Appendix L

Economic Assessment

Narrabri Underground Mine Stage 3 Extension Project

Environmental Impact Statement

AnalytEcon

NARRABRI UNDERGROUND MINE STAGE 3 EXTENSION PROJECT

Economic Assessment prepared for
Narrabri Coal Operations Pty Ltd

FINAL REPORT

October 2020

ACN 140 021 450

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Abbreviations

ABS	Australian Bureau of Statistics
ACHMP	Aboriginal Cultural Heritage Management Plan
AIP	Aquifer Interference Policy
CBA	Cost-benefit analysis
CHPP	Coal handling and preparation plant
EEX	European Energy Exchange
EA	Economic assessment
EA Guidelines	Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals (2015)
EA Technical Notes	Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals (2018)
EIS	Environmental impact statement
EPA	Environment Protection Authority
EUA	European emission allowance
FTE	Full-time equivalent
GAB	Great Artesian Basin
GDE	Groundwater dependent ecosystem
GDP	Gross domestic product
GHG	Greenhouse gas
GSC	Gunnedah Shire Council
GSP	Gross State Product
GVA	Gross value of agricultural production
ha	Hectare
LEA	Local effects analysis
LGA	Local Government Area
LQ	Location quotient
MDB	Murray Darling Basin
ML	Megalitres

MLA	Mining Lease Application
Mt	Million tonnes
Mt CO_{2-e}	Million tonnes of carbon dioxide equivalent
Mtpa	Million tonnes per annum
NPfI	Noise Policy for Industry
Project Region	Local region consisting of Narrabri Shire and Gunnedah Shire
NCOPL	Narrabri Coal Operations Pty Ltd
NMP	Noise Management Plan
NPV	Net Present Value
NSC	Narrabri Shire Council
NSW	New South Wales
NSW Government Guide	NSW Government Guide to Cost-Benefit Analysis (2017)
PCI	Pulverised coal injection
PM_{10}	Particulate matter less than 10 microns
$PM_{2.5}$	Particulate matter less than 2.5 microns;
RBA	Reserve Bank of Australia
ROM	Run of mine
SEARs	Secretary's Environmental Assessment Requirements
SA2	Narrabri Statistical Area 2
SA3 Region	Local region comprising the Moree – Narrabri Statistical Area 3
SIA	Social Impact Assessment
t CO_{2-e}	tonne of carbon dioxide-equivalent
VLAMP	Voluntary Land Acquisition and Mitigation Policy

EXECUTIVE SUMMARY

The Narrabri Mine is located approximately 25 kilometres (km) south east of Narrabri and approximately 60 km north west of Gunnedah within the Narrabri Shire Council Local Government Area (LGA) of New South Wales (NSW). The Narrabri Mine is operated by Narrabri Coal Operations Pty Ltd (NCOPL).

NCOPL is seeking a new Development Consent under the State Significant Development provisions of Part 4 of the NSW *Environmental Planning and Assessment Act 1979* for the Narrabri Underground Mine Stage 3 Extension Project (the Project). The Project involves an extension to the south of the approved underground mining area to gain access to additional coal reserves within Mining Lease Applications (MLAs) 1 and 2, an extension of the mine life to 2044, and development of supporting surface infrastructure. Run-of-mine (ROM) coal production would occur at a rate of up to 11 million tonnes per annum (Mtpa), consistent with the currently approved limit.

This Economic Assessment (EA) forms part of the Environmental Impact Statement which has been prepared to accompany the Development Application for the Project, with reference to the economic components of the Secretary's Environmental Assessment Requirements. The EA has been prepared in accordance with the NSW Government's '*Guidelines For The Economic Assessment Of Mining And Coal Seam Gas Proposals*' (NSW Government 2015) (the EA Guidelines) and the '*Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*' (NSW Government 2018). The EA Guidelines require the following analyses to be undertaken:

- a cost-benefit analysis (CBA) to assess the incremental net benefit that the Project would deliver to the NSW community; and
- a local effects analysis (LEA) to assess the incremental net benefit that the Project would deliver to the local region.

COST-BENEFIT ANALYSIS

In this report, the net benefits to NSW are derived by comparing outcomes in the 'Project Scenario' (whereby the Project is approved) with outcomes in the 'Reference Case', whereby the Project is not approved and mining of the approved mine layout continues. Although operations at the Narrabri Mine are currently approved through to July 2031, the Reference Case extends to 2034 to allow for all of the approved mine layout be mined. This Reference Case assumption is conservative since it implies that additional NSW benefits are attributed to the Reference Case from 2032 to 2034.

Table ES-1 summarises the estimated incremental net benefits of the Project for NSW: the additional net benefits that would be generated by the Project relative to the 'Reference Case' to the benefit of the NSW community.

The incremental net benefit of the Project for NSW is estimated at $599 million in net present value (NPV) terms, consisting of royalties of $259 million in NPV terms, the NSW share of company income tax of $177 million in NPV terms, and a NSW share of the net producer surplus of $163 million in NPV terms.

Table ES-1 Incremental net benefits of the Project for NSW community ($2020)

Incremental direct and indirect costs	NPV $m	Incremental direct and indirect benefits	NPV $m
External effects (GHG emissions)	$1	Royalties	$259
		NSW share of company income tax	$177
		Net producer surplus	$163
Total direct and indirect costs	$1	Total direct and indirect benefits	$599
Net benefits to NSW			$599

Note: Totals may not sum precisely due to rounding.
Source: AnalytEcon.

It is noted that the Project is also likely to result in significant 'economic benefits to suppliers' – NCOPL would be expected to direct an additional $775 million in NPV terms in operating expenditures to NSW suppliers between 2022 and 2044 if the Project is approved. As it is difficult to accurately calculate the net benefits accruing to suppliers, these benefits have conservatively been excluded from the estimated incremental net benefits of the Project for NSW outlined in Table ES-1.

In addition, the EA Guidelines set out a prescriptive methodology for the CBA that generally does not account for 'economic benefits to workers': the additional wages and salary payments that would accrue to the Project operational workforce following the closure of the currently approved Narrabri Mine. Table ES-1 therefore excludes the additional disposable income benefits that would accrue to NSW operational workers. These disposable income benefits are estimated at $113 million ($38 million in NPV terms).

The Project would potentially give rise to external effects that would impact third parties. However, with the exception of greenhouse gas (GHG) emissions, NCOPL would mitigate these external effects, including by implementing various management and compensation measures, by purchasing the requisite water licenses, and by implementing a biodiversity offset strategy. The costs of these external effects would therefore be internalised by NCOPL, so that no net cost is attributable to the NSW community.

Where GHG emissions are concerned, the NSW share of incremental GHG emissions attributable to the Project is estimated at around $860,000 in NPV terms; these costs represent a cost to the NSW community.

The results of sensitivities undertaken to establish the robustness of the net benefit estimates to the underlying assumptions suggests that the Project would generate significant net benefits to NSW in a broad range of circumstances.

FLOW-ON EFFECTS OF THE PROJECT

In addition to the immediate net benefits attributable to the Project, the Project would generate 'second round' or 'flow-on' effects. Flow-on effects are the result of the additional expenditures from a development. The additional demand for goods and services sets the economy in motion as businesses buy and sell goods and services from one another, and households earn and spend additional income. These linkages cause the total effects on the economy to exceed the initial change in demand as a result of the Project.

The incremental flow-on benefits for NSW have been derived using the same assumptions as those used for the CBA. The flow-on benefits for NSW are estimated as:

- on average an additional 162 full-time equivalent (FTE) jobs per annum over the life of the Project; and
- additional value-added accruing to NSW of $192 million in NPV terms, or $15 million per annum.

While the Project would result in the displacement of agricultural land, the resulting (contractionary) flow-on effects are immaterial at the State level. They are, however, potentially material at the level of the local region where they have been accounted for in the calculation of local (income and employment) flow-on effects.

LOCAL EFFECTS ANALYSIS

Local region

For the purpose of undertaking the LEA, the EA Guidelines require proponents to adopt a study area that should match a Statistical Area Level 3 (SA3) geographic definition. In the case of the Project, the relevant SA3 area is the 'Moree - Narrabri' SA3 Region (the SA3 Region). The SA3 Region includes Moree Plains Shire and most of Narrabri Shire.

At present 30 per cent of the operational workforce of the Narrabri Mine (comprising both NCOPL employees and long-term contractors) reside in Narrabri Shire, 29 per cent reside in Gunnedah Shire, 41 per cent reside elsewhere, but none reside in Moree Plains Shire. An LEA prepared for the SA3 Region would therefore capture only a small share of the local economic impacts of the Project.

The approach adopted in this EA is therefore to also consider the local impacts of the Project for a second region that better aligns with the places of residence of the Project local workforce:

- consistent with the EA Guidelines, the SA3 Region, which encompasses the place of residence of around 30 per cent of the operational workforce; and
- the 'Project Region', consisting of Narrabri Shire and Gunnedah Shire, which captures the places of residence of around 59 per cent of the operational workforce.

Net benefits of the Project for the local region

Table ES-2 summarises the net effects of the Project for the local region in the format required by the EA Guidelines.

The Project would allow for continued employment of up to approximately 520 FTE personnel at the Narrabri Mine. In addition, there would be multiple, short periods of development activity throughout the Project life as infrastructure development occurs, which would require approximately 20 FTE personnel (in addition to the operational workforce). Employment-related benefits (rows (2) and (3)) refer to the additional employment and the additional disposable income accruing to the operational workforce that the Project would bring to the local region. The Project would employ an average operational workforce of 370 FTE workers between 2022 and 2044, which would translate to:

- In the Project Scenario, an annual average of 218 FTE operational workers are expected to live in the Project Region, compared to an annual average of 111 FTE operational workers in the SA3 Region.
- In incremental terms – considering the Project Scenario relative to the Reference Case – the Project would employ an annual average of 99 FTE operational workers in the Project Region, compared to 51 in the SA3 Region.
- If broader employment flow-on effects are taken into account (and accounting for a small reduction in agricultural employment), the total incremental employment effects are estimated at an annual average of 168 FTE operational jobs for the Project Region, or 82 FTE operational jobs for the SA3 Region.

The disposable income accruing to the Project operational workforce between 2022 and 2044 is estimated at $537 million in NPV terms, which would translate to:

- The disposable income accruing to the operational workers expected to live in the Project Region is estimated at $317 million in NPV terms, compared to $161 million in NPV terms for the SA3 Region.
- The net local disposable income refers to the difference between the average wages paid to the local operational workforce in the Project Scenario relative to the Reference Case, and then additionally comparing that difference to the average local wage. On that basis, the incremental disposable income accruing to the Project operational workforce is estimated at $55 million in NPV terms for the Project Region, and $30 million for the SA3 Region.
- If broader disposable income flow-on effects are taken into account (also accounting for a small reduction in agricultural income), the total local income effects are estimated at $117 million in NPV terms for the Project Region and $54 million in NPV terms for the SA3 Region.

Total operating expenditures for the Project between 2022 and 2044 are estimated to amount to $4,126 million in NPV terms (row (4)). A share of these expenditures takes the form of purchases from local suppliers. Assuming that similar shares of operating expenditures are directed towards local suppliers going forward, $247 million in NPV terms would be sourced from suppliers in the Project Region, or $160 million in NPV terms from suppliers in the SA3 Region. If purchases from local suppliers in the Reference Case are deducted, the net additional purchases from local suppliers are estimated at $65 million in NPV terms for the Project Region or $43 million in NPV terms for the SA3 Region.

Row (5) focuses on local government rate payments. If the Project is approved, NCOPL would pay around $3.9 million in NPV terms in rate payments to Narrabri Shire Council, or $1.8 million in NPV terms more than in the Reference Case.

Row (6) refers to 'externalities', or potential negative environmental or other impacts of the Project on third parties. Where such impacts are expected to occur, NCOPL would mitigate these, for instance via the implementation of management and compensation measures, the purchase of the requisite water licenses, and through the implementation of a biodiversity offset strategy. No net cost should therefore be attributed to the local region. For all practical purposes, the societal costs of any GHG emissions that might be attributed to the local region are zero.

Table ES-2. LEA Summary ($2020, 2022 to 2044)

(A)			(B)	(C)		(D)		(E)	
			Project direct: Total	Project direct: Local		Net effect: Local		Total Local Effects	
				Narrabri Region	SA3 Region	Narrabri Region	SA3 Region	Narrabri Region	SA3 Region
(1)	Employment related								
(2)	Jobs created	Annual average FTE jobs	370	218	111	99	51	168	82
(3)	Disposable income	NPV $m	$537	$317	$161	$55	$30	$117	$54
(4)	Other, non-labour expenditure	NPV $m	$4,126	$247	$160	$65	$43	$65	$43
(5)	Local government rates	NPV $m	$3.9	$3.9	$3.9	$1.8	$1.8	$1.8	$1.8
(6)	Externality benefit/cost	NPV $m							

Note: * Refers to the sum of direct employment/disposable income effects plus flow-on employment/disposable income effects. Flow-on effects have been adjusted for the impact of a reduction in agricultural activity on related upstream and downstream industries.

Source: AnalytEcon.

The Project impacts on agricultural production were assessed by conservatively assuming that the MLA areas 1 and 2 (excluding State Forest areas) would be unavailable for agricultural use over the life of the Project. Based on this methodology, the Project would temporarily displace up to an additional 2,084 hectares (ha) of agricultural land. This assumption is considered to be conservative. In reality, only discrete portions of the MLA areas would be unavailable at a time as these areas are progressively used for site infrastructure. These same areas are then progressively restored to agricultural (and forestry) land use as this infrastructure is decommissioned and these areas rehabilitated.

The corresponding foregone value of agricultural production is an opportunity cost for NCOPL, and therefore does not represent a net cost for the local region. However, the incremental reduction in agricultural production would give rise to (contractionary) flow-on effects on related local downstream and upstream industries that are estimated at:

- around $15.4 million in NPV terms ($15.2 million in NPV terms) over the life of the Project for the Project Region (the SA3 Region), or around $1.4 million per annum ($1.3 million per annum) over the life of the Project in the Project Region (the SA3 Region); and
- a total reduction in agricultural employment (incorporating both direct and related upstream and downstream effects) of around 6.2 FTE jobs per annum (6.1 FTE jobs per annum) over the life of the Project in the Project Region (the SA3 Region).

These contractionary agricultural flow-on effects have been accounted for when calculating the total disposable income and employment effects (incorporating direct and flow-on impacts) in Table ES-2.

The Project may also result in the permanent displacement of agricultural land associated with the establishment of a land-based biodiversity offset area in accordance with the NSW Biodiversity Offset Scheme. The agricultural flow-on effects associated with the biodiversity offsets would likely be minor.

1. INTRODUCTION

The Narrabri Mine is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah within the Narrabri Shire Council (NSC) Local Government Area (LGA) of New South Wales (NSW) (Figure 1-1). The Narrabri Mine is operated by Narrabri Coal Operations Pty Ltd (NCOPL).

NCOPL is seeking a new Development Consent under the State Significant Development provisions of Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Narrabri Underground Mine Stage 3 Extension Project (the Project). This Economic Assessment (EA) forms part of the Environmental Impact Statement (EIS) which has been prepared to accompany the Development Application for the Project.

1.1. PURPOSE AND SCOPE OF THE ECONOMIC ASSESSMENT

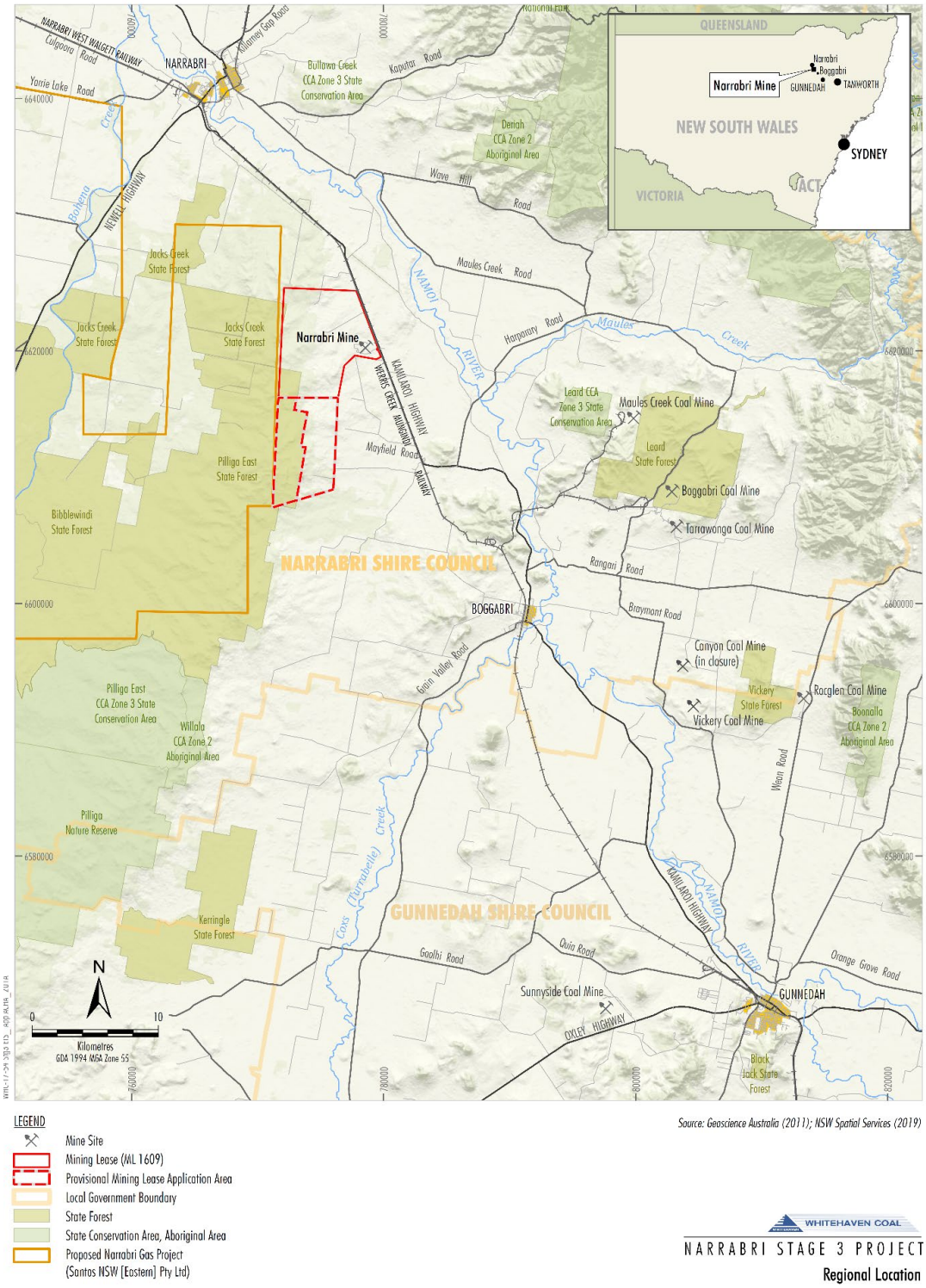
This EA has been prepared to address the economic components of the Secretary's Environmental Assessment Requirements (SEARs):

> *Economic – including an assessment of the likely economic impacts of the development, paying particular attention to:*
>
> - *the significance of the resource;*
> - *economic benefits of the project for the State and region; and*
> - *the demand for the provision of local infrastructure and services;*

This report has also considered the general requirements of the SEARs:

> *In particular, the EIS must include:*
>
> - *..*
> - *a full description of the development, including:*
>   - *..*
>   - *the likely interactions between the proposed development and the approved Narrabri Coal Mine, including the incremental and cumulative impacts of the extension and any other existing, approved or proposed mining-related and petroleum development in the vicinity of the site (including any relevant statutory approvals, environmental management regime relating to these operations);*
>   - *..*

Figure 1-1. Regional location



Source: Resource Strategies.

This EA of the Project has been prepared in accordance with the 'Guidelines For The Economic Assessment Of Mining And Coal Seam Gas Proposals' (NSW Government 2015) (the EA Guidelines) and the 'Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals' (NSW Government 2018) (the EA Technical Notes). The EA Guidelines require the following analyses to be undertaken:

- a cost-benefit analysis (CBA) to assess the net benefit that the Project will deliver to the NSW community; and
- a local effects analysis (LEA) to assess the net benefit that the Project will deliver to the local region.

1.2. ABOUT THIS REPORT

This report is structured as follows:

- Section 2 describes the Narrabri Mine and the Project, as well as the local region;
- Section 3 describes the CBA methodology, the derivation of the individual components of the CBA, the results of the CBA, and various sensitivities;
- Section 4 describes the methodology for analysing flow-on effects and the estimated flow-on effects for the State of NSW and the local region;
- Section 5 describes the LEA methodology, the derivation of individual local benefits, and the broader effects that might affect the local region; and
- Section 6 summarises the preceding discussion to show the significance of the resource.

Supporting documentation is presented in the following appendices:

- Appendix A describes general assumptions used to prepare the CBA and the LEA;
- Appendix B describes the derivation of the Project's value added and contribution to gross state product (GSP); and
- Appendix C describes the methodology for deriving the flow-on effects of the Project.

2. NARRABRI MINE AND PROJECT CONTEXT

This section describes the Narrabri Mine, the Project, and the relevant regional context.

2.1. NARRABRI MINE OVERVIEW

The Narrabri Mine extracts coal from the Hoskissons Seam. Project Approval 08_0144 allows for the production and processing of up to 11 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until July 2031. Based on current mine planning, mining operations would, however, need to continue through to 2034 (i.e. beyond the approved mine life) to allow for all of the approved mine layout to be mined.

ROM coal is processed at the Narrabri Mine coal handling and preparation plant (CHPP) to produce thermal and pulverised coal injection (PCI) product coal (i.e. coal that can be used for steel production). Product coal is then transported from site by rail.

2.2. PROJECT OVERVIEW

The Project involves an extension to the south of the approved underground mining area to gain access to additional coal reserves within Mining Lease Applications (MLAs) 1 and 2, an extension of the mine life to 2044 and development of additional supporting surface infrastructure. ROM coal production would occur at a rate of up to 11 Mtpa, consistent with the currently approved limit.

A detailed description of the Project is provided in Section 2 in the Main Report of the EIS.

2.3. LOCAL REGION

The Narrabri Mine is located within the NSC LGA in the New England North West region of NSW. For the purpose of undertaking the LEA, the EA Guidelines require proponents to adopt a study area that should match a Statistical Area Level 3 (SA3) geographic definition – that SA3 Region should contain the proposed development. In the case of the Project, the relevant SA3 area is the 'Moree - Narrabri' SA3 Region (the SA3 Region). The SA3 Region includes Moree and the Moree Region, and Narrabri and the Narrabri region, but it excludes Gunnedah and the Gunnedah Region.[1]

[1] The four areas that make up the SA3 Region – Moree, the Moree Region, Narrabri, and the Narrabri Region – represent Statistical Area Level 2 geographical definitions within the ABS Statistical Area Structure. These SA2 areas overlap with, but are not the same as the corresponding LGAs.

The SA3 Region does not represent a good approximation of the geographical area where the Project would lead to increased local economic activity. Table 2-1 below shows the places of residence of the Narrabri Mine operational workforce as of March 2020. Table 2-1 indicates that 30 per cent of the workforce live in Narrabri Shire, 29 per cent in Gunnedah Shire, and the remainder in other parts of NSW and interstate. None of the operational workforce live in Moree Plains Shire.

Table 2-1. Place of residence of the Narrabri Mine operational workforce (March 2020)

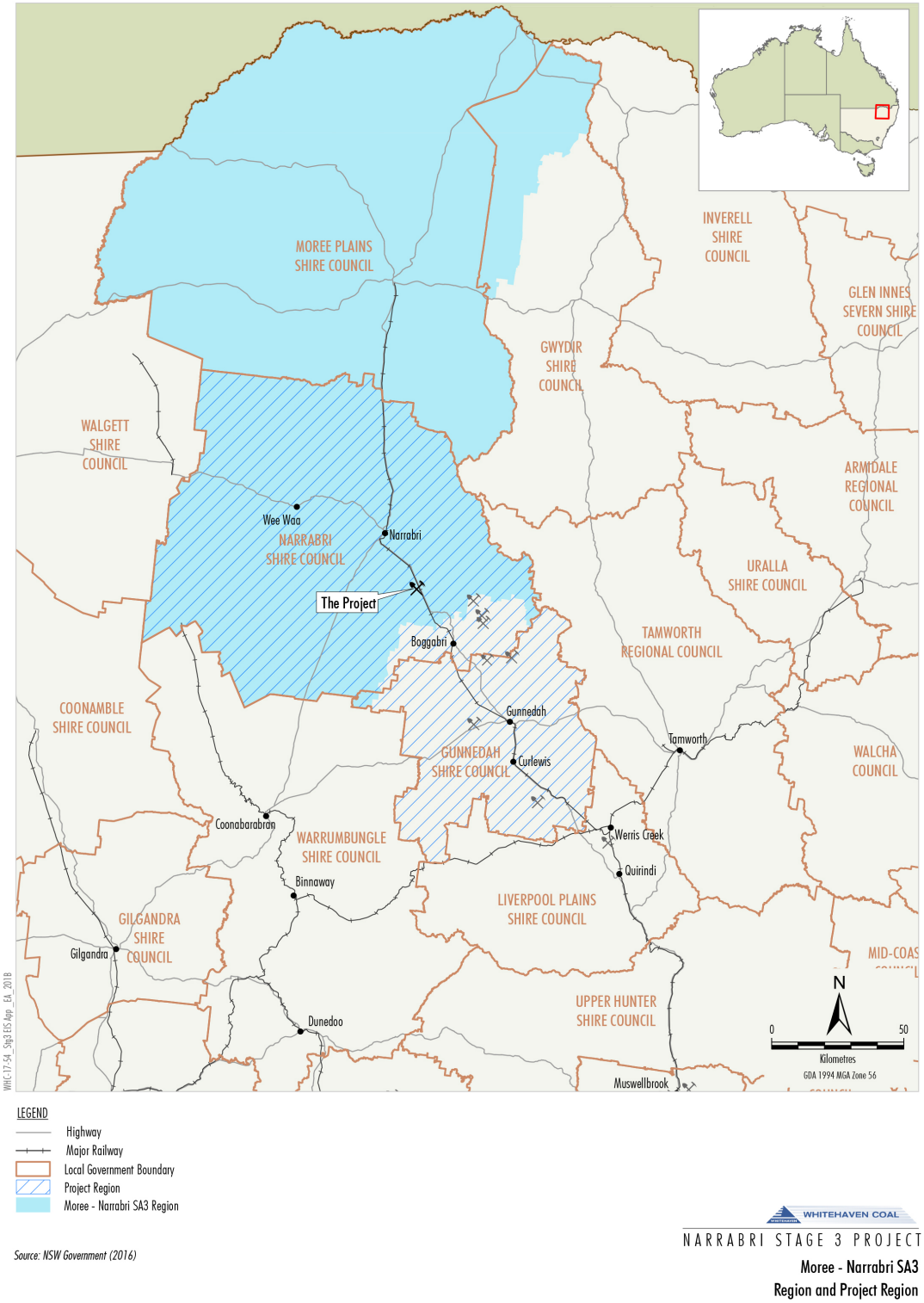
	Employees	Share of total	On-site contractors	Share of total	Total operational workforce	Share of total
	FTEs	%	FTEs	%	FTEs	%
Narrabri LGA	99	37%	60	24%	159	30%
Gunnedah LGA	106	39%	45	18%	151	29%
Tamworth LGA	11	4%	8	3%	19	4%
NSW Other	45	17%	104	41%	149	29%
Interstate	9	3%	27	11%	36	7%
Overseas	0	0%	8	3%	8	2%
Total	270	100%	253	100%	523	100%

Notes: FTE = Full-time equivalent. Totals may not sum exactly due to rounding.
Source: NCOPL.

Given that the SA3 Region includes the places of residence of only about 30 per cent of the operational workforce, the approach adopted in this EA is also to consider the local impacts of the Project for a second region that would better capture the local economic impacts (Figure 2-1):

- the 'SA3 Region', consistent with the EA Guidelines, which captures the places of residence of around 30 per cent of the operational workforce; and
- the 'Project Region', consisting of Narrabri Shire and Gunnedah Shire, which captures the places of residence of almost 60 per cent of the operational workforce.

Figure 2-1. Moree - Narrabri SA3 Region and Project Region



Source: Resource Strategies.

2.4. KEY ECONOMIC PARAMETERS

The following sections present key economic parameters for the Narrabri Mine and the Project.

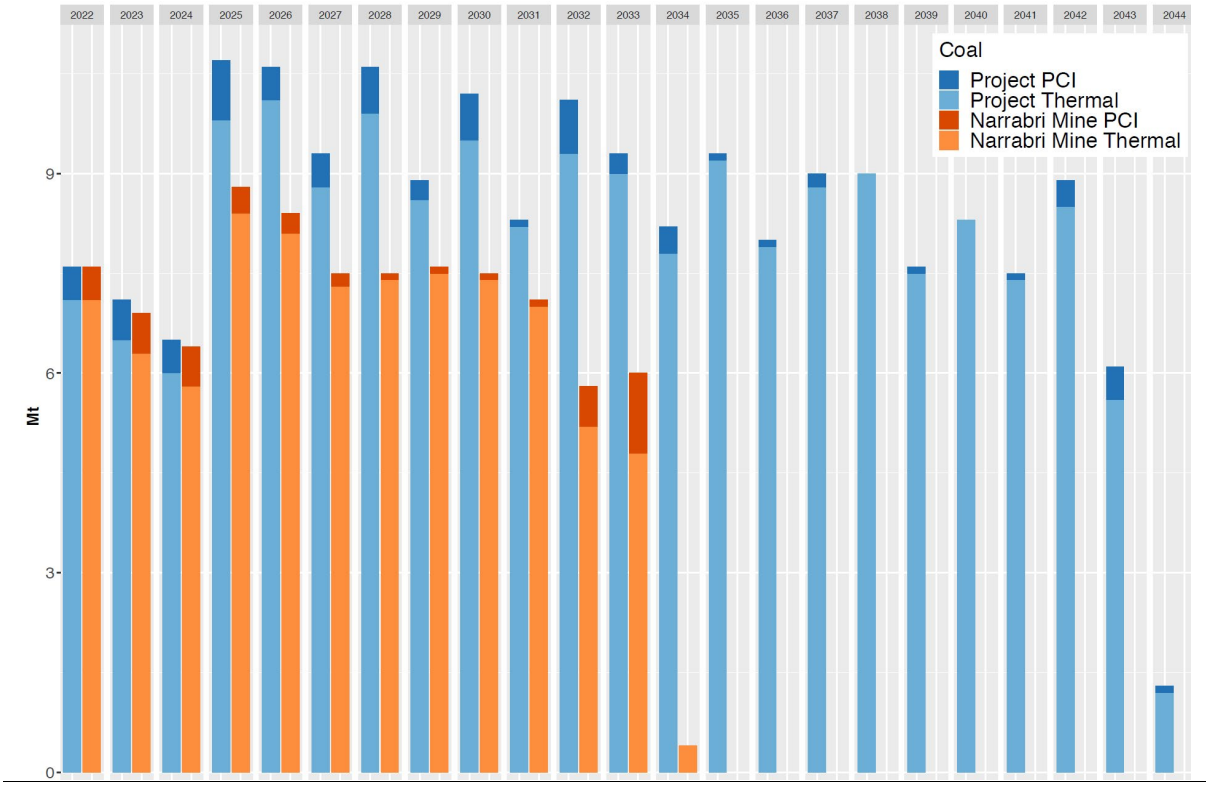
Although operations at the Narrabri Mine are currently approved through to July 2031, current mine planning indicates that mining operations would need to continue through to 2034 to allow for all of the approved mine layout to be mined. The information presented in this section is based on the extended Narrabri Mine life (i.e. through to 2034). The Project would commence operations in 2022 and remain operational through to 2044.

2.4.1. Product coal production

Figure 2-2 shows product coal production profiles for the Narrabri Mine and the Project, respectively:

- The Narrabri Mine would produce an annual average of 6.3 Mtpa of thermal coal and 0.4 Mtpa of PCI coal for a total of 87.4 million tonnes (Mt) of product coal between 2022 and 2034.
- The Project would produce an annual average of 8.0 Mtpa of thermal coal and 0.4 Mtpa of PCI coal for a total of 192.1 Mt of product coal between 2022 and 2044.

Figure 2-2. Production profile – Narrabri Mine and Project



Source: NCOPL.

2.4.2. Coal prices

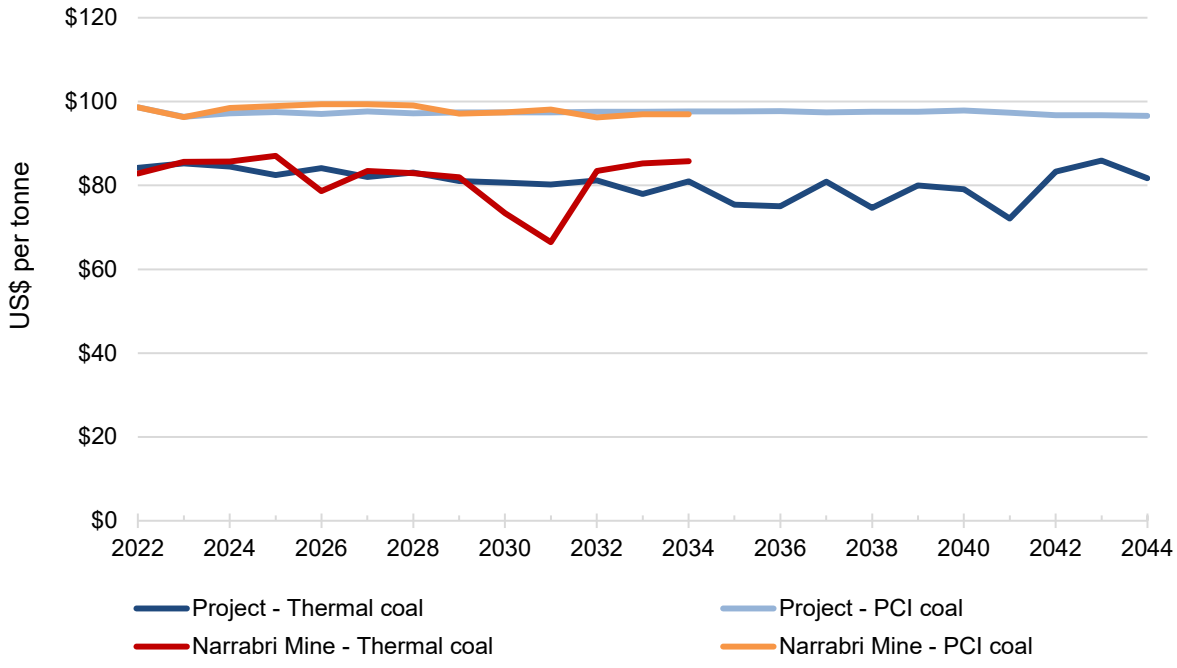
Projected benchmark coal prices and US$/AU$ exchange rates over the forecasting horizon were sourced from CRU by NCOPL (Table 2-2).[2] PCI realised prices for the Narrabri Mine and the Project are also based on thermal coal reference prices. These benchmark prices were adjusted by a price discount or premium to reflect predicted coal quality variations from the benchmark for the Narrabri Mine and Project, as shown in Figure 2-3.

Table 2-2. Coal and exchange rate forecasts (US$ 2020)

	Units	2022	2023	2024 onwards
Thermal and PCI coal reference price	US$/tonne	$83.0	$83.2	$84.3
Exchange rate	AU$/US$	0.74	0.78	0.79

Source: NCOPL.

Figure 2-3. Quality-adjusted realised coal prices (US$ 2020)



Source: NCOPL.

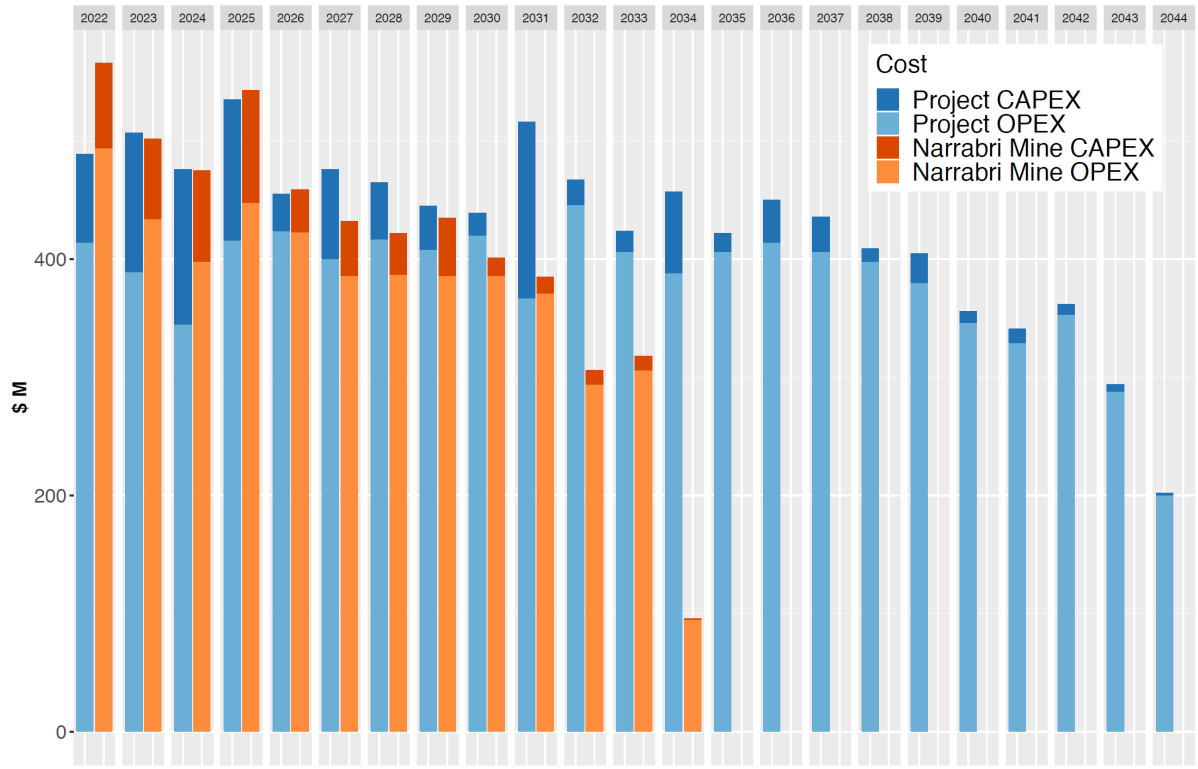
[2] CRU is an established research business based in London and a number of other overseas locations. CRU provides independent business intelligence on the global metals, mining and fertiliser industries, including market analysis and pricing forecasts.

2.4.3. Capital and operating expenditures

Figure 2-4 compares projected operating and capital expenditures for the Project and the Narrabri Mine, respectively. Capital expenditures include outlays on equipment to develop the underground roadways, sustaining capital and any other capital expenditures, but exclude the residual values of capital at the end of the mine life. Operating expenditures (excluding labour costs) include outlays for services such as repairs and maintenance, technical and safety services, as well as the costs of fuel, electricity, other consumables, and decommissioning and rehabilitation costs. Between 2022 and 2044:

- Capital expenditures for the Project are projected to be $1,067 million or $633 million in net present value (NPV) terms, compared to $531 million for the Narrabri Mine ($369 million in NPV terms).
- Operating expenditures (excluding labour costs) for the Project are projected to be around $8.8 billion or $4.1 billion in NPV terms, compared to around $4.8 billion for the Narrabri Mine (around $3.0 billion in NPV terms).

Figure 2-4. Capital and operating expenditure – Narrabri Mine and Project ($2020)



Notes: CAPEX refers to capital expenditures including sustaining capital expenditures, but excluding residual values at the end of mine life. OPEX refers to operating expenditure, including rehabilitation expenditures, but excludes wages & salaries.

Source: NCOPL.

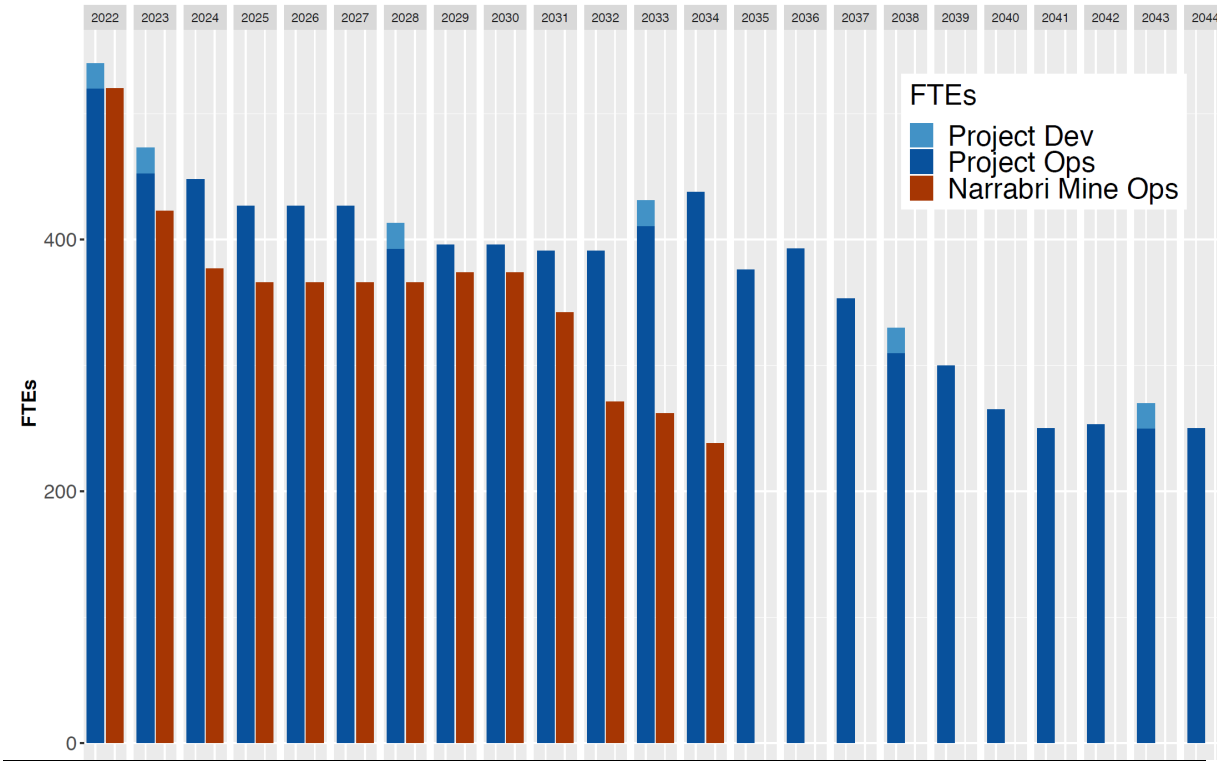
2.4.4. Workforce profile

The Project would allow for the continued employment of up to 520 full-time equivalent (FTE) personnel at the Narrabri Mine. In addition, there would be multiple, short periods of development activity throughout the Project life as infrastructure development occurs, which would require approximately 20 FTE personnel (in addition to the operational workforce).

Figure 2-5 shows the respective workforce profiles for the Narrabri Mine and the Project:

- The Narrabri Mine would operate with an average operational workforce of 357 FTE workers between 2022 and 2034.
- If the Project is approved, the operational workforce would average 370 FTE workers between 2022 and 2044. The Project would additionally employ an average development workforce of 5 FTE workers for intermittent projects.

Figure 2-5. Workforce profile – Project and Narrabri Mine



Notes: 'Dev' refers to the development workforce. 'Ops refers to operational workforce.
Source: NCOPL.

2.5. OTHER RESOURCES PROJECTS IN THE REGION

The potential for interactions with other resources projects in the local region is relevant for assessing the cumulative 'external effects' associated with the Project. Other proposed or approved developments that are remote from the Project include:

- Maules Creek Coal Mine, operated by Maules Creek Coal Pty Ltd, a subsidiary of Whitehaven Coal Ltd (Whitehaven);
- Boggabri Coal Mine, operated by Boggabri Coal Operations Pty Ltd, which is majority owned by Idemitsu Australia Resources Pty Ltd;
- Tarrawonga Coal Mine, operated by Tarrawonga Coal Pty Ltd, a subsidiary of Whitehaven;
- Rocglen Coal Mine (rehabilitation phase), operated by Namoi Mining Pty Limited, a subsidiary of Whitehaven;
- Sunnyside Coal Mine (rehabilitation phase), operated by Whitehaven;
- Werris Creek Coal Mine, operated by Werris Creek Coal Pty Limited, a subsidiary of Whitehaven;
- the approved Vickery Extension Project (SSD-7480), operated by Vickery Coal Pty Ltd, a subsidiary of Whitehaven; and
- the approved (but not commenced) Watermark Coal Project (SSD-4975), operated by Shenhua Watermark Coal Pty Ltd.

Where relevant, the potential cumulative environmental impacts have been considered in the specialist studies undertaken for the Project.

3. COST-BENEFIT ANALYSIS – NSW COMMUNITY

The EA Guidelines require a CBA to be prepared to evaluate the economic impacts of a coal mining proposal on the NSW community. This section describes the methodology for deriving the components of the CBA, as set out in the EA Guidelines, the results of the analysis, and the results of various sensitivities to test the robustness of the assumptions.

3.1. CBA REQUIREMENTS IN THE EA GUIDELINES

CBA is a technique for assessing the economic merits of an initiative or course of action (such as undertaking a mining investment) from the perspective of society, in this case, from the perspective of the NSW community. A CBA compares all costs and benefits attributable to the initiative, discounted to a common point in time, to arrive at an overall assessment of whether the initiative is 'net beneficial'; that is, whether society will benefit from its implementation. A project is net beneficial if the NPV of the sum of benefits minus the sum of costs is greater than zero.

3.1.1. Key assumptions

In the analysis presented in this EA, both the CBA and the LEA draw on the same data set. The central assumptions that underpin the analyses are common to both:

- the application of a central discount rate of 7 per cent per annum to discount all costs and benefits back to a common point in time; and
- the use of internally consistent prices expressed in 2020 Australian dollars ($2020).

3.1.2. Project Scenario and Reference Case

Preparing a CBA requires that the economic merits of a proposal be compared to a meaningful counterfactual. The CBA examines the incremental (net) benefits that would arise if the Project is approved, referred to as the 'Project Scenario', relative to those that would arise in the counterfactual 'Reference Case' that describes the operations of the Narrabri Mine. As noted in Section 2.4, although operations at the Narrabri Mine are currently approved through to July 2031, current mine planning indicates that mining operations would need to continue through to 2034 to allow for all of the approved mine layout to be mined. The Reference Case has therefore been extended to 2034 to allow for all of the approved mine layout to be mined. This Reference Case assumption is conservative since it implies that additional NSW benefits are attributed to the Reference Case from 2032 to 2034.

A central requirement of a CBA is that the two scenarios being considered are evaluated over a common timeframe. In this assessment a timeframe beginning in 2022 and ending in 2045 has been adopted. In this way, all incremental costs and benefits attributable to the Project and the Narrabri Mine, respectively, as well as any other residual costs and values that would arise post-2044 after Project operations have ceased, are captured and discounted to comparable NPVs. Table 3-1 contrasts the key differences between the Project Scenario and the Reference Case over the timeframe considered in the CBA.

Table 3-1. Project Scenario and Reference Case

	Project (Project Scenario)	Narrabri Mine (Reference Case)
Production timeline	2022 to 2044	2022 to 2034
Product coal production		
Total (Mt)	192.1	87.4
Average (Mt)	8.4	6.7
Maximum (Mt)	10.7	8.8
Outlays		
Capital expenditures (NPV $2020 M)	$633	$369
Operating expenditures (NPV $2020 M)	$4,126	$3,032
Average workforce	2022 to 2034	
Operational workforce – Employees (FTEs/year)	272	254
Operational workforce – Onsite contractors (FTEs/year)	153	104
	2035 to 2044	
Operational workforce – Employees (FTEs/year)	146	0
Operational workforce – Onsite contractors (FTEs/year)	154	0

Notes: Capital expenditures exclude land acquisition costs and residual values at the end of mine life.
Totals may not sum precisely due to rounding.

Source: NCOPL.

A CBA requires a full accounting calculation whereby the costs and benefits of a development are compared in monetary terms, and therefore requires that costs and benefits should, as far as possible, be valued. Table 3-1 in the EA Guidelines contains a list of the potential costs and benefits of a proposal that may be included in the CBA, which are derived in the following subsections.

As a general matter, a CBA relies on the 'opportunity cost' principle to value goods and services (NSW Government 2017). For 'conventional', market-based transactions, such as the sale of coal outputs or the purchase of labour and other inputs, the relevant value is determined with reference to market prices. For external effects, including environmental costs and impacts on third parties, alternative valuation methods need to be used (Section 3.9), as prescribed in the EA Technical Notes.

3.2. COAL ROYALTIES

The incremental coal royalty payments attributable to the Project were derived as shown in Table 3-2. Assessable revenues were estimated by multiplying product coal production schedules with projected (quality-adjusted) coal prices (see Section 2.4.2). The ad valorem royalty rate for underground coal mining is 7.2 per cent of the value of the coal recovered; for deep underground mining at depths of 400 m or more, the royalty rate reduces to 6.2 per cent. A small share (around 6 per cent) of product coal from the Project would be produced at these greater depths. Gross royalty payments accruing to NSW were calculated by multiplying gross mining revenues, net of allowable deductions for coal beneficiation, and net of estimated levies, with the relevant royalty rate of 7.2 per cent or 6.2 per cent applied to the net disposal value.

Table 3-2. Incremental royalty calculation ($2020)

	Project (NPV $m)	Narrabri Mine (NPV $m)	Difference (NPV $m)	Notes
Assessable revenues	$9,442	$5,750	$3,692	Coal production schedule multiplied with coal quality-adjusted coal prices
Allowable deductions				
Beneficiation	$91	$45	$45	Beneficiation deduction of $3.50 per tonne
Levies	$33	$20	$13	Coal Research Levy, Mine Subsidence Levy, Mines Rescue Levy
Net disposal value	$9,318	$5,685	$3,633	Assessable revenue net of allowable deductions
Royalty payment	$668	$409	$259	7.2 (6.2) per cent of net disposal value for coal produced at depths < 400m (>400 m)

Note: Totals may not sum precisely due to rounding.
Source: NCOPL, AnalytEcon analysis.

3.3. COMPANY INCOME AND OTHER TAX PAYMENTS

3.3.1. Company income taxes

The EA Guidelines require an estimate of the total annual company income tax payable for each year of the evaluation period of the Project, of which a share corresponding to the proportion of Australia's population based in NSW (31.9 per cent) should be attributed to NSW.

Aggregate Commonwealth company income tax payments were derived by deducting operating costs, including the costs of mitigating externalities, wages & salaries, royalty and tax payments, and depreciation of capital assets from gross revenues to derive taxable income, as shown in Table 3-3.

Table 3-3. Incremental company income tax calculation ($2020)

	Project (NPV $m)	Narrabri Mine (NPV $m)	Difference (NPV $m)	Notes
Coal revenues	$9,442	$5,750	$3,692	Coal production schedule multiplied with quality-adjusted coal prices
Less:				
Operating costs, incl. local contributions, externalities costs, decommissioning costs	$4,157	$3,032	$1,125	Costs of materials, consumables, services etc., incl. decommissioning and rehabilitation costs Costs of mitigating predicted externalities
Labour costs	$901	$603	$298	Wages & salaries for employees, long-term contractors, and the construction workforce
Royalties	$668	$409	$259	Royalty payments
All other taxes	$54	$35	$18	Payroll, land taxes, shire rates
Depreciation	$361	$223	$138	Depreciation of capital assets
Total assessable income	$3,301	$1,447	$1,854	Coal revenues minus all costs
Company tax	$990	$434	$556	30% of total assessable income
Share of company tax attributable to NSW	$316	$138	$177	31.9% of company tax (NSW share of Australian population)

Note: Totals may not sum precisely due to rounding.

Source: NCOPL, AnalytEcon analysis.

In Table 3-3, tax depreciation was calculated using the diminishing value method,[3] assuming an average effective tax life of 20 years. An inflation adjustment is necessary to account for the fact that depreciation is determined based on nominal asset values. Real ($2020) company tax payments were derived by adjusting for inflation, assumed to be 2.5 per cent per annum over the forecasting timeframe in line with the Reserve Bank of Australia's 2 to 3 per cent inflation target, on average, for its monetary policy.

3.3.2. Personal income and payroll taxes

The EA Guidelines note that a new mining project will also generate other taxes, such as additional payroll and personal income taxes. However, as discussed in Section 3.6, the EA Guidelines generally do not permit the higher than average salaries that are generally paid in the mining sector to be recognised as a benefit for NSW workers. Given that this is the case, we have conservatively not estimated the additional personal income taxes (a share of which can be attributed to NSW) and payroll taxes (which accrue to NSW in full) that would be generated by the Project.

3.3.3. Local government rates

Local government rates are levied on individuals and businesses located within an LGA and are collected by the local council, to the benefit of the local community. However, the EA Guidelines do not list local government rate payments as a benefit that accrues to the State of NSW.

In this EA local government rates paid by NCOPL have been included as a cost for the Narrabri Mine and the Project, respectively, but have not been included in the overall NSW net benefit calculation. NCOPL is assumed to pay rates of around $218,000 per annum through to 2031 in the Reference Case. In the Project Scenario, NCOPL would pay around $336,000 per annum through to 2044.[4]

[3] The diminishing value method assumes the decline in value each year is a constant proportion of the amount not yet written-off and produces a progressively smaller decline in value over time. Assuming that all assets are held for a full year, the formula for the decline in value is: base value × (200% ÷ asset's effective life). https://www.ato.gov.au/Forms/Guide-to-depreciating-assets-2019/?page=7; accessed on 28 January 2020.

[4] In the event that the Project is not approved, mining is projected to come to an end after 2034, and the land used by the Narrabri Mine would revert back to agricultural production. However, given the limited size of the Narrabri Mine area and the far lower rates charged for farmland, local government rates in the Reference Case post-2031 are likely to be immaterial and we have not attempted to estimate them. NSC annual rates for farmland comprise a base rate of $270 and an ad valorem rate of $0.0042482, compared to the annual rates for mining, which comprise a base rate of $23,000 and an ad valorem rate of $0.0279909 (NSC, 2019).

3.3.4. Land taxes

Land taxes are levied on the value of NSW land owned by individuals and businesses. Land taxes accrue to the State of NSW and benefit the NSW community. The EA Guidelines also do not comment on the treatment of land taxes.

In this EA land taxes paid by NCOPL have been included as a cost for the Narrabri Mine and the Project, respectively, but have also not been included in the overall net benefit calculation. NCOPL would pay land taxes of around $42,000 per annum in the Reference Case, increasing to around $56,000 per annum in the Project Scenario. Section 10AA of the *Land Tax Management Act 1956* (NSW) exempts land that is used for the dominant purpose of primary production. No offsetting land tax payments have therefore been incorporated in the Reference Case post-2031.

3.4. NET PRODUCER SURPLUS

Table 3.5 in the EA Guidelines sets out the approach to be applied to determine the net producer surplus; in effect, this calculation approximates cash profits. The total direct net benefit to the producer is the difference between the value of the output (including any residual value of land and capital), and expected expenditures on inputs, i.e. the costs of production. This approach has been adopted here (Table 3-4).[5]

The EA Guidelines set out that the net producer surplus attributable to NSW is the economic rent attributable to NSW owners of capital, which depends on the Australian share of a development's ownership. The Narrabri Mine is operated by NCOPL on behalf of the Narrabri Mine Joint Venture, which consists of Whitehaven Coal Limited's wholly owned subsidiary Narrabri Coal Pty Ltd and NCOPL (for a combined ownership stake of 77.5 per cent), as well as various overseas-owned entities with a combined ownership stake of 22.5 per cent. Whitehaven Coal Limited estimate that as of December 2019, the company's Australian share ownership was 57.4 per cent. The share of the net producer surplus attributable to NSW has therefore been approximated by multiplying the Australian ownership share (77.5 per cent × 57.4 per cent = 44.5 per cent) with the NSW share of the population (31.9 per cent).

The EA Guidelines also require the contributions to local government to be included in the net producer surplus calculation. To date, local government contributions for the Project have not been finally determined. A nominal estimate has therefore been included in the operating costs in Table 3-4.

[5] We have also included labour costs as part of overall costs; these costs are not included in Table 3.5 in the EA Guidelines.

In Table 3-4, the net producer surplus calculation is an incremental calculation; that is, the net producer surplus is the difference between the producer surplus in the Project Scenario and the producer surplus in the Reference Case. The producer surplus in the Project Scenario and the Reference Case, respectively, has been calculated by deducting costs from benefits, and is estimated at $2,013 million in NPV terms for the Project and $862 million in NPV terms for the Narrabri Mine. The incremental producer surplus attributable to the Project is therefore $1,150 million in NPV terms, of which $163 million in NPV terms accrue to NSW.

3.5. ECONOMIC BENEFITS TO EXISTING LANDHOLDERS

The EA Guidelines note that a mining proponent may purchase or lease land from existing landholders at a price which exceeds the opportunity cost of the land, for instance when a premium above market prices for land acquisitions or leases is paid. The corresponding surplus is an economic benefit that accrues to existing landholders and should be attributed to NSW.

In the case of the Project, any future acquisitions, may include a slight premium to market value. However, the resulting net benefit accruing to landholders is insignificant relative to the overall net benefit to NSW generated by the Project, and these premia often include a component of compensation to account for costs incurred by the landholder such as relocation costs. Therefore, any economic benefits accruing to local landholders are unlikely to be material and have not been estimated.

3.6. ECONOMIC BENEFITS TO WORKERS

The EA Guidelines place strict limitations on the extent to which higher than average salaries paid to the workforce of a mining project can be considered as a benefit in the CBA (although not in the LEA). Accordingly, we have not included any economic benefits to workers in the CBA in this EA.

However, the approach prescribed in the EA Guidelines does not accord with standard economic thinking, and is also inconsistent with the approach set out in the NSW Government (2017) 'Guide to Cost-Benefit Analysis' (the NSW Government Guide). For the reasons set out in the following, the EA Guidelines therefore prevent potentially significant benefits that accrue to NSW workers from being recognised as a net benefit to NSW.

Table 3-4. Incremental net producer surplus calculation ($2020)

Project				Narrabri Mine			
Revenues (NPV $m)		**Costs (NPV $m)**		**Revenues (NPV $m)**		**Costs (NPV $m)**	
Gross mining revenue	$9,442	Wages & salaries	$901	Gross mining revenue	$5,750	Wages & salaries	$603
Residual value of land at end of the evaluation period	$8	Operating costs, incl. local contributions and externalities costs, excl. decommissioning costs	$4,148	Residual value of land at end of the evaluation period	$14	Operating costs, incl. local contributions and externalities costs, excl. decommissioning costs	$3,023
Residual value of capital at end of the evaluation period	$1	Capital costs, net of decommissioning costs, net of purchase costs for land	$633	Residual value of capital at end of the evaluation period	$0	Capital costs, net of decommissioning costs, net of purchase costs for land	$369
		Decommissioning costs	$9			Decommissioning costs	$10
		Purchase costs for land	$2			Purchase costs for land	$0
		All taxes	$1,745			All taxes	$898
Total	$9,450		$7,437	Total	$5,765		$4,902
Producer surplus			$2,013				$862
Net producer surplus (Project Scenario – Reference Case)							$1,150
NSW share of the net producer surplus							$163

Notes: Totals may not sum exactly due to rounding.
Local contributions have been included in operating costs.

Source: NCOPL, AnalytEcon.

3.6.1. Wage premia in the EA Guidelines

The mining industry is a significant employer of skilled workers such as machinery operators, truck drivers, technicians and trades workers, as well as labourers, managers, professionals and support workers. At the same time, average wages in the Australian mining sector are significantly higher than in all other industries that require similarly skilled workers, such as the construction, transport, utilities, and manufacturing sectors. Wages and salaries paid to the Narrabri Mine workforce in both the Reference Case and the Project Scenario are correspondingly higher than the average or median NSW wage.

The EA Guidelines discount any above average wages that might accrue to the workforce of a mining project, noting that the starting point of any analysis should be that workers will not earn a 'wage premium' even if they earn more working in the mining sector. The rationale for this approach is that higher wages simply reflect the 'disutility' of working a particular job, for instance, doing physically demanding or otherwise difficult work, challenging working conditions, or that workers may have to relocate. Hence the EA Guidelines assume that the benefit to workers from higher pay will be offset by the (personal opportunity) costs associated with greater hardship of one form or another.

3.6.2. Wages and productivity

The view implied by the EA Guidelines that relatively higher wages essentially reflect worker disutility is not correct. While labour markets are complex, there is near universal agreement among economists that over a longer timeframe, the fundamental determinant of wages is labour productivity: the amount of output produced by a worker over a unit of time, say an hour.

Labour productivity does not evolve in a vacuum, but depends on the amount or quality of capital and other factors of production that are available to workers. For instance, workers mining coal will be far more productive if they can access heavy, specialised equipment as opposed to using a pick and shovel. Hence growth in labour productivity (or the increase in output per hour worked) depends on (Productivity Commission 2019, Australian Treasury 2017):

- *The capital-labour ratio*: the quantity of capital inputs used per unit of labour input, also referred to as the contribution from 'capital deepening'. Increased capital deepening means that, on average, each unit of labour has more capital to work with to produce output, and so is an indicator of a firm's ability to augment labour.

- *The contribution from 'multifactor productivity' (MFP) growth*: the efficiency with which labour and capital are combined in the production process. MFP growth may reflect many factors, including innovation and technological improvements, efficiency improvements arising from economies of scale and scope, improvements in management practices, and so on.

Recent empirical research from the Australian Treasury (2017) confirms the importance of this central economic relationship between wages and productivity. That analysis of Australian businesses across all industry sectors, for all sizes and other characteristics confirmed that:

- businesses with higher labour productivity pay higher real wages; and
- the relationship between real wages and labour productivity holds across all business characteristics examined, including size and export exposure.

The broad conclusions highlighted in the Australian Treasury (2017) analysis directly apply to the Australian mining sector:

- Average earnings in the mining sector far exceed those in sectors that require similar skills. These relatively high earnings are matched by the underlying labour productivity which, in absolute terms, is higher in the mining industry than in any other Australian industry.
- High labour productivity and high wages in the mining sector in turn reflects substantial investment in capital assets. As a share of market sector investment expenditure, that of the mining sector accounted for 27 per cent as of June 2019.

3.6.3. Compensating wage differentials

It is possible that the assumption in the EA Guidelines that differences in wages between the mining and other sectors of the economy merely compensate workers for greater hardship refers to the theory of 'compensating wage differentials' originally articulated by Adam Smith. That theory postulates that wages in some industries are high because workers want to be compensated for job attributes that are dangerous or unpleasant or otherwise undesirable.

In practice, however, empirical support for the theory of compensating differentials is weak. Those studies that identify a compensating effect find large variations in how work-reward trade-offs are valued by workers, including as a function of income levels, job risk, age, immigrant status, race, gender, and other characteristics. The results of empirical research into the theory of compensating differentials in Australia are inconclusive at best. Indeed, a 2012 study by Cai and Waddoups using Household, Income and Labour Dynamics in Australia (HILDA) survey data to estimate the role of negative job characteristics (job stress, employment security, complexity and difficulty, control of the work process, commute times) found that these job characteristics have a negligible effect on wages.

3.6.4. NSW Government Guide to Cost-Benefit Analysis

Standard economic analysis which draws on considerable empirical evidence in Australia and overseas suggest that the fact that there are wage differentials for otherwise similar jobs reflects productivity differences of individuals employed in different industries, rather than some form of personal opportunity cost or disutility. Wage differentials play a crucial role in attracting labour to higher productivity industries and facilitating important structural change over time.

Labour is an input into the production process, and wages are a component of value added in the national accounts. In effect, the EA Guidelines suggest an accounting system which is at odds with that used by both the NSW public and private sectors by treating the opportunity costs of choices that not made – remaining in a lower paying job – as real costs to the economy. In this respect, the EA Guidelines also conflict with the NSW Government Guide, which explicitly recognises wage increases as a benefit accruing to workers (Table 2.2, P.13):

> *Labour surplus is the difference between a worker's actual wages and what they are willing to accept (their reservation wage). If an initiative increased hourly wage rates, the incremental increase would be a benefit.*

In the context of the Project, setting aside incremental wage increases ignores a potentially significant benefit that would accrue to the NSW workforce. Between 2022 and 2044, the Project workforce would earn a gross income of $877 million in NPV terms, corresponding to a disposable income of $537 million in NPV terms. Assuming that the NSW share of the workforce remains at 92 per cent (as is currently the case), the NSW workforce would therefore earn a gross income of $813 million in NPV terms, corresponding to a disposable income of $492 million in NPV terms.

The incremental disposable income benefit attributable to the Project relative to the Narrabri Mine can be approximated as follows:

- In the Project Scenario NCOPL would employ an average of 370 FTE operational workers between 2022 and 2044, compared to an average operational workforce of 202 FTEs in the Reference Case over the same timeframe.[6] Between 2022 and 2044, the Project would therefore provide employment for an additional 168 FTE operational workers each year. Given the current places of residence of the Narrabri Mine workforce (Table 2-1), around 154 FTE workers (92 per cent of the current workforce) can be assumed to be NSW residents.

[6] The workforce average of 202 FTE workers in the Reference Case encompasses an average operational workforce between 2022 and 2034 of 357 FTE workers, and between 3035 and 2044 of 0 FTE workers.

- Between 2022 and 2044, operational workers on the Project would earn an average annual disposable income of $129,249 per annum, compared to the estimated disposable income of a worker earning the NSW average wage of $61,540.[7] This translates into a per worker, per annum difference in disposable income of $67,709 ($129,249 minus $61,540).
- The ABS Participation, Job Search and Mobility survey (ABS 2019) indicates that between 2015 and 2019, almost half (49 per cent) of newly employed workers in the mining sector came from a different industry.[8] If it is then assumed that 49 per cent of the 154 additional FTE workers came from a non-mining industry and would therefore benefit from an increase in annual disposable income of $67,709 from 2022 to 2044, the aggregate benefit accruing to NSW workers would amount to $113 million overall (or $38 million in NPV terms).

However, as noted, consistent with the EA Guidelines, these worker benefits are not included in the CBA.

3.7. ECONOMIC BENEFITS TO SUPPLIERS

The EA Guidelines note that NSW suppliers may receive an economic benefit by achieving higher surpluses as a result of supplying a mining project, and that the value of that economic benefit should be incorporated in the CBA.

Determining this benefit to suppliers poses practical difficulties, given that there are no statistics on which businesses are NSW-owned. Even if NSW-owned businesses could be identified, it is unknown whether the goods and services supplied by these businesses are produced in NSW or whether they are 'imported' from elsewhere in Australia (or from overseas), and therefore what share of any surplus or value added could be attributed to NSW. These data limitations imply that economic benefits to NSW suppliers cannot be measured reliably. These benefits have therefore not been included in the CBA.

[7] Disposable income refers to gross income, net of superannuation, personal tax and Medicare care payments. Future NSW average wages are assumed to increase by 1 per cent per annum in real terms.

[8] Around 46 per cent of newly employed workers had previously been employed in the mining sector, with the remainder moving to the mining sector from outside employment (5 per cent).

However, an illustrative calculation suggest that these impacts are likely to be significant. In the Project Scenario NCOPL would incur operating expenditures between 2022 and 2044 of around $4.1 billion in NPV terms, as opposed to around 3.0 billion in NPV terms in the Reference Case, a difference of around $1.1 billion in NPV terms. Around 71 per cent of NCOPL's operating expenditures are currently directed towards NSW suppliers (Table 5-3). If that share of NSW expenditures remains the same going forward, the Project Scenario would imply that an additional $775 million in NPV would be directed towards NSW suppliers between 2022 and 2044. If it is assumed, for illustrative purposes, that 10 per cent of these additional NSW expenditures represent margins to NSW suppliers, the additional surplus accruing to suppliers in the Project Scenario would be around $78 million in NPV terms.

3.8. NET PUBLIC INFRASTRUCTURE COSTS

As noted in the EA Guidelines, the incremental cost of public infrastructure (such as utilities and communications expenditures) and transport infrastructure required due to a proposal should be included in the CBA. No public infrastructure costs are expected to be incurred for the Project, and none have therefore been included in the CBA.

3.9. NET ENVIRONMENTAL, SOCIAL AND TRANSPORT-RELATED COSTS

This section reviews the predicted net environmental, social and transport-related costs of the Project, referred to as 'externalities' or 'external effects'. The potential impacts on other industries are discussed in Section 3.10.

3.9.1. Subsidence

Appendix A of the EIS contains the Subsidence Assessment (Ditton Geotechnical Services 2020) for the Project.

PREDICTED SUBSIDENCE IMPACTS

The potential subsidence impacts of the Project relate to natural features, built features, Aboriginal heritage sites (Section 3.9.5), and agricultural land (Section 3.10.1).

The following impacts for natural features located above the Project Area are predicted (Ditton Geotechnical Services 2020):

- surface cracking and shearing ranging in width from 100 mm to 200 mm with occasional (<5% probability) wider cracks up to approximately 350 mm in sand or loam, and up to approximately 700 mm in clay or rock;
- subsidence of up to 2.8 m on approximately 7.5 ha of steep slope, with impacts on the total length of steep slopes estimated at 0.3 per cent to 0.7 per cent;

- subsidence of up to 2.8 m with potential rock falls affecting cliff faces, with impacts on the total length of rock faces features estimated at 0.3 per cent to 4.4 per cent;
- subsidence of up to 2.8 m affecting 0.6 per cent to 1.4 per cent of the total length of minor cliff faces;
- general and localised slope instability along minor cliffs and steep rocky slopes considered to be 'very unlikely';
- an increase or decrease of surface gradients by up to 2.5 per cent along creeks;
- the possible temporary rerouting of surface flows into open cracks to below-surface pathways; and
- 18 potential ponding locations; while most of these already exist, they would develop further up to a maximum change in pond depths from -0.1 m to 0.9 m (average 0.6 m).

For built features above the Project Area, Ditton Geotechnical Services (2020) concluded that:

- a single storey residence and two sheds owned by NCOPL would be 'moderately' to 'significantly' impacted, while a second NCOPL owned dwelling would be 'slightly' impacted;
- a privately-owned incomplete dwelling that would also be 'moderately' to 'significantly' impacted; and
- agricultural infrastructure (e.g. farm dams, fences) may be impacted.

MITIGATION AND MANAGEMENT MEASURES

Subsidence monitoring, management and remediation measures would continue to be implemented for the Project in accordance with future Extraction Plans. The Extraction Plans would incorporate subsidence management and remediation measures for potential impacts such as surface and subsurface cracking, slope instability and erosion, valley closure and uplift, and ponding and altered drainage patterns. Further details on the proposed subsidence measures for the Project are provided in Ditton Geotechnical Services (2020).

VALUATION APPROACH

The cost of any monitoring, management and remediation measures to address subsidence impacts on natural and built features have been included in NCOPL's operating and capital costs over the Project evaluation period.

For potential subsidence impacts on natural features, material cracking, instability of contour banks and erosion would be addressed in a variety of ways, including by modifying mining heights and widths. It is possible that some remaining impacts on steep slopes and minor and major cliff faces may remain. However, the Subsidence Assessment suggests that the percentages of the lengths of slopes or cliff faces affected would be small (DGS 2020). Given that the value of subsidence-related impacts on natural features is therefore also likely to be small, no non-market valuation of these impacts has been prepared.

3.9.2. Groundwater

Appendix B of the EIS contains the Groundwater Impact Assessment (AGE 2020) for the Project.

PREDICTED GROUNDWATER IMPACTS

Numerical modelling conducted as part of the Groundwater Impact Assessment predicted the following (AGE 2020):

- Maximum drawdowns do not exceed 2 m in any part of the 'highly productive' Namoi Alluvium aquifers. Drawdowns at all bores accessing these 'highly productive' aquifers are within the Aquifer Interference Policy (AIP) minimal harm impact criterion (i.e. less than 2 m drawdown).
- Eight privately-owned water supply bores accessing 'less productive' aquifers are predicted to experience drawdowns exceeding the AIP minimal harm impact criterion (i.e. more than 2 m drawdown) in the Project Scenario, compared to one privately-owned water supply bore in the Reference Case.
- Net discharge to the Quaternary alluvium is predicted to reduce by up to approximately 4.5 per cent of predicted baseline discharge from underlying units to the alluvium. Net discharge reduction would peak around 150 years after mining ceases, before reducing to equilibrium.
- Net discharge to the Namoi River is predicted to reduce by up to approximately 3 per cent of predicted baseline discharge from the alluvium. Net discharge reduction would peak around 150 years after mining ceases, before reducing to equilibrium.
- In addition, the Project is anticipated to have a negligible adverse impact on groundwater quality (AGE 2020).

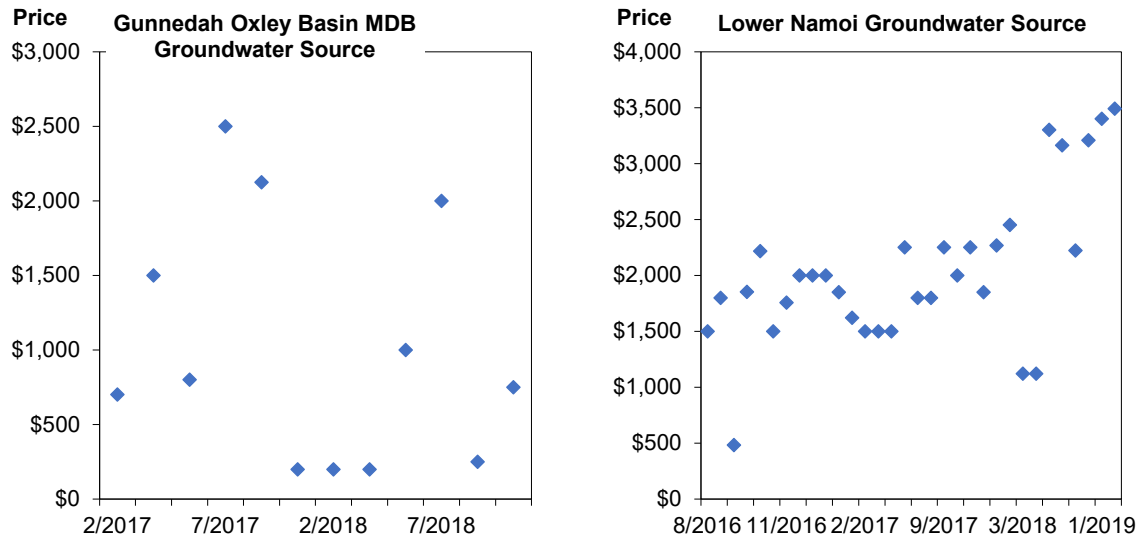
Table 3-5 shows the predicted water licence requirements for the Project and the licenses currently held by NCOPL. Based on peak predicted licensing requirements, NCOPL has sufficient licences for predicted groundwater take from the Upper and Lower Namoi Regulated River Water Sources, the Upper Namoi Zone 5 and the Great Artesian Basin (GAB) Southern Recharge Zone. NCOPL would acquire 1,089 additional shares (i.e. beyond its existing entitlements) for the NSW Murray Darling Basin (MDB) Porous Rock Groundwater Sources (Gunnedah Oxley Basin Groundwater Source), and 1 additional share for the Lower Namoi. No additional licensing requirements are predicted for the Project.

VALUATION APPROACH

The EA Technical Notes say that the economic significance of potential impacts on water resources should primarily be measured with reference to the market price of the relevant water resource(s) and, if relevant, other factors potentially not captured by market prices (such as specific locational or seasonal effects that may affect third parties).

Figure 3-1 below summarises the prices paid for unit shares for the last three years of trade history (permanent transfer and trades at prices greater than zero only) from the NSW Water Register for the groundwater sources that NCOPL would need to acquire (Table 3-5).

Figure 3-1. Price outcomes from recent trades of relevant groundwater sources



Notes: Prices shown exclude prices of zero. All prices reported in nominal terms.
Source: NSW Water Register.

Table 3-5. Groundwater licensing summary for the Project

Water sharing plan	Water source/ management zone	Impacted resource	Existing licensed volume (Shares) Shares	Peak volume requiring licensing during mining (ML/year)	Peak volume requiring licensing-post mining (ML/year)	Additional Licences Required?	Amount Required
Upper and Lower Namoi Regulated River Water Sources	Upper and lower Namoi	Surface water (indirect)	678	44	193	No	0
Upper and Lower Namoi	Upper Namoi Zone 5	Groundwater (indirect)	260	10	64	No	0
	Lower Namoi		0	0	1	Yes	1
NSW GAB Groundwater Sources	Southern Recharge Zone	Groundwater (indirect)	248	42	88	No	0
NSW MDB Porous Rock Groundwater Sources	Gunnedah Oxley Basin	Groundwater (direct and indirect)	1,221	2,310	2,310	Yes	1,089

Note: ML = Megalitres.

Source: AGE (2020).

As Figure 3-1 shows, prices for traded water entitlements are inherently variable and depend on a range of factors, including water allocations for a particular source, agricultural and industrial demand, and other factors. A comprehensive analysis of likely future price outcomes would require a detailed statistical analysis, and has not been attempted in this EA.

Given the available data, the following assumptions were made in respect of the price of unit entitlements that would need to be purchased by NCOPL:

- Prices for the NSW MDB Porous Rock Groundwater Sources (Gunnedah-Oxley Basin) have been highly variable, and no clear trend can be discerned. Over the last three years, the median price paid was $800 per unit, and the average price $1,067 per unit. To be conservative we have valued the 1,089 unit shares that would be required by NCOPL at the average price of $1,067 per unit. AGE (2020) note that the NSW MDB Porous Rock Groundwater Sources (Gunnedah-Oxley Basin Source) is significantly under-allocated and was included in the Controlled Allocation Order 2017 (17,175 shares for the Gunnedah-Oxley Basin Source offered at a minimum bid price of $650/share).[9] The implication is that significant price increases (and therefore an underestimate of the costs of the water resources required for the Project) are not expected.
- Prices for the Upper and Lower Namoi Groundwater Sources (Lower Namoi Groundwater Source) have trended upwards in recent years, with two trades in 2019 taking place at $3,400 and $3,490, respectively. To be conservative, we have assumed a price of $4,000 per unit for the 1 unit that NCOPL would need to acquire.

We have conservatively assumed that these entitlements would be purchased in Year 1 of the Project (2022). The cost of purchasing these groundwater licenses represents a cost to NCOPL, and has been included in the costs of the Project.

[9] https://www.industry.nsw.gov.au/water/allocations-availability/controlled/order-2017; https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/178585/Gazette-2017-53.pdf

The EA Technical Notes set out options for estimating the water-related costs borne by third parties, including the owners of potentially impacted bores. These include the costs of water treatment, providing an alternative water source, or compensating for lost income, among others. As noted, eight privately owned registered water supply bores in less productive groundwater sources would be affected by the Project, with one bore predicted to be impacted during the operation of the Project, and seven post-mining. The costs of remediating affected bores or of undertaking other make good measures would be site-specific, and depend on such factors as the type of bore, the extent of drawdown, the characteristics of the pump, and what mitigation measures are adopted. In order to estimate the average cost of the corresponding make-good measures that NCOPL would undertake, NCOPL has estimated a cost per bore of $40,000 that would either be expended in 2022 (for the single bore affected during the operation of the Project) or in 2044 (for the bores affected post-mining).

3.9.3. Surface water

The Surface Water Assessment (WRM 2020) for the Project is described in Appendix C of the EIS.

PREDICTED SURFACE WATER IMPACTS

The Surface Water Assessment indicates that the Project and the Narrabri Mine are not expected to materially impact the environmental values of the receiving surface waters (WRM 2020):

- the subsidence impacts on ephemeral waterways such as Kurrajong Creek and other minor watercourses are expected to be limited;
- the Namoi River would not be affected by direct subsidence, and any reduction in Namoi River flows would be insignificant;
- there would be no adverse impact on the quality of receiving surface water, given that the probability of an uncontrolled release of runoff water is very low, and that filtered water released into the Namoi River would comply with relevant release criteria;
- the potential reduction in catchment flows due to mine subsidence is expected to be minor and would reduce as the subsidence areas silt up over time; and
- the Project is not expected to have any significant impact on flooding.

MITIGATION AND MANAGEMENT MEASURES

The Surface Water Assessment concluded that the existing Narrabri Mine site water management system is robust and adequate for the Project, and that no major changes to the existing water management system would be required for the Project (WRM 2020).

NCOPL proposes to update the existing Water Management Plan, including a Surface Water Monitoring Plan, Raffinate Discharge Control and Monitoring Plan, Erosion and Sediment Control Plan and Surface Water and Groundwater Response, for the Project.

VALUATION APPROACH

The EA Technical Notes recommend that surface water impacts primarily be measured with reference to the market price of water, subject to ensuring that any remaining third-party effects are properly accounted for.

The water balance modelling undertaken as part of the Surface Water Assessment indicates that external water demands associated with the Project would be met by surface and groundwater entitlements already held by NCOPL (WRM 2020).

There is additionally no indication that the water requirements for the Project would impact third parties in a manner that is not already captured by market prices. As noted, the analysis of potential surface water impacts indicates that:

- the impacts on surface water resources are predicted to be minimal; and
- cumulative impacts to surface water quality are not anticipated as a result of the Project.

No additional surface water-related costs would therefore be incurred in the Project Scenario relative to the Reference Case, and none have been included in the CBA.

3.9.4. Biodiversity

Appendix D of the EIS contains the Biodiversity Development Assessment Report (Resource Strategies 2020) for the Project.

PREDICTED BIODIVERSITY IMPACTS

The Project would require the progressive clearance of woodland and derived native grassland over a 23-year period. NCOPL is committing to satisfying the biodiversity credit requirements using offset mechanisms allowed by the NSW Biodiversity Offset Scheme (i.e. retirement of biodiversity credits, ecological mine rehabilitation and/or contribution to the Biodiversity Conservation Fund). The Biodiversity Development Assessment Report (Resource Strategies 2020) includes an estimate of ecosystem credits and species credits required for the Project in accordance with the BAM Credit Calculator.

MITIGATION AND MANAGEMENT MEASURES

NCOPL would satisfy the biodiversity credit requirements using offset mechanisms allowed by the NSW Biodiversity Offset Scheme (i.e. retirement of biodiversity credits, ecological mine site rehabilitation and/or contribution to the Biodiversity Conservation Fund).

In addition, NCOPL has a number of existing measures available to mitigate and manage impacts on biodiversity, such as a vegetation clearance protocol, weed and pest animal control, monitoring programmes and a rehabilitation plan that would be implemented for the Project.

VALUATION APPROACH

The EA Technical Notes set out the requirement to assess and quantify impacts that are then reflected in a biodiversity offset requirement (or biodiversity credit) so that impacts on biodiversity have a direct and quantifiable economic cost. The biodiversity impacts associated with the Project have therefore been valued using NCOPL's estimated cost to establish a land-based biodiversity offset required to generate sufficient credits to meet the biodiversity offset requirement. NCOPL has estimated that the total cost of establishing a land based biodiversity offset for the Project would be $38.6 M ($2020) over approximately a five year period.

3.9.5. Aboriginal heritage

Appendix E of the EIS contains the Aboriginal Cultural Heritage Assessment (Whincop Archaeology 2020) for the Project.

PREDICTED IMPACTS

The Aboriginal Cultural Heritage Assessment found that 60 Aboriginal cultural heritage sites are known to exist within the area investigated for the Project, including 36 surface artefact scatters, 22 isolated artefacts, and two grinding groove sites (Whincop Archaeology 2020).

The archaeological significance of the 60 identified Aboriginal cultural heritage sites was considered by Whincop Archaeology (2020) and all but five sites are considered to be of low scientific significance. The remaining five Aboriginal cultural heritage sites are considered to be of moderate scientific significance. The sites of moderate scientific significance include four artefact scatters and one grinding groove site. No sites of high scientific significance were identified (Whincop Archaeology 2020).

None of the identified Aboriginal cultural heritage sites would likely be directly impacted by surface disturbance. One site of moderate scientific significance would likely be subject to indirect impacts associated with the effects of subsidence. Known isolated finds and artefact scatters are unlikely to be impacted by subsidence and associated ponding (Whincop Archaeology 2020).

MITIGATION AND MANAGEMENT MEASURES

The Aboriginal Cultural Heritage Assessment concluded that current design of the proposed surface disturbance would avoid all known Aboriginal cultural heritage sites. NCOPL would consider the location of known Aboriginal cultural heritage sites during final detailed engineering designs of surface infrastructure. Where avoidance of known Aboriginal cultural heritage sites is not practicable, the site(s) would be subject to salvage in accordance with the Section 3.6 of the approved Narrabri Mine Aboriginal Cultural Heritage Management Plan (ACHMP).

The Aboriginal Cultural Heritage Assessment concluded that the potential for impacts on other Aboriginal cultural heritage sites not identified in the site survey is low, particularly given the history of disturbance in the area from agricultural activities. Standard contingency plans for the possible discovery of further Aboriginal cultural heritage objects and/or human remains are already included within the approved Narrabri Mine ACHMP. An update to the Narrabri Mine ACHMP would be developed for the Project, in consultation with the Aboriginal community and the Biodiversity and Conservation Division.

Where subsidence-related impacts such as surface cracking are identified within the boundary of an existing site of moderate (or high) scientific significance, or where remediation works are required to address subsidence impacts, the site would be inspected by a qualified archaeologist to determine the nature and extent of impacts, and whether mitigation is required. Mitigation measures may include further monitoring, surface collection or open area salvage excavation.

Other management measures that would be undertaken by NCOPL would include:

- a requirement for all on-site personnel to participate in Aboriginal cultural heritage induction;
- the establishment of an Aboriginal Cultural Heritage Sites Database; and
- ongoing Consultation with Aboriginal Community as an integral participant in the management of Aboriginal cultural heritage values.

VALUATION APPROACH

Consistent with the EA Technical Notes, the costs of compliance with the recommendations in the Aboriginal Cultural Heritage Assessment, the ongoing application of the ACHMP and all related processes have been included in the Project costings.

3.9.6. Historic heritage

Appendix F of the EIS contains the Historic Heritage Assessment (Niche Environment and Heritage 2020) for the Project.

PREDICTED IMPACTS

The Historical Heritage Assessment did not identify any items of heritage significance within the area investigated for the Project. It therefore concluded that the Project would have no direct or indirect impact on any items or areas of heritage significance and would not affect the heritage values of the Narrabri region (Niche Environment and Heritage 2020).

MITIGATION AND MANAGEMENT MEASURES

The Project would not result in any adverse impacts on any heritage places, as such no specific measures are required to manage or mitigate any historic heritage impacts (Niche Environment and Heritage 2020).

The Historical Heritage Assessment concluded it is unlikely that any remains of historical value not identified in the survey could be exposed or impacted by the Project, as the ground surface has been significantly disturbed due to historical agricultural practices. Notwithstanding, in the unlikely event that historical archaeological relics were to be discovered during ground disturbance for the Project, NCOPL would cease work in the immediate area and a suitably qualified archaeologist would be engaged to assess the condition, extent and likely significance of the remains. Depending on the results of this assessment, the Heritage Council may be notified of the discovery in accordance with Section 146 of the NSW *Heritage Act 1977*.

VALUATION APPROACH

As no specific measures are required to manage or mitigate any historic heritage impacts, no costs have been included in the Project costings.

3.9.7. Noise and blasting

Appendix H of the EIS contains the Noise and Blasting Assessment (Wilkinson Murray 2020) for the Project.

PREDICTED NOISE AND BLASTING IMPACTS

The Noise and Blasting Assessment considered representative scenarios to evaluate operational noise, the noise from construction activities, blasting, as well as road and rail transportation noise. The Noise and Blasting Assessment found that (Wilkinson Murray 2020):

- noise contributions from the Project at most privately-owned receivers would be low and indistinguishable from background noise;

- with noise mitigation measures, two privately owned properties would be in the Noise Affectation Zone (greater than 40 A-weighted decibels [dB{A}]), and two privately owned properties would be in the Noise Management Zone (35 to 40 dB[A]) as defined in the *Noise Policy for Industry* (NPfI);
- the Project would comply with relevant criteria in relation to construction noise, blasting overpressure and ground vibration levels, road transportation noise and rail transportation noise and vibration; and
- cumulative noise levels with the Narrabri Gas Project are predicted to be within the relevant noise criteria designed to protect residential amenity.

MITIGATION AND MANAGEMENT MEASURES

Noise management at the Narrabri Mine is conducted in accordance with a Noise Management Plan (NMP), consistent with current approvals. The NMP specifies, among other things, the hours in which certain activities may be undertaken, the type of equipment that may be used and the manner of operation, and other conditions to minimise noise levels. The NMP also includes a noise monitoring program, which provides for attended noise monitoring to ensure compliance, and real time noise monitoring to assist in the management of Narrabri Mine noise impacts. If approved the NMP would be updated to incorporate the requirements of the Project.

Initial modelling of potential noise impacts resulted in key mitigation measures being adopted for the Project, including the selection of lower sound power equipment and the suitable location and directivity of ventilation infrastructure design optimised to minimise noise impacts. The Noise and Blasting Assessment accordingly concluded that given the relatively limited number of exceedances, reasonable and feasible mitigation measures are being implemented for the Project, and no other measures would be of material benefit.

VALUATION APPROACH

The EA Technical Notes require that the current and future cost of any mitigation measures, negotiated agreements or land acquisition to mitigate noise impacts should be noted and included in the proponent's operating and capital costs. Conservative estimates of the relevant property purchase costs have been allocated and included in NCOPL's costings.[10]

[10] Pending completion of negotiations around noise agreements and or purchase costs, these outlays are considered to be commercial-in-confidence.

No material residual noise impacts that cannot be mitigated through the *NPfI* and the NSW *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) are predicted. The costs of preparing the requisite management plans, associated monitoring and forecasting activities, and any equipment modifications have been incorporated in NCOPL's capital and operating expenditure costings. These costs would be incurred by NCOPL in the normal course of operations.

3.9.8. Air quality

Appendix I of the EIS contains the Air Quality and Greenhouse Gas Assessment (Jacobs 2020) for the Project.

PREDICTED AIR QUALITY IMPACTS

The potential air quality impacts of the Project were modelled as part of the Air Quality and Greenhouse Gas Assessment and overall, the assessment showed that the Project would not cause adverse air quality impacts (Jacobs 2020):

- 24-hour and annual average particulate matter less than 10 microns (PM_{10}) concentrations would not exceed Environment Protection Authority (EPA) or VLAMP criteria at any private sensitive receptor;
- 24-hour and annual average particulate matter less than 2.5 microns ($PM_{2.5}$) concentrations would not exceed EPA or VLAMP criteria at any private sensitive receptor;
- annual average Total Suspended Particulates concentrations and dust deposition levels would not exceed EPA or VLAMP criteria at any private sensitive receptor; and
- spontaneous combustion is not expected to result in material odour impacts.

MITIGATION AND MANAGEMENT MEASURES

NCOPL would implement dust and odour management measures and air quality in accordance with an Air Quality Management Plan.

Key dust mitigation measures that would be implemented for the Project include:

- the application of water to stabilise the surface of the ROM and product coal stockpiles;
- water sprays during loading of the ROM;
- product coal stockpiles; conveyors would be enclosed;
- enclosure of the CHPP; and
- the application of water and regular maintenance of unsealed rejects haul route.

VALUATION APPROACH

The costs of ongoing air quality management and mitigation measures, which would continue to be implemented if the Project is approved, have been included as part of NCOPL's operational costs in the Reference Case and the Project Scenario.

The Project is not expected to cause additional adverse air quality impacts relative to the Narrabri Mine, and the air quality assessment therefore concluded that no additional dust emission mitigation would be warranted. No additional costs to address potential air quality issues have therefore been incorporated in the CBA.

3.9.9. Greenhouse gas emissions

Appendix I of the EIS contains the Air Quality and Greenhouse Gas Assessment (Jacobs 2020) for the Project.

PREDICTED GHG EMISSIONS

Between 2022 and 2044, the Project is predicted to give rise to around 26.7 million tonnes of carbon dioxide equivalent (Mt $CO_{2\text{-}e}$) in Scope 1 and 2 greenhouse gas (GHG) emissions, compared to around 8.1 Mt $CO_{2\text{-}e}$ in Scope 1 and 2 GHG emissions attributable to the Narrabri Mine between 2022 and 2034 (Jacobs 2020).

MITIGATION AND MANAGEMENT MEASURES

The Project would use various mitigation measures to minimise the overall generation of GHG emissions to the greatest extent practicable. GHG abatement measures for the Project would be documented in the Greenhouse Gas Minimisation Plan (SLR, 2012) and the Energy Savings Action Plan (Advitech, 2014) (or their latest approved versions), including:

- regular maintenance of plant and equipment to minimise fuel consumption and associated emissions;
- continuing to select plant and equipment that are energy efficient; and
- training all staff on continuous improvement strategies regarding efficient use of plant and equipment including maintaining equipment to retain high levels of energy efficiency.

In addition, NCOPL would monitor gas volumes and composition, and continue to investigate developments in flaring technology to determine whether flaring is a viable option to abate Scope 1 greenhouse gas emissions associated with Project fugitive emissions. Depending on the outcomes of the above, NCOPL would flare gas for the Project and, if so, this would reduce direct emissions as it would convert methane to CO_2 as part of the combustion process.

VALUATION APPROACH

The costs associated with various mitigation measures to minimise the overall generation of greenhouse gas emissions at the Project have been incorporated in NCOPL's costings.

Where the valuation of GHG emissions is concerned, the EA Technical Notes clarify that the focus should be on Scope 1 and 2 emissions, and state that market prices should be referenced to value GHG emissions. The EA Technical Notes refer to the forecast price of European emission allowances (EUAs) as reflected in futures prices published by the European Energy Exchange (EEX). This approach has been adopted here.

Table 3-6 summarises total estimated (Scope 1 and 2) GHG emissions for the Project and the Narrabri Mine, respectively, and the valuation of these emissions at 'central', 'high' and 'low' carbon prices, as recommended in the EA Technical Notes:

- The central forecast relies on the prices of EUA futures, as published by EEX (2020), which increase from AU$ 34.78 per tonne of CO_2-e (t CO_2-e) in December 2022 to AU$ 39.55 t CO_2-e in December 2029. EUA futures prices are not published beyond 2029; it has therefore conservatively been assumed that prices from that year onwards will increase by 1.7 per cent in real terms, consistent with current trends.
- The high price forecast relies on carbon prices derived from the Australian Treasury Clean Energy Future Policy Scenario, in accordance with the NSW Government's 'Greenhouse Gas Emissions Valuation Workbook' (Department of Planning & Environment 2018). These prices are assumed to increase from $37.0 t CO_2-e in 2022 to A$124.84 t CO_2-e in 2044.
- The low price forecast relies on carbon prices derived from the US EPA Social Cost of Carbon (Department of Planning and Environment 2018). These prices are assumed to increase from $20.97 t CO_2-e in 2022 to $38.16 t CO_2-e in 2044.

The EA Technical Notes require that the economic impact of GHG emission should be estimated for NSW only. In Table 3-6, the NSW share of costs associated with increased GHG emissions has therefore been calculated with reference to NSW GSP as a percentage of world gross domestic product (GDP), which is around 0.31 per cent. On that basis, the incremental social costs of the GHG emissions associated with the Project using EUA futures prices amount to around $860,000 in NPV terms.

Table 3-6. Project emissions valuation ($2020)

	Total scope 1 & 2 emissions	Central price scenario EUAs - Futures prices	High price scenario Clean Energy Future Policy Scenario	Low price scenario US EPA Social Cost of Carbon
	(Mt CO_{2-e})	(NPV $m)	(NPV $m)	(NPV $m)
Total emissions / valuation				
Project	26.7	$471	$814	$313
Narrabri Mine	8.1	$192	$269	$121
Difference	18.6	$279	$546	$192
NSW share of emissions / valuation				
Project	0.08	$1.45	$2.52	$0.97
Narrabri Mine	0.03	$0.59	$0.83	$0.37
Difference	0.06	$0.86	$1.69	$0.59

Notes: NSW share of emissions has been calculated with reference to relative GDP/GSP. The Australian share of world GDP as of 2018 was 0.95%, and the NSW GSP share of Australian GDP as of 2018-19 was 32.6%. The €/AU$ exchange rate was assumed to be 1.68.

Source: NCOPL; World Bank 2019; https://www.eex.com/en/market-data/environmental-markets/derivatives-market/european-emission-allowances-futures, accessed on 10 May 2020; ABS, 2018; 5220.0 Australian National Accounts: National Income, Expenditure and Product; Table 1 & Table 26.

3.9.10. Road transport

Appendix J of the EIS contains the Road Transport Assessment (TTPP 2020) for the Project.

PREDICTED IMPACTS

The Road Transport Assessment concluded that:

- the Project would have minor or no impact on the midblock levels of service experienced by drivers on the Kamilaroi Highway;
- the key intersections which would be used by Project traffic are expected to operate at good levels of service with short delays and spare capacity without requiring upgrading; and
- a maximum impact case assessment of the potential peak 15-minute future traffic on the Kurrajong Creek Road railway level crossing found that the available storage space in Kurrajong Creek Road and the storage bays in the Kamilaroi Highway would contain the number of vehicles expected to be delayed during an extended closure of the level crossing.

MITIGATION MEASURES

Given that Project-generated traffic would have a negligible impact on the operation of the road network and its intersections, and that no specific safety concerns have been identified, no specific road or intersection upgrade measures are required to address potential adverse impacts of the Project.

VALUATION APPROACH

Given that the transport impacts associated with the Project are expected to be minimal and that no mitigation measures are needed, no transport-related costs have been included in the CBA.

3.10. LOSS OF SURPLUS TO OTHER INDUSTRIES

The EA Guidelines specify that the CBA should incorporate changes in economic surplus arising in other NSW industries such as the agricultural, forestry, tourism or equine industries.

There are a number of reasons for thinking that negative impacts on other industries are likely to be limited:

- The Project is an extension of an underground mining operation, which gives rise to less surface disturbance and other noise, visual and dust impacts than is the case for an open cut mine. While some infrastructure extensions are needed, the Project would make use of much of the existing surface infrastructure.
- Visual impacts associated with the Project would remain largely unchanged compared to those of the existing approved Narrabri Mine.
- The Air Quality and Greenhouse Gas Assessment (Jacobs 2020) concluded that the Project would not cause adverse air quality impacts.
- Noise contributions from the Project would generally be less than the EPA's noise criteria. Exceedances of the Project noise trigger levels are predicted for four privately-owned receivers; however, NCOPL would implement corresponding make management measures in accordance with the VLAMP.
- No specific measures or upgrades to the existing road network would be required, and the Project would not impact significantly on the capacity, safety or efficiency of the current road network (TTPP 2020).

3.10.1. Agriculture

The area around the Narrabri Mine is predominantly used for grazing for beef cattle and sheep, with some dryland cropping of cereal crops to support grazing production. Cropping is generally restricted to fodder crops for livestock and is opportunistic, based on favourable soil moisture conditions and weather forecasts. There is no irrigated agriculture around the Narrabri Mine, with surface water being the main water source for stock and domestic use since groundwater tends to be of poor quality (2rog Consulting 2020).

PREDICTED IMPACTS

The Agricultural Impact Statement (2rog Consulting 2020) concluded that the Project is likely to have insignificant impacts on agricultural resources and agricultural production with the implementation of appropriate management and rehabilitation measures. Further, the Agricultural Impact Statement (2rog Consulting 2020) concluded that the Project would have negligible outcomes for the regional agricultural industry and related services and employment.

VALUATION APPROACH

The agricultural impacts of the Project relate to the temporary displacement of agriculture over the Project life. These losses refer to:

- the foregone *gross* value of agricultural production (GVA); that is, the foregone revenue from the sale of primary agricultural products due to the disruption of agricultural land use; and
- the foregone *net* value of agricultural production; that is, the foregone gross revenue less the costs of production due to the disruption of agricultural land use.

The GVA is not a cost per se, but may reduce demand for inputs from upstream domestic industries and cause a loss of throughput to downstream domestic industries. These flow-on effects may result in a reduction in value added by these industries to the state and local economies, and are relevant for calculating agricultural flow-on effects (discussed in Section 4.3).

The direct agricultural impacts of the Project relate to the foregone net value of agricultural production, and represent an opportunity cost for NCOPL. That is, while the Project generates significant value added as a result of coal mining activities, that value added has an opportunity cost in the form of the value added from agricultural activities that is foregone.

To estimate the foregone value of agricultural production, conservative estimates of the land that would be temporarily displaced from agricultural production by land use class at the Narrabri Mine and the Project are shown in Table 3-7. These estimates conservatively assume that all of Mining Lease 1609 and MLAs 1 and 2 (excluding State Forest areas) would be unavailable for agricultural use over the life of the Narrabri Mine/Project. In reality, portions of agricultural land are excluded from agricultural use as surface development is progressively undertaken for the Project, and this land is progressively restored to agricultural use following rehabilitation (2rog Consulting 2020). Relative to the Narrabri Mine, the Project would require up to an additional 2,084 ha of various land classes to be temporarily taken out of production. This is considered to be conservative, as in reality, only discrete portions of the MLA areas would be unavailable at a time as these areas are progressively used for site infrastructure. These same areas are then progressively restored to agricultural (and forestry) land use as this infrastructure is decommissioned and these areas rehabilitated.

Table 3-7. Land taken out of agricultural production - Narrabri Mine and Project (hectares)

Land Type	Project 2022-2044	Narrabri Mine 2022-2034
Class 2 (ha)	57	0
Class 3 (ha)	1,828	1,190
Class 4 (ha)	2,282	1,627
Class 5 (ha)	3,166	2,792
Class >5 (ha)	1,479	1,119
Total	8,812	6,728

Note: Totals may not sum exactly due to rounding.
Source: Resource Strategies.

Gross margins per hectare for typical agricultural enterprises were taken from budgets compiled by the NSW Department of Primary Industry (Table 3-8). There are no published farm budgets for Class 6 land classes; this land was therefore conservatively valued as Class 5 land. The gross margins used here generally refer to the most valuable agricultural activity that might be feasible by land class, and can therefore be interpreted as conservative estimates of foregone agricultural margins. Agricultural gross margins refer to revenues less variable costs, but exclude capital costs and a return to owner-operator labour, and hence tend to overstate the opportunity cost of the foregone agricultural production.

Table 3-8. Agricultural gross margins, $ per hectare per annum

Land type	Agricultural activity	Gross margins ($ per hectare)
Class 2	Dryland cotton	$497.00
Class 3	Mixed weaned cattle on improved pasture	$416.47
Class 4	Mixed young cattle on improved and native pasture	$194.12
Class 5	Feeder cattle on native pasture	$173.81

Source: https://www.dpi.nsw.gov.au/agriculture/budgets; accessed on 22 May 2020.

The estimated incremental foregone value added of agriculture production associated with the Project – the land removed from production multiplied by the corresponding gross margins – is shown in Table 3-9. Table 3-9 shows the value of foregone agricultural margins, discounted over the respective life of either the Project or the Narrabri Mine. The total incremental forgone gross margin associated with the Project is around $10.5 million in NPV terms. The incremental foregone gross margin associated with the Project is an opportunity cost for NCOPL and is therefore not relevant to the CBA.

Table 3-9. Foregone net value of agricultural production - Narrabri Mine and Project (2020, $,000)

Land Type	Incremental Project 2022-2044	Narrabri Mine 2022-2034	Difference
Class 2 (NPV $,000)	$319	$0	$319
Class 3 (NPV $,000)	$8,582	$4,142	$4,440
Class 4 (NPV $,000)	$4,993	$2,640	$2,354
Class 5 (NPV $,000)	$6,203	$4,056	$2,147
Class >5 (NPV $,000)	$2,898	$1,626	$1,272
Total	$22,995	$12,463	$10,532

Note: NPVs calculated using a discount rate of 7 per cent.
Source: AnalytEcon.

It is noted that any agricultural land associated with the Project biodiversity offset area would be permanently displaced. The foregone value of agricultural production from the biodiversity offset area has not, however, been estimated as its location is to be determined. This foregone agricultural production is not expected to be significant as the biodiversity offset area site would be selected for its biodiversity values and is therefore expected to have marginal agricultural value.

Notwithstanding the above, the costs of establishing the land-based offset (including the purchase price of the land) have been included as part of NCOPL's costs in the CBA (Section 3.9.4). As is noted in the EA Guidelines, land prices can be assumed to reflect the present value of future earnings or other uses, and therefore it is considered that any foregone agricultural production from associated with the Project biodiversity offset areas has been considered in the CBA.

3.10.2. Forestry

NSW Forestry Corporation manage the regional state forest reserve for selective harvesting of sawlogs, iron bark residue and fencing brush over a timeframe of years to decades (2rog Consulting 2020). The Project would result in surface disturbance of approximately 243 ha of State Forest until the area is rehabilitated.

NCOPL would manage the temporary exclusion of harvesting in coordination with NSW Forestry Corporation. A silviculture management plan for the broader State Forest area would be developed in consultation with NSW Forestry Corporation so that there would be limited impact on silvicultural production or impact on milling operations. NCOPL will enter into an occupancy agreement with NSW Forestry Corporation whereby annual payments will be made over the operational life of the Project to make good any adverse impacts (commencing in 2027). An estimate of these annual payments has been included in the Project costs.

3.10.3. Tourism

As shown in Figure 1-1, the Narrabri Mine is located about halfway between the towns of Narrabri and Boggabri where most tourism businesses (such as hotels) in Narrabri Shire are located. The typical land use in the vicinity of the Narrabri Mine is grazing and the occasional fodder crop. The Jacks Creek State Forest and Pilliga East State Forest with selective silvicultural harvesting are situated on the western margin. The land has been used as such since settlement in the 1830s, and much of the more accessible land has been cleared for agricultural production (2rog Consulting 2020). As noted above, the Project is not expected to affect visual amenity, noise or air quality in the surrounding landscape.

TOURISM CONTEXT

The most recent 2016 Community Census information from the Australian Bureau of Statistics (ABS) indicates that employment in accommodation and food services – an indicator of the importance of tourism – was 6.2 per cent in Narrabri LGA, compared to 5.4 per cent in Moree Plains LGA, and 6.8 per cent in Tamworth Regional LGA (Table 3-10). The census also suggests that most tourism-related employment is concentrated in the town of Narrabri:

- employment in accommodation and food services in Narrabri Statistical Area 2 (SA2) which covers Narrabri and Narrabri West was 8 per cent; while
- employment in accommodation and food services in Narrabri Region SA2, which broadly covers the remainder of Narrabri LGA but excludes Boggabri, was 3.6 per cent.

These findings are consistent with those reported in the 'audit of tourism events, infrastructure and accommodation' documented in the Social Impact Assessment (SIA, CDM Smith 2020). 44 tourist accommodation facilities were identified in the audit, including hotels/motels, caravan parks, apartments and bed and breakfast style accommodation. Most of the facilities that were identified were located in Narrabri and Gunnedah townships (17 and 23 tourist accommodation facilities, respectively), with three tourist accommodation facilities identified in Boggabri and one in Wee Waa.

Table 3-10. Employment in accommodation and food services (2016)

Locality	Employment in accommodation and food services	
	Share of employed persons	Number of employed persons
Narrabri area:		
Narrabri LGA	6.2%	351
Narrabri SA2 (Narrabri, Narrabri West)	8.0%	252
Narrabri Region SA2 (Narrabri LGA, excl. Boggabri)	3.6%	75
Adjoining LGAs:		
Gunnedah LGA	6.8%	366
Moree Plains LGA	5.4%	298
Tamworth Regional LGA	6.8%	1,768
SA3 Region	5.7%	628
New England North West SA4 Region	6.6%	5,015

Source: ABS 2016 Community Census.

Table 3-11 shows other available indicators that relate to the importance of tourism in Narrabri and surrounding LGAs. Narrabri Shire is similar to Gunnedah and Moree Plains Shire in that these LGAs have far fewer tourism businesses than Tamworth Regional LGA.

Table 3-11. Tourism metrics (June 2018)

	Narrabri LGA	Gunnedah LGA	Moree Plains LGA	Tamworth Regional LGA	New England North West Region	NSW
Tourism businesses						
Non-employing	46	54	68	222	736	49,554
1 to 4 employees	51	47	59	199	703	33,799
5 to 19 employees	39	25	34	122	419	16,231
20 or more employees	3	4	7	43	85	4,475
Total	**139**	**130**	**168**	**586**	**1943**	**104,059**
Visitors ('000)	245	N/a	N/a	1,138	3,500	97,400
Nights ('000)	429	N/a	539	1,524	5,600	197,800
Spend ($m)	$53	N/a	N/a	$300	$972	$36,800

Note: Limited data are available for Moree Plains, and no data are available for Gwydir and Liverpool Plains LGAs, suggesting that these are not important tourism destinations.

Source: Austrade; https://www.tra.gov.au/regional/local-government-area-profiles/local-government-area-profiles; 28 February 2020. Destination NSW; https://www.destinationnsw.com.au/tourism/facts-and-figures/regional-tourism-statistics/new-england-north-west; 28 February 2020.

POTENTIAL IMPACTS ON TOURISM

The location of the Project relative to tourism establishments in Narrabri Shire, the relatively limited role of tourism in Narrabri Shire, and the outcomes of the visual, noise and air quality assessments suggest that impacts on tourism would not be expected. This finding seems consistent with the detailed assessment of potential tourism impacts in the SIA (CDM Smith 2020):

- Of the eight major tourist events held annually in the Narrabri LGA and Gunnedah LGAs, all but one are held in the Narrabri and Gunnedah townships. The Boggabri Drovers Campfire event is held at the Boggabri Showgrounds, a distance of about 24 km from the Narrabri Mine.
- Two areas classified as state forest are located relatively close to the Narrabri Mine: Jacks Creek State Forest and Bibblewindi State Forest. Under the Forestry Act 2012, a permit is required for people who intend on using a state forest for recreational, sporting or commercial activities. These forestry areas therefore allow only limited public recreation access and would not be utilised for tourism activities.

- Adjoining the state forest areas to the south west are conservation areas, including Pilliga East State Conservation Area (SCA), Pilliga Nature Reserve, Pilliga West SCA and Timmallallie National Park (jointly referred to as the Pilliga Forest or The Pilliga). The Pilliga East SCA is the closest conservation area to Narrabri Mine (approximately 14 km at its closest point). Although tourism uses are allowed in the Pilliga East SCA, there were no visitor facilities, and the most recent (2014) data suggests that visitor numbers were low. The Narrabri Mine is likely not visible from this location, and the low visitation suggests the impacts to tourism would be minor even if visible.
- The Willala Aboriginal Area is located to the east of Pilliga East SCA. No information was identified concerning the current use of this area by Aboriginal people or whether it is accessible to visitors.
- The Mount Kaputar National Park features a range of walking trails and scenic lookouts, and tourists visiting the park may be able to see the Narrabri Mine, albeit at a distance of around 37 km so that the visual impact is likely to be low.

In summary, and given that the impact of the Project on the local tourism industry is expected to be low, no additional cost has been included in the CBA for the Project.

3.10.4. Horse breeding

Horse studs and other equine businesses in the New England North West region tend to be located around Tamworth and to the south of Gunnedah. No equine businesses are located within a 30km radius of the Narrabri Mine. As such, no impacts from the Project on the equine industry are expected.

Given that there are similarly no expected impacts of the Project the horse breeding industry, no additional cost has been included in the CBA.

3.11. INCREMENTAL NET BENEFITS OF THE PROJECT FOR THE NSW COMMUNITY

This section summarises the results of the CBA. The net benefits derived in the previous subsections have been allocated to the NSW community consistent with the EA Guidelines (Appendix A). Table 3-12 summarises the estimated net benefits of the Project for NSW. The NPV of the net benefits of the Project accruing to NSW are estimated at $599 million in NPV terms, consisting of:

- royalties of $259 million in NPV terms;
- the NSW share of company income tax of $177 million in NPV terms; and
- the NSW share of the net producer surplus of $163 million in NPV terms.

Table 3-12. Incremental net benefits of the Project for the NSW community ($2020)

Incremental direct and indirect costs	NPV $m	Incremental direct and indirect benefits	NPV $m
External effects (GHG)	$1	Royalties	$259
		NSW share of company income tax	$177
		NSW share of the net producer surplus	$163
Total direct and indirect costs	$1	Total direct and indirect benefits	$599
Net benefits to NSW			$599

Note: Totals may not sum precisely due to rounding.
Source: AnalytEcon.

The Project would potentially give rise to some additional external effects that would impact third parties. However, NCOPL would mitigate the great majority of these, including through the purchase of the requisite water licenses, and via compensation provisions that would make whole any affected private landowners or other third parties. These external effects therefore do not impose a cost on the NSW community. The NSW share of the incremental GHG emissions attributable to the Project is estimated at around $860,000 in NPV terms and constitutes a cost to the NSW community.

Overall, the Project's incremental contribution to NSW GSP is estimated at $799 million in NPV terms. As set out in Appendix B, the change in GSP as a result of the Project being approved captures the incremental benefits accruing to NSW from:

- the additional disposable income paid to the NSW workforce, including the NSW share of income tax and Medicare payments;
- the share of the Project's 'gross operating surplus' (GOS) that can be attributed to NSW, including coal royalty payments to NSW, and Commonwealth income taxes that can be attributed to NSW residents; and
- the additional payroll taxes, land taxes and local government rates paid.

3.12. SENSITIVITY ANALYSIS

The EA Guidelines require a proponent to undertake sensitivity analyses of a range of variables as part of the CBA in order to test the robustness of the results to changes in the underlying assumptions.

3.12.1. Variations in the discount rate

The sensitivity of the results of the CBA to changes in the central discount rate of 7 per cent has been tested by applying a discount rate of 4 per cent and 10 per cent, respectively (Table 3-13).

Table 3-13. Incremental net benefit to NSW – Discount rate sensitivity ($2020)

Discount rate assumption	Net benefits for NSW (NPV $m)
7 per cent	$599
4 per cent	$891
10 per cent	$417

Source: AnalytEcon.

3.12.2. Variations in coal prices and exchange rates

Most of the Project's coal production would be exported and priced in US dollars. Different combinations of coal prices and US$/A$ exchange rates would affect company revenues, and therefore royalty and income tax payments. Table 3-14 shows the net benefits accruing to NSW as a function of various combinations of coal prices and exchange rates:

- for the coal price sensitivity, product (thermal and PCI coal prices) have been varied by +20 per cent and –30 per cent over the life of the Project, respectively; and
- for the exchange rate sensitivity, the US$/AU$ exchange rate has also been varied by +30 per cent and –20 per cent, respectively, over the life of the Project.

Table 3-14 shows that in the 'worst case' scenario of a combination of a low coal price and a low (US$/AU$) exchange rate (implying that the value of the US$ is low relative to the AU$), sustained through all the years from 2022 through to 2044, the net benefits to NSW would amount to $57 million in NPV terms.

The EA Guidelines require proponents, where practicable, to undertake a sensitivity analysis of how much output prices would need to fall for a project to have a zero NPV, and to report on whether such a scenario is either likely or unlikely. The analysis suggests that all coal prices over the life of the Project would need to be reduced by 62 per cent to result in a net benefit to NSW of $0.

Table 3-14. Incremental net benefit to NSW and royalties – Coal price and exchange rate sensitivity (NPV $m 2020)

	Coal price assumptions		
Exchange rates (US$/A$)	**All coal prices reduced by 30%**	**Central coal price assumptions**	**All coal prices increased by 20%**
All US$/A$ exchange rates increased by 20%	$543	$934	$1,195
Central US$/A$ exchange rate assumption	$308	$599	$791
All US$/A$ exchange rates reduced by 30%	$56	$234	$353

Notes: NPVs have been derived using an annual discount rate of 7 per cent.
Source: AnalytEcon.

3.12.3. Variations in royalty payments

The EA Guidelines require an assessment of the royalties derived from the Project if mining revenues are 25 per cent lower or higher than in the central case. Table 3-15 summarises the results of the analysis.

Table 3-15. Incremental net benefits to NSW and royalties – Mining revenues sensitivity ($2020)

	Net benefits to NSW (NPV $m)	**Net royalty receipts (NPV $m)**
Central case mining revenues	$599	$259
25 per cent increase in mining revenues	$839	$327
25 per cent decrease in mining revenues	$358	$191

Notes: NPVs have been derived using an annual discount rate of 7 per cent.
Source: AnalytEcon.

3.12.4. Variations in company income tax payments

The EA Guidelines require an assessment of a variation in company income tax by +/- 50 per cent. Table 3-16 summarises the results of the analysis, including a scenario where no company income tax would be payable.

Table 3-16. Incremental net benefits to NSW and NSW share of company income tax payments – Income tax sensitivity (NPV $2020)

	Net benefits to NSW (NPV $m)	Net company income tax payments (NPV $m)
50 per cent increase in company income tax	$688	$266
Central case company income tax	$599	$177
50 per cent decrease in company income tax	$511	$89
No company income tax attributable to the Project	$422	$0

Notes: NPVs have been derived using an annual discount rate of 7 per cent.
Source: AnalytEcon.

3.12.5. Variations in the Australian ownership share

As noted in Section 3.4, the Australian ownership share of the Narrabri Mine Joint Venture (which is in turn owned by a Whitehaven Coal Limited subsidiary, NCOPL, and overseas-owned entities) is estimated to be 44.5 per cent. Variations in the Australian ownership share would affect the portion of the Project's incremental producer surplus that can be attributed to NSW. To test the implications of this variation, the Australian ownership share has been varied by +/ 30 per cent (57.8 per cent and 31.1 per cent, respectively), as shown in Table 3-17.

Table 3-17. Incremental net benefits to NSW and producer surplus – Australian ownership share sensitivity ($2020)

	Net benefits to NSW (NPV $m)	Net producer surplus (NPV $m)
Central case Australian ownership share (44.5 per cent)	$599	$163
30 per cent increase Australian ownership share (57.8 per cent)	$648	$212
30 per cent decrease Australian ownership share (31.1 per cent)	$550	$114

Notes: NPVs have been derived using an annual discount rate of 7 per cent.
Source: AnalytEcon.

3.13. DISTRIBUTIONAL IMPACTS

The EA Guidelines recommend commenting on the distributional impacts of a proposal:

- As described in previous sections of this report, the Project would deliver significant net benefits to the NSW community as a whole, estimated at $599 million in NPV terms.
- The Project would employ an average of 300 FTE operational workers between 2035 and 2044 and therefore benefit the workforce. In NPV terms, the incremental disposable income accruing to the operational workforce is estimated at $38 million in NPV terms.
- The assessments of the likely external effects associated with the Project suggest that no adverse effects on other industries, such as agriculture, tourism, or equine industries would be expected.
- Given the significant operating costs that would be incurred over the life of the Project, local and NSW suppliers can be expected to benefit from additional sales.

As described in Section 3.9, the additional (negative) environmental and other impacts of the Project on third parties are predicted to be limited.

4. FLOW-ON EFFECTS OF THE PROJECT FOR THE NSW COMMUNITY

This section describes the incremental 'second-round' or 'flow-on' effects that the Project would generate for the NSW community and the local region. The choice of approach for deriving these flow-on effects, the necessary caveats, and the derivation of multipliers is summarised in this section and detailed in Appendix C.

4.1. CHOICE OF INPUT-OUTPUT ANALYSIS

Second-round or 'flow-on' effects refer to the adjustments in the economy that follow on from the initial changes in the demand for goods, services and labour arising from a significant development such as the Project. Such a change in demand for a range of inputs sets the economy in motion as the productive sectors buy and sell goods and services from one another, and households earn additional incomes. These relationships cause the total effects on the regional or state economy to exceed the initial change in demand so that an entire jurisdiction benefits from the increased economic activity that arises from a significant investment.

Two main methods are generally used to calculate the flow-on effects for resources projects: input-output analysis and general equilibrium (GE) analysis. These methods differ in terms of their complexity, but they also face some common issues.

First, the degree of difficulty in estimating flow-on effects increases when moving from the national to the state and the regional economy (Coughlin and Mandelbaum, 1991). This reflects a general lack of information about the specific composition and source of intermediate inputs used by local and state industry, as well as about trade at a state and regional level. At the same time, state and local impact analysis depends, in large part, on adjusting the flows of production and expenditure, as represented in national input-output tables, to represent a state or local economy.[11] Industries at a local or state level have differing compositions of inputs and outputs than is the case for the national average. Hence, a consistent set of ancillary information that is specific to the state or regional economy is required to apportion national aggregates. The most commonly used information for this purpose (which is also recommended by the ABS and has been used in this EA) is industry employment.

[11] Input-output tables capture the flows of intermediate inputs between producers and form the basis for deriving multipliers. These tables are generally prepared at a national level. Thus, the Australian input-output tables reflect a snapshot in time of the entire Australian economy and the inter-relationships between producers, households, governments, and the outside world. However, similar information about the relationships between economic agents within a region and flows into and out of a region ('imports' and 'exports') is not available.

Second, all methodologies used to estimate flow-on effects are underpinned by various strong assumptions, which result in the impacts of a proposal being overstated if they are breached (Bess and Ambargis 2011).[12] The implication is that the regional or state flow-on impact estimates should be interpreted as an upper bound of the likely effects.

4.1.1. Income, employment and value added multipliers

The approach for estimating flow-on effects in this EA is to rely on input-output analysis to derive various 'multipliers'. The primary reasons for selecting this methodology are the simplicity and clarity with which the underlying assumptions can be set out and appropriate caveats made. Further, when compared to more complex methods such a GE analysis, given the lack of information about industry structure and trade at a regional and state level, there is no reason to think that one method would be materially more accurate than another. Finally, the value of the Project is small relative to the size of the NSW economy. While GE analysis takes into account the price impacts of a proposal on inputs and outputs, given the relative size of the Project, material price impacts would not be expected and the difference between the results of a GE and an input-output analysis should also be small.

Economic flow-on impacts can be measured in terms of the effects on income, employment and value added multipliers. In the case of the Project:

- The income multiplier refers to the percentage change in total income arising per dollar of the incremental disposable income paid to the workforce in the Project Scenario relative to the Reference Case.
- The employment multiplier corresponds to the change in total employment arising per additional person employed in the Project Scenario relative to the Reference Case.
- The value added multiplier refers to the percentage change in total value added arising per dollar change in the value added created in the Project Scenario relative to the Reference Case.[13]

[12] These assumptions and limitations are detailed in Appendix C, but include: that inputs are used in fixed proportions to one another; that all firms within an industry are characterised by a common production process; that prices are fixed (for input-output analysis), and that there are no supply constraints.

[13] Value added is the difference between output and intermediate inputs (the value created by production), and equals the contribution of labour and capital to the production process (Appendix B). Subject to some adjustments, the sum of gross value added across all industries in a country or state equals gross domestic product (GDP) or gross state product (GSP), respectively.

4.1.2. Type IA, IB and IIA multipliers

Multipliers are further classified into 'types'. 'Type IA' multipliers refer to the 'initial' and 'first-round' effects arising from an increase in demand generated by a proposal. Type IA multipliers capture the immediate subsequent impacts on income, employment or value added from all industries whose output is required to produce the additional output from the Project.

Type IB and Type IIA multipliers capture the initial and 'production induced' effects, and additionally the effects on households, respectively. These are compound multipliers that effectively trace the entire chain of interactions from an initial increase in employment or income through to all affected industries and households. Type IIA multipliers take into account all adjustments in an economy and are therefore the best choice for calculating flow-on effects from a theoretical perspective. However, this multiplier is calculated in a manner that compounds any measurement errors and breaches in the assumptions that underpin the analysis. A more conservative approach is therefore to rely only on multipliers that capture only first-round effects (Type IA multipliers), and this is the approach adopted in this EA.

4.2. INCREMENTAL FLOW-ON BENEFITS FOR NSW

Table 4-1 shows the estimated flow-on effects of the Project for NSW. The assumptions made for the input-output analysis are consistent with those made in the CBA; that is, the flow-on effects arise from the incremental employment and value added generated in the Project Scenario relative to the Reference Case. Given that the EA Guidelines do not generally permit increases in disposable income accruing to the workforce to be recognised as a benefit, disposable income flow-on benefits have not been calculated for the CBA.

Table 4-1 indicates that these flow-on benefits amount to:

- additional annual average employment flow-on benefits of 162 FTE jobs; and
- additional value added of $192 million in NPV terms, or $15 million per annum.

Table 4-1. Incremental initial flow-on effects (Type IA) of the Project – NSW ($2020)

	Units	Total	Annual
Employment	FTEs	N/a	162
Value added	NPV $m	$192	$15

Notes: NPVs have been derived using a discount rate of 7 per cent.
Source: AnalytEcon analysis.

4.3. INCREMENTAL FLOW-ON BENEFITS FOR THE LOCAL REGION

The flow-on effects of the Project for the local region consist of the positive incremental flow-on effects generated by the Project, but also a small offsetting impact arising from a reduction in agricultural activities.

4.3.1. Mining flow-on effects

Table 4-2 shows the estimated flow-on effects from the Project for the Project Region and the SA3 Region, respectively, without adjusting for the reduction in agricultural output. Table 4-2 indicates that these flow-on benefits amount to:

- additional disposable income of $77 million in NPV terms in the Project Region ($6 million per annum), or $39 million in NPV terms in the SA3 Region ($3 million per annum); and
- additional annual average employment flow-on benefits of 75 FTE jobs in the Project Region, or 38 FTE jobs in the SA3 Region.

Table 4-2. Incremental flow-on effects (Type IA) for the Project ($2020)

		Project Region		SA3 Region	
	Units	Total	Annual	Total	Annual
Disposable income	NPV $m	$77	$6	$39	$3
Employment	Annual average FTE jobs	N/a	75	N/a	38

Notes: NPVs have been derived using an annual discount rate of 7 per cent.
Source: AnalytEcon.

4.3.2. Agricultural flow-on effects

While the value of foregone agricultural production is an opportunity cost for NCOPL but not for the broader community, the loss of agricultural output may result in a reduced demand for inputs from local upstream domestic industries and a loss of throughput to local downstream domestic industries. These flow-on effects are immaterial at the state level, but they are potentially relevant at the level of the local region.

The flow-on impacts of foregone agricultural production on downstream and upstream industries are related to the level of agricultural output, as measured by the GVA (Section 3.10.1). Flow-on effects are calculated from the Type 1A input-output multipliers (Appendix C). These multipliers are slightly higher for the Project Region than for the SA3 Region, so the corresponding results also differ slightly.

In the most recent (2016) ABS requirements table for broadacre agriculture, value added (for which the gross margin is a proxy) is approximately equal to expenditure on intermediate inputs. Hence the incremental NPV of the GVA for the land taken out of production during the Project life has been approximated as twice the NPV of the incremental total gross margin foregone.[14] Applying the agricultural income multipliers for the Project Region and the SA3 Region, respectively, results in estimates for the incremental agricultural income flow-on effects of:[15]

- around $15.4 million in NPV terms over the life of the Project for the Project Region (or around $1.4 million per annum); and
- around $15.2 million in NPV terms over the life of the Project for the SA3 Region (around $1.3 million per annum).

Income in the form of wages and salaries derived from agriculture is a component of agricultural value added; it can therefore be expected that there may be some limited local impacts on income and employment due to agricultural land being removed from production. The incremental employment impact of the Project has been calculated with reference to the ratio of agricultural employment per $ million of GVA of agricultural output in the local region, which is 3.32 FTE workers. This ratio was used to translate the amortised annual foregone GVA into a corresponding annual employment impact. On that basis:

- the incremental employment flow-on effect – that is the employment flow-on effect on downstream and upstream industries – is estimated at around 1.7 FTEs per annum for both the Project Region and the SA3 Region; and
- the total incremental impact on agricultural employment – that is, the number of agricultural jobs lost directly plus the flow-on effect on other industries – is estimated at around 6.2 FTE jobs per annum for the Project Region and 6.1 FTE jobs for the SA3 Region.

Table 4-3 summarises the results for the incremental income and employment flow-on effects for the local region.

[14] GVA (agricultural revenues) = the gross agricultural margin + the value of intermediate inputs.

[15] The flow-on calculation shown here excludes any flow-on effects that may be associated with the Project land-based offset area (whose size and location is presently unknown). While there may be some related flow-on impacts, these are likely to be minor, given that the site(s) would be selected on the basis of biodiversity characteristics, and would be expected to have a marginal agricultural value, if any.

Table 4-3. Incremental (foregone) income and employment agricultural flow-on effects ($2020)

	Project Region	SA3 Region
Income flow-on effects		
Total (2022-2044, $ m)	$15.4	$15.2
Annual (per annum, $,000)	$1.4	$1.3
Employment flow-on effects		
Annual – Incremental (per annum, FTEs)	1.7	1.7
Annual – Total (per annum, FTEs)	6.2	6.1

Source: AnalytEcon.

4.3.3. Combined mining and agricultural flow-on effects

Table 4-4 shows the estimated flow-on effects from the Project for the Project Region and the SA3 Region, respectively. The estimated employment flow-on effects take into account the reduction in flow-on impacts that is attributable to the displacement of agriculture by the Project.

Table 4-4. Incremental flow-on effects (Type IA) for the Project ($2020)

		Project Region		SA3 Region	
	Units	Total	Annual	Total	Annual
Disposable income	NPV $m	$62	$5	$24	$2
Employment	Annual average FTE jobs	N/a	68	N/a	32

Notes: NPVs have been derived using an annual discount rate of 7 per cent.
Source: AnalytEcon.

5. LOCAL EFFECTS ANALYSIS

This section describes the LEA that has been prepared for the Project. The LEA is intended to complement the CBA by translating the effects estimated at the state level into local impacts. For the reasons set out in Section 2.3, the LEA has been prepared for two regional definitions:

- the SA3 Region, consistent with the requirements in the EA Guidelines; and
- the Project Region, encompassing Narrabri and Gunnedah LGAs, where a large share of the operational workforce resides.

5.1. LOCAL EMPLOYMENT AND INCOME EFFECTS

According to the EA Guidelines, estimating the employment and income effects accruing to the local workforce requires an estimate of the local workforce and the additional income attributable to the local workforce because of the Project.

5.1.1. Local workforce

Over the operational timeframe of the Project from 2022 to 2044, the Project operational workforce would consist of, on average, 370 FTE workers. Table 5-1 below summarises the shares of the workforce assumed to live in the Project Region and the SA3 Region, respectively, in the Project Scenario and in the Reference Case.[16] These shares have been derived from the places of residence of the current Narrabri Mine workforce (Table 2-1).

Table 5-1. Operational workforce Project and Narrabri Mine – FTE averages, 2022 to 2044

	Project Region			SA3 Region		
	Project	Narrabri Mine	Difference	Project	Narrabri Mine	Difference
	FTEs	FTEs	FTEs	FTEs	FTEs	FTEs
Ordinarily resident in the local region	218	119	99	111	61	51
Not ordinarily resident in the local region	152	83	69	259	141	118
Total	370	202	168	370	202	168

Note: Totals may not sum precisely due to rounding.
Source: AnalytEcon.

[16] In this calculation, all FTE averages have been calculated from 2022 to 2044, notwithstanding the fact that employment at the Narrabri Mine in the Reference Case would cease post-2031. This has been done to enable a 'like with like' comparison of FTE and disposable income averages between the two scenarios.

5.1.2. Incremental disposable income

Table 5-2 derives the incremental disposable income accruing to the local operational workforce, in the format set out in Table 4.2 in the EA Guidelines. Table 5-2 focuses on the difference between the Project and the Narrabri Mine, for each of the Project Region and the SA3 Region. The incremental disposable income benefit accruing to the Project workforce is calculated by comparing, for the Project and the Narrabri Mine, the additional disposable income that the respective workforce would earn relative to the average regional wage, and then taking the difference.

Table 5-2 should be read as follows:

- Row (1) contains the numbers of operational workers assumed to live in the Project Region and the SA3 Region, respectively, consistent with Table 5-1.
- Rows (2) through (4) derive the difference in disposable incomes for workers earning a mining sector wage (the average wage earned by the NCOPL operational workforce) relative to the disposable income corresponding to the average wage in the Project Region and the SA3 Region, respectively.
- Row (5) translates the average increase in disposable income per person into a per annum aggregate by multiplying it with the average number of local FTE jobs for the Project and the Narrabri Mine, respectively. For instance, looking at the Project Region, multiplying the per worker annual incremental disposable income for the Project of $73,917 with the average number of local workers (218) gives a per annum total of $16.2 million. For the Narrabri Mine, the corresponding per annum total is $8.4 million. The difference of $7.7 million is the incremental annual disposable income benefit attributable to the Project for the Project Region.
- Row (6) translates the additional annual disposable income into an implied FTE number by dividing by gross income in the mining sector.
- Rows (7) determines the aggregate incremental disposable income benefit from 2020 to 2044 in NPV terms for the Project Region and the SA3 Region, respectively.

In summary, Table 5-2 suggests that in the Project Scenario (relative to the Reference Case) the local operational workforce would benefit from:

- an increase in disposable income of $55 million in NPV terms in the Project Region; and
- an increase in disposable income of $30 million in NPV terms in the SA3 Region.

Table 5-2. Incremental increase in disposable income calculation ($2020, 2022 to 2044)

		Units	Project Region			Moree-Narrabri SA3 Region		
			Project	Narrabri Mine	Difference	Project	Narrabri Mine	Difference
(1)	Direct employment during operations phase	FTE jobs	218	119	99	111	61	51
(2)	Average disposable income in mining industry	$ per year	$129,249	$126,011	$3,238	$129,249	$126,011	$3,238
(3)	Average disposable income in other industries	$ per year	$55,332	$55,332	$0	$51,441	$51,441	$0
(4)	Average increase in net income per employee (2) – (3)	$ per year	$73,917	$70,679	$3,238	$77,807	$74,570	$3,238
(5)	Increase in disposable income per year due to direct employment (4) x (1)	$m per year	$16.2	$8.4	$7.7	$8.6	$4.5	$4.1
(6)	FTE job equivalent (5) / (average gross mining income)	FTE jobs	75	41	35	40	22	19
(7)	Increase over the operational mine life (NPV)	$m	$187	$132	$55	$100	$70	$30

Note: Totals may not sum exactly due to rounding.
Source: AnalytEcon.

5.2. EFFECTS RELATED TO NON-LABOUR PROJECT EXPENDITURE

The EA Guidelines require proponents to quantify (non-labour) construction and operating expenditures and to attribute those expenditures to the relevant local region. NCOPL has prepared an analysis of the local operating expenditures, shown in Table 5-3 below. Table 5-3 suggests that almost 71 per cent of NCOPL's operating expenditures are directed at NSW suppliers, and that around 6 per cent of operating expenditures are directed at suppliers in the Project Region (Narrabri Shire and Gunnedah Shire).

Table 5-3. Analysis of direct operating expenditures in NSW (excluding labour, calendar year 2019)

Expenditure by geography	Expenditures	Percentage of total operating expenditures
Narrabri Shire	$14,250,762	3.9%
Gunnedah Shire	$7,658,217	2.1%
Tamworth Regional Shire	$3,160,578	0.9%
Total local operating expenditures	$25,069,557	6.8%
Other NSW operating expenditures	$209,480,978	57.2%
Total NSW operating expenditures	$259,620,092	70.9%

Source: NCOPL.

Using the ratios derived in Table 5-3 it is possible to estimate the share of local and NSW expenditures going forward in the Project Scenario and the Reference Case, respectively, assuming that these shares remain the same going forward. Table 5-4 suggests that of the $4,126 million in NPV terms of operating expenditures in the Project Scenario, around $2,924million in NPV terms would be expended in NSW (compared to $2,149 million in NPV terms for the Narrabri Mine). $247 million in NPV terms would be expended in the Project Region in the Project Scenario, compared to $160 million in NPV terms in the SA3 Region. Overall, the Project would result in additional operating expenditures relative to the Reference Case of:

- $775 million in NPV terms in NSW;
- $65 million in NPV terms in the Project Region; and
- $43 million in NPV terms in the SA3 Region.

Table 5-4. Estimated future NSW and local operating expenditures ($2020)

Operating expenditures by state/region		Project	Narrabri Mine	Difference
Total operating expenditures	NPV $ m	$4,126	$3,032	$1,094
NSW	NPV $ m	$2,924	$2,149	$775
Project Region	NPV $ m	$247	$181	$65
SA3 Region	NPV $ m	$160	$118	$43

Source: AnalytEcon.

5.3. OTHER NET BENEFITS ATTRIBUTABLE TO THE LOCAL REGION

In addition to the incremental income benefits discussed above, net rate payments accruing to NSC represent a direct benefit to the local region. In the Project Scenario, NCOPL would pay $3.9 million in NPV terms to NSC; an additional $1.8 million in NPV terms relative to the Narrabri Mine (Section 3.3).

As reported in the SIA, NCOPL has made a number of community contributions in accordance with Condition 9, Schedule 2 of Project Approval 08_0144 (CDM Smith 2020). These contributions also represent a benefit to the local community:

- the upgrade and seal of 7 km length of the Kurrajong Creek Road for the NSC;
- a $7,000 contribution to NSC for provision of bushfire services;
- a total contribution of $93,000 to NSC for community infrastructure;
- a total contribution of $100,000 to the Gunnedah Shire Council (GSC) for the Gunnedah Urban Riverine Scheme;
- a total contribution of $1,500,000 to the NSC for the Narrabri Swimming Complex; and
- a total contribution of $100,000 to the GSC for community enhancement.

NCOPL also makes financial and in-kind contributions to non-government and community organisations in the region (CDM Smith 2020). NCOPL's and Whitehaven Coal Limited's financial contributions (in the form of sponsorships and donations) in the region in FY2019 were $150,800 in the Narrabri LGA, and $530,900 in total in the regions where Whitehaven Coal Limited operates. Over the past five years, Whitehaven Coal Limited has made several higher value, longer term donations to the region including $560,000 to support the Westpac rescue helicopter, as well as state and nation-wide companies and not for profit organisations, including $155,000 to the Girls Academy, $40,000 to the Clontarf Foundation and $45,000 to the Winanga-Li Aboriginal Child and Family Centre. The Project may see the continuation of community contributions for an additional period.

5.4. EFFECTS ON OTHER LOCAL INDUSTRIES

The EA Guidelines require a qualitative discussion of the effects of a proposal on other local industries, including whether a project would displace specific land uses, affect tourism, or whether short run market adjustments, for instance in housing markets, might be expected.

5.4.1. Agriculture

As set out in Section 3.10.1, the foregone net value of agricultural production represents an opportunity cost for NCOPL. The reduction in agricultural production as a result of the Project may also result in a reduced demand for inputs from upstream domestic industries and a loss of throughput to downstream domestic industries (Section 4.3.1). These flow-on effects may cause a reduction in value added by these industries to the state and local economies.

5.4.2. Local tourism

As set out in Section 3.10.3, no material negative impacts on local tourism businesses are expected because of the Project.

5.5. NET BENEFITS OF THE PROJECT FOR THE LOCAL REGION

Table 5-5 summarises the net effects of the Project for the Project Region and the SA3 Region over the operational life of the Project, as derived in the previous sections of the LEA, and in the format set out in Table 4.5 in the EA Guidelines.

Employment-related benefits (rows (2) and (3)) refer to the additional employment and the additional disposable income that the Project would bring to the Project Region and the SA3 Region, respectively.

The Project would require an average operational workforce of 370 FTE workers between 2022 and 2044. Over that timeframe, 218 (111) FTEs workers of the Project operational workforce are expected to live in the Project Region (the SA3 Region). In incremental terms, i.e. considering the Project Scenario relative to the Reference Case over the same timeframe, 99 (51) FTE workers are expected to live in in the Project Region (the SA3 Region). If broader employment flow-on effects are included (including by accounting for the direct and indirect loss of agricultural jobs), the total employment effects are estimated at 168 FTE jobs for the Project Region and 82 FTE jobs for the SA3 Region.

In aggregate terms, the disposable income accruing to the operational workforce of the Project between 2022 and 2044 is estimated at $537 million in NPV terms. The disposable income accruing to the 218 (111) operational workers expected to live in the Project Region (SA3 Region) is estimated at $317 ($161) million in NPV terms. Taking the difference between the Project Scenario and the Reference Case and considering the difference between mining wages and the average local wage, the net incremental income accruing to the Project operational workforce is estimated at $55 million for the Project Region and $30 million for the SA3 Region. If broader disposable income flow-on effects are taken into account (accounting for the foregone income from agricultural activities), the total local income effects are estimated at $117 million in NPV terms for the Project Region and $54 million in NPV terms for the SA3 Region.

Row (4) summarises the information on non-labour related local expenditures.[17] Over the Project operational timeframe, total operating expenditures for the Project are estimated to amount to $4,126 million in NPV terms. Assuming that, going forward, the same shares as currently of operating expenditures continue to be directed towards local suppliers (Table 5-4), $247 million in NPV terms would be sourced from suppliers in the Project Region, and $160 million in NPV terms from suppliers in the SA3 Region in the Project Scenario. The net effect (relative to the Narrabri Mine) amounts to $65 million in NPV terms for the Project Region, and $43 million in NPV terms for the SA3 Region.

Row (5) focuses on local government rate payments. From 2022 to 2044, NCOPL would pay around $3.9 million in rate payment to NSC, or $1.8 million in NPV terms more than in the Reference Case.

Row (6) refers to potential negative environmental or other impacts of the Project on third parties. Where such impacts are expected to occur, NCOPL would mitigate these, for instance via the implementation of management and compensation measures, the purchase of the requisite water licenses, and through the implementation of a biodiversity offset strategy. No net cost should therefore be attributed to the local region.

[17] We note that, as explained in Section 3.7, expenditures directed at local suppliers cannot be considered to be 'benefits' in the conventional economic sense. This is because it is not possible to identify NSW- or locally owned businesses, nor is it known whether the goods and services supplied by these businesses are produced locally or in NSW.

The Project would conservatively displace up to an additional 2,084 ha of agricultural land. The corresponding foregone value of agricultural production represents an opportunity cost for NCOPL, and therefore does not represent a net cost for the local region. However, as noted in Section 4.3, the incremental reduction in agricultural production would give rise to (contractionary) flow-on effects on related downstream and upstream industries. These offsetting agricultural flow-on effects have been accounted for when calculating total income and employment effects in Table 5-5.

Table 5-5. LEA Summary ($2020, 2022 to 2044)

(A)			(B)	(C)		(D)		(E)	
			Project direct: Total	Project direct: Local		Net effect: Local		Total Local Effects	
				Narrabri Region	SA3 Region	Narrabri Region	SA3 Region	Narrabri Region	SA3 Region
(1)	Employment related								
(2)	Jobs created	Annual average FTE jobs	370	218	111	99	51	168	82
(3)	Disposable income	NPV $m	$537	$317	$161	$55	$30	$117	$54
(4)	Other, non-labour expenditure	NPV $m	$4,126	$247	$160	$65	$43	$65	$43
(5)	Local government rates	NPV $m	$3.9	$3.9	$3.9	$1.8	$1.8	$1.8	$1.8
(6)	Externality benefit/cost	NPV $m							

Source: AnalytEcon.

6. SIGNIFICANCE OF THE RESOURCE

The net benefits that are attributable to the Project as described in this EA indicate the significance of the resource, in terms of the additional employment and payments to the workforce, the generation of taxation revenues including royalties, and the share of the producer surplus attributable to NSW. These net benefits would accrue both at the State level and at the local level.

The incremental economic benefits of the Project for NSW is estimated at $599 million in NPV terms, consisting of:

- $259 million in NPV terms of incremental royalty payments;
- a NSW share of incremental company income tax payments of $177 million in NPV terms; and
- an incremental net producer surplus of $163 million in NPV terms that is attributable to NSW shareholders of Whitehaven.

The Project would furthermore create 168 operational FTE jobs per annum on average between 2022 and 2044. Overall, the Project's net contribution to NSW GSP is estimated at $799 million in NPV terms.

If approved, the Project would give rise to capital expenditures of $633 million in NPV terms between 2022 and 2044, compared to $369 million in NPV terms for the Narrabri Mine. Over that same timeframe, the Project would additionally account for operating expenditures of $4,126 million in NPV terms, compared to $3,032 million in NPV terms for the Narrabri Mine. On current trends, around 71 per cent of those operating expenditures would be expected to be directed at NSW suppliers.

The wider economic flow-on effects for the State of NSW are estimated at an additional 162 FTE jobs per annum over the life of the Project, as well as additional value added of $192 million in NPV terms ($15 million per annum).

The Project would deliver significant net benefits to the local region. For the Narrabri Region, consisting of Narrabri Shire and Gunnedah Shire where almost 60 per cent of the current operational workforce live, these incremental benefits are estimated at:

- an additional 99 FTE operational jobs;
- additional disposable income accruing to the local workforce of $55 million in NPV terms; and
- additional expenditures directed at local suppliers of $65 million in NPV terms.

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APPENDIX A ASSUMPTIONS CBA AND LEA

A.1. CBA - ATTRIBUTION OF BENEFITS

Table A-1 summarises (gross) benefits, and the share of these benefits that has been attributed to NSW, as prescribed in the EA Guidelines.

Table A-1. Attribution of incremental benefits to the NSW community ($2020)

Incremental benefits	Total value (NPV $m)	Share attributed to NSW (Per cent)	Value attributed to NSW (NPV $m)
Royalties	$259	100%	$259
Company income tax	$607	31.9%	$177
Economic benefit to NSW landholders	$0	100%	$0
Economic benefit to NSW suppliers	$0	100%	$0
Net producer surplus	$1,270	14.2%	$163

Source: AnalytEcon.

A.2. MEAN EMPLOYEE INCOME

Mean employee income estimates for the Project Region and the Moree – Narrabri SA3 Region for 2017 were sourced from ABS regional data (Table A-2). Mean employee income for 2020 was derived by applying the ABS wage price index through to June 2019. From 2020 onwards, local incomes are assumed to increase by 1 per cent per annum in real terms.

Table A-2. Mean employee income assumptions

Jurisdiction	June 2017	June 2020
Project Region	$54,385	$57,991
Moree – Narrabri SA3 Region	$50,403	$53,744

Note: For the Project Region the average employee income was calculated as the weighted average of employment income in Narrabri Shire and Gunnedah Shire.

Sources: ABS 2020, Data by Region; 6345.0 - Wage Price Index, Australia.

A.3. CARBON PRICES

The EA Technical Notes state that an appropriate reference price for the cost of carbon is the forecast price of emission allowances (EUAs) with the European Union Emissions Trading System based on futures derivatives published by the European Energy Exchange.

Table A-3 summarises EUA futures prices as of 4 April 2020, beginning in December 2020 and extending through to December 2029. EUA futures prices were converted into Australian dollars using an exchange rate of 1.6. Given that no futures prices are available for dates beyond December 2028, we have assumed that EUA prices will continue to increase in real terms at their historic rate of 1.7 per cent per annum through to 2044.

Table A-3.EUA futures prices (26 January 2020)

Delivery date	Settlement Price (€)	Settlement Price (AU$)
Dec-20	€ 20.26	$34.04
Dec-21	€ 20.33	$34.15
Dec-22	€ 20.70	$34.78
Dec-23	€ 21.13	$35.50
Dec-24	€ 21.29	$35.77
Dec-25	€ 21.94	$36.86
Dec-26	€ 22.34	$37.53
Dec-27	€ 22.74	$38.20
Dec-28	€ 23.14	$38.88
Dec-29	€ 23.54	$39.55

Note: EUA Futures Products, EU Allowances (EUA) permitting the emission of one tonne of carbon dioxide equivalent

Source: European Energy Exchange, 2020.

APPENDIX B PROJECT CONTRIBUTION TO NSW GSP

B.1. VALUE ADDED AND GROSS STATE PRODUDCT

From an economic perspective, the extent to which a commercial development contributes to the welfare of a country or state differs from a private benefit calculation, which focuses on profits. The public benefit of a project is measured with reference to value added. Value added is the additional value of goods and services that are newly created in an economy, and that are available for domestic consumption or for export.

Value added is a central concept in the Australian System of National Accounts, where it is referred to as 'gross value added' to emphasise that this measure is gross of the consumption of fixed capital (that is, depreciation). Gross value added is the difference between output and intermediate inputs (the value created by production), and equals the contribution of labour and capital to the production process (ABS 2013). Subject to adjustments that need to be made to ensure that valuations are internally consistent by accounting for various taxes and subsidies, the sum of gross value added across all industries in a country or state equals gross domestic product (GDP) or gross state product (GSP), respectively.

Formally, GSP at market prices derived using the income approach (GSP(I)) measures the sum of income flows accruing to the factors of production, plus taxes less subsidies on production and imports (ABS 2013):

$$\begin{aligned}\text{GSP(I)} = {} & \text{Compensation of employees and contractors} \\ & + \text{Gross operating surplus} \\ & + \text{Gross mixed income} \\ & + \text{Taxes} - \text{Subsidies on production and imports}\end{aligned}$$

Where:

- The gross operating surplus (GOS) is a measure of the surplus accruing to the owners of incorporated enterprises, and is the difference between gross output, on the one hand, and intermediate consumption, the compensation of employees and long-term contractors, and taxes less subsidies on production and imports. GOS is calculated before deduction of consumption of fixed capital, dividends, interest, royalties and land rent, and direct taxes payable.
- Gross mixed income (GMI) is a similar concept as GOS, and refers to the share of income from production that can be attributed to unincorporated businesses (for instance, self-employed people), and is not relevant here.

- Taxes (subsidies) on production include taxes on products, such as GST and import duties, and other taxes (subsidies) on production, such as payroll taxes or subsidies, land taxes, stamp duties and taxes on pollution.

The change in GSP as a result of the Project being approved therefore captures the incremental benefits accruing to NSW from:

- the additional salaries and wages paid to the NSW workforce;
- the share of the Project's 'gross operating surplus' (GOS) that can be attributed to NSW, including coal royalty payments to NSW and Commonwealth income taxes that can be attributed to NSW residents; and
- the additional payroll taxes, land taxes and local government rates paid to NSW and to local government.

B.2. INCREMENTAL COMPENSATION OF THE NSW WORKFORCE

In order to correctly apportion wage and salary benefits to NSW, gross wages and salaries have been decomposed into disposable income, income taxes, superannuation contributions, and Medicare levies. Only incremental disposable income is assumed to constitute a full benefit to NSW (Table B-1).

Table B-1. Disposable income accruing to the NSW workforce – Project and Narrabri Mine ($2020)

	Project	Narrabri Mine	Difference
Gross income (NPV $m)	$813	$552	$261
Superannuation (NPV $m)	$77	$52	$25
Personal income taxes (NPV $m)	$227	$153	$74
Medicare (NPV $m)	$16	$11	$5
Disposable income (NPV $m)	$492	$335	$157

Some share of income taxes and Medicare levies paid by the Project workforce to the Commonwealth Government can be deemed to benefit the residents of NSW. That share of income taxes and other imposts has been determined on the basis of population share (31.9 per cent).

B.3. INCREMENTAL VALUE ADDED

Table B-2 shows the estimated incremental contribution of the Project to NSW GSP.

Table B-2. Value added – Project and Narrabri Mine ($2020)

Components of value added	Project (NPV $ m)	Narrabri Mine (NPV $ m)	Difference (NPV $ m)
Compensation of employees and long-term contractors:			
Disposable income	$492	$335	$157
NSW share of net personal income tax & other receipts:			
Net income tax	$72	$49	$24
Net Medicare	$5	$4	$2
NSW share of Narrabri GOS:			
Producer surplus	$286	$122	$163
Royalties	$668	$409	$259
Company tax	$316	$138	$177
Other taxes on production less subsidies on production:			
Payroll	$49	$33	$16
Land taxes	$1	$0	$0
Local government rates	$4	$2	$2
Externalities:			
GHG emissions	$1	$1	$1
Net change in GSP:	$1,908	$1,109	$799

APPENDIX C INPUT-OUTPUT ANALYSIS AND DERIVATION OF FLOW-ON EFFECTS

This appendix describes the interpretation of input-output multipliers, the limitations of input-output analysis, and the methods used to calculate the flow- on effects of changes in the level of mining investment and production in NSW, the SA3 Region as specified by the EA Guidelines and the Project Region in which the great majority of employees reside or expected to reside.

The detail is intended to be sufficient for an independent third party to independently recreate the results. It is also intended to provide an overview of the multiplier types, the propensity for overstatement and what constitutes a reasonable conservative view of the trade-off between benefits and costs.

C.1. INPUT-OUTPUT MULTIPLIERS

Economic impacts can be measured in terms of income, value added and employment, which in turn gives rise to income, value added and employment multipliers. Multipliers are classified into 'types'. Type I multipliers refer only to flow-on effects in the production sectors, while Type II multipliers incorporate subsequent impacts on households:

- Type IA multipliers refer to the 'initial' and 'first-round' effects arising from an increase in demand from a proposal. The first-round effect captures the immediate subsequent impacts on income, employment or value added from all industries whose output is required to produce the additional output from the proposal.
- Type IB multipliers refer to the initial and 'production induced' effects, which encompass first-round effects and additionally 'industrial support' effects. Industrial support effects capture subsequently induced effects that occur after the first-round effects (since the initial output effect from a proposal will induce additional output in other industries, which will in turn lead to further rounds of effects and so on).
- Type IIA multipliers incorporate the effects of the initial increase in output from a proposal on households, and refer to the sum of production induced and consumption induced effects. Consumption induced effects capture the fact that, as a result of the additional output from a proposal and subsequent production induced effects in other industries, wage and salary earners will earn extra income which they spend on goods and services produced by all industries in the state or region.

C.2. LIMITATIONS OF INPUT-OUTPUT ANALYSIS

The principal advantage of the impact multiplier method is the simplicity with which levels of mining investment, employment and output can be translated into measures of changes in regional income and employment. However, the accounting conventions that form the basis of input-output models and hence how multipliers are derived impose several restrictive assumptions. Some of these assumptions pertain to input-output analysis generally while others relate to the use and interpretation of input-output analysis at a regional or state, as opposed to a national level.

The key assumptions used for the input-output analysis of flow-on effects are summarised in the following. Many of these assumptions can lead to an overstatement of the impacts of a proposal (Bess and Ambargis 2011, Coughlin et al. 1991). The implication is that the resulting regional impact estimates should therefore be interpreted as an upper bound of the likely effects. There are additionally specific issues that arise in deriving local value added multipliers. Value added includes profits that are distributed on the basis of ownership of capital assets, which becomes increasingly uncertain as the analysis becomes more granular. The calculation of value added multipliers at a local level is therefore not meaningful.

C.2.1. Fixed capital stocks

The National Accounts, on which input-output analysis is based, do not explicitly account for fixed capital stocks. This is an issue with input-output analysis generally, as fixed capital has a significant impact on how an industry adjusts over time. A corollary to this is that input-output analysis is static in the sense that it takes no account of the time required for the composition of inputs and outputs of production to shift to a changed level in output. Industries that require large amounts of fixed capital and labour adjust slowly, particularly when they are near full employment or when the supply of skilled labour is tight. These dynamics are hard to predict, but the implication over the short- to medium-term is that input-output effects will be overstated to varying degrees across industries.

The fixed nature of the capital stock is a critical issue in local impact assessments. In moving from the national to a state or local level, the location of fixed assets becomes increasingly important in establishing the goods and services that are supplied locally and those which are imported. Moreover, there is no information as to whether fixed assets are owned locally or whether the owners are located outside the region or state. Consequently, determining the valued added by local industry becomes increasingly problematic.

C.2.3. Supply constraints

Relatedly, when the initial impact considered is an increase in production, the assumption of fixed production patterns requires that there is a sufficient endowment of resources that is either available in (or able to migrate to) a local region to meet the increase in demand for inputs whose supply is fixed. These inputs include resources such as land and water, as well as labour with adequate skills.

C.2.4. Homogenous and fixed production patterns

The input coefficients that measure inter-industry flows between sectors are 'fixed' in input-output models; at any level of output, an industry's relative pattern of purchases from other sectors is unchanged. These assumptions are likely to be inconsistent with production patterns in the local economy, since the local economy may not have on offer the range of inputs required for a given industry. Therefore, the impact of the change in output on the local economy will differ from that implied by a national multiplier.

C.2.5. Fixed prices

Input-output analysis assumes that prices in the economy in question are held constant, so that the additional material and labour inputs are available at existing prices and wage rates. In reality, prices of inputs may change with substantive changes in their demand. To the extent that there is an impact on prices, imputed output effects will be overstated. However, this is only a problem in input-output analysis for projects of a sufficient scale to materially shift the demand for production inputs and the total supply of industry output.

C.3. DERIVATION OF MULTIPLIERS

The following describes the various steps required to derive state and local input-output multipliers.

C.3.1. Concordance of the national accounts with census employment data

The Australian National Accounts input-output tables set out the flows of industry inputs (columns) and outputs (rows) for 114 industry classifications. The input output tables are for the year 2016-17 which were released in July 2019. The ABS census records employment at an aggregated level with 19 industry classifications. The employment data was drawn from the most recent, 2016, census. The ABS census records employment an aggregated level with 19 industry classifications. The concordance between the census and the accounts is set out in Table C-1.

Table C-1. Industry concordance between the industries in the National Accounts and industry level employment data in the 2016 Census

2011 ABS census Aggregate Industry	ABS National Accounts industry codes	
	Starting from	Ending with
Agriculture, forestry and fishing	101	501
Mining	601	1001
Manufacturing	1101	2502
Electricity, gas, water and waste services	2601	2901
Construction	3001	3201
Wholesale trade	3301	3301
Retail trade	3901	3901
Accommodation and food services	4401	4501
Transport, postal and warehousing	4601	5201
Information media and telecommunications	5401	6001
Financial and insurance services	6201	6401
Rental, hiring and real estate services	6601	6702
Professional, scientific and technical Services	6901	7001
Administrative and support services	7210	7310
Public administration and safety	7501	7701
Education and training	8010	8210
Health care and social assistance	8401	8601
Arts and recreation services	8901	9201
Other services	9401	9502

Source: 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2016-17. 2016 ABS Census.

To construct the flows of industry inputs and outputs at the same level of the census, the rows and columns are summed. For example, there are seven industries classified as being part of the broader agriculture classification. Summing the seven rows aggregates the outputs of agriculture as a whole into each of the 114 industries. Summing the resulting new rows across the seven individual agricultural industries give the total input requirements for agriculture as a whole from each the 114 regions. The final result is a balanced flow table with 19 industry classifications.

The balancing items include rows and columns that are important for the regional impact analysis:

- there are rows for wages and salaries, imports and value added, respectively; and
- there are columns for household consumption, as well as for other final demands.

C.3.2. Requirements matrix and first-round (Type IA) output multipliers

The initial requirement for an extra dollar's worth of output of a given industry is called the initial output effect. It equals one in total for all industries, since an additional dollar's worth of output from any industry will require the initial one dollar's worth of output from that industry plus any induced extra output. The first-round effect is the amount of output required from all industries of the economy to produce the initial output effect.

First-round effects can be measured by deriving the 'direct requirements matrix'. In this matrix, the coefficients in a given industry's column show the amount of extra output required from each industry to produce an extra dollar's worth of output from that industry. The requirements matrix has been constructed from the Australian input-output (flows) table by standardising the inputs into each industry to produce one unit of output in each industry. This is achieved by dividing each row of the table by the total output on an industry-by-industry basis.

The first-round impact multiplier is then the sum of the standardised inputs for a given industry. For example, each element of the column for agriculture is divided by total agricultural output and then summed to obtain the total input requirement for one addition unit of output. The initial multiplier can be interpreted as the direct costs of an additional unit of production at current prices. Given these inputs are supplied domestically, the costs are other industry outputs and therefore contribute to total economic output. The sum of the initial output effect (which equals one) and the first-round effect is the Type IA output multiplier. This is simply the total first-round contribution of a project to the economy. For a project that is small when compared to the size of the industry, the first-round and Type IA impact multipliers are valid given the requirements are representative of those used in the project.

C.3.3. Simple output or Type IB multiplier

The simple Type IB multiplier takes into account the inputs required for the increased agricultural output (for example) that must also be produced, which requires the expansion of these industries and those that support them. These may be seen as series of flow-on effects that continue until the overall industry flows are again balanced.

Calculation of the simple multipliers requires solving a matrix equation. Let A be the 19 by 19 matrix of industry requirements (as discussed above), x a vector of inputs used in each of the industries and y a vector of net outputs from the economy. Net output can be standardised to 1 for each industry, giving rise to the simple linear input-output equation:

$$Ax - x = 1$$

Solving for the overall input requirement to one additional unit of output from each industry:

$$x = (I - A)^{-1}$$

where I is an identity matrix with ones along the main diagonal and zeros elsewhere, and the superscript -1 denotes the matrix inverse.

Summing the columns of $(1 - A)^{-1}$ gives the simple multipliers. For example, summing the agricultural column gives the total inputs from all industries needed to sustain the production of one additional unit of net agricultural output at the national level.

The simple multiplier represents a shift in the composition of industry output, as well as the total level of industry output assuming constant prices. This may be reasonably valid for a small increase in, for example agricultural, output. However, for large change like what has occurred in the Australian mining industry, output prices for most industries will adjust in an offsetting manner. That is, the relative prices for the outputs that are used more extensively in mining will rise, while prices for those that are less extensively use will fall. The implication is that the simple multiplier will, for a given increase in mining output, overstate the flow-on effects in industries where relative prices rise and understate flow-on effects where relative prices fall.

For a project that is small relative to the size of industry the price effects will be small and the bias in the simple multiplier may be ignored. However, the composition of flow effects will vary if the input requirements for the project differ from those of the industry. A comparison can lead to useful caveats regarding the simply multiplier effects on other industries.

C.3.4. The total or Type IIA output multiplier

The total multiplier takes into account the relationship between wages and household demand, that is, the increase (decline) in household demand that results from a rise (fall) in household income. This is derived by adding the wages row and the household expenditure column to the A matrix from the requirements table. Let the expanded matrix be denoted B. The total multipliers are analogous to the simple multiplier and given by the column sums of the matrix $(I - B)^{-1}$.

The key issue with the total multiplier is that wage rates and output price changes will tend to offset the effect. In a limiting case, an increase in wage rates will result in an increase in output prices and leave total output and real household expenditure unchanged. However, if the project is small relative to the size of the economy the effects on household income and wages can be ignored.

C.3.5. Employment, income and value added multipliers

First-round, simple and total employment, income and value add multipliers can be calculated in much the same way as the output multipliers. The caveat noted for wage rates and employment in the previous section applies.

C.3.6. Employment multipliers

To calculate employment multipliers requires information about employment by industry that is provided in the ABS National Accounts (Table 20). For each industry, the FTE level of employment is divided by total industry output. This creates a vector of employment requirements per unit of output (denoted h) that can be used to convert the physical input requirements per additional unit of industry output into requirements for labour. The sum of these labour requirements constitutes the employment multipliers, written in matrix notation as:

Type IA: hA;

Type IB: $h(I-A)^{-1}$

Type IIA: $h(I-B)^{-1}$

These multipliers give the FTEs of employment needed to support an additional unit of output. These multipliers can be adjusted to Type IA, Type IIA multipliers by expressing the multiplier as the total employment needed per person directly employed on the project. This is done by dividing each of the multipliers above by the number of workers required per unit of output. They are not the number of jobs created as this will be impacted by the number of part-time work that are converted to full-time workers or vice versa.

C.3.7. Income multipliers

The calculation of the income multiplier is done in the same way. The wage and salary requirement per unit are given in the requirements table. Designating these as a vector w the income multipliers written in matrix notation are:

Type IA: wA;

Type IB: $w(I-A)^{-1}$

Type IIA: $w(I-B)^{-1}$

These multipliers can be adjusted to Type IA, Type IIA multipliers by expressing the multiplier as the total income per dollar of salaries and wages expended directly on the project. This done by dividing each of the multipliers above by the salaries and wages required per unit of output.

C.3.8. Value added multipliers

Value added is the value of industry output less the costs of inputs, whether produced domestically or imported (the contribution to regional GDP). This can again be calculated, as a vector, v, from the requirements table as value added per unit of industry output. The multipliers are then calculated in an identical way to employment and income:

Type IA: vA;

Type IB: $v(I-A)^{-1}$

Type IIA: $v(I-B)^{-1}$

These multipliers can be adjusted to Type1A, Type 2a multipliers by expressing the multiplier as the total income per dollar of value added by the project. This done by dividing each of the multipliers above by the valued added per unit of output.

C.4. REGIONAL IMPACTS

It is not possible to maintain the level of consistency that exists in national input output tables at a regional level. Comprehensive data on industry composition, household consumption and the flow of goods and services to and from regions is not available.

C.4.1. Location quotients

A standard approach that can be reproduced across different regional definitions in a consistent manner is to use employment by industry data to form what are known as location quotients (LQs). Employment based LQs are ratios that indicate the percentage of people employed in a particular industry at a state or regional level, relative to the percentage of people employed in that industry in the national economy. Employment based LQs are then used to proportionally adjust the contribution of an industry to the use of intermediate inputs in a state or region. The consequent shortfall in intermediate inputs is made up by increasing 'imports' from outside the state or region across all industries.

LQs are used to translate economy-wide input-output relationships into state or regional relationships. Hence the national input-output tables need to be adjusted to better reflect the characteristics of the local economy (Table C-2).

The use of employment LQs has a critical limitation. Input-output tables do not explicitly account for fixed capital, human or physical, although the returns to these assets are implicitly reflected in wages and operating surpluses (profits). As the impact analysis becomes more granular, the geographic location of these assets becomes increasingly important. A local region may simply not have the fixed capital needed to cost-effectively produce the input required by a local industry. The input will be then be 'imported' from other regions, states, or from overseas.

Table C-2. NSW, SA3 and Project Region FTE employment by industry as a percentage of total employment (2016 Census)

Industry	NSW	SA3	Project region
Agriculture, forestry and fishing	2.1	23.3	17.5
Mining	0.9	2.2	9.9
Manufacturing	5.8	2.9	4.2
Electricity, gas, water and waste services	0.9	1.1	1.2
Construction	8.4	6.1	5.8
Wholesale trade	3.1	2.8	2.8
Retail trade	9.7	8.6	8.9
Accommodation and food services	7.1	5.7	6.8
Transport, postal and warehousing	4.7	4.2	4.3
Information media and telecommunications	2.2	0.5	0.6
Financial and insurance services	4.9	1.6	1.2
Rental, hiring and real estate services	1.8	0.8	1.0
Professional, scientific, and technical services	8.1	4.2	4.2

Industry	NSW	SA3	Project region
Administrative and support services	3.5	3	3.1
Public administration and safety	6	5.5	5.0
Education and training	8.4	8	7.7
Health care and social assistance	12.5	9.5	10.6
Arts and recreation services	1.5	0.6	0.5
Other services	3.7	4.4	4.9
Total	100.0%	100.0%	100.0%

Adjusting regional/state industry composition and trade

A raw LQ is simply the percentage of FTE employment in a given industry and region, divided by the percentage of FTE employment in a given industry at the national level. This may be written for the ith industry and the jth region as:

$$LQ_{i,j} = \frac{\dfrac{\text{employment}_{i,j}}{\sum_i \text{employment}_{i,j}}}{\dfrac{\sum_j \text{employment}_{i,j}}{\sum_i \sum_j \text{employment}_{i,j}}}$$

The LQ has a natural interpretation for an industry within a region:

- if the LQ is less than one, the goods and services from that industry will tend to be imported into the region to meet demand; while
- if the LQ is greater than one, the goods and services from that industry will tend to be exported into the region to meet demand elsewhere.

Given that goods and services and labour requirements are the same in all regions, the relationship will tend to be proportional so long as the actual size of the labour force does not represent a constraint. These are standard assumptions in an input output analysis. However, at the regional level, the violation of these assumptions can often be more apparent. For example, specialised good or services demanded for a project may simply not be produced domestically and may have to imported, with a consequent reduction in regional flow-on effects. However, this can be addressed within the context of the requirements table if project information on where purchases are made is available.

Total employment may not be a constraint for a large region, such as a state. However, while a large proportion of people may be employed in an industry in a small region, the overall workforce in that industry may not be sufficient to meet labour requirements. While this may in part be offset by migration, it can simply be more efficient to import goods and services into the region.

It is recommended practice (Bess and Ambargis 2011) to adjust the raw LQs in small regions by the following formula:

$$LQ_{i,j} = \begin{cases} LQ_{i,j} & if \;\; LQ_{i,j} < 1 \\ 1 & if \;\; LQ_{i,j} >= 1 \end{cases}$$

LQs consist of the ratio of an industry's share of regional earnings to the industry's share of national earnings. This adjustment has the effect of holding constant or reducing regional flow-on effects. The basic idea is that industries in the region are not likely to produce all of the intermediate inputs required to produce the change in final demand. In these cases, local industries must purchase intermediate goods and services from producers outside the region, thereby creating leakages from the local economy.

C.4.2. Regional multipliers

Given LQ is a vector of location quotients, the regionally adjusted Type IA and Type IB input multipliers are calculated by multiplying the industry requirements by the quotients. The output multipliers are the column sums of:

Type IA: $LQ \times A$;

Type IB: $\left(I - LQ \times A\right)^{-1}$

Type IIA: $\left(I - LQ \times B\right)^{-1}$

Where $\times$ denotes element-by-element multiplication of each column of A by LQ.

The income, employment and value add multipliers are calculated in the same manner as the national multipliers.

C.4.3. Adjusted mining and agricultural industry expenditures

The LQ adjusts for locally sourced intermediate inputs. Therefore, the expenditure column of the input-output matrix, which includes wages, gross operating surplus, taxes and imports needs to be rebalanced to sum to total industry output. The balancing item is imports. The adjusted state and regional mine expenditures are shown in Table C-3.

Table C-3. NSW, SA3 Region and Project Region – Regional adjusted mining expenditures

Expenditures	NSW	SA3	Project Region
Agriculture, forestry and fishing	0.1%	0.1%	0.1%
Mining	3.7%	6.4%	6.4%
Manufacturing	3.2%	2.2%	2.2%
Electricity, gas, water and waste services	1.9%	2.1%	2.2%
Construction	5.2%	3.5%	3.4%
Wholesale trade	1.6%	1.4%	1.4%
Retail trade	0.5%	0.4%	0.4%
Accommodation and food services	0.4%	0.4%	0.4%
Transport, postal and warehousing	2.3%	2.3%	2.0%
Information media and telecommunications	0.2%	0.1%	0.1%
Financial and insurance services	4.0%	1.2%	1.3%
Rental, hiring and real estate services	1.8%	1.0%	1.0%
Professional, scientific and technical Services	3.6%	1.8%	2.0%
Administrative and support services	0.7%	0.5%	0.6%
Public administration and safety	0.7%	0.5%	0.5%
Education and training	0.1%	0.1%	0.1%
Health care and social assistance	0.0%	0.0%	0.0%
Arts and recreation services	0.1%	0.0%	0.0%
Other services	1.5%	1.5%	1.5%
Total Domestic Inputs	31.5%	25.6%	11.7%
Wages and Salaries	11.7%	11.7%	11.7%
Gross Operating Surplus	53.8%	53.8%	53.8%
Taxes	0.7%	0.7%	0.7%
Imports	2.3%	8.2%	22.1%
Total	100.0%	100.0%	100.0%

C.5. ESTIMATES OF MULTIPLIERS

The multipliers reported in the following were derived from national level multipliers in accord with guidelines provided by the ABS. State and regional multipliers were derived using employment LQs to translate economy-wide input-output relationships into regional relationships.

C.5.1. Mining multipliers

Table C-4 shows NSW multipliers derived from the 2010 National Accounts tables and employment data for:

- income;
- employment (FTE equivalent); and
- value added (contribution to GDP).

Table C-4. NSW input-output multipliers - Mining

Multiplier	Type IA: Direct + Type IA effects	Type IB: Direct + Type IA + industry support effects	Type IIA: Direct + Type IA + industry support + consumption induced effects
Income	1.59	3.08	4.14
Employment	1.96	3.75	5.82
Value Added	1.24	2.43	2.87

Source: AnalytEcon.

Table C-5 shows the corresponding multipliers for the SA3 Region and the Project Region, respectively.

Table C-5. SA3 Region/Project Region input-output multipliers – Mining

	SA3 Region			Project Region		
Multiplier	IA	IB	IIA	IA	IB	IIA
Income	1.46	2.68	3.34	1.46	2.84	3.36
Employment	1.75	3.13	4.48	1.75	2.42	4.50
Value Added	1.20	2.29	2.56	1.20	3.18	2.57

Source: AnalytEcon.

C.5.2. Agriculture multipliers

The multipliers for broadacre agriculture used to estimate the flow impacts of foregone agriculture were calculated in an identical manner as those for mining.

Table C-6 shows the NSW agriculture multipliers; Table C-7 shows these multipliers for the respective local regions.

Table C-6. NSW input-output multipliers – Agriculture

Multiplier	Type IA: Direct + Type IA effects	Type IB: Direct + Type IA + industry support effects	Type IIA: Direct + Type IA + industry support + consumption induced effects
Income	1.91	3.78	5.19
Employment	1.42	2.76	3.40
Value Added	1.44	2.79	3.39

Source: AnalytEcon.

Table C-7. SA3 Region/Project Region input-output multipliers – Agriculture

	SA 3 Region			Project Region		
Multiplier	IA	IB	IIA	IA	IB	IIA
Income	1.72	3.18	4.03	1.73	2.68	4.06
Employment	1.37	2.57	2.98	1.38	2.43	2.99
Value Added	1.34	2.56	2.92	1.37	2.92	2.93

Source: ABS, 2016. 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2016-17; ABS 2016 Census.