the Project.

6.8.5 However, some suburban and rural receivers are located in close proximity to existing mine infrastructure (**Figure 18**). The Dendrobium Pit Top is located off Cordeaux Road and close to Mount Kembla village. The KVCLF is located in a rural setting, with the closest residential receiver located approximately 700 m to the south-east.

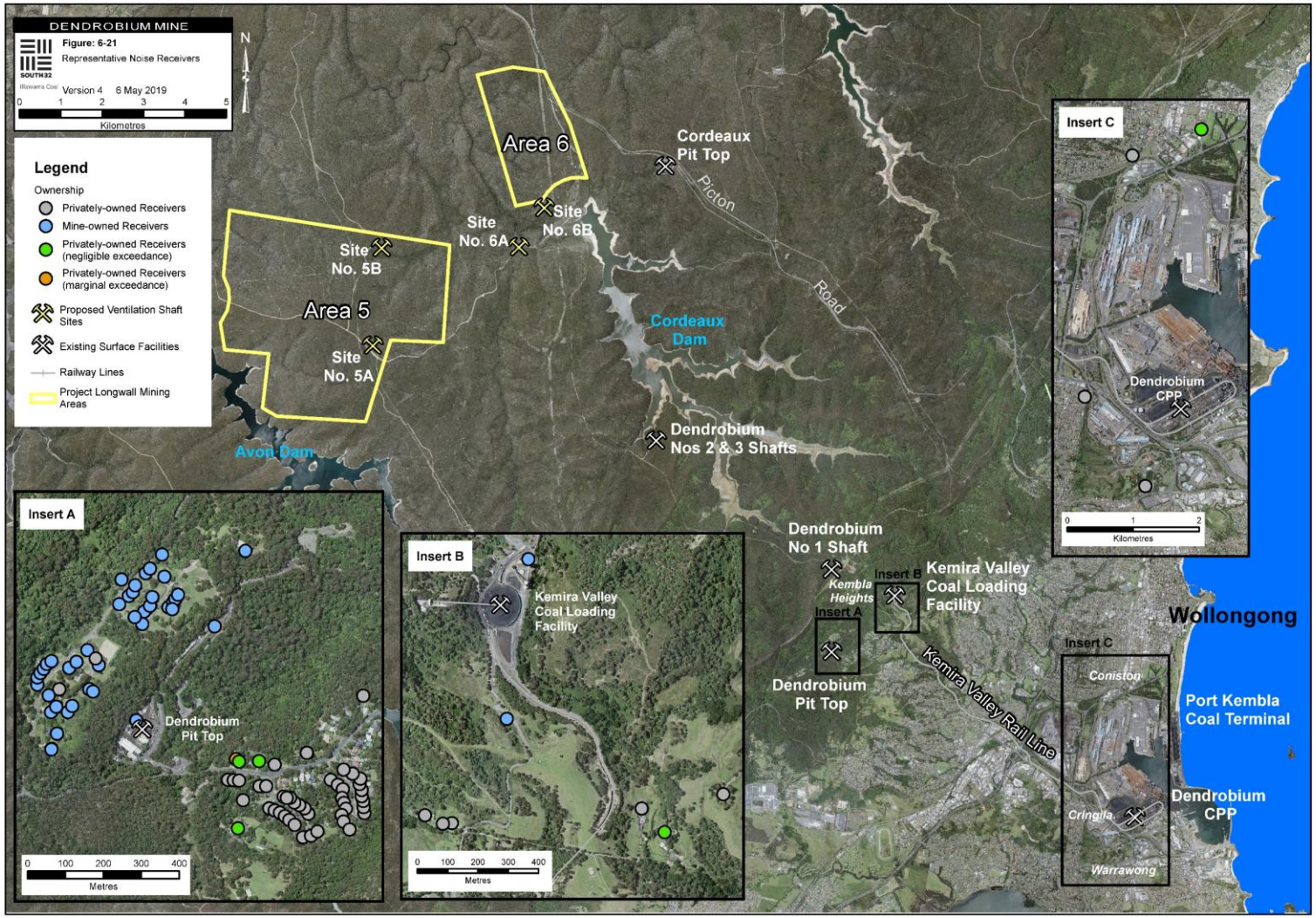

Figure 18 | Noise receiver locations near key Project surface infrastructure
(Source: EIS)

6.8.6 The Dendrobium CPP is located on Flinders Lane within the Port Kembla Steelworks precinct, which is a heavy industrial area incorporating the BlueScope Steelworks and PKCT. The closest residential receivers to the Dendrobium CPP are located approximately 650 m to the west.

6.8.7 The Cordeaux Pit Top is located in a bushland setting off Picton Road and is isolated from potential private residential receivers (**Figure 2**). The proposed new ventilation shaft sites for the Project (ie Shaft Nos 5A, 5B, 6A and 6B) are also located in bushland settings and isolated from residential receivers (**Figure 2**).

6.8.8 The operational noise criteria for the existing Dendrobium Mine (as set out in DA 60-03-2001) were derived in accordance with the previous *Industrial Noise Policy* (INP), which was superseded in October 2017 by the NPfI. Because the continued use of the existing surface facilities is part of the Project, the existing noise criteria in the current consent must be re-assessed and recalculated in accordance with the NPfI, even if no change to noise emissions would result from the Project. Because the NPfI's methodologies differ somewhat from those in the INP, consented noise emissions criteria for some existing receivers would change (either somewhat higher or lower) if the Project is approved. This issue is addressed in detail in South32's RTS.

6.8.9 In project noise assessment, the Rating Background Level (RBL) is the background noise level determined, in accordance with the NPfI, without the subject premises in operation. The NBA reports that background noise monitoring was conducted by Renzo Tonin in June and July 2018 at three locations close to key Dendrobium Mine surface facilities. The measured noise levels were then used to determine RBLs for each residential receiver, based on proximity to the background noise monitoring sites and location. Where *measured* background noise levels were below the *minimum* levels specified in the NPfI, then the NBA adopted the applicable minimum criteria as the RBLs.

6.8.10 The RBLs were then used to develop 'intrusiveness criteria' for the management of Project noise emissions at nearby residential receivers. These criteria are 5 dB(A) higher than the applicable RBL. The intrusiveness criteria calculated in the NBA for the three Project surface facilities that have nearby residential receivers are shown in **Table 15**.

Table 15 | Intrusiveness Criteria for the Project's Surface Facilities *(Source: EIS)*

	Intrusiveness Criteria, $LA_{eq(15min)}$ dB(A)		
Project Noise Emission Source	**Day**	**Evening**	**Night**
Dendrobium Pit Top	40	37	37
KVCLF	40	40	39
Dendrobium CPP	45	45	45

6.8.11 The NPfI also contains 'amenity criteria', partly to address cumulative emissions in crowded noisescapes, such as near the Port Kembla industrial precinct. In most parts of the Project area, such as in Areas 5 and 6 and close to the proposed ventilation shafts, the NPfI's 'rural' amenity criteria apply. However, close to the Dendrobium Pit Top and the KVCLF, the NBA applied the 'rural residential' amenity criteria, as is appropriate. Close to the Dendrobium CPP, the NBA applied the 'suburban' amenity criteria, although the Department considers that the less stringent 'industrial interface' criteria would also be appropriate.

6.8.12 The NPfI specifies that the lower of the calculated 'intrusiveness' and 'amenity' criteria are to be applied as Project Specific Trigger Levels (PSTLs) at residential receivers, whereas the amenity criteria apply as PSTLs at all non-residential private receivers (such as houses of worship, school classrooms and rural caretaker's cottages).

6.8.13 The NBA shows that predicted Project noise emissions would comply with the relevant amenity criteria at *all* non-residential private receivers. Further, noise emissions from the Dendrobium CPP are predicted to meet the applicable intrusiveness criteria as well as both the 'industrial interface' and 'suburban' amenity criteria at the nearest residential locations.

6.8.14 Therefore, the only place where either the intrusiveness criteria or amenity criteria need to be further considered is in respect of the residential receivers close to the Dendrobium Pit Top and the KVCLF. The result of this further consideration is that the applicable 'intrusiveness' criteria are lower than the applicable 'amenity' criteria, and therefore become the PSTLs for receivers in these localities (see **Table 16**).

6.8.15 The NBA then assessed the levels of operational noise from the two facilities on this basis. The NBA determined that, without operational controls (such as equipment restrictions) noise modelling indicated potential for exceedances of the PSTLs at a high number of residences close to the Dendrobium Pit Top, particularly in shift change-over periods when more mobile equipment would be active. The NBA therefore applied a number of operational controls that were considered to be 'reasonable and feasible' in terms of the NPfI. These controls included:

- restricting surface vehicle movements (eg limiting operation of forklifts) from 10.00 pm to 6.15 am;
- restricting vehicle access to the site (other than personnel passenger vehicles) through amending allowable travel times in the site's Drivers' Code of Conduct; and
- closing the main workshop door during the evening and night-time periods.

6.8.16 The NBA modelled that these operational controls would significantly reduce noise emissions from the Dendrobium Pit Top during the more sensitive evening and night-time periods.

6.8.17 Of the scores of individual locations assessed in the NBA regarding noise emissions, only five privately-owned residential receivers are predicted to exceed the calculated PSTLs. Four of these (R6a, D0065, D0066 and D0071) are located in the village of Mount Kembla and are amongst the closest privately-owned residential receivers to the Dendrobium Pit Top. The remaining receiver (R39a) is in the centre of the Kemira Valley and affected by noise emissions from the KVCLF, located at the head of the Valley. The relevant PSTLs and predicted noise emissions for these five locations are shown in **Table 16**.

6.8.18 **Table 16** shows predicted operational noise levels under worst-case scenarios, ie under 'adverse' meteorological conditions, as required by the NPfI. It can be seen that, after the application of 'reasonable and feasible' operational controls (which are also a requirement of

the NPfI), most predicted exceedances of the PSTLs are only 1-2 dB(A) above the 'trigger level'. Such exceedances are deemed to be 'negligible' under the NPfI because the ears of most people cannot readily discern such differences in noise levels.

Table 16 | Predicted Operational Noise Levels under Adverse Conditions at Potentially Affected Privately-owned Receivers Close to Dendrobium Pit Top and KVCLF *(Source: RTS)*

	PSTLs, $LA_{eq(15min)}$ dB(A)			Predicted Operational Noise Levels, $LA_{eq[15min)}$ dB(A)			
Receiver	**Day**	**Evening**	**Night**	**Day (max)**	**Evening (max)**	**Night: 10 pm to 6:15 am (max)**	**Night: 6:15 to 7:00 am (max)**
R6a	40	37	37	41	**40**	**40**	27
D0065	40	37	37	40	39	39	25
D0066	40	37	37	41	39	38	28
D0071	40	37	37	41	39	38	38
R39a	40	40	39	39	40	40	40

Green text indicates a 1-2 dB(A) exceedance of the PSTL
***Red** text indicates a 3-5 dB(A) exceedance of the PSTL*

6.8.19 However, at receiver R6a, the NBA calculated that exceedances would be up to 3 dB(A) above the relevant PSTL. The NPfI categorises such exceedances as 'marginal'. The VLAMP requires that such receivers are offered architectural and similar treatments that reduce the expected exceedances. This receiver has not previously been offered such mitigation rights, as application of the NPfI leads to a lower PSTL at this location than was the case under the previous INP. This is primarily because of the NPfI's requirement to model noise impacts under 'adverse' weather conditions. The RTS reports that South32 is currently consulting with receiver R6a regarding potential mitigation measures to manage noise impacts.

6.8.20 The NBA predicts that receivers close to Project facilities would not be affected by any sleep disturbance or cumulative noise issues.

6.8.21 After considering South32's RTS, the EPA expressed satisfaction with the NBA and its assessment of the Project's operational noise impacts. The Department is similarly satisfied. It notes again that the existing noise environment at Dendrobium Mine would not change in any material manner. However, the necessary application of the NPfI has led to slightly different PSTLs and therefore slightly different intrusive noise criteria.

Operational Rail Noise

6.8.22 The Kemira Valley Rail Line is used to carry all Dendrobium Mine's ROM coal from the KVCLF to the Dendrobium CPP, passing through the suburbs of Mount Kembla, Cordeaux Heights, Unanderra and Cringila.

6.8.23 Both the KVCLF and the rail line predate by many years the commencement of operations at Dendrobium Mine. A rail line from Mt Keira Colliery to Port Kembla was first developed in 1861. The KVCLF was developed in the late 1940s. More than 500 receivers within the Mount Kembla, Cordeaux Heights and Unanderra communities are located within 200 m of the rail line. Most residences in Cordeaux Heights, Cringila and Mount Kembla located close to the rail line were constructed well after it was developed. Rail noise from coal trains has been an ongoing feature of the noise environment for this community for at least 80 years, other than for a brief hiatus between the year 2000 and the commencement of coal dispatch from Dendrobium Mine in September 2003.

6.8.24 The mine's existing consent prohibits train movements on the rail line between 11.00 pm and 6.00 am. Operational limitations at Dendrobium CPP generally prevent rail journeys on the Rail Line exceeding 10 per day. The EIS states that South32 is not seeking to remove or vary any of these limitations. In essence, the Project involves a continuation of the existing approved level of rail traffic and consequent impacts, rather than any increase in either traffic or impacts.

6.8.25 However, noise from laden and unladen coal trains on the rail line, particularly brake squeal and wheel squeal, has been a key operational noise issue for South32. The track geometry consists of relatively tight curves which can increase the likelihood of squeal events caused by the wheel/track interface and/or brake related issues. The fundamental reason for ongoing brake squeal is the need to apply brakes to slow laden coal trains as they descend the steep grade from the foothills of the Illawarra Escarpment to the coastal plain. Wheel squeal can occur on both ascent and descent along the line, due to the tight curves.

6.8.26 In 2015, South32 trialed and implemented a range of improvements to braking activities on the Kemira Valley Rail Line to reduce brake and wheel squeal noise, including:

- use of on-board data loggers to increase consistency of driver behaviour;
- review and trial of dynamic/dual braking (engine and brakes);
- use of dynamic braking as standard practice for a key rail noise impact section; and
- standardisation of braking durations.

6.8.27 Following a further detailed (four-stage) investigation in 2017 by Transport for NSW and Pacific National (the rolling stock operator), new brake shoes were fitted on all trains in FY2018. The NBA states that subsequent noise monitoring has shown a significant reduction in noise levels from brake squeal and a reduction in the number of brake squeal events. Apart from these key reductions, the total noise level for trains travelling downhill (ie when the brakes are applied) dropped by 4 to 6 dB(A), when averaged over the time period that it takes a train to pass the point of measurement.

6.8.28 As a result, the NBA reports that community complaints to South32 regarding rail noise dropped from 90 during FY2014 to 10 in FY2017 and five in FY2018. In addition, recent monitoring indicates that rail noise is compliant with existing criteria for rail haulage specified in the mine's current consent by a substantial margin (approximately 5 dB(A)).

6.8.29 However, more recently, the mine's Annual Review for FY 2019 reports that between April and June 2019, a total of 27 rail-noise complaints were lodged, with six across the remainder of the year. The great majority of these related to wheel squeal on a single corner during the

train's ascending journey. Following discussions with the rail contractors, the following actions were taken:

- review and trialing of different train speeds;
- track adjustments;
- track tamping; and
- installation of a new greasing unit on the line.

6.8.30 A noise monitor at an adjacent property monitored rail noise prior to and after implementing these improvements. The monitoring indicated that there was a reduction in the frequency and level of squeal events. Community complaints over rail noise dropped from 15 in April, to nine in May and three in June 2019.

6.8.31 During the first 11 months of FY20, the Department understands that there has been a total of 23 rail noise related community complaints at Dendrobium. Complaints have varied between zero and five in any month.

6.8.32 Project rail noise was assessed in the NBA according to the RING, which was introduced in 2013, many years after approval of the Dendrobium Mine in 2001. The EPA supported the use of the RING as the most applicable noise assessment and management guideline and the Department agrees with this position.

6.8.33 However, the RING is primarily intended to apply to new rail projects or rail redevelopment projects which require environmental impact assessment and approval. It does not contain any provisions which deal directly with existing or legacy rail lines. The RING sets out methodology for assessing rail traffic generation on existing network (ie 'public') and non-network (ie 'private') rail lines. As the Kemira Valley Rail Line would continue to be used exclusively by Dendrobium Mine, the NBA's assessment of rail operational noise is based on a non-network rail line exclusively servicing industrial sites.

6.8.34 The RING contains varying rail noise criteria for such private rail lines, according to the receiving environment. The two sets of criteria applied in the NBA are for a 'suburban' environment (eg Cringila) and a quieter 'rural' environment (eg Mount Kembla village).

6.8.35 The NBA concludes that Project-related rail movements cannot meet either set of noise assessment criteria at a substantial number of residences, due to the proximity of many houses to the rail line. If this was a new project, each of these homeowners would be entitled to request noise mitigation measures to be installed at their residence. However, the VLAMP contains an exception to this entitlement for this type of legacy operation, as follows:

> "*A consent authority can apply voluntary mitigation and voluntary land acquisition rights to reduce … rail noise impacts of a development on privately owned land near a non-network rail line (private rail line), that is on, or exclusively servicing an industrial site … But not … Modifications of existing developments with legacy noise issues, where the modification would have beneficial or negligible noise impacts"*.

6.8.36 The EPA noted the VLAMP's exception and did not raise concerns. The Department also considers that it is appropriate to apply the exception to the Project, given its legacy nature. In this respect, the Department notes that:

- the majority of community complaints regarding rail noise have related to brake squeal and wheel squeal, rather than to the general rail noise associated with locomotive engines and movement of rail wagons;
- detailed investigation of brake squeal undertaken by Transport for NSW and Pacific National between December 2015 and July 2017 led to a program to replace all brake shoes on rolling stock during FY2018;
- South32 maintains an active program which seeks to reduce brake squeal and wheel squeal on the rail line;
- the Project involves no increase in either rail traffic or predicted rail noise impacts over the existing and approved levels; and
- the frequency of community complaints relating rail noise dropped markedly after January 2016 and over the past two financial years have averaged two or three per month.

6.8.37 The existing consent already contains a detailed set of strict rail haulage noise emissions criteria. These criteria primarily address maximum locomotive noise during train pass-bys, rather than averaged noise levels over the entirety of the applicable noise measurement periods (ie the 9-hour daytime and 4-hour evening periods). As it is short-term noise peaks which are of primary concern to nearby residents, noise averages based on a general maximum of 10 train journeys over these 13 hours would appear to offer little benefit to nearby residents.

6.8.38 The existing consent also contains a condition addressing continuous improvement in noise management (including in respect of the rail line) and a separate condition directly addressing wheel squeal and brake squeal, in the following terms:

"The Applicant must use its best endeavours to minimise wheel squeal, brake squeal and locomotive wheel slippage arising from rail haulage on the Kemira Valley rail line."

6.8.39 The Department also considers that the existing conditions are appropriate, particularly as the RING's criteria could not be achieved at a substantial number of residences. That is not to say that further opportunities to reduce rail noise (eg dampening on the front wheels and possible muffler improvements on ARTC's locomotives and additional and improved lubricators to better address wheel flanging noise) cannot be identified and implemented. These matters should be addressed in a new Noise Management Plan for the Project, if it is approved.

6.8.40 The draft consent conditions relating to rail noise as proposed by the Department contain updated content but are otherwise equivalent to those in the existing consent, including the current rail noise criteria.

Construction Noise

6.8.41 Project surface construction activities would generally be undertaken during the ICNG's recommended standard construction hours (ie Monday to Friday: 7.00 am to 6.00 pm, Saturday: 8.00 am to 1.00 pm, no work on Sundays or public holidays). However, some construction works would occur outside these hours, such as on Saturday afternoons, and development of ventilation shafts would take place 24 hours per day, seven days per week.

6.8.42 The NBA assessed potential noise impacts for the key construction activities proposed to occur at the Dendrobium Pit Top, Cordeaux Pit Top and Ventilation Shaft Sites 5A and 6B. These sites are the closest to receivers and construction activities would generate significant

noise. Construction activities at other Project locations would be relatively minor and temporary in nature or else are remote from potential receivers.

6.8.43 Construction noise is most likely to be of potential concern to those residents living close to the Dendrobium Pit Top, where activities would include construction of additional car parking facilities, extension of built infrastructure (eg bathhouses and administration buildings) and new electricity distribution infrastructure.

6.8.44 The ICNG is based on the expectation that residential receivers would not react to construction noise levels that do not exceed the RBL plus 10 dB(A) $L_{Aeq(15min)}$ during standard hours, or that do not exceed the RBL plus 5 dB(A) $L_{Aeq(15min)}$ outside standard hours. It considers these levels as the thresholds for residences to be 'noise affected' by construction activities. The ICNG recommends that developers should adopt all 'reasonable and feasible' measures to reduce exceedances of these levels and also inform affected residents of their proposed activities.

6.8.45 The ICNG also establishes a 'highly noise affected' level of 75 dB(A) $L_{Aeq(15min)}$ where 'strong' community reaction might be expected to construction noise. The NBA concluded that no privately-owned residences would be 'highly noise affected' by any Project construction.

6.8.46 All proposed construction activities at the Dendrobium Pit Top are short-term in nature. The noisiest activity would be construction of the proposed carpark extension, which would take from four to eight weeks to complete. For these reasons, South32 has committed to limit this activity to the standard construction hours noted above.

6.8.47 Renzo Tonin modelled potential construction noise at the Dendrobium Pit Top with and without the carpark extension. Assuming concurrent construction, under adverse meteorological conditions, some 25 nearby residences are modelled to experience daytime noise levels higher than the 45 dB(A) $L_{Aeq(15\ min)}$ noise management threshold (ie RBL plus 10 dBA), with the highest predicted noise levels being 57 dB(A) $L_{Aeq(15\ min)}$ at the two closest receivers. The closest private receiver is some 200 m from the site of the proposed extension.

6.8.48 Without carpark construction, only the three closest residential receivers (ie R6a, D0066 and D0071) would be 'noise affected' during standard construction hours. For the limited construction activities proposed to take place outside of standard hours, this number would increase to six (ie R6a, D0066, D0069, D0070, D0071 and D0078).

6.8.49 It is apparent that the great majority of predicted exceedances would be as a result of the carpark extension (ie regardless of whether this activity occurred at the same time or separately to the other Pit Top works). Therefore, there is little or no benefit in staging the Pit Top construction activities, which would otherwise extend their duration.

6.8.50 South32 has advised that it would manage construction noise for the Project by implementing mitigation measures as per the ICNG, which would include:

- notifying noise affected residences prior to commencing and during construction;
- providing information regarding proposed noise mitigation measures (eg the Mine's Noise Management Plan);
- selecting equipment type and location, as well as work practices to generate less noise (eg noise-attenuated equipment);

- minimising use of equipment where practicable (eg turning off equipment not in use, minimising use of reversing alarms on mobile plant);
- ensuring equipment is appropriately maintained, repaired and/or replaced;
- using equipment in a manner that minimises noise, avoiding use of radios or stereos outdoors and avoiding dropping materials from heights; and
- handling complaints in a prompt and responsive manner, including implementing additional control measures where reasonable and feasible.

6.8.51 Given that construction at the Pit Top is not expected to exceed eight weeks in duration, that the noisiest activity would be undertaken only during standard construction hours and that modelled noise emissions would not exceed 57 dB(A) $L_{Aeq(15\ min)}$ at the two closest receivers, construction noise is not expected to significantly affect the amenity of nearby residents.

6.8.52 Construction of the proposed Ventilation Shaft and related infrastructure would occur 24 hours per day, seven days per week. However, there are no nearby private receivers. Predicted construction noise levels for nearby non-private receivers would comply with the ICNG.

6.8.53 The EPA expressed no concerns over potential construction noise impacts and the mitigation measures proposed by South32. The Department agrees with this position.

Road Noise

6.8.54 The NBA assessed road traffic noise in accordance with the RNP.

6.8.55 Given that all coal from the Project would be transported by rail, the main contributors to Project-related road noise near the Dendrobium Pit Top are arrival and departure of workers during shift changes and deliveries to the site. Dendrobium Mine currently contributes 19.7% of traffic flows on Cordeaux Road east of Mount Kembla village and 4.9% to the west of the village. The mine contributes a very small percentage of movements on any other local or arterial road.

6.8.56 The EIS's Road Transport Assessment reports that, currently, there is a weekday average of 474 one-way light vehicle trips and 54 one-way heavy vehicle trips to Dendrobium Pit Top. Peak trips are between 66 and 77 vehicles per hour, during early morning and late afternoon shift changes, Monday to Thursday.

6.8.57 Traffic movements to and from the Dendrobium Pit Top are controlled by South32 via a Drivers' Code of Conduct which includes restrictions on vehicle access during both night-time hours and day-time peak traffic periods. Since FY2015, there has only been one complaint received in relation to road transport noise for the Dendrobium Mine.

6.8.58 The current workforce at Dendrobium Mine is approximately 400 persons. This is predicted to increase to about 500 persons in 2027. In addition, there would be up to 200 additional contractor positions required for construction and underground mine development.

6.8.59 Because the Cordeaux Pit Top is located in a bushland environment with no nearby sensitive receivers, the road noise assessment focused on Cordeaux Road east of Mount Kembla village as the road segment most likely to be affected by noise generated by ongoing and increased road traffic movements. The NBA considered road traffic noise for the following Project years:

- Year 2020 – peak total workforce at Dendrobium Pit Top, including short-term construction and ongoing operational workforce;
- Year 2027 – peak operational workforce at Dendrobium Pit Top; and
- Year 2035 – operational movements at Dendrobium Pit Top following primary mine access relocating to Cordeaux Pit Top.

6.8.60 The NBA predicts traffic noise levels at the closest affected receiver location on Cordeaux Road, east of Mount Kembla village, for each of these three Project years, based on the EIS's traffic projections. Because of construction-related traffic, Year 2020 is anticipated to lead to the greatest increase in traffic (up from 688 trips per day to 998 trips per day).

6.8.61 Noise levels resulting from night-time total traffic movements are predicted to comply with the relevant RNP criteria for each of the three years as modelled.

6.8.62 Noise levels from day-time total traffic movements are predicted to exceed the RNP's applicable criteria for all modelled years, either with or without Project traffic. However, the RNP contains provisions that address these relatively common-place exceedances. The RNP states that, in such cases, an increase of up to 2 dB(A) is considered to be barely perceptible and is therefore acceptable.

6.8.63 Predicted increases in noise levels resulting from the Project during both day-time and night-time are small, and are well below this relative increase criterion.

6.8.64 Traffic movements would continue to be controlled via Dendrobium Mine's Drivers' Code of Conduct. South32 would also continue to encourage construction workers and operational workers to carpool to reduce employment-related traffic movements to and from the Dendrobium Pit Top or the Cordeaux Pit Top.

6.8.65 The EPA expressed no concerns over potential road traffic noise impacts. The Department agrees with this position.

6.9 Air Quality

Greenhouse Gas Emissions

6.9.1 The EIS contains a detailed Air Quality and Greenhouse Gas Assessment (AQGGA) which includes an assessment of the Project's predicted greenhouse gas emissions (GHGEs). Under the internationally recognised Greenhouse Gas Protocol, three 'Scopes' of GHGEs (Scope 1, Scope 2 and Scope 3) are defined for accounting and reporting purposes.

6.9.2 Scope 1 emissions are direct emissions from sources owned or operated by the entity being accounted for. Scope 1 emissions assessed for the Project include diesel combustion, CO_2 resulting from deliberate flaring of drained mine methane, fugitive mine methane emissions, rail transport of ROM coal to Dendrobium CPP and road transport of product coal to PKCT and coal washery waste from Dendrobium CPP to the West Cliff CWE. Scope 2 emissions are limited to emissions associated with generation of electricity purchased for the operation of the Project. Scope 3 emissions are a range of indirect or 'consequential' emissions (either upstream or downstream). The ACGGA has assessed Scope 3 emissions from the Project as the downstream combustion of all product coal, as is commonplace.

6.9.3 The EIS states that the key measure proposed to minimise the Project's direct GHGEs is flaring of pre- and post-drainage gas "to the greatest extent practicable". Total Scope 1 emissions over the life of the Project were calculated in the AQGGA as approximately 17 to 22 Mt of carbon dioxide-equivalent (CO_2-e), depending on the proportion of methane that is actually recovered and flared.

6.9.4 Generally speaking, there are much higher percentages of methane in mine gases recovered by pre- and post-mining drainage than there is in 'mine ventilation air', which circulates in the workings to enable personnel to breathe and internal combustion engines to operate. These higher percentages commonly allow mine drainage gases to be combusted, which would reduce the associated greenhouse warming potential from that of methane to that of CO_2 (ie a reduction >95%).

6.9.5 The AQGGA's calculation of Scope 1 emissions includes fugitive and/or flaring emissions associated with already-approved mining in Areas 3B and 3C that would occur during the life of the Project, until roughly 2030. This is considered to be conservative, as mining these areas would take place under the existing consent, notwithstanding that delivery of this coal to the Dendrobium CPP and its processing and sale would take be part of the Project.

6.9.6 On this basis, annual average Scope 1 emissions are expected to be between 0.59 and 0.77 Mt CO_2-e per annum over the life of the Project. The Project's direct contribution to Australian emissions would be relatively small. Annual average Scope 1 emissions would be approximately 0.5% of NSW's and 0.1% of Australia's annual GHGEs.

6.9.7 Total Scope 2 emissions over the life of the Project are estimated to be approximately 1.7 Mt CO2-e, or an average of about 0.1 Mt CO_2-e per annum.

6.9.8 Total Scope 3 emissions from the combustion of product coal by third parties (ie customers such as the BlueScope Steelworks, Liberty Primary Steel Steelworks or various international steelworks) are estimated within the AQGGA to be approximately 237 Mt CO_2-e over the life of the Project, or an average of about 8.2 Mt CO_2-e per annum. This figure is 11 to 14 times higher than the predicted direct emissions of the Project.

6.9.9 South32's Amendment Report (see **Appendix D**) included a revised estimate of the Project's Scope 3 GHGEs. Based on the proposed reduction in ROM coal production of 0.5%, Scope 3 emissions over the life of the Project were estimated to reduce (by the same proportion) to 235.9 Mt CO_2-e and annual average emissions to about 8.1 Mt CO_2-e. These reductions are very small and not material to the assessment of the Project. The Amendment Report contained no estimates of reductions in Scope 1 and Scope 2 emissions, as they would be even smaller in quantum and not statistically significant.

6.9.10 No State agency expressed significant concerns relating to GHGEs. However, GHGEs were a matter of significant concern to a large number of special interest groups and members of the community and to WCC. Of the 152 public objections to the Project, 104 raised concerns over GHGEs, which was the 2nd most frequent ground for objection. WCC provided detailed commentary on the EIS's assessment of GHGEs and considered that South32 should prepare a revised greenhouse gas assessment report. WCC's position was based on a resolution of its Council in August 2019 that *"Council recognises we are in a state of climate emergency that requires urgent action by all levels of government."*

6.9.11 South32 responded to the issues raised in community submissions and by WCC in its RTS and also in its later correspondence to the Department and WCC of 6 May 2020. WCC's response to this additional information was solely that the RTS *"does not adequately address the downstream greenhouse gas emissions relating to approximately 40% of the coal from the project, which would be sent to elsewhere in Australia or rest of the world."* This position seems to accept the direct GHGEs associated with the mining of coal by the Project and the Scope 3 emissions from its use at the BlueScope Steelworks, but seeks further consideration of downstream GHGEs that take place outside of the WCC LGA.

6.9.12 The Department acknowledges that the mining of coal and its combustion is a major contributor to anthropogenic climate change, which has the potential to impact future generations. However, the Department considers that the key areas for active management of GHGEs within the development assessment and approval process for new projects in NSW are reductions in direct (ie Scope 1) emissions and improved energy efficiency (ie reduction and efficiency in the use of fuels and bought-in electricity).

6.9.13 In terms of orthodox GHGE accounting, only Scope 1 and Scope 2 GHGEs are within the control of an entity, and therefore only they are able to be directly controlled or otherwise managed by a consent authority. It is a fundamental principle of accounting to avoid double counting, and it must be noted that one entity's Scope 3 emissions are another entity's Scope 1 emissions. More straightforwardly, GHGEs associated with burning coal to produce coke and burning coke to produce steel are accounted for at the BlueScope Steelworks, or at the other domestic or international steelworks where that combustion takes place.

6.9.14 This principle has been reinforced by Government legislation recently introduced to the NSW Parliament which would remove the specific emphasis on considering downstream GHGEs within clause 14 of the Mining SEPP and that consent authorities should not impose conditions that seek to achieve outcomes or objectives in international jurisdictions, as these matters relating to international trade and agreements, which are Commonwealth responsibilities.

6.9.15 Further, it is important to note that there is no current practical alternative to the use of coking coal (ie the key product of the Project in terms of both tonnage and value per tonne) for the large scale, economic production of virgin iron and steel. While progress is being made in regard to the development of 'green steel' technology based on using hydrogen as a fuel, the Department is not aware of any steelmaking in Australia or overseas able to produce steel in commercial quantities without relying on coking coal. It is likely to be many years before this technology is adopted at a scale that would significantly reduce global demand for coking coal.

6.9.16 In terms of Scope 1 and Scope 2 emissions, the Department considers that the Project's direct GHGEs and bought-in electricity use would make a very small contribution towards anthropogenic climate change at either the State, national or global scales. The Project contains proposals by which its direct GHGEs from drained mine gas may be substantially mitigated through flaring, which through combustion turns methane into CO_2, with its substantially reduced greenhouse intensity.

6.9.17 One of the four priorities of the State Government's new *Net Zero Plan Stage 1: 2020-2030* is to invest in innovative emissions reduction technologies. This Plan contains a proposed Coal

Innovation Program, which will focus on limiting fugitive methane emissions from coal mining through capture and combustion. This program has been prioritised for bilateral funding with the Commonwealth. The Department anticipates that South32 may seek support from this program to establish its proposed methane flaring infrastructure.

6.9.18 Wherever flaring of methane-rich mine gas is proposed, the possibility arises of using some or all of this methane to power gas engines to produce electricity, either for use at the mine, or else for export to the grid. At South32's Appin and Appin West mine sites (where the Bulli Seam is extracted), a total of 94 gas engines with a capacity of 81.4 megawatts (MW) produce up to 654 gigawatt hours of electricity annually, which is enough to power approximately 60,000 homes.

6.9.19 The EIS reports that analysis and modelling of potential gas liberation in Areas 5 and 6 indicates that this gas is expected to be highly variable in both quantity and composition; ie the flow of gas would not be constant and the methane percentage would be variable. On this basis, South32 considered that using the gas for electricity generation would not be feasible.

6.9.20 However, the Department considers that South32 should do more work to identify whether a reduced number of gas engines can safely be installed and operated in Area 5 (Bulli Seam) and/or both Area 5 and Area 6, to combust what could be considered to be a constant (or increasing) 'baseload' of methane, with any additional quantity of drained methane fluctuating above this baseload diverted to flare stacks. It may be possible that electricity so generated could be delivered directly underground through the same means by which drained gas is brought to the surface (ie through infrastructure installed in the ventilation shafts).

6.9.21 Even so, it would be a number of years before mining in Area 5 is likely to produce sufficient drained methane as might support installation of a small number of gas engines. Dendrobium Mine has an existing "Greenhouse Gas & Energy Efficiency Management Plan", which already makes provision for flaring of drained mine gases. However, South32 is yet to install flaring infrastructure in any of the mine's current five mining areas. South32 has stated that the reason for this is that the gas content (including methane) is low in Areas 1, 2, 3A and 3B (Wongawilli Seam) and that the demonstration of this is that no gas drainage infrastructure has been needed. Area 3C (Wongawilli Seam) has a high gas content, but the gas is rich in CO2, not methane. While gas drainage will be required for mine safety reasons in Area 3C, it may not be possible to flare any of this gas because it is so low in methane.

6.9.22 Current standard conditions for underground coal mines require preparation and implementation of an Air Quality and Greenhouse Gas Management Plan, which must include:

- description of measures to ensure capture of methane and its flaring or beneficial use;
- description of measures to ensure best practice management (including in respect of minimisation of greenhouse gas emissions and energy efficiency); and
- provisions for a detailed feasibility study of options for beneficial use of methane, to be completed within 2 years of commencing second workings.

6.9.23 The Department considers that these requirements are sufficient to ensure that South32 identifies any feasible option to install flaring infrastructure and/or gas engines to produce electricity in both Area 5 and Area 6.

6.9.24 Potential environmental costs associated with GHGEs are considered in **Section 6.9**.

Other Air Quality Impacts

6.9.25 The AQGGA includes an assessment of dust emissions and other potential air quality impacts from both the existing Dendrobium Mine and the Project, which includes:

- dust emissions from the Dendrobium Pit Top, KVCLF and Dendrobium CPP;
- dust, odour and products of combustion (eg oxides of nitrogen) emissions from upcast ventilation shafts and gas flaring infrastructure; and
- dust emissions from transporting ROM coal by rail along the Kemira Valley Rail Line.

6.9.26 Apart from very temporary and localised impacts associated with construction, the only significant air quality impacts which are additional to existing emissions from the existing mine are those resulting from the additional upcast ventilation shafts. This is because the Project does not propose any changes to the existing mine's rates of ROM coal production and transport. Thus, while modelling of future impacts always remains valuable, the best data on which to assess the expected air quality impacts of the Project are the existing background and mine monitoring data.

6.9.27 The AQGGA therefore collected background air quality data from the Dendrobium Mine's current air quality monitoring program and other relevant local and regional sources. These monitoring sites reflect the existing contributions of the Dendrobium Mine.

6.9.28 Monthly dust deposition rates are currently monitored at the Dendrobium Pit Top and KVCLF. Annual average total dust deposition rates for the period 2012-2016 at these two sites have varied from 0.7 g/m^2/month to 3.5 g/m^2/month and 1.8 g/m^2/month to 3.8 g/m^2/month respectively, with an average across both sites over this period of 2.5 g/m^2/month. These results indicate that there is somewhat more dust associated with the KVCLF than at the Pit Top. However, microscopic analysis indicates that only 20% and 30%, respectively, of the total dust deposition at these two sites is coal particles. The remainder is crustal dust, vegetation, insects and other fibrous matter. Dust deposition at the nearest privately owned receptors is much less than at either of the two South32 sites. The applicable standard is 4.0 g/m^2/month and is rarely approached, even at the South32 sites.

6.9.29 Monthly monitoring results for Total Suspended Particulates (TSP) and PM_{10} are similarly low. Mean TSP concentrations for the period 2012-2016 at these two sites varied from 27.6 µg/m³ to 53.1 µg/m³ and 19.0 µg/m³ to 32.4 µg/m³, respectively, with an average across both sites of 34.7 µg/m³. The relevant standard is 90.0 µg/m³.

6.9.30 The average annual background PM_{10} concentration at both sites is 17.7 µg/m³ over the same period. This is about 70% of the relevant 25 µg/m³ impact assessment criterion and is very similar to EPA monitoring results at urban sites in Kembla Grange and Wollongong.

6.9.31 Currently, there is no $PM_{2.5}$ monitoring undertaken at the Dendrobium Mine, as there are no $PM_{2.5}$ criteria included in the current consent. The EIS therefore has had regard to $PM_{2.5}$ monitoring at Kembla Grange and Wollongong. These results average 81% and 86%, respectively, of the relevant annual standard. There is no prospect that these results would be exceeded at the Dendrobium Pit Top or KVCLF, since $PM_{2.5}$ emissions in industrial and urban situations principally result from internal combustion engines and there will be many more of these at or near the two monitoring sites, rather than at Dendrobium Pit Top or KVCLF.

6.9.32 The AQGGA predicts that potential impacts from transport of ROM coal on the Kemira Valley Rail Line would be negligible and well below criteria for dust deposition and 24-hour PM_{10} and $PM_{2.5}$. Key reasons for this are that the average moisture content of the transported ROM coal is sufficiently high as to minimise dust lift off and that the transport distance is very short, which reduces the chance of the surface of the coal drying out.

6.9.33 It is not expected that odours and/or oxides of nitrogen emitted from either the existing or proposed upcast ventilation shafts or the proposed gas flaring infrastructure would lead to any significant impact on the environment or on sensitive receivers.

6.9.34 The only agency that expressed any concern relating to air quality impacts was the EPA, which sought further information to support its analysis of the AQGGA. This information was provided in South32's RTS and the EPA then raised no further issues.

6.9.35 An Air Quality Management Plan (AQMP) is currently implemented at Dendrobium Mine and deposited dust and particulate monitoring data is collected at a number of nearby sites. The AQGGA reviewed Dendrobium Mine's complaints data for the previous 10 years and identified that, on average, only one dust-related complaint is received each year.

6.9.36 This is not greatly surprising, as underground coal mines usually do not generate large amounts of dust. The key causes of dust generation at underground coal mines are unpaved roads in the vicinity of the pit top and dust lift off from coal stockpiles. At Dendrobium, all roads and other travel surfaces are sealed and also regularly cleaned with a road sweeper. Dust lift off from the stockpile and conveyors at KVCLF is controlled through the use of a system of automatic water sprays. Water carts operate at the Dendrobium CPP.

6.9.37 The Department is satisfied that the current Dendrobium Mine has relatively low levels of particulate matter and other air pollutant emissions. Further, the Project is not anticipated to lead to any significant increase in dust and related emissions. The Department recommends that contemporary air quality impact assessment criteria (including $PM_{2.5}$ criteria) are included in any consent granted for the Project. Subject to these revised criteria and a review of the mine's AQMP, the Department considers that the Project's air quality impacts are relatively low and are acceptable.

6.10 Economic Costs and Benefits

6.10.1 An Economic Assessment (EA) undertaken by Cadence Economics was included with the EIS for the Project. The Economic Assessment was prepared in accordance with the Government's *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (Guidelines) and its supporting Technical Notes.

6.10.2 Consistent with the Guidelines, the EA includes a Cost Benefit Analysis (CBA) and a Local Effects Analysis (LEA). The CBA provides an estimate of the net benefits of the proposed development across the State of NSW. As set out in the Guidelines, the LEA is intended to be complementary to the CBA by translating the effects estimated at the State level into effects on local communities. The LEA was based on analysis of the Australian Bureau of Statistics' Dapto-Port Kembla Statistical Area Level 3 (SA3) region.

6.10.3 It should be noted that the manufacturing, transport and mining sectors are of greater relative importance to the Dapto-Port Kembla SA3 regional economy than to the State economy, as the region is a major producer of steel products and port services.

6.10.4 Key potential economic impacts were also evaluated at a third scale – a broader region that the EIS termed the 'greater Wollongong area'; being Wollongong, Kiama, Shellharbour, Wollondilly, Campbelltown and Camden LGAs. The EIS reports that this scale is more appropriate to capture the residential localities and regional expenditure of the Project's workforce. It notes that, while only about 19% of the existing Dendrobium workforce resides in the Dapto-Port Kembla SA3 region, about 93% reside in this 'greater Wollongong area'.

6.10.5 The EA considered the effect of the Project in terms of key indicators such as employment, regional income, supplier benefit and net benefit. The EA used a computable general equilibrium model developed by Cadence Economics to examine regional economic effects.

6.10.6 The Department obtained an independent review of the EA by BAEconomics, whose principal is Dr Brian Fisher, a previous director of the Australian Bureau and Agricultural and Resource Economics. Overall, BAEconomics concluded that the EA "is comprehensive and the analysis is of high quality". Key elements of BAEconomics' review are included below.

6.10.7 The principal agency that provided comments concerning positive economic benefits flowing from the Project was MEG, whose views are set out in paras 5.3.62 – 5.3.64 above. No agency expressed significant concerns relating to negative economic impacts arising from the Project.

Cost Benefit Analysis

6.10.8 The EA's CBA evaluated the potential net benefits of the Project to the State of NSW. The key components of the CBA were:

- coal royalties accruing to NSW;
- company income and other tax payments attributable to NSW;
- net producer surplus attributable to NSW;
- economic benefits to NSW workers;
- economic benefits to NSW suppliers;
- net environmental, social and transport-related costs (including impacts on the Sydney water catchment) attributable to NSW;
- net public infrastructure costs (if any); and
- potential loss of surplus to other industries.

6.10.9 With the exception of environmental costs, all benefits listed above were determined using market prices, as prescribed in the Guidelines. The environmental costs were assessed in accordance with the Technical Notes.

6.10.10 The results of the CBA were that the Project would provide a net benefit to NSW. This net benefit was estimated to be $1,073.2 million in net present value (NPV) terms, comprising $497.8 million in direct benefits and $583.4 million in indirect benefits.

6.10.11 The great majority of direct benefits would flow to the State and local Governments, rather than as a producer surplus attributable within NSW. $272 million (NPV) would come to Government through royalties, payroll tax and Council rates. Nearly $151 million (NPV) would

come to NSW as Commonwealth company income tax apportioned to NSW. Only about $75 million (NPV) would come to NSW shareholders of South32 as distributions from the producer surplus.

6.10.12 Indirect benefits would accrue either to NSW workers employed by the Project ($365.8 million (NPV)) or to NSW suppliers of goods and services to the Project ($217.6 million (NPV)).

6.10.13 The CBA found that the great majority of the $102.4 million (NPV) in indirect costs to NSW that would arise from the Project is already incorporated in the Project's financials, and is therefore already accounted for in the CBA's headline numbers. Such indirect costs include:

- subsidence remediation works;
- rail noise investigation and reduction measures;
- purchasing water rights;
- implementing a biodiversity offset strategy; and
- other environmental management and mitigation costs.

6.10.14 However, there are additional indirect costs in respect of $PM_{2.5}$ emissions and direct GHGEs that are not already included in the Project's financials. The CBA found that these additional indirect costs totaled just $8.1 million (NPV) over the 28-year life of the Project. The great majority of this ($8.0 million) is in respect of current and continuing $PM_{2.5}$ emissions from the Dendrobium CPP, above-ground diesel consumption and the KVCLF.

6.10.15 At full development, the Project's operational workforce would be in the order of 500 full-time equivalent personnel, including both direct South32 employees and on-site contractors.

6.10.16 Construction and development would require up to approximately 207 additional personnel in the first year of the Project. Other construction activities (eg for ventilation shafts) would be undertaken at other times over the life of the Project, with smaller associated construction workforce peaks.

6.10.17 The projected direct employment would lead to gross income for the NSW economy of $1,802.3 million (NPV) and an associated increase in worker benefit of $365.8 million (NPV).

6.10.18 Approximately 75% of the mine's current and expected suppliers are currently based in NSW. Their supply of goods and services to the Project would result in a net supplier benefit (ie producer surplus) for the NSW economy of $217.6 million (NPV). The projected increase in gross state product for NSW is $2,285.8 million (NPV).

6.10.19 The central case assumptions in the CBA were South32's proposed $731.6 million in capital expenditure (for mine development, equipment replacement and sustaining capital) and average coal prices of $173.2 per tonne for metallurgical coal, $92.9 for thermal coal and $136.5 for PCI coal (in 2018 AUD). The CBA included a sensitivity analysis which showed that the estimated net benefits of the Project are 'robust' in that they remain strongly positive after testing all the key assumptions used in undertaking the analysis.

6.10.20 The review by BAEconomics concluded that the EA is well presented, logically set out, comprehensive and consistent with the Guidelines. BAEconomics considered that, as with most CBAs for mining projects, the calculation of net benefits is most sensitive to product coal price assumptions. In this respect, BAEconomics stated that the EA's "assumed long run real price of hard coking coal of $173/t is close to the Commonwealth Government's most recent

long-term forecast of $184/t published in March 2020". Further, "even with an assumed lower bound on coal prices of 25 per cent below the central case, the Project remains NPV positive."

6.10.21 South32's Amendment Report (see **Appendix D**) included a revised estimate of the Project's net benefit to NSW as a result of that Report's 0.5% reduction in projected ROM coal production (from 77.6 to 77.2 Mt). Rather than fully revise the EA, the Amendment Report simply reduced the EA's calculation of the net benefit to NSW ($1,073.2 million NPV) by 0.5% to $1,069.6 million NPV. The Report similarly reduced the EA's calculations for royalties, rates and payroll tax; attributable net producer surplus; attributable company income tax and net benefit to NSW suppliers. On this basis, the Report estimates that the reductions in Project value would be $2.4 million NPV to State and local Government and $1.1 million NPV to NSW suppliers, with no reduction in benefits to NSW workers.

6.10.22 The Amendment Report made no reductions in the environmental costs of the Project, which were (conservatively) assumed to remain at the levels calculated in the EA.

6.10.23 In addition, it is noted that South32's revised commitments such that the Project results in a "net gain to Metropolitan water "supplies would also result in additional Project costs, which would also reduce the Project NPV to a small degree.

6.10.24 The Department has not sought an updated CBA from South32 which fully reflects these changes to the Project and other changes to Project economics since the CBA was completed in May 2019. The Department considers that all such changes would be small and are unlikely to materially reduce the benefits accruing to State and local Governments beyond the 0.5% reduction identified in the Amendment Report. South32's increased commitments regarding water offsetting would actually reduce the environmental costs of the Project, at South32's cost, as is appropriate.

Local Effects Analysis

6.10.25 The LEA assesses the costs and benefits of the Project on residents of the Dapto-Port Kembla SA3 region. The analysis shows an estimated net benefit of $116.1 million (NPV) to this local area over the life of the Project, including:

- benefits to local workers of $71.8 million (NPV);
- benefits to local suppliers of $42.5 million (NPV), based on the assumption that 15% of inputs to production are locally sourced; and
- payment of local council rates of $3.0 million (NPV).

6.10.26 The EA considered that its sensitivity analysis demonstrated that these estimated local effects are 'robust', with a lower bound estimate of local net benefits of $96.8 million (NPV) and upper bound estimate of $127.4 million (NPV).

6.10.27 BAEconomics reported that the LEA had been undertaken in a manner consistent with the Guidelines and that its assumptions regarding benefits and costs attributed to the local area appear conservative.

6.10.28 As noted above, the EA also included a regional analysis for the 'greater Wollongong area'. This analysis demonstrated benefits to regional workers much greater than in the LEA and much closer to the overall State analysis, seeing as a much higher proportion of employees (93%) are expected to come from this region. This equates to $341.7 million (NPV).

6.10.29 The region also is predicted to receive a considerably larger proportion of supplier benefits, given the estimate that 43% of such Project expenditure would be within the region. This equates to $92.8 million (NPV).

6.10.30 The Project is estimated to result in a total net benefit to the 'greater Wollongong area' of $431.3 million (NPV), which is approximately 40% of the overall net benefit to NSW.

Downstream Economic Costs and Benefits

6.10.31 The Project's potential downstream economic costs and benefits on BlueScope Steel and PKCT were not assessed in the EIS or the EA in any degree of detail, partly because such specific impacts are outside the scope of the Guidelines. The Department considered that the potential implications of approval or refusal of the Project on other key economic entities in the Illawarra Region should be examined carefully as part of the Project's assessment. The Department therefore engaged BAEconomics to undertake a separate study of these potential implications.

6.10.32 BAEconomics provided the Department with a detailed report titled *Review of the Key Economic Interactions between the Dendrobium Mine and Related Entities in the Wollongong Region* (see **Appendix F**). The key facts and conclusions which emerge from the report are discussed in the following subsections.

Port Kembla Coal Terminal

6.10.33 PKCT has an annual handling capacity of 16 Mt. However, its throughput is variable and has consistently trended downwards over the past five years, with the average throughput over the past two financial years being 44% less than during the period 2014-15 to 2016-17. South32 supplies around 70% of PKCT's current throughput. Other details regarding the structure and operations of PKCT are set out in **Section 3.5**.

6.10.34 The current coal export loading charge at PKCT is $6.50/t, compared to about $2.40/t at Port Waratah Coal Terminal in Newcastle, which has a very much higher throughput and much higher economies of scale. The highly competitive loading charge at Port Waratah, together with complicated rail transport logistics in western Sydney, limit the future likelihood of coal from the Western Coalfield being exported through PKCT. It is therefore likely that PKCT will remain highly dependent on coal from the Southern Coalfield for its future viability.

6.10.35 PKCT's cost base consists of approximately 80% fixed costs and 20% variable costs. Given this very high proportion of fixed costs, it follows that any significant fall in terminal throughput will have a detrimental impact on the average cost per tonne of coal exported.

6.10.36 PKCT provided advice that a total loss of Dendrobium coal exports would result in a 75% increase in its loadout costs per tonne. BAEconomics considered it 'likely' that an increase in charges of this level would make exports through PKCT 'economically marginal' under average conditions in the global coal market. Further, BAEconomics considered that the total loss of South32 product to PKCT (ie if the Bulli Seam Operations also closed) is "likely to lead to the closure of PKCT given its high dependence on coal from that company." The expiry of PKCT's lease in 2030 may add to its cost pressures at around that date.

BlueScope's Port Kembla Steelworks

6.10.37 BlueScope's annual requirement for hard coking coal is about 2.5 Mt, of which the great majority (2.2 Mt or 88%) is sourced from mines in the Southern Coalfield. Of this locally supplied coal, about 1.5 Mt (68%) is sourced from South32, 0.6 Mt (27%) from Metropolitan Mine and 0.1 Mt (5%) from Tahmoor Mine.

6.10.38 BlueScope's blast furnace is optimised to use coke with characteristics the same or very similar to that produced from the coking coal blend sourced from South32's two mines. However, BlueScope does and could use other sources of coking coal including coal shipped from Queensland mines. The main impediment to substituting large quantities of Queensland coal for coal currently sourced from South32 is BlueScope's limited import capacity at Port Kembla and the shipping costs involved.

6.10.39 BlueScope's domestic primary steel making operation at Port Kembla is not low cost from a global perspective. BlueScope considers its blast furnace operation to lie somewhere in the 3rd quartile of the global cost curve.

6.10.40 BlueScope estimates that upgrading its port infrastructure to significantly increase coal imports from Queensland would cost approximately $200 m. Shipping costs are estimated to be around $20/t. BlueScope estimates that this freight cost, together with unloading costs and the price differential on Queensland coal, would add about $40/t of coal (or around $100 m per year) to the cost of its blast furnace operation.

6.10.41 Around 2025, BlueScope will face a critical decision regarding continuing primary steel making in Australia as it decides whether to invest in excess of $500 m on relining its blast furnace. This decision will need to be made at around the same time as a potential reduction in availability of Wongawilli Seam coal due to the proposed staging of operations under the Project (ie production from the Bulli Seam in Area 5 would be coming on-line).

6.10.42 Given the projected cost of the reline, coupled with uncertainties and issues associated with the availability and coking characteristics of local coal and the additional cost of imports from Queensland, there is a risk that primary steelmaking will be discontinued at Port Kembla by the end of this decade. BAEconomics considered that the *"availability of a reliable long-term supply of local premium coking coal will remain of critical importance to [this] decision."*

6.10.43 BAEconomics concluded that "continued operation of BlueScope's primary steel production is dependent on the supply of local coal from the Southern Coalfield. If the supply of local coal is compromised then this would lead to a significant increase in operating costs for BlueScope, which ultimately would threaten the viability of iron and steel making at Port Kembla."

6.10.44 Other details regarding BlueScope's recent financial performance and its interconnectivity with South32's two mines are set out in **Sections 3.2 – 3.4**.

South32's Bulli Seam Operations

6.10.45 As noted above, South32 sells a blended coking coal product made of Bulli and Wongawilli Seam coals, with approximately two thirds of coming from Bulli Seam coal extracted by South32's Bulli Seam Operations. South32's cash cost for its total coal production (ie averaged across the two mines) was about $130/t ROM coal in FY19. However, Dendrobium is a low cost mine with high production and Appin is a high cost mine with lower production.

6.10.46 During the most recent quarter, the cash cost at Bulli Seam Operations was about $130/t ROM coal compared with $54/t ROM coal at Dendrobium. Bulli Seam Operations was not profitable to operate over that quarter. Operating costs at Appin place it in the 4th quartile of the global metallurgical coal mine cost curve. BAEconomics considered that Bulli Seam Operations is only likely to remain economically viable in the long term under one or both of the following circumstances:

- average global coking coal prices remain high; and/or
- production continues at design levels at Dendrobium Mine, thus allowing South32 to continue to average its cash costs across the two mines and continue to produce the blended coking coal product sought after by BlueScope and various export markets.

6.10.47 BAEconomics concluded that *"The Appin Mine is very high cost and Illawarra Metallurgical Coal is likely to be economically unviable as a business unit of South 32 without the ability to jointly operate both the Appin and Dendrobium Mines."*

6.10.48 Other details regarding the operations of the Bulli Seam Operations are set out in **Section 3.5**.

Other Coal Mines in the Southern Coalfield

6.10.49 BAEconomics also gave consideration to the potential flow-on effects to other coal mines in the Southern Coalfield (ie Metropolitan, Tahmoor and Russell Vale). BAEconomics considered that, should PKCT close, then it may well lead to the other mines in the Southern Coalfield becoming unviable, unless an existing mine could profitably operate without exports and could enter into a new contract to supply hard coking coal to BlueScope Port Kembla. Russell Vale Colliery, which is currently on care and maintenance, has no rail spur. Consequently, should PKCT close, it would be inevitable that Russell Vale would close permanently.

Further Economic Flow-On Effects

6.10.50 Application of the Australian Bureau of Statistics' latest Input-Output Tables[21] led BAEconomics to conclude (as might be expected) that both the coal and iron and steel sectors result in substantial positive flow-on effects to the rest of the NSW economy.

6.10.51 For every dollar invested in a coal mine, the economy would benefit by a further $1.01 (arising from materials supplied to the mine and consumption arising from its worker's labour income). For every dollar of wages for a job created in a coal mine, about $2.75 in additional wages income would result in the wider economy.

6.10.52 For every dollar invested in the iron and steel industry, the economy would benefit by a further $2.21. This is higher than coal mining, which is one of the most upstream industries in the overall economic supply chain. For every dollar of wages for a job created in the iron and steel industry, about $2.48 in additional wages income would result in the wider economy.

6.10.53 Jobs in both coal mining and the iron and steel sectors are relatively high paying. The average salary earned by an employee in the coal industry in FY18, including superannuation, was $116,100, which was about 63% higher than the average salary across all industries and 3.6 times the average salary earned in the food and beverage services industry. The average salary earned by an employee in the iron and steel industry in FY18, including

[21] These tables provide data on production, consumption and total economic multipliers for 114 separate industries across Australia.

superannuation, was $87,024, which was about 22% higher than the average salary across all industries or 2.7 times the average salary in the food and beverage services industry. BAEconomics considered that “creation of high-paying jobs is key to raising living standards and boosting the well-being of NSW society.”

6.10.54 Applying the Input-Output Tables in another way allows for measurement of jobs created across the economy as a result of an industry’s production. BAEconomics reported that, for an additional million dollars of output from the coal industry, 0.78 jobs would be created within that industry. When production and consumption flow-on effects are considered, the total number of jobs created in the whole economy would increase to about four. In simple terms, every million dollars of output from the coal industry leads to four jobs, only 0.78 of which would be in the industry itself. For iron and steel, an additional million dollars of output creates 7.83 jobs across the whole economy, of which 2.26 would be in the industry itself.

6.10.55 BAEconomics considered that there was a ‘worst-case scenario’ where ‘cascading closures [of South32’s two mines] lead to both the cessation of coal exports through PKCT and the production of primary steel at BlueScope.’ Using its derived multipliers, BAEconomics sought to estimate the overall cost to the economy should this happen.

6.10.56 BAEconomics applied the most recent Commonwealth projections for 2025 metallurgical and thermal coal export prices, providing an average price for all coal shipped at that time through PKCT of $205/t. Based on PKCT’s FY19 throughput of 7.29 Mt, this would be valued at about $1.49 billion. The value of BlueScope’s annual production of 3 Mt of blast furnace steel is about $2.4 billion ($800/t in FY19). Adding the two output values together, the direct annual output loss would be $3.89 billion per year for the domestic economy.

6.10.57 Using its derived output multipliers, BAEconomics estimated that the total output loss for the economy, including flow-on effects, would increase to around $10.7 billion per year. This excluded any output disruptions in downstream industries, as all domestic steel products were assumed to be replaced by imports. It also excluded any potential future losses arising from lost capabilities in the State or national economies.

6.10.58 Using its labour income multipliers, BAEconomics estimated direct labour income losses of about $610 million a year. For the overall economy, total labour income loss would increase to $2.14 billion a year.

6.10.59 Using its employment multipliers, BAEconomics estimated direct employment loss of about 6,586 workers. It then compared these estimates with actual numbers employed by the two industries in the region. BlueScope employs around 3,000 persons at Port Kembla and mines in the Southern Coalfield currently employ around 2,500 persons. Use of the multiplier may over-state likely direct job losses in NSW that would follow closure of primary steel making at Port Kembla, but is more reasonable if potential losses at Liberty Steel are taken into account. BAEconomics concluded that the likely direct job loss under the worst-case scenario in both the iron and steel and coal sectors in NSW but more particularly in the Wollongong region is likely to be around 5,500.

6.10.60 For the whole economy, the total job loss would increase to just under 25,000 workers This is the sum of nearly 19,000 job losses induced by the output loss of 3 Mt of crude steel and 6,000 job losses induced by the output loss of coking coal.

6.10.61 BAEconomics' conclusions regarding the interrelationships between Dendrobium Mine and the other key industrial entities in the Wollongong region are sobering. Rather than summarising them, the Department quotes them in full, as follows:

"In summary, the historical linkages and dependencies between Illawarra Metallurgical Coal and the primary steelmaking operations at BlueScope mean that the failure of one will compromise the other.

While it is likely that the overall operations of Illawarra Metallurgical Coal would be economically viable without coal offtake by BlueScope Steel, it would be unlikely to be viable to keep the Appin Mine operating should the Dendrobium Mine be forced to close. Without the Dendrobium Mine, it is likely that Illawarra Metallurgical Coal would be unviable as a business unit for South32 and the Appin Mine would also be closed, or possibly sold to a smaller player. The closure of these mines would lead to the immediate loss of around 1700 high paying jobs.

Without product from Illawarra Metallurgical Coal, PKCT would become unviable. This, in turn, may well lead to the closure of the remaining mines in the Southern Coalfield and the loss of a further 740 coal mining jobs. This would provide a second pathway by which BlueScope may be forced to close its primary steelmaking operation at Port Kembla with a consequent loss of around 3000 local jobs.

Conservatively, the closure of these coal mining and steelmaking operations could cost the local Wollongong region around $6.4b per year in lost regional product. The estimated loss to the Australian economy as a whole could be as high as $10.7b per year.

In conclusion, the ongoing economic viability of the premium hard coking coal mining, iron smelting and coal transport and shipping businesses located in and around the Wollongong-Port Kembla area and elsewhere in the Southern Coalfield of NSW is critically dependent on the continuing success of both Illawarra Metallurgical Coal and BlueScope Steel. Major changes in either of these businesses would have flow on effects to the other as well as to other significant coal and iron and steel related businesses. The annual economic loss under such a scenario could approach $10.7 billion per year with a large share of this loss falling directly on the Wollongong regional economy.

Therefore, the decision on whether or not to approve the extension of the Dendrobium Mine should be taken in the context not only of the net economic contribution of the mine itself but of the net contribution to the NSW community of the complex of coal, transport and iron smelting, steelmaking and steel fabrication businesses in the local region."

Conclusion

6.10.62 The Department notes that the BAEconomics report has been reviewed by senior representatives of South32, BlueScope and PKCT. None of these companies have raised any issues with the report's analysis or conclusions.

6.10.63 The issues examined in detail by BAEconomics were referred to in South32's EIS (see its section 9.1.3). They were also referred to by BlueScope in its submission (see **Appendix B**) and in its statements to local media (see **Section 3.4**). The issues were also referred to by WCC and MEG in their submissions (see **Section 5.3** and **Appendix E**). They were also referred to by a very large proportion of public and special interest group submissions in support of the Project (see **Sections 5.2, 5.3** and **Appendix B**).

6.10.64 The Department accepts the key assessments and conclusions of the BAEconomics report. It has no reason to question them to any significant extent. Any awareness of the highly integrated nature of the key industrial entities in the Wollongong region would identify the risks that BAEconomics has confirmed and quantified in detail for the purposes of this assessment.

Other Matters

6.10.65 In its review of the EA, BAEconomics also drew attention to the EA's Appendix C, which presents a broader economic analysis of the Project that includes the benefits of mining Area 3C. Mining of Area 3C is already approved under the existing consent and is not part of the Project's development application. However, the EIS states that it will take South32 a number of years to drain the high quantities of CO_2 found in the Wongawilli Seam in Area 3C. At the moment, South32 proposes to Mine Area 3C after Area 5 and before Area 6.

6.10.66 If the Project is not approved, or if mining of Area 5 is not approved, then this would affect the likelihood of Area 3C being mined as well, seeing as the mine would have only very limited production from around 2024 until gas drainage is complete. In fact, it is possible that South32 would close the Dendrobium Mine at that date, rather than accumulate significant costs during an interregnum until it can safely recommence operations in Area 3C.

6.10.67 BAEconomics stated that, if it is necessary to gain access to the new mine areas before Area 3C is mined, then the analysis presented in the EA's Appendix C represents an appropriate estimate of the overall benefits of the Project. Taking into account the mining of Area 3C, the Project's direct benefits to NSW would increase from $498 million (NPV) to $547 million (NPV).

6.10.68 A significant number of objections to the Project from community and special interest groups considered that the EA was deficient in not including an assessment of the downstream (ie indirect) environmental costs associated with Scope 3 GHGEs. South32's RTS noted that the EA also does not include an assessment of indirect economic benefits associated with the end use of product coal by domestic and international iron and steel manufacturers and other customers. Consequently, it is only appropriate that it does not include an assessment of downstream environmental costs from GHGEs generated by third parties. The Department agrees with this position.

Conclusion

6.10.69 Based on the review by BAEconomics, the Department accepts that the EA is a comprehensive and detailed assessment that has been undertaken in accordance with the applicable Guidelines and accompanying Technical Notes. The EA draws appropriately reliable conclusions in its CBA, LEA and regional analysis of the overall net benefits of the Project. The additional discussion in the EA's Appendix C is also useful.

6.10.70 However, neither the EIS nor the EA went into great detail regarding the potential interactions between the Project and the Bulli Seam Operations, the BlueScope Steelworks, PKCT and the other coal mines in the Southern Coalfield. This deficit has been remedied by a careful and comprehensive report provided to the Department by BAEconomics.

6.10.71 The BAEconomics report has demonstrated that most of the major industrial entities in the Wollongong region are highly integrated and interdependent. While loss of any one of these key entities would hold significant ramifications for the others, the most critical interdependencies relate to the key inputs to the industrial chain. In this case, South32's coking coal production is the key input to both BlueScope and PKCT. Of South32's two mines, production from Dendrobium Mine (ie Wongawilli Seam coal) is the most difficult to replace.

6.10.72 In the absence of approval of Wongawilli Seam production from any other mine,[22] the Department must conclude that approval of the Project is critically linked to the ongoing health and productivity of the key industrial entities of the Wollongong region and to the overall health of its economy and employment.

6.11 Social Costs and Benefits

6.11.1 The assessment of the Project's social costs and benefits has been placed towards the end of this report. This is not because of their perceived level of significance, but so that specific issues relating to social impacts (in particular impacts related to noise emissions and air quality emissions) could first be given focused and integrated consideration (see **Sections 6.8 and 6.9**). Other specific issues relating to social costs and benefits (eg heritage impacts, visual impacts and traffic-related impacts) are also separately addressed (see **Sections 6.11 and 6.12**). The social benefit of continued and increased employment opportunities is addressed in **Section 6.10**. **Section 6.11** only addresses social costs and benefits not elsewhere addressed in this report.

6.11.2 As the Project involves continued operation of the existing Dendrobium Mine without any increase in ROM coal production, it is clear that there would be limited social costs on top of those already arising from the mine for the directly-affected communities of Mount Kembla, Cordeaux Heights and Cringila. Given that the mine has been operating for close to 20 years, its associated employment, expenditure and community sponsorship form part of the existing social baseline for both the local and wider region.

6.11.3 The additional social costs of the Project are principally related to short-term construction-related impacts and the extra traffic associated with additional permanent positions. Noise, air quality and traffic impacts associated with construction and operations are addressed elsewhere in this report (see **Sections 6.8, 6.9 and 6.12)**.

6.11.4 The potential social impacts of the Project were not a key feature of community and special interest group submissions. While 87 such submissions objected to the Project on socio-economic grounds, the majority of these related to potential economic costs and the adequacy of the Economic Assessment. There were very low levels of community and special interest group objection to the Project on the grounds of noise impacts (3), traffic impacts (3), visual impacts (3) and non-GHGEs air quality impacts (1) (see **Figure 6**). In addition, no agency expressed concerns relating to negative social impacts arising from the Project.

6.11.5 A Social Impact Assessment (SocIA), undertaken by Elliot Whiteing, was included with the EIS for the Project. The SocIA considered the potential impacts of the Project on employment, population, community infrastructure demand and current social values; and was prepared in accordance with the Department's 2017 *Social Impact Assessment Guideline for State significant mining, petroleum production and extractive industry development*.

6.11.6 The SocIA considered the Wollongong LGA to be the primary region of social influence for the Project, as this is where the majority of its operational workforce is predicted to reside. The SocIA then focused on the local suburbs of Mount Kembla, Kembla Heights, Cordeaux

[22] It should be noted that no other mine in the Southern Coalfield currently extracts from the Wongawilli Seam, albeit that the Hume Coal Project proposes extraction from the Wongawilli Seam.

Heights, Unanderra and Figtree, as the areas where potential social impacts of the Project are more likely to be experienced.

6.11.7 The Project's continuation of existing employment would contribute to individual and household well-being for South32's employees and contractors and their families, and contribute to economic development. In addition, the SocIA's community consultation identified the potential for increased jobs as the most commonly identified benefit of the Project. Benefits from South32's existing community investment initiatives were also noted.

6.11.8 The SocIA identified that additional employees (whether permanent or construction related) would require additional services within the Wollongong LGA. These services would include temporary and permanent accommodation, health services and schooling. The SocIA considered that these additional demands are small in the overall context of the Wollongong LGA and that it is not expected that they would lead to any significant impacts on the provision of services to existing residents.

6.11.9 The SocIA reported that residents of Mount Kembla and Cordeaux Heights who were affected by rail noise from the Kemira Valley Rail Line described feeling stress and frustration, as well as occasional sleep disturbance.

6.11.10 However, it must be recognised that most families living close to the rail line would have purchased their properties while it was operational (since it has been operating since the 19th century). In fact, it is likely that a considerable number will have purchased their home after Dendrobium Mine commenced transport of coal by rail in September 2003. It is also reasonable to assume that the burden of regular intrusive rail noise was reflected within residential purchase prices at the time. Similarly, rental prices, also being market driven, are also likely to be lower closer to the railway line.

6.11.11 In addition, rail noise mitigation measures recently successfully implemented by South32 and Pacific National have resulted in a significant decrease in brake and wheel squeal noise and a consequent drop in community complaints (see **Section 6.8**). This is seen as a recent increase to the amenity of residents living close to the rail line.

6.11.12 The Project would have no direct impacts on privately-owned property, ie no private property requires to be purchased for the implementation of the Project.

6.11.13 The SocIA identified community concerns regarding the effects of proposed underground coal mining on water catchment values (eg water supply/quality) within the Metropolitan Special Area. These issues are separately addressed in **Section 6.3**.

6.11.14 The EIS reported that South32 would develop a Social Impact Management Plan (SocIMP) for the Project, if required by conditions of consent (see para 6.11.28 below).

Early or Eventual Mine Closure

6.11.15 If the Project is not approved, South32 has indicated that mining would likely cease in 2024, because Area 3C would not be ready to be mined. Even if this mining can be undertaken, the existing consent ends in 2030. If the mine does close in 2024 (or even 2030), this would lead to a number of very significant social impacts associated with mine closure.

6.11.16 The Dendrobium Mine's early closure would see the loss of approximately 265 jobs and 140 full-time equivalent contractor positions, which would be experienced as a significant loss to the mining labour force in the Wollongong LGA and adjoining areas.

6.11.17 In addition, there would be major effects on the Mine's suppliers of goods and services and its key customers, particularly the BlueScope Steelworks. These issues are further addressed in **Section 6.10**.

6.11.18 On the other hand, if the Project is approved, then the potential social costs associated with mine closure would be deferred by as much as 24 years, to a planned Project life of 2048.

6.11.19 The EIS states that the effects following closure of the Project at this deferred date are likely to be similar to those associated with closure in either 2024 or 2030, but of less magnitude. The basis for this reasoning is that Wollongong LGA's population would have grown more by 2048 and a more diversified economy is expected to have developed. The Department accepts this reasoning and its conclusion.

Developer Contributions

6.11.20 The EIS drew attention to the provisions of the EP&A Act governing voluntary planning agreements that may be entered into between a planning authority and a developer, and that these provisions are based on the developer's voluntary offer. South32 currently finances a number of community projects, primarily through an annual contribution per saleable tonne of coal, which is required by existing conditions of consent and is administered by its Dendrobium Community Enhancement Program (DCEP). South32 committed that financing of the DCEP would continue throughout the Project. Apart from this, South32 made no additional offer in respect of voluntary public purpose contributions.

6.11.21 The EIS also drew attention to the provisions of the EP&A Act permitting a consent authority to impose within its consent requirements developer contributions where the development would increase demand for public services, after having given consideration to local contributions plans.

6.11.22 Both WCC and WOSC have section 94 or 94A Contributions Plans that may be potentially applicable to the Project. However, neither Council (nor WISC) has proposed that South32 make local developer contributions.

6.11.23 The Department considers that the impact of the Project on the demand for local services is very limited. There would be up to 200 additional contractor construction personnel for surface facility construction and re-opening and development of underground gateroads and infrastructure to support longwall mining. A significant number of these would be associated with construction at the surface facilities sites in Area 5 and Area 6 and at the Cordeaux Pit Top, rather than at the Dendrobium Pit Top or KVCLF.

6.11.24 Because the existing Dendrobium Mine has been either in construction or operating since 2002, and the Kemira Valley Rail Line has been operating since the 19th century, most of the social costs and benefits associated with the Project have already been 'internalised' to the community.

6.11.25 On this basis, the Department considers that the most appropriate manner to provide for ongoing community contributions and other support for WCC is in respect of the continuation of existing conditions of consent regarding annual contributions per tonne of saleable coal and road maintenance.

Conclusion

6.11.26 The Department considers that the key social cost of the existing mine has been rail noise, principally associated with brake and wheel squeal. However, community complaints about rail noise dropped from 90 in FY2014 to five in FY2018 due to a number of improvements to rail operating behaviour and the fitting of new brake shoes. Community complaints over rail noise then increased to 33 in FY2019 but reduced somewhat to 23 in the first 11 months of FY20. This is an ongoing level of 2 or 3 complaints per month which, while regrettable, is not considered to be excessive.

6.11.27 The Department considers that the additional social costs of the Project, ie those associated with construction and additional traffic are very low and are greatly outweighed by the social benefits associated with permanent and construction-related employment. It does not consider that any social cost is sufficient as to stand in the way of approval of the Project.

6.11.28 Notwithstanding, the development of a SocIMP offers advantages for both South32 and the local community. The most important matter for South32 to address in terms of social impacts which have not already been 'internalised' in its relationships with the local and regional communities is eventual mine closure. For these reasons, the Department proposes the inclusion of its standard conditions regarding development of a SocIMP in any consent granted for the Project.

6.12 Heritage

Aboriginal Heritage

6.12.1 An Aboriginal Cultural Heritage Assessment (ACHA) was undertaken for the Project by Niche Environment and Heritage (Niche). The ACHA was undertaken in accordance with applicable guidelines. The ACHA built on more than 13 previous Aboriginal heritage surveys undertaken in the area since 1990. The majority of these surveys were undertaken for the Dendrobium Mine or South32's Bulli Seam Operations but some were independent academic work.

Surface Disturbance

6.12.2 New ground surveys undertaken as part of the ACHA focused on surface areas with potential to be directly disturbed which are located outside of the Dendrobium Mine's existing disturbance footprint (ie the proposed ventilation shaft sites and the Dendrobium Pit Top Carpark Extension). No Aboriginal heritage sites were found in the area of the proposed carpark extension. One new axe-grinding site (AGG-1) was found close to the proposed new Ventilation Shaft 5B Site. This heritage site is not expected to be directly disturbed by the proposed works and the EIS indicates that it would be fenced off during construction.

6.12.3 South32's Amendment Report (see **Appendix D**) stated that the *"location and design of the ETL corridor would avoid Aboriginal cultural heritage sites and areas of cultural sensitivity as*

far as practicable." However, while the ETL corridors have been located so as to avoid previously identified Aboriginal heritage sites, Niche did not undertake additional on-ground surveys before the Amendment Report was finalised.

6.12.4 Heritage NSW sought that that on-ground surveys are undertaken prior to surface disturbance associated with construction of the ETL infrastructure. The Department accepts this proposal and has recommended conditions to give it effect.

Subsidence Impacts

6.12.5 The principal risk to Aboriginal heritage from the Project arises from subsidence impacts associated with the two new mining areas, Area 5 and Area 6. The ACHA considered Aboriginal heritage directly above these two areas and also within a much larger boundary representing their predicted 20 mm subsidence contours. Within this larger area, the ACHA reported a total of 58 heritage sites, of which 52 were known from previous surveys.

6.12.6 These 58 sites include:

- 23 axe grinding groove sites;
- 34 sandstone shelters with art and/or archaeological deposits; and
- a single isolated artefact.

6.12.7 Of the 34 sandstone shelters, six were identified as having 'high' scientific (ie archaeological) significance. Each of these sites contains Aboriginal art and one contains a potential archaeological deposit. Of the axe grinding groove sites, three were identified as having 'moderate' archaeological significance. All other sites were identified as having 'low' archaeological significance. The ACHA notes that the Registered Aboriginal Parties (RAPs) participating in the ACHA consider that *all* Aboriginal heritage sites hold cultural significance, regardless of archaeological value.

6.12.8 The ACHA reports that *all* Aboriginal heritage sites within the subsidence footprint (ie all 58 sites) have a risk of being impacted. This is particularly the case since 57 sites are found in sandstone overhangs or on rock slabs close to watercourses. Solid rock is much more prone to subsidence impacts (such as cracking, block fall or collapse) than are soil-based sites.

6.12.9 However, it is not expected that all sites *would* be impacted. Firstly, the EIS reports that 15 of the 58 sites are outside the 35^{O} 'angle of draw' of the longwall voids and therefore have a relatively low risk of impact.

6.12.10 The ACHA also reports that, in 2017, researchers Regal and Reeves published a review of 206 Aboriginal cultural heritage sites in the Southern Coalfield that had been subject to mining subsidence since 1990. All of these sites are located within solid rock and are similar in nature to those within the ACHA's investigation area (ie nearly all are sandstone shelters or axe grinding groove sites). Regal and Reeves reported that 22 of the 206 sites (10.7%) developed changes after their baseline monitoring that either were or could have been caused by subsidence. Nearly all impacts involved cracks developing in solid rock or the further opening of existing joints or bedding planes. Six sites also exhibited block falls (generally minor) from the roof or walls, but none involved total collapse of a shelter.

6.12.11 Significantly, only two of these 22 likely impact events caused direct impacts to Aboriginal art. In the first, a 40 cm crack developed across a hand stencil. In the second, a thin crack developed adjacent to another hand stencil, which could facilitate water ingress and

consequent damage to the art. The recorded percentage of Aboriginal heritage sites in solid rock subject to subsidence in the Southern Coalfield over a period of 27 years that developed actual impacts to Aboriginal art is therefore just 1% of the total 206 sites surveyed, or 1.4% of the 144 sites with Aboriginal art.

6.12.12 Of the 34 rock shelters potentially affected by the Project, 23 were predicted in the SA to experience <20 mm of vertical subsidence, which is the accepted minimum for reliable measurement. Nine of 10 shelters predicted to experience >100 mm of vertical subsidence were judged by the ACHA as having low scientific significance. The exception is the Upper Avon 43 site (AHIMS # 52-2-1780)). This site is a large rock shelter with a number of human and other art figures on the roof which the ACHA states are generally in poor condition. However, some of the human figures are unusual for the Southern Coalfield, which is the reason why the site was judged as having high scientific significance. This site is addressed further below.

6.12.13 An additional shelter judged in the ACHA as having high scientific significance (the Upper Avon 47 site (AHIMS # 52-2-1752)) was predicted in the SA to experience vertical subsidence of 50 mm, as it is located very close to the point directly above what would have been the western (commencing) end of LW 516. However, the Amendment Report revised the subsidence predictions for this site, because it is this longwall which is being shortened to maintain a 300 m setback distance from the FSL of Avon Reservoir. Consequently, the distance from the longwall to site 52-2-1752 would increase by an estimated 290 m. The Amendment Report stated that the revised vertical subsidence prediction for this site is <20 mm, substantially less than the 50 mm predicted in the SA. Consequently, this Aboriginal heritage site with high archaeological significance now has a very low impact risk.

6.12.14 Of the 22 grinding groove sites within the ACHA's investigation area, nine are predicted to be subject to 20 mm or less of vertical subsidence. However, 11 are located directly above proposed longwalls and are predicted to be subject to vertical subsidence ranging from 325 mm to 2150 mm. Most of these were judged by the ACHA as having a low scientific significance, however three were judged as having a moderate scientific significance. Two of these are predicted to be subject to <20 mm vertical subsidence. The third (Tega Site 1 (AHIMS # 52-2-1456) is a large rock platform with at least 40 axe grinding grooves located within a creek bed directly overlying LW 603. The reason for the rating of moderate scientific significance is the unusually large number of grooves in a single site.

6.12.15 The SA states that it is extremely difficult to *"assess the likelihood that fracturing would be coincident with the grinding groove sites themselves, as this is dependent on the localised response of the bedrock to the mining-induced ground movements."* The SA also assessed the potential of adverse impacts on grinding groove sites located directly above longwalls as "unlikely". The Department notes that the study by Regal and Reeves did not identify any grinding grooves in the Southern Coalfield that had been directly impacted by subsidence. Nonetheless, it is possible that some grinding groove sites located directly over longwalls would be impacted by rock fracturing as a result of subsidence. This is particularly the case for site 52-2-1456, which is a large rock platform in the bed of the headwaters of a 1st order stream

6.12.16 The only State agency that expressed significant concerns relating to predicted or potential Aboriginal heritage impacts was BCD, which stated in its submission that vertical subsidence

of 1 to 2 m “would” impact key sites and that such sites were “unlikely to survive”. BCD proposed that: “*Measures be put in place to reduce subsidence levels to a minimum or imperceptible level at all affected Aboriginal heritage sites, particularly at sites 52-2-1780, 52-2-1752 and 52-2-1456. … As a minimum, we recommend the applicant is required to reduce the impacts of these long walls on Aboriginal heritage sites:*

- *LW 514 – likely to harm sites 52-2-1780, 52-2-1779 and 52-2-1782.*
- *LW 516 – likely to harm site 52-2-1752.*
- *LW 603 – likely to harm sites 52-2-1456 and 52-2-1466.”*

6.12.17 South32 responded to these concerns in its RTS. However, BCD considered that this response did not satisfactorily address Aboriginal heritage and reiterated its concerns. For this reason, the Department sought an additional, more detailed response from South32, as indeed it did in respect of a number of other agency submissions. South32 responded in correspondence dated 3 July. South32 also met with BCD on 27 August 2020.

6.12.18 The Department has given careful consideration to BCD’s proposals regarding the six sites that it proposed for particular protection. As noted above, site 52-2-1752 has been substantially protected by South32’s Project amendment to set back LW 516 by 290 m.

6.12.19 The five remaining sites all sit centrally above longwall panels (either LW 514 or LW 603). Three (one rock shelter and two sets of axe grinding grooves) were judged in the ACHA as having low scientific significance. The two remaining sites (sites 52-2-1780 and 52-2-1456) were judged in the ACHA as having high and moderate scientific significance, respectively.

6.12.20 However, all five sites are in locations that do not readily lend themselves to shortening the relevant longwall (see **Figure 19**). The two sites of particular significance would each require substantial mid-panel pillars (solid coal pillars such as are proposed by South32 to protect identified ‘key stream features’) to significantly reduce, although certainly not eliminate, the risk of cracking and other subsidence impacts.

6.12.21 The Department considers that the Project’s overall impacts on Aboriginal cultural heritage are unlikely to be significant or widespread. Based on previous experience in the Southern Coalfield, it is possible that a small number of axe grinding groove sites would be impacted by subsidence cracking and/or a small number of shelters with art or deposit may be impacted by subsidence cracking or limited block falls. Sites 52-2-1780 and 52-2-1456 are the only sites with recognised scientific significance amongst the sites that may be impacted.

6.12.22 The State’s legislative framework allows for such levels of impact, subject to appropriate scientific study and the obtaining of Aboriginal heritage impact permits (or, in the case of SSD, development consent). The Department considers that all Aboriginal cultural heritage sites situated above Area 5 and Area 6 should be subject to appropriate scientific study and recording, with a focus on sites 52-2-1780 and 52-2-1456.

6.12.23 The Department’s standard conditions of consent to manage Aboriginal cultural heritage on underground coal mine sites include requirements to prepare an Aboriginal Cultural Heritage Management Plan (ACHMP) for the Project as well as a Heritage Management Plan (addressing both Aboriginal and historic heritage) as a component of each Extraction Plan.

Proposed conditions require South32 to consult with Heritage NSW (which now has responsibility for Aboriginal cultural heritage matters) and Registered Aboriginal Parties during preparation of both these plans.

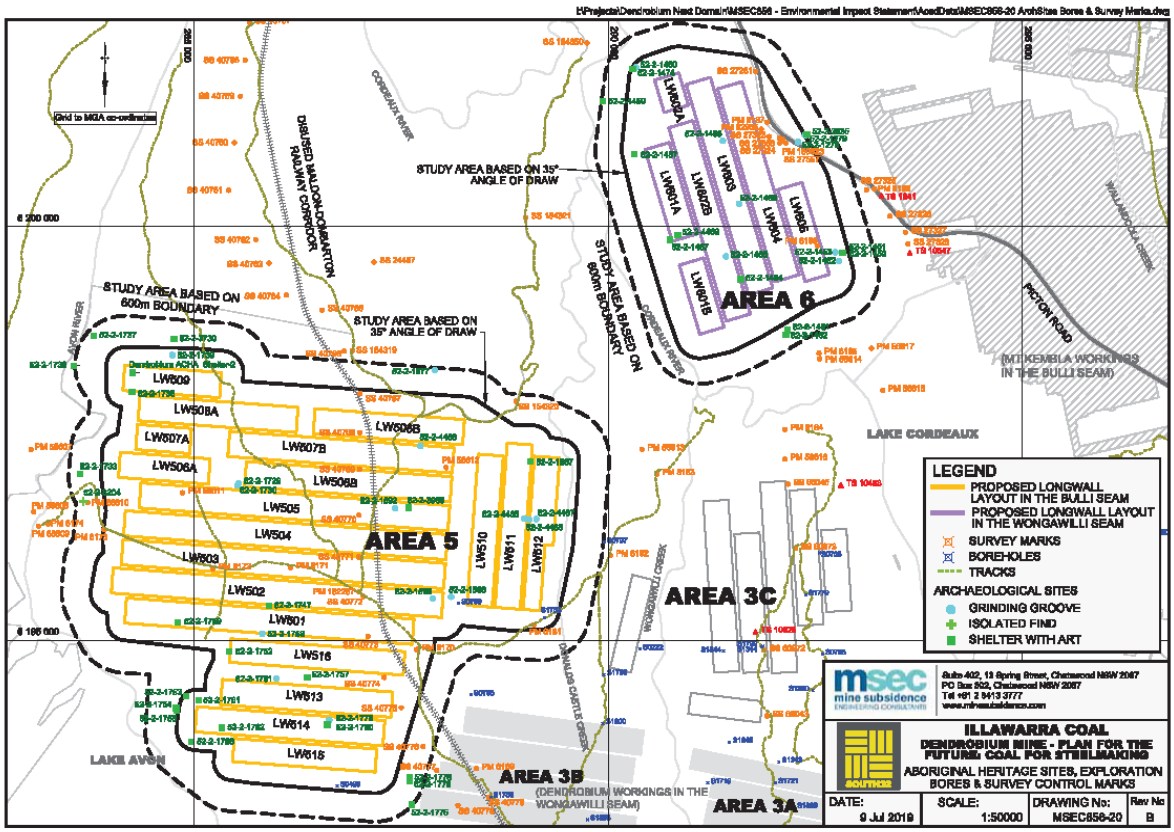

Figure 19 | Aboriginal heritage sites in and around the Project area *(Source: SA)*

6.12.24 In addition to these conditions, the Department proposes that the condition governing the content of the ACHMP also require that this plan provides that South32 must undertake an archaeological investigation of all identified Aboriginal objects and Aboriginal places within the Project's approved disturbance area, with a particular focus on sites 52-2-1780 and 52-2-1456.

Historic Heritage

6.12.25 A Historic Heritage Assessment (HHA) was undertaken for the Project by Niche, in accordance with applicable guidelines. Niche's search of heritage registers revealed that, either in or near the Project area, there are:

- two items of State heritage significance (ie the dam walls and heritage curtilage of Avon Dam and Cordeaux Dam); and
- two items of local heritage significance (ie the former Nebo Colliery, located on the site of the Dendrobium Pit Top, and the Kembla Heights Mining Village Heritage Conservation Area).

6.12.26 Sites listed as having State and local heritage significance are considered separately below.

State Heritage Significance

6.12.27 The only State agency that expressed concerns relating to predicted or potential impacts on State-listed heritage sites was the Heritage Council.

6.12.28 The Heritage Council considered that subsidence and surface fracturing could potentially "radically alter" the landscapes and built elements within the State-listed heritage curtilages of Avon Dam and Cordeaux Dam. On this basis, the Heritage Council sought reductions in the size of both Area 5 and Area 6 such that they do not overlap with the two curtilage areas.

6.12.29 South32 addressed these concerns in its RTS and, more particularly, in its later correspondence to the Department of 4 May 2020. South32 also discussed these concerns with Heritage NSW on 20 May 2020.

6.12.30 South32's response stated that its proposed 1,000 m setback from the dam walls and proposed 300 m setback from the reservoirs' full supply levels (see **Figure 11**) would avoid undermining all of Avon Dam's State-listed heritage curtilage and the substantial majority of Cordeaux Dam's State-listed heritage curtilage. The section of the Cordeaux Dam curtilage that would be undermined is largely native bushland, north of the 28 built structures within the curtilage area (ie buildings, toilet blocks, barbecue shelters and the like in the public picnic area). Further, predicted subsidence movements and resultant subsidence impacts for these 28 structures would be no more than negligible and subsidence of bushland is not expected to lead to any significant alterations to the vegetation.

6.12.31 The Heritage Council also considered that the EIS did not provide sufficient information on the potential visual impacts at the dam walls and associated public areas from the proposed construction of the four new ventilation shafts. It sought further information on the potential visual impacts of the proposed new ventilation shaft infrastructure from viewpoints on access roads and other locations in the curtilage areas, not just for viewers walking on the walls of the Avon and Cordeaux Dams.

6.12.32 In response, South32 drew attention to figures in the HHA which provided a visual analysis for both construction of the ventilation shafts (temporary drilling infrastructure height of 35 m) and operation (Project-life building height of 8 m), but only from viewpoints on the dam walls.

6.12.33 This analysis indicates that Shaft Site 6B (located about 1 km northwest of Cordeaux Dam wall) may be visible during operations (ie following completion of construction), although it may be shielded by vegetation. During operations, no other shaft site would be visible from Cordeaux Dam wall. However, during construction, both Shaft Site 6A and 6B (and possibly also the much more distant Shaft Site 5B) would be visible from Cordeaux Dam wall.

6.12.34 No shaft site would be visible from Avon Dam wall during either construction or operation.

6.12.35 Other viewpoints were not considered by South32 on the basis that, except for access tracks surrounded by dense vegetation, there are no other publicly accessible viewpoints of the proposed ventilation shafts within the Cordeaux Dam curtilage.

6.12.36 Following consideration of South32's additional information, Heritage NSW reiterated the Heritage Council's original position that the Cordeaux Dam's curtilage should not be undermined. However, it also provided conditions that it considered should be applied if the Project was approved, to the following effect:

- a pre-mining condition survey of the landscape and structures to record existing damage and condition and features that might be affected by the anticipated subsidence;
- regular inspection and monitoring during mining and for the two years following completion of mining and rectification; and
- any damage to the landscape or structures should be prevented if possible and otherwise carefully rectified in accordance with conservation standards.

6.12.37 The Department has considered potential impacts on heritage values resulting from subsidence caused by mining in Area 6 and from visual impacts caused by construction and operation of the proposed new ventilation shafts. The Department considers that the risk of subsidence impacts on heritage values is very low and is acceptable. It has recommended that standard conditions be applied in respect of avoiding or minimising damage, inspections and monitoring and rectification of damage to listed-heritage structures and other features.

6.12.38 In the case of visual impacts, the Department first notes that Shaft Site 6B and Shaft Site 6A are about 1 km and 1.6 km from Cordeaux Dam's wall, respectively. Construction at both sites would be able to be seen (and in the case of 6B, sometimes heard) from the wall and parts of the associated picnic area. The EIS contains an indicative schedule for the Project (see **Figure 2**) which indicates that construction at Shaft Sites 6A and 6B would take place, consecutively, over a total period of five years between 2035 and 2039. On this basis, the most intrusive impact (construction of site 6B) is not expected to exceed 30 months in total. The visual impacts are considered to be limited in nature, largely temporary and generally acceptable.

6.12.39 It is proposed that conditions of consent require South32 to minimise the visual impacts of the construction and operation of all four ventilation shaft buildings, particularly on viewers located within the curtilage of the heritage-listed Cordeaux Dam.

Local Heritage Significance

6.12.40 WCC was the only agency that expressed concerns relating to potential impacts on locally listed heritage sites. WCC sought additional information on the proposed construction works at the Dendrobium Pit Top and requested that concept design plans, a Heritage Impact Statement and a draft Conservation Management Plan (CMP) are developed by South32 and considered by WCC *prior to* determination of the Project.

6.12.41 South32 responded to these issues in its RTS. WCC reviewed the RTS and provided additional comments to the Department, however, none of these comments addressed local heritage matters. South32 also committed to provide WCC with concept plans and the draft CMP when they are developed, should the Project be approved.

6.12.42 The Heritage Council also supported the HHA's recommendations that:

- a CMP is developed during the detailed design, construction and operational phases of the Project, to provide guidance for the management and conservation of heritage items within the Nebo Colliery archaeological site; and
- significant heritage features on this site are recorded to appropriate standards if they would be subject to demolition works or material alteration.

6.12.43 The Department also endorses these recommendations and has drafted a condition requiring preparation of a Historic Heritage Management Plan, in consultation with WCC and Heritage NSW, and its approval by the Secretary prior to commencing construction. Subject to this

condition, the Department considers that the potential impacts of the Project on items of local heritage significance are very limited and can be appropriately and adequately managed.

6.13 Other issues

6.13.1 Apart from the key issues and other significant assessment issues considered in detail above, there are a number of other, more minor issues that were raised in the EIS or in submissions. These other issues are briefly considered in **Table 17** below.

Table 17 | Other Issues

Issue	Findings	Recommended Conditions
Impacts to Other Built Infrastructure	The only agency that expressed significant concerns relating to predicted or potential impacts on built infrastructure other than WaterNSW's assets was RMS. RMS sought additional modelling based on current traffic loads, particularly at the intersection of the Cordeaux Pit Top access road with Picton Road. These matters were addressed to RMS's satisfaction in South32's RTS. The Department has no additional concerns.	No specific conditions required.
Traffic Impacts	No agency expressed concerns over predicted or potential traffic impacts, other than RMS in respect of seeking additional modelling of intersection performance (see above). The Department has no additional concerns.	No specific conditions required.
Visual Impacts	The only agency that expressed concerns relating to predicted or potential visual impacts was the Heritage Council, in respect of visual impacts in relation to the values of listed State heritage items. These issues are addressed in **Section 6.12**. The Department has no additional concerns.	No specific conditions required.
Blasting	The EPA sought clarification of blasting assessment criteria used in the NBA and specific consideration of potential impacts from small and infrequent underground blasts on built infrastructure. Each of these matters was addressed to the EPA's satisfaction in South32's RTS. The Department has no additional concerns.	No specific conditions required.

7 Evaluation

7.1.1 The Department has assessed South32's development application, EIS, RTS, Amendment Report and other information provided and has carefully considered:

- submissions received from members of the community and special interest groups;
- advice received from State and local Government agencies;
- advice provided by MineCraft and BAEconomics; and
- advice provided by the Mining Panel and the IESC; and
- reports of the Catchment Panel.

7.1.2 The Department has also considered the objectives of the EP&A Act, including the ESD principles, and relevant considerations under section 4.15 of the EP&A Act.

7.1.3 Based on this assessment, the Department considers that South32 has designed the project in a manner that achieves an appropriate balance between maximising the recovery of a recognised coking coal resource of State significance and minimising the potential impacts on the water resource, biodiversity values and other environmental values of the Metropolitan Special Area as far as is practicable, particularly through:

- setting back its proposed longwall footprint from the walls of the Avon and Cordeaux Dams by at least 1,000 m;
- setting back its proposed longwall footprint at least 300 m from the FSL of the Avon and Cordeaux Dam reservoirs;
- setting back its proposed longwall footprint from all named watercourses (ie Cordeaux River, Avon River and Donalds Castle Creek) to achieve Project-related valley closure of 200 mm or less;
- proposing at least 4 mid-panel solid coal pillars and narrowing of two longwalls to protect 'key stream features' and narrowing a further longwall to avoid Project-related subsidence impacts on Wongawilli Creek;
- siting key surface infrastructure away from TECs;
- avoiding subsidence impacts on Aboriginal cultural heritage sites of high or moderate scientific significance, wherever possible;
- offsetting all surface water taken from the overlying catchment, on conservative assumptions; and
- offsetting biodiversity impacts on threatened species, TECs and other native vegetation.

7.1.4 In terms of surface water losses, South32 has proposed to make annual payments to the Government for the Project's actual annual surface water take, which would be spent on important strategic water supply capital works to enhance Sydney's overall water supply. It would also provide a single up-front payment to cover the modelled water take that would continue from the fractured surface post-mining. South32 has calculated that this would total $103.1 in current dollars, made up of $86.4 million in annual payments during longwall mining and a $16.7 million upfront payment.

7.1.5 The Department has recommended a comprehensive and precautionary suite of conditions to ensure that the Project complies with acceptable criteria and standards, that the impacts are consistent with those predicted by South32 in its documentation, and that residual impacts are effectively minimised, managed and compensated for.

7.1.6 In particular, the Department has recommended strengthening a number of key consent conditions, including:

- a performance measure of negligible environmental consequences for Avon and Cordeaux Rivers;
- requiring early preparation and regular review of a Mine Closure Plan, which would contain a detailed mine closure strategy for Dendrobium Mine;
- involvement of the Mining Panel in preparation of the Mine Closure Plan and Extraction Plans;
- rehabilitation objectives to include:
  - remediation of physical damage as soon as reasonably practicable (unless the environmental impacts of remediation exceed the environmental benefits) in four unnamed third order streams, as well as the four major named watercourses and all identified key stream features;
  - negligible environmental consequences from any mine water discharges that occur after Project completion;
- improved monitoring of upland swamps; and
- regular review of the groundwater model for the development.

7.1.7 The recommended suite of conditions was provided to key NSW Government agencies and their comments were taken into account in finalising them. The Department considers that the conditions reflect current best practice for the regulation of underground coal mining projects in environmentally sensitive areas.

7.1.8 The Department recognises that the Project would provide major economic and social benefits for Wollongong and its surrounding region and to NSW, including:

- direct capital investment of $956 million in the Project;
- continuation of an existing c. 400 jobs at the Dendrobium Mine, together with c. 100 new positions at peak development of the Project and c. 200 construction jobs during Project construction, which would lead to the continuation or creation of about three times as many indirect jobs;[23]
- continued supply of economically attractive and locally-produced hard coking coal to the BlueScope Steelworks at Port Kembla;
- continued support for PKCT and other underground coal mines (particularly South32's Bulli Seam Operations) in the Southern Coalfield;
- an estimated net benefit to NSW of $1,073.2 million (NPV, comprising $497.8 million in direct benefits and $583.4 million in indirect benefits;
- direct revenue for the NSW State Government, including more than $237 million in royalties and $151 million in company tax;
- estimated benefits to local workers (in the 'greater Wollongong area') of $341.7 million (NPV);
- estimated benefits to local suppliers (in the 'greater Wollongong area') of $92.8 million (NPV); and
- generation of Project revenue of nearly $10.4 billion over 29 years (in undiscounted real 2018 Australian dollars), or $3.92 billion (NPV);

7.1.9 The Project is consistent with the NSW Government's *NSW Climate Change Policy Framework* and its associated *Net Zero Plan Stage 1: 2020-2030*. It may also receive funding associated with mitigation of GHGEs through that Plan's Coal Innovation Program.

[23] See para 6.10.54.

7.1.10 The Department has carefully weighed the environmental impacts of the Project against the significance of the Project's identified coking coal resource and the socio-economic benefits associated with continued operation of the Dendrobium Mine for a further 25 years. On balance, the Department believes that the Project's benefits significantly outweigh its residual costs, and that it is in the public interest and is approvable, subject to stringent conditions.

7.1.11 In addition, the Department has carefully considered the economic and social costs to the people and businesses of the Illawarra Region should the Project not be approved. The BAEconomics report has made clear that the costs to the local, regional and State economies would be very large indeed.

7.1.12 This assessment report is hereby presented to the Commission to determine the application. Recommended conditions of approval are included in **Appendix H**.

30/10/20

Stephen O'Donoghue
Director
Resource Assessments

30/10/20

Mike Young
Executive Director
Energy, Industry and Compliance

Appendices

Appendices should follow this general layout but may be modified to suit your specific assessment needs where necessary:

Appendix A – Environmental Impact Statement

Please see department's website at: https://www.planningportal.nsw.gov.au/major-projects/project/9696 under 'EIS'

Appendix B – Public Submissions

Please see department's website at: https://www.planningportal.nsw.gov.au/major-projects/project/9696 'Submissions'

Appendix C – Response to Submissions and Related Documents

RTS (See Department's website under 'Response to Submissions')	https://www.planningportal.nsw.gov.au/major-projects/project/9696
Department's request for additional consideration of key agency advice	Response to Submissions – Request for Further Information
South32 Responses (See Department's website under 'Additional Information')	• Response to NSW Dams Safety Advice • Response to DPIE Biodiversity Queries • Response to DPIE Surface Water Queries • Response to DPIE Water Advice • Response to BCD Advice • Supplementary Response to BCD Advice • Response to Heritage Council Advice • Response to WaterNSW Advice • Response to IESC Advice • Response to Wollongong City Council Advice

Appendix D – Amended Development Application

Please see Department's website at: https://www.planningportal.nsw.gov.au/major-projects/project/9696 under 'Amendments'

Appendix E – Agency advice

Please see Department's website at: https://www.planningportal.nsw.gov.au/major-projects/project/9696 under 'Agency Advice'

Agency	Advice
Planning, Industry and Environment	
Biodiversity Conservation Division	• Advice on EIS • Advice on RTS • Advice on Amendment Report
Water	• Advice on EIS • Advice on RTS • Advice on Additional Information
Environment Protection Authority	• Advice on EIS • Advice on RTS
Regional NSW	
Mining, Exploration and Geoscience	• Advice on EIS • Advice on RTS
Resources Regulator	• Advice on EIS
Premier and Cabinet	
Heritage Council of NSW	• Advice on EIS • Advice on RTS • Advice on Additional Information
Transport for NSW	
RMS	• Advice on EIS
NSW Health	• Advice on EIS • Advice on RTS
Customer Service	
NSW Rural Fire Service	• Advice on EIS
Subsidence Advisory NSW	• Advice on EIS
Councils	
Wollongong City Council	• Advice on EIS • Advice on RTS

	• Advice on Additional Information
Wollondilly Shire Council	• Advice on EIS
Wingecarribee Shire Council	• Advice on EIS
WaterNSW	• Advice on EIS • Advice on RTS • Advice on Amendment Report
Dams Safety NSW	• Advice on EIS • Advice on RTS
Endeavour Energy	• Advice on EIS

Appendix F – List of Referenced Documents

List of Documents Referenced in Department's Assessment Report
Independent Expert Panel for Mining in the Catchment's Final Report (October 2019)
Independent Advisory Panel for Underground Mining Advice (20 October 2020)
The Ecology of Subsidence – Upland Swamps in the Southern Coalfield, Richardson, M. and D. Ryan (2007)
Hydrogeological Bayesian Hypothesis Testing through Trans-Dimensional Sampling of a Stochastic Water Balance Model, Turnadge, Mallants and Peeters (July 2019)
The Net Zero Plan Stage 1: 2020-2030, Department of Planning, Industry and Environment (March 2020)
MineCraft Final Report (July 2020)
Review of the Key Economic Interactions between the Dendrobium Mine and Related Entities in the Wollongong Region – BAEconomics (July 2020)

Appendix G – Statutory Considerations

The Department's assessment of the Project has given detailed consideration to the applicable statutory requirements (see **Section 4**). Some of the key statutory requirements are further addressed below.

G1 Ecological Sustainable Development (ESD)

The EP&A Act adopts the definition of ESD found in the *Protection of the Environment Administration Act 1991*, as follows:

> *"ecological sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following principles and programs:*
>
> *a) the precautionary principle;*
>
> *b) inter-generational equity;*
>
> *c) conservation of biological diversity and ecological integrity; and*
>
> *d) improved valuation, pricing and incentive mechanisms."*

The Department has considered ESD and its related principles and programs. The Department has also had regard to the manner in which ESD and its principles and programs are addressed in the EIS, particularly in its Section 9.3.5. A summary of the Department's consideration follows.

Precautionary Principle

The Department has assessed the Project's threat of serious or irreversible environmental damage and considers that the Project is based on a significant number of precautionary setbacks and key conservative assumptions. It considers that there is sufficient scientific certainty regarding environmental impacts and residual risks to enable determination of the application. The Department has carefully considered the material provided by South32 in its EIS, RTS, Amendment Report and other documents and has consulted closely with key Government agencies to obtain their input and advice on various aspects of the Project.

The EIS contains a substantial number of specialist environmental impact assessments and also an Environmental Risk Assessment and a Preliminary Hazards Assessment. The Project would result in a number of environmental impacts, with the key impacts that could cause serious or irreversible environmental damage being impacts on important water resources and biodiversity values.

The Project incorporates a number of design measures to avoid or minimise such impacts. It also incorporates a number of other measures to mitigate, remediate or offset these and other impacts.

These measures also include a range of management measures and offsets to compensate for residual impacts on biodiversity values, including the retirement of ecosystem credits for four PCTs affected by direct clearing, two upland swamp PCTs affected by subsidence, three threatened fauna species affected by direct clearing and five threatened fauna species affected by subsidence.

The Project would be required to be operated in accordance with a strict and comprehensive suite of conditions of consent, as well as all necessary licences and approvals related to the take, management and discharge of water (ie water access licences, an EPL, etc). The conditions take a precautionary approach to avoid significant environmental consequences on key water resources and related infrastructure (ie Avon and Cordeaux Dams and Avon and Cordeaux Rivers).

The Department has also recommended that South32 be required to provide very substantial payment to offset its surface water take.

The Department considers that the recommended performance measures and other conditions of consent would provide appropriate protection for the sensitive water resource and environmental values of the Metropolitan Special Area, including the catchments and dam walls of the Avon and Cordeaux Dams, and minimise the potential for any serious or irreversible environmental damage.

Intergenerational Equity

The Department accepts that it is important to protect the very sensitive environmental and water resource values of the Metropolitan Special Area for the benefit of future generations. It considers that the recommended performance measures and other conditions of consent would provide an appropriate degree of protection for these values and not constrain the ability of future generations to continue to access a high-quality water supply from the Special Area.

The Department acknowledges that the mining of coal and its combustion is a major contributor to anthropogenic climate change, which has the potential to impact future generations. The Department considers that the Project's direct energy use and direct GHGEs would constitute a very small contribution towards climate change at both the national and global scale. The Project contains proposals by which its direct GHGEs from fugitive emissions of drained mine gas may be substantially mitigated through flaring, which through combustion turns methane into carbon dioxide, with its substantially reduced greenhouse intensity.

Scope 3 emissions for the Project are significant. However, there is no current alternative to the use of coking coal (ie the key product of the Project in terms of both tonnage and value per tonne) for the large scale, economic production of virgin iron and steel. While alternative technologies do exist, they are not currently economic. In this respect, the iron and steel making industry is not in the same position as electricity generation, where renewable energy technologies offer competitive (but limited) alternatives to energy production using fossil fuels.

Conservation of Biological Diversity and Ecological Integrity

The Project's potential impacts on biodiversity have been an important consideration in the Department's assessment of the Project. As set out in **Section 6.6**, the Department considers that these impacts can be mitigated and/or offset to achieve beneficial long-term biodiversity outcomes in the region. South32 has committed to provide an appropriate offset package, comprising retirement of the required ecosystem and fauna species credits and residual payments into the BCF, for its biodiversity impacts.

Further, it should be noted that underground coal mining, including its related subsidence impacts, does not have the same universal, broadacre impacts on biodiversity that open cut mining has. Instead, its major impacts are partial and focused on much smaller areas – the areas of watercourses and upland swamps immediately above and adjacent to longwall panels. The areas of direct clearing are limited and restricted to relatively small areas required for surface infrastructure such as ventilation shafts. The Project contains offsets for these impacts and appropriate remediation measures. Therefore, it is considered that the Project would not have a significant impact on the 'ecological integrity' of the Metropolitan Special Area. The impacts within Areas 5 and 6 are limited, appropriately offset, and acceptable.

Improved Valuation, Pricing and Incentive Mechanisms

This ESD principle emphasises the internalisation of environmental costs in the pricing of assets and services. The Department supports the comprehensive inclusion of environmental factors in the assessment of any development application for potential assets, such as the Project. Its assessment has sought to do this.

The Department's assessment has sought to apply the 'polluter pays principle', insofar as South32 would be required to pay to offset its biodiversity impacts and remediate its potential significant environmental impacts.

The environmental costs of the Project have been addressed in detail and quantified to the degree possible in the CBA prepared as part of the EA for the Project. The direct environmental effects of the Project would be internalised through the adoption and funding of the mitigation measures proposed by South32 or otherwise required by conditions to mitigate, remediate or offset them.

Many of the proposed conditions of consent are 'outcomes focused', ie they apply either performance measures to avoid impact or else require particular outcomes ('environmental goals'), such as remediation or further offsetting. They do not seek to codify which mechanisms must be applied by South32 in order to achieve these environmental goals. Consequently, they allow for South32 to identify and pursue cost-effective solutions, including via the market-based mechanisms inherent in the State's biodiversity offsetting policies.

G2 Environmental Planning Instruments

Under section 4.15(1) of the EP&A Act, the consent authority is required to consider, amongst other things, the provisions of the relevant EPIs, including any exhibited draft EPIs.[24] The Department notes South32's consideration of these instruments in its EIS (see the EIS's Attachment 6) and has undertaken its own consideration of the Project against the applicable provisions of relevant EPIs.

SEPP (Mining, Petroleum Production and Extractive Industry) 2007

Permissibility

Clause 7(1)(a) of the Mining SEPP identifies that underground mining is permissible with consent on any land. Clause 7(1)(d) provides that 'facilities for the processing or transportation of minerals or mineral bearing ores' are permissible with consent on land 'on which mining may be carried out (with or without development consent), but only if they were mined from that land or adjoining land'.

Clause 7(1) of the Mining SEPP has the effect that the entirety of the Project is permissible with consent, notwithstanding provisions in the applicable LEPs which would otherwise have the effect of making parts of the Project prohibited development (see **Section 4.2**).

Matters for Consideration

Part 3 of the Mining SEPP lists a number of matters that a consent authority must consider before determining an application for consent for development for the purposes of mining. These matters were considered in South32's EIS (see Section A6.15 of Attachment 6). The Department has

[24] Note that due to the effect of clause 11 of the SRD SEPP, development control plans do not apply to SSD.

considered these matters in its assessment of the Project and has included a brief outline of key considerations below.

Non-discretionary development standards (clause 12AB)

Clause 12AB identifies non-discretionary development standards for the purposes of section 4.15(2) of the EP&A Act in relation to the carrying out of development for the purposes of mining. Table A6-1 in the EIS's Attachment 6 sets out South32's consideration of the applicable standards and whether or not the Project meets them. The Department agrees with this assessment.

Compatibility with other land uses (clause 12)

The Department's assessment has considered the potential impacts of the Project on other land uses in the area, including land use for water catchment purposes, conservation purposes, residential purposes and industrial purposes. The principal issue regarding compatibility is the interaction between the proposed underground coal mining in Areas 5 and 6 and the water catchment and conservation purposes of the overlying Metropolitan Special Area.

The Department considers that, subject to the proposed surface water offsetting measures and biodiversity offsetting measures, the Project is compatible with these purposes. That is, the Project would have limited residual impacts on the capacity of the Metropolitan Special Area to satisfactorily fulfil its purposes.

The Department has considered the potential noise, air quality and visual impacts at nearby private residences, as well as the potential impacts on the communities dependent on the water catchment. This consideration has been undertaken in consideration of the public benefits of the Project and measures to avoid, mitigate and minimise any land use incompatibility.

Overall, the Department considers that, subject to appropriate conditions, the Project could be managed to minimise any potential land use conflicts and meet the aims, objectives and provisions of clause 12.

Voluntary Land Acquisition and Mitigation Policy (clause 12A)

The Department's assessment has considered the NSW Government's *Voluntary Land Acquisition and Mitigation Policy* in **Sections 6.8** and **6.9**. This assessment concluded that a single additional receiver would be entitled to noise mitigation rights under the NPfI.

Natural Resource Management and Environmental Management (clause 14)

Clause 14(1) requires that, before granting consent for development for the purposes of mining, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure that impacts on significant surface water and groundwater resources, threatened species and biodiversity are avoided or minimised to the greatest extent practicable and that greenhouse gas emissions are minimised to the greatest extent practicable.

The critical issues for the assessment of the Project are its potential impacts on the significant surface and groundwater resources of the Metropolitan Special Area and WaterNSW's water catchment and supply infrastructure. Potential impacts on threatened species and biodiversity and greenhouse gas emissions are also important issues for the assessment. These matters are comprehensively addressed in **Sections 6.3 to 6.6** and in **Section 6.9**.

The Department has recommended a detailed suite of conditions to ensure that the Project is undertaken in an environmentally responsible, including conditions in relation to significant water resources, threatened species and biodiversity and greenhouse gases.

Resource Recovery (clause 15)

The Department has considered the recovery of coal resources in its assessment of the Project. It considers that the Project can be carried out in an efficient manner that optimises resource recovery while giving appropriate recognition to and protection for the significant environmental and other values that may be affected.

The Department has also recommended conditions requiring South32 to implement reasonable and feasible measures to minimise waste and maximise the salvage and re-use of resources within the disturbance area (including water, soil and vegetative resources).

Transport (clause 16)

While the framing of clause 16 is quite broad, its particular purpose is to limit the transport of coal, other minerals and their ores, and extractive materials on public roads. No ROM coal from the Project would be transported on public roads. All ROM coal would be transported by rail to Dendrobium CPP. From there, product coal would be transported to BlueScope Steelworks (primarily by conveyor but also limited amounts by trucks using a private road), to PKCT (by private road) or to Boral Cement's cement kiln at Berrima (by Boral-operated trucks).

Coal washery waste from the Dendrobium CPP would be transported by road to the West Cliff CWE or to customers for beneficial use. However, all coal wash transported to West Cliff CWE would be via 'backloading' operations, using trucks that would already be on public roads.

The Department considers that this limited use of public roads for transport of coal washery waste and product coal is acceptable. There is further consideration of the Project's traffic-related impacts in **Section 6.13**.

Rehabilitation (clause 17)

Clause 17 outlines particular requirements relating to consideration of whether any consent granted should be subject to conditions aimed at ensuring rehabilitation of land disturbed by mining and, in particular, whether conditions should require preparation of a rehabilitation management plan, appropriate treatment of waste, remediation of soil contamination and the avoidance of public safety risks.

The Department recommends a comprehensive suite of conditions relating to rehabilitation of land disturbed by the Project (including, but not limited to, the Dendrobium Pit Top, Cordeaux Pit Top, KVCLF, Dendrobium CPP, West Cliff CWE Stage 3 and the ventilation shafts). Conditions are also recommended in respect of the remediation of named watercourses, upland swamps and 'key stream features', should they be subject to subsidence impacts.

SEPP (Infrastructure) 2007 (the Infrastructure SEPP)

The Infrastructure SEPP requires the consent authority to notify relevant public authorities about development that may affect public infrastructure or land, including electricity transmission and distribution networks, gas pipeline corridors, railways and rail corridors. The Department notified affected State agencies, infrastructure owner/operators and the three affected councils and received submissions from Endeavour Energy, Transgrid, RMS, NSW Ports, Pacific National and the three affected councils.

The EIS has considered the Infrastructure SEPP (see section A6.1.6), particularly in respect of potential damage to infrastructure from subsidence, and the RTS responded to submissions from these parties. The Department carefully considered advice from these parties in its assessment of this application.

SEPP (State and Regional Development) 2011 (the SRD SEPP)

The Project is declared to be SSD under section 4.36 of the EP&A Act as it triggers the criteria in clause 5(a) of Schedule 1 of the SRD SEPP, because it is development for the purposes of coal mining. No scale limitations apply in respect of this declaration. That is, any coal mining, of any scale and proposed anywhere in the State, is SSD.

In accordance with section 4.5 of the EP&A Act and clause 8A(1) of the SRD SEPP, the Commission is the consent authority and must determine the application, as more than 50 public submissions in the nature of objection were received.

SEPP (Sydney Drinking Water Catchment) 2011

This SEPP was promulgated to manage and maintain water quality within Sydney's Drinking Water Catchment. The provisions of this SEPP, the manner in which the EIS and RTS address them, the position of WaterNSW and the manner and degree to which the Project satisfies the requirements of this SEPP, including in regard to the NorBE test, are addressed in **Section 6.3**.

SEPP No. 33 – Hazardous and Offensive Development (SEPP 33)

The key aims of SEPP 33 are to ensure that, in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impacts and that any measures proposed to be employed to reduce the impact of the development are taken into account.

Clause 12 of SEPP 33 requires persons proposing to carry out development for the purposes of potentially hazardous industry to prepare a Preliminary Hazard Analysis (PHA) and to submit this with the DA. The EIS considered the potential hazards and risks associated with the Project, including the storage of hazardous goods, potential for fire and/or explosion and contamination of land, water and air and contained a PHA (see the EIS's Appendix N).

The Department considers that the Project is consistent with the aims, objectives and requirements of SEPP 33.

SEPP No. 44 - Koala Habitat Protection (SEPP 44)

The *SEPP (Koala Habitat Protection) 2019* commenced on 1 March 2020, replacing the previous SEPP 44. However, clause 15 of the new SEPP provides that *'a development application made, but not finally determined, before the commencement of this Policy in relation to land to which this Policy applies must be determined as if this Policy had not commenced.'* Consequently, the provisions of SEPP 44 continue to apply to the Project.

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

The EIS's assessment of potential impacts on Koalas was against the provisions of SEPP 44. The Project involves limited clearing of native vegetation and the assessment found that, within the

surveyed area (ie Area 5 and Area 6), 20% is made up of 'potential Koala habitat' and 3% is likely to be 'core Koala habitat', as it contains both Koala feed tree species and records of a resident Koala population (see **Section 6.6**). A Koala Plan of Management has been prepared for the Project.

The Department considers that the Project is consistent with the aims, objectives and requirements of SEPP 44.

SEPP No. 55 – Remediation of Land (SEPP 55)

SEPP 55 relates to the remediation of contaminated land. A 'preliminary investigation' was carried out for South32 in respect of land proposed to be subject to a 'change of use' under the SEPP (ie the proposed underground mining Areas 5 and 6 and the proposed carpark for the Dendrobium Pit Top).

The Department is satisfied that the Project area does not have a significant risk of existing contamination (including the area of the proposed car park) given its historical and current land uses, and that the development is generally consistent with the aims, objectives and provisions of SEPP 55.

Applicable Local Environment Plans

The Department has considered the permissibility of the proposed development under the Wollongong, Wollondilly and Wingecarribee LEPs. While each of these LEPs contains certain prohibitions which would otherwise impact the permissibility of the Project, these prohibitions are overcome due to the overriding permissibility provisions found in clause 7(1) of the Mining SEPP (see **Section 4.2** and above).

Appendix H – Recommended Instrument of Consent

Please see Department's website at: https://www.planningportal.nsw.gov.au/major-projects/project/9696