

While no strong links between subsidence effects and vegetation response have been identified, the time between the impact and vegetative response may not be immediate and, therefore, not yet detected (Appendix D).

Monitoring at the Wollongong Coal and Metropolitan Coal Mines also reported a lack of evidence linking subsidence effects to vegetative response, consistent with monitoring results at the Dendrobium Mine (Appendix D).

Vegetation monitoring of Swamp 15b, for example, which was undermined in 2010, confirms upland swamp vegetation persists following subsidence-related impacts (Plates 6-4a and 6-4b).

Appendix D provides further detail on historic upland swamp monitoring and its findings. More detail on recent analysis of piezometric data is provided in Section 6.8.4.



Plate 6-4a – Swamp 15b - Nine Years after Undermining Source: Niche (2019a).



Plate 6-4b – Swamp 15b - Nine Years after Undermining Source: Niche (2019a).

Existing Upland Swamp Mitigation Measures and Offset Strategy

The Dendrobium Area 3B Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (South32, 2017b) details performance measures and TARPs specific to predicted subsidence impacts for upland swamps within Area 3B.

Consistent with the SIMMCP, if impacts observed within Area 3B are greater than predicted, an attempt is made to remediate the swamp. If remediation is not practicable, or if remediation and management measures do not restore the function of the upland swamp, suitable offsets are required.

To account for predicted offset requirements for upland swamps within Areas 3A and 3B and at the Bulli Seams Operations, South32 established a Strategic Biodiversity Offset at Maddens Plains.

The Strategic Biodiversity Offset at Maddens Plains contains biodiversity values in excess of the offset requirements of Areas 3A and 3B and at the Bulli Seams Operations. As permitted by the Strategic Biodiversity Offset, the excess biodiversity values are available for future South32 projects, including the Project offset requirements.

In addition, as part of the SMP for Area 3B, South32 developed the *Dendrobium Area 3B Swamp Rehabilitation Research Program* (South32, 2016). This program is focused on:

- Investigating methods to rehabilitate upland swamps impacted by subsidence to restore groundwater levels and recharge response behaviour to pre-mining levels.
- Establishing field trials for rehabilitation techniques.
- Providing funding of at least \$3.5 million to undertake the investigations and field trials.
- Scheduling subsequent trials, work plans and ongoing reporting.

6.8.3 Existing Environment

Forty-six upland swamps have been identified within 600 m of the proposed longwalls, of which 37 contain vegetation communities that represent the upland swamp TEC. These 37 upland swamps are listed in Table 6-11 and shown on Figure 6-13.

Of the 37 swamps that contain upland swamp TEC, 36 are within 400 m and 25 are within 60 m of the proposed longwalls (Table 6-11).



Table 6-11
Threatened Ecological Community Upland Swamps within Project Underground Mining Area

Swamp Name	Project Underground Mining Area	Within 400 m of Longwalls	Within 60 m of Longwalls	Swamp Type	Special Significance*	Area of Upland Swamp TEC [#] (ha)
Den83	6	Yes	Yes	Headwater/Valley In-fill	-	1.7
Den85	5	Yes	-	Headwater	-	2.1
Den86	5	Yes	Yes	Headwater	-	2.4
Den97	5	Yes	Yes	Headwater	-	1.0
Den98	5	Yes	Yes	Valley In-fill	Yes	2.2
Den99	5	Yes	Yes	Headwater	-	2.0
Den100	5	Yes	Yes	Headwater	-	0.5
Den101	5	Yes	Yes	Headwater	-	0.4
Den102	5	Yes	Yes	Headwater	-	0.3
Den103	5	Yes	Yes	Headwater	-	0.5
Den104	5	Yes	Yes	Valley In-fill	-	0.2
Den105	5	Yes	Yes	Headwater	-	0.2
Den106	5	Yes	Yes	Headwater	-	0.7
Den108	5	Yes	Yes	Valley In-fill	-	0.1
Den109	5	Yes	Yes	Headwater	-	0.4
Den110	5	Yes	Yes	Headwater	-	0.3
Den111	5	Yes	Yes	Valley In-fill	-	0.2
Den112	6	Yes	-	Headwater	-	1.0
Den113	6	Yes	Yes	Headwater	-	2.4
Den115	6	Yes	-	Headwater	-	0.4
Den116	6	Yes	Yes	Headwater	-	1.5
Den117	6	Yes	Yes	Headwater	-	2.5
Den118	6	Yes	Yes	Valley In-fill	-	0.5
Den119	6	Yes	-	Headwater	-	0.4
Den120	5	Yes	Yes	Headwater	-	0.6
Den121	5	Yes	Yes	Valley In-fill	-	0.5
Den122	5	Yes	Yes	Headwater	-	0.4
Den123	5	Yes	Yes	Headwater	-	0.1
Den124	5	Yes	-	Valley In-fill	-	1.4
Den128	6	Yes	Yes	Valley In-fill	-	0.3
Den131	6	Yes	-	Headwater	-	1.3
Den132	6	Yes	-	Valley In-fill	-	6.5
Den134	6	Yes	-	Headwater	-	0.5
Den136	6	Yes	-	Headwater	-	1.0
Den138	6	-	-	Headwater	-	0.5
Den02	5	Yes	-	Headwater	-	0.9
Den01b	5	Yes	-	Headwater	-	11.3

Source: Niche (2019a)

* As per Upland Swamp Environmental Assessment Guidelines – Guidance for the underground mining industry operating in the Southern Coalfield (OEH, 2012).

Excludes areas of "Coastal Upland Swamps: Fringing Eucalypt Woodland (MU45)".





One swamp (Den 98) was classified by Niche (2019a) as being of special significance, against the criteria provided in OEH's (2012) Upland Swamp Environmental Assessment Guidelines – Guidance for the underground mining industry operating in the Southern Coalfield.

Relevant to ongoing monitoring and analysis of potential future impacts and offset requirements (Sections 6.8.4 and 6.9.6), shallow piezometers and soil moisture probes have been installed in upland swamps in the proposed underground mining areas.

6.8.4 Assessment

Direct Surface Impacts

Other than installation of monitoring equipment, direct impacts to upland swamps as a result of Project surface disturbance works would be avoided (Section 3.10.4).

Subsidence Impacts

The Project may result in the following subsidence impacts on upland swamps and associated environmental consequences:

- A change to the hydrological regime of swamp sediments as a result of:
 - fracturing of downstream rockbars;
 - fracture networks forming in the bedrock below the swamp; and/or
 - upsidence and dilation of bedrock below the swamp.
- Alteration of surface drainage patterns due to subsidence-induced tilting, resulting in localised erosion or scour or alteration of water distribution.
- Consequential impacts to vegetation composition (i.e. transition to a drier community) due to changes in the soil moisture regime.

Swamp Hydrology

Subsidence-induced fracturing of bedrock below an upland swamp can alter the permeability of the bedrock resulting in increased vertical drainage from the swamp sediments.

As a component of the Surface Water Assessment (Appendix C), the potential change in vertical and horizontal flow due to subsidence-related fracturing of the base of the swamp was modelled by HEC (2019) to determine the effect to swamp hydrology. HEC (2019) concluded that the change in permeability of the base of an upland swamp due to subsidence would have the following potential effects:

- change in the water table (i.e. groundwater level) within swamp sediments below the pre-mining level;
- accelerated rate of water table recession following rainfall events; and
- less frequent inundation of swamps (i.e. longer dry periods) and for a shorter period of time.

Swamp Stability

Subsidence has the potential to change the longitudinal gradient and cross-sectional characteristics of upland swamps, increasing the risk of erosion and scour or affecting the distribution of water.

It is unlikely that there would be large-scale adverse changes in the levels of ponding or scouring of the swamps based on the predicted subsidence-related tilt, as potential changes in gradient are small relative to the existing grades (Appendix A).

The onset of erosion and scour within an upland swamp can be directly related to bed shear stress, which is a function of the depth of flow and change in slope (Appendix C).

The risk of erosion (i.e. predicted changes in shear stress) for upland swamps within the Project area that had a greater than negligible predicted change in tilt was determined in the Surface Water Assessment (Appendix C). Two swamps (Den118 and Den110) were predicted to exceed the erosion threshold for upland swamp vegetation during a 'rare' 1% AEP peak flow event. These upland swamps therefore have a very minor increased erosion and scour risk as a result of subsidence-related tilt.

Vegetation Changes

The predicted impacts to swamp hydrology could potentially affect upland swamp vegetation composition, albeit that no strong link between subsidence effects and vegetation response have been identified (Appendix D).

Notwithstanding, persistent changes to the hydrological regime of an upland swamp has the potential to affect the composition and extent of swamp vegetation and a precautionary approach is required.



Application of the Swamp Offset Policy

The Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence (OEH, 2016a) (Swamp Offset Policy) provides the framework for offsetting potential impacts to upland swamps from longwall mining. It requires consideration of avoidance and minimisation methods with offsets to compensate for impacts of longwall mining where it can be demonstrated all feasible measures to avoid and minimise impacts have been taken.

The Swamp Offset Policy also requires proponents to demonstrate that reasonable and feasible avoidance and mitigation measures have been considered and that (OEH, 2016a) (emphasis added):

> "a maximum predicted offset liability must be calculated for the total area of upland swamps predicted to be subject to greater than negligible environmental consequences"

'Maximum predicted offset liability' is defined as (OEH, 2016a):

... 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. This is consistent with the precautionary principle.

Greater than negligible environmental consequences' are defined as including one or both of the following (OEH, 2016a):

- a shallow groundwater level within swamp sediments lower than the baseline level at any monitoring site within a swamp (in comparison to control swamps); and/or
- a rate of shallow groundwater level reduction post-mining that exceeds the rate of shallow groundwater level reduction during the baseline period at any monitoring site (measured as average millimetres per day during the recession curve).

The Swamp Offset Policy also states that (OEH, 2016a):

Where it is predicted that a partial impact to an upland swamp is likely, then only the portion of the swamp likely to experience greater than negligible environmental consequences should be included in the offset calculation. Further to the historic and ongoing monitoring of subsidence impacts on upland swamps (Section 6.8.3), Watershed HydroGeo (2019) completed a detailed analysis of upland swamp shallow piezometer data from the Dendrobium Mine Areas 2, 3A and 3B. A full copy of the analysis is included as an attachment to Appendix D.

The analysis was specifically focused on assessing the measured change in groundwater against the above quoted negligible environmental consequences criteria.

The analysis of groundwater data found that almost all upland swamps directly above or within 60 m of previously-mined longwall panels exhibited a response (either as a reduction in the water level in the swamp and/or change in recession rate) that were greater than the negligible environmental consequences criteria.

However, greater than negligible environmental consequences were not observed at distances greater than 60 m from undermined longwall panels (Watershed HydroGeo, 2019).

Credit Requirements

Based on hydrological changes and consequential vegetation changes being limited to swamps within 60 m from the proposed longwalls, Niche (2019a) calculated the maximum predicted offset liability for threatened portions of these upland swamps in accordance with the Swamp Offset Policy. The credit requirements are summarised in Table 6-12, including consideration of the offset liability reduction due to the Project relinquishing authority to impact certain upland swamp vegetation areas in Area 3 (Appendix D).

Table 6-12 Threatened Ecological Community Upland Swamp Ecosystem Credit Requirements

Upla	nd Swamp Vegetation Community	Area (ha)	Credits Required
HN560	Needlebush - banksia wet heath on sandstone plateaus of the Sydney Basin Bioregion	16.3	227
HN662	Needlebush - banksia wet heath swamps on coastal sandstone plateaus of the Sydney Basin	4.6	78

Source: Niche (2019a)



6.8.5 Mitigation Measures

The Project has considered various measures to avoid and mitigate potential impacts to upland swamps. These are detailed in Section 9.2.1 and include:

- The selection of proposed mining in Areas 5 and 6 as opposed to Area 4 in addition to siting surface infrastructure to avoid direct impacts to upland swamps.
- Alternative longwall geometry/methods within Areas 5 and 6 have been considered, however, no material difference in the potential for impacts to upland swamps associated with alternative longwall layouts is expected.
- The implementation of the mine constraints for the Project (Section 3) would result in avoidance of directly undermining a number of upland swamps including Den124, Den115, Den131, Den132, Den119 and Den134.
- Avoidance of direct disturbance of mapped upland swamp TECs².
- Relinquishment of existing authority to impact upland swamp vegetation areas in Area 3.

It is not considered reasonable for the Project to avoid undermining all upland swamps given the significant reduction in resource recovery and associated reduction in economic benefits to NSW (a reduction of \$220 million in net present value [NPV] terms compared to the Project longwall layout plus the completion of mining in Area 3C).

Residual predicted impacts to upland swamps would be offset via the Project Biodiversity Offset Strategy, developed consistent with NSW and Commonwealth Government policy (Section 6.9.6). This includes offsets for potential subsidence impacts to TECs associated with upland swamps, as well as offsets for threatened fauna species for which the upland swamps provide habitat.

Current mitigation and remediation measures for subsidence impacts on upland swamps at the Dendrobium Mine are described within the SIMMCP (South32, 2017b).

6.8.6 Adaptive Management

The Swamp Offset Policy states groundwater level as the most certain indicator of potential impacts to upland swamp ecological communities (OEH, 2016a).

Baseline surface water and groundwater monitoring (including shallow piezometers and soil moisture probes) of upland swamps within 400 m of the proposed longwalls would be undertaken to refine the maximum predicted offset liability.

Monitoring would be detailed in the Extraction Plans for the Project, and would include subsidence, surface water, groundwater and vegetation composition.

In accordance with the Swamp Offset Policy, should monitoring indicate impacts greater or less than those predicted, the ultimate offset liability would be increased or decreased accordingly.

As described in Section 6.8.2, South32 is conducting research into methods for swamp rehabilitation as described in the *Dendrobium Area 3B Swamp Rehabilitation Research Program* (South32, 2016).

Subject to confirmation from key stakeholders that swamps undermined in Area 3 have been successfully remediated, swamp remediation measures could be implemented for the Project.

6.9 TERRESTRIAL ECOLOGY AND PROJECT BIODIVERSITY OFFSET STRATEGY

6.9.1 Methodology

The BARBOS for the Project was prepared by Niche by Accredited Assessors in accordance with section 142B(1)(c) of the *Threatened Species Conservation Act, 1995* and is presented in Appendix D.

The BARBOS was prepared in accordance with the Project SEARs and relevant State and Commonwealth requirements. In regard to the State requirements, the *NSW Biodiversity Offset Policy for Major Projects* (the NSW Offset Policy) (OEH, 2014a), and supporting NSW *Framework for Biodiversity Assessment* (FBA) (OEH, 2014b) were applied.

² Other than minor disturbance associated with the installation of monitoring equipment



Assessment of potential impacts to threatened aquatic ecology (not listed under the BC Act) and upland swamps are described in Sections 6.7 and 6.8, respectively.

A description of the existing environment relating to biodiversity values in the Project area is provided in Section 6.9.2. Section 6.9.3 describes the potential impacts of the Project to these biodiversity values, while Sections 6.9.4 and 6.9.5 outline avoidance/mitigation and adaptive management measures. Section 6.9.6 describes the proposed Biodiversity Offset Strategy for the Project.

6.9.2 Existing Environment

Landscape Setting

The Project is located within the Sydney Basin Interim Biogeographic Regionalisation of Australia (IBRA) and the Sydney Cataract IBRA subregion. The Project area is predominantly within the Woronora Plateau Mitchell Landscape (Appendix D).

The Project underground mining areas are located entirely within the Upper Nepean Catchment and Metropolitan Special Area. Major landscape features that occur within, or immediately adjacent to, the Project underground mining areas include those associated with the Avon River, Cordeaux River, Lake Avon and Lake Cordeaux. Surface water hydrology in the vicinity of the Project is detailed in Section 6.6.2.

Baseline Surveys

Flora and fauna surveys of the Project area (i.e. the Dendrobium Pit Top and directly above and within 600 m of the proposed longwalls) and surrounds were conducted by Niche (2019a) in accordance with the FBA and in consideration of the *Threatened Biodiversity Survey and Assessment – Guidelines for Developments and Activities* (DEC, 2004) and OEH's (2016c) *NSW Guide to Surveying Threatened Plants* (Appendix D).

Baseline surveys targeted threatened species and communities, focusing on proposed vegetation disturbance areas and landscape features susceptible to subsidence-related impacts. A detailed description of the survey methodology is provided in Appendix D. A total of 241 flora species and 116 fauna species (comprising 58 bird, 32 mammal, 14 reptile and 12 amphibians) were recorded by Niche (Appendix D).

Native Vegetation Communities

A total of 16 native vegetation communities (including three sub communities of MU44) were mapped across the Project area, namely (Figure 6-14):

- MU4: Sandstone Riparian Scrub.
- MU9: Nepean Gorge Moist Forest.
- MU18: Highlands Shale Tall Open Forest.
- MU22: Transitional Shale Dry Ironbark Forest.
- MU23: Transitional Shale Stringybark Forest.
- MU26: Sandstone Gully Peppermint Forest.
- MU27: Nepean Sandstone Gully Forest.
- MU29: Exposed Sandstone Scribbly Gum Woodland.
- MU38: Rock Pavement Heath.
- MU42: Coastal Upland Swamps: Banksia Thicket.
- MU43: Coastal Upland Swamps: Tea-tree Thicket.
- MU44: Coastal Uplands Swamps: Sedgeland-Heath Complex (Sedgeland, Restiod Heath and Cyperoid Heath).
- MU45: Coastal Upland Swamps: Fringing Eucalypt Woodland.
- N/A: Sydney Blue Gum x Bangalay Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion.

Detailed vegetation community descriptions are provided in Appendix D.



Legend

Main Roads

Fire Roads

Dendrobium Pit Top Carpark Extension

Study Area

Proposed Ventilation Shaft Sites

Upland Swamps (Niche Validated)

978: Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion, (TEC: BC Act and EPBC Act)

978: Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion, (Not TEC)

1804: Needlebush - banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin, (TEC: BC Act and EPBC Act)

Vegetation (Niche Validated)

1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin

1245: Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion

Woronora Vegetation (NPWS 2003)

881: Hairpin Banksia - Kunzea ambigua -Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin

1395: Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin

1804: Needlebush - banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin

1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin

1181: Smooth-barked Apple - Red Bloodwood -Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin

1250: Sydney Peppermint - Smooth-barked Apple -Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin

1254: Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin Bioregion

1284: Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion

1292: Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin



Threatened Flora Species

No threatened flora species were recorded during baseline surveys undertaken for the Project. Notwithstanding, four threatened flora species have been previously recorded within the Project area, namely Prickly Bush-pea (*Pultenaea aristata*) and Woronora Beard-heath (*Leucopogon exolasius*), both listed as Vulnerable under the BC Act and EPBC Act, as well as Rufous Pomaderris (*Pomaderris brunnea*), listed as Endangered under the BC Act and Vulnerable under the EPBC Act, *Epacris purpurascens var. purpurascens*, listed as Vulnerable under the BC Act. Locations of these threatened flora species records are shown on Figure 6-15.

Threatened Fauna Species

Fourteen threatened fauna species were recorded during baseline surveys for the Project (Figure 6-16), including:

- 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*);
- Greater Glider (Petauroides volans);
- Koala (Phascolarctos cinereus);
- Little Bentwing-bat (*Miniopterus australis*);
- Littlejohn's Tree Frog (*Litoria littlejohni*);
- Rosenberg's Goanna (Varanus rosenbergi);
- Scarlet Robin (Petroica boodang);
- Varied Sittella (Daphoenositta chrysoptera);
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*); and
- Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris).

An additional nine threatened species have a high likelihood of occurrence within the Project area, including:

- Broad-headed Snake (Hoplocephalus bungaroides);
- Eastern Pygmy-possum (Cercartetus nanus);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Giant Burrowing Frog (*Heleioporus australiacus*);
- Giant Dragonfly (*Petalura gigantean*)³;
- Glossy Black-Cockatoo (Calyptorhynchus lathami);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Powerful Owl (Ninox strenua); and
- Red-crowned Toadlet (*Pseudophryne* australis).

Threatened Ecological Communities

Two TECs are represented by some of the 17 recorded native vegetation communities, namely:

- Shale Sandstone Transition Forest in the Sydney Basin Bioregion (Shale Sandstone Transition Forest TEC), listed under the BC Act and the EPBC Act; and
- Coastal Upland Swamps in the Sydney Basin Bioregion, listed under the BC Act and the EPBC Act.

Potential impacts to upland swamps are detailed in Section 6.8. The potential for other TECs to occur within the Project area was investigated and is reported in Appendix D.

Introduced Flora

Introduced flora species records are limited to those found opportunistically along fire roads. These include *Ageratina riparia*, *Plantago lanceolata* and *Hypochaeris radicata*.

Introduced Fauna

Four introduced fauna species were recorded during baseline survey for the Project, including Fox, Cat, House Mouse and Rabbit (Appendix D).

³ Recorded by Cardno in the Aquatic Ecology Assessment (Appendix E)







Matters of National Environmental Significance

The Project was referred under the EPBC Act in December 2016 and was determined to be a controlled Action (EPBC 2017/7855).

The following threatened species and communities have been recorded within the Project area and are listed under the EPBC Act:

- Greater Glider;
- Grey-headed Flying Fox;
- Koala;
- Littlejohn's Tree Frog;
- White-bellied Sea Eagle (migratory);
- Shale Sandstone Transition Forest TEC; and
- upland swamps.

The following threatened species listed under the EPBC Act are considered to have a moderate to high likelihood of occurring within the Project area (Appendix D):

- Broad-headed Snake;
- Giant Burrowing Frog;
- Bynoe's Wattle (Acacia bynoeana);
- White-flowered Wax Plant (Cynanchum elegans);
- Small-flower Grevillea (Grevillea parviflora ssp. Parviflora);
- Woronora Beard-heath (*Leucopogon* exolasius);
- Rufous Pomaderris (*Pomaderris brunnea*);
- Hairy Geebung (Persoonia hirsuta); and
- Prickly Bush-pea (*Pultenaea aristata*).

6.9.3 Assessment

Vegetation Clearance

The Project would result in direct disturbance of approximately 28.5 ha of native vegetation for surface infrastructure, comprising (Appendix D):

- 18.8 ha for the ventilation shaft sites;
- 0.2 ha for the Dendrobium Pit Top car park extension;

- an allowance of 5.0 ha for service boreholes and associated infrastructure (which includes allowance for clearing of a maximum of 1 ha of Shale Sandstone Transition Forest TEC); and
- an allowance of 4.5 ha for electricity supply to the ventilation shaft sites and associated infrastructure (which includes allowance for clearing of a maximum of 0.5 ha of Shale Sandstone Transition Forest TEC).

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 TEC.

Direct disturbance to native vegetation as a result of service boreholes would be short-term and actively rehabilitated following decommissioning.

Direct disturbance required for installing and maintaining electricity supply to the ventilation shaft sites would predominantly affect vegetation above an approximate height of 2 m, which would be cleared and maintained via slashing. However, for the purposes of this assessment a full loss scenario has been assumed (Appendix D).

Calculated ecosystem credit requirements as a result of direct disturbance to native vegetation are summarised in Table 6-13. The Biodiversity Offset Strategy proposed to address these requirements is described in Section 6.9.6.

Subsidence

Alteration of habitat following subsidence due to longwall mining is a Key Threatening Process under the BC Act.

A number of longwall design constraints have been incorporated in the Project underground mining layout (Section 3.5.3) to reduce potential environmental impacts due to mining-induced subsidence, including potential impacts to biodiversity values.



 Table 6-13

 Ecosystem Credit Requirements – Surface Disturbance

	Vegetation Community	Area (ha)	Credits Required
HN566	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaus, Sydney Basin	25.8	1,022
HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	1.5	120
HN651	Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest	1.0	80
ME044	Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion	0.2	6
	Total	28.5	1,228

Source: Niche (2019a)

The subsidence-related impacts to swamps, streams and cliffs within the Project underground mining area and immediate surrounds are described in Sections 6.8, 6.6 and 6.3, respectively. Potential consequences of subsidence-related impacts to swamps, streams and cliffs to threatened species habitat for the Giant Burrowing Frog and Littlejohn's Tree Frog (for both streams and swamps), Giant Dragonfly (for swamps), Red-crowned Toadlet (for streams) and Broad-headed Snake (for cliffs) have been considered in Appendix D.

These potential consequences are incorporated in offset calculations for the Project.

It is noted that for streams, consequences to threatened species habitat has been assessed conservatively assuming the entire lengths of streams within the Project underground mining areas would be impacted, irrespective of the mining constraints adopted for the Project (Section 3.5.3).

There is potential for vegetation dieback as a result of gas emissions from sandstone strata during mining (Appendix D). Niche (2019a) concluded that any impacts to vegetation would be localised and short-term, as vegetation would regenerate once gas emissions have stopped. Therefore, it is unlikely that the potential gas releases as a result of the Project would impact the extent of vegetation and habitat within the Project area.

Potential impacts to upland swamps as a result of subsidence are assessed in Section 6.8.3.

Threatened Species – Species Credit Species

Of the species listed in Section 6.9.2, and in consideration of potential impacts from surface disturbance and subsidence, the Project requires a Biodiversity Offset Strategy that accounts for species credits for the Broad-headed Snake, Littlejohn's Tree Frog, Giant Burrowing Frog, Red-crowned Toadlet, Giant Dragonfly and Koala (Table 6-14). The Biodiversity Offset Strategy proposed to address these requirements is described in Section 6.9.6.

Table 6-14 Species Credit Requirements – Surface Disturbance and Subsidence

Threatened Fauna Species	Area (ha)	Credits Required
Broad-headed Snake	0.3	9
Littlejohn's Tree Frog	32.7	851
Giant Burrowing Frog	32.7	426
Red-crowned Toadlet	7.2	94
Giant Dragonfly	13.9	1,073
Koala	1.5	39

Source: Niche (2019a)

Matters of National Environmental Significance

Of the threatened biodiversity considered, Niche (2019a) concluded that the Littlejohn's Tree Frog, Giant Burrowing Frog and upland swamps (Section 6.8.4) require an offset under the EPBC Act (Table 6-15).



					Offset	ting Options					
Threatened Entity	Area (ha)	Credits Required	Retirement of FBA Credits from Existing BioBank Sites	Establishment of Stewardship Site – Private Landholding	Establishment of Stewardship Site – South32 Landholding	Maddens Plains	Swamp Rehabilitation and Remediation Research Projects	Other Direct or Supplementary Measures	Payment into the BCT Fund	NSW Offset Liability met?	Commonwealth Offset Liability met?
Ecosystem Credits											
HN556	25.8	1,022	\checkmark	-	-	-	-	-	\checkmark	Yes	N/A
HN566	1.5	120	-	-	\checkmark	-	-	-	\checkmark	Yes	N/A
HN651	1.0	80	-	-	\checkmark	-	-	-	\checkmark	Yes	N/A
ME044	0.2	6	-	-	\checkmark	-	-	-	~	Yes	N/A
HN560 / HN662 (Coastal Upland Swamp TECs)	20.9*	305	-	\checkmark	-	-	~	~	✓ NSW only	Yes	Yes
Species Credits											
Koala	1.50	39	~	-	-	-	-	-	~	Yes	N/A
Littlejohn's Tree Frog	32.7	851	-	-	\checkmark	\checkmark	-	-	✓ NSW only	Yes	Yes
Broad-headed Snake	0.3	9	-	-	\checkmark	-	-	-	\checkmark	Yes	N/A
Giant Burrowing Frog	32.7	426	-	-	\checkmark	~	-	-	✓ NSW only	Yes	Yes
Red-crowned Toadlet	7.2	94	-	-	~	\checkmark	-	-	~	Yes	N/A
Giant Dragonfly	13.9	1,073	-	-	-	-	-	-	\checkmark	Yes	N/A

Table 6-15Offset Requirements and Strategy Options

* Note the area of offset liability for upland swamps incorporates residual credits available at the Maddens Plains Strategic Biodiversity Offset site (Section 6.9.4).



Koala Habitat Assessment under State Environmental Planning Policy No 44 – Koala Habitat Protection

Niche (2019a) concludes that Shale Sandstone Transition Forest TEC is core Koala habitat. Therefore, approximately 1.5 ha of core Koala habitat would be subject to direct disturbance (Table 6-14).

A Koala Plan of Management has been prepared in accordance with SEPP 44 that describes management measures proposed for potential impacts to core Koala habitat (Section 6.9.4). The Koala Plan of Management is provided as part of Appendix D.

Cumulative Impacts

The Project proposes to expand underground mining operations from approved and completed Dendrobium Mine areas by approximately 28.5 ha, in addition to other existing underground mining operations within the Southern Coalfield.

The potential cumulative impacts arising from the Project would be localised compared to the wider distribution of threatened species and communities and any direct disturbance of vegetation and habitat would be rehabilitated following decommissioning.

Ongoing monitoring within previously mined areas (including Area 3) has informed the proposed mine plan and subsidence and impact predictions for the Project, as well as development of avoidance, mitigation and management measures (Appendix D).

6.9.4 Avoidance/Mitigation Measures

South32 has well established and accepted management practices for operating an underground coal mine in the same environment as the Project. South32 would continue to implement management and mitigation measures currently employed at the Dendrobium Mine for the Project, as outlined below.

Bushfire Management

Bushfire risk management measures currently employed at the Dendrobium Mine as part of the existing Bushfire Management Plan would continue for the Project. Specific mitigation and management measures to reduce bushfire risk are detailed in Section 6.22.3. South32 would continue to consult with WaterNSW with respect to management of bushfire risk activities within the Special Areas.

Erosion and Sediment Control

Erosion and sediment control strategies for the Project would be based on similar practices currently undertaken as part of the existing Erosion and Sediment Control Plan (part of the existing Water Management Plan) for the Dendrobium Mine.

Site-specific Erosion and Sediment Control Management Plans would be developed for construction activities for the Project where required.

Vehicle Strikes

Existing speed limits and traffic rules would be maintained along roads travelling to and from the Project. Vehicle strikes would be monitored to inform implementation of future protocols to reduce potential impacts.

Landscape Management

Landscape management measures for the Project, including vegetation clearance protocols, weed control and pest management, would be implemented in accordance with the existing approved Landscape Management Plan. The Landscape Management Plan would be reviewed and revised where necessary for the Project.

If installation of surface infrastructure is required outside of the proposed ventilation shaft site disturbance areas, the areas would be subject to environmental assessment studies. These studies and any associated management measures would be detailed in a Surface Services Management Plan (Section 3.10.4).

Koala Plan of Management

A Koala Plan of Management has been prepared in accordance with SEPP 44, which describes management measures proposed for potential impacts to core Koala habitat (refer to Appendix D).



Rehabilitation and Remediation

All areas of native vegetation subject to direct disturbance would be progressively rehabilitated following decommissioning of surface infrastructure, such that only a practical minimum area is disturbed at any one time. Section 7 details relevant rehabilitation performance measures and completion criteria for the Project.

Current mitigation and remediation measures for subsidence impacts on upland swamps and watercourses at the Dendrobium Mine are described within the WIMMCP and SIMMCP (South32, 2017a; 2017b).

Other Measures

Other measures implemented by South32, relevant to reducing potential indirect impacts to biodiversity values within the Project area, would include noise, air quality and lighting management and mitigation measures consistent with existing Dendrobium Mine management plans (which would be updated to incorporate the Project).

Avoidance

A number of avoidance measures were developed by South32 and are incorporated in the design of the Project layout, including:

- Longwall design constraints to reduce potential environmental impacts due to mining-induced subsidence (Section 3.5.3), including:
 - setbacks from named watercourses; and
 - setbacks from "key stream features" (e.g. certain pools and waterfalls/steps).
- Shortening of longwall panels where the conceptual layout had longwall panels ending coincident with the location of upland swamps (Section 6.8.4).
- Avoidance of direct disturbance of upland swamps.
- Avoidance of direct disturbance of threatened flora species.
- Minimisation of Shale Sandstone Transition Forest TEC clearance required for installation and maintenance of supporting surface infrastructure, as far as practicable.
- Relinquishing the existing authority to impact an area of upland swamp within Area 3 (Section 9).

6.9.5 Adaptive Management

The proposed Biodiversity Offset Strategy for predicted impacts to ecology as a result of the Project is detailed in Section 6.9.6

Monitoring of threatened fauna habitat, flora and TECs, predicted to be impacted by subsidence, would be undertaken by South32 to refine the maximum offset liability for threatened fauna species.

Details of monitoring, performance measures, trigger levels and contingencies for subsidence-related impacts would be described in Extraction Plans prepared for the Project.

Monitoring of impacts to upland swamps and aquatic ecology is detailed in Sections 6.7.5 and 6.8.5.

6.9.6 Project Biodiversity Offset Strategy

The existing approved Biodiversity Offset Strategy for the Dendrobium Mine would be augmented with an additional Biodiversity Offset Strategy for the Project to account for further impacts to TECs, flora and fauna.

The proposed Biodiversity Offset Strategy for the Project has been prepared in consideration of the Project SEARs, the NSW Offset Policy (and supporting FBA), the Swamp Offset Policy and the Commonwealth *Environment Protection and Biodiversity Conservation Act Environmental Offsets Policy* (DSEWPAC, 2012).

The following options are available to South32 to address the NSW and Commonwealth offset liability:

- 1. Retirement of FBA credits through existing South32 BioBank sites.
- Establishment of Stewardship sites on South32 landholdings and/or privately-owned property.
- 3. Other direct offset options rehabilitation.
- 4. Payment into the Biodiversity Conservation Trust (BCT) Payment Fund.
- 5. Other direct or supplementary measures.

Table 6-15 provides a summary of the credit requirements and proposed offset strategies. The offset strategies are described below.



Given the options presented, it is expected South32 will be able to satisfy the Project's offset liability (Appendix D).

Retirement of FBA Credits

South32's existing Appin West and Douglas Park BioBank sites have sufficient residual credits to address both the NSW and Commonwealth offset requirements for HN556 and the Koala.

South32's Cataract River BioBank site also contains sufficient residual credits to address both the NSW and Commonwealth offset requirements for HN556.

Habitat for the Giant Burrowing Frog, Littlejohn's Treefrog and Red-crowned Toadlet has been identified within upland swamps in Maddens Plains. An estimate of the credits that could be generated at Maddens Plains confirms that it would address both the NSW and Commonwealth offset requirements for these species for the Project (Appendix D).

Establishment of Stewardship Sites

Additional South32 landholdings on the eastern portion of the Illawarra Escarpment contain more than 1,000 ha of mapped native vegetation, comprising at least 100 ha of HN566, 100 ha of HN561 and 200 ha of ME044.

Formal establishment of portions of these landholdings as a Stewardship site (formerly BioBank site) would address both the NSW and Commonwealth offset requirements for these vegetation communities.

Desktop mapping undertaken by Niche (2019a) of upland swamps within the wider region determined that more than 90% are located within existing National Parks Estates, Conservation Areas or WaterNSW catchment land. Upland swamps on private landholdings are generally smaller (approximately 2 ha) and scattered across multiple properties with different owners.

Notwithstanding, private landholdings have been identified that contain upland swamp communities suitable for use as offsets. South32 is currently in discussions with the landholders regarding the potential for Stewardship sites to be established. The discussions would continue and subject to the outcome, the land may be used to satisfy a portion of the required offsets for upland swamps.

Other Direct Offset – Rehabilitation

A number of the upland swamps within existing National Parks Estates, Conservation Areas or WaterNSW catchment land have been identified by Niche (2019a) as having some existing degree of impact from surface disturbance. This includes impacts from illegal tracks, fire roads, service easements and access roads, which are identified as key threats in the NSW and Commonwealth community profiles (OEH, 2017; DoE, 2014a).

Rehabilitation of the impacted portions of these upland swamps would provide a direct offset for potential impacts to upland swamps as a result of the Project.

As a component of the Project Biodiversity Offset Strategy, South32 proposes to work with WaterNSW and the NSW NPWS to prioritise upland swamps for rehabilitation work as an offset measure permissible under the NSW FBA and consistent with the requirements of the Commonwealth *Environment Protection and Biodiversity Conservation Act Environmental Offsets Policy* (DSEWPAC, 2012).

An example of an upland swamp within WaterNSW catchment land impacted by surface disturbance, which could be rehabilitated for the Project, is provided in Plates 6-5a and 6-5b.

Direct benefits to upland swamps as a result of this work include rehabilitation of cleared upland swamp communities, reducing the potential for localised erosion, preventing spread of weed species and enhancing threatened fauna habitat.

Payment into the BCT Payment Fund

Under the NSW FBA, payment into the BCT Payment Fund is permissible as an offset action. NSW offset requirements for the following vegetation communities and threatened species could be satisfied via sufficient payment into the BCT Payment Fund:

- HN566;
- HN561;
- ME044;
- HN560/HN662 (upland swamps);
- Koala;
- Red-crowned Toadlet;
- Giant Dragonfly; and
- Broad-headed Snake.





Plate 6-5a – Example of Coastal Upland Swamp Impacted by Surface Disturbance Source: Niche (2019a).



Plate 6-5b – Example of Coastal Upland Swamp Impacted by Surface Disturbance Source: Niche (2019a).

Note - portions of surface disturbance within upland swamps which could be rehabilitated are denoted by red dashed line.



Other Direct or Supplementary Measures

Should residual offset requirements beyond those described above be required for the Project, these credits could be offset using one or a combination of the following:

- Funding and/or undertaking research regarding the remediation of upland swamps impacted by subsidence.
- Funding and/or undertaking actions specifically related to threats to upland swamps. For example, actions to:
 - Address the "Objectives" of the Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi (DoEE, 2018).
 - Address the "Priority Conservation Actions" listed in the Conservation Advice (including listing advice) for Coastal Upland Swamps in the Sydney Basin Bioregion (DoE, 2014a).
- Purchasing credits on the market.
- Other supplementary measures as outlined in the NSW Offset Policy (OEH, 2014).

6.10 ABORIGINAL HERITAGE

6.10.1 Methodology

An ACHA was undertaken for the Project by Niche (2019b) and is presented in Appendix F.

The ACHA for the Project has been undertaken in general accordance with the following guidelines:

- Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (NSW Department of Environment and Conservation [DEC] 2005);
- Aboriginal cultural heritage consultation requirements for proponents 2010 (ACHCRs) (NSW Department of Environment, Climate Change and Water [DECCW], 2010a);
- Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b);
- Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (DECCW, 2010c);
- Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (OEH, 2011);

- The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance (Australia International Council on Monuments and Sites [ICOMOS], 2013);
- NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects (NSW Minerals Council, 2010).
- Engage Early (Commonwealth Government, 2016); and
- Clause 80c NSW National Parks and Wildlife Regulation, 2009 (NPW Regulation).

A description of Aboriginal heritage in the vicinity of the Project and the consultations undertaken with the Aboriginal community is provided in Section 6.10.2. Section 6.10.3 describes the potential impacts associated with the Project to Aboriginal heritage, while Sections 6.10.4 and 6.10.5 outline applicable mitigation and adaptive management measures.

6.10.2 Existing Environment

Management of Aboriginal cultural heritage at the Dendrobium Mine is currently undertaken consistent with the approved SMP.

Aboriginal Cultural Heritage Assessment

The ACHA (Appendix F) incorporates:

- results from extensive fieldwork, surveys and archaeological and cultural assessments previously undertaken at the Dendrobium Mine and surrounds;
- search results from the OEH Aboriginal Heritage Information Management System (AHIMS) database and other heritage registers;
- results from ongoing consultation with the Aboriginal community regarding archaeological and cultural heritage values;
- a description of the methods implemented and the results of archaeological and cultural surveys and inspections conducted by archaeologists and representatives of the Aboriginal community for the Project between February 2017 to July 2018; and
- a description of the consultation undertaken for the Project from 2017 to 2018.

The key steps involved in the preparation of the ACHA and associated consultation are described below.



Aboriginal History

The Sydney Basin has been occupied by Aboriginal people since approximately 30,700 years before present, based on the age of archaeological material found within the region (Jo McDonald Cultural Heritage Pty Ltd, 2005). Nearer to the Project area, the site of Bass Point at Shellharbour was occupied by Aboriginal people from approximately 20,000 years ago, indicating a great antiquity of Aboriginal occupation in the region (Appendix F).

The Project underground mining areas are located on land that was the traditional country of the Tharawal people. The Tharawal people distinguished themselves as Fresh Water, Bitter Water or Salt Water depending on where in the wider language boundary their traditional lands were – the inland hills and valleys, the plateaus and swamps or the coastal plain of the region, respectively (Appendix F).

At the time of first contact with European observers, the Tharawal people regularly traded, moved around the region and participated in ceremonies between their country and neighbouring areas (Appendix F).

It is expected that traditional values and activities remained in the region, practiced by the Tharawal people until the early 19th Century. At this time, European graziers began cultivating land in the south of the Cumberland Plain and the coastal plains around Wollongong, which impacted access to traditional and everyday resources (e.g. water) and traditional way of life, and caused social disruption to local Aboriginal groups (Appendix F).

Despite the changes that were brought to the Aboriginal people of the region, today there are many thousands of Aboriginal people living in the Illawarra (Appendix F).

Much of the underground Project area is undisturbed, due to the reservation of these areas for catchment reserves (i.e. Metropolitan Special Area located within the Sydney Drinking Water Catchment). This has resulted in relatively little disturbance to many Aboriginal heritage sites in these areas.

The Project surface infrastructure areas are more disturbed due to historic and current mining activities. Subsequently, Aboriginal heritage sites in these areas are more likely to have been disturbed (Appendix F).

Previous Archaeological Investigations

A number of Aboriginal heritage surveys and assessments have been undertaken in the Project area over the past 29 years, including survey and assessment previously undertaken for the Dendrobium Mine.

The assessments and surveys undertaken in the vicinity of the Project include:

- an archaeological survey of the Cordeaux and Woronora River (Sefton, 1990);
- a comprehensive analysis of rock art and prehistoric information exchange within the Sydney Basin (McDonald, 1994);
- an archaeological survey of the Avon River (Sefton, 1994);
- an assessment of the artefact and Aboriginal archaeological site patterns of the Woronora Plateau (Sefton, 1998);
- a comprehensive Cultural Heritage Assessment for Dendrobium Mine Area 1 (Longwalls 1 to 3) (Navin Officer, 2000);
- an assessment of the monitoring of sandstone overhangs for the effects of mining subsidence in the Illawarra Coal Measures (Sefton, 2000);
- a survey and assessment for Dendrobium Mine Longwalls 9 and 10 (Sefton, 2002);
- a Review of Environmental Factors (REF) assessment for Dendrobium Area 3 and Cordeaux Dam foreshore (Biosis Research, 2004);
- a survey and assessment for the West Cliff Colliery Stage 3 Coal Wash Emplacement (Biosis Research, 2007a);
- a comprehensive Archaeological and Cultural Heritage Assessment for Dendrobium Mine Area 3 (Biosis Research, 2007b);
- an ACHA for the Bulli Seam Operations Project (Biosis, 2009a);
- an Archaeological Assessment supporting the Dendrobium Mine Area 3 SMP (Niche, 2012); and
- various due diligence assessments for the Dendrobium Mine (Appendix F).

A description of the assessments and surveys undertaken in the Project area and surrounds is provided in Appendix F.



Heritage Register Searches

In addition to the AHIMS database searches undertaken for the ACHA (Appendix F), searches of the following heritage registers and planning instruments were undertaken in 2016 for Aboriginal heritage items:

- National Heritage List and Commonwealth Heritage List (via the Australian Heritage Database);
- Register of the National Estate (via the Australian Heritage Database);
- State Heritage Register;
- The s170 Heritage and Conservation Register; and
- The National Trust Register.

Community Consultation

Consultation for the Project was undertaken in accordance with the ACHCRs (DECCW, 2010a) and the NPW Regulation.

Table 6-16 summarises the main stages of the Aboriginal heritage consultation process undertaken for the Project.

A detailed account of the consultation process (including consultation records and a detailed consultation log) for the Project is provided in Appendix F.

Consultation with the RAPs regarding the Dendrobium Mine and the Project has been extensive and involved various methods including public notices, on-site meetings, written and verbal correspondence, archaeological survey attendance and on-site inspections.

Survey Methodology

Surveys undertaken for the Project focused on surface areas with the potential to be disturbed by the Project that are not already part of the Dendrobium Mine (i.e. the proposed ventilation shaft sites and the Dendrobium Pit Top Carpark Extension).

The surveys were also undertaken within the underground mining areas to ground truth sites recorded previously in addition to identifying new sites. Further to this, natural features within the underground mining areas that have the potential to be impacted by subsidence from the Project were also subject to systematic survey (Appendix F). Surveys undertaken were informed by the predictive model and designed in consultation with the Aboriginal community as part of the Proposed Methodology.

Summary of Archaeological Findings

Following review of desktop investigation outcomes and the results of the Project surveys, a total of 58 Aboriginal heritage sites were identified within the surveyed area (Table 6-17), consisting of:

- 23 axe grinding groove sites;
- 34 sandstone shelters with art and/or archaeological deposits; and
- a single isolated artefact.

This included a total of six new Aboriginal heritage sites that were located during the surveys (including two sandstone shelter sites with art and four sites containing axe grinding grooves within creek beds) and 52 previously recorded sites (i.e. recorded during previous archaeological investigations and relocated during Project surveys) (Appendix F).

Descriptions of each of the 58 Aboriginal heritage sites are provided in Appendix F (including photos and site information) and listed in Table 6-17 below.

No sites were identified in the Dendrobium Pit Top Carpark Extension area (Appendix F).

Archaeological and Cultural Heritage Values

The archaeological significance of the 58 known Aboriginal heritage sites identified during the Project surveys is summarised as follows (Table 6-17) (Appendix F):

- 49 were assessed as being of low scientific significance;
- 3 were assessed as being of moderate scientific significance; and
- 6 were assessed as being of high scientific significance.

The statements of significance for the Aboriginal heritage sites were prepared in consideration of comments received from the RAPs throughout the consultation process (Appendix F).



Table 6-16

Summary of Aboriginal Heritage Consultation Undertaken for the Project

Date	Consultation
Notification of Project ar	nd Registrations
3 January and 31 January 2017	Letters requesting the names of Aboriginal parties or groups who may have a cultural interest in and, therefore, may have been interested in registering for the consultation process were sent to Greater Sydney Local Land Services, Illawarra Local Aboriginal Land Council (ILALC), NTS Corp Limited, Office of the Registrar (<i>Aboriginal Land Rights Act, 1983</i>), South East Local Land Services, Tharawal LALC, Wollongong City Council, Wollongong Regional Operations Group (OEH), Wollondilly Shire Council, Wingecarribee Shire Council and NNTT, in order to identify Aboriginal stakeholders.
4 January to 18 January 2017	Responses to the above request were received from the NNTT, Tharawal Local Aboriginal Land Council, Office of the Registrar (<i>Aboriginal Land Rights Act, 1983</i>), Wollondilly Shire Council, Wingecarribee Shire Council and Wollongong Regional Operations Group (OEH).
18 January 2017	Letters seeking registrations of interest were sent to a portion of the 75 Aboriginal parties (individuals and organisations) identified in the above step.
17 January and 18 January 2017	Public notices were placed in the <i>Illawarra Mercury</i> and the <i>Macarthur Advertiser</i> , respectively, inviting interested Aboriginal parties or groups to register.
8 February 2017	Letters seeking registrations of interest were sent to the remaining Aboriginal parties (individuals and organisations).
8 February 2017	Public notices were placed again in the <i>Illawarra Mercury</i> and the <i>Macarthur Advertiser</i> inviting interested Aboriginal parties or groups to register.
22 February 2017	Record of names of RAPs provided to the Illawarra Regional OEH Environmental Protection and Regulation Group Office, Illawarra LALC and Tharawal LALC in accordance with the OEH policy ACHCRs (DECCW, 2010a).
February 2017	A total of 17 individuals and/or organisations were registered as RAPs for the Project following completion of the registration period (17 January to 22 February).
Proposed Methodology	Review and Information Session
6 February 2017	Provision of the Proposed Methodology for the undertaking of the ACHA was distributed to the RAPs. A request for comments on the Proposed Methodology and an invitation to attend an information session to discuss the Project and Proposed Methodology were included.
6 March 2017	An information session to discuss the Project and the Proposed Methodology was held at the Cordeaux Colliery, which included an opportunity for RAPs to provide comments on the Proposed Methodology.
February to March 2017	Feedback from the RAPs in regard to the Proposed Methodology was received, and consideration was given to all comments.
Field Surveys	
6 February 2017	Invitation sent to RAPs to attend field surveys for the Project ¹ .
13 March 2017, 1 May to 5 May 2017, 11 May to 12 May 2017, 16 May to 18 May 2017, 22 May to 26 May 2017	Aboriginal cultural heritage surveys were conducted by archaeologists from Niche and registered RAPs.
22 June 2017	Additional Aboriginal cultural heritage survey was conducted to assess changes to one of the proposed ventilation shaft site locations by archaeologists from Niche and registered RAPs.
7 May 2018	Letters informing the RAPs that a revision had been made to the Project longwall layout and an additional survey would be required for the Project.
28 to 29 May 2018, 5 June 2018, 26 to 28 June 2018, 3 July 2018	Additional Aboriginal cultural heritage survey was conducted on portions of the proposed Area 5 for the Project to assess additional AHIMS registered sites and the landscape surrounding these sites by archaeologists from Niche and by registered RAPs.
Draft ACHA Review, Info	rmation Sessions and Site Inspection
5 January 2018	A copy of the initial draft ACHA was provided to all RAPs for their review and comment. Feedback on the initial draft ACHA was requested by 5 February 2018. Comments received on the initial draft ACHA were considered and included in the ACHA (Appendix F).
22 January 2018	An information session was held at the Cordeaux Colliery to discuss the key findings of the initial draft ACHA and to provide an opportunity for RAPs and other community stakeholders and Elders to discuss, ask questions and provide comment on the initial draft ACHA.
2 October 2018	Following additional field surveys undertaken, a copy of the second draft ACHA was provided to all RAPs for their review and comment. Feedback on the second draft ACHA was requested by 29 October 2018. No comments were received from the RAPs.

Source: After Appendix F ¹ The fieldwork participation process is described in further detail in Appendix F.



Table 6-17
Aboriginal Heritage Sites within Project Underground Mining Areas

Site Type	Scientific Significance	Aboriginal Heritage Site Name	Number Recorded
		Dendrobium ACHA AGG-1	1
Axe Grinding Groove	Low	Dendrobium ACHA AGG-2, Dendrobium ACHA AGG-3, Dendrobium ACHA AGG-4, Tega Site 11, Tega Site 12, Donalds Castle Creek Site 31, Ricki Lee 1, Ricki Lee 2	8
	LOW	Wallandoola Site 39, East Cordeaux 33, Tega Site 6, Donalds Castle Creek Site 5, Donalds Castle Creek Site 7, Donalds Castle Creek Site 16, Donalds Castle Creek Site 17, Ricki Lee 12, Upper Avon 54, Upper Avon 42, Upper Avon 44,	11
		Tega Site 1	1
	Moderate	Wallandoola Site 38, East Cordeaux 34	2
Shelter with Art		Dendrobium ACHA Shelter-1, Dendrobium ACHA Shelter-2, Tega Site 10, Upper Avon 53, Upper Avon 45	5
	Low	East Cordeaux 31, Tega Site 5, Tega Site 7, Tega Site 8, Tega Site 13, Ricki Lee 5, Ricki Lee 6, Ricki Lee 8, Ricki Lee 9, Ricki Lee 10, Upper Avon 48, Upper Avon 60, Upper Avon 51, Upper Avon 55, Upper Avon 46, Upper Avon 52	16
		Upper Avon 43	1
	High	Tega Site 20, Upper Avon 47, Metro Catchment-Art01, Ricki Lee 11	4
Shelter with Deposit	Low	Upper Avon 39, Upper Avon 41	2
	Low	East Cordeaux 32, Tega Site 2, Upper Avon 40, Ricki Lee 7	4
Shelter with Art and Deposit	High	Upper Avon 49	1
Isolated Find	Low	Avon Dam IF1	1
Shelter with Potential Archaeological Deposit	Low	M2D PAD 2	1
Total			58

Source: After Appendix F





6.10.3 Assessment

Project Surface Development

Surface disturbance works associated with the Project would include the development of the Dendrobium Pit Top Carpark Extension, as well as the development of the proposed ventilation shaft sites to support the Project underground mining areas. These surface development works have the potential to impact Aboriginal cultural heritage sites through disturbance of the ground surface (e.g. vegetation clearance and topsoil stripping) or through secondary impacts that may alter a site or locations of cultural value.

The proposed surface infrastructure for the Project has been designed to avoid identified sandstone shelters, axe grinding grooves and other natural landscape features (Table 6-17) (Appendix F).

Of the 58 Aboriginal heritage sites identified, only one site is located within close proximity to the proposed surface infrastructure. This site is the newly identified Dendrobium ACHA AGG-1 (identified as having low scientific significance), which is located proximal to proposed Shaft No 5B. This site would not be directly disturbed by the surface development works for Shaft No 5B as appropriate measures would be implemented to avoid potential impacts during construction of this shaft site (e.g. fencing installed) (Appendix F).

The location and design of ancillary infrastructure (e.g. access tracks, Project power and/or water supply infrastructure) required progressively over the life of the Project is flexible and would be located to avoid Aboriginal heritage sites as far as practicable (Appendix F).

As part of the Project detailed design phase, the final location of some of the surface infrastructure and surface works would also be determined.

Project Extent of Underground Mining Area

Potential subsidence effects from underground mining operations at the Project are discussed in detail in Appendix A.

Potential impacts from subsidence to Aboriginal heritage sites, based on the maximum predicted subsidence movements as provided in Appendix A, are described below. For areas where the landscape is comprised of rock formations (e.g. sandstone and rock outcrops), the risks of harm to Aboriginal heritage sites are greater than those for open sites on soil landscapes (Appendix F). Rock buckling and deformation, block fall, cracking and overhang collapse have the potential to impact Aboriginal heritage sites (e.g. grinding grooves and sandstone shelters). Cracking, exfoliation and block fall (and in some cases overhang collapse, although this has not been documented within the existing Dendrobium mining area) are all typical of natural weathering processes however, subsidence effects have the potential to exacerbate these processes (e.g. bring forward the timing of block fall).

Subsidence-induced ground movements can potentially result in soil cracking, changes to surface or sub-surface drainage or mass movement effects on steep slopes (e.g. large surface cracking) in areas with a soil profile. However, subsidence-induced ground movements would result in stresses and strains generally within the tolerance limits of the soil profile and hence Aboriginal heritage sites at the surface in these areas are predicted to have little to no impact (Appendix F). Isolated cracking of soils at the surface may also occur, and impacts may occur to an Aboriginal heritage site if the site is coincident with the precise location of soil cracking.

All 58 Aboriginal heritage sites identified have the potential to be impacted by subsidence due to their location on the surface relative to the proposed Project underground mining area (Appendix F).

For the nine sites assessed as having moderate or high scientific significance, there is potential for partial loss of value (aesthetic/visual) due to predicted subsidence effects (Appendix F).

Monitoring of the effects of subsidence-induced ground movements to Aboriginal heritage sites (e.g. rock shelters and grinding groove platforms) has been conducted since the 1990s (Appendix F). Previous experience has shown that approximately only 1 in 10 rock-based sites that have been subjected to subsidence-induced ground movements show changes that can be attributed to subsidence (e.g. block fall, exfoliation, cracking) (Biosis Research, 2009b).

Cumulative Impacts

A consideration of the potential cumulative impacts associated with the Project has been undertaken and is presented in Appendix F.



The Project would result in a minor increase to cumulative potential impacts to Aboriginal cultural heritage of the region, noting that Aboriginal heritage items in the area have had limited impact due to the restrictions to access associated with the Metropolitan Special Area.

The Aboriginal sites identified for the Project would be monitored as part of the Project and Dendrobium Mine operations, and become part of the wider list of sites monitored within the Southern Coalfield (Appendix F).

Other Project Areas

The ACHA assesses potential impacts to Aboriginal heritage items in the Project underground mining areas (Areas 5 and 6) and areas of new surface disturbance (e.g. ventilation shafts and the Dendrobium Pit Top carpark). There would be no additional potential disturbance of Aboriginal heritage items (i.e. beyond what has previously been assessed and is currently approved) at other Project areas where additional surface disturbance is not required, such as the Dendrobium CPP, Kemira Valley Coal Loading Facility and Stage 3 of the West Cliff Coal Wash Emplacement.

6.10.4 Mitigation Measures

The mitigation and adaptive management measures detailed below have been developed in consultation with the RAPs, in consideration of the cultural archaeological significance of Aboriginal heritage sites identified within the Project underground mining area.

Aboriginal Heritage Management Plan

An Aboriginal Heritage Management Plan (AHMP) would be developed for the Project in consultation with the RAPs and the relevant regulatory authorities.

The AHMP would include:

- Protocols for the involvement of RAPs in cultural heritage works conducted under the AHMP for the life of the Project.
- A protocol describing methods of communication, including expectations of suitable notification and response time, between South32 and the RAPs.
- A protocol to allow for access to Aboriginal heritage sites as required by the AHMP (noting that access is also subject to the requirements of WaterNSW).

- Procedures to establish, maintain and update a database of Aboriginal heritage sites identified within the Project underground mining area.
- A protocol for the determination of the final location of Project surface infrastructure and surface works, including systematic survey of the relevant development area(s) (in consultation with the RAPs) if the area has not already been surveyed.
- If previously unknown Aboriginal heritage sites or items are identified during the life of the Project, procedures for the management and reporting of these sites.
- Protocols for the incorporation of heritage awareness training into mine site inductions for both Illawarra Coal employees and external contractors who may be conducting works that have the potential to impact on any Aboriginal heritage sites.
- A protocol that defines actions to be followed in the event that human remains are discovered (e.g. stop work provisions and notification protocols).
- A description of fencing of site ACHA AGG-1 to avoid the risk of indirect or accidental harm from surface disturbance activities.

Subsidence Monitoring

Monitoring of potential impacts to Aboriginal heritage items would be conducted prior to and following subsidence from longwall mining. This would include detailed baseline and archival site recordings of Aboriginal heritage sites prior to the commencement of mining operations to ensure appropriate documenting of sites. The details of the subsidence monitoring program would be outlined in the AHMP and detailed in Extraction Plans for the Project.

6.10.5 Adaptive Management

Surface Disturbance

South32 would avoid disturbance of known Aboriginal heritage sites where practicable during development of surface infrastructure for the Project. In addition, depending on the Aboriginal heritage site type and nature of proposed surface development works, further management measures would be undertaken prior to any potential disturbance of Aboriginal heritage sites (e.g. additional archival recording and the implementation of fencing to isolate the site).



6.11 NON-ABORIGINAL HERITAGE

6.11.1 Methodology

A Historic Heritage Assessment for the Project was conducted by Niche (2019c) and is presented in Appendix G.

The assessment for the Project has been undertaken in general accordance with the following principles and guidelines:

- NSW Heritage Manual (NSW Heritage Office and NSW Department of Urban Affairs and Planning, 1996); and
- The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance (ICOMOS, 2013);

A description of historic heritage in the vicinity of the Project is provided in Section 6.11.2. Section 6.11.3 describes the potential impacts associated with the Project on historic heritage, while Sections 6.11.4 and 6.11.5 outline applicable mitigation and adaptive management measures.

6.11.2 Existing Environment

A background discussion on exploration, European settlement, historical land use, development of the Upper Nepean Scheme (e.g. Upper Nepean Water Supply System including Nepean Tunnel, Avon Dam and Cordeaux Dam) and a history of mining in the Illawarra region of relevance to historical heritage in the vicinity of the Project is provided in Appendix G.

Heritage Register Searches

Niche completed a review of heritage registers for listed historical heritage items located within the vicinity of the Project, including searches of the following (Appendix G):

- National Heritage List.
- Commonwealth Heritage List.
- NSW State Heritage Register.
- State Heritage Inventory.
- Schedules of the *Wollongong Local* Environmental Plan 2009 (Wollongong LEP).

- Schedules of the *Wollondilly Local* Environmental Plan 2011 (Wollondilly LEP).
- Schedules of the *Wingecarribee Local Environmental Plan 2010* (Wingecarribee LEP).

The review of heritage registers found two items of State heritage significance (i.e. heritage curtilage of Avon Dam and Cordeaux Dam) and two items of local heritage significance (i.e. the former Nebo Colliery, located on the site of the Dendrobium Pit Top and the Kembla Heights Mining Village [Heritage Conservation Area]), which are located within, or in the vicinity of, the Project area.

Previous Investigations

A cultural heritage assessment was prepared by Navin Officer (2000) for the Dendrobium Mine. The assessment identified historical buildings associated with the former Nebo Colliery infrastructure (now located at the site of the existing Dendrobium Pit Top), which date back to 1946, as listed on the Wollongong LEP. Archival recordings of the Nebo Colliery buildings were undertaken in 2001 (Rogers, 2001) prior to works on these buildings at the existing Dendrobium Pit Top, with supplementary archival recordings undertaken in 2003 to document alterations as a result of these works (Appendix G).

Excavations undertaken in 2000 for the EGP identified deposits of spent shale along the historical kerosene flats (on the lower flat of the Dendrobium Pit Top adjacent to American Creek), associated with the early kerosene works. Further excavation works undertaken in 2002 also uncovered a stone and brick setting (Appendix G).

Further assessments and surveys conducted by Biosis Research in 2007 and 2012 for Dendrobium Mine Area 3 identified one previously unidentified historical heritage item, namely a small timber bridge on a tributary of the Cordeaux River (Biosis, 2007b).

A heritage impact assessment undertaken specifically for Dendrobium Mine Area 3B conducted by Biosis Research in 2012 did not identify any items of historical heritage (Appendix G).



Heritage Items within and in Proximity of the Project Area

Following a desktop assessment and review of previous investigations, additional site investigations were conducted in 2017 and 2019 across the Project underground mining area and at the Dendrobium Pit Top. The site investigations focused on locating and characterising heritage items from previous assessments and surveys, as well as identifying potential additional heritage sites.

As a result of the heritage register searches, previous historic heritage investigations and the site investigations undertaken for the Project, no additional heritage items were identified in the Project area. A summary of the heritage significance of the previously identified heritage sites (i.e. historical buildings associated with the former Nebo Colliery and the Kembla Heights Mining Village [Heritage Conservation Area] [Figure 6-17] and heritage curtilage of the Avon Dam and Cordeaux Dam [Figure 6-18]), is provided in Table 6-18.

The Cordeaux Dam and Avon Dam are items of State heritage significance and were constructed in 1926 and 1927, respectively. The Cordeaux Dam and Avon Dam are popular tourist attractions, which include picnic areas, shelters and remnant landscaping dating from approximately the late 1920s to early 1930s (Appendix G). The Cordeaux Dam and Avon Dam wall entrance ways are characterised by Egyptian-style architecture (Appendix G). Although this infrastructure and the recreational areas are not located within the Project underground mining areas, portions of the heritage curtilages of the Avon Dam and Cordeaux Dam extend into Project underground mining Area 5 and Area 6, respectively.

The former Nebo Colliery dates back to 1946, and is located on the site currently occupied by the existing Dendrobium Pit Top. This site is classified as significant as it was the first fully mechanised mine to be opened (OEH, 2017). Buildings associated with the former Nebo Colliery are of local heritage significance and are currently used as part of the existing operations at the Dendrobium Pit Top. The Dendrobium Pit Top is also located within the Kembla Heights Mining Village (Heritage Conservation Area), which is of local heritage significance.

6.11.3 Assessment

Avon and Cordeaux Dams

The Project underground mining layout has been designed to reduce potential subsidence impacts on the structural integrity or external fabric of the Avon and Cordeaux Dam walls. Monitoring and investigation works would be conducted to maintain the structure in a safe and serviceable condition.

The proposed Project surface infrastructure would have little to no adverse impacts on the heritage significance of the Avon and Cordeaux Dams and their associated views and vistas (Appendix G).

Nebo Colliery and Kembla Heights Mining Village

Operations at the Dendrobium Pit Top (and, therefore, the current use of historic Nebo Colliery buildings) are approved as part of the Dendrobium Mine in accordance with Development Consent DA 60-03-2001, and would continue under the Project. The site has previously been fully recorded as part of the process of conducting the previous range of site upgrade works authorised under Development Consent DA 60-03-2001.

The Project represents continued and adaptive use wholly consistent with the nature of the item, which is an operational colliery (Appendix G).

The upgrades to facilities at the Dendrobium Pit Top would not result in key buildings being demolished or significantly remodelled, and would be designed to minimise physical impact to the values and significance to the Nebo Colliery and Kembla Heights Mining Village. It is unlikely that the heritage values of the Kembla Heights Mining Village would be significantly adversely impacted by the Project (Appendix G). Any potential impacts to heritage values would be managed through the implementation of a Conservation Management Plan to be prepared prior to the commencement of the Dendrobium Pit Top upgrades.







Heritage Item	Identified in Historic Heritage Register?	Description	Significance	Located within Project Area
Avon Dam	Yes	Dam wall and associated infrastructure, recreational facilities (e.g. picnic areas, shelters)	State	Yes – a portion of the heritage curtilage (excluding the dam wall and recreational areas) is partially located above proposed Area 5 underground mining area.
Cordeaux Dam	Yes	Dam wall and associated infrastructure, recreational facilities (e.g. picnic areas, shelters)	State	Yes – a portion of the heritage curtilage (excluding the dam wall and recreational areas) is partially located within proposed Area 6 underground mining area.
Nebo Colliery	Yes	Historical buildings including workshop and bathhouse	Local	Yes – located at existing Dendrobium Pit Top.
Kembla Heights Mining Village	Yes	Heritage Conservation Area	Local	Yes – Dendrobium Pit Top partially located within heritage area.

Table 6-18Identified Heritage Items in the Project Area

Source: After Appendix G.

6.11.4 Mitigation Measures

A Conservation Management Plan would be developed for the Project, which would provide guidance for management of heritage items during the detailed design, construction and operational phases of the Project. The proposed upgrades and construction of additional structures at the Dendrobium Pit Top would be designed to reduce potential physical impact to the values and significance of the Nebo Colliery and the Kembla Heights Mining Village (Heritage Conservation Area), and would consider construction techniques that would not require sub-surface excavations (Appendix G).

Any significant heritage items not previously identified would be recorded if they are subject to potential damage or demolition.

Mitigation and management measures to reduce the potential visual impacts of the proposed ventilation shaft sites on the visual amenity of the Cordeaux Dam heritage site would include colouring the infrastructure similar to the surrounding vegetation. Measures to manage potential subsidence impacts to the Avon and Cordeaux Dams are provided in Appendix A.

6.11.5 Adaptive Management

In the unlikely event that previously unrecorded historical archaeological relics were to be discovered during ground disturbance for the Project, work in the immediate area would cease and a suitably qualified archaeologist would be engaged to assess the condition, extent and likely significance of the remains. If required, the Heritage Council would be notified of the discovery in accordance with section 146 of the *Heritage Act, 1977*.

6.12 ROAD TRANSPORT

6.12.1 Methodology

A Road Transport Assessment for the Project was undertaken by GTA Consultants (2019) and is presented as Appendix H.

The Road Transport Assessment was conducted in accordance with the *Guide to Traffic Generating Developments* (Roads and Traffic Authority, 2002). Reference is also made to applicable Australian Standards and Austroads guidelines where applicable.

A description of the existing traffic environment in the vicinity of the Project is provided in Section 6.12.2. Section 6.12.3 describes the potential road transport impacts associated with the Project, while Sections 6.12.4 and 6.12.5 outline applicable mitigation and adaptive management measures for road transport.



The SEARs refer to the assessment of the capacity, condition, safety and efficiency of the rail network, however, this is not considered to be required given the Project would use a private rail line.

6.12.2 Existing Environment

The Project is located in the greater Wollongong area, which has a significant regional population and an extensive and highly trafficked road network.

Relevant Roads

The existing road network in the vicinity of the Project is described in Appendix H and is summarised below (Figure 6-19).

Princes Motorway

The Princes Motorway (Route M1) is predominantly a dual-carriage motorway linking Waterfall in the south of Sydney to Mount Ousley Road and the Illawarra Highway at Yallah. It follows a roughly parallel route to the Princes Highway to the Bulli Tops interchange, bypassing the Wollongong CBD (Figure 6-19).

Princes Highway

The Princes Highway (HW1) is a State and Regional Road linking Sydney to the Victorian border (Figure 6-19).

Mount Ousley Road

Mount Ousley Road is the portion of the Princes Motorway between the top of Bulli Pass and North Wollongong, where Mount Ousley Road extends to the Princes Highway (Figure 6-19).

Springhill Road

Springhill Road is an arterial road providing a link between Five Islands Road to the south and Corrimal Road in the north, primarily servicing the Port Kembla industrial precinct facilities (Figure 6-19).

Appin Road

Appin Road is a sub-arterial road providing a link between Campbelltown and the Bulli Tops interchange north of Wollongong, and passes through the Appin township (Figure 6-19).

Picton Road

Picton Road (Main Road 95) is a local road extending from Mount Ousley Road at its south-eastern end to Picton at its north-western end (Figure 6-19). There are interchanges at the intersections of Picton Road with both the Hume Motorway and Mount Ousley Road, which allow vehicle movements between the two routes.

Picton Road is identified in the *Illawarra-Shoalhaven Regional Plan* (NSW Government, 2015) as part of the primary freight route for the region, which nominates a number of inter-regional transport infrastructure improvements to support growth, including duplication of Picton Road in the long term.

Cordeaux Road

In the vicinity of the Project, Cordeaux Road provides access from Kembla Heights to the Princess Highway at Figtree, via Cordeaux Heights and Mount Kembla residential areas to the east of the Dendrobium Pit Top access road (Figure 6-19).

West of the Dendrobium Pit Top Access Road, Cordeaux Road forms a narrow and winding two-lane road, through Kembla Heights (Figure 6-19).

Five Islands Road

Five Islands Road provides a connection from the Princes Motorway to the suburbs located to the south of the Port Kembla industrial precinct, including Cringila and Warrawong (Figure 6-19).

Harry Graham Drive

Harry Graham Drive provides a link from Cordeaux Road west of the Dendrobium Pit Top Access Road to Mount Keira Road (Figure 6-19).

Mount Keira Road

Mount Keira Road extends between Picton Road and the Princes Highway at West Wollongong, via Mount Keira and is typically a two-lane, two-way rural road (Figure 6-19).

Clive Bissell Drive

Clive Bissell Drive provides a link from Mount Keira Road to Mount Ousley Road (Princes Motorway) (Figure 6-19).





Central Road

A level crossing of the Kemira Valley Rail Line is located on Central Road, south of its intersection with Cordeaux Road. North of the level crossing, Central Road has two northbound travel lanes allowing for traffic to queue. Turn bays are provided on both approaches of Cordeaux Road (Figure 6-19).

Stones Road

Stones Road provides a link between Cordeaux Road, and the Kemira Valley Coal Loading Facility Access Road (Figure 6-19).

Flinders Street

Flinders Street extends east from Five Islands Road, and provides several access points to the Port Kembla industrial precinct (Figure 6-19).

Key Existing Mine Access Routes

The primary access routes to the main surface facilities at the Dendrobium Mine includes:

- access to the Dendrobium Pit Top off Cordeaux Road (Figure 6-19);
- access to the Kemira Valley Coal Loading Facility via the Kemira Valley Coal Loading Facility Access Road, off Stones Road (Figure 6-19); and
- access to the Dendrobium CPP via the Dendrobium CPP Access Road, off Flinders Street (Figure 6-19).

Coal wash from the Dendrobium CPP is transported to the West Cliff Coal Wash Emplacement by backloading coal haulage trucks under Project Approval 08_0150 for the Bulli Seam Operations. These trucks use private roads within the Port Kembla industrial precinct and join the public road network on Springhill Road between Masters Road and Five Islands Road. Coal wash is then transported to the West Cliff Coal Wash Emplacement or for other beneficial uses using the regional public road network (Figures 3-10a and 3-10b). Movements to and from West Cliff use Appin Road.

As the Project would not materially alter the existing workforce and coal/reject truck movements to and from West Cliff and the Port Kembla industrial precinct, the assessment in Appendix H and the following discussion is focused on potential Project traffic generation at the other Dendrobium Mine surface facilities. The Cordeaux Pit Top is not part of the existing Dendrobium Mine operations, but is used to support other South32 operations such as exploration, survey and environmental monitoring. Access to the Cordeaux Pit Top is via a mine access road, off Picton Road (Figure 6-19). The Cordeaux Pit Top would be used later in the Project life for primary operational access to the underground mine.

Existing Traffic Volumes

Historical and recent RMS Annual Average Daily Traffic (AADT) data on roads in the vicinity of the Project is summarised in Appendix H. Current traffic ranges from approximately 8,600 movements per day at Picton Road, south of Macarthur Drive to approximately 41,000 movements per day at Five Islands Road, east of Lake Avenue (Appendix H).

In addition, Project traffic surveys were conducted along the key routes of relevance to the Dendrobium Mine workforce and deliveries, including Cordeaux Road, Picton Road and mine access routes (Figure 6-19). The traffic survey program included surveys of peak period turning movements at key intersections, and automatic tube counter surveys between 30 March and 5 April 2017 (Appendix H).

The traffic flows of key routes of relevance to the Dendrobium Mine were assessed to determine the contribution of the traffic generated by the Dendrobium Pit Top and Cordeaux Pit Top to existing traffic conditions on public roads (Table 6-19).

The traffic analysis of existing traffic flows indicates that with the exception of Cordeaux Road east of Mount Kembla (19.7%) and Cordeaux Road west of Mount Kembla (4.9%), the Dendrobium Pit Top and Cordeaux Pit Top currently contribute 0.5% or less of the existing daily traffic on the routes surveyed (Appendix H).

To manage delivery traffic at the Dendrobium Pit Top, South32 has established curfew times through the Dendrobium Mine Drivers' Code of Conduct (i.e. vehicle access restrictions).

Beyond the local Mount Kembla area, Dendrobium Mine traffic is distributed onto the arterial road network, including the Princes Highway, Five Islands Road and Princes Motorway, and its contribution to total traffic on those routes is sufficiently low that further investigation of the implications of Dendrobium Mine traffic on those routes is not warranted (Appendix H).



Table 6-19

Average Daily Traffic Movements on Haulage Routes and Local Roads

Road and Location	Total Vehicles ¹	Mine Generated	Dendrobium Mine and Cordeaux Pit Top Contribution to Existing Traffic Flows (%)
Cordeaux Road East of Mt Kembla	3,518 ²	692	19.7%
Cordeaux Road West of Mt Kembla	700 ³	34	4.9%
Picton Road East of Cordeaux Pit Top	19,835 ⁴	100	0.5%
Picton Road West of Cordeaux Pit Top	19,746 ⁵	11	<0.1%

Source: After Appendix H

¹ Average two-way daily traffic (flow in both directions) - Monday to Thursday

² Surveyed 2017.

³ Estimated from surveyed conditions in 2017.

⁴ Average 2016 weekday volume.

⁵ Estimated from average 2016 weekday volume.

Background Traffic Growth

Traffic volumes are expected to continue to generally increase on local roads, irrespective of Project traffic contributions (Appendix H).

Measured traffic growth rates in the area surrounding the Project recorded between 2015 and 2016 are shown in Table 6-20.

Intersection Performance

Intersection traffic flow data was collected at three relevant intersections (Figure 6-19) on 30 March 2017 between 5.30 am and 8.30 am, and between 2.00 pm and 5.00 pm. The 'AM peak' and 'PM peak' periods were identified for the morning and afternoon sampling period, respectively. The performance of these intersections was assessed using the intersection analysis computer program SIDRA (Signalised and Unsignalised Intersection Design and Research Aid) (Appendix H).

Intersection Level of Service criteria is used as a comparative measure that provides an indication of the operating performance of an intersection. Intersections are ranked from a Level of Service A, which represents good intersection operation, to a Level of Service F, which represents unsatisfactory intersection performance. Appendix H describes the average vehicle delay and intersection characteristics for each Level of Service.

With the exception of the intersection of Picton Road with the Cordeaux Pit Top Access Road, all intersections analysed have an overall Level of Service of A and operate satisfactorily at existing traffic levels with minor delays during peak hours (Appendix H). The intersection of Picton Road with the Cordeaux Pit Top Access Road has an overall Level of Service of B, during the 'PM Peak' period, due to delays caused by vehicles turning right into (morning) or right out of (afternoon) the access road (Table 6-21).

Roadway Capacity

The existing capacity of the public roads and the extent to which existing traffic volumes use that capacity can be assessed according to a 'Level of Service' (Appendix H).

With respect to roadway capacity, Level of Service is a qualitative measure describing operational conditions within a traffic stream (in terms of factors such as speed and travel time, room to manoeuvre, traffic interruptions, safety and convenience) and their perceptions by motorists and passengers.

Roadway Capacity Level of Service A provides the best traffic conditions, with no restriction on desired travel speed or overtaking, while Levels of Service B to F describes progressively worse traffic conditions (Appendix H).

GTA Consultants (2019) concluded that drivers would be expected to experience good levels of service on the surrounding road network, with volumes on these public roads representing acceptable conditions inclusive of the current contribution of Dendrobium Mine traffic to the road network.



Table 6-20Traffic Growth Rate (2015-2016)

Road	Annual Growth Rate ¹
Picton Road	11%
Mount Ousley Road	6.2%
Princes Highway at North Wollongong	1.8%
Princes Highway at Unanderra	0.5%
Princes Highway at Bulli	-2.5%
Five Islands Road	1.6%

Source: After Appendix H

¹ Annual growth rate recorded for 2015-2016.

 Table 6-21

 Relevant Intersection Performance – Surveyed Traffic Flows (March 2017)

Site*	Intersection	Intersection Level of Service ¹	
		AM Peak	PM Peak
5	Cordeaux Road and Dendrobium Pit Top Access Road	А	А
7	Picton Road and Cordeaux Pit Top Access Road	А	В
6	Cordeaux Road and Stones Road	A	A

Source: After Appendix H

¹ Intersection Level of Service as determined by SIDRA – Refer to Appendix H.

A = Good operation

B = Acceptable delays and spare capacity

* See Figure 6-19

Road Safety

A review of road safety in the vicinity of the Project on key routes was undertaken by GTA Consultants (2019) and included a review of the RMS road accident data for the period of 1 July 2011 to 30 June 2016.

A review of the crash data of the surrounding road network identified no specific concerns with the safety of the key routes and access roads used by mine-related traffic (Appendix H).

6.12.3 Assessment

Potential impacts of the Project on road traffic movements, key intersection performance and road safety are assessed in Appendix H and are summarised below. These potential impacts have been assessed in the context of anticipated future background traffic growth.

Project Traffic Generation

Additional traffic generation would occur as a result of increased construction activities associated with the Project. Construction activities would involve additional workers, deliveries and visitors to the surface facilities and traffic movements would primarily be associated with the Dendrobium Pit Top and proposed ventilation shaft sites.

Other minor construction works and traffic movements would occur at the Cordeaux Pit Top, the Kemira Valley Coal Loading Facility, Dendrobium CPP, existing ventilation shaft sites and along the Kemira Valley Rail Line over the life of the Project.

Following the initial construction activities, the workforce and some operational activity at the Dendrobium Mine is expected to increase. The Project would, therefore, involve additional workers, deliveries and visitors accessing the Dendrobium Mine.



Predicted traffic generation during both construction and operational activities would comprise both light and heavy vehicle movements associated with employee transport and deliveries/services, respectively. Deliveries and visitors would primarily be during daytime hours up to seven days per week.

Three traffic scenarios were investigated to determine the potential impact of Project traffic flows on the local road network during peak Project construction and operations. These scenarios were (Appendix H):

- Year 2020 peak construction workforce at Dendrobium Pit Top and a new ventilation shaft site (combined) plus the current operational workforce.
- Year 2027 maximum operational workforce at the Dendrobium Pit Top (with 10 years of background traffic growth).
- Year 2035 operational movements assuming transfer of the primary underground mine access to the Cordeaux Pit Top (with background growth).

Table 6-22 summarises the predicted peak daily vehicle movements (traffic in both directions) for these Project scenarios on the local road network, in comparison to existing traffic levels. During non-peak times, it is anticipated that Project traffic flows would be lower.

As shown in Table 6-22, the maximum relative increase in road traffic volumes as a result of the Project during the peak construction phase (Year 2020) of 5.9% is generally minor on Cordeaux Road, considering the total existing and future background traffic levels. Road traffic volumes on Cordeaux Road as a result of the Project would decrease significantly following the proposed change of the primary operational access (Year 2035) from Dendrobium Pit Top to Cordeaux Pit Top, except for Cordeaux Road west of Mount Kembla which would increase from 5.6 to 9.8%.

The Project contribution to total traffic on Picton Road would remain small, with an increase following the proposed change to primary access (Year 2035) of 0.4 to 2.5% and 0.1 to 0.3% for Picton Road east of Cordeaux Pit Top and Picton Road west of Cordeaux Pit Top, respectively (Appendix H).

The Road Transport Assessment concluded that with the additional Project traffic, there is not anticipated to be any material change in the condition of the roads in the region (Appendix H).

Intersection Performance

The peak hour performance with predicted background traffic growth was assessed for the three key intersections using the intersection analysis computer programme SIDRA (Appendix H). An additional intersection, the Picton Road and Cordeaux Dam Access Road intersection was also assessed to reflect the operation of this intersection during the peak construction period for the Project (Year 2020) (Appendix H). It is noted there will be some minor construction activities (requiring up to approximately 55 workers) occurring for the development of the Area 6 ventilation shaft sites in 2035 that would use this intersection (Appendix H).

The majority of key intersections along Project haulage routes would continue to operate at good levels of service in the future during peak hours. The intersection of Picton Road with the Cordeaux Dam Access Road, would operate at a satisfactory Level of Service during the peak construction phase (Year 2020) (Appendix H).

The Dendrobium Pit Top carpark extension would provide additional parking for Project employees. It is expected that the intersection between this overflow carpark and Cordeaux Road would operate at a similar level of service as the Cordeaux Road and Dendrobium Pit Top Access Road intersection (i.e. intersection Level of Service A).

Due to projected background growth in traffic on Picton Road, the intersection of Picton Road with the Cordeaux Pit Top Access Road and with the Cordeaux Dam Access Road would decline to an unacceptable Level of Service from 2035. The operation of the intersection of Picton Road with the Cordeaux Pit Top Access Road and Cordeaux Dam Access Road is highly dependent on the background growth over the period until 2035. This intersection would require improvements, and/or the review of operational shift arrangements in order to provide suitable performance during peak periods.

Recommended improvements to address future peak hour intersection performance are described in Appendix H.
Table 6-22
Predicted Average Weekday Traffic Movements on the Local Road Network

Existing Conditions		Year 2020			Year 2027			Year 2035				
Location	Daily Total	Mine Generated	Mine Contribution									
Cordeaux Road East of Mt Kembla	3,518	692	19.7%	3,912	1,002	25.6%	3,989	880	22.1%	3,614	279	7.7%
Cordeaux Road West of Mt Kembla	700	34	4.9%	735	48	6.5%	780	44	5.6%	863	85	9.8%
Picton Road East of Cordeaux Pit Top	19,835	100	0.5%	21,334	226	1.1%	24,566	100	0.4%	29,041	737	2.5%
Picton Road West of Cordeaux Pit Top	19,746	11	<0.1%	21,245	137	0.6%	24,477	11	0.1%	28,386	82	0.3%
Picton Road West of Cordeaux Dam	-	-	-	21,133	25	0.1%	-	-	-	28,400	96	0.3%

Source: After Appendix H

Note: All values represent average weekly vehicles per day Monday-Thursday.



Roadway Capacity

GTA Consultants (2019) concluded that future Levels of Service experienced along Picton Road would be expected to deteriorate due to existing traffic volumes and background traffic growth, regardless of the inclusion of Project traffic, which is expected to have a negligible incremental impact.

Car Parking

Additional car parking would be developed at the Dendrobium Pit Top to accommodate the changes in the workforce associated with the Project in accordance with appropriate standards.

South32 would also upgrade the existing car parking facilities at the Cordeaux Pit Top to accommodate the increased workforce when the Cordeaux Pit Top becomes the primary operational access to the underground mine (Section 3.4.6).

Road Safety

A review of the crash data of the surrounding road network identified no specific concerns with the safety of the key routes and accesses used by mine-related traffic (Appendix H). As the Project is not expected to significantly alter traffic flows, the Project is considered unlikely to exacerbate any existing safety issues with the operation of the road network (Appendix H).

Cumulative Traffic Increases

Other developments in the vicinity of the Project have the potential to add additional traffic flow that may result in cumulative impacts on the local road network. Of potential relevance, there are a number of existing and proposed major developments proximal to the Dendrobium CPP, which would continue to operate under the Project. The surrounding road network has existing high traffic volumes and there are no anticipated Project changes to the number or distribution of vehicles to and from the Dendrobium CPP. Further discussion regarding potential cumulative traffic impacts for the Project can be found in the Road Transport Assessment (Appendix H).

Special Areas

The Project would continue to require South32 staff and contractors to access the Metropolitan Special Area and the Illawarra Escarpment and Upper Nepean State Conservation Areas for environmental management, monitoring, stream restoration works and other limited surface activities.

Level Crossings

Road/rail level crossings relevant to the Project are located on Central Road south of Cordeaux Road and off Marley Place at Unanderra. The Project would not result in any changes to the existing number of trains operating on the Kemira Valley Rail Line.

The probability of vehicles being delayed by train movements as a result of the Project at level crossings is predicted to be low and would not warrant upgrading of the level crossings (Appendix H).

Oversize Vehicles

A number of oversize vehicle movements may be generated on an occasional basis during the life of the Project. These oversize vehicle movements would be associated with the transport of mining equipment and infrastructure to and from the Project.

The proposed movement for any oversize vehicles would be negotiated with RMS and relevant local councils on a case-by-case basis. All oversize loads would be transported with the relevant permits and load declarations obtained in accordance with Additional Access Conditions for oversize and overmass heavy vehicles and loads (RMS, 2016), and any other licences and escorts as required by regulatory authorities (Appendix H).

Dangerous Goods

The transportation, handling and storage of all dangerous goods at the Project would be conducted in accordance with the requirements of the *Storage and Handling of Dangerous Goods – Code of Practice 2005* (WorkCover, 2005). Dangerous goods required for the Project would be transported in accordance with relevant legislation (Appendix H).



6.12.4 Mitigation Measures

Although the Project is not predicted to significantly alter the proportion of Dendrobium Mine contribution to traffic on the majority of the public road network, South32's existing Traffic Management Plan (TMP) would be reviewed for the Project and updated accordingly.

The following mitigation measures would continue to be implemented as a component of the TMP for the Project:

- use of signage and physical structures to notify and control drivers to maintain correct driver behaviour;
- curfew times for road use at the Dendrobium Pit Top, consistent with the Dendrobium Mine Drivers' Code of Conduct (i.e. vehicle access restrictions during night-time hours and during peak traffic periods during the day);
- control of materials being transported on the road network consistent with the Storage and Handling of Dangerous Goods – Code of Practice 2005 (WorkCover, 2005);
- encouragement of the Project construction and operational workforce as well as contractors to use 'car-pooling' to minimise related light vehicle movements to site; and
- notification of relevant stakeholders when large loads are required, or road closures are to occur along relevant road networks.

Where new car parking facilities are to be developed for the Project, these would be designed and constructed in accordance with Australian Standards and in consultation with the relevant authorities.

The volumes of traffic associated with activities in the Metropolitan Special Area and the Illawarra Escarpment and Upper Nepean Conservation Areas would increase, however, would remain low and access to these areas would be in accordance with relevant landholder requirements (e.g. conditions of entry, speed limits, etc.). No additional specific traffic management measures are considered to be required for these activities.

Drivers' Code of Conduct

South32 currently implements a Drivers' Code of Conduct at the Dendrobium Mine. The purpose of this document is to specify requirements to minimise potential impacts of traffic on the wider community, and maintain road safety, including allowable travel times to and from Dendrobium Mine surface facilities.

South32 employees as well as contractor staff would be required to continue to observe the Drivers' Code of Conduct as a component of the Project.

Carpark Extension Intersection

The intersection between the overflow carpark and Cordeaux Road would be designed and constructed consistent with Council Standards to maintain a satisfactory Level of Service.

6.12.5 Adaptive Management

The intersection of Picton Road with the Cordeaux Pit Top Access Road and Cordeaux Dam Access Road may require improvements in order to accommodate an increase in future traffic volumes due to projected background traffic growth and the contribution of Project-related turning traffic (Section 6.12.3). Operational shift arrangements and peak traffic demand would be reviewed prior to 2035 at the intersection of Picton Road with the Cordeaux Pit Top Access Road and the Cordeaux Dam Access Road (Appendix H).

In accordance with the recommendations in Appendix H, South32 would consult with RMS to assess the need for any mitigation measures to manage the operation of these intersections when accounting for long-term growth in traffic on Picton Road.

6.13 OPERATIONAL AND CONSTRUCTION NOISE

6.13.1 Methodology

A Noise and Blasting Assessment for the Project was undertaken by Renzo Tonin and is presented in Appendix J.



The Noise and Blasting Assessment includes assessment of:

- operational noise from existing/approved surface facilities that would continue for the Project;
- construction noise;
- blasting activities;
- road traffic noise; and
- rail traffic noise.

This section describes the assessment of potential noise impacts from the operation and construction of the Project, in accordance with:

- NSW Noise Policy for Industry (NPfl) (EPA, 2017); and
- NSW Interim Construction Noise Guideline (ICNG) (DECC, 2009).

Consideration was also given to the NSW Government (2018) Voluntary Land Acquisition and Mitigation Policy - For State Significant Mining, Petroleum and Extractive Industry Developments (Voluntary Land Acquisition and Mitigation Policy).

A description of the operational and construction noise assessment criteria and characterisation and existing noise environment is provided in Section 6.13.2. Section 6.13.3 describes the potential impacts of the Project with respect to operational and construction noise, while Section 6.13.4 outlines applicable operational and construction noise assessment criteria. Sections 6.13.6 and 6.13.7 outline applicable mitigation and adaptive management measures for the Project.

Potential noise impacts from rail transport movements are described in Section 6.14. Potential impacts of Project road transport noise are described in Section 6.15, while Section 6.16 describes potential impacts as a result of blasting.

6.13.2 Background

Setting

The Dendrobium Mine surface facilities are significant industrial facilities that have been operating in the local area for an extended period. Suburban and rural receivers are in some cases located in close proximity to infrastructure associated with these existing industrial facilities. The *Illawarra-Shoalhaven Regional Plan* recognises that the Dendrobium Mine and other collieries are located near current and future residential developments (NSW Government, 2015a). The *Illawarra-Shoalhaven Regional Plan* describes the need to balance the ability of these mines to continue to operate, and any future extraction of resources, with the expectations of current and future residents (NSW Government, 2015a) (Section 4.1.2).

The Project would involve the continued use of the Dendrobium Pit Top, Kemira Valley Coal Loading Facility, Kemira Valley Rail Line, Dendrobium CPP and existing Dendrobium 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.

The Dendrobium Pit Top is located adjacent to Mount Kembla village near the top of Cordeaux Road (Figure 1-2). The Kemira Valley Coal Loading Facility is located in a rural setting, with the closest residential receiver located approximately 700 m to the south-east. The Cordeaux Pit Top is located off Picton Road and is isolated from potential private residential receivers (Figure 1-2).

The proposed ventilation shaft sites for the Project (i.e. Shaft Nos 5A, 5B, 6A and 6B) and existing Shaft Nos 1, 2 and 3 are located in bushland settings and are isolated from residential receivers (Figure 1-2).

The Dendrobium CPP is located on Flinders Lane within the Port Kembla Steelworks precinct, which is a heavy industry area incorporating the BlueScope Steelworks and Port Kembla Coal Terminal (Figure 1-2). The closest residential receivers to the Dendrobium CPP are located approximately 650 m to the west.

The development and rehabilitation of the West Cliff Stage 3 and Stage 4 Coal Wash Emplacements are approved under Development Consent DA 60-03-2001 and the Bulli Seam Operations Project Approval 08_0150 respectively. The closest residential receivers to the approved Coal Wash Emplacement are located at Appin township, approximately 2 km to the north-west. Operational activities at the West Cliff Coal Wash Emplacement would be effectively unchanged by the Project. Management and monitoring of noise emissions at the West Cliff Coal Wash Emplacement is undertaken in accordance with the Bulli Seam Operations Noise Management Plan and EPL 2504 and this would continue to be the case, should the Project be approved.



Noise Measurement and Description

The assessed noise levels presented in Appendix J and summarised in this section are expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to lower frequency sounds. Table 6-23 provides information on common noise sources in dBA for comparative reference.

Hearing 'nuisance', for most people, begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specific percentage (N) of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is also considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

Derivation of Previous Operational Noise Criteria

Prior to the Project, the existing operational noise criteria for the Dendrobium Mine (Development Consent DA 60-03-2001) were derived in accordance with the methodology provided in the *Industrial Noise Policy* (INP).

The INP was superseded in October 2017 by the introduction of the NPfI, which is now used for the regulation and management of noise emissions from industry (EPA, 2017).

The NPfI was introduced to provide a more balanced approach to the assessment of daytime industrial noise and to allow a clearer process for the setting of achievable statutory noise limits for industry. The NPfI also considers noise assessment to now apply under all weather conditions, rather than the more limited conditions previously specified under the INP (EPA, 2017).

Following the introduction of the NPfI, operational noise criteria for the Project have been derived in accordance with the methodology provided in this new policy (Section 6.13.4).

For a number of potential receivers proximal to the Project, the noise criteria derived under the NPfI differ somewhat (i.e. higher or lower criteria have been determined) to those derived under the previous INP assessment methodology and specified in Development Consent DA 60-03-2001.

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

Table 6-23 Relative Scale of Various Noise Sources

Source: After United States Department of the Interior (1994) and Richard Heggie Associates (1995).



It is also noted that the Dendrobium CPP does not currently have any applicable noise criteria at the nearest private receivers under Development Consent DA 60-03-2001.

6.13.3 Existing Environment

Noise Management and Monitoring Regime

Noise management at the Dendrobium Mine is currently undertaken in accordance with the Noise Management Plan (NMP), which outlines:

- noise mitigation measures and controls;
- noise monitoring and reporting regimes; and
- procedures for the management of exceedances and complaints.

The NMP describes a range of existing noise management and mitigation measures, including:

- low frequency reversing alarms which have been installed on all underground and surface-based vehicles;
- the replacement of steel rollers with lower noise polyurethane coated rollers of the Kemira Valley conveyor;
- extensive modifications to the rill tower at the Kemira Valley Coal Loading Facility to modify the impact plates on the coal delivery chute and the exit doors to reduce noise emissions;
- replacement of old compressor units with quieter noise attenuated units;
- attended monitoring to verify ongoing compliance with noise criteria;
- review of sound power levels of operational equipment; and
- real-time monitoring where required (e.g. in response to community complaints).

The NMP describes the combination of attended noise monitoring and continuous real-time monitoring (when required) used in the noise monitoring program. Current attended noise monitoring locations in the vicinity of the Dendrobium Pit Top are shown on Figure 6-20.

Compliance and Complaints

To date, the obligation to meet the noise criteria specified in Development Consent DA 60-03-2001 for privately-owned receivers has been achieved through the implementation of the Dendrobium Mine noise management strategy described in the NMP.

South32 reported compliance with relevant noise limits at the majority of the nearest-privately owned receivers during the most recent Independent Audit period between 2014 and 2017. Exceedances during this period did occur at receiver R39a, where rail noise was attributed by the independent auditor Environmental Resources Management (ERM) to be a contributing factor (ERM, 2017). South32 reported compliance with relevant noise limits for the 2017 and 2018 annual review periods.

South32 manages operational noise complaints in accordance with the NMP. A summary of noise-related complaints is provided in Appendix J.

For the 2017 annual review period, eight complaints were received relating to operational noise, while six complaints were received in the 2018 annual review period. All complaints were investigated and in cases where it was necessary site operations were modified to address the complaint.

Background Noise Monitoring

The Rating Background Level (RBL) is the background noise level determined without the subject premises in operation, in accordance with the NPfI.

Background noise monitoring was conducted by Renzo Tonin in June and July 2018 at three locations proximal to key Dendrobium Mine surface facilities. In accordance with the procedures outlined in the NPfI, the measured noise levels were used to determine RBLs for each residential receiver, based on proximity to the background monitoring sites and location. Table 6-24 shows the RBL values adopted for receivers modelled in the Noise and Blasting Assessment (Appendix J).

Background noise monitoring in Mount Kembla in 2000, prior to the Dendrobium Mine being developed, recorded background noise levels typically higher, albeit similar, to the monitoring results for the Project (Appendix J).

6.13.4 Applicable Criteria

Operational Noise Criteria

The NPfI recommends two noise assessment criteria, "intrusiveness" and "amenity", both of which are relevant for the assessment of noise from the Project (Appendix J). Cumulative noise impacts are assessed against the amenity criteria, while Project-only noise impacts are assessed against Project Specific Trigger Levels (PSTL).





 Table 6-24

 Rating Background Level Values Derived from Noise Monitoring

Locality	Monitoring Location	Logger ID	Rating Background Level, L _{A90} (dBA)			
			Day	Evening	Night	
Kembla Heights/Mount Kembla	374 Cordeaux Road, Mount Kembla	L1	35 ¹	32	32	
Mount Kembla/Figtree	Figtree Farm (O'Briens Road), Figtree	L2	35 ¹	35	34	
Cringila/Warrawong	2 Birmingham Street, Cringila	L3	40	40 ²	40 ²	

Source: Appendix J

Notes: Day = 7.00 am to 6.00 pm, Evening = 6.00 pm to 10.00 pm, Night = 10.00 pm to 7.00 am ¹ RBLs have adopted the minimum background noise levels nominated in the NPfI as long-term background noise levels were recorded at below the minimum RBL in accordance with the NPfI.

² Where evening and night time RBLs are recorded to be higher than the day time, the day time RBL is adopted.

The intrusiveness criteria applies for residential receivers only, and is based on an energy average sound pressure level over a 15-minute period. The intrusiveness criterion requires that the L_{Aeq} noise level from the source being assessed, when measured over 15 minutes, should not exceed the RBL by more than 5 dBA in accordance with the NPfI. Measured RBL values are presented in Table 6-24 and the resulting Project specific intrusiveness criteria are presented in Table 6-25.

Amenity criteria are based on the setting of the area (e.g. rural, suburban, urban, industrial, etc.) (EPA, 2017). Amenity criteria are based on the energy average noise level over the entire day, evening or night period rather than a 15-minute interval, and cumulative criteria include all industrial noise rather than noise from the Project only. Under the NPfI the Project amenity noise levels used for assessment purposes are based on an energy average sound pressure level over a 15-minute period.

Given the nature of the area surrounding the Project (including environmental living and conservation areas and rural landscape areas), it is considered that the "rural" amenity criteria would generally apply (Appendix J). However, for residences close to the Dendrobium CPP, the "suburban" criterion has been adopted. Caretaker's Quarters, passive recreation areas, a place of worship, a school, industrial facilities and commercial premises have also been identified within the study area. Relevant amenity criteria for the Project are presented in Table 6-26. The NPfI prescribes detailed calculation routines for establishing Project-specific $L_{Aeq(15 minute)}$ intrusive criteria and $L_{Aeq(period)}$ amenity criteria. Appendix J assesses against the lesser (i.e. the more stringent) of the Project-specific intrusive and amenity assessment criteria for the Project residential receivers. These PSTLs are presented in Table 6-27.

Cumulative noise levels are assessed against the recommended NPfI amenity noise criteria, as the amenity criteria includes all industrial noise at a receiver (Table 6-26).

For potential receivers proximal to the Dendrobium CPP, the 'industrial interface' criteria adjustment has also been considered due to the proximity of the receivers to the major Port Kembla industrial precinct. The relevant noise criteria when this adjustment is applied are presented in Table 6-26 and Table 6-27.

Noise Management and Noise Affectation Zones

In those cases where the NPfI PSTLs are exceeded, it does not automatically follow that all people exposed to the noise would find the noise noticeable or unacceptable.



Table 6-25 NPfl Project-specific Intrusiveness Criteria

Poprocontotivo Project Lecelity	Intrusiveness Criteria, L _{Aeq(15minute)} (dBA)					
Representative Project Locality	Day	Evening	Night			
Dendrobium Pit Top	40	37	37			
Kemira Valley Coal Loading Facility	40	40	39			
Dendrobium CPP	45	45	45			

Source: Appendix J

Table 6-26					
NPfl	Project-specific Amenity Criteria				

Representative Project	Noise Amenity Area	Recommended Amenity Noise Level, L _{Aeq(period)} (dBA)			Project Amenity Noise Level, L _{Aeq(15minute)} (dBA)				
Locality		Day	Evening	Night	Day	Evening	Night		
Dendrobium Pit Top	Rural Residential	50	45	40	48	43	38		
Kemira Valley Coal Loading Facility	Rural Residential	50	45	40	48	43	42		
Dendrobium CPP	Suburban Residential	55 (60)	45 (50)	40 (45)	53 (58)	43 (48)	40 (43)		
Ventilation Shaft Sites/Cordeaux Pit Top	Caretaker's Quarters (Rural)	55	50	45	58	53	48		
Any	Any School Classrooms		External 48 dBA when in use						
Any	Place of Worship	External 53 dBA when in use							
Any	Passive Recreational	53 dBA when in		vhen in use	en in use				
Any	Commercial Premises	68 dBA when in use							
Any	Industrial Premises			73 dBA v	vhen in use				

Source: Appendix J

Note: Criteria in brackets specifies the amenity noise levels representing the application of the 'industrial interface' criteria adjustment for the receivers proximal to the Port Kembla industrial precinct.

Table 6-27 NPfl Project-specific Trigger Levels (PSTL)

Representative Project Locality	Noise Amenity Area	Project Specific Trigger Level, L _{Aeq(15minute)} (dBA)			
		Day	Evening	Night	
Dendrobium Pit Top	Rural Residential	40	37	37	
Kemira Valley Coal Loading Facility	Rural Residential	40	40	39	
Dendrobium CPP	Suburban Residential	45	43 (45)	40 (43)	
Ventilation Shaft Sites/Cordeaux Pit Top	Caretaker's Quarters (Rural)	58	53	48	
Any	School Classrooms	Externa	al 48 dBA when	in use	
Any	Place of Worship	Externa	al 53 dBA when	in use	
Any	Passive Recreational	53	dBA when in us	е	
Any	Commercial Premises 68 dBA when in us		е		
Any	Industrial Premises	73	dBA when in us	е	

Source: Appendix J

Note: Criteria in brackets specifies revised PSTLs if 'industrial interface' criteria adjustment is applied for receivers proximal to the Port Kembla industrial precinct.



Table 6-28 presents the methodology used for assessing operational noise against the NPfI PSTLs. For the purposes of assessing potential noise impacts consistent with the Voluntary Land Acquisition and Mitigation Policy, exceedences can be separated into a Noise Management Zone (i.e. negligible, marginal or moderate impacts) and a Noise Affectation Zone (i.e. significant impacts).

Construction Noise Criteria

The ICNG (DECC, 2009) is considered applicable to the Project construction activities. Project construction activities at the surface would be undertaken generally during the standard ICNG hours (i.e. Monday to Friday: 7.00 am to 6.00 pm, Saturday: 8.00 am to 1.00 pm, no work Sundays or public holidays). However, some surface construction activities would occur outside of ICNG standard construction hours (e.g. on Saturday afternoons and Sundays). Select construction and development works (e.g. development of ventilation shafts and underground development activities) would also occur 24 hours per day, seven days per week.

For residential receivers, the recommended acceptable construction noise levels during ICNG standard hours are the RBL plus 10 dBA, while the construction noise criteria outside of standard hours are the RBL plus 5 dBA. For all potential residential receivers, a 'highly affected' noise level of LAeq(15minute) 75 dBA is also adopted (Appendix J).

The ICNG also sets out recommended acceptable noise levels for other noise sensitive non-residential receivers (Appendix J).

Predicted Noise Level exceeds PSTL by	Total Cumulative Industrial Noise Level	Characterisation of Impacts	Potential Treatment
All time periods 0-2 dBA	Not applicable	Impacts are considered to be negligible	The exceedances would not be discernible by the average listener and therefore would not warrant receiver based treatments or controls.
All time periods 3-5 dBA	< recommended amenity noise level in Table 2.2 of the NPfI; or > recommended amenity noise level in Table 2.2 of the NPfI, but the increase in total cumulative industrial noise level resulting from the development is < 1 dB	Impacts are considered to be marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
All time periods 3-5 dBA	> recommended amenity noise level in Table 2.2 of the NPfI, and the increase in total cumulative industrial noise level resulting from the development is > 1dB	Impacts are considered to be moderate	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building façade to noise levels.
Day and Evening > 5 dBA	< recommended amenity noise levels in Table 2.2 of the NPfI	Impacts are considered to be moderate	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building façade to noise levels.
Day and Evening > 5 dBA	> recommended amenity noise levels in Table 2.2 of the NPfI	Impacts are considered to be significant	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions below.
Night > 5 dBA	Not applicable	Impacts are considered to be significant	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions below.

 Table 6-28

 Characterisation of Noise Impacts and Potential Treatments

Source: EPA (2018)



6.13.5 Assessment

Operational Noise

Modelling Methodology

An acoustic model (SoundPLAN) was developed by Renzo Tonin that simulates the major noise emitting sources associated with the Project. The model domain encompassed all of the major noise sources including Dendrobium Pit Top, Kemira Valley Coal Loading Facility, Cordeaux Pit Top, Ventilation Shaft Sites (Shaft Sites 5A and 6B) and the Dendrobium CPP.

The SoundPLAN noise has previously been accepted by the EPA and DPE for use in environmental noise assessments (Appendix J).

The sources of noise included in the modelled scenarios are outlined in Appendix J. Consistent with the NPfI, the noise model also considered meteorological effects, topographical features, distance from source to receiver and noise attenuation. The locations of key modelled receivers are provided in Figure 6-21 and the locations of all modelled receivers are provided in Appendix J.

Assessment of Meteorological Conditions

The NPfI generally directs the use of two approaches for the assessment of noise impacts through the use of default meteorological parameters or site-specific parameters.

The noise modelling completed for the Project by Renzo Tonin has adopted the more detailed approach using site-specific meteorological data obtained from the Kemira Valley meteorological station for the year 2016. The meteorological data includes wind speed, wind direction and stability class (Appendix J).

Renzo Tonin (2019) assessed the meteorological data in accordance with Fact Sheet D of the NPfI to determine the significance of noise-enhancing meteorological conditions.

Based on the site-specific meteorological data, temperature inversions were deemed to be relevant to the Project. Therefore, temperature inversions were considered in the assessment as a component of the night-time noise enhancing conditions. Further details of the analysis and meteorological conditions modelled are provided in Appendix J.

Assessment of Feasible and Reasonable Noise Mitigation Measures

South32 has previously committed to maintaining operational noise levels at relevant receivers to the Project at the current Dendrobium Mine noise compliance levels through the implementation of the NMP.

Renzo Tonin (2019) conducted an assessment of feasible and reasonable noise mitigation measures for the Project, particularly in relation to reducing potential noise impacts at the receivers which are located in close proximity to the Dendrobium Pit Top (Figure 6-21).

A number of iterative steps were undertaken to determine noise mitigation measures which were incorporated to reduce potential noise emissions from the Project, including the following (Appendix J):

- Preliminary noise modelling of scenarios representative of the maximum noise emissions from the Project to identify potential for noise exceedances.
- Evaluation of various combinations of curfew and/or additional noise management and mitigation measures to assess their relative effectiveness.
- Review of the effectiveness of these measures and assessment of their feasibility.
- Adoption of management and mitigation measures to minimise noise emissions associated with the Project.

Without operational controls (e.g. equipment restrictions) Dendrobium Pit Top preliminary noise modelling indicated potential for exceedances of the PSTLs at a high number of nearby residences due to their proximity to the facilities (Figure 6-21), particularly in shift change-over periods when more mobile equipment is active.

The following noise management and mitigation measures were therefore incorporated to reduce potential Project noise emissions at the Dendrobium Pit Top:

 restriction of surface vehicle movements (e.g. limiting the number and type of operating forklifts) from 10.00 pm to 6.15 am;





- vehicle access restrictions (other than personnel passenger vehicles) controlled through the allowable travel times specified in the Dendrobium Mine Drivers' Code of Conduct; and
- closure of the main workshop door during the evening and night-time periods.

With adaptation of these reasonable and feasible noise mitigation measures (also generally reflective of current operations), the night-time period was split into two noise modelling scenarios to reflect differing Project operations (Scenario 1 - 10.00 pm to 6.15 am and Scenario 2 - 6.15 am to 7.00 am).

The proposed incorporation of the adopted mitigation measures resulted in a significant reduction in the number of initially identified potential noise exceedances at the Pit Top, with only a small residual number of very proximal privately-owned receivers predicted to experience negligible or marginal exceedances of the PSTLs derived in accordance with the NPfI, under adverse conditions.

Operational Noise Level Predictions

Project-only Noise Emissions

Table 6-29 presents a summary of predicted exceedances of noise criteria due to the operational noise from the Project, based on maximum noise predictions for all time periods and meteorological conditions. In summary, the operational noise assessment indicated the following under adverse meteorological conditions (Appendix J):

- During the day, exceedances of the PSTLs of 0-2 dBA (i.e. negligible exceedances) are predicted at privately-owned receivers R6a, R39a and D0071.
- During the evening, exceedances of the PSTLs of 0-2 dBA (i.e. negligible exceedances) are predicted at privately-owned receivers R39a, D0065, D0066 and D0071. An exceedance of the PSTL of 3 dBA is also predicted at privately-owned receiver R6a.
- During the night-time period, exceedances of the PSTLs of 0-2 dBA (i.e. negligible exceedances) are predicted at privately-owned receivers R39a, D0065, D0066 and D0071.

The impact of a potential exceedance of 0-2 dBA above the PSTL is negligible and not discernible by the average listener based on the characterisation of noise impacts outlined in Table 6-28.

One-privately owned receiver (R6a) is predicted to experience a marginal exceedance of the PSTLs (i.e. 3 dBA above the PSTL) in the evening period and night (scenario 1) period. This exceedance is classed as marginal exceedances in accordance with the Voluntary Land Acquisition and Mitigation Policy as the predicted noise level is less than the recommended amenity noise level (Appendix J and Table 6-26). It is also noted that the predicted Project evening noise level would comply with the existing evening noise criteria under DA 60-03-2001 (40 dBA) for this receiver.

Table 6-29

Dendrobium Pit Top Summary of Potential Operational Noise Exceedances at Privately-owned Receivers under Adverse Meteorological Conditions

Period	Negligible 0-2 dBA above PSTL	Marginal 3-5 dBA above PSTL	Moderate 3-5 dBA above PSTL	Moderate >5 dBA above PSTL	Significant >5 dBA above PSTL (Day and Evening)	Significant >5 dBA above PSTL (Night)
Day	R6a ³ , R39a, D0071	-	-	-	-	-
Evening	R39a, D0065 ³ , D0066 ³ , D0071 ³	R6a ³	-	-	-	-
Night	R39a ^{1,2} , D0065 ¹ , D0066 ¹ , D0071 ^{1,2}	R6a ¹	-	-	-	-

Source: After Appendix J.

Note: Based on maximum predicted noise levels for all scenarios under NPfI meteorological conditions.

¹ Night (Scenario 1) – 10.00 pm to 6.15 am

² Night (Scenario 2) – 6.15 am to 7.00 am

³ Predicted noise levels would comply with existing Development Consent DA 60-03-2001 noise criteria for the Approved Mine.



Predicted noise levels at privately-owned receivers proximal to the Dendrobium CPP (i.e. Port Kembla industrial complex) would comply with the noise criteria if the 'industrial' interface' criteria adjustment was to be applied for the Project (Appendix J). If this criteria adjustment was considered not to apply, one receiver locality proximal to the Dendrobium CPP (CPP004) would be predicted to experience a negligible exceedance of the PSTLs (i.e. 1 dBA above the PSTL) for the night period due to the continuation of currently approved activities.

Potential noise impacts at non-residential receivers in the vicinity of the Project were assessed against the Project NPfI Amenity Criteria (Table 6-26). Noise predictions at all non-residential private receivers were compliant with the Project amenity criteria (Appendix J).

The limited number of exceedances (Table 6-29) indicates that, with the implementation of Project noise mitigation measures, noise from the Project would be managed to the maximum extent reasonable (Appendix J).

Indicative noise contours of maximum noise predictions are presented in Appendix J.

Potential noise impacts at Stage 3 of the West Cliff Coal Wash Emplacement were assessed as part of the Noise Impact Assessment (Wilkinson Murray, 2009) prepared for the Bulli Seam Operations EIS. As no material changes are expected to the operational noise emissions at West Cliff as a result of the Project, the West Cliff Coal Wash Emplacement was not re-modelled for the Project.

However, the approved noise impacts from the West Cliff Stage 3 Coal Wash Emplacement operations would continue for the life of the Project. Similarly, existing and approved noise from Shaft Nos 1, 2 and 3 would continue for the life of the Project.

Sleep Disturbance

Renzo Tonin (2019) has also conducted an assessment of potential sleep disturbance impacts (Appendix J).

No private receivers are predicted to experience exceedances of the relevant sleep disturbance criterion during the night-time as a result of the Project (Appendix J).

Cumulative Noise Emissions

There are currently no material industrial noise sources in the vicinity of the Project, with the exception of those proximal to the Dendrobium CPP.

Potential cumulative noise impacts resulting from the concurrent operation of the Project and the adjacent BlueScope Steel Port Kembla site, the Port Kembla Coal Terminal and the proposed Port Kembla Gas Terminal (all located within the Port Kembla industrial precinct) were assessed against the NPfI recommended amenity criteria (Appendix J).

The assessment indicated that cumulative industrial noise levels from the concurrent operation of the Project and the industrial facilities located within the Port Kembla industrial precinct would comply with the recommended amenity criterion for the worst-case scenario for all relevant receivers, with the exception of CPP004, however, existing noise levels from the Port Kembla Coal Terminal currently exceed the recommended amenity criteria at this receiver. All receivers would comply with the recommended amenity criteria with the application of the 'industrial interface' criteria adjustment (Appendix J).

Construction Noise Level Predictions

Assessment of the potential for noise impacts was conducted for the key construction activities occurring at the Dendrobium Pit Top, Cordeaux Pit Top and Ventilation Shaft Sites 5A and 6B, as these locations were the most proximal to receivers and would have construction activities with material noise generation potential (Section 3).

Construction activities at other Project locations would be relatively minor and temporary in nature and/or are remote from potential receptors and have therefore not been considered further in the assessment of construction noise for the Project.

Construction noise is most likely to be of potential concern to those residents in close proximity to the Dendrobium Pit Top, where activities would include the construction of additional car parking facilities, extensions of building infrastructure (e.g. bathhouses and administration buildings) and additional electricity distribution infrastructure.





Construction activities at the Dendrobium Pit Top would generally occur within recommended standard hours in accordance with the ICNG, however, some activities would also occur outside of recommended standard hours (e.g. on Saturday afternoon or Sunday during the day).

Due to proximity to residential receivers, construction of the Dendrobium Pit Top Carpark Extension would be a potential material contributor towards predicted construction noise levels at the nearest private receivers. South32 would therefore limit this construction activity to ICNG-recommended standard hours.

Renzo Tonin modelled potential construction noise at the Dendrobium Pit Top with and without the Carpark Extension. Assuming concurrent carpark construction with other construction activities potential exceedances of the daytime 45 dBA L_{Aeq(15 minute)} recommended noise management levels (i.e. RBL plus 10 dBA) are predicted for some 25 of the closest residential receivers under adverse meteorological conditions (Appendix J) and these residences would be considered 'noise affected' by construction activities in accordance with the ICNG.

Without the carpark construction activity the number of residences considered to be 'noise affected' by construction activities in accordance with the ICNG would be reduced to the three closest residential receivers only (i.e. R6a, D0066 and D0071) (Appendix J).

For construction activities occurring at the Dendrobium Pit Top outside of ICNG-recommended standard hours (i.e. excluding carpark works), some six residential receivers (i.e. R6a, D0066, D0069, D0070, D0071 and D0078) are predicted to exceed the recommended acceptable noise level of 40 dBA LAeq(15 minute) and would also be considered 'noise affected' during this period in accordance with the ICNG.

Renzo Tonin (2019) concluded no privately-owned residences would be considered 'highly noise affected' as a result of Project construction activities in accordance with the ICNG (Appendix J). Construction activities at the proposed Ventilation Shaft Sites would occur 24 hours, seven days per week, however, there are no private receivers located in close proximity to these sites. Predicted construction noise levels for non-private receivers (i.e. Caretaker's Quarters and commercial receivers) located proximal to the Ventilation Shaft Sites construction activities would comply with the relevant recommended noise management levels defined in the ICNG (Appendix J).

6.13.6 Mitigation Measures

Noise mitigation and management measures for the existing Dendrobium Mine are described in the NMP (Section 6.13.7) and would continue to be implemented for the Project. This plan would be reviewed and updated to address the Project where appropriate.

Operational Noise

South32's existing NMP would, as relevant, be revised for the Project to include the following:

- applicable Development Consent noise criteria;
- a summary of relevant Project noise mitigation/management measures;
- procedures to be followed in the event of an exceedance of applicable noise criteria, should this occur; and
- updated complaint response protocols, where applicable.

Construction Noise

Construction activities for the Project would be temporary in nature, and general construction noise management measures would be implemented to minimise noise levels at the nearest private receptors, where applicable.

6.13.7 Adaptive Management

South32 would continue to conduct Dendrobium Mine operational noise monitoring in accordance with the NMP (as amended for the Project).



In addition to mitigation measures already incorporated, Project noise adaptive management measures would include:

- response to any community issues of concern or complaints including discussions with relevant landowners;
- refinement of on-site noise mitigation measures and mine operating procedures, where practicable; and
- if necessary (i.e. as informed by operational noise monitoring results) implementation of feasible and reasonable mitigation at relevant private receivers, in accordance with the Voluntary Land Acquisition and Mitigation Policy.

6.14 RAIL TRANSPORT NOISE

6.14.1 Methodology

Rail transport noise was considered as part of the Noise and Blasting Assessment undertaken for the Project by Renzo Tonin (2019) which is provided in Appendix J. A summary of the assessment is provided below.

This section describes the assessment of potential noise impacts from rail transport noise associated with the Project in accordance with the NSW *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013). The RING sets out methodology for assessing rail traffic noise generation on non-network rail lines exclusively servicing industrial sites such as the Kemira Valley Rail Line.

Consideration was also given to Voluntary Land Acquisition and Mitigation Policy.

A description of the rail noise background is provided in Section 6.14.2 and the existing rail noise environment is described in Section 6.14.3. Section 6.14.4 describes the rail transport noise assessment criteria and assessment of the Project with respect to rail transport noise, while Sections 6.14.5 and 6.14.6 outline mitigation and adaptive management measures, respectively.

6.14.2 Background

Longwall mining operations at the Dendrobium Mine commenced in April 2005, with an approved operational capacity of 5.2 Mtpa of ROM coal until 30 December 2030. ROM coal is transported from the Kemira Valley Coal Loading Facility to the Dendrobium CPP via the Kemira Valley Rail Line.

The Kemira Valley Rail Line passes through the suburbs of Mount Kembla, Cordeaux Heights and Cringila between the Kemira Valley Coal Loading Facility and the Dendrobium CPP. Currently, rail journeys are generally limited to 10 per day due to shared logistics with BlueScope Steel trains at the Dendrobium CPP. Further, train movements on the Kemira Valley Rail Line are not permitted between 11.00 pm and 6.00 am under Development Consent DA 60-03-2001 for the Dendrobium Mine.

Although the Dendrobium Mine has been in operation since 2005, the Kemira Valley Rail Line preceded the Dendrobium Mine as it was supporting infrastructure associated with the preceding Kemira Colliery. Many residential areas in Mount Kembla, Cordeaux Heights and Cringila that are in close proximity to the Kemira Valley Rail Line were constructed well after the Kemira Valley Rail Line was developed.

The *Illawarra-Shoalhaven Regional Plan* recognises that the Dendrobium Mine and other collieries are located near current and future residential developments (NSW Government, 2015a). The *Illawarra-Shoalhaven Regional Plan* describes the need to balance the ability of these mines to continue to operate, and any future extraction of resources, with the expectations of current and future residents (NSW Government, 2015a).

Proximal residences in Mount Kembla and Cordeaux Heights are exposed to rail noise associated with the operation of the Kemira Valley Rail Line for the Dendrobium Mine.

Previous Rail Noise Investigations and Noise Reduction Programs

Noise associated with rail operations on the existing Kemira Valley Rail Line has historically been a source of complaints from local residents in Mount Kembla and Cordeaux Heights. In particular, these complaints related to brake and wheel squeal noise.



In 2015, South32 trialled 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);
- dynamic braking was incorporated into standard practices for a key rail noise impact section; and
- standardisation of braking durations.

Further to these measures, a detailed investigation into brake and wheel squeal noise impacts was undertaken by Transport for NSW, in partnership with Pacific National, from December 2015 to July 2017 (Appendix J).

Based on the rail noise investigation outcomes, all trains operating on the Kemira Valley Rail Line were modified with new brake pads during the 2018 annual reporting period.

Subsequent noise monitoring has shown a significant reduction in the overall noise levels due to brake squeal events and a reduction in the number of brake squeal events (Appendix J).

6.14.3 Existing Environment

Compliance

Recent monitoring indicates that the current rail noise is compliant with (i.e. approximately 5 dBA lower than) the existing criteria for rail haulage specified in Development Consent 60-03-2001 for the Dendrobium Mine (Appendix J).

As part of the attended rail haulage noise monitoring undertaken for the Dendrobium Mine, no exceedances of the existing rail haulage noise criteria were reported during the 2017 and 2018 annual reporting periods.

Complaints

Since the implementation of the rail noise mitigation measures described above, rail noise-related complaints have dropped from a total of 73 complaints for the 2015 annual reporting period, to a total of 10 and five complaints for the 2017 and 2018 annual reporting periods, respectively (Appendix J).

6.14.4 Assessment

Under the Project, there would be no proposed change to the current maximum daily rail movements or approved operating hours of the Kemira Valley Rail Line.

However, the duration of these currently approved movements would be extended beyond the currently approved life of the Dendrobium Mine under the Project (i.e. from 2030 to 2048).

Rail Noise Assessment Criteria

Contemporary assessment of potential noise impacts from rail traffic generation is against the RING, which was introduced in 2013.

The RING sets out methodology for assessing rail traffic generation on existing rail network and non-network rail lines. As the Kemira Valley Rail Line would continue to be used exclusively by Dendrobium Mine, the assessment for rail operational noise is based on the methodology for assessing rail traffic generation on non-network rail lines on or exclusively servicing industrial sites (Appendix J).

Where a non-network line extends beyond the boundary of the industrial premises, noise from that section of the track should be assessed against the recommended acceptable L_{Aeq} noise level from industrial sources for the relevant receiver type under the RING (Appendix J).

Consistent with the SEARS for the Project, the rail traffic noise assessment considered the non-network section of the Kemira Valley Rail Line between the Kemira Valley Coal Loading Facility and the Dendrobium CPP, which passes through both rural (e.g. Mount Kembla) and suburban (e.g. Cringila) residential areas.



The criteria for the noise impacts associated with the Kemira Valley Rail Line for the relevant receiver types adopted for the assessment are provided in Table 6-30.

Table 6-30
Non-network Rail Noise Assessment Criteria
Adopted

Receiver	Time of Day	Acceptable L _{Aeq(period)} Noise Level (dBA)
	Day	50
Rural residence	Evening	45
	Night	40
	Day	55
Suburban residence	Evening	45
	Night	40

Source: After Appendix J

Project Rail Traffic Noise Assessment

The rail traffic noise assessment considered a 'maximum' case rail movement scenario as well as an 'average' case, representing typical rail movements for the Project. Minimum setback distances from the centreline of the Kemira Valley Rail Line to privately-owned receivers for compliance against the relevant RING criteria is shown in Table 6-31.

The night-time period minimum setback distance from the Kemira Valley Rail Line required for both rural and suburban privately-owned receivers to be compliant with the RING criteria is 126 m under the maximum rail movement case. For both rural and suburban receivers along the rail line, the rail traffic noise assessment indicated that a moderate number of privately-owned receivers would currently exceed the relevant RING criteria introduced in 2013, and this would continue under the Project, should it be approved.

Given that the Kemira Valley Rail Line has been in operation for many decades and preceded the Dendrobium Mine, the provisions of the Voluntary Land Acquisition and Mitigation Policy specify that at receiver mitigation or voluntary acquisition rights would not be afforded to private receivers predicted to exceed the relevant RING criteria due to the continued operation of the Kemira Valley Rail Line.

It is also noted that recent rail noise monitoring results indicate that existing rail noise levels would be compliant with (i.e. approximately 5 dBA lower than) the existing criteria for rail haulage noise specified in Development Consent 60-03-2001 for the Dendrobium Mine (Appendix J).

6.14.5 Mitigation Measures

South32's existing NMP would be reviewed for the Project, and updated where required.

Rail noise mitigation measures for the Project would include, but would not necessarily be limited to:

 continuation of restricted rail haulage operating hours for the Kemira Valley Rail Line to between 6.00 am and 11.00 pm (i.e. no rail haulage occurs after 11.00 pm at night or before 6.00 am in the morning);

Table 6-31 Minimum Setback Distance from the Kemira Valley Rail Line for Rural and Suburban Receivers in Accordance with the RING

Receiver	Period	Amenity Noise Level	Amenity Minimum (Noise Level Setback D		Compliance Minimum M Distance (m) Setback Dis		ı Mitigation Minimum / Distance (m) Setback D	
		(UDA)	Average	Maximum	Average	Maximum	Average	Maximum
Rural	Day	50	55	59	40	42	31	34
	Evening	45	97	107	69	76	55	60
	Night	40	103	126	74	89	58	72
Suburban	Day	55	31	34	22	24	18	19
	Evening	45	97	107	69	76	55	60
	Night	40	103	126	74	89	58	72

Source: After Appendix J.



- regular track walks to identify defects in the rail infrastructure that may contribute to rail noise; and
- continued implementation of the track maintenance program.

6.14.6 Adaptive Management

Rail noise monitoring would continue to be undertaken in accordance with the NMP.

South32 would also continue to investigate, and where reasonable and feasible, implement further progressive rail noise mitigation measures over the life of the Project. This would include addressing any further rail brake or wheel squeal issues that may arise during the life of the Project from landholder complaints, or if material deterioration of rail noise performance is identified by rail noise monitoring in accordance with the NMP.

6.15 ROAD TRANSPORT NOISE

6.15.1 Methodology

Road transport noise was considered as part of the Noise and Blasting Assessment undertaken for the Project by Renzo Tonin (2019) provided in Appendix J. A summary of the assessment is provided below.

This section describes the assessment of potential noise impacts from road transport associated with the Project, in accordance with the NSW *Road Noise Policy* (RNP) (DECCW, 2011).

A description of the existing noise environment is provided in Section 6.15.2. Section 6.15.3 describes the road transport noise assessment criteria and potential impacts of the Project with respect to road transport noise, while Section 6.15.4 outlines mitigation and management measures for the Project.

6.15.2 Existing Environment

The Project is located in the greater Wollongong area, which has a significant regional population and an extensive and highly trafficked road network.

Analysis of existing traffic flows indicates that the Dendrobium Pit Top and Cordeaux Pit Top contribute 0.5% or less of the existing daily traffic on the key routes surveyed with the exception of Cordeaux Road east of Mount Kembla (19.7%) and west of Mount Kembla (4.9%) (Appendix H). Traffic movements to and from the Dendrobium Pit Top are already controlled by South32 via the Dendrobium Mine Drivers' Code of Conduct (i.e. vehicle access restrictions during night-time hours and during peak traffic periods during the day).

Since the 2015 annual reporting period, there has only been one complaint received specifically in relation to road transport noise for the Dendrobium Mine (South32, 2018b).

6.15.3 Assessment

The road traffic noise assessment for the Project (Appendix J) focuses on Cordeaux Rd East of Mount Kembla as the road segment most likely to be affected by noise generated by ongoing and increased road transport movements associated with the Project (i.e. the Project would contribute a greater relative proportion of total traffic near the Dendrobium Pit Top) (Appendix H).

The Dendrobium CPP is located within the Port Kembla industrial precinct and hence the surrounding road network is a high traffic area. Trucks hauling Project coalwash to the West Cliff Coal Wash Emplacement would continue to operate on a combination of arterial and sub-arterial roads (Figure 6-19). This would involve the continued backloading of approved Bulli Seam Operations product coal haulage trucks until 2041. If the life of the Bulli Seam Operations is not extended beyond 2041 this activity would then be undertaken by Project contract haulage trucks.

Given the high traffic environment of the coal reject haulage route and the modest quantum of the maximum Project coal reject production (i.e. up to 1.6 Mtpa) in comparison to the approved coal haul truck movements from West Cliff to Port Kembla (i.e. up to 9.3 Mtpa), which were assessed (Wilkinson Murray, 2009) and approved in 2011, no further road noise assessment of ongoing Project coal wash trucking movements is considered warranted.

Road Noise Criteria

Road traffic noise was assessed by Renzo Tonin (2019) in accordance with the RNP (DECCW, 2011), which establishes criteria to be applied to particular types of road and land use for the assessment of road noise in NSW (Appendix H).

The total traffic noise criteria and relative increase criteria for the Project is provided in Table 6-32.



 Table 6-32

 NSW Road Noise Policy Criteria for Residential Land Uses

Road	Type of Project/Land Use	Period	Total Traffic Noise Criteria ¹	Relative Increase Criteria
Cordeaux Road,	Existing residences affected by additional	Day	60 dBA L _{Aeq(15 hour)}	Existing L _{Aeq(15 hour)} plus 12 dBA
East of Mount Kembla	traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	Night	55 dBA L _{Aeq(9 hour)}	Existing L _{Aeq(9 hour)} plus 12 dBA

Source: After Appendix J.

¹ Day = 7.00 am to 10.00 pm; Night = 10.00 pm to 7.00 am

In relation to situations where exceedances of the road traffic noise assessment criteria are predicted, the RNP states that an increase of up to 2 dB is considered to be barely perceptible (DECCW, 2011).

Project Road Traffic Noise Assessment

The road noise assessment considered road noise associated with the following Project years:

- Year 2020 peak construction workforce for the Project including the operational workforce;
- Year 2027 maximum operational workforce of the Project; and
- Year 2035 operational movements following primary mine access relocating to Cordeaux Pit Top.

The Project traffic noise levels at the closest affected receiver location were predicted by Renzo Tonin (2019) for each of the Project years based on traffic projections developed by GTA Consultants (Appendix H).

Along Cordeaux Road, East of Mount Kembla, noise levels resulting from daytime cumulative traffic movements are predicted to exceed the relevant RNP criteria for all modelled Project years with or without Project traffic. Predicted incremental traffic noise for the daytime are also within the 2 dB relative increase criteria for the nearest privately-owned receivers for all Project years (Appendix J).

Noise levels resulting from night-time cumulative traffic movements are predicted to comply with the relevant RNP criteria for all Project years (Appendix J).

Along Cordeaux Road, East of Mount Kembla, increases in the predicted noise levels resulting from the Project during the daytime and night-time cumulative traffic movements are small, and are well below the relative increase criteria (Appendix J).

6.15.4 Mitigation Measures

Notwithstanding that the Project is not predicted to significantly alter existing off-site road transport noise on the public road network, South32's existing NMP would be reviewed and updated for the Project, where required.

Traffic movements to and from the Dendrobium Pit Top would continue to be controlled by South32 via the Dendrobium Mine Drivers' Code of Conduct (i.e. vehicle access restrictions during night-time hours and during peak traffic periods during the day).

South32 would also continue to encourage construction workers and operational workers to carpool to reduce employment related traffic movements in and out of the Dendrobium Mine surface facilities.

6.16 BLASTING

6.16.1 Methodology

Potential blasting impacts were considered as part of the Noise and Blasting Assessment undertaken for the Project by Renzo Tonin (2019) provided in Appendix J. A summary of the assessment is provided below.



This section describes the assessment of potential noise impacts from blasting associated with the Project, in accordance with the *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990).

A description of the existing blasting environment is provided in Section 6.16.2. Section 6.16.3 describes the blasting assessment criteria and potential impacts of the Project with respect to blasting impacts, while Section 6.16.4 outlines mitigation measures for the Project.

6.16.2 Existing Environment

Underground blasting is only undertaken infrequently at the Dendrobium Mine if development works or the longwall mining operation intercept geological structures that require the use of explosive charges to break up the feature, and avoid damage to underground mining equipment.

Surface blasting is not typically undertaken at Dendrobium Mine. However, some very small and highly controlled blasts have historically also been undertaken during specific surface construction activities (e.g. ventilation shaft construction).

6.16.3 Assessment

Blasting Vibration Criteria

The ANZECC (1990) *Technical Basis for the Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* has been adopted by the EPA for assessing potential annoyance from blast emissions during daytime hours, as listed below:

 the recommended maximum level for airblast is 155 linear decibels (dB[Lin]);

- exceedences above the level of 155 dB(L_{in}) should be limited to no more than 5% of the total number of blasts in a 12-month period. The level should not exceed 120 dB(L_{in}) at any time;
- the recommended maximum level for ground vibration is 5 mm/s vibration velocity; and
- exceedences above the level of 5 mm/s should be limited to no more than 5% of the total number of blasts in a 12-month period. The level should not exceed 10 mm/s at any time.

A summary of the ground vibration and airblast overpressure criteria is provided in Table 6-33.

For assessment of structural damage due to airblast overpressure, Australian Standard AS2187.2-2006 *Explosives – Storage, Transport and Use – Part 2 Use of Explosives* recommends a maximum airblast level of 133 dB(Lin).

Ground vibration and airblast overpressure levels that cause human discomfort (Table 6-33) are generally lower than the recommended structural damage limits.

Given that Project blasting would generally take place underground (infrequently as part of Project mining operations and construction activities), it is not considered necessary to assess potential impacts from blast overpressure due to the attenuation provided by the underground workings (Appendix J).

Project Blasting Assessment

The explosive charges required for underground geological feature management are very small, and explosive use is infrequent. Blasts would therefore be undertaken at any time as required (i.e. 24 hours a day, seven days a week) (Appendix J).

Table 6-33 Blasting Assessment Criteria

Day	Time of Blasting	Blast Overpressure Level (dB[L _{in}])	Ground Vibration Level, (mm/s)
Monday to Saturday	9.00 am – 3.00 pm	115	5
Monday to Saturday	6.00 am – 9.00 am 3.00 pm – 8.00 pm	105	2
Sunday and Public Holidays	6.00 am – 8.00 pm	95	1
Any day	8.00 pm – 6.00 am	95	1

Source: After Appendix J.





Potential blasting effects from occasional underground blasting at the Project has been assessed in Appendix J, with impact assessment focused on potential impacts from blast vibration.

Potential blast vibration impacts associated with the Project underground mining are predicted to be negligible, regardless of blast location, due to the depth of cover over the Project underground mining areas, and the distance from these areas to the closest potential receivers (Appendix J).

Further, maximum predicted ground vibration at the surface is well below structural damage criterion for infrastructure items (e.g. buried pipelines), therefore no adverse potential impacts are predicted, regardless of blast location, for all infrastructure at the surface (Appendix J).

Potential minor blasts for surface construction activities, if required, for the construction of the proposed ventilation shaft sites are remote from surface infrastructure and would be designed to comply with relevant blast limits (Appendix J).

6.16.4 Mitigation Measures

Underground mine blasting would only be required for the Project under circumstances where geological structures are encountered. Notwithstanding, when blasting is required for the management of particular geological structures underground, South32 would design blast parameters to meet the applicable criteria with a high margin of conservatism at the nearest sensitive receptors or any infrastructure that overlies the blast location.

It is also acknowledged that some blasting could potentially be required at the surface during construction activities, subject to detailed engineering design and/or collection of site-specific geotechnical data (e.g. for the Cordeaux Pit Top upgrades and construction of the proposed ventilation shafts).

In the event that some limited surface blasting is required in support of the Project upgrades, South32 would employ a blast maximum instantaneous charge that provides a high margin of conservatism for compliance with the criteria in Table 6-33 at the nearest private receptors, and applicable structural criteria for any proximal infrastructure such as ETLs. The locations of Aboriginal and non-Aboriginal heritage sites would also be considered in blasting design, with blasts designed accordingly to avoid damage as would be detailed in the Blast Management Plan for the Project.

6.17 AIR QUALITY

6.17.1 Methodology

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by Ramboll and is presented in Appendix I.

The Air Quality and Greenhouse Gas Assessment includes assessment of:

- dust emissions from the Dendrobium Pit Top, Kemira Valley Coal Loading Facility and Dendrobium CPP;
- dust, products of combustion (e.g. oxides of nitrogen) and odour emissions from upcast ventilation shafts and gas management infrastructure;
- dust emissions from the transportation of ROM coal by rail along the Kemira Valley Rail Line; and
- Scope 1, 2 and 3 greenhouse gas emissions.

This section describes potential impacts of predicted emissions to air from the Project as assessed against criteria levels set to protect human health and amenity in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (EPA, 2016).

Project greenhouse gas emissions are described in Section 6.21.

A description of the air quality assessment criteria and existing air quality environment in the vicinity of the Project is provided in Sections 6.17.2 and 6.17.3, respectively. Section 6.17.4 describes the potential impacts of the Project with respect to air quality, while Sections 6.17.5 and 6.17.6 outline mitigation and adaptive management measures for the Project.



6.17.2 Applicable Criteria

Dust Deposition

The NSW EPA impact assessment criteria for dust deposition seeks to limit the maximum increase in the mean annual rate of dust deposition from a new or expanding development to 2 grams per square metre per month (g/m²/month) and total dust deposition (i.e. including background air quality) to 4 g/m²/month.

Suspended Particulates

Exposure to suspended particulate matter can lead to health and amenity impacts. The likely risk of these impacts depends on a range of factors including the size, structure and composition of the particulate matter and the general health of the person (New South Wales Health and New South Wales Minerals Council, 2017).

Such particles (Total Suspended Particulates [TSP]) are typically less than 50 micrometres (μ m) in size and can be as small as 0.1 μ m. Fine particles less than 10 μ m are referred to as PM₁₀, while fine particles less than 2.5 μ m are referred to as PM_{2.5}. Suspended particulate matter are assessed against the impact assessment criteria provided in the Approved Methods (EPA, 2016), with the relevant criteria presented in Table 6-34.

Table 6-34 Air Quality Assessment Criteria for Concentrations of Suspended Particulate Matter

Pollutant	Averaging Period	Impact Assessment Criteria (µg/m³)
TSP	Annual	90
514	24-hour	50
PM_{10}	Annual	25
514	24-hour	25
PM _{2.5}	Annual	8

Source: After Appendix I

 $\mu g/m^3 = micrograms$ per cubic metre

The 2016 update to the Approved Methods, gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

Gaseous Pollutants

The impact assessment criteria for relevant gaseous products of combustion as specified in the Approved Methods (EPA, 2016) are presented in Table 6-35.

Table 6-35 Air Quality Assessment Criteria for Concentrations of Oxides of Nitrogen

Pollutant	Averaging	Concentration		
Tonutant	Period	µg/m ³⁽¹⁾	pphm	
	1-hour	246	12	
NO ₂	Annual	62	3	

Source: After Appendix I

pphm = parts per hundred million

Gas volumes for criteria pollutants expressed at 0°C and 1 atmosphere.

Gas flaring at the ventilation shafts has the potential to generate material emissions of the oxides of nitrogen (NO_x) and therefore this pollutant has been assessed for the Project (Appendix I).

Odour

Potential odour emissions associated with Project upcast ventilation shaft emissions are assessed in Appendix I.

The assessment criteria for odour are based on the detectability of an odour. The 'odour detection threshold' represents the maximum diluted volume (i.e. minimum concentration) of an odour that results in it being detectable. The units for odour measurement are odour units (OU), which are effectively "dilutions to threshold". Therefore, an odour criterion of less than 1 OU would theoretically result in no odour impact being experienced.

The odour nuisance level can be as low as 2 OU and as high as 10 OU (for less offensive odours). The NSW EPA's *Technical framework - Assessment and management of odour from stationary sources in NSW* (EPA, 2006) recommends that, as a design criterion, no individual should be exposed to ambient odour levels of greater than 7 OU.

The Approved Methods prescribes odour goals that take into account the population density for a particular area. The most stringent odour goal of 2 OU is considered to be acceptable for the whole population and therefore appropriate for urban areas (EPA, 2016).



6.17.3 Existing Environment

An Air Quality Management Plan (AQMP) is currently implemented at the Dendrobium Mine and dust and particulate monitoring data is collected at a number of proximal monitoring sites (Figure 6-22).

Background Air Quality

As a component of the Air Quality and Greenhouse Gas Assessment, background air quality was reviewed. Background air quality data was collected from the current Dendrobium Mine air quality monitoring program and other relevant local and regional sources as follows:

- dust emission data collected from five dust deposition gauge locations at the Dendrobium Pit Top and Kemira Valley Coal Loading Facility;
- TSP and PM₁₀ concentration data collected on a monthly basis at the Dendrobium Pit Top and the Kemira Valley Coal Loading Facility; and
- NSW OEH PM₁₀ and PM_{2.5} particulate monitoring sites at Kembla Grange and Wollongong; and
- PM₁₀ monitoring sites at Port Kembla maintained by BlueScope Steel.

It is noted that these monitoring sites would already include the existing dust and particulate contributions of the operation of the Dendrobium Mine. The following sub-sections provide an overview of the existing air quality for the relevant parameters considered in Appendix I.

Dust Deposition

Monthly dust deposition rates are currently monitored by Illawarra Coal on-site at the Dendrobium Pit Top and Kemira Valley Coal Loading Facility (points 13 and 19) which provide data for the mining operation.

Offsite dust gauges at points 6, 9 and 17 are sufficiently remote from the major mining related activities and provide information representative of background conditions in the study area. The locations of the dust gauges are shown on Figure 6-22. Annual average dust deposition rates for the period 2012-2016 have been in the range of 0.6 g/m²/month to 3.8 g/m²/month, with an average across all sites and years of 1.9 g/m²/month (Appendix I). This is typical of background dust deposition across much of NSW (Appendix I).

Suspended Particulate Matter

PM₁₀ and PM_{2.5} Concentration

The average PM₁₀ concentrations on-site are monitored by HVAS located at the Dendrobium Pit Top and the Kemira Valley Coal Loading Facility (EPL Points 21 and 20 respectively) (Figure 6-22).

As the HVAS are run once a month (i.e. not continuously), the true annual PM_{10} averages and maximum 24-hour PM_{10} concentrations cannot be determined at these locations. However, the data are useful to provide an indication of background conditions on-site at the Dendrobium Pit Top and Kemira Valley Coal Loading Facility. The average background PM₁₀ concentration at both sites and all years (2012 to 2016) is 17.7 µg/m³ (approximately 70% of the impact assessment criteria) (Appendix I).

For offsite measurement of PM₁₀ and PM_{2.5} concentrations, data is recorded from continuous samplers located at Kembla Grange and Wollongong (NSW OEH monitoring sites). For the Port Kembla area, PM₁₀ data is recorded from continuous samplers operated by BlueScope Steel (located at Warrawong and North Gate) (Figure 6-22).

Based on the period 2012-2016 at Kembla Grange and Wollongong, annual average background PM_{10} concentrations are 18.4 µg/m³ and 17.5 µg/m³ respectively (approximately 74% and 70% of the impact assessment criteria, respectively) (Appendix I). For the same period annual average background $PM_{2.5}$ concentrations are 6.5 µg/m³ and 6.9 µg/m³ (approximately 81% and 86% of the impact assessment criteria, respectively) at these locations (Appendix I).

Annual average background PM_{10} concentrations for the Port Kembla area recorded for 2016 showed that Warrawong and North Gate sites average background PM_{10} concentrations were 17.9 µg/m³ and 21.1 µg/m³ respectively (approximately 72% and 84% of the impact assessment criteria, respectively).







Table 6-36 presents the annual average monitored PM_{10} and $PM_{2.5}$ concentrations at these sites.

Total Suspended Particulates

The average TSP concentrations on-site are monitored at the Dendrobium Pit Top and the Kemira Valley Coal Loading Facility (EPL Points 21 and 20) (Figure 6-22). The average background TSP concentration across both sites and all years are well below the impact assessment criteria (Appendix I).

Background Air Quality for Assessment Purposes

The assessment of Project and cumulative annual average air quality impacts requires background particulate matter concentrations and dust deposition levels to be defined and added to dispersion modelling results for Project emissions.

Cumulative assessment for annual average PM₁₀, PM_{2.5}, TSP and dust deposition is based on a background derived from the period average of all available data from all sites over the period 2012 to 2016 (Table 6-36). It is considered that this approach accounts for temporal and spatial variation in background particulate matter that might occur for the Project in future years (Appendix I).

For the assessment of short term impacts for PM₁₀ and PM_{2.5}, daily varying concentrations for 2016 from the Kembla Grange monitoring site are paired with modelling predictions for assessment of cumulative impacts (Appendix I).

The background values adopted for cumulative assessment are presented in Table 6-37. These background values have been derived from monitoring that includes the existing operations of the Dendrobium Mine.

Table 6-37 Adopted Background Values for Cumulative Assessment

Pollutant	Averaging Period	Adopted Background Value	
	24-hour	Daily varying	
PM ₁₀	Annual	18.9 µg/m³	
514	24-hour	Daily varying	
PM _{2.5}	Annual	6.7 µg/m³	
TSP	Annual	34.7 µg/m³	
Dust deposition	Annual	2 g/m ² /month	

Source: After Appendix I

6.17.4 Assessment

The majority of potential air quality related impacts due to the Project are related to the continuation and extension of the Project surface facilities rather than the extension of the underground mining operations.

Site ¹	Parameter	2012	2013	2014	2015	2016
EPL Point 20	PM ₁₀	16.5	12.8	14.4	13.4	14.2
EPL Point 21	PM ₁₀	16.8	24.2	25.9	19.9	19.3
Kembla Grange	PM ₁₀	18.3	18.5	17.3	17.8	20.0
(NSW OEH)	PM _{2.5}	6.3	6.9	6.3	2015 13.4 19.9 17.8 6.5 16.9 7.6	6.6
Wollongong (NSW	PM ₁₀	18.0	17.6	17.7	16.9	17.3
OEH)	PM _{2.5}	4.6	7.7	7.0	7.6	7.4
BlueScope Steel - Warrawong	PM ₁₀	-	-	-	-	17.9
BlueScope Steel – North Gate	PM ₁₀	-	-	-	-	21.1

Table 6-36	
Measured Annual Average PM ₁₀ and PM ₂	₅ Concentrations (µg/m ³)

Source: After Appendix I

¹ Refer to Appendix I for locations.

PM_{2.5} was only added at Kembla Grange in February 2015, however measurements of fine particles by nephelometry are available for the previous five years and can be used to fill in gaps in the PM_{2.5} data record.



While there would be some upgrades over the life of the Project, the key dust-generating activities of the Dendrobium Mine with the potential to contribute to particulate levels at private receivers (e.g. coal stockpiling and rail loading activities at the Kemira Valley Coal Loading Facility) would be largely unchanged.

The Air Quality and Greenhouse Gas Assessment has considered the air quality emissions likely to be generated by the Project and the predicted impact of these emissions, in combination with existing background air quality in the vicinity of the Project. As the measured background air quality includes the existing air quality contributions of the Dendrobium Mine, this is inherently conservative, as an element of double counting of emissions would occur.

Similarly, the operation of existing ventilation Shafts Nos 1, 2 and 3 would continue for the Project, and any existing emissions from these shafts are captured by background air quality levels, and therefore, are included in the cumulative assessment for the Project.

Potential air quality impacts associated with the operation of the Project would primarily be as a result of:

- coal dust emissions from the surface operations of the Project, including the handling and stockpiling of coal at the Kemira Valley Coal Loading Facility and Dendrobium CPP, and from rail operations on the Kemira Valley Rail Line (including diesel particulate emissions);
- dust emissions associated with vehicle access to the underground operations; and
- dust, products of combustion and odour emissions associated with the upcast ventilation shafts and gas management infrastructure, including potential pollutants from pre-drainage and post-drainage gas flaring.

The majority of emission sources are located at existing surface facilities associated with the Dendrobium Mine or additional surface facilities for the Project, with the proposed ventilation shafts comprising the only material additional emission source from underground operations. A full description of the dispersion models and the emissions inventory (including the locations of emission sources) is provided in Appendix I.

Potential air quality impacts were modelled for the Project proposed maximum production rate of 5.2 Mtpa of ROM coal.

A summary of the potential impacts of the Project on air quality and a comparison with air quality criteria is provided below.

Potential Project-only Impacts

Particulate Matter Concentrations and Dust Deposition

No exceedances of the NSW EPA's impact assessment criterion are predicted at any privately-owned receiver for Project-only 24-hour average PM₁₀ or PM_{2.5} concentrations, annual average PM₁₀, PM_{2.5}, TSP concentrations or dust deposition levels (Appendix I).

Nitrogen Dioxide

Nitrogen dioxide concentrations resulting from flaring as part of gas management for the Project were calculated as maximum 1-hour average and annual average concentrations for comparison to NSW EPA's impact assessment criteria.

The incremental 1-hour average and annual nitrogen dioxide concentrations from flaring are predicted to be significantly less than the 1-hour average and annual criteria at the closest receptors (Appendix I).

Therefore, no exceedances of the 1-hour average or annual average nitrogen dioxide concentrations were predicted at any receiver within the vicinity of the Project (Appendix I).

Odour

The emission of potentially odorous compounds from upcast ventilation shafts is predicted to result in undetectable odour at sensitive receivers, with the maximum predicted odour level below 1 OU.

Therefore, no exceedance of the most stringent odour assessment criteria of 2 OU is predicted at any sensitive receivers for the Project (Appendix I).



Potential Cumulative Impacts

Particulate Matter Concentrations and Dust Deposition

The cumulative analysis conducted by Ramboll (2019) for emissions of dust from the Dendrobium Pit Top, Kemira Valley Coal Loading Facility, upcast ventilation shafts and Dendrobium CPP predicts the following for sensitive receivers:

- no exceedances of the annual average dust deposition criteria of 4 g/m²/month;
- no exceedances of the annual average TSP (90 μg/m³), PM₁₀ (50 μg/m³) or PM_{2.5} criteria (25 μg/m³);
- no additional exceedances of the 24-hour average PM_{2.5} criteria of 25 μg/m³; and
- no additional exceedances of the 24-hour average PM₁₀ criteria of 50 µg/m³ for receivers in the vicinity of the Dendrobium Pit Top and Kemira Valley Coal Loading Facility.

The Dendrobium CPP is located within the Port Kembla industrial precinct, and is surrounded by various other commercial buildings and industrial infrastructure associated with the existing industries that contribute to the existing air quality environment.

Real-time air quality monitoring in the vicinity of the Port Kembla industrial precinct indicates there have historically been days above the 24-hour average PM_{10} criteria of 50 µg/m³ (Appendix I).

The risk of additional exceedances of the 24-hour average PM_{10} criteria due to the Project has been assessed by Ramboll (2019) as very low, with exceedances predicted on an additional one day (or less) due to the Project. On the one additional day per year when an exceedance of criteria could occur, the predicted cumulative PM_{10} concentrations are dominated by background sources unrelated to the Project (Appendix I).

Nitrogen Dioxide

Background concentrations of nitrogen dioxide in the vicinity of the gas management infrastructure supporting the underground mining operations are expected to be low and therefore cumulative impacts from gas flaring are not expected (Appendix I).

Kemira Valley Rail Line

Material Property Testing

The propensity for ROM coal from the Dendrobium Mine to "lift off" coal wagons during transport along the Kemira Valley Rail Line was tested for the Project.

The testing showed that the moisture content of ROM coal arriving at the Dendrobium CPP (6.5%) to be higher than the moisture content at which dust lift off would be expected (4.6% based on the Dust Extinction Moisture [DEM] level) (Appendix I).

This means that fugitive emissions of coal dust during rail transport for the Project are not expected.

Impact Assessment

Ramboll (2019) modelled potential air quality impacts from trains transporting ROM coal from the Project along the Kemira Valley Rail Line. The modelling considered particulate emissions from diesel locomotives, and conservatively assumed that fugitive dust emissions from coal wagons could occur.

Potential impact from ROM coal transportation along the Kemira Valley Rail Line is predicted to be negligible and well below the criteria for dust deposition and 24-hour PM₁₀ and PM_{2.5} (Appendix I).

West Cliff Coal Wash Emplacement and Coal Wash Transport

The development and rehabilitation of the West Cliff Stage 3 and Stage 4 Coal Wash Emplacements, and the transportation of coal wash from the Dendrobium CPP to West Cliff, would continue to be undertaken in accordance with Development Consent DA 60-03-2001 and the Bulli Seam Operations Project Approval 08_0150.

Potential air quality impacts were assessed previously as part of the Bulli Seam Operations EIS (PAEHolmes, 2009), which concluded that Project-specific and cumulative dust concentrations and deposition levels would be in compliance with all relevant air quality impact assessment criterion for receivers proximal to West Cliff.



As these operations would continue consistent with the assessment conducted for the Bulli Seam Operations EIS, the conclusions of PAEHolmes (2009) are relevant to the continued transportation and emplacement of coal wash for the Project.

Management and monitoring of air quality emissions at the West Cliff Coal Wash Emplacement is undertaken in accordance with the Bulli Seam Operations AQMP and EPL 2504 and this would continue to be the case, should the Project be approved.

6.17.5 Mitigation Measures

South32 would review and update the AQMP, where appropriate, to reflect the mitigation and management measures, complaint response protocols and reporting requirements for the Project.

Air quality management measures currently implemented at the Dendrobium Mine would continue to be implemented for the Project, including:

- use of automated dust suppression spray systems on access roads, conveyors and train loading chamber;
- enclosed train loading facility to eliminate fugitive emissions;
- reduced drop height of rill tower;
- use of dust suppression spray system to maintain moisture content of ROM coal in rail wagons above the DEM level;
- enclosed conveyor and conveyor transfer points;
- regular operation of a road sweeper on sealed travel routes;
- dust suppression sprays on underground mining equipment to reduce ventilation fan emissions;
- wind protection on conveyor gantries; and
- scrapers to clean return conveyors.

6.17.6 Adaptive Management

South32 would continue to conduct Dendrobium Mine air quality monitoring in accordance with the AQMP (as amended for the Project). As a component of the Project South32 would also install additional PM₁₀ and PM_{2.5} real-time monitoring equipment to evaluate the emissions of the Project against contemporary particulate matter criteria at a location reflective of the nearest private receivers to the Kemira Valley Coal Loading Facility.

Project air quality adaptive management measures would include response to any community issues of concern or complaints including discussions with relevant landowners and/or refinement of on-site air quality mitigation measures and mine operating procedures.

While no odour impacts are predicted from the Project (Appendix I), in the event of an issue or complaint arising with respect to odour, suitable complaint response and management measures would be implemented.

6.18 VISUAL CHARACTER

6.18.1 Methodology

The potential visual impacts of the Project were qualitatively assessed using the techniques developed by EDAW Australia Pty Ltd (EDAW) (2006), which are largely based on those adopted by the United States Department of Agriculture – Forestry Service (1974).

The potential visual impacts of the Project were assessed by evaluating the level of visual modification of the development in the context of the visual sensitivity of relevant surrounding land use areas from which the Project may be visible.

The level of visual modification of a development can be measured as an expression of the visual interaction, or the level of visual contrast between the development and the existing visual environment. Throughout the visual catchment, the level of visual modification generally decreases as the distance from the development to various viewpoint locations increases (EDAW, 2006).

Visual (viewer) sensitivity is a measure of how critically a change to the existing landscape is viewed from various use areas, and is a function of both land use and duration of exposure (i.e. individuals generally view changes to the visual setting of their dwelling more critically than changes to the visual setting of the broader setting in which they travel or work). An additional factor is the extent to which the viewer has become accustomed to significant modifications to the landscape and existing industrialisation in the region (EDAW, 2006).



The visual impact resulting from the combination of visual modification and viewer sensitivity are shown in Table 6-38.

Table 6-38 Visual Impact Matrix



For the purposes of the visual assessment, land use areas in the vicinity of the Project were characterised in terms of low, moderate or high visual sensitivity as shown in Table 6-39.

As the Project primarily involves the continuation of existing surface facilities, the extent to which the viewer may have become accustomed to visual modifications as a result of the existing surface facilities was also considered.

As the Project does not propose significant modifications to the visibility of existing surface facilities, no visual simulations were required.

The existing visual character of the Project area from a regional, sub-regional and local setting is described in Section 6.18.2. Potential impacts on visual character as a result of the Project are described in Section 6.18.3, with proposed mitigation measures provided in Section 6.18.4.

6.18.2 Existing Environment

The following discussion makes reference to visual settings that are based on distance as follows:

- regional setting greater than 5 km;
- sub-regional setting 1 to 5 km; and
- local setting up to 1 km.

Regional Setting

Project Underground Mining Areas

The Project underground mining area is entirely located within the Upper Nepean Catchment, which is a declared protected catchment area (i.e. the Metropolitan Special Area) (Section 6.2). As a protected catchment, the area is generally undisturbed (apart from historical development of water supply infrastructure), with public access being restricted by WaterNSW. The Upper Nepean Catchment is located at the southern end of the Woronora Plateau, which extends from Robertson, northwards to Liverpool and is bordered by the Illawarra Escarpment to the east, Campbelltown to the north-west and the towns of Bargo and Yerrinbool in the south-west.

Within the Upper Nepean Catchment there are four major dams proximal to the Project area, Nepean Dam to the west, Avon Dam to the south-west, Cordeaux Dam to the south-east and Cataract Dam to the east (i.e. collectively known as the Upper Nepean Catchment Scheme).

Land Use	Local	Setting	Sub-regior	al Setting	Regional Setting	
	0 to 0.5 km	0.5 to 1km	1 to 2.5 km	2.5 to 5 km	>5 km	
Natural/Recreation Area	High	High	High	Moderate	Low	
Residential (Rural)	High	High	High	Moderate	Low	
Residential (Township)	High	High	High	Moderate	Low	
Tourist Roads	High	Moderate	Moderate	Low	Low	
Other Major Roads	Moderate	Low	Low	Low	Low	
Local Roads	Low	Low	Low	Low	Low	
Industrial Areas	Low	Low	Low	Low	Low	

Table 6-39Visual Sensitivity Levels

Source: EDAW (2006)



The visual character of the Project underground mining area is characterised by native vegetation covering the undulating topography of the Woronora Plateau, and the various streams and associated tributaries of the Upper Nepean Catchment. The Woronora Plateau is located in Hawkesbury Sandstone geology and supports dry Eucalypt Forest (Appendix D).

When viewed from the city of Wollongong, the Woronora Plateau is a major elevated landscape in the region, with elevations in excess of 300 m AHD. The Illawarra Escarpment represents the eastern boundary of this elevated landform in the vicinity of the Project.

The city of Wollongong and associated residential and industrial areas lie to the east of the Woronora Plateau. Further to the west lies the Warragamba Catchment area and the townships of Bargo and Hilltop. The Upper Nepean State Conservation Area and Illawarra Escarpment State Conservation Area surround the Project underground mining area, both of which are areas of high scenic value.

Existing Surface Facilities

The regional setting of the Dendrobium Pit Top, Cordeaux Pit Top and Kemira Valley Coal Loading Facility is similar to that of the Project underground mining areas (i.e. the Woronora Plateau, Metropolitan Special Area and Illawarra Escarpment are located in the regional setting). The city of Wollongong and associated rural residential, suburban and industrial areas to the east of these locations include suburbs such as Port Kembla, Kembla Grange and Dapto to the south. Other surface facilities of the Approved Mine in the regional setting include the Kemira Valley Rail Line.

Dendrobium CPP

The Woronora Plateau, Metropolitan Special Area and Illawarra Escarpment are located to the west of the Dendrobium CPP. Lake Illawarra is a significant natural feature to the region and is located to the south of the Dendrobium CPP, and is surrounded by the suburbs of Windang, Oak Flats and Dapto. The remainder of the regional setting to the north is characterised by various rural and suburban areas, including the suburbs of North Wollongong and Keiraville.

West Cliff Coal Wash Emplacement

The Dharawal National Park is located within the regional setting of the West Cliff Coal Wash Emplacement. The Dharawal National Park and the adjoining Dharawal Nature Reserve consist of natural features of high scenic quality. Large areas of native vegetation are present within the Woronora and Metropolitan Special Areas and Holsworthy Military Reserve. Public access to the Holsworthy Military Reserve, Woronora and Metropolitan Special Areas is restricted. Further to the west the region is characterised by rural residential and suburban areas.

Sub-Regional Setting

Project Underground Mining Areas

The majority of the Project area, including the underground mining areas, falls within part of the Upper Nepean Catchment and the Woronora Plateau. The southern portion of the underground mining area (Area 5) is proximal to Avon Dam on the south-west, Avon River on the west, and Donalds Castle Creek on the east, with Cordeaux Dam to the south, and Cordeaux River to the west. As described previously, these areas have restricted public access.

There are clearings in the vegetated landscapes associated with the existing surface facilities of the Dendrobium Mine, WaterNSW infrastructure and reservoirs, electricity supply infrastructure, rural residential development and Picton Road to the north.

It has been established through previous studies that scenic quality increases as topographic ruggedness and relative relief increase (Leonard and Hammond, 1984; Anderson *et al.*, 1976; Burns and Rundell, 1969).

Using these factors, the majority of the Project area could be given a medium to high scenic quality compared to the surrounding urban areas, as the area has high relief, ruggedness and a natural landscape, with minimal visual disturbance.



Existing Surface Facilities

The sub-regional setting of the Dendrobium Pit Top, Cordeaux Pit Top and Kemira Valley Coal Loading Facility is similar to that of the Project underground mining areas, however, includes rural residential, suburban and industrial settings to the east of the Illawarra Escarpment and proximal to the Dendrobium Pit Top and Kemira Valley Coal Loading Facility. In the sub-regional setting, Cordeaux Dam is located to the north-west and south of the Dendrobium Pit Top and Kemira Valley Coal Loading Facility, and Cordeaux Pit Top, respectively.

Dendrobium CPP

The Dendrobium CPP is located within the Port Kembla industrial precinct and is surrounded by rural residential and suburban areas. There are also a number of commercial facilities and industrial infrastructure located within the sub-regional setting of the Dendrobium CPP, including the Kemira Valley Rail Line and commercial facilities proximal to Unanderra.

West Cliff Coal Wash Emplacement

The Dharawal State Conservation Area, and portions of the Dharawal National Park and Metropolitan Special Area are located within the sub-regional setting, and consist of natural features with high scenic quality. The Appin township is located to the north-west, which encompasses surrounding rural and suburban areas. The West Cliff Coal Wash Emplacement is proximal to the Cataract Dam, located to the south.

Local Setting

Cordeaux Pit Top

The Cordeaux Pit Top facility is located on Picton Road, north of Cordeaux Dam.

Views of the Cordeaux Pit Top facility are restricted by the local vegetation and undulating terrain. Due to the geometry of the access road junction with Picton Road, potential views are limited by intervening vegetation.

Dendrobium Pit Top

The existing Dendrobium Pit Top facility is located immediately south of the Illawarra Escarpment, in Kembla Heights.

Views of the Dendrobium Pit Top from local residential areas are restricted by local vegetation and the sloping landscape between both Kembla Heights and Mount Kembla. Views of the access road, existing carpark and electric power distribution site can be viewed from the entrance point to the Dendrobium Pit Top at Cordeaux Road.

Kemira Valley Coal Loading Facility

The existing Kemira Valley Coal Loading Facility is located to the south of the Illawarra Escapement and west of the suburb of Figtree. The Kemira Valley Coal Loading Facility is located in a slightly more cleared landscape than the Dendrobium Pit Top, but potential views remain limited by undulating topography and intervening vegetation.

Dendrobium Coal Preparation Plant

The Dendrobium CPP is located within the Port Kembla industrial precinct and is surrounded by major roads, railways and electrical infrastructure, along with various significant commercial facilities, including the BlueScope Steelworks and other industrial infrastructure, which is a major visual setting in the local area.

Kemira Valley Rail Line

The Kemira Valley Rail Line passes through the rural residential and suburban areas of Mount Kembla, Cordeaux Heights and Cringila between the Kemira Valley Coal Loading Facility and the Dendrobium CPP. Views of the Kemira Valley Rail Line are available from these residential areas which are located along portions of the rail line, as well as from the local road network where the rail runs parallel to local roads including Cordeaux Road and Five Islands Road.

West Cliff Coal Wash Emplacement

The final approved heights of Stages 2 and 3 of the West Cliff Coal Wash Emplacement are 356 m AHD and 353 m AHD, respectively. An assessment of the potential visual impacts of Stages 2 and 3 undertaken as a component of the Bulli Seam Operations EIS (PAE Holmes, 2009), determined that brief views would be available along Appin Road directly to the south of the West Cliff Pit Top (now referred to as the Appin North Pit Top), and the emplacement would be visible along a ridgeline from Appin Road immediately south-east of Appin township (PAE Holmes, 2009).



Night-lighting

Lighting is used at night at the Cordeaux Pit Top, Dendrobium Pit Top, Kemira Valley Coal Loading Facility, Dendrobium CPP and the West Cliff Coal Wash Emplacement. The use of safety operational night-lighting is primarily associated with the following sources:

- overhead lighting of the Dendrobium CPP, Kemira Valley Coal Loading Facility, workshops, administration areas and other buildings;
- mobile plant lighting for materials handling activities at the Kemira Valley Coal Loading Facility, Dendrobium CPP and West Cliff Coal Wash Emplacement;
- mobile equipment and work vehicle-mounted lights at surface facilities such as the Dendrobium Pit Top and Cordeaux Pit Top; and
- lighting for stockpiling and truck loading activities.

Night-lighting from the existing surface facilities has the potential to be visible as a glow over the facilities, however, the visual impacts of direct night-lighting are generally minimised by the surrounding mature vegetation and undulating topography.

Night-lighting at the Dendrobium CPP may be visible from surrounding residencies, particularly residences to the north-east of Cringila. No complaints regarding night-lighting from the Dendrobium CPP have been received since January 2017 (South32, 2019a).

Ventilation Shaft Sites

The Project involves the continued use of existing Dendrobium Mine ventilation shafts (Site Nos 1, 2 and 3). The Project also involves the development of four proposed ventilation shafts (Site Nos 5A, 5B, 6A and 6B).

The proposed ventilation shafts within Area 5 (Shaft Nos 5A and 5B) are located approximately 400 m AHD, west of Avon Dam. The proposed ventilation shafts within Area 6 (Shaft Nos 6A and 6B) are located approximately 340 m AHD, north-west of the Avon Dam. Views of the existing ventilation shaft sites are restricted by the local undulating terrain and vegetation cover, as well as access restrictions as they are located within the Metropolitan Special Area.

Streams and Key Stream Features

Named streams proximal to the Project longwall mining areas include Cordeaux River, Avon River and Donalds Castle Creek. These streams within the Project area, although not accessible to the public, have the potential to provide aesthetic value. The aesthetic value of streams is influenced by the surrounding vegetation, water quality and surrounding stream features.

The potential for visual disturbance of streams and key stream features as a result of public access to the Special Areas is minimal, as the Project underground mining areas fall within a restricted access area.

Streams and stream features within the Project area are generally in a heavily vegetated landscape, and have a variety of bed materials and natural forms that would provide high aesthetic value.

Cliffs, Other Rock Features and Steep Slopes

The Project underground mining areas include a variety of geological forms including continuous cliff lines, overhangs, cliffs, rock outcrops and steep slopes (Section 6.4.1), which have the potential to provide aesthetic value, although public access is restricted.

6.18.3 Assessment

The visual character of the local area would not be significantly altered by the Project, as the Project involves underground mining with minimal surface disturbance, and the continuation of existing surface infrastructure.

Elements of the Project considered to have the potential to impact the visual landscape include:

- continuation of use and associated upgrades to the existing Dendrobium Pit Top, Kemira Valley Coal Loading Facility, Cordeaux Pit Top, Kemira Valley Rail Line and ventilation shaft sites;
- continuation of night-lighting;
- Project ventilation shaft construction activities;
- continued development and rehabilitation of the West Cliff Coal Wash Emplacement;
- subsidence-related impacts on watercourses; and
- subsidence-related impacts on cliffs, other rock features and steep slopes.



Potential visual impact levels of the Project are shown in Table 6-40.

Project Visual Impact Assessment

Existing Surface Facilities

The Project would involve the continued use and some upgrades to the existing Dendrobium Mine surface facilities, including the Dendrobium Pit Top, Kemira Valley Coal Loading Facility and ventilation shaft sites. These minor upgrades would occur within, or proximal to, the existing footprints of the existing surface facilities and would involve replacement, upgrade or addition of components as required. Views of the existing surface facilities are generally restricted by mature native vegetation and undulating topography. The potential for material visual modification from public viewpoints is, therefore, considered to be very low.

The Kemira Valley Rail Line is more visible, but also preceded the Dendrobium Mine. The Project would involve the continued use and periodic minor upgrades of the Kemira Valley Rail Line, hence Project visual impacts are expected to be very low from public viewpoints as little or no visual modification would arise.

Similarly, the Dendrobium CPP is located in a major industrial complex and no Project visual modification is expected from public viewpoints.

The potential visual impacts of the West Cliff Coal Wash Emplacement are also not expected to change as a result of the Project. The presence of extensive mature native vegetation around Appin township and along Appin Road and the presence of the approved Stage 2 and Stage 4 of the West Cliff Coal Wash Emplacement would continue to limit potential impacts of Stage 3 on visual amenity. With progressive rehabilitation of the West Cliff Coal Wash Emplacement, the potential long-term visual impacts would be reduced further.

It is considered that the development activities associated with the Dendrobium Pit Top Carpark Extension, Cordeaux Pit Top and proposed ventilation shaft sites for the Project have more potential to alter views from public viewpoints, as described below.

Dendrobium Pit Top Carpark Extension

Views of the proposed Dendrobium Pit Top Carpark Extension would be available from immediately proximal sections of Cordeaux Road, and works at the new intersection may also be visible from the nearest residential receivers, where vegetation and topography permit.

The Dendrobium Pit Top Carpark Extension would contribute a low level of visual modification to these viewpoints. It is noted that the visual sensitivity would potentially be low from Cordeaux Road and high for the most proximal private residences. However, the steep local topography and extensive native vegetation would limit potential impacts to the nearest residences and only low visual impacts are anticipated.

Cordeaux Pit Top

Views of the Cordeaux Pit Top Access Road are available from sections of Picton Road. Visual modifications from Picton Road could occur when Project operation activities move to the Cordeaux Pit Top in 2035 if the access arrangements are modified. However, potential levels of visual modification are expected to be very low, and although visual sensitivity may be moderate due to proximity to Picton Road, views of the Cordeaux Pit Top from Picton Road are restricted by mature native vegetation and local topography and only low visual impacts are anticipated.

Proposed Ventilation Shaft Sites

Potential visual impacts would occur at the proposed ventilation shaft sites during the Project construction phase, when distant views of the proposed Shaft Nos 6A and 6B construction infrastructure would be available from the Cordeaux Dam wall, as well as potential views to Shaft No 5B. Following the temporary construction period and removal of the construction infrastructure, public views to the lower operational ventilation shaft infrastructure would likely be restricted by the existing mature vegetation, as the shaft sites are located within the Metropolitan Special Area, which is heavily vegetated (Figures 6-23 to 6-25).

While these shaft sites may be visible from the Cordeaux Dam wall, low levels of visual modification and moderate levels of visual sensitivity (in the case of Shaft No 6B) would occur given that the construction activities would be temporary, and the distance from publicly accessible viewpoints to these sites (approximately 0.8 km) (Figures 6-23 to 6-25).



Potential Visual Impacts	Land-use	Potentially Worst-affected Viewpoint	Viewer Sensitivity	Visual Modification	Visual Impact
Existing Surface Facilities					
Dendrobium Pit Top	Residential – Township	Mount Kembla/Kembla Heights	Н	VL	L
Kemira Valley Coal Loading Facility	Residential – Rural	Residences in Kemira Valley	Н	VL	L
Shaft Nos 1, 2 and 3	Natural Area – Recreation	Cordeaux Dam wall	Μ	VL	VL
	Local Road	Harry Graham Drive	L	VL	VL
Kemira Valley Rail Line	Residential – Township	Various	Н	VL	L
Dendrobium CPP	Residential – Township	Cringila/Warrawong	Н	VL	L
Cordeaux Pit Top	Other Main Roads	Picton Road	М	VL	L
West Cliff Coal Wash Emplacement	Residential - Township	Appin	М	L	L
Proposed Surface Facilities					
Dendrobium Pit Top Carpark Extension	Residential - Rural	Mount Kembla/Kembla Heights	Н	VL	L
Shaft Nos 5A, 5B, 6A and 6B	Natural Area - Recreation	Cordeaux Dam wall	Н	L/VL ¹	M/L ²
Other					
Other short-term surface activities	Natural Area - Recreation	Cordeaux Dam wall	Н	VL	L
Aesthetic Value of Key Stream Features	Natural Area - Recreation	Cordeaux Dam wall	Н	VL	L
Aesthetic Value of Cliffs, Other Rock Features and Steep Slopes	Natural Area - Recreation	Cordeaux Dam wall	Н	VL	L

Table 6-40 Project Visual Impact Levels

¹ Visual modification of Shaft Nos 5A, 5B, 6A and 6B assessed as 'Low' during construction phase, and 'Very Low' during operational phase.

² Visual impact of Shaft Nos 5A, 5B, 6A and 6B assessed as 'Medium' during construction phase, and 'Low' during operational phase.








As such, moderate levels of visual impact would be expected during the construction phase of the Project, which would be a temporary activity, which would reduce to low following the completion of shaft construction.

Night-lighting and Flaring

Night-lighting would continue to be used at the Dendrobium Mine, with some variation and extension to the use of night-lighting associated with the upgrades and augmentations proposed at the Project surface facilities.

The visibility of operational night-lighting may potentially increase as the Stage 3 emplacement of coal wash in the West Cliff Coal Wash Emplacement progresses towards Appin.

It is anticipated that gas flaring would be required to safely manage pre-mine and goaf drainage gas. Ventilation stacks and flares would be located with ventilation infrastructure above Areas 5 and 6.

Potential incremental impacts of Project night-lighting and flaring are expected to be minimal given the distance of flaring activities from private residences, intervening topography and native vegetation at other surface facilities, and the continued implementation of the existing mitigation measures of the Dendrobium Mine described in Section 6.18.4.

Impacts to Aesthetic Value of Stream Features

Potential impacts on the aesthetics value of stream features (e.g. rockbars, pools) would occur above longwall panels as a result of mining-related subsidence. Potential subsidence-related impacts on streams and stream features, including swamps, are discussed in Sections 6.6, 6.7, 6.8 and 6.9. Impacts to the aesthetic value of stream features may include:

- visible surface cracking of stream bed material;
- iron staining, which can be exacerbated by this surface cracking and alter the colour and texture of the stream beds;
- reduced water levels in some pools or increased ponding in other areas;
- increased levels of erosion (e.g. due to increased tilt); and
- reduced moisture levels in upland swamps and alteration of vegetation.

Impacts to streams and associated stream features, and swamps, as a result of mining subsidence would not be visible unless the viewer is in close proximity. Public access to these locations is restricted and therefore potential for visual impacts is low. However, it is recognised that members of the community may still be concerned about these impacts, irrespective of their visibility.

The Project longwall layout has been designed to reduce potential subsidence impacts on named streams (e.g. Avon River and Cordeaux River) as well as key stream features identified by South32, as discussed in Section 6.6 and Appendix C.

Impacts to Aesthetic Value of Cliffs, Other Rock Features and Steep Slopes

Cracking, exfoliation and block fall, and in some cases overhang collapse, are all typical of natural weathering processes, however subsidence has the potential to exacerbate these processes (e.g. hastening block fall). In the local setting, these visual modifications may be very low to moderate, however, the visibility of overhangs and cliffs within the Project area is very limited due to vegetation cover and restricted public access. Potential Project visual impacts on the aesthetic impacts of cliffs, rock features and steep slopes would, therefore, be low.

Other Short-term Surface Activities

Environmental monitoring, subsidence remediation and other short-term surface activities above the underground mining areas may be visible if located close to public vantage points.

Surface disturbances associated with short-term surface activities would be remediated progressively and any visual impacts would, therefore, be limited in extent and temporary in nature.

6.18.4 Mitigation Measures

Proposed Ventilation Shaft Sites

Construction activities associated with the proposed ventilation shaft sites would be short-term, after which potential visual impacts would be low. In addition, the proposed ventilation shafts and associated infrastructure with the potential to be visible from the Cordeaux Dam wall would be coloured similar to the surrounding vegetation.



Night-lighting and Flaring

A Lighting Management Plan (LMP) is currently implemented at the Dendrobium Mine. Although night-lighting arrangements are not expected to materially change as a result of the Project, South32 would review and update the LMP, where appropriate, to reflect the mitigation and management measures for the Project.

Flares would be enclosed to minimise visibility and fire risk, and would be designed in accordance with the relevant design and safety standards and guidelines.

Other Short-term Surface Activities

Surface disturbance areas associated with any short-term surface activities would be rehabilitated progressively (Section 7).

Impacts to Streams and Key Stream Features

The Project underground mining layout has been designed to reduce subsidence effects on rivers and named streams and key stream features identified by South32.

Mitigation measures and management for potential impacts to key stream features are described in Section 8.2.1. Remediation measures would be developed as part of relevant Extraction Plans for the Project, where applicable.

Impacts to Cliffs, Other Rock Features and Steep Slopes

No specific visual remediation measures are proposed for isolated rock falls that may occur as result of the Project. Such events occur naturally within the sandstone landscape, and exposed rock surfaces weather over time and any disturbed vegetation re-establishes naturally.

6.19 ECONOMIC EFFECTS

6.19.1 Methodology

An Economic Assessment for the Project was undertaken by Cadence Economics (2019) and is presented in Appendix L. The Economic Assessment was prepared in accordance with the *Guidelines for the Economic* Assessment of Mining and Coal Seam Gas Proposals (NSW Government, 2015b) and the Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals (DPE, 2018b).

Cadence Economics has conducted a cost-benefit analysis to evaluate the potential net benefits of the Project to NSW, as described in further detail in Appendix L and Section 9.

The impact assessment component of the Economic Assessment was conducted at two different scales, to assess the potential impact of the Project on the local region and in NSW. The local region adopted for the economic impact assessment was the Dapto-Port Kembla Statistical Area Level 3 (SA3) region (Figure 6-26) (Appendix L).

It is noted that SA3 regions vary in size based on population, with more densely populated areas having smaller SA3 extents. In the case of this Project, limiting the analysis to a single SA3 as is required by the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW Government, 2015b) does not capture all of the potential regional economic effects of the proposal.

Key potential economic impacts were, therefore, also evaluated at a broader regional scale (i.e. the greater Wollongong area, which includes Wollongong, Kiama, Shellharbour, Wollondilly, Campbelltown and Camden (Appendix L), as this scale is more appropriate to capture more of the Project workforce residential localities and regional expenditure by South32.

The economic impact assessment is primarily concerned with the effect of the proposal on an economy in terms of specific indicators, such as employment, regional income, supplier benefit and net benefit of the Project. The Project Economic Assessment used a computable general equilibrium model developed by Cadence Economics to examine potential regional economic effects.

A description of the existing regional and NSW economies is provided in Section 6.19.2. The potential impacts of the Project on the regional and NSW economies are described in Section 6.19.3, while mitigation and management measures are provided in Section 6.19.4.





6.19.2 Existing Environment

Dapto-Port Kembla SA3 Region

The population of the Dapto-Port Kembla SA3 region is approximately 78,000 (Appendix L).

The manufacturing, health care and social assistance and retail trade sectors are the largest sectors from an employment perspective in the Dapto-Port Kembla SA3 (Appendix L).

The manufacturing, transport and mining sectors are of greater relative importance to the Dapto-Port Kembla SA3 regional economy than to the NSW economy, as the region is a major producer of steel products and port services (Appendix L). The professional, scientific and technical services and agriculture, forestry and fishing sectors are of less relative importance in the Dapto-Port Kembla SA3 than they are in the NSW economy (Appendix L).

Approximately 19.4% of the Dendrobium Mine workforce resides in the Dapto-Port Kembla SA3 (Appendix L).

Greater Wollongong Region

The population of the greater Wollongong area (i.e. Wollongong, Kiama, Shellharbour, Wollondilly, Campbelltown and Camden) is approximately 597,000 (Appendix L).

Approximately 93% of the Dendrobium Mine workforce resides in the greater Wollongong area (Appendix L).

6.19.3 Assessment

The economic impact assessment in Appendix L included consideration of the impacts of the Project on the Dapto-Port Kembla SA3 and greater Wollongong regional economies, as well as the broader NSW economy.

Dapto-Port Kembla SA3 and NSW Economies

Employment and Income

The average Project South32 operational workforce would be in the order of approximately 265 full-time equivalent on-site personnel (Appendix L) (i.e. excluding on-site contractor employment). At full development, the Project operational workforce would be in the order of 500 full-time equivalent on-site personnel, inclusive of both direct South32 employment and on-site contractor employees (Section 3.14.2). Construction and development activities would require up to approximately 207 personnel in Year 2020 for the Project. Construction activities would, however, be undertaken at various times over the life of the Project, with smaller construction workforce peaks associated with other activities as required.

The projected direct employment would be accompanied by gross income for the Dapto-Port Kembla SA3 and NSW economies of \$578.6 million and \$1,802.3 million in NPV terms, respectively.

The Project is also projected to result in indirect employment impacts associated with related upstream or downstream industries and any 'crowding out' of activity in other sectors of the economy (Appendix L).

Considering these direct and indirect employment impacts, the incremental increase in indirect employment in the Dapto-Port Kembla SA3 and NSW economies is predicted, on average, to be 29 and 65 full-time equivalent jobs, respectively (Appendix L).

The projected growth in direct and indirect employment would be accompanied by an increase in worker benefit for the Dapto-Port Kembla SA3 and NSW economies of \$71.8 million and \$365.8 million in NPV terms, respectively (Appendix L).

Supplier Benefit

For the Dendrobium Mine, approximately 75% of suppliers are currently based in NSW, which is expected to continue for the Project. The Project would result in a net supplier benefit for the Dapto-Port Kembla SA3 and NSW economies of \$43.5 million and \$217.6 million in NPV terms, respectively, resulting from producer surplus generated from goods and services from NSW firms that provide goods and services to the Project (Appendix L).

Net Benefit

The economic impact assessment indicates the Project would result in a total net benefit to the Dapto-Port Kembla SA3 and NSW economies of \$116.1 million and \$1,073.2 million in NPV terms, respectively, inclusive of estimated costs for environmental externalities and internalisation of environmental management costs by South32 (Appendix L). Sensitivity testing of the Project benefits and the consideration of Project alternatives is provided in Appendix L.



A key contribution of the Project net benefits is \$272.1 million paid to the NSW and local governments, in the way of coal royalties, payroll tax, land taxes and council rates (Appendix L).

Comparison to the Greater Wollongong Economy

Project economic impacts were also evaluated at a broader regional scale (i.e. the greater Wollongong area, which includes Wollongong, Kiama, Shellharbour, Wollondilly, Campbelltown and Camden) (Appendix L). This was conducted to better reflect the geographical catchment of potential Project economic effects in comparison to those captured by the smaller Dapto-Port Kembla SA3.

A comparison between worker benefit, supplier benefit and net benefit of the Project for the Dapto-Port Kembla SA3, greater Wollongong and NSW economies is shown on Figure 6-27.

The majority of the Project workforce would be based in the greater Wollongong area, which would contribute approximately 93% (\$341.7 million in NPV terms) of the total worker benefit to NSW (Appendix L).

The Project would result in net supplier benefit for the greater Wollongong area of \$92.8 million in NPV terms, or approximately 43% of the total supplier benefit to NSW (Appendix L). The Project would result in a total net benefit to the greater Wollongong area of \$431.3 million in NPV terms, or approximately 40% of the net benefit to NSW (Appendix L).

The benefits of the use of product coal by customers of the product coal such as BlueScope Steel and Liberty Primary Steel Wyalla Steelworks have not been estimated. However, the economic contribution of the steelmaking industry to the regional and Australian economies is acknowledged by the Australian Competition and Consumer Commission (ACCC) (Commonwealth of Australia, 2017) (Section 9.1.3).

End of Project Life

The establishment and operation of the Project would stimulate demand in the regional and NSW economies leading to increased employment and benefits to suppliers (Appendix L). Cessation of the mining operations would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts of cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the broader regional economy at the time.



Source: Appendix L





6.19.4 Mitigation Measures

South32 would develop a Mine Closure Plan for the Project approximately 5 years prior to closure which would be developed in consultation with the Wollongong City Council, Wollondilly and Wingecarribee Shire Councils, the DPE and the local community. The Mine Closure Plan would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure (Section 7).

6.20 SOCIAL AND COMMUNITY INFRASTRUCTURE

6.20.1 Methodology

A Social Impact Assessment was prepared by Elliot Whiteing (2019) and considers the potential impacts of the Project on employment, population, community infrastructure demand and social values (Appendix K).

The Social Impact Assessment was prepared in accordance with the SEARs and the Social Impact Assessment Guideline for State significant mining, petroleum production and extractive industry development (DPE, 2017).

Because the Project is a continuation of the existing Dendrobium Mine, and there would only be limited changes to surface facilities, the following discussion is focused on concerns with the existing operations that have been identified in consultation with the community, or potential social impacts arising from the Project extensions.

A summary of the social baseline results including outcomes of community consultation is provided in Section 6.20.2. Potential estimated Project-only and cumulative employment and community infrastructure demands, as well as potential impacts on amenity are described in Section 6.20.3. Proposed mitigation and adaptive management measures are provided in Sections 6.20.4 and 6.20.5, respectively.

6.20.2 Existing Environment

Area of Social Influence

The Social Impact Assessment defines the Wollongong LGA as the primary region of social influence for the Project, as this is where the majority of the Project operational workforce are predicted to reside. The Wollongong LGA had a total population of approximately 204,000 people in 2016 (Appendix K).

The Social Impact Assessment further focuses on the key local suburbs of Mount Kembla, Kembla Heights, Cordeaux Heights, Unanderra and Figtree, as these areas are where potential social impacts of the Project are more likely to be experienced (Appendix K).

Employees

Approximately 19.4% of the Dendrobium Mine workforce resides in the Dapto-Port Kembla SA3, while approximately 93% of the Dendrobium Mine workforce resides in the greater Wollongong area (Appendix L).

It is also noted that the operations of the Dendrobium Mine support manufacturing employment at the BlueScope Steelworks and Whyalla Steelworks.

Community Consultation

The Social Impact Assessment has been informed by extensive consultation undertaken by South32 since commencement of operations at the Approved Mine in 2002, and during the preparation of the Project EIS (Section 5).

Additional consultation undertaken by Elliot Whiteing for the Project Social Impact Assessment is summarised in Table 6-41. In consideration of records of historic feedback from community members, a particular element of the consultation effort was to engage with local landholders who had concerns regarding rail noise emissions (Table 6-41).

As part of the Social Impact Assessment, a local community survey was undertaken within the Dendrobium Mine's Zone of Influence. The community survey was designed to enable a range of community members to participate in consultation, obtain information for the social baseline, and seek community members' views about the Project's potential impacts and opportunities.

Key community concerns regarding the potential impacts and benefits of the Project identified during this consultation are discussed below.



Table 6-41

Summary of Social Impact Assessment Stakeholder Engagement and Consultation

Stakeholder	Engagement Method
Wollongong City Council	 Meeting with the General Manager, Special Projects Manager and as well as other Managers and Principal Officers within other departments (e.g. Planning and Environment, Economic Development and Community and Cultural Development) to discuss potential Project impacts and opportunities.
Wollondilly Shire Council	Representation of the Wollondilly Shire Council on the DCCC.
Community members	 Meeting with Cubbitch Barta Elder to discuss potential Project impacts and opportunities of specific relevance to Aboriginal people.
	 Attendance at DCCC meetings (4) to listen to community concerns about the Project and discuss the Project's potential social impacts and benefits.
	Interviews with DCEC and DCCC members.
	 Phone interviews with Wollondilly Community Development Officer and a member of Illawarra Coal's Bulli Seam Operations Community Consultative Committee.
Social infrastructure providers and local businesses	 Interview with Wollongong Local Area Command Operations Duty Officer (NSW Police) and Mount Kembla Public School Principal.
	Interviews with six representatives of local and regional businesses.
Landholders (rail noise)	 Interviews (5) and meetings (1) with residents to discuss potential for the Project to impact on social values including amenity and way of life in relation to rail noise.

Source: Appendix K

Social Baseline

A description of the existing population profile, employment, housing, health, education and other services in the region is provided in Appendix K. This includes key local and regional social baseline findings identified during consultation. The Project is primarily located within the Wollongong LGA, which has a significant population and established social services and infrastructure within the region.

South32's existing operations, and associated employment, expenditure and sponsorship form part of the social baseline for the local and wider region.

Project consultation with Wollongong City Council identified that mining and manufacturing are major contributors to the Wollongong LGA economic base (Appendix K). Community consultation for the Project identified the potential for increased jobs as the most commonly identified benefit as a result of the Project, and the benefits of South32's existing community investment initiatives were also noted (Appendix K). The Social Impact Assessment identified there is community concern regarding the effects of the underground coal mining on water catchment values (e.g. water supply/quality) within the Metropolitan Special Area. Consultation identified the natural amenity of the Wollongong region as significant with stakeholders, and a contributing reason (combined with more affordable housing) for the increase of Sydney residents settling within the Wollongong LGA (Appendix K).

Consultation also indicated that rail noise, dust and traffic are also of key concern to the local community in the vicinity of the Dendrobium Mine surface facilities (particularly the Dendrobium Pit Top, Kemira Valley Coal Loading Facility and Kemira Valley Rail Line) (Appendix K).

6.20.3 Assessment

Elliot Whiteing (2019) has assessed potential social impacts and opportunities of the Project for local and regional communities.

The potential cumulative impacts of the Project with other proposed, approved or recently commenced regional projects have also been considered in Appendix K.

The potential State and regional economic impacts of the Project are described in Section 6.19.



Surroundings

The potential for changes to local communities' environment that could affect community values from the Project have been assessed as part of the Social Impact Assessment (Appendix K).

In regard to the local community environment, some stakeholders expressed concerns regarding the potential impact of the Project underground mining on surface features including streams, landforms and biodiversity, and particularly in relation to potential impacts to the water catchment within the Metropolitan Special Area.

It is noted that the Project would not materially affect the Metropolitan Special Area's provision of water to the major water storages maintained by Sydney Water (Appendix C). South32 would also pay Sydney Water for the volume of water diverted away from the region's water storages (Section 8).

Stakeholders also expressed concern regarding the potential for the Project to increase traffic volumes on the local road network.

Potential impacts to the water supply and on the road network are discussed in detail in the Groundwater, Surface Water and Road Transport Assessments for the Project (Appendices B, C and H, respectively).

Measures to avoid, mitigate, manage and offset the potential environmental impacts of the Project are described throughout the EIS.

Personal and Property Rights

The Project would have no direct impacts on privately-owned property (Appendix K).

Some local residences proximal to the Kemira Valley Rail Line have experienced stress and occasional sleep disturbance as a result of rail noise impacts from the Dendrobium Mine. The Project would involve the continued and extended use of the Kemira Valley Rail Line, however, South32 and Pacific National have progressively implemented mitigation measures that have reduced rail noise levels and the number of rail noise complaints (Section 6.14.2).

Potential impacts relating to noise (e.g. potential sleep disturbance from rail noise) and dust impacts are described in Sections 6.13 to 6.15 and Section 6.17.

Culture

The potential for impacts on Aboriginal cultural values, community identity (which is tied to sense of place) and appreciation of environmental qualities from the Project have been considered as part of the Social Impact Assessment (Appendix K).

As public access to the Metropolitan Special Area (and Area 5 and Area 6) is restricted by WaterNSW, there is no current Aboriginal community use of the area for social or cultural purposes that could be disturbed by the Project (Appendix K).

There is potential that Aboriginal heritage items could be impacted by subsidence (Sections 6.3 and 6.10). Management measures for potential impacts to heritage items are described in the ACHA for the Project (Appendix F), which has been prepared in consultation with the RAPs.

The Project would also support Indigenous employment, as well as Indigenous businesses, which also act a source of employment for Indigenous people (Appendix I).

Employment and Business Opportunities

At full development, the Project operational workforce would be in the order of 500 full-time equivalent on-site personnel inclusive of both direct South32 employment and on-site contractor employees. The Project therefore represents an increase of approximately 100 operational personnel from the workforce of the Dendrobium Mine.

Construction and development activities for the Project would require up to approximately 207 personnel in 2020. Construction activities would however be undertaken at various times over the life of the Project, with smaller construction workforce peaks associated with other activities as required.

The Project would therefore increase the availability and longevity of employment at the Dendrobium Mine. The employment opportunities of the Project would be experienced as a substantial regional benefit, with a large portion of the workforce drawn from Wollongong LGA and the greater Wollongong region. Wollongong City Council also noted that any construction project with more than 100 jobs would provide a substantial positive impact on employment and flow-on business activities (Appendix K).



The Project would also facilitate continuation of existing relationships between the Dendrobium Mine's suppliers and customers (including the BlueScope Steelworks) in the Wollongong and adjoining LGAs (Appendix K).

Community

Population and Housing

The potential for changes to population size, composition or distribution at local or regional level from the Project have been assessed as part of the Social Impact Assessment (Appendix K).

Non-local construction workers may require temporary accommodation within the region. Up to 62 people may require temporary accommodation, however, increased demand for accommodation is likely to be experienced as a positive effect for providers in the region (Appendix K).

New employees (both construction and operational workforce) who move to the region may require approximately 71 dwellings in the Wollongong LGA (Appendix K). In the context of the LGA's existing and planned future housing supply, this is likely to have negligible impact (Appendix K).

Regional population growth associated with the Project (e.g. migration of non-local workers to the region) is unlikely to cause a noticeable increase in the population size or composition at the Wollongong LGA level (Appendix K).

Community Identity and Sense of Place

The Wollongong LGA community's identity and sense of place is strongly influenced by its natural environment, urban and natural amenities, and the Wollongong LGA's industrial history (Appendix K).

On a regional scale, impacts on sense of place are not likely as a result of the Project (Appendix K).

The Project would support ongoing recognition of the Mount Kembla area's identity as a mining community through the continuation of mining (Appendix K). This identity is celebrated and commemorated through community events, with local mining heritage protection previously part of the activities of the Mount Kembla Heritage Centre and its committee. The Mount Kembla Heritage Centre is currently inactive due to falling revenue and volunteer support (Appendix K).

Access to Services and Infrastructure

Local social infrastructure (e.g. Mount Kembla Public School, NSW Police etc.) is expected to have sufficient capacity to respond to any potential increased demand as a result of the Project (Appendix K).

Construction generated demand from non-local workers (i.e. up to 62 workers) on regional social infrastructure (e.g. social and health infrastructure) would be negligible (Appendix K).

It is anticipated that there would be some increased demand for policing of construction traffic (including workers' cars and delivery vehicles) and for police escorts for over-size vehicles. An occasional requirement for Ambulance or Fire Service response to accidents could also be anticipated. However, this level of demand is unlikely to disadvantage local residents through competition for police and emergency services, or to lead to a significant strain on services' resources (Appendix K).

Any potential Project-related increased demand for health services, school services, policing, emergency services or other community infrastructure are likely to be negligible in the context of the regional population (Appendix K).

Health and Wellbeing

The Project's continuation of employment would contribute to individual and household well-being for employees and their families, and contribute to economic development.

Those residents in the Mount Kembla area affected by rail noise from the Kemira Valley Rail Line described feeling stress and frustration, as well as occasional sleep disturbance due to rail noise. The recent rail noise mitigation measures implemented by South32 have resulted in a significant decrease in brake squeal noise, and affected residents are likely to experience some relief from the stress and frustration experienced previously (Appendix K).

The Project would also continue to support community wellbeing through the DCEP (Appendix K).

Cumulative Impacts

The potential cumulative impacts of the Project and other potentially relevant approved and proposed projects within the Wollongong, Wollondilly and Wingecarribee LGAs has been considered in Appendix K.





Key findings of the cumulative assessment include (Appendix K):

- There are no other mining projects currently operating in the direct vicinity of Dendrobium Mine that would contribute to cumulative impacts on amenity.
- It is unlikely that the construction phases of all projects considered would occur simultaneously. However, if this was to occur, the Project's contribution to cumulative impacts on labour availability for other industries would be minimal.
- If the construction phase of another project of similar size was to occur simultaneously, cumulative demand for mine construction workers would result. However, the specialised nature of underground construction work means that this is unlikely to cause significant impacts for other industries or businesses in the Wollongong region.
- The Project would continue the Dendrobium Mine's contribution to cumulative impacts on the road network, but would not significantly intensify impacts.
- Community concerns about the effects of individual mining projects and the cumulative impacts of mining in the Metropolitan Special Area would likely continue.

Impacts of Mine Closure

If the Project is not approved, mining would likely cease by 2026, however, if the Project proceeds, the potential social impacts and benefits of Project closure would be extended by approximately 18 to 22 years. The effects following closure of the Project are likely to be similar, but of less magnitude, as the Wollongong LGA's population will have grown and a more diversified economy developed (Appendix K).

If the Project does not proceed, the Dendrobium Mine's closure would see the loss of approximately 265 jobs and 140 full-time equivalent contractor positions, which would likely be experienced as a significant loss to the mining labour force in the Wollongong LGA and adjoining regions (Appendix K).

In addition, if the Project does not proceed, there would also be an effect on the upstream production and downstream processes that the Dendrobium Mine, and Project would support, including at the BlueScope Steelworks (Appendix K).

Greenhouse Gas Emissions

Climate change and potential greenhouse gas contributions of the Project and/or the combustion of Project coal by third parties are of potential concern to many stakeholders in NSW.

Greenhouse gas emissions from the existing Dendrobium mining operations (Scope 1), electricity consumption (Scope 2) and downstream use of product coal (Scope 3) are accounted for in NSW's and Australia's current greenhouse gas inventories. These existing emissions would continue for the life of the Project at a similar scale as those currently occurring, should the Project be approved.

South32 would also implement corporate and Project-specific greenhouse gas mitigation measures over the life of the Project (Section 6.21.4). The potential impacts of climate change to NSW are discussed further in Section 9.3.4.

6.20.4 Mitigation Measures

South32 would continue to work with local government and the local community to minimise potential social impacts of the Project and maximise potential opportunities.

A number of mitigation and management strategies have been identified and would be implemented by South32, including:

- identifying and engaging with Indigenous businesses;
- providing ongoing community engagement;
- providing access to dust monitoring for concerned households in Mount Kembla and Cordeaux Heights, to provide reassurance about the potential for health issues due to coal dust;
- providing clear, accessible and independently-sourced information to the local community about management and monitoring of subsidence and groundwater impacts in the lead-up to Project execution;
- establishing goals for female representation (10%) and Indigenous participation (2.5%) in the Project workforce;
- implementing standard construction noise management techniques and consult with nearby neighbours during the duration of construction activities;



- continuing to implement the Dendrobium Mine Drivers' Code of Conduct;
- maintaining rail noise mitigation initiatives (e.g. installation of modified brake shoes) throughout the life of the Project;
- continuing South32's existing employment, contracting and training strategies for the Project, including continuation of existing apprenticeship and graduate traineeship programs;
- implementing South32's Diversity and Inclusion policy;
- establishing strategies to achieve Indigenous participation in the Project's workforce and supply chains, supporting the key objective of improving Indigenous community well-being through greater economic participation;
- supporting Indigenous community and economic well-being initiatives that benefit the communities in which the Dendrobium Mine operates; and
- maintaining the DCEP for the life of the Project.

6.20.5 Adaptive Management

A number of adaptive management strategies have been identified and would be implemented by South32, including:

- collecting, monitoring and reporting mitigation performance data, at least six-monthly during the first five years after Project execution and at intervals determined in consultation with the DCCC thereafter;
- monitoring of social indicators which may change how Project impacts and benefits are experienced;
- engaging with stakeholders who should benefit from mitigations, to ensure their opinions are identified and considered in review of mitigation and performance outcomes;
- reviewing (annually) the delivery of mitigation strategies, performance outcomes, any unexpected impacts or benefits and the status of social indicators, conducted in consultation with the DCCC; and
- identifying and implementing required changes to mitigation and enhancement strategies.

A Social Impact Management Plan would also be developed by South32 for the Project, if required (Appendix K).

6.21 GREENHOUSE GAS EMISSIONS

6.21.1 Methodology

An assessment of Project greenhouse gas emissions was undertaken by Ramboll (2019) and is presented in Appendix I. A summary of the assessment is provided below.

The following sub-sections provide a quantitative assessment of potential direct and indirect greenhouse gas emissions of the Project (Section 6.21.2), comparison of the Project emissions to Australian and NSW greenhouse gas emissions reduction targets (Section 6.21.3), a summary of mitigation and abatement measures (Section 6.21.4) and adaptive management (Section 6.21.5).

Further consideration of greenhouse gas emissions from the Project in the context of the Paris Agreement and ESD is provided in Section 9.3.5.

6.21.2 Quantitative Assessment of Potential Greenhouse Gas Emissions

Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) contains methodologies for assessing and calculating greenhouse gas emissions (World Business Council for Sustainable Development [WBCSD] and World Resources Institute [WRI], 2015). The GHG Protocol provides standards and guidance for companies and other types of organisations preparing a greenhouse gas emissions inventory. It covers the accounting and reporting of the six greenhouse gases covered by the Kyoto Protocol.

Under the GHG Protocol the establishment of operational boundaries involves identifying emissions associated with an entity's operations, categorising them as direct or indirect emissions, and identifying the scope of accounting and reporting for indirect emissions.

Three "Scopes" of emissions (Scope 1, Scope 2 and Scope 3) are defined for greenhouse gas accounting and reporting purposes. Scopes 1 and 2 have been carefully defined to ensure that two or more entities would not account for emissions in the same Scope.



Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the entity (WBCSD and WRI, 2015). Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity and include:

- Generation of electricity, heat or steam these emissions result from combustion of fuels in stationary sources (e.g. boilers, furnaces, turbines).
- Physical or chemical processing most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, adipic acid and ammonia, or waste processing).
- Transportation of materials, products, waste, and employees – these emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions these emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; HFC emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport) (WBCSD and WRI, 2015).

Scope 2: Electricity Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that accounts for greenhouse gas emissions from the generation of purchased electricity consumed by an entity.

Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity (WBCSD and WRI, 2015). Scope 2 emissions physically occur at the facility where electricity is generated (WBCSD and WRI, 2015). Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as Scope 2.

Scope 3: Other Indirect Greenhouse Gas Emissions

Under the GHG Protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions.

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services (WBCSD and WRI, 2015).

The GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions (e.g. when compiling national inventories) and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

Greenhouse Gas Estimation Methodology

Project direct and indirect greenhouse gas emissions have been estimated by Ramboll (2019) (Appendix I) using published emission factors from the *National Greenhouse Accounts Factors* (NGAF) (DoE, 2014b). Fugitive emissions have been calculated using site-specific emission data.

The NGAF provide greenhouse gas emission factors for carbon dioxide, methane and nitrous oxide. Emission factors are standardised for each of these greenhouse gases by being expressed as a carbon dioxide equivalent (CO₂-e) based on their Global Warming Potential. This is determined by the differing periods that greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation (e.g. methane has a Global Warming Potential 21 times that of carbon dioxide) (DoE, 2014b).

Project Greenhouse Gas Emissions

Key potential Project greenhouse gas emission sources considered in the greenhouse gas estimate and their respective scopes include:

- direct emissions from continued diesel consumption by existing on-site plant and equipment (Scope 1);
- direct emissions from flaring of gas for pre- and post-drainage and venting of gas (via mine ventilation air) (Scope 1);
- residual (post-mining) fugitive emissions from stockpiled coal (Scope 1);





- direct emissions from gas consumption at the existing Dendrobium CPP (Scope 1);
- fugitive emissions from the continued transportation of ROM coal on the existing Kemira Valley Rail Line and by road from the Dendrobium CPP to the Port Kembla Coal Terminal (Scope 1);
- fugitive emissions from the continued transportation of coal wash to the West Cliff Coal Wash Emplacement (Scope 1);
- indirect emissions from the continued consumption of purchased electricity (Scope 2); and
- downstream emissions generated from end use of product coal (Scope 3).

Scope 1

Quantification of Scope 1 Emissions

The total direct (i.e. Scope 1) emissions over the life of the Project are estimated to be between approximately 17 to 22 Mt CO₂-e (depending on proportion of methane able to be flared) (Appendix I).

This value conservatively includes gas ventilation/flaring emissions associated with approved underground mining in Areas 3B and 3C that would occur during the life of the Project.

Annual average Scope 1 greenhouse gas emissions are expected to be between 0.59 to 0.77 Mt CO_2 -e per annum over the life of the Project (Appendix I).

A portion of Project Scope 1 emissions are associated with activities that are currently occurring at the Approved Mine (and could continue to operate as currently approved until 2030). Existing greenhouse gas emissions from these existing activities, and venting from the current Approved Mine, would be captured in current national and state greenhouse gas accounting.

Greenhouse Gas Emission Minimisation

The key greenhouse gas minimisation measure for Project Scope 1 emissions is the flaring of pre- and post-drainage gas to the greatest extent practicable, to convert methane to carbon dioxide (i.e. as methane has a Global Warming Potential 21 times that of carbon dioxide). Analysis and modelling of potential gas liberation as mining occurs in Areas 5 and 6 indicated that gas volumes and methane content are such that the Project gas drainage program (and associated flaring) is required to facilitate safe mining.

Gas liberated during mining of Areas 5 and 6 is expected to be highly variable in content and composition. On this basis, South32 determined that utilisation of the gas (e.g. for electricity generation) would not be feasible for the Project.

Scope 1 greenhouse gas emissions from all of South32's assets are managed via company-wide greenhouse gas emission (and energy) targets.

South32's Climate Change Strategy includes the following targets:

- Staying below a baseline Scope 1 greenhouse gas emissions level (established based on financial year 2015) until 2021.
- Reviewing and reducing greenhouse gas emissions every five years from 2021 to achieve a goal of net-zero Scope 1 greenhouse gas emissions by 2050 (including carbon offsetting for any residual emissions).

Scope 2

The total Scope 2 (indirect) emissions over the life of the Project are estimated to be approximately 1.7 Mt CO₂-e, with an average of approximately 0.1 Mt CO₂-e per annum (Appendix I).

The majority of electricity consumption for the Project is associated with activities that are currently occurring at the Approved Mine and Dendrobium CPP (and could continue to operate as currently approved until 2030). Existing Scope 2 greenhouse gas emissions associated with the electricity consumption from these existing activities would be captured in current national and state greenhouse gas accounting.

Energy efficiency and reduction is a key consideration for the purchase and upgrade of equipment. Accordingly, electricity consumption and associated Scope 2 emissions are reduced as far as practicable.



As part of its Climate Change Strategy, South32 regularly reviews its energy supply options to identify opportunities for sustainable energy supply. Notwithstanding, the emissions intensity of purchased electricity for the Project is outside the control of South32. If the emissions intensity of electricity generation reduces over time, Scope 2 emissions from the Project will reduce accordingly.

Scope 3

The total Scope 3 (indirect) emissions over the life of the Project are estimated to be approximately 237 Mt CO₂-e, with an average of approximately 8.2 Mt CO₂-e per annum (Appendix I).

These Scope 3 emissions are associated with the end use of coal by third parties, such as BlueScope's Port Kembla Steelworks and Liberty Primary Steel's Whyalla Steelworks.

Project Greenhouse Gas Emission Intensity

The estimated Scope 1 and 2 greenhouse gas emissions intensity of the Project emissions is estimated to be between approximately 0.17 to $0.21 \text{ t } \text{CO}_2$ -e per tonne of ROM coal.

Potential Impacts of Greenhouse Gas Emissions on the Environment

The Project's contribution to Australian emissions would be relatively small, as estimated annual average Scope 1 emissions from the Project represent approximately 0.5% of NSW's and 0.1% of Australia's annual greenhouse gas emissions from 2016, respectively (Appendix I).

The Project greenhouse gas emissions would make some contribution to global emission and the Project's contribution to climate change and the associated environmental impacts would be in proportion with its contribution to global greenhouse gas emissions.

The potential effects of climate change on the nature and extent of the Project potential impacts have also been considered, including those relating to groundwater (Appendix B), surface water (Appendix C), aquatic ecology (Appendix E) and terrestrial flora and fauna (Appendix D).

Potential environmental costs associated with Project greenhouse gas emissions have also been considered in Appendix L (Economic Assessment).

6.21.3 Australian Greenhouse Gas Emissions Reduction Targets

The potential impacts of greenhouse gas emissions from all Australian sources will be collectively managed at a national level, through initiatives implemented by the Commonwealth Government.

The Commonwealth Government has committed to reduce greenhouse gas emissions by 5% below 2000 levels by 2020, consistent with Australia's commitments under the Kyoto Protocol (Commonwealth of Australia, 2014).

In addition to the 2020 target, the Commonwealth Government has also committed to reducing greenhouse gas emissions by 26 to 28% below 2005 levels by 2030, as part of the Paris Agreement (Commonwealth of Australia, 2015).

The Emissions Reduction Fund is the centrepiece of a suite of Commonwealth Government policies designed to incentivise business and other entities to adopt better technologies and practices to reduce greenhouse gas emissions (Commonwealth of Australia, 2017). In addition, a range of policies including the Renewable Energy Target and the National Energy Productivity Plan have been implemented to help Australia meet its greenhouse gas commitments (Commonwealth of Australia, 2017).

The NSW Government has released the NSW Climate Change Policy Framework (OEH, 2016b), which commits NSW to the "aspirational long-term objective" of achieving net-zero emissions by 2050.

The NSW Government's aspiration and long-term objective is consistent with the target of South32's Climate Change Strategy.

South32 would also implement Project-specific greenhouse gas mitigation measures, as described below.

6.21.4 Project Greenhouse Gas Mitigation Measures

Greenhouse gas management at the Approved Mine is currently undertaken in accordance with the Greenhouse Gas & Energy Efficiency Management Plan.



The Greenhouse Gas & Energy Efficiency Management Plan describes a number of greenhouse gas abatement measures and mining efficiency improvement projects, including:

- flaring of coal mine waste gas extracted by surface means;
- selection and design of equipment and processes to optimise efficiency and reduce energy consumption;
- maintaining plant and equipment to optimise reliability and efficiency;
- routine calibration and servicing of monitoring equipment;
- use of alternative fuels where practical;
- mining at the optimum coal seam height to reduce energy consumption and waste production;
- use of automated process controls to optimise plant run time and performance;
- operational practices (e.g. optimising the utilisation of available plant and personnel); and
- maintenance of transport roadways and surfaces to reduce fuel consumption of mobile equipment.

Energy use (electricity consumption and diesel usage) for the Project would continue to be recorded through direct measurement and/or invoicing.

Greenhouse gas and energy data would continue to be accounted for and reported in compliance with legislative and other requirements.

The existing Greenhouse Gas & Energy Efficiency Management Plan would be reviewed and updated accordingly to address the Project. South32 would continue to assess and implement energy and greenhouse gas management initiatives during the life of the Project.

6.21.5 Adaptive Management

South32 would continue the ongoing management of its contribution to Australian greenhouse gas emissions inventories through participation in the Commonwealth Government's NGERS, as well as any other government initiatives implemented to manage emissions at the national level.

6.22 HAZARD AND RISK

6.22.1 Methodology

A Preliminary Hazard Analysis (PHA) was conducted to evaluate potential hazards associated with the Project (Appendix N). The PHA has been conducted in accordance with the general principles of risk evaluation and assessment outlined in the DP&I (now DPE) Assessment Guideline: Multi-level Risk Assessment (DP&I, 2011b) and has been documented in general accordance with Hazard Industry Planning Advisory Paper No. 6: Hazard Analysis (DoP, 2011a).

The PHA also addresses the requirements of SEPP 33 within the *Hazardous and Offensive Development Application Guidelines: Applying SEPP* 33 (DoP, 2011b).

Consistent with the requirements of the SEARs, the PHA addresses potential hazards relating to bushfire risk and the use of dangerous goods.

Potential incidents and hazards identified for the Project are described in Section 6.22.2. Proposed preventative and control measures to address potential hazards are described in Section 6.22.3.

6.22.2 Hazard Identification and Risk Management

Potentially hazardous materials required for the Project include hydrocarbons (diesel, petrol, oils, greases, degreaser and kerosene), chemicals, explosives and Liquid and Non-Liquid Wastes (Appendix N). The risks posed by the usage of these materials for the Project would include their transport, handling, storage and consumption.

In accordance with DP&I (2011b), the PHA specifically covers the risks from fixed installations. As such, the main focus was on on-site storages, coal stockpile areas, ventilation/gas management infrastructure and water management structures. Risks associated with subsidence are considered in the Subsidence Assessment (Appendix A) and the ERA (Appendix M).

For the purposes of risk identification, the Project was subdivided into a number of operational areas (Appendix N) and potential incidents were identified and divided into generic classes for each operational area, including:

- leaks/spills;
- fire;



- explosion; and
- theft/vandalism.

Other classes of incidents included:

- unplanned/unauthorised movement of mobile plant;
- release of noxious gases to the atmosphere; and
- equipment/mine infrastructure malfunction.

The potential risks identified in the PHA related to the following Project elements/activities:

- on-site storage (hydrocarbons, explosives and chemicals);
- on-site storage (ROM and product coal);
- construction/development activities;
- underground mining operations; and
- other infrastructure and supporting systems.

Following identification of the potential hazards associated with the Project, a qualitative assessment of the risks to the public, property and the environment associated with the development and operation of the Project was undertaken (Appendix N).

An assessment of the combination of the consequence and likelihood rankings concluded that overall risk rankings for the identified hazards would be low, and therefore tolerable. Given the existing or proposed mitigation measures, no potential scenarios with significant off-site consequences were identified (Appendix N).

Bushfire Regime

The Project is located in the jurisdiction of the Illawarra Bush Fire Management Committee (Illawarra BFMC) and Wollondilly/Wingecarribee Bush Fire Management Committee (Wollondilly/Wingecarribee BFMC), which follow the LGA boundaries of the Wollongong City Council, Wollondilly Shire Council and Wingecarribee Shire Council, respectively. The proposed ventilation shaft sites as well as the majority of proposed Area 5 and Area 6 are within the jurisdiction of the Wollondilly/Wingecarribee BFMC. Bushfire risk management plans have been prepared by the Illawarra BFMC (2016) and Wollondilly/Wingecarribee BFMC (2016).

For the Illawarra BFMC area, the fire season generally coincides with fresh to strong south-westerly to north-westerly winds, which prevail during August/September and continue until the onset of summer rains or coastal showers. Longer fire seasons are experienced when rainfall is lower than average, extending the bushfire season through summer to early autumn. Extreme fire danger days in the area are usually experienced due to strong west to north-westerly winds, particularly in dry conditions (Illawarra BFMC, 2016).

The bushfire season in the

Wollondilly/Wingecarribee BFMC area is generally from August to December, but can extend to March depending on weather conditions and the onset of summer rainfall (Wollondilly/Wingecarribee BFMC, 2016).

The major sources of fire ignition include arson, car dumping, lightning, electrical power lines (i.e. arcing in high winds) and fires that escape from legal and illegal burning activities (Illawarra BFMC, 2016; Wollondilly/Wingecarribee BFMC, 2016).

Major fire activity in the vicinity of the Dendrobium Mine, including the Illawarra Escarpment and WaterNSW Special Areas occurred on a number of occasions since September 1939, with the most recent uncontrolled bushfire event occurring in the area proximal to existing Shaft No. 1 in September 2003. These fires coincided with extended dry periods coupled with hot and windy conditions (South32, 2019b).

Bushfire risk management measures are currently employed at the Approved Mine as part of the existing Bushfire Management Plan (Section 6.22.3).

The West Cliff Coal Wash Emplacement is located within the jurisdiction of the Wollondilly BFMC. Major fire activity in the vicinity of the West Cliff Coal Wash Emplacement, including the Dharawal State Conservation Area/National Park and Sydney Drinking Water Catchment land occurred on a number of occasions since 1965, with the most recent major wildfire event occurring in 2006 which burned the majority of the area in these reserves (Illawarra Coal, 2017).



The development and rehabilitation of the West Cliff Stage 3 and Stage 4 Coal Wash Emplacements would continue to be undertaken in accordance with Development Consent DA 60-03-2001 and the Bulli Seam Operations Project Approval 08_0150. Bushfire risks at the West Cliff Coal Wash Emplacement were considered in the PHA conducted for the Bulli Seam Operations EIS (PAE Holmes, 2009).

The Dendrobium CPP is located within the Port Kembla industrial precinct, which is a heavy industry area incorporating the BlueScope Steelworks and Port Kembla Coal Terminal, and as such bushfire risk in this location has not been discussed further.

Bushfire Hazard

Any uncontrolled bushfires originating from Project activities may present potentially serious impacts to the townships of Kembla Heights, Mount Kembla or more remote residential and rural properties located on the boundaries of the Metropolitan Special Area and Upper Nepean State Conservation Area. In addition, the Metropolitan Special Area, Upper Nepean State Conservation Area and surrounds may also be potentially adversely impacted by bushfire events.

Similarly, fires originating in nearby bushland, residential or rural areas could pose a significant risk to Project infrastructure and to staff, contractors and equipment. Smoke from bushfires can also have adverse impacts on the operation of the Project (e.g. impact underground air quality through ventilation infrastructure).

The degree of potential impact would vary with climatic conditions (e.g. temperature and wind), location of the bushfire and the quantity of available fuel.

The continuation and expansion of surface activities for the Project could increase the potential for fire generation. However, given the range of management measures currently in place for the Dendrobium Mine, which would continue for the Project (e.g. appropriate flare design), it is unlikely that there would be an increase in fire frequency resulting from the Project.

6.22.3 Hazard Prevention and Mitigation Measures

South32 implements a safety management system at the Dendrobium Mine to manage risks to health and safety in accordance with the requirements of the Work Health and Safety (Mines and Petroleum Sites) Act, 2013 and the Work Health and Safety (Mines and Petroleum Sites) Regulation, 2014. South32 would continue to meet these obligations for the Project.

In addition, a number of hazard control and mitigative measures are currently in place. These measures are described in the Dendrobium Mine management plans relevant to the Project, including:

- Water Management Plan;
- Landscape Management Plan;
- Mining Operations Plan;
- Pollution Incident Response Management Plan;
- Air Quality Monitoring Program;
- Bushfire Management Plan; and
- Waste Management Plan.

The management plans would be revised or replaced where necessary to address mitigation measures, monitoring, reporting and review requirements for the Project.

The following hazard control and/or mitigation measures would be adopted by South32 to reduce the likelihood and/or consequences of potentially hazardous incidents associated with the Project:

- **Maintenance** Ongoing and timely maintenance of all mobile and fixed plant and equipment in accordance with the recommended maintenance schedule, and consistent with the maintenance schemes required by legislation.
- Staff Training Operators and drivers would be trained and (where appropriate) licensed for their positions. Only those personnel licensed to undertake skilled and potentially hazardous work would be permitted to do so.



- Engineering Structures Mining and civil engineering structures would be constructed in accordance with the applicable codes, guidelines and Australian Standards. Where applicable, South32 would obtain the necessary licences and permits for engineering structures.
- Contractor Management All contractors employed by South32 would be required to operate in accordance with the relevant Australian Standards and NSW legislation.
- Water Management As reported in Appendix C of the EIS, water management structures would be constructed to generally separate runoff from undisturbed areas and disturbed areas.
- Storage Facilities Storage and usage procedures for potentially hazardous materials (i.e. fuels, lubricants and chemicals) would be developed in accordance with Australian Standards and relevant legislation. A register of chemicals and dangerous goods stored on-site would be kept up-to-date via a tracking, storage and chemical information management system.
- Emergency Response Emergency response procedures, manuals and systems would continue to be implemented.
- Waste Management System Waste would be managed according to a hierarchy of waste control (avoidance, resource recovery and disposal). Waste disposal measures and a monitoring program are described in the Waste Management Plan.

Bushfire Hazards

Bushfire risk management measures currently employed at the Dendrobium Mine as part of the existing Bushfire Management Plan would continue for the Project. Specific mitigation and management measures to reduce bushfire risk could include:

- Fire awareness and fire safety training would continue to be included in the induction of appropriate South32 staff and contractors.
- Mitigation measures that would be implemented by South32 to reduce bushfire risk would focus on education and training, reducing bushfire hazard (principally fuel levels), minimising and controlling ignition sources (e.g. by appropriate engineering design, where relevant) and developing appropriate responses and evacuation strategies.

- South32 has implemented a number of management and mitigation measures to reduce the potential risk of bushfire, including hazard treatment and mitigation measures (as described in Section 6.22), fire management plans and emergency response to bushfires and evacuation procedures.
- Suitable firebreaks and/or radiation zones would be established to reduce bushfire hazards, where required. Firebreaks have been established around the existing surface facility locations, including Cordeaux Pit Top, Dendrobium Pit Top and the Kemira Valley Coal Loading Facility, and extensive firefighting water pipelines and booster pump facilities are available around the Dendrobium and Cordeaux Pit Top sites. South32 would continue to regularly inspect bushfire management controls on its properties, Bushfire risk management works would be undertaken on an as required basis and would include clearing of excessive growth within property fire protection boundaries.

South32 would continue to consult with WaterNSW with respect to management of bushfire risk activities within the Special Areas.