APPENDIX L

Economic Assessment

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ECONOMIC IMPACT ASSESSMENT OF THE DENDROBIUM MINE – PLAN FOR THE FUTURE: COAL FOR STEELMAKING

ILLAWARRA COAL PTY LTD SOUTH32

MAY 2019

Table of Contents

General reliance restriction

This report is prepared for South32 Limited. The purpose of this report is to provide an economic impact assessment of the Dendrobium Mine – Plan for the Future: Coal for Steelmaking Project to NSW and to the local community. You should not use the advice for any other purpose. This report should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. Due to the uncertain nature of economic data, Cadence Economics does not warrant the completeness or accuracy of the analysis or estimates provided in this report.

Executive Summary

Illawarra Coal Holdings Pty Ltd (Illawarra Coal) is seeking development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for an expansion of the Dendrobium Mine, an existing underground coal mine. Illawarra Coal is a wholly owned subsidiary of South32 Limited (South32). The proposed development, the Dendrobium Mine – Plan for the Future: Coal for Steelmaking Project (the Project) is located within three Local Government Areas, Wollongong, Wingecarribee and Wollondilly.

South32 is seeking development consent for the Project to extract additional coal from Area 5 and Area 6. The Project will extract an additional 77.6 million tonnes (Mt) of run-of-mine (ROM) coal from Area 5 and Area 6, at an extraction rate of up to approximately 5.2 Mt of ROM coal per annum, over the period 2020 to 2048. The Project will produce 64.6 Mt of saleable coal, which includes 48.8 Mt of high quality metallurgical coal. The remainder is made up of thermal coal and Pulverised Coal Injection (PCI) coal, 6.2 Mt and 9.6 Mt respectively.

The existing approved underground operations extract coal within the approved Dendrobium Mine domains from areas designated as Area 1, Area 2, Area 3A, Area 3B and the yet to be mined Area 3C. The Dendrobium Mine is currently extracting coal from Area 3B, with planned extraction of 18.1 Mt of ROM coal from this area. Current mining operations in Area 3B are independent from the Project and are included in the economic baseline.

The yet to be mined Area 3C accounts for a total of 16.1 Mt of ROM coal. For Area 3C to be mined, significant gas drainage works would be required, and in the absence of the Project, there would be a discontinuity of work at the Dendrobium Mine following the completion of mining in Area 3B, which would adversely affect the economic viability of Area 3C.

To be conservative, the Economic Assessment has limited the net benefits of the Project exclusively to the additional areas of Area 5 and Area 6. However, an assessment of the net economic benefits of mining Area 5, Area 6 as well as Area 3C has been presented in Appendix C.

This report provides an Economic Impact Assessment (EIA) for the proposed development and follows the economic assessment framework set out in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the New South Wales (NSW) Government in December 2015. In addition, the Guidelines require an estimate of the potential costs generated by the Project. These costs may include residual public infrastructure costs and environmental, social and transport-related costs. To estimate the environmental, social and transport-related costs, the EIA uses the methods outlined in the *Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*.[1]

Consistent with these guidelines, the EIA includes a Cost Benefit Analysis (CBA) and a Local Effects Analysis (LEA). The CBA provides an estimate of the net benefits of the proposed development to NSW. The LEA is

[1] Department of Planning and Environment (2018)

based on analysis for the Dapto – Port Kembla local region (as defined by the Australian Bureau of Statistics SA3 (10701) region).

Results of the CBA

Based on the CBA methodology outlined in the Guidelines, and information provided by Illawarra Coal, the proposed development is estimated to provide a net benefit to NSW. This net benefit is estimated to be $1,073.2 million in net present value (NPV)[2] terms, as shown in Table 1. This is comprised of $497.8 million and $583.4 million in direct and indirect benefits respectively. The incremental indirect costs are estimated at $8.1 million. These estimates are based on central case assumptions in relation to the proposed $731.6 million capital expenditure (both mine development capital and replacement and sustaining capital) and average coal prices of $173.7 per tonne for metallurgical coal, $92.8 for thermal coal and $136.5 for PCI.

Table 1: CBA summary of the Project net benefits under central case assumptions ($ million)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	74.9		
2. Royalties, payroll tax and Council rates	272.1		
3. Company income tax apportioned to NSW	150.8		
Total direct benefits	**497.8**	**Total direct costs**	**-**
Indirect benefits	**-**	**Indirect costs**	
1. Net economic benefit to landholders	-	1. Air quality	8.0
2. Net economic benefit to NSW workers	365.8	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	217.6	3. Visual amenity	-
	-	4. Transport impact	-
	-	5. Net public infrastructure cost	-
	-	6. Surface water impact	-
	-	8. Residual value of land	-
	-	7. Biodiversity impact^^	-
	-	8. Noise impact	-
	-	9. Loss of surplus to other industries	-
	-	10. Water ^^	-
	-	11. Aboriginal cultural and Historical heritage ^^	-
	-	12. Subsidence^^	-
Total indirect benefits	**583.4**	**Indirect Costs**	**102.4**
Total Project economic benefit	**1,081.2**	**Incremental Indirect Cost**	**8.1**
NPV of Project - ($m)	**1,073.2**		

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated into mitigation and management costs.

[2] All NPV figures reported are in real 2018 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

The ***direct benefits*** of the project are a function of the profitability of the proposed development which, in turn, depends on the prevailing coal price. The analysis shows that the combination of relatively high value of coking coal and relatively low capital, extraction and processing costs underpins the economic viability of the Project. This results in the proposed development generating:

- An overall net producer surplus of $478.8 million, of which 15.7 per cent, or $74.9 million is attributed to NSW;
- Total corporate taxes of $471.3 million in NPV terms for Australia, of which $150.8 million is attributed to NSW; and
- Other government revenue for NSW of $272.1 million in NPV terms, the largest component of this being royalties of $237.1 million, based on a royalty rate of 6.2 per cent, payroll taxes of $30.2 million and council rates contributing $4.8 million respectively.

The ***indirect benefits*** of the project are related to the linkages that the proposed development has to the NSW economy through both the labour market and suppliers. The analysis shows that of the $583.4 million in NPV terms of indirect benefits:

- Worker benefits are $365.8 million in NPV terms attributable to Project employees; and,
- Supplier benefits are $217.6 in NPV terms based on NSW-based operational expenditure over the life of the development of $1,078.3 million.

The ***indirect costs*** of the Project are related to the costs borne on the NSW community through the generation of externalities by the Project. These costs include:

- Greenhouse gas emissions costs of $0.1 million in NPV; and
- Air quality impacts of $8.0 million in NPV terms.

Sensitivity analysis

Consistent with the Guidelines, systematic sensitivity analysis of the estimated net benefits is undertaken in this report. This sensitivity analysis shows that the estimated net benefits are ***robust*** in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

In isolation, the estimated net benefit of the proposed development is most sensitive to the coal price assumptions underpinning the analysis. For example, assuming coal prices are 25 per cent lower than the central case assumptions, the net benefits to NSW are estimated to be $825.5 million in NPV terms (a 23.1 per cent reduction in net benefit).

The lower bound estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure, worker and supplier benefits as well as indirect costs, yields an estimated net benefit to NSW of $754.3 million in NPV terms. The upper bound estimate, based on the most optimistic assumptions, is $1,349.3 million in NPV terms.

The results are relatively sensitive to the choice of discount rate chosen due to the relatively long timeframe of the proposed development. The NPV of the estimated net benefits to NSW range from between $751.2 million and $1,588.3 million under real discount rates of 10 and 4 per cent, respectively.

Results of the LEA

The LEA considers the costs and benefits of the proposed development on residents of the Dapto – Port Kembla region of NSW. The analysis shows an estimated net benefit of $116.1 million to the Dapto Port Kembla region in NPV terms. This is driven largely by:

- Benefits to local workers of $71.8 million in NPV terms, currently 19.4 per cent of Dendrobium mine employees are sourced from the Dapto Port Kembla SA3;
- Benefits to local suppliers of $42.5 million in NPV terms which is based on the assumption that 15 per cent of the inputs to production are from the region; and
- The payment of local council rates of $3.0 million in NPV terms over the life of the Project.

This assessment demonstrates that the estimated local effects are ***robust*** under the sensitivity analysis conducted with a lower bound estimate of net benefits to the Dapto-Port Kembla region of $96.8 million and upper bound estimate of $127.4 million in NPV terms.

Economy-wide modelling of the proposed development

In total the Project is projected to provide significant positive economy-wide impacts to both the local region of Dapto-Port Kembla and to NSW. In the Dapto-Port Kembla region, the Project is projected to increase gross regional product (GRP) by $2,382.8 million in NPV terms, as outlined in Table 2. For NSW, the projected increase in gross state product (GSP) is $2,285.8 million in NPV terms.

Gross region income (GRI), or regional welfare, is projected to increase by $578.6 million in NPV terms. The projected increase in GRI is significant to the relatively small region of Dapto-Port Kembla. In total, the Project is projected to increase welfare for each person in Dapto-Port Kembla by $6,670 in NPV terms. Gross state income (GSI) is projected to increase by $1,802.3 million, or $192 per person in NPV terms.

The relative size of the local region and the NSW economy-wide impacts is reflective of how each region is impacted by the Project. As outlined in Chapter 4 the CGE modelling takes into account the capital expenditure, the coal output, the migration of workers into the region and the payment of royalties from Dapto-Port Kembla into NSW and the repatriation of profits.

Table 2: Project economy-wide impacts of the Project, 2020 – 2048

Variable	Description	Dapto-Port Kembla	NSW Total
Real GRP/GSP^	NPV* - $m	2,382.8	2,285.8
Real GRI/GSI^	NPV* - $m	578.6	1,802.3
Employment	Average FTE^^	293.8	329.9
Real GRI per person^	NPV* - Dollars	$6,670	$192

Source: Cadence Economics Computable General Equilibrium (CGE) modelling. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2020 to 2048, full time equivalent (or FTE).

Total employment in the region is projected to increase by 294 FTE workers on average. As outlined above the Project will employ 265 FTE workers on average, as a result 29 additional workers will be employed in other sectors of the economy in the Dapto-Port Kembla region, taking into account employment in supplier industries and any crowding out effects.

Across NSW, employment is projected to increase by 329.9 FTE comprising 265 direct FTE and around 65 flow on FTE.

1 Introduction

Cadence Economics was commissioned by Illawarra Coal Holdings Pty Ltd (Illawarra Coal) to undertake an Economic Impact Assessment (EIA) of the Dendrobium Mine – Plan for the Future: Coal for Steelmaking Project (the Project). Illawarra Coal is a wholly owned subsidiary of South32 Limited (South32).

Illawarra Coal is currently preparing a development application seeking Development Consent for the Project. This application will be made under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This EIA is based on a cost benefit analysis (CBA) and local effects analysis (LEA) prepared under the framework established in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the New South Wales (NSW) Government in December 2015.[3] The CBA requires an assessment of the net benefits that accrue to the proponent, government, workers and suppliers of the Project.

In addition, the Guidelines require an estimate of the potential costs generated by the Project. These costs may include residual public infrastructure costs and environmental, social and transport-related costs. To estimate the environmental, social and transport-related costs, we have incorporated into our analysis relevant requirements of the *Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*.[4]

1.1 Description of existing operations

Illawarra Coal operates the Dendrobium Mine, an underground coal mine located within the Southern Coalfield of NSW 8 kilometres (km) west of Wollongong within the southern portion of the Permo-Trassic Sydney Basin.

Existing mining operations are undertaken in accordance with Development Consent DA 60-03-2001 (as modified) as well as the original 2001 approval issued under the EP&A Act in 2001. Construction at the Dendrobium Mine began in 2002 with longwall mining commencing in April 2005.

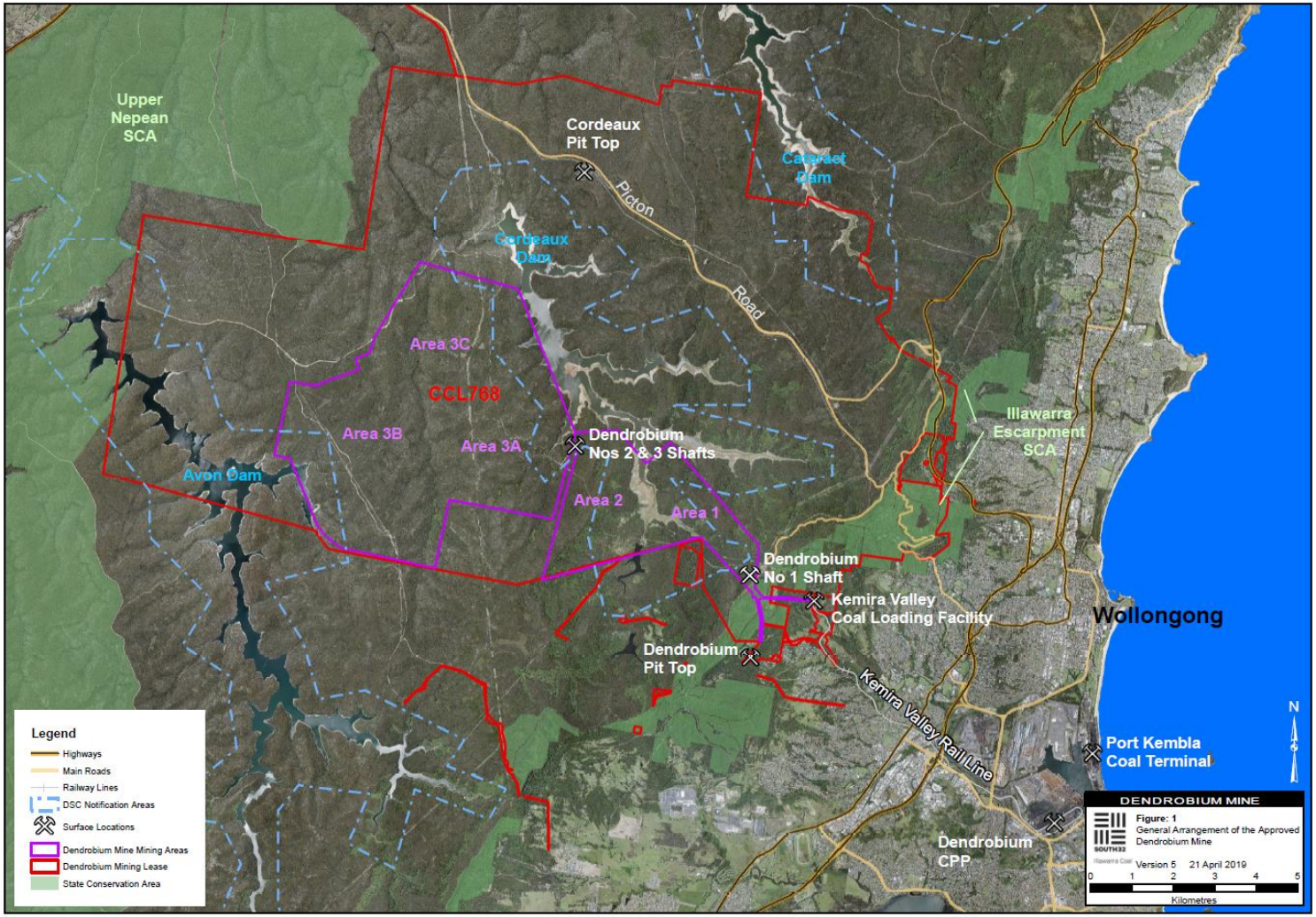
Underground mining takes place within the Consolidated Coal Lease (CCL) 768. Mining operations at the Dendrobium Mine include five approved underground Mining Areas, 1, 2, 3A, 3B and 3C. Longwall mining is currently being undertaken in Area 3B, with extraction largely complete in Areas 1, 2 and 3A. Figure 1 also outlines the supporting surface infrastructure, including:

- Dendrobium Pit Top – which includes administration, workshop and other ancillary infrastructure
- Dendrobium Ventilation Shafts
- Kemira Valley Coal Loading Facility – run-of-mine (ROM) coal transported from underground operations (via conveyor network), where it is sized and stockpiled for transport
- Kemira Valley Rail Line – 9 km private rail line transporting ROM to the Dendrobium Coal Preparation Plant (CPP)

[3] New South Wales Government (2015).

[4] Department of Planning and Environment (2018)

Figure 1: General Arrangement of the Approved Dendrobium Mine



Source: Figure provided by South32

- The CPP processes ROM coal, the facilities also include, ROM and product coal stockpiles, and other infrastructure.

Mining in Area 3B will continue until 2024, with a total of 18.1 million tonnes (Mt) of ROM coal to be extracted over the period 2020 to 2024. Extraction of the 16.5 Mt of ROM coal within Area 3C will require gas drainage of carbon dioxide, and these gas drainage activities may necessitate the discontinuity of mining activity at Dendrobium Mine (in the absence of the Project). As outlined in Section 2.1, this may adversely alter the economic viability of Area 3C.

Under the current approvals, it is anticipated that operations at the Dendrobium Mine would continue until 2024, where coal within the approved Mining Areas (1, 2, 3A and 3B) will be exhausted. Under DA 60-03-2001, mining operations at Dendrobium Mine are currently permitted until 2030.

1.2 Description of the proposed development

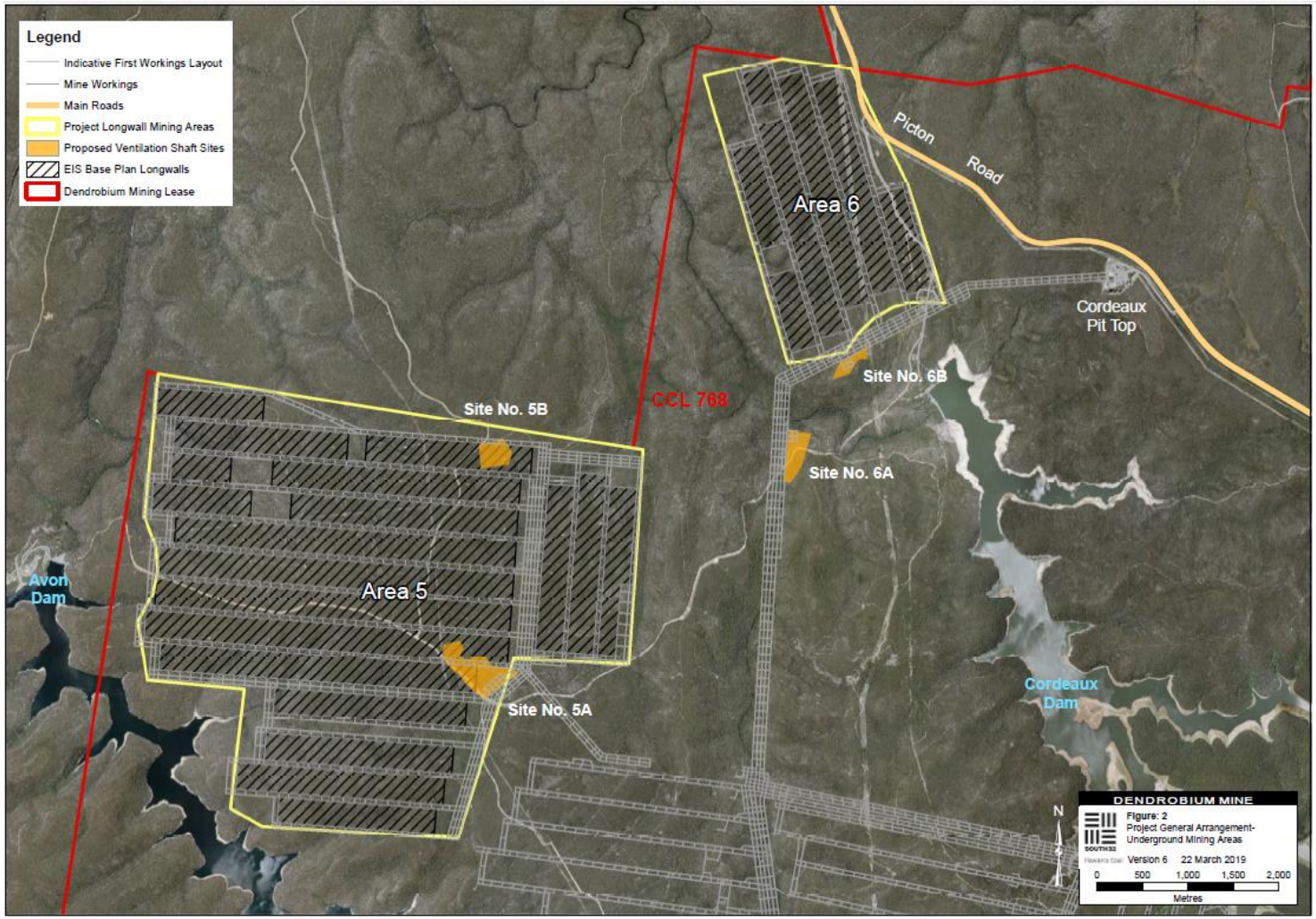
The Project includes an extension of the underground mining areas at the Dendrobium Mine to gain access to additional coal within CCL 768 in two proposed future Mining Areas, namely Area 5 and Area 6, see Figure 2. This extension would be supported by the development of supporting infrastructure and an extension to the approved surface operations.

The ROM coal would continue to be transported to the Dendrobium CPP to be processed. The CPP is located within the Port Kembla Steelworks precinct. Product coal would also continue to be delivered from the CPP to the Port Kembla Steelworks or to Port Kembla Coal Terminal for export.

The development involves the construction and operation of underground mining assets and ancillary surface infrastructure. This includes:

- Use of existing
  - roadways and drifts for personnel and materials access, ventilation, dewatering and other ancillary activities
  - Dendrobium Pit Top, Kemira Valley Coal Loading Facility, Dendrobium CPP and Dendrobium Ventilation Shafts with minor upgrades, extensions and removal of redundant infrastructure
  - Cordeaux Pit Top, including upgrades and decommissioning and removal of redundant infrastructure.
- Upgrades to the existing surface, transport and processing facilities including:
  - Underground mining machinery
  - Kemira Valley Rail Line
  - Additional Ventilation Shafts
  - Minor augmentations of other surface facilities.

Figure 2: Project General Arrangement – Underground Mining Areas



Source: Figure provided by South 32

A summary of the key elements of the Project are presented in Table 3. Project new mine development capital expenditure of $284.6 million is required with an additional $447 million of replacement and sustaining capital. The proposed development is expected to produce an additional 77.6 Mt of ROM output, yielding a total of 64.6 Mt of saleable coal. Of this saleable coal, metallurgical hard coking coal (HCC) accounts for 48.8 Mt with the remainder 6.2 Mt and 9.6 Mt of thermal and Pulverised Coal Injection (PCI) coal, respectively.

Table 3: Summary of operations under the Project, Area 5 and 6

Description of operations	
ROM	77.6 Mt
Product Coal	64.6 Mt
Metallurgical Coal (HCC)	48.8 Mt
Thermal Coal	6.2 Mt
PCI	9.6 Mt
New mine development capital	In real 2018 Australian dollars, the total new mine development capital requirement is $284.6 million (in net present value [NPV] terms using a real 7 per cent discount rate)
Replacement and sustaining capital	Total sustaining capital requirement is $447.0 million (in NPV terms using a real 7 per cent discount rate)
Mining Methods	Underground mining, including development of first workings and longwalls
Mining Rate	Maximum annual ROM of 5.2 Mt (in 2026)
Life of Mine	2020-2048
Operational Workforce^	Averages 265 FTE^^ over the life of the Project, 413 FTE (in 2033)

Source: Based on information provided by South32

^ Excluding on-site contractors, ^^ full time equivalent (or FTE)

The data inputs for the analysis presented in this report are derived primarily from:

- The Environmental Impact Statement being prepared by Resource Strategies
- Various social and environmental consultant reports including:
    - Air Quality and Greenhouse Gas Assessment undertaken by Ramboll Australia presented in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Air Quality and Greenhouse Gas Assessment*;
    - Subsidence Predictions and Impact Assessment (Subsidence Assessment) undertaken by Mine Subsidence Engineering Consultants presented in the report *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Subsidence Predictions and Impact Assessment for the Natural and Built Features in Support of the Environmental Impact Statement Application;*
    - Biodiversity Assessment undertaken by Niche Environment and Heritage presented in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Biodiversity Assessment Report*;
    - Noise and Blasting Assessment undertaken by Renzo Tonin & Associates presented in the report *Dendrobium Mine – Plan for the Future: Coal for Steelmaking, Noise and Blasting Assessment*;
    - Road Transport Assessment undertaken by GTA Consultants (GTA) presented in the report *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Road Transport Assessment;*

  - Aboriginal Cultural Heritage Assessment (ACHA) undertaken by Niche Environment and Heritage presented in the report *Aboriginal Cultural Heritage Assessment, Dendrobium Mine – Plan for the Future: Coal for Steelmaking;*
  - Historical Heritage Assessment undertaken by Niche Environment and Heritage presented in the report *Dendrobium Mine – Coal for Steelmaking: Plan for the Future Historical Heritage Assessment;*
  - Surface Water Assessment undertaken by Hydro Engineering and Consulting presented in the report *Dendrobium Mine Plan for the Future Surface Water Assessment*
  - Watershed HydroGeo (2019) *Geographic review of mining effects on Upland Swamps at Dendrobium Mine*; and
  - Groundwater Assessment undertaken by Hydro Simulations presented in the report *Dendrobium Mine: Plan for the Future Groundwater Assessment*.
- *Energy & Metals Consensus Forecast*, November 2018, Consensus Economics
- Various data from the Australian Bureau of Statistics (ABS) including the most recent Census data

In addition, Cadence Economics was provided the financial model prepared by South32, which includes Project capital expenditure, operational costs, output and employment for an optimised mine plan scenario for each year of the Project. All values in the financial model were in real 2018 Australian dollars.

The optimised mine plan scenario includes mining in Area 5 (Project), Area 3C (currently approved) and Area 6 (Project) sequenced in that order. Cadence Economics was provided the capital costs for each of these mining areas. The new mine development capital and the replacement and sustaining capital costs for Area 5 and Area 6 are included in the net benefit calculations for the Project. In addition, employment estimates for each of the areas was provided by South32 and the operational employment associated with Areas 5 and 6 (i.e. excluding Area 3C) is included in the net benefits calculation.

The operational costs are based on the optimised mine plan scenario that includes Area 5, Area 3C and Area 6. The operational costs were prorated to the Project, as the share of the ROM Mt output in Area 5 and Area 6 to the total optimised mine plan (i.e. because the optimised mine plan includes Area 3C which represents South32's planned operational mining sequence).

In addition to the operational costs, South32 has provided Cadence Economics with several costings to meet required environmental mitigation and management costs of the Project. Some of these costs are subject to commercial negotiation and are not therefore available to publish on an individual basis. The economic analysis therefore combines all the environmental costs into one item called "mitigation and management" to ensure commercial confidentiality, and are included in the cost of the Project. The costs included in mitigation and management are:

- Subsidence monitoring and, prevention, remediation and repair;
- Heritage monitoring and remediation;
- Road and rail noise controls, investigation and reduction measures;
- Biodiversity offsets;
- Other environmental, management and mitigation costs; and

- Water licences.

The information underpinning this assessment therefore is a combination of publicly available information and commissioned expert studies assessing the project financials and environmental impacts. Cadence Economics has not verified the information in the studies provided as they have been prepared by relevant experts in the field. Where there is uncertainty around key assumptions, such as the coal price, sensitivity analysis has been conducted to test the robustness of the assessment to these key inputs.

The CBA is presented in Chapter 2 and measures the net benefits of the Project approval, and the extraction of coal from Area 5 and Area 6. The LEA, which focusses on the benefits accruing to the Dapto – Port Kembla (SA3) region is presented in Chapter 3.

In addition to the CBA and LEA, the report also contains an assessment of the economic impacts of the proposed development on the Dapto – Port Kembla region and the State of NSW based on computable general equilibrium (CGE) modelling. This modelling is presented in Chapter 4.

Appendix A, provides an account of the year-on-year production, output and prices for the Project scenario. Appendix B outlines more detail on the sensitivity analysis to both the CBA and the LEA.

Appendix C provides a CBA of a number of alternative scenarios, as follows:

- Scenario with Area 3C – where the proposed operations in (the currently approved) Area 3C are included.
- Low Scenario – extracting 72.52 Mt of ROM coal over the period 2020 to 2045 (inclusive of Area 3C).
- High Scenario – extracting 112.94 Mt of ROM coal over the period 2020-2050 (inclusive of Area 3C).

2 Cost-Benefit Analysis

The Guidelines released by the NSW Government in December 2015 set out the CBA framework to measure the net benefits of a proposed mining project to the NSW community. This approach has been adopted in the economic analysis outlined in this report. Table 4 provides a summary of how these net benefits are measured.

Table 4: Cost Benefit Analysis framework as defined in the Guidelines

Direct Benefits	Indirect Benefits	Indirect Costs
The net benefits that accrue to NSW from the direct operations of the proposed mine	The net benefits that are generated for parties that economically interact with the proposed mine	Social costs generated by the proposed mine, borne by the NSW community
Includes: • Net producer surplus attributable to NSW • Royalties payable • Company tax attributable to NSW	Includes: • Net economic benefits to landowners • Net economic benefits to NSW employees • Net economic benefits to NSW suppliers	Includes: • Net environmental, social and transport-related costs • Net public infrastructure costs • Loss of surplus to other industries

Source: NSW Government (2015).

The direct benefits are those that accrue to the project proponent and payments made to government. The indirect benefits are those that accrue to economic agents that engage with the project proponent. These include employees, suppliers and land owners. The indirect costs are the costs borne by the community of NSW, through environmental and social impacts or public infrastructure costs.

A major emphasis of the Guidelines is on transparency of assumptions made. The remainder of this section describes in detail the assumptions underpinning the CBA.

The costs and benefits outlined in this report only include the costs and benefits from the operation of the Project only. It does not include the costs and benefits of the use of coal output in NSW.

These benefits may include the output and employment in sectors like the iron smelting and steel manufacturing industries that use HCC and PCI as key inputs to the manufacturing process. Various mines in the Illawarra region, including the Dendrobium Mine, supply coal to the BlueScope Steelworks at Port Kembla.

In addition, the analysis does not include any of the costs associated with coal use in NSW, including the scope 3 greenhouse gas emissions.

2.1 Baseline

The starting point for any CBA is the baseline, or counterfactual. This scenario considers all costs and benefits if the proposed development does not proceed. The Dendrobium Mine currently has approved operations within Area 3B (currently occurring) and Area 3C (not yet commenced). As such, the economic benefits and costs associated with extraction of coal within these areas have been excluded for the

purposes of assessing the incremental net benefits of the Project. The baseline includes closure costs associated with decommissioning the currently approved site infrastructure and undertaking rehabilitation. If the Project is approved, these costs would be delayed into the future, representing a saving in NPV terms.

Mining in Area 3B is not impacted by the proposed Project, and as a result is included in the baseline. In addition we have made the conservative assumption that Area 3C is also included in the baseline, although the economic viability of Area 3C would be influenced by the proposal.

There is a geological dyke between Area 3B and 3C within the approved Dendrobium Mine domains. Investigation of gas content north of the dyke has identified high gas content and low permeability coal in the target Wongawilli Seam in Area 3C. The Wongawilli Seam is divided into three discrete gas sub-reservoirs (i.e. by intervening rock horizons) in Area 3C that will each require separate gas drainage, and the carbon dioxide content is high (more difficult to drain than methane-rich gas).

Previous Illawarra Coal experience suggests that given the nature of the geology and gas content, Area 3C's safe pre-drainage lead time would result in a mining development (longwall) discontinuity following completion of Area 3B, while gas drainage is sufficiently advanced to allow safe development of the longwalls in Area 3C. This development discontinuity would adversely alter the economic viability of Area 3C, as it is expected to force closing, and then subsequent restarting, of the Dendrobium Mine underground longwall mining operations.

The proposed Project mining of Area 5 (with lesser advance gas drainage requirements) between Areas 3B and 3C, would facilitate the progressive and safe gas drainage of Area 3C, avoiding a need for a mining discontinuity.

The remainder of Chapters 2 and 3, considers the net impacts of the Project, or mining within the new Area 5 and 6 only and considers all the net benefits of mining in Area 3B and 3C as in the baseline.

Appendix C provides the net benefits of including Area 3C within the Project case. As outlined above, the development discontinuity between Area 3B and Area 3C may result in the non-development of this area without the Project approval (due to the costs of closing and re-opening mining operations). The short analysis in Appendix C provides an account of the induced net benefits of including Area 3C as part of the Project (as is proposed to occur, subject to South32 obtaining the relevant modification of Development Consent DA 60-03-2001).

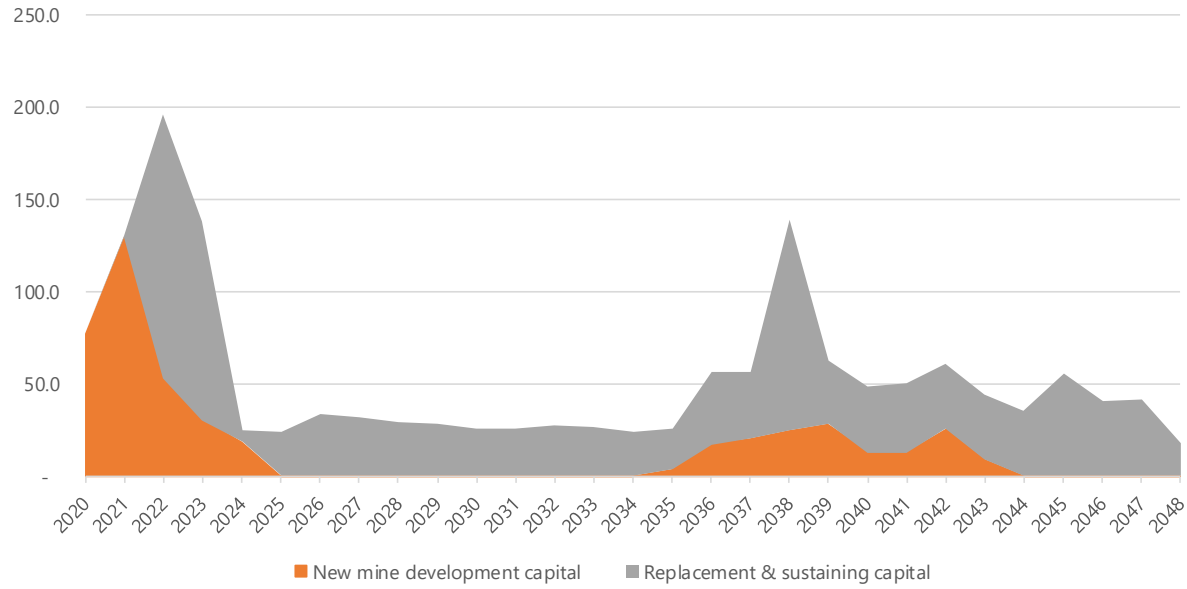
2.2 Proposed development – central case assumptions

The following analysis sets out the financial assumptions underpinning the Project, including the capital expenditure, the output and price assumptions and the operating cost assumptions, including labour input costs and intermediate inputs. These assumptions are used to estimate the direct and indirect benefits to NSW, and also form the basis of the LEA presented later in the report.

2.2.1 Capital costs

South32 provided Cadence Economics with the capital expenditure profile of the proposed development which is summarised in Figure 3. As shown, the new mine development capital is planned to take place from 2020 to 2025 and 2035 to 2044 coinciding with the development of Project Area 5 and Area 6 respectively.

Figure 3: Profile of capital expenditure under the proposed development ($ million^)



Source: South32. ^ Real 2018 Australian dollars

In total the Project requires $731.6 million in NPV terms of capital expenditure. This includes, new mine development capital expenditure of $284.6 million in NPV terms, in real 2018 Australian dollars, based on a 7 per cent discount rate.[5] Over the period 2020 to 2048, replacement and sustaining capital expenditure is expected to average $38.5 million per year, or account for $447.0 million in NPV terms.

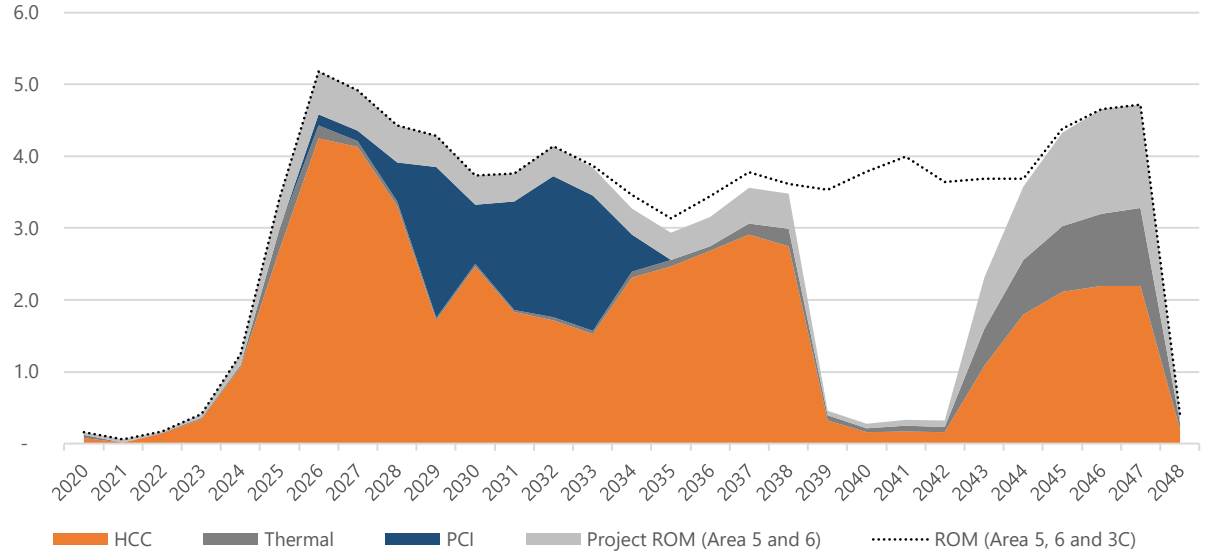
2.2.2 Production assumptions

South32 provided Cadence Economics with the production figures for the Project which are summarised in Figure 4. The Project will extract additional 77.6 Mt of ROM, in Area 5 and Area 6 over the 29-year period 2020 to 2048, under the optimised mine plan. Longwall development in Area 5 is expected to take place over the period 2020 to 2023 with extraction rates of between 0.1 Mt and 0.4 Mt of ROM per year. Once Area 5 longwall panels are established, starting in around 2024, extraction rates increase substantially to peak in 2026 at 5.2 Mt of ROM. Mining in Area 5 ceases in 2038, and Project output between 2039 and 2042 is related to the longwall development in Area 6. Once Area 6 longwall panels are established extraction rates increase, peaking at 4.7 Mt in 2047. The reduction in Project extraction rates from 2039 to 2042 coincide with the planned operations in (the currently approved) Area 3C.

[5] All NPV figures reported are in real 2018 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

The proposed development largely extracts HCC. Over the life of the proposed development, HCC is expected to account for 48.8 Mt of the saleable coal output, with thermal coal accounting for 6.2 Mt with an additional 9.6 Mt of PCI.

Figure 4: Key production figures under the Project (Mt)



Source: South32

Figure 4 also outlines the total ROM coal extracted including Area 3C, this includes the development works and longwall extraction from 2033 to 2044.

2.2.3 Price assumptions

The price assumptions used for this analysis come from a number of sources, including South32, Consensus Economics, the Office of Chief Economist and other information sources as outlined below.

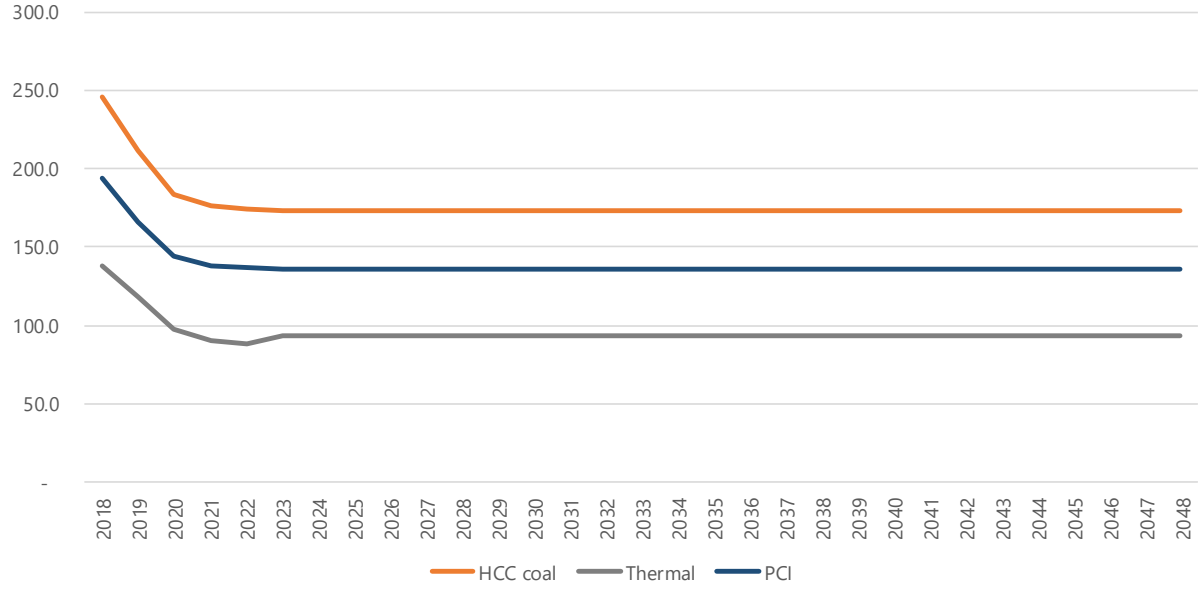
South32 did not provide Cadence Economics with its internal price forecasts for HCC, PCI and thermal coal (which is typical for mining companies undertaking this process). South32 did however provide guidance on the relative quality of the coal extracted at the Dendrobium Mine to those published in benchmark prices.

Consensus Economics (November 2018) publish HCC price forecast in nominal US dollars out to 2027. This figure is converted to real Australian dollars using the exchange rate and inflation rate forecasts produced by the Office of the Chief Economist Department of Innovation and Science Resources and Energy (2018). Based on information provided by South32, HCC extracted at the Dendrobium Mine, is sold at the reference price. Taking these factors into account, over the life of the current plan proposed development (2020 to 2048), the HCC coal price in real 2018 Australian dollars ranges from $183.2 per tonne in 2020 to $173.2 per tonne from 2023 onwards, Figure 5. South32 advises that the Dendrobium Mine PCI (which is often referred to as semi-soft coking coal) sells for 69 per cent of the benchmark HCC price.

Over the same period the average thermal price for project coal is estimated to be $92.8 per tonne (real 2018 Australian dollars). A similar procedure was used to estimate the thermal coal price, starting with the

Consensus Economics forecast for thermal coal, then adjusting for forecast exchange rate and inflation published by the Office of Chief Economist. In addition, South32 advises that the Dendrobium Mine thermal coal will typically sell for $1USD less than the benchmark.

Figure 5: HCC and thermal coal price assumptions (real 2018 Australian dollars)



Source: Cadence Economics estimates, based on Consensus Economics forecasts

2.2.4 Projected revenue and project financials

Based on the production assumptions outlined in Figure 4 and the real price assumptions in Figure 5, the proposed development is expected to generate real revenue of just over $10,337.8 million over 29 years in undiscounted real 2018 Australian dollars. This equates to $3,922.4 million revenue in real NPV terms as shown in Table 5 (this table shows selected years; full results are presented in Appendix A). In the context of this analysis, these are deemed to be ***central case assumptions***, and subject to sensitivity analysis later in this report.

Table 5: Central case assumptions – revenue projection (selected years)

	Total - Undiscounted	2020	2025	2030	2035	2040	2045
Production (Mt)							
Met coal	48.8	0.1	2.7	2.5	2.5	0.2	2.1
Thermal coal	6.2	0.0	0.3	0.0	0.1	0.1	0.9
PCI	9.6	-	0.0	0.8	-	-	-
Real price^							
Met coal	5,037.2	183.2	173.2	173.2	173.2	173.2	173.2
Thermal coal	2,690.7	97.5	92.9	92.9	92.9	92.9	92.9
PCI	3,958.3	143.9	136.1	136.1	136.1	136.1	136.1
Total Revenue^	10,337.8	18.9	494.8	542.6	435.9	32.7	450.8
NPV*	3,922.4						

Source: Cadence Economics estimates ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

Based on information provided by South32, the operating costs for the proposed development are summarised in Table 6. In addition to operating revenue of $3,922.4 million in NPV terms, asset sales at the end of the development's life are expected to yield $242.6 million dollars (undiscounted in 2048), or $31.9 million in NPV terms. This results in total revenue from the proposed development of $3,954.3 in NPV terms.

Operating costs are estimated to be $2,000.6 million in NPV terms. Costs include savings to decommissioning costs at $64.1 million in NPV terms and a total cost of $94.3 million of mitigation and management costs. These mitigation and management costs include the costs associated with reducing the environmental impacts of the Project operations, as discussed in the Introduction.

In terms of other costs:

- Depreciation is calculated using the diminishing value method; and
- Royalties are based on standard NSW Government royalty rates of 6.2 per cent *ad valorem* for underground mines below 400 metres (m). While the proportion of longwall mining in Area 6 would occur at a depth above 400 m (i.e. where a royalty rate of 7.2 per cent would apply), for the purposes of this Economic Assessment, the lower royalty rate of 6.2 per cent has been conservatively adopted for both Area 5 and Area 6. A discount of $3.50 per ROM tonne is applied for washing as is allowed by the NSW Government.

These are deemed to be ***central case assumptions***, and subject to sensitivity analysis later in this report.

Table 6: Central case assumptions – project financials (selected years, $ million^)

	NPV	2020	2025	2030	2035	2040	2045
Operational revenue	3,922.4	18.9	494.8	542.6	435.9	32.7	450.8
Asset Sales Revenue	31.9	-	-	-	-	-	-
Total Revenue	3,954.3	18.9	494.8	542.6	435.9	32.7	450.8
Operating costs	2,000.6	27.0	230.3	261.0	273.6	21.1	259.5
Closure Costs/ Rehabilitation	-64.1	-	-25.2	-1.7	-1.7	-0.1	2.1
Mitigation and management costs	94.3	4.5	7.5	7.5	7.5	7.5	4.5
Depreciation	292.7	0.0	27.2	28.2	26.5	39.3	40.1
Royalties	237.1	1.1	29.9	32.8	26.4	2.0	27.0
Council Rates and Land Tax	4.8	0.4	0.4	0.4	0.4	0.4	0.4
Total costs	2,565.4	33.1	270.2	328.3	332.7	70.2	333.7
Operating Profit	1,388.9	-14.2	224.6	214.3	103.2	-37.5	117.2

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. ^^ Includes intermediate inputs, labour costs and payroll taxes paid * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

2.2.5 Direct benefits

Based on the Guidelines, the direct benefits to NSW of the proposed development are derived from three sources:

- The net producer surplus generated by the project that is attributable to NSW.
- The share of company tax payments that are attributable to NSW.
- Other tax payments such as royalties and payroll tax that are paid to the NSW and local government.

2.2.6 Net producer surplus attributable to NSW

Consistent with the Guidelines, the net producer surplus of the proposed development represents the private benefit, or operating surplus, generated that is attributable to NSW. Unlike profit which is measured on an accrual basis, the producer surplus is based on a net cash incomings and net cash outgoings Table 7 below outlines the net producer surplus on this basis.

Based on the financial information summarised in Table 6 above, and the capital costs of $731.6 million in NPV terms, the proposed development is estimated to generate an operating surplus of $950.0 million in NPV terms. The Project generates $471.3 million of company tax, levied on the accrued Project profits.

In total the Project generates a net producer surplus of $478.8 million in NPV terms. Of this, 15.7 per cent, or $74.9 million is payable to NSW-based shareholders (based on the 2018 South32 shareholder register).

Table 7: Central case - estimate of net producer surplus attributable to NSW ($ million^)

Key data	NPV*
Total revenue	3,954.30
Operating costs	2,000.6
Closure Costs/ Rehabilitation	-64.1
Mitigation costs	94.3
Capital	731.6
Royalties	237.1
Council Rates	4.8
Total Costs	3,004.3
Net Producer Surplus before Tax	950.0
Company Tax	471.3
Net Producer Surplus	478.8
NSW share of Project ownership (per cent)	15.7%
Value of net producer surplus attributable to NSW	74.9

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. ^^ Based on a 30 per cent company tax rate. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

2.2.7 Company tax attributable to NSW

Consistent with the Guidelines, the company tax payments made to the Australian Government are levied on the profits generated under the proposed development as summarised in Table 6. A company tax rate of 30 per cent is used to estimate the tax payments made to the Australian Government under the assumption that all the profit generated by the Project is subject to company tax in Australia (for example, ignoring financing costs). Consistent with the Guidelines, company tax is attributable to NSW based on the State's share of population which is 32 per cent.

As summarised in Table 8, it is estimated the proposed development will generate $1,388.9 million in taxable profit in NPV terms (this is an estimate of the accounting profit from which company taxes are calculated). At a company tax rate of 30 per cent, the company tax estimate is $471.3 million in NPV terms, of which $150.8 million is attributable to NSW.

Table 8: Central case - company income tax attributable to NSW (NPV, $ million^)

Company tax attributable to NSW	NPV*
Total Revenue	3,954.3
Operating costs	2,000.6
Closure Costs/ Rehabilitation	-64.1
Mitigation costs	94.3
Depreciation	292.7
Royalties	237.1
Council rates and taxes	4.8
Total Costs	2,565.4
Operating Profit	1,388.9
Company Tax^^	471.3
NSW Share^^^	150.8

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. ^^ Based on a 30 per cent company tax rate. ^^^ Based on a 32 per cent population share. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

2.2.8 Payments to the State and the local Council

Under the proposed development, various payments will be made to NSW Government and the Wollongong, Wingecarribee and Wollondilly Council to extract and process coal in the State.

These are made up of three types of payments: coal mining royalties and payroll tax paid to the NSW Government, council rates and NSW land tax. Over the life of the proposed development, a total of $272.1 million in payments are made, in NPV terms (Table 9). This is made up of $237.1 million of royalty payments and $30.2 million in payroll tax to the State of NSW and $4.8 million in council rates and land taxes.

Table 9: Central case - total payments to State Government and local Council ($ million^)

	NPV*
Operating revenue	3,922.4
Revenue for royalties (including allowable discounts)	3,824.1
Total Royalties paid	237.1
Payroll tax	30.2
Council rates and land taxes	4.8
Total Payments	272.1

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

2.2.9 Summary of direct benefits to NSW

Based on the central case assumptions, revenue and cost data described above, the proposed development is estimated to generate $497.8 million in total direct benefits to NSW in NPV terms, as outlined in Table 10.

Table 10: Central case - summary of the direct benefits of the proposed development ($ million^)

	NPV*
Net producer surplus attributable to NSW	74.9
Company income tax attributable to NSW	150.8
Payments to the NSW and local Government	272.1
Total financial benefit attributable to NSW	497.8

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

These benefits are comprised of $74.9 million of net producer surplus attributable to NSW, $150.8 million in company tax attributable to NSW and $272.1 million in NPV terms paid to the NSW and local governments, in the way of coal royalties, payroll tax, land taxes and council rates.

2.3 Indirect Benefits to NSW

Based on the Guidelines, the indirect benefits to NSW of the proposed development are derived from three sources:

- The net economic benefit to workers in NSW.
- The net economic benefit to suppliers in NSW.
- Any land owner premiums attributable to the Project.

2.3.1 Benefit to workers

Consistent with the Guidelines, a key factor in determining the benefit to workers are defined as the:

- Wages earned in the Dendrobium Mine;
- Minus the opportunity cost of labour for working in the mining sector, that is compared to working in non-mining sectors (or being unemployed); and
- Minus the wage difference due to skills and the disutility to work in the mining industry.

South32 provided Cadence Economics with information relating to the overall level of employment and the average wages for the proposed development. Over the period of the proposed development, an average of 265 FTE workers will be employed. It should be noted that this average is calculated by excluding the employment generated by mining of approved Area 3C. In practice the development and operation of mining activities in Area 3C would be integrated with the Project mining activities in Area 5 and Area 6.

The average annual planned wage for a full-time coal mining employee average $194,085 for the life of the proposed development. This yields a ***total of wages paid*** to employees of $562.9 million in NPV terms (see Table 11).

Table 11: Central case – employee wages under the proposed development (selected years)

	NPV	2025	2030	2035	2040^^	2045
Employment (FTEs)	-	374.5	343.0	369.4	154.0	234.0
Total wages paid ($ million^)	562.9	69.9	64.7	70.4	31.2	47.2

Source: South32 and Cadence Economics estimates. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Reflects period where Area 3C workforce has been excluded from the analysis.

To measure the ***opportunity cost*** compared to the non-mining sector, the average wage earned by workers at the Dendrobium Mine are compared with the average wage paid in NSW. This implies that should the proposed development not go ahead, those who would have been employed at the Dendrobium Mine would find alternative work at the average wage paid in NSW. The average wage across NSW is $66,123 per annum based on the 2016 Census data (updated to 2018 dollars).

Table 12: Central case – estimated NSW worker benefit (selected years)

Employees	NPV	2025	2030	2035	2040^^	2045
Average NSW wage ($ per annum^)		66,610.5	66,610.5	66,610.5	66,610.5	66,610.5
Mining wage ($ per annum^)		186,737.9	188,549.1	190,626.8	202,870.6	201,634.8
Total wages paid ($ million^)						
- All sectors (NSW)	197.0	24.9	22.8	24.6	10.3	15.6
- Mining (Dendrobium Mine)	562.9	69.9	64.7	70.4	31.2	47.2
Estimated worker benefit ($ million^)	365.8	45.0	41.8	45.8	21.0	31.6

Source: South32, ABS (Table W17) Census (2016) Occupational Total Personal Income (Weekly) by Hours Worked and Cadence Economics estimates. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Reflects period where Area 3C workforce has been excluded from the analysis.

As shown, there is a significant premium incorporated in mining wages compared with the average wage paid in NSW. There are a number of likely reasons for this premium that might be explained by relative skill and productivity levels. In relation to the latter, mining employees are more productive than workers in other industries as they operate with higher levels of capital (for example, based on capital stock figures produced by the ABS, miners work with over 10 times the amount of capital than average employees across Australia).

Any metrics around the disutility of working in mining are very difficult to ascertain in both an absolute (mining specific) or relative (compared with other industries) manner. One source of information considered in this analysis was any documented 'hardship' allowances recognised in mining awards. However, these allowances appear to be relatively minor. For example, the Black Coal Mining Industry Award 2010 does provide for the payment of an underground allowance (Electrical/ Mechanical) of 0.23 per cent per day or shift (above the standard rate/ reimbursement) to an adult employee who works underground on any shift. In addition, there is a confined space allowance of 0.08 per cent and a dirty work allowance of 0.23 per cent that may apply to underground workers. To put this into context, First Aid Officer Allowance is 0.76 per cent per day or shift above the standard rate.

In addition, a further consideration is whether workers would experience more or less disutility being employed at the Dendrobium Mine compared with any alternate employment. In this context, as the assumption is made that any worker employed at the Dendrobium Mine would find alternative employment if the Project did not go ahead, it is the relative disutility of mine work versus non-mine work that is a key consideration. Given the minor allowances for working in a coal mine and the measurement

difficulties associated with measuring these disutilities generally, Cadence have assumed that the disutility for workers at the Dendrobium Mine is zero. This implies, effectively, that those workers employed at the Dendrobium Mine experience no additional disutility from working in the Dendrobium Mine compared with any alternative employment they would have secured in the absence of the Project.

Based on this assumption, estimated worker benefit is $365.8 million in NPV terms.

2.3.2 Benefit to suppliers

Consistent with the Guidelines, the economic benefit to suppliers is estimated as a producer surplus generated from goods and services from NSW firms that provide goods and services to the proposed development. As summarised in Table 13, based on the input cost data provided by South32, the proposed development is estimated to use $1,078.3 million in intermediate inputs supplied from NSW over its life-cycle in NPV terms. Currently, 75 per cent of the Dendrobium Mine inputs used are supplied from NSW-based businesses and it is assumed this would also be the case with the Project.

The estimated economic benefit to suppliers (producer surplus) is based on the Cadence Economics Regional Input-Output Model (CERIOM). This model was customised to generate a NSW-specific Input-Output table so as to not include benefits generated in other Australian states.

The producer surplus estimates are based on Type I multipliers which limit the benefit to direct value added generated by NSW suppliers. This methodology does not account for second round, nor induced consumption, effects, that are captured within the CGE modelling. Using this relatively conservative technique, the total supplier benefits are estimated to be $217.6 million in NPV terms.

Table 13: Central case – estimated supplier benefits

	NPV*
Total intermediate inputs ($ million^)	1,437.8
Intermediate inputs supplied from NSW	1,078.3
Gross operating surplus ratio	0.202
Total benefits to suppliers (NPV*)	217.6

Source: Cadence Economics estimates. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. * NPV in 2018 dollars based on a 7 per cent real discount rate.

2.3.3 Summary of indirect benefits to NSW

Consistent with the Guidelines, the indirect benefits of the proposed development that accrue to workers, suppliers and land owners are summarised in Table 14. The total indirect benefits are estimated to be $583.4 million in NPV terms. The main source of these benefits is $365.8 million to workers and $217.6 million to suppliers in NPV terms. There are no anticipated benefits to land owners as a result of the Project due to its location in the Metropolitan Special Area.

Table 14: Summary of indirect benefits ($ million^)

Indirect benefits	NPV*
Net economic benefit to workers	365.8
Net economic benefit to suppliers	217.6
Land owner premiums (land sales made above market rates)	0
Total indirect benefit	583.4

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

2.4 Indirect Costs to NSW

Consistent with the Guidelines, the Project's indirect costs cover a range of net environmental, social and transport-related costs as well as the net public infrastructure costs as well as the estimated loss of surplus to other industries (listed in Table 15). Consideration of these costs are based on a range of assessments undertaken by specialised consultants for the Project, including:

- Air Quality and Greenhouse Gas Assessment undertaken by Ramboll Australia presented in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Air Quality and Greenhouse Gas Assessment*;
- Subsidence Predictions and Impact Assessment (Subsidence Assessment) undertaken by Mine Subsidence Engineering Consultants presented in the report *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Subsidence Predictions and Impact Assessment for the Natural and Built Features in Support of the Environmental Impact Statement Application;*
- Biodiversity Assessment undertaken by Niche Environment and Heritage presented in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Biodiversity Assessment Report*;
- Noise and Blasting Assessment undertaken by Renzo Tonin & Associates presented in the report *Dendrobium Mine – Plan for the Future: Coal for Steelmaking, Noise and Blasting Assessment*;
- Road Transport Assessment undertaken by GTA presented in the report *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Road Transport Assessment;*
- ACHA undertaken by Niche Environment and Heritage presented in the report *Aboriginal Cultural Heritage Assessment, Dendrobium Mine – Plan for the Future: Coal for Steelmaking;*
- Historical Heritage Assessment undertaken by Niche Environment and Heritage presented in the report *Dendrobium Mine – Coal for Steelmaking: Plan for the Future Historical Heritage Assessment;*
- Surface Water Assessment undertaken by Hydro Engineering and Consulting presented in the report *Dendrobium Mine Plan for the Future Surface Water Assessment*;
- Watershed HydroGeo (2019) *Geographic review of mining effects on Upland Swamps at Dendrobium Mine*; and,
- Groundwater Assessment undertaken by Hydro Simulations presented in the report *Dendrobium Mine: Plan for the Future Groundwater Assessment*.

This section outlines the calculation of both the total indirect costs, as well as the incremental costs of the Project. It is the calculation of incremental costs that are accounted for in the CBA.

The incremental costs are those attributable by the Project that are not already included in the Project financials (and therefore already accounted for in the CBA). The total indirect incremental costs for the Project are $8.1 million, as shown in Table 15.

In addition, as shown in Table 15, there are several environmental costs that are internalised by South32, of which the company would spend $94.3 million in NPV terms over the life of the operation. These costs include;

- Subsidence remediation works;
- Rail noise investigation and reduction measures;
- Purchasing requisite water rights;
- Implementing a biodiversity off-set strategy; and
- Other environmental management and mitigation costs.

These costs are classified as indirect costs of the Project, however, to avoid double counting, are excluded from the incremental costs as they are already included in the operational costs of the Project. South32 provided Cadence Economics with the year-on-year cost estimates for each of the environmental mitigation and management measures. Several of these anticipated costs are subject to commercial negotiation and therefore have been aggregated into mitigation and management costs and included in the total Project costs.

Table 15 provides a summary of the assessment methods used for calculating the Project's indirect costs. In total the Project is estimated to generate $8.1 million in NPV terms of incremental indirect costs (being comprised of the incremental costs associated with greenhouse gas (GHG) emissions, impacts to surface water, groundwater impacts and air quality impacts).

Table 15: Summary of indirect costs impacts ($ million^)

	Assessment type	Cost*
Indirect costs		
Greenhouse gas emissions	Quantitative	0.1
Air quality impacts	Quantitative	8.0
Residual value of land	Quantitative	0.0
Transport/ traffic impacts	Quantitative	0.0
Visual amenity	Quantitative	0.0
Net public infrastructure costs	Quantitative	0.0
Loss of surplus to other industries	Quantitative	0.0
Mitigation and management cost		
Biodiversity impacts	Quantitative	^^
Water impact - including surface and ground water	Quantitative	^^
Ambient noise impacts	Quantitative	^^
Subsidence impacts	Quantitative	^^
Aboriginal cultural heritage and historical heritage	Quantitative	^^
Total mitigation and management costs		94.3
Indirect costs		8.1

Source: Cadence Economics estimated based on information provided from South32 and relevant environmental assessments for the Project.

^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

^^ Confidential, included in the total internalised costs

The following sections provide more detail on how the indirect environmental costs have been assessed based on the relevant environmental assessments provided.

2.4.1 Greenhouse gas emissions

Consistent with Australia's international obligations under the United Nations Framework Convention on Climate Change the level of GHG emissions attributable to the Project is measured by the:

1. Scope 1 emissions: representing the direct GHG emissions from the Project (e.g. from the use of diesel in plant and equipment); and
2. Scope 2 emissions: representing the indirect emissions from the Project's purchases of inputs, (generally associated with the purchase of electricity).

The estimation of GHG emissions over the life of the Project was undertaken by Ramboll Australia. The estimation of the GHG emissions in the Air Quality and Greenhouse Gas Assessment is outlined in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Air Quality and Greenhouse Gas Assessment*.

The GHG emissions were estimated using information from the Australian Government Department of the Environment and Energy's National Greenhouse Accounts Factors and the requisite workbooks, methodologies and technical guidelines.

The Air Quality and Greenhouse Gas Assessment provides an account of the annual GHG emissions for all the Project sources (i.e. including the additional extraction from Area 5 and 6), as well as the GHG emissions from the transport and processing of coal for the approved Mine. Hence, the assessment of GHG emissions undertaken by Ramboll Australia includes the total GHG emissions resulting from the approved Mine operations of 34.6 Mt of ROM coal (including Area 3C) and the additional Project operations of 77.6 Mt of additional ROM coal. However, this economic assessment has considered GHG emissions resulting from the Project only. To estimate the level of GHG emissions associated with the Project:

- The Life-of-Mine GHG emissions (Scope 1 and Scope 2 emissions), per ROM tonne, as specified in the Air Quality and Greenhouse Gas Assessment was calculated, then
- The level of GHG emissions is adjusted by simple scaling to the Project plan figure (i.e. 77.6 Mt of ROM coal from Area 5 and Area 6 for the Project).

To price the GHG emissions, Cadence has applied the latest carbon price resulting from the most recent (June 2018) auction undertaken by the Clean Energy Regulator under the Emissions Reduction Fund (ERF).[6] The results of this auction yielded an average carbon price of $13.52 per tCO2-e abated. While this is an average figure, it represents a useful proxy to the marginal cost of abatement under Australia's current emission abatement policy represented by the ERF.

The externalities arising from GHG emissions associated with the Project are derived by taking the year-on-year emissions and multiplying these figures by the $13.52 per tCO2-e carbon price under the ERF over the life of the Project.

The impacts of GHG emissions are global in nature, and as a result, apportioning all the costs of climate change impacts associated with the Project to NSW overstates the cost of these impacts to NSW. To estimate the impacts on NSW, it is appropriate to apportion a component of the total global costs to NSW. The approach adopted is to apportion the global GHG costs estimated to NSW using the ratio of the NSW population to the global population.

On a global basis, the total estimated GHG cost is $111.7 million in NPV terms, see Table 16. Attributing the GHG costs based on the NSW population, consistent with the Guidelines, results in an attributed GHG cost of $0.122 million to NSW in NPV terms.

[6] The results of this auction are summarised at http://www.cleanenergyregulator.gov.au/ERF/Auctions-results/june-2018 which was accessed in September 2018 for this analysis. (Australian Government, 2018).

Table 16: Greenhouse gas emissions attributable to the Project

	Total	2020	2030	2040	2045
ROM Coal Output Mt	77.6	3.4	3.7	2.9	0.3
Tonnes of GHG (Mt)	-	-	-	-	-
Scope 1	21.7	1.0	1.0	0.8	0.1
Scope 2	1.1	0.1	0.1	0.0	0.0
Total	22.8	1.0	1.1	0.9	0.1
Price Path ($ per tonne CO2-e abated^)		13.5	13.5	13.5	13.5
Global Impact (NPV*, $ million^)	111.7	13.6	14.9	11.7	1.1
NSW (NPV*, $ million^)	0.12	0.01	0.02	0.01	0.00

Source: Cadence Economics estimates based on Ramboll Australia (2018).

^ Real 2018 Australian dollars.

* NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

2.4.2 Air quality

Mining and extractive industries may impact on the air quality of residences adjacent to project sites through the generation of dust and particulate matter. These may arise directly, for example, from shifting or driving over unpaved roads, or from stockpiles of coal. These activities could potentially generate Total Suspended Particulates (TSP), particulate matter of less than 10 micrometres in diameter (PM_{10}) or particulate matter of less than 2.5 micrometres in diameter ($PM_{2.5}$).

The Air Quality and Greenhouse Gas Assessment undertaken by Ramboll Australia includes estimates of the annual particulate matter for the Project, including TSP, PM_{10} and $PM_{2.5}$ and other gases including oxides of nitrogen, sulphur dioxide, carbon monoxide and odour.

The analysis uses dispersion modelling to assess the potential air quality impacts to local residents located near the Dendrobium Pit Top, Kemira Valley Coal Loading Facility, the Kemira Valley Rail Line, Ventilation Shaft Sites and the Dendrobium CPP located at Port Kembla. Receiver locations representative of the residential areas proximal to these locations have been selected to assess the potential impacts. Table 17 provides a summary of the predicted particulate matter emissions for an annual extraction rate of 5.2 Mt of ROM coal output for the Project.

Table 17: Estimated particulate matter emissions (kg per 5.2 Mt of ROM output)

	TSP	PM_{10}	$PM_{2.5}$
Kemira Valley Coal Loading Facility	33,875	9,304	820
Dendrobium Pit Top	1,350	259	63
Ventilation Shafts (upcast)	42,889	42,889	42,889
Kemira Valley Rail Line	3,773	2,165	781
Dendrobium CPP	127,272	31,459	4,617
Diesel consumption	2,170	2,170	2,106
Total	211,329	88,246	51,276

Source: Ramboll Australia (2018).

To quantify the potential impact of the Project on air quality, the economic assessment uses the methodology as prescribed in Methodology for Valuing the Health Impacts of Changes in Particle Emissions, published by the NSW Environmental Protection Authority (EPA, 2013). The EPA report uses a

damage cost approach for each of the Significant Urban Areas (SUA) in NSW, as measured cost per tonne of $PM_{2.5}$ emissions.

This methodology assesses the potential impact at the source of emissions which has been adjusted in this analysis to exclude those emissions that are remote from any residential areas, including from the proposed ventilation shafts modelled as upcast shafts (note that ventilation shafts operating as downcast shafts do not produce material air quality emissions).

This analysis assesses the potential impacts of the $PM_{2.5}$ emissions only and excludes any potential damage from PM_{10} or TSP. This is because there are no credible damage functions available to assess the impacts of PM_{10} or TSP, noting that any potential impacts from PM_{10} are highly correlated with $PM_{2.5}$. In addition, predicted emissions that are remote from any residential areas (e.g. upcast ventilation shafts), are excluded from the calculations as they are assumed to cause no material damage.

Table 18 summarises the calculation of indirect costs attributable to the Project resulting from predicted $PM_{2.5}$ emissions. As shown, the estimates depend on the population density of the Wollongong SUA region (which changes over time as a result of population growth), the damage function (cost per person per square kilometre) as estimated by the EPA and the predicted emissions of $PM_{2.5}$ that are linked to Project ROM tonnes.

The unit damage cost per tonne of $PM_{2.5}$ is $162,517 at the start of the Project for the year 2020. At the end of the Project, in 2048, the unit damage cost increase to $195,031 per tonne of $PM_{2.5}$, due to population increase in the Wollongong SUA. Based on a total production of 77.6 Mt of Project ROM coal, and predicted total $PM_{2.5}$ emission of 125.1 tonnes, the Project would generate an incremental unit damage cost of $8.0 million in NPV terms.

Table 18: Estimated cost of $PM_{2.5}$ emissions attributable to the Project

	Total	2020	2030	2040	2048
Area (km^2)	-	572	572	572	572
Population (Persons)	-	291,399	313,533	333,247	349,697
Population Density (People/km^2)	-	509	548	583	611
Cost per Person/km^2	-	319	319	319	319
Unit Damage Cost ($/tonne of $PM_{2.5}$)	-	162,517	174,862	185,857	195,031
ROM Mt	77.6	0.2	3.7	0.3	0.4
Tonnes of $PM_{2.5}$	125.1	0.3	6.0	0.5	0.6
NSW (NPV*, $ million^)	8.0	0.04	1.05	0.08	0.13

Source: Cadence Economics estimates based on Ramboll Australia (2018) and NSW EPA (2013).

In addition, the Project may also generate residual impacts from the other potential emissions including oxides of nitrogen, sulphur dioxide, carbon monoxide and odour, however, compliance with all relevant air quality impact assessment criteria is predicted for the Project and odour would also be undetectable at the closest potential receivers.

2.4.3 Subsidence

For underground mining operations, subsidence can often be a contributing factor to further environmental impacts, for example, potential impacts to groundwater, surface water and natural and built features such as roads, rail lines, dwellings or historical and Aboriginal cultural heritage sites.

In addition, subsidence impacts may generate requirements to mitigate or repair these features. South32 has provided a yearly cost estimate for the remediation of subsidence impacts, which are included in the mitigation and managements costs of the Project.

A Subsidence Assessment for the Project was undertaken by Mine Subsidence Engineering Consultants, the findings of which are in the *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Subsidence Predictions and Impact Assessment for the Natural and Built Features in Support of the Environmental Impact Statement Application*.

The Study Area for the Subsidence Assessment, included those surface areas likely to be affected by the proposed underground mining in Area 5 and Area 6, which includes the area enclosed by the greater of the 35 degree angle of draw from the extent of the proposed longwalls and by the predicted 20 millimetres (mm) subsidence contour due to the extraction of the proposed longwalls. Other potential far-field or valley related movements were also assessed in the Subsidence Assessment, in this case features within but not limited to 600 m from the proposed longwalls were included in the assessment that could be subject to these movements.

The predicted subsidence analysis was undertaken using the Incremental Profile Method. This method was updated and re-calibrated based on the updated ground monitoring and LiDAR data from the previous mining in Area 3A and Area 3B for the approved Mine.

The Subsidence Assessment includes a discussion of the predicted impacts to natural features, utilities, other public infrastructure and buildings. The report also provides discussion of the management strategies proposed to reduce and mitigate the potential impacts. The main findings of the potential subsidence impacts are outlined in Table 19 below.

Table 19: Discussion of subsidence impacts

Features	Impact
Rivers and Creeks	The Avon River, Cordeaux River, Donalds Castle Creek and Wongawilli Creek are predicted to experience less than 20 mm vertical subsidence with maximum predicted closures for these streams predicted to be 200 mm for the Avon River, 80 mm for Cordeaux River, 210 mm for Donalds Castle Creek and less than 20 mm for Wongawilli Creek. The likelihood of Type 3 impacts (including rockbar or upstream pool fracturing) is considered low.
Drainage Lines	Some identified drainage lines (AR31, DC9 and CR31) may experience potential increased ponding due to mining-induced tilt. Fracturing of bedrock could occur along sections of the drainage lines that are located directly above the proposed longwalls as well as those located outside of the proposed longwalls.
Cliff faces	40 cliff faces have been identified within Area 5, and none for Area 6. The 40 cliffs located above the proposed longwalls in Area 5 could experience fracturing which could result in cliff instabilities where the exposed rockface is marginally stable. Isolated rock falls could occur at some of the cliffs located outside the extents of the proposed longwalls.
Rock outcrops	Potential subsidence impacts include tension cracks at the top of rock outcrops and steep slopes, and buckling and compression ridges at the bottoms of the steep slopes. Surface deformations are expected to be similar to those previously experienced at the approved Mine, typically in the order of 100 mm to 150 mm in width.
Swamps	46 upland swamps have been identified within the Study Area and 600 m boundary from the proposed longwalls. 25 swamps are located partially or entirely above the proposed longwalls and are expected to experience the full range of predicted subsidence movements. The remaining swamps located outside of the extent of the longwalls would experience reduced levels of subsidence.
Railway	The Maldon-Dombarton railway (not in use) crosses directly above the proposed longwalls in Area 5. The infrastructure could be impacted, including the cuttings embarkments and drainage culverts. With the appropriate management strategies in place it is likely that there would be no more than negligible impacts on the (currently unused) Maldon-Dombarton Railway infrastructure.
Roadways	Picton Road is located outside of the proposed longwalls in Area 6 and is expected to experience less than 20 mm of vertical subsidence. It is therefore unlikely Picton Road would experience adverse subsidence impacts.
Tracks	Identified unsealed tracks are predicted to be maintained in safe and serviceable condition throughout the life of the Project.
Pipelines	Two natural gas pipelines are located partially within the Study Area and could experience up to 900 mm of vertical subsidence. The potential impacts on the gas pipelines could be managed using management strategies similar to those adopted where similar pipelines have been directly mined beneath in the Southern Coalfield, which could include the installation of ground monitoring lines along the pipeline route, the development of a Trigger Action Response Plan (TARP) and the development of preventative measures (e.g. uncovering and exposing sections of pipeline using temporary support structures, such as sandbags).
Transmission and power lines	There is a 330 kilovolt (kV) transmission line which crosses two longwalls in Area 6 and nine transmission towers located within the Study Area, six of which are located directly above the proposed longwalls. There is also a 33 kV transmission line partially located within Area 6. Transmission towers could experience up to 1850 mm of vertical subsidence. The potential impacts on power lines could managed by adopting management strategies such as the implementation of cable rollers, the construction of cruciform bases, the provision of monitoring points at the tower bases and the implementation of a TARP. For the 33kV power line the Subsidence Assessment outlined the predicted impacts could be managed using preventative measures including installation of cable rollers, guy wires or additional poles or the adjustment of cable catenaries.
Reservoir	The Avon Reservoir is located to the south-west of Area 5 and the Cordeaux Reservoir is located south of Area 6. The dam walls associated with these reservoirs are located at a minimum distance

	of 1 km from the proposed mining areas. The dam walls are not predicted to experience measurable vertical subsidence. These structures could experience far-field horizontal movements, in the order of 20 mm, but are not predicted to result in measurable strains. It is unlikely that the dam walls would experience adverse impacts due to mining of the Project longwalls.
Aboriginal heritage	The Study Area includes 55 Aboriginal heritage sites, 20 of these sites are located directly above the proposed longwalls.^
Historical heritage	Items of historical heritage significance located in the vicinity of the Study Area include the Avon Dam and Cordeaux Dam, as well as historical buildings associated with the Nebo Colliery (i.e. the current site of the Dendrobium Pit Top). The infrastructure associated with the Nebo Colliery is predicted to experience negligible impacts due to subsidence. The dam walls associated with these reservoirs are located at a minimum distance of 1 km from the proposed mining areas and are predicted to experience negligible impacts due to subsidence.
Survey control marks	Survey and control marks could experience small vertical subsidence and far-field movements
Buildings	The Study Area for Area 6, includes 28 buildings and other structures. These include, a picnic area, three houses, eight sheds, four toilet blocks, six barbeque shelters, one tank and six amenities structures. It is possible that some of these structures could experience adverse impacts, however, it is recommended that Property Subsidence Management Plans be developed for the Project in consultation with WaterNSW to manage the potential impact on buildings and other structures in the Sydney Drinking Water Catchment.

Source: Mine Subsidence Engineering Consultants (2018).
^ Subsidence impacts are discussed in the Aboriginal cultural heritage section

The Subsidence Assessment concluded that potential subsidence impacts to natural and built features could be managed by the preparation and implementation of the appropriate management strategies. The Subsidence Assessment also noted that similar subsidence management plans are currently in operation for the ongoing operations at the approved Mine and for other mining operations within the Southern Coalfields. Additional management strategies not included in Table 5 proposed for the Project include:

- A Watercourse Impact Monitoring and Management Plan to manage the potential subsidence impacts to the Avon River, Cordeaux River and other rivers and creeks and drainage lines identified above the Study Area;
- Implementation of a Landscape Management Plan to monitor and manage and potential impacts resulting from cliff instabilities and impacts to rock outcrops and steep slopes;
- Monitor the potential impacts to swamps through the installation of monitoring lines in the vicinity of swamps to measure subsidence movements, comparison of observed movements to predicted movements, establish appropriate surface water and groundwater monitoring programs based on recommendations from the specialist surface water and groundwater assessments and development of a TARP;
- Periodic visual inspection of the disused Maldon-Dombarton Railway, with larger surface cracking remediated if there is potential for long-term erosion;
- Develop a Picton Road Management Plan in conjunction with the Roads and Maritime Services; and,
- South32 would work with WaterNSW and the Dams Safety Committee to develop the appropriate monitoring and management that could include a TARP for managing potential subsidence impacts to the Avon and Cordeaux Dams.

The Subsidence Assessment also included a discussion of the impacts to potential future developments. For example, WaterNSW is considering the construction of new infrastructure near the proposed mining areas, including the Lower Cordeaux Reservoir and Dam Wall, Burrawang to Avon Dam Tunnel, Avon Dam to the New Lower Cordeaux Dam Tunnel and Lower Cordeaux to Broughtons Pass Weir Tunnel. The Subsidence Assessment recommends management strategies be developed in consultation with WaterNSW to manage the potential impacts on these future developments, should they be developed in the future.

2.4.4 Biodiversity

The Biodiversity Assessment was undertaken by Niche Environment and Heritage, the findings of the assessment are outlined in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Biodiversity Assessment Report* (December 2018). The Biodiversity Assessment includes both a Biodiversity Assessment Report and a Biodiversity Offset Strategy to address the specific requirements in the Project Secretary's Environmental Assessment Requirements (SEARs).

The analysis completed by Niche was undertaken in accordance with NSW and Commonwealth policies and legislation. These include assessment under the Framework for Biodiversity Assessment - NSW Biodiversity Offsets Policy for Major Projects (FBA) and assessment of the potential impacts of the Project on the Matters of National Environmental Significance in the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as well as threatened biodiversity listed under the NSW Biodiversity Conservation Act 2016 (BC Act).

The Biodiversity Assessment Study Area is made up of the proposed mining area, Area 5 and 6, which includes a subsidence effected area of 2,958 hectares (ha) and 1,075 ha respectively. In addition, the Study Area also contains related surface infrastructure, including:

- four proposed ventilation shafts;
- an extension of the existing Dendrobium Pit Top Carpark off Cordeaux Road; and
- additional service boreholes.

The Biodiversity Assessment draws on findings from other technical studies, including the Subsidence Assessment discussed above. To assess the Project's potential impacts on ecological values, the Biodiversity Assessment includes the findings of previous surveys undertaken within the Study Area, which includes mapping previously completed by the National Parks and Wildlife Service.

2.4.4.1 Avoidance, mitigation and management

The current Project mine plan includes a number of longwall setbacks from both built and natural features to reduce the potential for subsidence impacts to surface infrastructure and the environment. Further, the selection of the location of the ventilation shafts was subject to a preliminary biodiversity constraints assessment to reduce biodiversity impacts. Sites were chosen adjacent to existing fire roads to minimise access disturbance within native vegetation areas.

The Biodiversity Assessment outlines an extensive set of mitigation measures designed to reduce the potential impacts of the Project to biodiversity. A brief summary of some of these mitigation and management measures are outlined in Table 20.

Table 20: Biodiversity mitigation measures

Likely impact from the Project	Potential extent of impacts	Mitigation measure	Expected success of measure
Edge effects – new site infrastructure would generate additional surface edges exposed to native vegetation.	Varying distance from subject site – potentially occurring within 20 m of disturbance area.	1. Boundary demarcation 2. Signposting 3. Weed management 4. Sedimentation management	Active weed, and pest management are anticipated to be successful at managing edge effects from the Project.
Erosion and sedimentation – including the alteration of soil structure and surface water flow.	Variable depending on topography and operation.	An Erosion and Sediment Control Plan has been developed for the approved Mine which would continue for the Project.	Likely that erosion and sediment spills would be reduced.
Air quality/ dust emissions – as a result of surface facilities, likely impacts are negligible. Dust from ventilation shaft sites predicted to be minor.	Variable depending on wind conditions.	Incorporated into the air quality mitigation management measures.	Successful implementation of dust control would minimise dust. Current dust suppression mitigation works are on-going at the Dendrobium Mine.
Fire – Potential for equipment to trigger fire ignition	Potentially widespread, but unlikely.	Bushfire Management Plan with protocols to prevent and deal with bushfire.	Likely assist in prevention.

Source: Niche Environment and Heritage (2018)

The costs of these mitigation measures are included in the mitigation and management costs of the Project, but are not individually identified.

2.4.4.2 Subsidence

For native non-swamp vegetation, the Biodiversity Assessment outlines that the potential impacts could include vegetation die-back around strata gas emission or drainage sites with creeks, change to the floristic composition, or the destruction or smothering of vegetation by rock falls or earth slippage. However, the Biodiversity Assessment concludes that based on the analysis in the Subsidence Assessment and previous events in the Southern Coalfields, the likelihood for such an event occurring and detrimentally changing native vegetation is unlikely.

The Biodiversity Assessment specifies there are 46 coastal upland swamps located within the Study Area, with 25 of these swamps located entirely or partially above the Project longwalls, and an additional two swamps located within a 60 m buffer area around the longwalls. To predict the impacts of subsidence on the swamps located entirely or partially above the Project longwalls, the Biodiversity Assessment relies on conclusions made in the Subsidence Assessment.

For the 25 swamps located directly above the longwalls the Subsidence Assessment concludes that fracturing could occur within the bedrock beneath the swamps. Fracturing bedrock has the potential to result in hydraulic regime change and impacts may include, reduction in groundwater, transition to drier vegetation, peat desiccation, exposure to greater bushfire intensity and increased scour and erosion events.

Based on assessments of water levels and recession rates around past mining in Areas 2, 3A and 3B, it was concluded by Watershed HydroGeo (2019) that hydrographs from swamp piezometers directly above or within 60 m of longwalls exhibit a mining effect, be that through a reduction in the water table to below pre-mining levels and/or increased recession (drainage) rate. Effects on swamp water tables were not reported at distances greater than 60 m from a longwall panel.

Based on the results of Watershed HydroGeo (2019) and the impact assessment undertaken by Niche (2019), subsidence related impacts such as hydrological changes are likely to occur in coastal upland swamps above and within 60m of the longwalls.

2.4.4.3 Clearing native vegetation

The Project would result in the direct disturbance of approximately 24 ha of native vegetation for surface infrastructure.

Development of the Dendrobium Pit Top Carpark would clear 20 ha of native vegetation, including:

- 18.8 ha of HN566 Red Bloodwood - scribbly gum heathy woodland; and
- 0.2 ha of ME044 Sydney Blue Gum x Bangalay - Lilly Pilly moist forest.

Development of the additional service boreholes would clear up to 4 ha of potential HN566 Red Bloodwood - scribbly gum heathy woodland and up to 1 ha of HN556 Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest.

The Biodiversity Assessment concludes that no threatened flora was recorded in those areas proposed to be disturbed by the Dendrobium Pit Top Carpark Extension or ventilation shafts.

2.4.4.4 Biodiversity offsets required

The Biodiversity Assessment concludes that, either through subsidence or native vegetation clearing, the Project would have an adverse impact on biodiversity (both flora and fauna) within the Study Area. The impacts of flora and fauna would require offsets to be either purchased or generated to manage the impacts of the Project. The biodiversity credit requirements are summarised in Table 21, which shows a breakdown of the number of credits required to offset the impacts of the Project.

Table 21: Biodiversity credit requirements

		Area (ha)	Credits
Species credit requirements			
Broad-headed Snake		0.05	2
Littlejohns Tree Frog		30.83	802
Giant Burrowing Frog		30.83	401
Red-crowned Toadlet		5.36	70
Giant Dragonfly		12.37	952
Koala		1.00	26
Ecosystem credit requirements			
HN566	Red Bloodwood - scribbly gum heathy woodland on sandstone plateaus, Sydney Basin	22.8	903
HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	1.0	80
HN560	Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	15.9	222
HN662	Needlebush - banksia wet heath swamps on coastal sandstone plateaus of the Sydney Basin	4.2	72
ME044	Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion	0.2	6

Source: Niche Environment and Heritage (2018)

To generate these biodiversity credits, South32 would implement a biodiversity offset strategy. The strategy includes several steps including payments into the Biodiversity Conservation Trust fund and the establishment of stewardship sites. As outlined previously in this assessment, these costs are included in the mitigation and management costs of the Project.

2.4.5 Net public infrastructure costs

It is anticipated that the Project would generate no net public infrastructure costs. The subsidence section above outlines some of the potential risk exposure to public infrastructure including road, rail, pipelines and transmission lines. In summary, the Social Impact Assessment concludes that there would be no adverse impact to roadways and that the predicted impacts to railways, pipelines and transmission like could be managed with appropriate management strategies.

Further, the Road Transport Assessment has identified some potential mitigation measures that could be applied at the Project including intersection upgrades or changes to shift times to address future traffic levels on Picton Road, with no residual costs currently anticipated.

The costs associated with the implementation of the environmental management strategies are included in the mitigation and management costs of the Project.

2.4.6 Ambient noise and blasting

Potential noise impacts in relation to the Project are predicted to occur from activities such as the processing and transportation of coal and employee transport. Renzo Tonin & Associates undertook a Noise and Blasting Assessment for the Project. The findings of the Noise and Blasting Assessment are

outlined in the report, *Dendrobium Mine – Plan for the Future: Coal for Steelmaking, Noise and Blasting Assessment*.

The noise impacts are assessed using a number of policies, guidelines and standards, including the NSW *Noise Policy for Industry* (NPfI) published by the EPA and the *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments*, published by the NSW Government.

The Noise and Blasting Assessment considers the noise sensitive receivers proximal to the Project surface facilities, including privately owned dwellings, and a mixture of community and commercial properties and mine owned properties. To assess the potential impacts, the Noise and Blasting Assessment uses representative noise sensitive receiver locations adjacent to the Dendrobium Pit Top, the Cordeaux Pit Top, the Kemira Valley Coal Loading Facility, the Kemira Valley Rail Line, Dendrobium CPP and ventilation shaft sites.

The Noise and Blasting Assessment considered the noise impacts for each Project activity, which are:

- Construction Noise;
- Operational Noise;
- Blasting Activities;
- Road Traffic Noise; and
- Rail Traffic Noise, including both:
    - Rail Operational Traffic Noise; and
    - Brake Squeal Noise.

Noise generating activities are subject to various noise impact criteria, as summarised in Table 22.

Table 22: Project Activity and Noise Criteria

Project Activity	Criteria
Project Construction Noise	Construction noise management levels for residential receivers is assessed in reference to the Rating Background Level (RBL) during the day evening and night. Noise Management Levels (NML) for residential receivers are: • Standard Hours (Day) – RBL + 10 decibels (dB[A]) • Outside Standard Hours (evening and night) – RBL + 5 dB(A) The NML for other noise sensitive receivers varies across use (e.g. 45 dB(A) for classrooms at schools, hospitals and places of worship, to 75 dB(A) for industrial premises). In addition, the highly affected noise level is 75 dB(A)
Project Operational Noise	NPfI outlines the following noise criteria: • Residential Intrusiveness Criteria – RBL + 5 dB(A) • Non-Residential Amenity criteria – Recommended amenity level - 5 dB(A) Noise impacts are assessed in terms of both intrusiveness and amenity, with the Project Specific Trigger Level (PSTL) defined as the lower (i.e. more stringent) of the intrusiveness and amenity noise levels. For receivers proximal to the Port Kembla industrial precinct, the 'industrial interface' criteria adjustment has also been applied. In addition, the night time sleep disturbance noise trigger level of $L_{Aeq, 15minute}$ 40 dB(A) and L_{AFmax} 52 dB(A) applies to the Project.
Project Blasting Activities	The Project is subject to blast over pressure criteria of (95 – 115 dB(L_{in})) and Ground Vibration Criteria (1 – 5 mm/sec)
Project Road Traffic Noise	*Road Noise Policy* (RNP), noise assessment criteria: Day 7am – 10pm of $L_{Aeq,(15 hour)}$ 60 dB(A), and Night $L_{Aeq,(15 hour)}$ 55 dB(A) (external)
Rail Operational Traffic Noise	NSW Rail Infrastructure Noise Guidelines (RING) recommended acceptable L_{Aeq} noise levels from industrial noise sources from the *Noise Policy for Industry*.
Brake Squeal Noise	NSW RING recommended acceptable L_{Aeq} noise levels from industrial noise sources from the *Industrial Noise Policy*.

Source: Renzo Tonin & Associates (2018)

The Noise and Blasting Assessment notes that many of the potential noise sources for the Project would be largely unchanged from the existing operations of the approved Mine. Table 23 provides a summary of the potential Project noise impacts.

Table 23: Project noise impacts

Project Activity	Impact
Project Construction Noise	All receivers would experience noise levels well below the highly affected noise levels specified in the *Interim Construction Noise Guideline* (DECC, 2011). The major construction noise source is the development of the Dendrobium Pit Top Carpark Extension. Several receivers close to the Dendrobium Pit Top are predicted to experience short-term impacts, including: • 25 privately-owned receivers exceeding the standard hours NML for the full fleet construction scenario. • 6 privately-owned receivers exceeding the outside standard hours NML for the full fleet minus Dendrobium Pit Top Carpark Extension construction fleet scenario. • 3 privately-owned receivers exceeding the standard hours NML for the full fleet minus Dendrobium Pit Top Carpark Extension construction fleet scenario.
Project Operational Noise	Four dwellings (D0065, D0066, D0071 and R39a) are predicted to experience negligible (0-2 dB(A)) noise increases above the PSTLs. One residence (R6a) is also predicted to experience marginal (3-5 dB(A)) noise increase above the PSTL during the evening, however, the total cumulative industrial noise level would be below the recommended amenity noise level for this receiver. Only one receiver (R39a) is predicted to experience a sleep disturbance noise trigger level exceedance of 1 dB(A) which is considered negligible. Private receivers proximal to the Port Kembla industrial precinct would be compliant with the relevant criteria considering the application of the 'industrial interface' criteria adjustment.
Project Blasting Activities	The maximum predicted ground vibration at the surface occurs above Area 6. No adverse impacts are expected.
Project Road Traffic Noise	Traffic noise is assessed using the scenarios as outlined in the Noise and Blasting Assessment. Existing total day traffic noise levels are predicted to exceed the RNP noise criteria of 60 dB(A) for all assessed Project years, however, additional Project traffic noise is within the 2 dB(A) relative increase criteria. Total night traffic noise predictions for the Project are within the RNP 55 dB(A) noise criteria for all scenarios.
Cumulative Noise	The assessment of cumulative noise impacts has considered the total and relative noise from the Project and the adjacent BlueScope Steel Port Kembla site, the proposed Port Kembla Gas Terminal and the Port Kembla Coal Terminal (all located within the Port Kembla industrial precinct). Cumulative noise impacts were found to be within the nominated criteria for all periods when the application of the 'industrial interface' criteria adjustment is considered.
Rail Operational Traffic Noise	Minimum setback distances to comply with the RING criteria were determined based on the Project rail movements. Review of the required minimum setback distances showed that there would be a number of

	dwellings exceeding the RING criteria along the length of the Kemira Valley Rail Line.
Brake Squeal Noise	The Noise and Blasting Assessment concludes, based on the results of changed driver practices and the Phase 1 to Phase 4 investigation of brake squeal noise on the Kemira Valley Rail Line that the subsequent replacement of brake pads on all trains operating on the line has resulted in a significant reduction in the overall rail noise levels due to brake squeal events and a reduction in the percentage of trains that generate brake squeal. South32 would continue to implement reasonable and feasible rail noise mitigation measures over the life of the Project.

Source: Renzo Tonin & Associates (2018).

To minimise the impact to surrounding residents and businesses, South32 currently employs a number of noise reduction measures for the approved Mine that would also apply to the Project. These include:

- Enforcing a self-imposed curfew at night to limit the likelihood of sleep disturbance events;
- Vechicle access restrictions are controlled through the Driver's Code of Conduct which specifies allowable travel times to the Dendrobium Pit Top;
- Closure of the workshop door at the Dendrobium Pit Top during the evening and night periods;
- Modified underground machinery (rubber tyred vehicles);
- Introduction of low frequency alarms fitted to all Surface Mining Equipment and mine vehicles; and
- Implementation of a range of improvements to braking activities on the Kemira Valley Rail Line, including, trial and implementation of dynamic/ dual braking, standardisation of braking durations and implementation of modified brake shoes with larger radius backing plates.

The costs of meeting these mitigation measures are included in the mitigation and management costs of the Project.

As outlined in the Noise and Blasting Assessment, the incremental noise impacts from the Project are likely to be minor. The most significant impacts are expected during the construction phase, however, these noise impacts are temporary. South32 has also committed to limit construction of the Dendrobium Pit Top Carpark Extension to standard hours. South32 has implemented a number of steps to reduce operational noise and rail noise impacts, and the Noise and Blasting Assessment outlines a number of steps to further reduce community noise impacts, the costs of which are included in the capital and operating costs of the Project.

Any residual noise impacts are qualitatively acknowledged in this economic assessment. It is also noted that operational noise sources are already occurring under the approved Mine.

2.4.7 Transport

A Road Transport Assessment was undertaken by GTA, with findings outlined in *Dendrobium Mine – Plan for the Future: Coal for Steelmaking Road Transport Assessment*. The Road Transport Assessment takes into account the established operations and existing Dendrobium Pit Top access points as well as the development of new surface infrastructure for the Project. The Road Transport Assessment also considered the location of workers across the life-cycle of the Project, including the use of the Cordeaux Pit Top from approximately 2035 (replacing the Dendrobium Pit Top) to allow worker access to Area 6.

The Road Transport Assessment has also utilised the SIDRA intersection analysis program, which determines characteristics of intersections including the degree of saturation, average delays, and Levels of Service. Level of Service A is characterised as good operation, with an average delay of less than 14 seconds per vehicle. A full description of the service criteria is set out in Table 24.

Table 24: Level of Service criteria at priority intersections

Level of Service	Worst Movement Average Delay^	Operational character
A	less than 14	Good operation
B	15 to 28	Acceptable delays and spare capacity
C	29 to 42	Satisfactory, but accident study required
D	43 to 56	Near capacity and accident study required
E	57 to 70	At capacity, requires other control mode
F	> 70	Extreme delay, traffic signals or other major treatment required

Source: GTA Consultants (2018)
^per Vehicle (sec/ vehicle)

GTA undertook an assessment of the intersection operating conditions for the key intersections with and without the Project. Table 25 summarises the unmitigated intersection operating conditions for three key periods during the Project life:

- the peak construction period including the Dendrobium Mine's existing operational workforce (year 2020);
- peak operations (higher concentration access at the Dendrobium Pit Top in year 2027); and
- shift of operational access to the Cordeaux Pit Top (year 2035).

During the peak construction phase, three of the four intersections are expected to experience minor changes to average delay times as a result of the Project with no overall change in the Level of Service. At the intersection of Picton Road and the Cordeaux Dam Access Road the No Project case would generate no material traffic. For the Project, the Project-related construction activity is expected to generate short-term increase in intersection wait-time. GTA concluded that the Level of Service at this intersection would be satisfactory during the Project peak construction phase (year 2020). In addition, a review of accident data suggests that there are no particular safety concerns with the intersection. It is noted that there may also be some minor Project construction traffic movements at this intersection in 2035, however, this activity would only be temporary in nature.

During the peak operational phase (year 2027), there are no major changes to average time delays or Level of Service.

Table 25: Future peak hour intersection operating conditions

Intersection		Average Delay^		Level of Service	
		AM Peak	PM Peak	AM Peak	PM Peak
Project Peak Construction 2020					
Cordeaux Road and Dendrobium Pit Top Access Road	No Project	5.6	5.9	A	A
	With Project	6.3	5.8	A	A
Picton Road and Cordeaux Dam Access Road	No Project	-	-	-	-
	With Project	21.7	34.9	B	C
Picton Road and Cordeaux Pit Top Access Road	No Project	7.8	24.6	A	B
	With Project	9.4	24.5	A	B
Cordeaux Road and Stones Road	No Project	7.6	7.8	A	A
	With Project	7.6	7.9	A	A
Project Operational 2027					
Cordeaux Road and Dendrobium Pit Top Access Road	No Project	5.6	5.9	A	A
	With Project	5.6	6.2	A	A
Picton Road and Cordeaux Pit Top Access Road	No Project	7.8	35.5	A	C
	With Project	7.8	35.5	A	C
Cordeaux Road and Stones Road	No Project	7.6	7.8	A	A
	With Project	7.6	7.9	A	A
Project Operational 2035					
Cordeaux Road and Dendrobium Pit Top Access Road	No Project	-	-	-	-
	With Project	5.6	5.6	A	A
Picton Road and Cordeaux Dam Access Road	No Project	-	-	-	-
	With Project	58.0	>70	E	F
Picton Road and Cordeaux Pit Top Access Road	No Project	38.6	53.4	C	D
	With Project	54.6	>70	D	F
Cordeaux Road and Stones Road	No Project	7.5	7.9	A	A
	With Project	7.5	8.1	A	A

Source: GTA Consultants (2018)

^per Vehicle (sec/ vehicle), for movement with highest average delay per vehicle

By 2035, the operation of the intersection of Picton Road with Cordeaux Pit Top Access Road and Picton Road with Cordeaux Dam Access Road would decline to an unacceptable Level of Service with and without the Project. GTA outlines that this decline is a result of assumed background growth in westbound through traffic on Picton Road.

GTA notes that by reducing the demand during the PM peak times, from 2035, wait-times could be reduced. The report sets out a number of steps to reduce overall peak demand, including, modifying Project workforce shift times so they don't coincide with Picton Road PM traffic peak as well as providing carpooling incentives or a bus service to the Cordeaux Pit Top access for the Project workforce.

In addition, GTA notes that the NSW Government has identified duplication of Picton Road as a long-term means of supporting growth in the region. Where demand cannot be sufficiently managed through the measures mentioned previously, upgrading of the intersection may be required to provide additional capacity. GTA suggests that given the performance of the intersection would still deteriorate even in the

absence of the Project, it is envisaged that any upgrades to, or duplication of Picton Road undertaken by RMS should include any necessary intersection upgrades to accommodate eastbound traffic exiting the Cordeaux Pit Top post-2035.

GTA concludes that the Project can be satisfactorily accommodated by the road network, subject to the mitigation measures set out in the report. These measures include:

- Review operational shift arrangements before the transfer of primary underground mine access moves to the Cordeaux Pit Top.
- Review the Transport Management Plan before the move to the Cordeaux Pit Top.
- Design proposed Dendrobium Pit Top Carpark Extension off Cordeaux Road in accordance with relevant guidelines.

As outlined by GTA, the Project would generate traffic, and in some contexts also marginally increase wait-time for commercial and residential road users. In the short-term these impacts are expected to be minor and are qualitatively acknowledged in the economic assessment. In the long-term, there may be residual impacts including a loss of performance on Picton Road by 2035. As outlined above, GTA has outlined potential steps to be taken to mitigate these residual impacts which would where applicable be incorporated into Project costs.

2.4.8 Aboriginal cultural heritage

An ACHA was undertaken by Niche Environment and Heritage, the findings of which are outlined in *Aboriginal Cultural Heritage Assessment, Dendrobium Mine – Plan for the Future: Coal for Steelmaking*. The ACHA has been undertaken in accordance with the SEARs for the Project and other relevant NSW and Commonwealth Government documents, as well as the Burra Charter. Niche consulted with 17 Aboriginal stakeholders, surveyed the Subject Area and reviewed previous surveys and assessments in the preparation of the ACHA for the Project.

The ACHA accounts for the potential impacts from several sources including: subsidence, development of additional surface infrastructure and ancillary infrastructure (e.g. Dendrobium Pit Top Carpark Extension and ventilation shaft sites) and also considers potential cumulative impacts.

In total, 58 Aboriginal heritage sites were identified within the Subject Area of the ACHA.

The majority of these sites (49 of the 58), have low scientific significance. The remaining nine sites are classified as having either moderate (three) or high (six) scientific significance. Table 26 provides a description of the moderate and high scientific significance sites, including the predicted impact type and the potential consequence.

Table 26: Summary of predicted impacts to Aboriginal cultural heritage sites: moderate and high significance sites

Site Name	Site Type	Location	Impact Type	Degree of Harm	Consequence of Harm
Moderate Significance					
Wallandoola Site 38	Axe Grinding Groove	Area 6	Potential Subsidence	Partial	Partial Loss of Value (aesthetic visual)
East Cordeaux 34	Axe Grinding Groove	Area 6			
Tega Site 1	Axe Grinding Groove	Area 6			
High Significance					
Tega Site 20	Shelter with Art	Area 6			
Upper Avon 47	Shelter with Art	Area 5			
Upper Avon 43	Shelter with Art	Area 5			
Metro Catchment-Art01	Shelter with Art	Area 6			
Ricki Lee 11	Shelter with Art	Area 5			
Upper Avon 49	Shelter with Art and Deposit	Area 5			

Source: Niche Environment and Heritage (2018).

The ACHA outlines a number of proposed management and mitigation measures to minimise harm to Aboriginal heritage sites, including:

- Project design giving consideration to the location Aboriginal heritage sites (e.g. including the location of ventilation shafts and ancillary infrastructure).
- Implementation of site fencing, to mitigate the risk of indirect or accidental harm.
- Subsidence monitoring.

Finally, the ACHA outlines a number of recommendations including establishing an Aboriginal Heritage Management Plan (AHMP) to implement the proposed mitigation and management measures. Niche recommends that the AHMP include, for example:

- Protocols for the involvement of Registered Aboriginal Parties (RAPs), including communication and site-access protocols.
- Establish and maintain a GIS database of Aboriginal heritage sites identified within the Subject Area.
- Subsidence monitoring.
- Protocols for the discovery and management of human remains, including stop work provisions and notification protocols.
- Protocols for heritage awareness training to be established into mine site inductions
- Regular review of the AHMP.
- Copies of the final report should be made available to RAPs, the Department of Planning and the Environment and the Office of Environment and Heritage.

The costs of managing and mitigating the potential impacts to Aboriginal heritage is included in the mitigation and management costs of the Project. The partial loss of value to Aboriginal heritage that would potentially arise due to the Project is qualitatively acknowledged in this economic assessment.

2.4.9 Historical Heritage

A detailed Historical Heritage Assessment has been undertaken for the Project, conducted by Niche Environment and Heritage. The findings of the Historical Heritage Assessment are outlined in *Dendrobium Mine – Coal For Steelmaking: Plan for the Future Historical Heritage Assessment*. To conduct the Historical Heritage Assessment Niche undertook:

- Research on the Commonwealth Heritage List, the National Heritage List, the NSW State Heritage Register, the State Heritage Inventory and various Local Environment Plans.
- Considered the findings from previous studies, including previous Dendrobium Mine heritage assessments and a Conservation Management Plan by the Sydney Catchment Authority.
- Field survey within the Study Area.

Only four heritage items were identified, the Cordeaux Dam, Avon Dam and heritage listed infrastructure located at the Dendrobium Pit Top (i.e. associated with the old Nebo Colliery) and the Kembla Heights Mining Village (Heritage Conservation Area). The Dam sites are listed as State significant heritage items on the NSW State Heritage Register, the Nebo Colliery and Kembla Heights Mining Village (Heritage Conservation Area) are of local heritage significance.

The Historical Heritage Assessment characterised both the Cordeaux Dam and Avon Dam sites as having Egyptian-style architectural character and include visitor amenities and picnic areas.

The Historical Heritage Assessment concluded that mining in Areas 5 and 6 would result in negligible impact on the heritage significance of both the Cordeaux Dam and Avon Dam and the associated infrastructure, provided proper mitigation and monitoring measures are implemented to prevent potential impacts from subsidence.

The Historical Heritage Assessment concluded that the underground mining layout has been designed to mitigate any subsidence impacts on the Avon and Cordeaux Dam walls and would result in negligible impacts on the structural integrity or external fabric. The surface infrastructure would be located remotely from both dam sites and would not result in any potential direct impacts. The potential for *in situ* archaeological deposits (historical heritage) is low. In addition, any potential disturbance due to upgrades and surface works at the Dendrobium Pit Top on the old Nebo Colliery infrastructure would be mitigated and managed through the implementation of a Conservation Management Plan for the Project.

Regarding the visual amenity to the Cordeaux Dam site, the Historical Heritage Assessment outlined that the Project would be located remotely from this site, and public access to these sites is restricted to areas outside of the picnic areas and dam wall by WaterNSW, as they are located within the Metropolitan Special Area. Ventilation Shaft Site 5A is located away from the site, however, Ventilation Shaft Sites 6A and 6B may be temporarily visible during construction. Overall, the proposed Project surface infrastructure would have a negligible impact on the visual setting of the Cordeaux Dam. The Historical Heritage Assessment concluded that the Project surface infrastructure would have no impact on the visual setting of the Avon Dam.

Overall, in relation to mitigating the impacts on historical heritage, the Historical Heritage Assessment recommends the following:

- Paint the structural features to Ventilation Shaft Sites 6A and 6B in green or black where practical to mitigate the potential visual impacts to the Cordeaux Dam;
- Monitoring equipment at the Cordeaux and Avon Dams should avoid impacts to the heritage fabric and the structural integrity;
- Engage a suitably qualified archaeologist where relics are discovered; and
- Development of a Conservation Management Plan for the construction works at the Dendrobium Pit Top for the Project.

The costs of managing and mitigating the potential impacts to historical heritage is included in the mitigation and management costs of the Project The potential for some short-term visual impacts associated with ventilation shaft construction at the Cordeaux Dam and any other residual impacts to historical heritage arising from the Project is qualitatively acknowledged in this economic assessment.

2.4.10 Surface water

The Surface Water Assessment was undertaken by Hydro Engineering & Consulting outlined in *Dendrobium Mine Plan for the Future Surface Water Assessment*. The Surface Water Assessment considers the unique factors that make up the Project Area, including the location of the Project within the Metropolitan Special Area and land reserved for the Sydney Drinking Water Catchment. The Project lies adjacent to Avon Dam and Cordeaux Dam, respectively. In addition, the Project longwalls also lay under the catchment area of these water supply reservoirs.

The Surface Water Assessment outlines a range of mitigation and management options incorporated into the design of the Project and a number of recommended remediation and monitoring options, including sediment dams to capture run off from proposed ventilation shaft sites.

The Surface Water Assessment provides a set of potential stream remediation options, including several grouting possibilities from hand grouting which can be applied to surface cracks or expanding Polyurethane grouting.

Surface water monitoring is currently being undertaken for the approved Mine and within the Project Area. The Surface Water Assessment recommends several options to expand the current monitoring, these options include:

- Water level and flow rate monitoring, including surface water flow rates, swamp water levels, swamp flow rates and pool water levels;
- Water quality monitoring, including surface water quality monitoring and observational and photographic monitoring;
- Monitoring the performance of stream remediation works; and
- Water balance of all pump flows.

The cost of incorporating these recommendations are included in the mitigation and management costs of the Project.

Despite these mitigation efforts, the Project is predicted to have some potential impact on surface water quality. As required by the SEARs, the Surface Water Assessment considers the potential impact the Project has on water supply infrastructure, and the quality and quantity of surface water that interacts with the Project. To complete this assessment the Surface Water Assessment provides an impact assessment on:

- the streamflow contributions into Avon Dam, Cordeaux Dam and Pheasants Nest Weir;
- Swamps; and
- Water quality.

These are explored in further detail in the subsections below.

2.4.10.1 Implications for streamflow into Avon Dam, Cordeaux Dam and Pheasants Nest Weir

The Surface Water Assessment concludes that the Project would have a negligible impact on the streamflow into Cordeaux Dam, as the dam is upstream of the Project mining areas.

In relation to Avon Dam and Pheasants Next Weir, the expected impact on streamflow is estimated to be minimal. The predicted streamflow losses from the Avon Dam and Pheasants Nest Weir catchments is detailed in the Surface Water Assessment for the Project.

2.4.10.2 Swamp Stability Assessment

Subsidence has the potential to impact swamps located both directly above and adjacent to longwall mining. These impacts occur as a result of several changes to the longitudinal gradients and cross-sectional characteristics of overlying swamps. In addition, changes to the surface water and groundwater flow conditions of the swamps may impact swamp vegetation. Vegetation increases swamp erosion resistance, and as a result, any vegetation reduction may increase the potential for scour and erosion.

The Surface Water Assessment assesses the impacts on swamps under two modelling conditions, under a relatively frequent 50 per cent Annual Exceedance Probability (AEP) and the rare 1 per cent AEP peak flow events. The Surface Water Assessment concludes that it is unlikely that erosion and scouring would occur in any swamps in the Project Area during frequent flow events. During rare high flow events, there is potential for erosion and scouring to occur in two of the 24 swamps as a result of longwall-induced subsidence.

2.4.10.3 Impacts to water quality

The Surface Water Assessment states that the potential water quality impacts caused by subsidence would be localised to the Avon and Cordeaux Rivers and their tributaries. Mine subsidence can potentially result in isolated episodic pulses in iron manganese, aluminium and electrical conductivity. The Surface Water Assessment concludes that these occurrences haven't had a measurable effect on water quality in reservoirs downstream of mine induced subsidence in the Southern Coalfields. As a result, any changes to water quality are not expected to impact on the performance of Avon Dam, Cordeaux Dam or Pheasants Nest Weir.

The potential impacts of surface water runoff associated with land disturbance for new ventilation shafts in Area 5 and Area 6 is assessed in the Surface Water Assessment. These cleared areas would also include sediment dams to capture run off from each of the four proposed ventilation shafts. The Surface Water Assessment assessed the potential impacts to water quality at the downstream Pheasants Nest Weir

(Sydney water supply take-off point) and predicted no discernible changes, therefore the Project would have a neutral impact on water quality at Pheasants Nest Weir.

2.4.11 Groundwater

The Groundwater Assessment was undertaken by Hydro Simulations, with the findings of the assessment is outlined in *Dendrobium Mine: Plan for the Future Groundwater Assessment*. To complete the assessment Hydro Simulations completed several steps, including a review of:

- Literature;
- Geological data and mapping and aquifer property data;
- Groundwater levels data from the extensive monitoring network at the approved Mine, including swamps and deep or hard-rock groundwater systems;
- Surface water flow data;
- Mine inflow estimates from Dendrobium Mine's detailed mine water balance; and
- Surface water and groundwater chemistry data.

The Groundwater Assessment provides an impact assessment of mine inflow, bores, streamflow and impact on reservoirs. The Groundwater Assessment also outlines a number of recommendations for monitoring and data gathering, which are included in the mitigation and management costs of the Project.

The Groundwater Assessment predicted the level of mine inflow of groundwater entering the Project underground areas in millions of litres per day (ML/d). In Area 5 of the Project, the Groundwater Assessment concludes that over the life of extraction in this area, an average of 12 ML/d of inflow would be generated, peaking at 18 ML/d in 2033 and 2037. In Area 6 of the Project, inflow averages 3 ML/d, peaking in 4 ML/d in 2047.

Groundwater changes caused by the underground mining of the Project may impact the operation of bores located within the Project Area. There are 650 bores located within the bounds of the groundwater model used by Hydro Simulations. Of these bores, a portion have been affected beyond the Aquifer Interference Policy (AIP) 2 m drawdown threshold as a result of historical mining (not as a result of the Dendrobium Mine) with no additional bores predicted to be affected as a result of the Project.

As outlined in the Groundwater Assessment, longwall mining can also cause a reduction in stream flow via groundwater depressurisation and drawdown or cracking, fracturing and deformation. The streamflow modelling outlined in the Groundwater Assessment indicates that the streams directly above the longwall footprint are impacted by surface cracking and depressurisation, where outside the longwall footprint streams are impacted through depressurisation only. Impacts on stream flow may contribute to water losses in catchments adjacent to the Project.

The Groundwater Assessment concludes that the Dendrobium Mine as a whole including the Project (i.e. Areas 5, 6, 3A and 3B) has the potential to result in the loss of approximately 1300-1400 ML/yr of stream flow from the Cordeaux River catchment and a similar amount from the Avon River catchment (including the reservoirs).

To estimate the costs associated with this water loss the economic assessment uses the Volumetric charge $76.80 ($/ML) from the Independent Pricing and Regulatory Tribunal report *Review of Prices for WaterNSW,*

from 1 July 2016 to 30 June 2020, as an estimate of the opportunity cost of the incidental take of water from the catchment for each Project year (2020 to 2085).

The inclusion of incidental take of surface water as well as groundwater inflows as a cost is a conservative approach, as some of this water lost from the catchment may be reused for beneficial industrial purposes. The benefits of this potential reuse have not been included in the potential economic benefits of the Project.

Included in the mitigation and management costs of the Project are the costs associated with the potential losses of surface water (i.e. incidental water take) from the Sydney Drinking Water Catchment.

2.4.12 Visual amenity

It is expected that the Project would not have significant impacts on visual amenity. As the Project coal extraction operations are located underground, any of the potential visual impacts would be generated by surface infrastructure. Much of the surface infrastructure of the Project is currently operational, including the Dendrobium Pit Top which would remain in use until 2035 and the Dendrobium CPP located at Port Kembla. In the case of the Dendrobium CPP, the facility is located within an existing major industrial complex.

New surface facilities including the Cordeaux Pit Top upgrades and the Ventilation Shaft Sites are not expected to generate significant visual impacts. In the case of the Cordeaux Pit Top the site is an existing facility in a forested area, away from residential areas. The Ventilation Shaft Sites are also remote and located away from residential areas. As outlined above the Historical Heritage Assessment concludes that the Project surface infrastructure (i.e. the ventilation shafts), would have no impact on the visual setting of the Avon Dam.

In addition, the Historical Heritage Assessment recommended several steps to mitigate any potential visual impacts, including painting the ventilation shafts, which is included in the mitigation and management costs of the Project.

2.4.13 Loss of surplus to other industries

The Project may generate loss of surplus in other industries where it competes directly for resources and inputs. The Project may generate these loses through directly competing for land or water rights with other industries, in particular agriculture.

The Project is unlikely to generate significant impacts to other industries. The land used to support new Project-related site infrastructure is not suitable for agriculture, as it is in forested areas. As a result, the loss of surplus to other industries has been assessed as zero.

It is expected that, as a result of the reduced inflows to Avon Dam and Pheasants Nest Weir that there will be no loss of surplus to other industries.

2.4.14 Residual value of land

The residual value of land captures any of the benefits associated with an alternate use of the land. That is, where the Project is not approved, the earmarked land used by the Project may be used for an alternate benefit-purpose. Any benefits generated by the alternate use, are a cost to the Project.

The Project would continue to use much of the surface infrastructure that is currently used by the approved Mine operations. As result of the current approved use, it is unlikely that further approvals would significantly impact land use. New surface infrastructure sites are isolated, (such as ventilation shafts), and are in heavily forested areas and unsuitable for agriculture and housing.

2.5 Net Benefits Analysis results

Consistent with the Guidelines, the CBA is based on comparing the net direct and indirect benefits and subtracting the indirect costs of the proposed development compared against the baseline scenario where the proposed development does not occur. The results are summarised in Table 27.

Based on the CBA methodology outlined in the Guidelines, and information provided by South32, the proposed development is estimated to provide a net benefit to NSW. This net benefit is estimated to be $1,073.2 million in NPV[7] terms. This is comprised of $497.8 million and $583.4 million in direct and indirect benefits respectively, and estimated incremental indirect costs of $8.1 million in NPV terms.

[7] All NPV figures reported are in real 2018 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

Table 27: Central case - estimated net benefits of the proposed development ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	74.9		
2. Royalties, payroll tax and Council rates	272.1		
3. Company income tax apportioned to NSW	150.8		
Total direct benefits	**497.8**	**Total direct costs**	**-**
Indirect benefits	**-**	**Indirect costs**	
1. Net economic benefit to landholders	-	1. Air quality	8.0
2. Net economic benefit to NSW workers	365.8	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	217.6	3. Visual amenity	-
	-	4. Transport impact	-
	-	5. Net public infrastructure cost	-
	-	6. Surface water impact	-
	-	8. Residual value of land	-
	-	7. Biodiversity impact^^	-
	-	8. Noise impact	-
	-	9. Loss of surplus to other industries	-
	-	10. Water ^^	-
	-	11. Aboriginal cultural and Historical heritage ^^	-
	-	12. Subsidence^^	-
Total indirect benefits	**583.4**	**Indirect Costs**	**102.4**
Total Project economic benefit	**1,081.2**	**Incremental Indirect Cost**	**8.1**
NPV of Project - ($m)	**1,073.2**		

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated into mitigation and management costs.

The ***direct benefits*** of the project are a function of the profitability of the proposed development which, in turn, depends on the prevailing coal price. This results in:

- An overall net producer surplus of $478.8 million in NPV, of which 15.7 per cent, or $74.9 million is attributed to NSW (based on shareholder's location);
- Total corporate taxes of $471.2 million in NPV terms for Australia, of which $150.8 million is attributed to NSW (based on population); and
- $272.1 million in other government revenue for NSW in NPV terms, the largest component of this being royalties of $237.1 million, with payroll taxes contributing $30.2 million.

The ***indirect benefits*** of the project are related to the linkages that the proposed development has to the NSW economy through both the labour market and suppliers. The analysis shows that of the $583.4 million in estimated indirect benefits:

- Worker benefits are $365.8 million in NPV terms attributable to an average direct employment of 265 FTE workers over the period of the proposed development (when excluding the workforce associated with Area 3C); and

- Supplier benefits are $217.6 in NPV terms, based on NSW-based procurement for the proposed development of $1,078.3 million.

The ***indirect costs*** of the Project are related to the costs borne on the NSW community through the generation of externalities by the Project. These costs include:

- GHG emissions costs of $0.1 million in NPV terms (based on population); and,
- Air quality impacts of $8.0 million in NPV terms (based on $PM_{2.5}$ emissions).

2.6 Net Benefits – Sensitivity analysis

Consistent with the Guidelines, this section outlines a summary of the systematic sensitivity analysis undertaken for the proposed development. The sensitivity analysis considers all key areas of the CBA, particularly coal prices, key costs (both capital expenditure and operating costs) as well as worker benefits. Where there are considered to be higher levels of potential uncertainty with the figures, a range of plus/minus 25 per cent is used. In areas where the figures are deemed more certain, a range of plus/minus 10 per cent is used. The sensitivity analysis is comprised of the following:

- Revenue sensitivity
  - Higher price assumptions, where coal prices are increased by 25 per cent over the central case assumptions
  - Lower price assumptions, where coal prices are decreased under the central case assumptions by 25 per cent for the life of the proposed development
- Cost-base sensitivity
  - Higher operational expenditure (increased by 10 per cent over the central case)
  - Lower operational expenditure (decreased by 10 per cent under the central case)
  - Higher capital expenditure (increased by 10 per cent over the central case)
  - Lower capital expenditure (decreased by 10 per cent under the central case)
- Worker and Supplier assumptions
  - Increased disutility of mining wage premium by 25 per cent on central case assumptions
  - Reduced supplier benefits of 10 per cent from central case assumptions
- Higher environmental costs (increased by 10 per cent)
- Discount rate sensitivity, using a 4 per cent and a 10 per cent real discount rate (see Appendix B).

In addition, upper and lower bound estimates are undertaken which assume:

- ***'Worst-case' scenario***, the coal price is reduced by 25 per cent, operational and capital expenditure are increased by 10 per cent, the disutility of the mining wage premium is set to 25 per cent and supplier benefits are lowered by 10 per cent compared with central case assumptions.
- ***'Best case' scenario***, the coal price is increased by 25 per cent, operational and capital expenditure are decreased by 10 per cent, the disutility of the mining wage premium is set to zero and supplier benefits are increased by 10 per cent compared with central case assumptions.

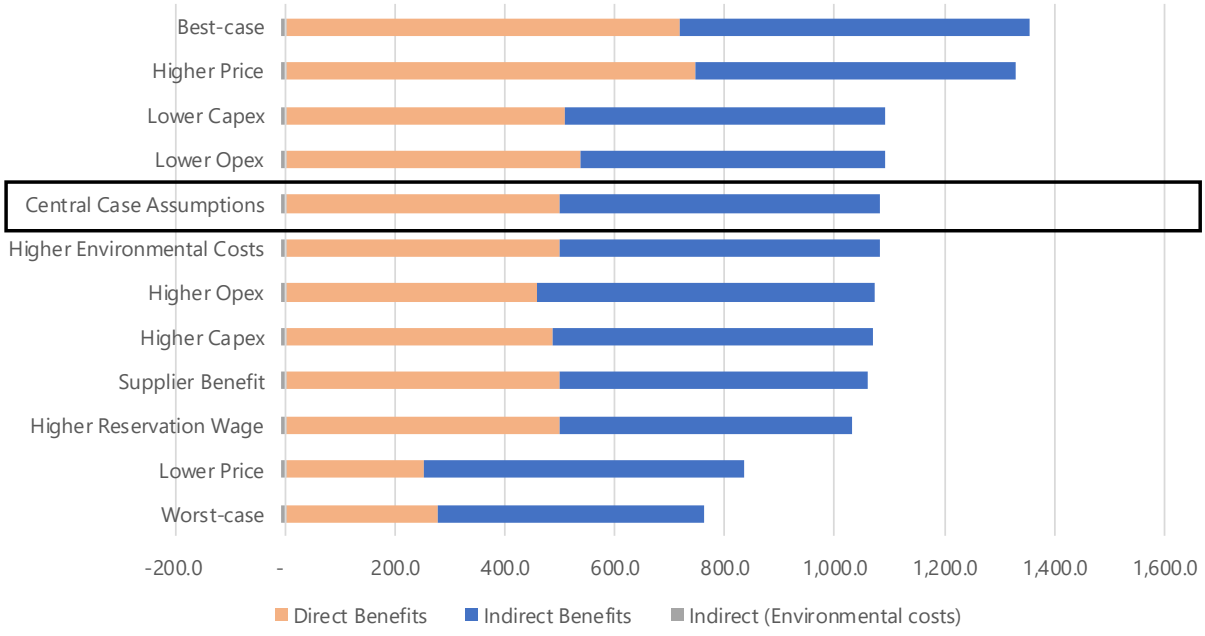
2.6.1 Results of sensitivity analysis

The results of the systematic sensitivity analysis are summarised in Figure 6. This sensitivity analysis shows that the estimated net benefits are ***robust*** in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

In isolation, the estimated net benefit of the proposed development is most sensitive to the coal price assumptions underpinning the analysis, but even assuming coal prices are 25 per cent lower than under the central case assumptions the net benefits are estimated to be $825.5 million in NPV terms, a reduction of 23.1 per cent from the central case assumptions.

The lower bound, or worst-case, estimate of net benefits, which takes the combined assumptions around coal prices, capital expenditure, operational expenditure as well as worker, environmental impacts and supplier benefits, yields an estimated net benefit of $754.3 million in NPV terms. The upper bound, or best-case, estimate, based on the combined optimistic assumptions, is $1,349.3 million in NPV terms.

Figure 6: Systematic sensitivity analysis of the CBA to key assumptions (NPV*, $ million^)



Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

It can also be inferred from the sensitivity analysis how large the non-quantified negative externalities would need to be before the proposed development would no longer represent a net benefit to the NSW community. Using the most conservative estimate, the worst-case assumptions, these externalities would need to be $754.3 million in NPV terms before the proposed development would represent a net negative return to NSW.

Given the relatively long time frame of the proposed development (2020 to 2048) the net benefits are particularly sensitive to the discount rate used for the analysis. Under central case assumptions the proposed development is expected to generate $1,073.2 million of net benefit using a 7 per cent discount

rate. Using a 4 per cent discount rate increases the net benefit to $1,588.3 million; conversely a 10 per cent discount decreases the net benefit to $751.2 million.

Appendix B provides a detailed account of the direct and indirect benefits and the indirect costs for each of the sensitivities conducted. The analysis shows that the net benefits of the Project remain ***robust*** under various assumptions. In addition, if conservatively the indirect benefits were all set to zero, that is suppliers were assumed to gain no benefit and workers reservation wages are equal to those earned in the Dendrobium Mine, the net benefits to NSW would remain positive.

3 Local Effects Analysis

Consistent with the Guidelines, the LEA uses a similar framework to the CBA presented in the previous section, but is focussed on the net economic impacts to the local community. The Guidelines refer to the local area as being consistent with the relevant SA3 as defined by the Australia Bureau of Statistics. In the case of this Project the Dapto – Port Kembla SA3 area is used for the LEA.

3.1 The Dapto – Port Kembla region

As shown in Figure 7, the Dapto – Port Kembla region is located to the south west of Wollongong. In 2016 The Dapto – Port Kembla SA3 has a population of approximately 77, 623 (ABS, 2018A). The region is home to a number of coal mines and the Port Kembla steel works. Port Kembla is also home to port facilities, exporting coal from the Southern Coal Field.

Figure 7: Dapto – Port Kembla SA3

Source: Australian Bureau of Statistics (2018B), MapData Services, stat.abs.gov.au/itt/r.jsp?ABSMaps

The Dendrobium Mine, Dendrobium Pit Top and access areas are located in the northern part of the SA3, adjacent to Kembla Heights, where the coal processing facilities are located in Port Kembla along the eastern shoreline of the SA3.

The underground operations are located within the Illawarra Catchment Reserve (SA3 – 10702), this SA3 has no population and does not have an industrial base. The Illawarra Catchment Reserve is home to

number of other coal mines including the Cordeaux Mine and the underground operations for the Russell Vale Colliery.

3.1.1 Regional characteristics

Table 28 outlines the education and employment characteristics of persons who reside within the Dapto – Port Kembla SA3 region. The region can generally be classified as being highly industrial with a high proportion of trades workers, machinery operators and drivers.

The region is a major producer of steel products and port services, with approximately 17 per cent of workers in the region employed in the manufacturing sector and a further 9 per cent within the Transport sector. The manufacturing share in the Dapto-Port Kembla SA3 region is almost three times higher than the NSW average and transport's share is almost twice as high as the state-wide average.

The region's work force also has a relatively high proportion of workers with a Certificate III and IV attainment. Workers with Certificate III and IV account for 42.7 per cent of the region's workers, compared to 30.6 per cent for NSW.

Technicians and trade workers account for 19.3 per cent of the workforce in the region, compared to 12.9 per cent for NSW. Similarly, machinery operators and drivers account for 13.7 per cent, more than double the state-wide average of 6.2 per cent.

Both the educational attainment and occupational structure is a result of the high share of manufacturing, transportation and construction workers in the region.

Mining employment accounts for a relatively small share of employment for Dapto – Port Kembla-based employees, with 2.4 per cent of workers.

Table 28: Education and employment characteristics

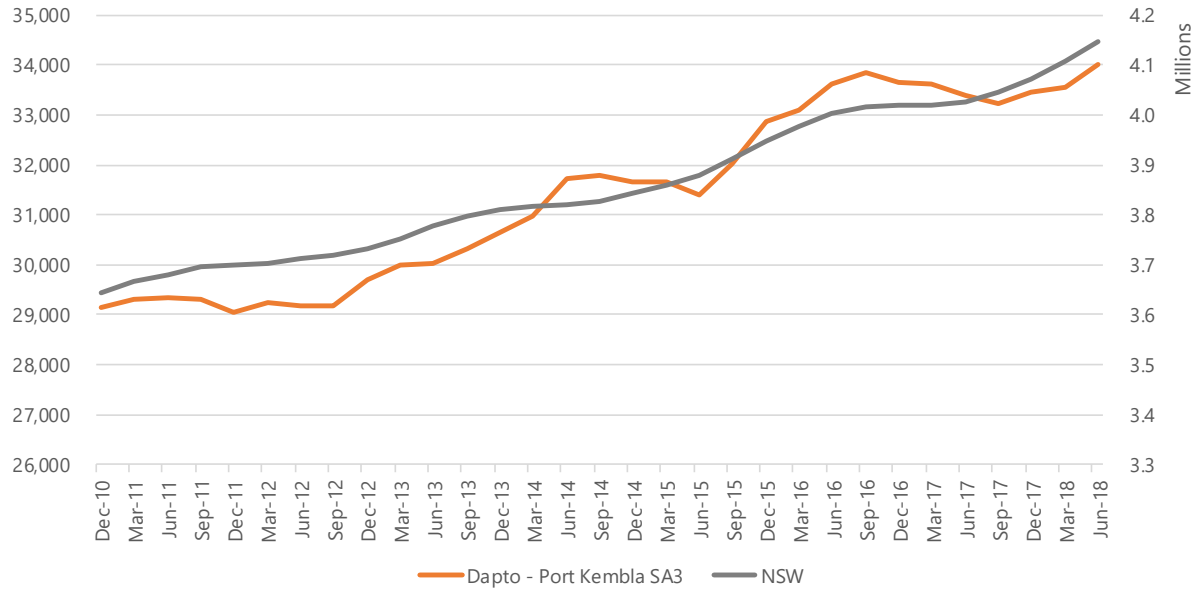
	Dapto - Port Kembla	New South Wales
Level of highest educational attainment	%	%
Higher Education - Bachelor Degree and above	17.4	33.4
Certificate III & IV and Diploma	42.7	30.6
Secondary Education (incl. Certificate I and II)	39.9	36.1
Occupation	%	%
Managers	10.3	13.7
Professionals	14.8	24.1
Technicians and Trades Workers	19.3	12.9
Community and Personal Service Workers	10.1	10.6
Clerical and Administrative Workers	11.5	14.1
Sales Workers	9.0	9.4
Machinery Operators and Drivers	13.7	6.2
Labourers	11.4	9.0
Industry of employment	%	%
Agriculture, Forestry and Fishing	0.4	2.3
Mining	2.4	1.0
Manufacturing	17.3	6.2
Electricity, Gas, Water and Waste Services	2.2	1.0
Construction	10.2	8.8
Wholesale Trade	3.0	3.2
Retail Trade	10.4	10.2
Accommodation and Food Services	6.0	7.5
Transport, Postal and Warehousing	9.2	4.9
Information Media and Telecommunications	0.6	2.3
Financial and Insurance Services	1.0	5.2
Rental, Hiring and Real Estate Services	1.2	1.9
Professional, Scientific and Technical Services	3.2	8.5
Administrative and Support Services	3.6	3.7
Public Administration and Safety	3.3	6.1
Education and Training	6.9	8.8
Health Care and Social Assistance	13.0	13.1
Arts and Recreation Services	0.9	1.6
Other Services	5.2	3.9

Source: 2016 Census General Community Profile, Dapto – Port Kembla SA3, New South Wales and Australia, Australian Bureau of Statistics cat. no. 2001.0

3.1.2 Employment outcomes

Figure 8 shows total employment in the Dapto – Port Kembla SA3 region and the NSW economy, from December 2010 to June 2018. Employment in the region peaked in June 2018 at just over 34,000 workers. Over the period since December 2017 employment within the region has steadily increased.

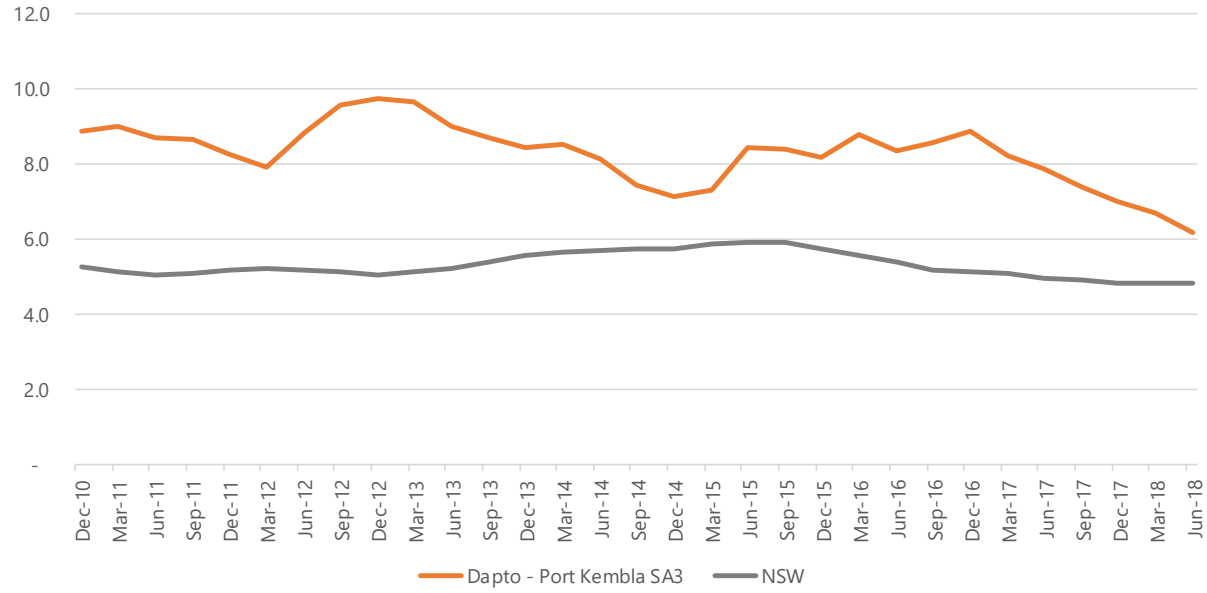
Figure 8: Employment, Dapto – Port Kembla SA3 and New South Wales



Source: Department of Jobs and Small Business, *SA2 Data tables – Small Area Labour Markets – June quarter 2018* (September 2018)

As shown in Figure 9, unemployment in the region has been consistently higher than NSW. Unemployment in the local region, over the period December 2010 to June 2018, peaked in December 2012 at 9.7 per cent.

Figure 9: Unemployment rate (per cent), Dapto – Port Kembla SA3 and New South Wales



Source: Department of Jobs and Small Business, *SA2 Data tables – Small Area Labour Markets – June quarter 2018* (September 2018)

3.2 Local Effects Analysis

The LEA accounts for the economic benefits to the Dapto – Port Kembla region only. It does not include any economic benefits that may accrue to the major regional centres that are located adjacent, including the wider Illawarra region and Sydney.

Given the nature of coal operations and the export port located in Port Kembla, many of the inputs may be supplied from the broader Illawarra. In addition, analysis from South32 indicates over the life of the proposed development only a proportion of the inputs will be supplied from the Dapto – Port Kembla region and most employees are sourced from the wider region. As a result, this Project would generate economic benefits to these regions; for example, those supplies that are sourced from the wider Wollongong region, Sydney and regional communities to the south and the west of the proposed development.

Underpinning the LEA are the assumptions that:

- Local rates, of $3.0 million in NPV terms are paid to the City of Wollongong Local Government Area;
- No net producer surplus accrues to the region (conservative assumptions);
- No company income tax accrues to the Dapto – Port Kembla SA3 region (conservative assumptions);
- Based on information provided by South32, 19.4 per cent of the workforce requirement of the proposed development come from the SA3 region;
- 32 per cent of suppliers are located within the Illawarra region, which includes Wollongong, Wollondilly, Campbelltown and Camden. It is assumed that 15 per cent of intermediate inputs will be supplied from the smaller SA3 region; and
- Indirect costs associated with air quality have been apportioned to the smaller Dapto-Port Kembla SA3 region in proportion to the Wollongong SUA region, while the indirect costs associated with GHG have been apportioned to the NSW population.

As a result of these assumptions, it is expected the proposed development will generate indirect benefits to local suppliers and employees of $43.5 million and $71.8 million respectively in NPV terms over the baseline case, as outlined in Table 28. The incremental indirect costs associated with the Project are allocated to the SA3 region. The proposed development is estimated to confer a net benefit on the Dapto – Port Kembla SA3 region of $116.1 million in NPV terms.

Table 29: Estimated Local Effects Analysis of the proposed development ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	-		
2. Royalties, payroll tax and Council rates	3.0		
3. Company tax	-		
Total direct benefits	**3.0**	**Total direct costs**	**-**
Indirect benefits	**-**	**Indirect costs**	
1. Net economic benefit to landholders	-	1. Air quality	2.2
2. Net economic benefit to NSW workers	71.8	2. Greenhouse gas emissions	0.0
3. Net economic benefit to NSW suppliers	43.5	3. Visual amenity	-
	-	4. Transport impact	-
	-	5. Net public infrastructure cost	-
	-	6. Surface water impact	-
	-	8. Residual value of land	-
	-	7. Biodiversity impact^^	-
	-	8. Noise impact	-
	-	9. Loss of surplus to other industries	-
	-	10. Water	-
	-	11. Aboriginal cultural and Historical heritage	-
	-	12. Subsidence^^	-
Total indirect benefits	**115.2**	**Indirect Costs**	**2.2**
Total Project economic benefit	**118.3**	**Incremental Indirect Cost**	**2.2**
NPV of project - ($m)	**116.1**		

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated in operational costs.

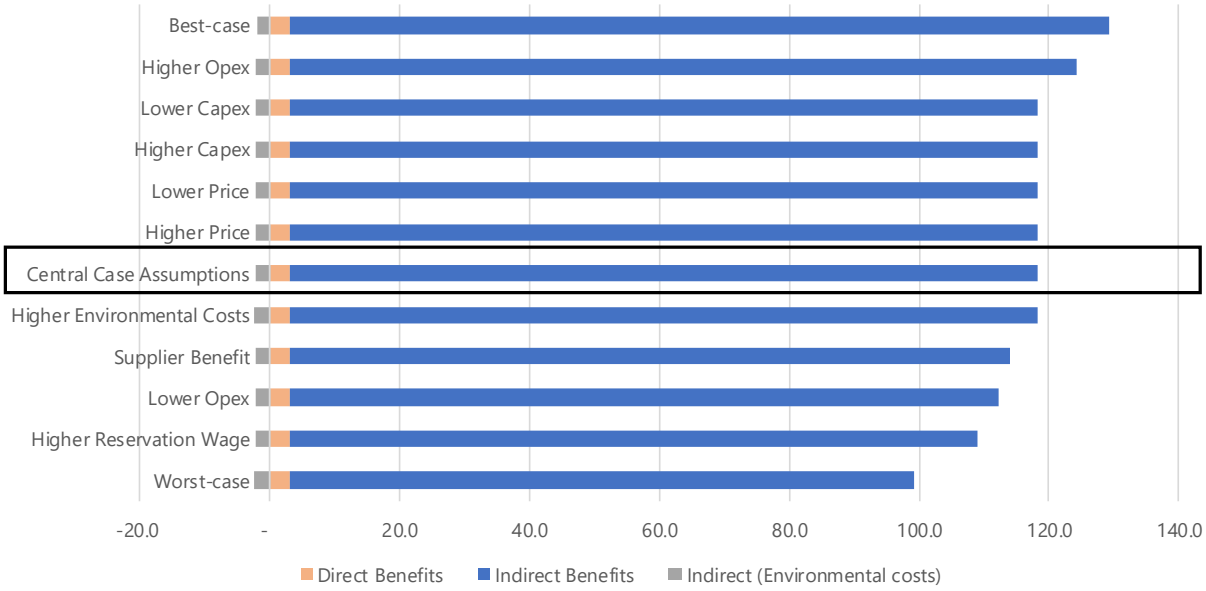
3.3 Sensitivity analysis

As outlined above the LEA relies on a number of modelling assumptions. Consistent with the Guidelines, this assessment provides a summary of the systematic sensitivity analysis undertaken for the proposed development. The sensitivity analysis tests the same assumptions outlined in the CBA.

The main drivers for the regional impact are the supplier and employee benefits. Those sensitivities that change the supplier benefits through lower operational costs, lower supplier benefit or employee benefit have the greatest impact on the regional net benefit.

The results of the systematic sensitivity analysis are summarised in Figure 10. This sensitivity analysis shows that the estimated net benefits are ***robust*** in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis. Full detail of the sensitivity analysis is presented in Appendix B. The lower bound, or worst-case, estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker and supplier benefits, yields an estimated net benefit of $96.8 million in NPV terms. The upper bound, or best-case, estimate, based on the most optimistic assumptions, is $127.4 million in NPV terms.

Figure 10: Systematic sensitivity analysis of the LEA to key assumptions (NPV*, $ million^)



Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate.

Given the relatively long time-frame of the proposed development (2020 to 2048) the net benefits are sensitive to the discount rate used for the analysis. Under the Central case assumptions, the proposed development is expected to generate $116.1 million of net benefit using a 7 per cent discount rate. Using a 4 per cent discount rate increases the net benefit to $170.9 million; conversely a 10 per cent discount decreases the net benefit to $82.4 million.

3.4 Regional Area Assessment

As outlined above, 19.4 per cent of workers in the Dendrobium Mine are sourced from the Dapto-Port Kembla SA3 region. A high proportion of workers, 93.4 per cent, are sourced from the wider region, that includes, Wollongong (including the local government areas of Kiama, Shellharbour, Wollongong City) and Wollondilly, Campbelltown and Camden. The wider region has a population of approximately 596,900 (Department of Planning and Environment, 2018).

3.4.1 Regional characteristics

Table 30 outlines the education and employment characteristics of persons who reside within the wider regional area. Workers in the region are generally employed in similar industries to those workers in the rest of NSW. The relatively small Dapto-Port Kembla region has relatively high proportion of employment in manufacturing, healthcare and social assistance and retail trade.

In the wider region employment in the manufacturing and transportation sectors is similar in proportion to those in NSW.

The wider region's work force also has a relatively high proportion of workers with secondary educational attainment, accounting for 48.2 per cent of the region's workers, compared to 36.1 per cent for NSW.

Professionals and technicians and trade workers account for 18.9 per cent and 15.5 per cent of the workforce in the region, respectively, compared to 24.1 per cent and 12.9 per cent for NSW.

Table 30: Education and employment characteristics (Wider regional area)

	Wider regional area	New South Wales
Level of highest educational attainment	%	%
Higher Education - Bachelor Degree and above	19.2	33.4
Certificate III & IV and Diploma	32.6	30.6
Secondary Education (incl. Certificate I and II)	48.2	36.1
Occupation	%	%
Managers	10.7	13.7
Professionals	18.9	24.1
Technicians and Trades Workers	15.5	12.9
Community and Personal Service Workers	11.8	10.6
Clerical and Administrative Workers	15.0	14.1
Sales Workers	9.7	9.4
Machinery Operators and Drivers	8.7	6.2
Labourers	9.7	9.0
Industry of employment	%	%
Agriculture, Forestry and Fishing	0.7	2.3
Mining	1.3	1.0
Manufacturing	7.7	6.2
Electricity, Gas, Water and Waste Services	1.1	1.0
Construction	10.6	8.8
Wholesale Trade	2.9	3.2
Retail Trade	10.8	10.2
Accommodation and Food Services	6.9	7.5
Transport, Postal and Warehousing	6.3	4.9
Information Media and Telecommunications	1.2	2.3
Financial and Insurance Services	3.9	5.2
Rental, Hiring and Real Estate Services	1.6	1.9
Professional, Scientific and Technical Services	5.3	8.5
Administrative and Support Services	3.5	3.7
Public Administration and Safety	7.2	6.1
Education and Training	9.9	8.8
Health Care and Social Assistance	13.6	13.1
Arts and Recreation Services	1.4	1.6
Other Services	4.1	3.9

Source: 2016 Census General Community Profile, Australian Bureau of Statistics cat. no. 2001.0

Supplier information from South32 suggests that 32 per cent of supplies are from the region that includes Wollongong, Wollondilly, Campbelltown and Camden.

The LEA, as outlined above, does not include the potential total net benefits to the wider regional area, and therefore likely understates the potential regional benefits. Table 31 provides an account of the potential benefits of the Project to this wider regional area.

Underpinning the wider area effects analysis, are the assumptions that:

- Local rates, of $4.8 million in NPV terms are paid to the City of Wollongong and the Wollondilly local governments;
- No net producer surplus accrues to the wider area (conservative assumption);
- No company income tax accrues to the wider area (conservative assumption);
- Based on information provided by South32, 93.4 per cent of the workforce requirement of the proposed development come from the wider area;
- 32 per cent of suppliers are located within the Illawarra region that includes, Wollongong, Wollondilly, Campbelltown and Camden; and
- The costs associated with air quality and GHG are the same as those in the full CBA.

As a result of these assumptions, it is expected the proposed development will generate indirect benefits to local suppliers and employees of $92.8 million and $341.7 million in NPV terms over the baseline case. The proposed development is estimated to confer a net benefit on the wider area of $431.3 million in NPV terms.

Table 31: Estimated Wider Area Effects Analysis of the proposed development ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	-		
2. Royalties, payroll tax and Council rates	$4.8		
3. Company tax			
Total direct benefits	**$4.8**	**Total direct costs**	**-**
Indirect benefits		**Indirect costs**	
1. Net economic benefit to landholders		1. Air quality	8.0
2. Net economic benefit to NSW workers	$341.7	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	$92.8	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact^^	-
		8. Noise impact	-
		9. Loss of surplus to other industries	-
		10. Water	-
		11. Aboriginal cultural and Historical heritage	-
		12. Subsidence^^	-
Total indirect benefits	**$434.6**	**Indirect Costs**	**$8.1**
Total Project economic benefit	**$439.4**	**Incremental Indirect Cost**	**$8.1**
NPV of project - ($m)	**$431.3**		

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated in operational costs.

4 CGE Modelling Framework

The economy-wide impacts of the proposed development have been undertaken using a CGE model of the regional and NSW economy.

The aim of an economic impact study based on applied CGE modelling is to estimate the net benefit of the proposed development on economic activity and the living standards of those residing within the Dapto – Port Kembla SA3, the same region used for the LEA analysis, and in NSW.

CGE modelling is the preferred technique to assess the impacts of large projects as they are based on a more detailed representation of the economy, including the complex interactions between different sectors of the economy.[8] As a CGE model is able to analyse the impacts of the proposed development in a comprehensive, economy-wide framework meaning the modelling captures:

- ***Direct increases in demand*** associated with the proposed development (short term construction activity) as well as the assumed increases output attributable to increased coal production.
- ***Indirect increases in demand***, or flow-on effects associated with increased economic activity relating to both the construction phase of development and additional coal production.
- ***Labour market displacement*** caused by the direct increase in demand from a project of this nature (and the associated investment) on other sectors of the economy bidding up wages and 'crowding out' other sectors of the economy.
- ***Revenue leakage*** associated with the expropriation of profits from the Project to overseas interests (in this case, South32).

4.1 About Cadence Economics' CGE model

The estimates are based on the Cadence Economics General Equilibrium Model (CEGEM). CEGEM is a large scale, dynamic, multi-region, multi-sector model of the global economy, with an explicit representation of the Dapto – Port Kembla SA3 and the NSW economy. CEGEM is based on a substantial body of accepted microeconomic theory.

The model projects change in macroeconomic aggregates such as real gross state product (real GSP) which is an output measure of the NSW economy and real gross state income (real GSI) which is a welfare measure for NSW residents. At a regional level the model projects change in real gross regional product (real GRP) and real gross regional income (real GRI). The model also projects state-wide and regional employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced. A brief description of the model is presented in Box 1.

[8] See for example the Policy & Guidelines Paper produced by the NSW Treasury (2009).

Box 1: An overview of CEGEM

CEGEM is a multi-commodity, multi-region, dynamic model of the world economy. Like all economic models, CEGEM is a based on a range of assumptions, parameters and data that constitute an approximation to the working structure of an economy. Its construction has drawn on the key features of other economic models such as the global economic framework underpinning models, such as GTAP and GTEM, with state and regional modelling frameworks such as Monash-MMRF and TERM.

Labour, capital, land and a natural resource comprise the four factors of production. On a year-by-year basis, capital and labour are mobile between sectors, while land is mobile across agriculture. The natural resource is specific to mining and is not mobile. A representative household in each region owns all factors of production. This representative household receives all factor payments, tax revenue and interregional transfers. The household also determines the allocation of income between household consumption, government consumption and savings.

Capital in each region of the model accumulates by investment less depreciation in each period. Capital is mobile internationally in CEGEM where global investment equals global savings. Global savings are made available to invest across regions. Rates of return can differ to reflect region specific differences in risk premiums.

The model assumes labour markets operate in a model where employment and wages adjust in each year so that, for example, in the case of an increase in the demand for labour, the real wage rate increases in proportion to the increase in employment from its base case forecast level.

CEGEM determines regional supplies and demands of commodities through optimising behaviour of agents in perfectly competitive markets using constant returns to scale technologies. Under these assumptions, prices are set to cover costs and firms earn zero pure profits, with all returns paid to primary factors. This implies that changes in output prices are determined by changes in input prices of materials and primary factors.

In terms of specifying the elasticity of labour supply, Cadence follow the lead of the Australian Treasury and use a labour supply elasticity assumption of 0.15, which indicates a relatively 'inelastic' response from workers.

Importantly, in terms of interpreting the results as well as for consistency with the CBA analysis, real GSI represents the preferable welfare measure to the commonly reported change in real GSP (a measure of production). As a measure of income, Pant et al (2000) show how the change in real GSI is a good approximation to the ***equivalent variation*** welfare measure in global CGE models such as CEGEM. This measure is widely used by practitioners and can also be decomposed into various components to assist in the analysis of results. Real GSI is computationally more convenient than (say) an equivalent variation, and a more familiar concept to explain to decision makers (Layman, 2004).

As noted by Pant et al (2000), in considering welfare results in global CGE such as CEGEM, the main components are the change in: output (measured by real GSP), terms of trade and payments to foreigners. Of relevance in the discussion around estimating the net benefits of the proposed development are the terms of trade effects. These can be closely linked to changes in labour market conditions because any

increase in real wages as a result of higher levels of coal exports will result in an improvement in the terms of trade and, hence, welfare.

That noted, real GSI does not capture some non-market effects that can impact on the living standards of NSW residents. These could include impacts such as the noise impacts for residents or pollution as considered in the detailed CBA above.

CEGEM is a recursive dynamic model that solves year-on-year over a specified timeframe. The model is used to project the relationship between variables under different scenarios over a predefined period. A typical scenario is comprised of a reference case projection (or the Base case scenario) that forms the basis of the analysis. In this instance, the reference case assumes no proposed development investment or coal output from the Project. Set against this scenario is the policy scenario (or the Project case) under consideration.

4.1.1 Overview of scenarios

All scenarios outlined in the modelling below use the central case assumptions:

- Capital expenditure of $731.6 million; and
- Coal output of $3,922.4 million.

Cadence have also factored into our scenarios the benefits that flow from the proposed development outside of the Dapto – Port Kembla region and the NSW economy. This includes, the repatriation of profits out of the region to foreign shareholders, along with wages and the payments out of the region for royalties to the NSW Government and corporations tax to the Australian Government. Cadence have conservatively assumed these royalty payments accrue to the rest of NSW.

In addition, Cadence have factored into our scenarios the level of migration of workers from the rest of NSW into the Dapto-Port Kembla SA3. As outlined above, 19.4 per cent of the workers at the Dendrobium Mine reside in Dapto-Port Kembla, where the remainder are sourced from the Rest of NSW. This represents a migration into the region, increasing the labour supply in Dapto-Port Kembla and reducing the labour supply in the Rest of NSW.

4.2 Economy-wide modelling of the proposed development

The key macroeconomic variables projected under the core scenario is shown in Table 32. In the Dapto-Port Kembla region, the Project is projected to increase GRP by $2,382.8 million in NPV terms. GRI or regional welfare, is projected to increase by $578.6 million in NPV terms. The projected increase in GRI is significant to the relatively small region of Dapto-Port Kembla. In total, the Project is projected to increase welfare for each person in Dapto-Port Kembla by $6,670 in NPV terms.

For NSW, the projected increase in GSP is $2,285.8 million in NPV terms. GSI is projected to increase by $1,802.3 million.

Table 32: Project economy-wide impacts of the Project, 2020 – 2048

Variable	Description	Dapto-Port Kembla	NSW Total
Real GRP/GSP^	NPV* - $m	2,382.8	2,285.8
Real GRI/GSI^	NPV* - $m	578.6	1,802.3
Employment	Average - FTE^^	293.8	329.9
Real Wages	Average – Per cent^^	0.56	0.01
Real GRI per person^	NPV* - Dollars	$6,670	$192

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2020 to 2048.

Total employment in the region is projected to increase by 294 FTE workers on average. As outlined above the Project will employ 265 FTE workers on average, as a result 29 additional workers will be employed in other sectors of the economy in the Dapto-Port Kembla region, taking into account employment in supplier industries and any crowding out effects.

Across NSW, employment is projected to increase by 329.9 FTE comprising 265 direct FTE and around 65 flow on FTE.

The analysis above outlines the impacts of the Project over the whole time scale of the proposed development. The Project includes several phases, these are:

- Capital intensive phase, with some development of Area 5;
- Longwall operations in Area 5;
- Development work in Area 6 (while longwall operations are in Area 3C; and,
- Longwall operations in Area 6.

Table 33, provide an account of the economy-wide impacts during each of these phases, for an indicative year, for the Dapto Port Kembla region. The relative impacts do shift during each phase of the Project. During the capital intensive phase welfare, as measured by real GRI, in the region is similar in relative size with the gross regional product. As we move into the operational phases of the Project, the welfare measure falls in relative size to GRP, showing the impacts of the repatriation of income to other regions.

Table 33: Project economy-wide impacts of the Project to Dapto Port Kembla, 2020 – 2048

Variable	Description	Capital Intensive 2022	Longwall Area 5 2035	Development work Area 6 2040	Longwall Area 6 2046
Real GRP	Deviation (%)	1.5	3.3	1.8	2.9
	$million (real 2018)	88.5	261.0	161.9	293.3
Real GRI	Deviation (%)	1.5	1.1	0.4	0.7
	$million (real 2018)	94.7	103.5	40.6	96.0
Employment	Deviation (%)	0.6	1.1	0.5	0.7
	FTE	188.3	385.0	184.5	270.2
Real wages	Deviation (%)	1.7	0.3	0.5	0.6
Real GRI per Capita	Dollars (real 2018)	1,162.0	1,162.4	442.2	1,014.5

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2020 to 2048.

Table 34 outlines the economy-wide impacts to NSW during each phase of the Project.

Table 34: Project economy-wide impacts of the Project to NSW, 2020 – 2048

Variable	Description	Capital Intensive 2022	Longwall Area 5 2035	Development work Area 6 2040	Longwall Area 6 2046
Real GRP	Deviation (%)	0.01	0.03	0.02	0.02
	$million (real 2018)	79.3	245.5	156.4	283.9
Real GRI	Deviation (%)	0.02	0.02	0.01	0.02
	$million (real 2018)	109.1	231.2	109.5	230.3
Employment	Deviation (%)	0.003	0.003	0.002	0.002
	FTE	201.6	427.8	214.2	307.4
Real wages	Deviation (%)	0.016	0.009	0.009	0.010
Real GRI per Capita	Dollars (real 2018)	13.0	23.6	10.5	21.0

Source: Cadence Economics estimates based on information provided by South32. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Average over the period 2020 to 2048.

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APPENDIX A: FULL-YEAR INPUTS

Table 35: Central case assumptions – revenue projection (all years)

Year	ROM Output (Mt)	HCC (Mt)	Thermal Coal (Mt)	PCI (Mt)	HCC Price^	Thermal Coal Price^	PCI Price^	Total Revenue^
2020	0.16	0.08	0.04	-	183.16	97.49	143.93	18.89
2021	0.06	0.01	0.00	-	175.82	90.72	138.16	2.60
2022	0.17	0.14	0.01	-	173.77	88.01	136.55	25.23
2023	0.41	0.34	0.02	-	173.25	92.87	136.14	60.61
2024	1.25	1.07	0.02	-	173.25	92.87	136.14	187.32
2025	3.42	2.70	0.29	0.00	173.25	92.87	136.14	494.85
2026	5.18	4.25	0.18	0.15	173.25	92.87	136.14	773.69
2027	4.91	4.13	0.08	0.15	173.25	92.87	136.14	743.13
2028	4.43	3.30	0.07	0.54	173.25	92.87	136.14	652.52
2029	4.29	1.72	0.04	2.09	173.25	92.87	136.14	585.65
2030	3.73	2.46	0.04	0.83	173.25	92.87	136.14	542.63
2031	3.76	1.83	0.04	1.51	173.25	92.87	136.14	525.61
2032	4.14	1.72	0.04	1.97	173.25	92.87	136.14	569.07
2033	3.84	1.52	0.05	1.88	173.25	92.87	136.14	524.10
2034	3.27	2.31	0.08	0.52	173.25	92.87	136.14	477.75
2035	2.93	2.47	0.09	-	173.25	92.87	136.14	435.88
2036	3.16	2.68	0.07	-	173.25	92.87	136.14	470.56
2037	3.56	2.91	0.16	-	173.25	92.87	136.14	518.47
2038	3.48	2.75	0.24	-	173.25	92.87	136.14	498.20
2039	0.46	0.33	0.07	-	173.25	92.87	136.14	62.83
2040	0.28	0.16	0.06	-	173.25	92.87	136.14	32.73
2041	0.33	0.17	0.07	-	173.25	92.87	136.14	36.56
2042	0.33	0.16	0.07	-	173.25	92.87	136.14	34.73
2043	2.31	1.08	0.51	-	173.25	92.87	136.14	234.99
2044	3.58	1.80	0.76	-	173.25	92.87	136.14	381.65
2045	4.33	2.11	0.91	-	173.25	92.87	136.14	450.84
2046	4.66	2.20	1.00	-	173.25	92.87	136.14	473.76
2047	4.72	2.20	1.08	-	173.25	92.87	136.14	481.21
2048	0.40	0.19	0.09	-	173.25	92.87	136.14	41.72
Total	77.6	48.8	6.2	9.6				10,337.8
NPV*								3,922.43

Source: Cadence Economics estimates ^ Real 2018 Australian dollars. * NPV to 2018 based on a 7 per cent real discount rate.

APPENDIX B: SENSITIVITY ANALYSIS – CBA AND LEA

Table 36: Sensitivity analysis of the net benefits of the proposed development (NPV*, $ million)**

	Central Case Assumptions	Higher Price	Lower Price	Higher Opex	Lower Opex	Higher Capex	Lower Capex	Higher Reservation Wage	Supplier Benefit	Higher Environmental Costs	Worst-case	Best-case	Central Case Assumptions (4%)	Central Case Assumptions (10%)
Direct Benefits	497.8	746.3	250.2	457.7	538.0	486.0	509.7	497.8	497.8	497.8	278.1	718.1	740.8	343.4
1. Net producer surplus	74.9	177.0	-27.9	52.0	97.7	64.9	85.0	74.9	74.9	74.9	-14.9	164.3	127.1	41.5
2. Royalties, payroll tax and Council rates	272.1	332.9	211.3	272.1	272.1	272.1	272.1	272.1	272.1	272.1	211.3	332.9	398.7	192.9
3. Company income tax apportioned	150.8	236.4	66.8	133.6	168.2	149.0	152.6	150.8	150.8	150.8	81.7	220.9	215.1	109.0
Indirect Benefits	583.4	583.4	583.4	613.7	553.2	583.4	583.4	534.2	561.7	583.4	485.2	638.5	859.7	413.5
1. Net economic benefit to existing landholders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Net economic benefit to Local workers	365.8	365.8	365.8	365.8	365.8	365.8	365.8	316.6	365.8	365.8	316.6	365.8	537.1	259.9
3. Net economic benefit to Local suppliers	217.6	217.6	217.6	247.9	187.3	217.6	217.6	217.6	195.9	217.6	168.6	272.7	322.6	153.6
Indirect (Environmental costs)	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.9	8.9	7.3	12.2	5.6
Net Benefits	1,073.2	1,321.7	825.5	1,063.3	1,083.1	1,061.3	1,085.1	1,023.9	1,051.4	1,072.3	754.3	1,349.3	1,588.3	751.2

Source: Cadence Economics estimated based on information from various sources. Estimated as the benefits of the Project case less the Baseline case. * NPV to 2018 * in 2018 dollars based on a 7 per cent real discount rate.

Table 37: Sensitivity analysis of the net regional benefits of the proposed development (NPV*, $ million)**

	Central Case Assumptions	Higher Price	Lower Price	Higher Opex	Lower Opex	Higher Capex	Lower Capex	Higher Reservation Wage	Supplier Benefit	Higher Environmental Costs	Worst-case	Best-case	Central Case Assumptions (4%)	Central Case Assumptions (10%)
Direct Benefits	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.2	2.2
1. Net producer surplus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Royalties, payroll tax and Council rates	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.2	2.2
3. Company income tax apportioned	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Benefits	115.4	115.4	115.4	121.4	109.3	115.4	115.4	106.1	111.0	115.4	96.3	126.4	170.0	81.8
1. Net economic benefit to existing landholders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Net economic benefit to Local workers	71.8	71.8	71.8	71.8	71.8	71.8	71.8	62.5	71.8	71.8	62.5	71.8	105.5	51.1
3. Net economic benefit to Local suppliers	43.5	43.5	43.5	49.6	37.5	43.5	43.5	43.5	39.2	43.5	33.7	54.5	64.5	30.7
Indirect (Environmental costs)	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.4	2.4	2.0	3.3	1.5
Net Benefits	116.1	116.1	116.1	122.2	110.1	116.1	116.1	106.8	111.8	115.9	96.8	127.4	170.9	82.4

Source: Cadence Economics estimated based on information from various sources. Estimated as the benefits of the Project case less the Baseline case. * NPV to 2018 * in 2018 dollars based on a 7 per cent real discount rate.

APPENDIX C: PROJECT SCOPE

The analysis in this appendix outlines the net benefits of the proposed development, to include Area 3C. The inclusion of Area 3C increases the Project output to 93.7 Mt of ROM coal. The appendix also includes two further alternatives that included Area 3C which varied the environmental externalities as follows:

- Low Scenario – where there is no direct undermining of upland swamps;
- High Scenario – where no standard South32 mine planning controls are incorporated (e.g. setbacks from rivers etc.)

For both the low and high scenario, Project underground mine workings are included as well as Area 3C (i.e. Area 5, 6 and 3C).

To estimate the net economic benefits of these scenarios, Cadence used the same information as outlined above, including detailed financial models from South32. To estimate the indirect costs Cadence prorated the costs by the ROM coal extracted.

These alternatives are further discussed in the Environmental Impact Statement Main Report. The results are described in the subsections below.

Scenario with inclusion of Area 3C

As outlined in the Introduction, the economic assessment in this Appendix provides an account of including Area 3C within the Project case and two further alternative Project cases. That is, it assesses the potential impacts of development of the Project proposed Area 5 and Area 6 as well as the induced mining within the approved Area 3C. In total the inclusion of Area 3C provides an additional 16.1 Mt of ROM coal, for a total output of 93.7 Mt. This represents an additional output of 20.8 per cent over the core Project output of 77.6 Mt.

The results are summarised in Table 38. This net benefit is estimated to be $1,188.8 million in net present value (NPV)[9] terms. This is comprised of $547.3 million and $650.8 million in direct and indirect benefits respectively. The incremental indirect costs of the Project are estimated to be $9.2 million in NPV terms.

Table 38: Project with 3C - estimated net benefits of the proposed development ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	88.9		
2. Royalties, payroll tax and Council rates	299.3		
3. Company income tax apportioned to NSW	159.1		
Total direct benefits	**547.3**	**Total direct costs**	**-**
Indirect benefits		**Indirect costs**	
1. Net economic benefit to landholders		1. Air quality	9.1
2. Net economic benefit to NSW workers	401.6	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	249.2	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact^^	-
		8. Noise impact	-
		9. Loss of surplus to other industries	-
		10. Water ^^	-
		11. Aboriginal cultural and Historical heritage ^^	-
		12. Subsidence^^	-
Total indirect benefits	**650.8**	**Indirect Costs**	**103.5**
Total Project economic benefit	**1,198.0**	**Incremental Indirect Cost**	**9.2**
NPV of project - ($m)	**1,188.8**		

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated into mitigation and management costs.

The net benefit of the Project scenarios that includes Area 3C is $1,188.8 million in NPV.

Low Scenario

The Low Scenario reduces coal output by 21.2 Mt of ROM coal, for a total output of 72.5 Mt. This represents reduced output of 22.6 per cent over the Project (including Area 3C) output of 93.7 Mt.

The results are summarised in Table 39, the net benefit of the low scenario is $968.5 million in net NPV terms, a reduction of 18.5 per cent over the Project (including Area 3C) scenario. This is comprised of $368.9 million and $607.1 million in direct and indirect benefits respectively. The incremental indirect costs of the Project are estimated to be $7.5 million in NPV terms.

[9] All NPV figures reported are in real 2018 Australian dollars based on a 7 per cent real discount rate (unless otherwise stated).

Table 39: Low Scenario - estimated net benefits of the proposed development ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	20.5		
2. Royalties, payroll tax and Council rates	247.5		
3. Company income tax apportioned to NSW	100.9		
Total direct benefits	**368.9**	**Total direct costs**	**-**
Indirect benefits		**Indirect costs**	
1. Net economic benefit to landholders		1. Air quality	7.4
2. Net economic benefit to NSW workers	369.3	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	237.8	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact^^	-
		8. Noise impact	-
		9. Loss of surplus to other industries	-
		10. Water ^^	-
		11. Aboriginal cultural and Historical heritage ^^	-
		12. Subsidence^^	-
Total indirect benefits	**607.1**	**Indirect Costs**	**101.8**
Total Project economic benefit	**975.9**	**Incremental Indirect Cost**	**7.5**
NPV of project - ($m)	**968.5**		**-**

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated into mitigation and management costs.

High Scenario

The High Scenario increased coal output by 19.2 Mt of ROM coal, for a total output of 112.9 Mt. This represents increased output of 20.5 per cent over the Project (including Area 3C) output of 93.7 Mt.

The results are summarised in Table 40. The net benefits of the high scenario are estimated to be $1,271.1 million in NPV terms, an increase of 6.9 per cent over the Project (including Area 3C) scenario. This is comprised of $614.1 million and $666.9 million in direct and indirect benefits respectively. The incremental indirect costs of the Project are estimated to be $9.9 million in NPV terms.

Table 40: High Scenario - estimated net benefits of the proposed development ($ million^)

Benefits	NPV*	Costs	NPV*
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	107.2		
2. Royalties, payroll tax and Council rates	319.6		
3. Company income tax apportioned to NSW	187.4		
Total direct benefits	**614.1**	**Total direct costs**	**-**
Indirect benefits	**-**	**Indirect costs**	
1. Net economic benefit to landholders	-	1. Air quality	9.7
2. Net economic benefit to NSW workers	412.8	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	254.1	3. Visual amenity	-
	-	4. Transport impact	-
	-	5. Net public infrastructure cost	-
	-	6. Surface water impact	-
	-	8. Residual value of land	-
	-	7. Biodiversity impact^^	-
	-	8. Noise impact	-
	-	9. Loss of surplus to other industries	-
	-	10. Water ^^	-
	-	11. Aboriginal cultural and Historical heritage ^^	-
	-	12. Subsidence^^	-
Total indirect benefits	**666.9**	**Indirect Costs**	**104.2**
Total Project economic benefit	**1,281.0**	**Incremental Indirect Cost**	**9.9**
NPV of project - ($m)	**1,271.1**		**-**

Source: Cadence Economics estimated based on information from various sources. ^ Real 2018 Australian dollars. * NPV in 2018 Australian dollars based on a 7 per cent real discount rate. ^^ Incorporated into mitigation and management costs.