APPENDIX M

ECONOMIC ASSESSMENT

Deloitte Access Economics

Cost Benefit Analysis and Economic Impact Analysis of the Wilpinjong Extension Project

2015

Deloitte.

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Glossary

ABS	Australian Bureau of Statistics
AUD	Australian dollar
CHPP	Coal Handling and Preparation Plant
CBA	Cost Benefit Analysis
CGE	Computable General Equilibrium
CO_2-e	Carbon Dioxide Equivalent
CPI	Consumer Price Index
DA	Development Application
DP&E	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
EL	Exploration Lease
EPA	Environment Protection Authority
ETL	Electricity Transmission Line
FOB	Free On Board
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GRP	Gross Regional Product
GSP	Gross State Product
ha	hectares
km	kilometres
kV	kilovolt
LGA	Local Government Area
ML	Mining Lease
Mtpa	million tonnes per annum
NPV	Net Present Value
NSW	New South Wales
PM	Particulate Matter
ROM	Run-of-Mine
SEARs	Secretary's Environmental Assessment Requirements
SUA	Significant Urban Area
TSP	Total Suspended Particulates
WCPL	Wilpinjong Coal Pty Limited

Executive Summary

Deloitte Access Economics has been commissioned to undertake a Cost Benefit Analysis and Economic Impact Analysis of the Wilpinjong Extension Project ('the Project').

The findings of this report can be summarised as follows:

- The Project delivers net benefits of around $735 million (in net present value [NPV] terms) over its life and generates a benefit cost ratio of around 1.43.
- Royalties generated by this Project, relative to the baseline, are estimated to be worth around $190.5 million (in NPV terms) to the New South Wales (NSW) Government.
- It is estimated that the Project could generate a net benefit to those in the Mid-Western Regional Local Government Area (LGA) of up to $263.5 million (in NPV terms) over the life of the Project, assuming that in the absence of the Project, local employees and suppliers would earn the average level of income in the area.
- It is considered unlikely that the externalities treated qualitatively in this analysis would be of a scale that would exceed the net benefits of the Project.
- Over the life of the Project, the Gross Regional Product (GRP) of the broader region (i.e. Bathurst Regional, Lithgow, Mid-Western Regional, Muswellbrook, Singleton and Upper Hunter LGAs) is projected to increase by almost $1.8 billion (in NPV terms) as a consequence of the Project.
- NSW's Gross State Product (GSP) (including the broader region) increases by around $2.2 billion (in NPV terms) as a consequence of the Project.
- The economic impact analysis projects a state-wide employment peak in 2018 with 278 additional full time equivalent (FTEs) workers being employed. This employment includes the incremental effects of direct employment, any employment from suppliers and crowding out of any economic activity. Around 77% of this incremental employment is expected to occur in the broader region.

About the Project

The Wilpinjong Coal Mine is an existing open cut coal mining operation situated in the Western Coalfield approximately 40 kilometres (km) north-east of Mudgee, within the Mid-Western Regional LGA in central NSW.

Wilpinjong Coal Pty Limited (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Limited (Peabody Energy), is the owner and operator of the Wilpinjong Coal Mine.

WCPL is seeking development consent to extend the Wilpinjong Coal Mine, including both physical extensions to the mine footprint to gain access to additional run-of-mine (ROM) coal reserves, and an extension to the approved life of the mine.

The Project will include approximately 800 hectares (ha) of open cut extensions, comprising incremental extensions to the existing open cut pits of around 500 ha, and development of a new open cut pit of approximately 300 ha. The extension will largely make use of existing infrastructure (such as the Wilpinjong Coal Mine Coal Handling and Preparation Plant (CHPP) and general coal handling and rail loading facilities).

It is expected that up to approximately 13 million tonnes of thermal product coal will be transported via rail to domestic and export customers each year, over the period to 2033. It is anticipated that three distinct coal outputs will be produced: mid ash thermal export coal, high ash thermal export coal and thermal coal that will be sold to domestic customers for electricity generation purposes. The additional mining activity under the Project case, relative to the baseline, primarily involves additional production of the export coal outputs.

The Project will also involve construction of additional mine access roads, relocation of a section of a 330 kilovolt electricity transmission line, and various local infrastructure relocations including realignment of a road and associated rail level crossings.

Project level cost benefit analysis

A cost benefit analysis (CBA) involves obtaining a consolidated estimate of the net economic value of the Project by identifying the incremental costs and benefits of the Project relative to the baseline case, and placing a quantitative value on these items wherever possible. The CBA compares the Project case to a baseline case which restricts operations at the Wilpinjong Coal Mine to currently approved operations (i.e. production to primarily focus on domestic coal, over the period to 2026). It should be noted that the analysis has drawn on information provided by Peabody Energy, WCPL and the findings of the EIS.

In undertaking the CBA we have had regard to the costs and benefits listed in Table i. These items have been drawn from a number of guidelines for CBA published by the NSW Government, and the items listed in the Secretary’s Environmental Assessment Requirements (SEARs) for the Project.

Table i: Wilpinjong Extension Project – direct costs and benefits

	Costs	Benefits
Production	Other onsite revenue forgone	Gross mining revenue
	Exploration costs	Deferred decommissioning costs
	Capital investment costs	
	Operating costs excluding royalties, rates and taxes	
	Rehabilitation costs	
	Residual value of capital forgone	
	Residual value of land forgone	
Externalities	Related public expenditure*	
	Offsite agricultural revenue	
	Groundwater quality*	
	Surface water quality*	
	Air pollution – carbon emissions	
	Air pollution – particulate matter	
	Air pollution – other pollutants*	
	Noise pollution	
	Visual amenity*	
	Traffic impacts	
	Biodiversity – flora and fauna*	
	Conservation*	
	Quality of open space*	
	Rural amenity and culture*	
	Aboriginal heritage*	
	Historical heritage*	
	Health*	

* Item has been considered qualitatively

Note: As the Project involves open-cut mining activity, there are no subsidence impacts which need to be valued in this analysis. Nevertheless, this item is discussed qualitatively in Section 5 in accordance with NSW Government Guidelines (2012)

Assessment of the costs and benefits listed above indicates that the Project is expected to generate net benefits. In the central case (which is based on a 7% discount rate) the Project delivers net benefits of around $735 million over its life and generates a benefit cost ratio of around 1.43. These results are shown in the table below.

Table ii: CBA results

Discount rate	Total net benefits ($m)	Benefit Cost Ratio
4%	911.82	1.41
7%	735.07	1.43
10%	604.06	1.45

Source: Deloitte Access Economics

As recommended in CBA guidelines such as NSW Treasury (2007), where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. We consider that all of the potentially large externalities of the Project have been valued in quantitative terms. The remaining externalities which have been considered qualitatively, such as visual amenity and Aboriginal and historical heritage are identified in Table i and discussed in Section 5.

The results indicate that these non-quantified externalities would need to generate costs of around $78 million per year (in real terms) over the operational phase of the Project from 2016 to 2033 to fully offset the estimated net benefits of the Project. This is equivalent to undiscounted costs of $1,407 million over the period. This is considered to be unlikely, given the nature of the evidence regarding these impacts.

As the outcomes in Table ii rely on a number of input assumptions, the sensitivity of the overall results to ranges of these inputs was tested. The results are shown in Table iii.

Table iii: Sensitivity Analysis – comparison of net benefits

Parameter	Variation in Parameter	Net Benefits ($m)		
		4%	7%	10%
Central CBA	N/A	$912	**$735**	$604
Export coal price forecasts	+ 30%	$1,852	**$1,466**	$1,186
	- 15%	$442	**$370**	$313
Project capital investment	+ 25%	$876	**$703**	$575
	- 25%	$948	**$767**	$633
Operating costs per tonne	Industry cost model (without 10% central case discount) (+ 11%)	$688	**$565**	$472
	WCPL expected costs (with 20% discount on industry cost model) (- 11%)	$1,136	**$905**	$737
Social cost per tonne of carbon emissions	Australian Treasury Clean Energy Future Policy Scenario prices (+ 288%)	$885	**$716**	$590
	US EPA Social Cost of Carbon prices (+ 87%)	$904	**$729**	$600

Source: Deloitte Access Economics calculations

The sensitivity ranges for the export coal prices were arrived at through an analysis of data over the period from January 1995 to September 2015. Specifically, the range used covers 67% of the range of historical monthly coal prices over this period.

These results indicate that the benefits of the Project are likely to exceed the costs, including any negative externalities imposed on broader society, in all scenarios. It is noted that the scenario where there is a 15% reduction in export coal prices represents an extreme case whereby prices remain at historically low levels throughout the life of the Project, fluctuating between the 16th and 31st percentiles of historical export coal prices. This scenario also assumes that WCPL is fully exposed to the spot market rather than longer term contracts – a conservative assumption.

Regional disaggregation of costs and benefits

A disaggregation of the above CBA results to consider net benefits to the community within the Mid-Western Regional LGA and NSW is also of interest. CBA calculations are not easily disaggregated into regional assessments. However, to do this we have assumed that payments to mine suppliers and employees are proportional to the share of suppliers and employees from different geographic locations, respectively. It was also assumed that these businesses and workers would earn the current average level of income in the Mid-Western Regional LGA in the baseline case. This assumption reflects a situation where workers would experience a range of outcomes including employment at comparable wages through to unemployment resulting in the group as a whole earning the average wage.

Under these assumptions, along with a number of others regarding the share of externalities borne by different regions, it is estimated that the Project would generate:

- A net benefit to the Mid-Western Regional LGA of up to $263.5 million (in NPV terms) over the life of the Project.
- A net benefit to NSW of around $873.8 million (in NPV terms) over the life of the Project.

There are also likely to be additional benefits to the region as a result of the continuation of financial contributions made by WCPL to the Mid-Western Regional Council for the purposes of the existing Voluntary Planning Agreement and Ulan Road Strategy, as detailed in the existing Project Approval. These have not been quantified in the estimates above.

Furthermore, the benefits to the region are likely to be significant in the context of this Project, given the regional economic profile. When considering the results above it is also important to take into account specifics of the local economic circumstances. In particular, data indicates that the Mid-Western Regional LGA has higher levels of unemployment than the state and that mining jobs pay significantly more than other jobs in the LGA.

One important regional benefit is the generation of taxation revenue for the NSW Government. We estimate that the Project would generate around $190.5 million (in NPV terms) in additional royalties for the NSW Government, relative to the baseline. In undiscounted terms, this is equivalent to an additional $358.3 million in government revenue over the life of the Project.

Impact on broader economy

We have used a Computable General Equilibrium (CGE) model to assess the flow on effects of the Project to the broader region. A CGE model represents the dynamic relationship between economic agents and can show how changes in one part of the economy (such as the production of more coal) flow through to other parts of the economy (such as effects on employment levels, exports and labour income). This is in contrast to CBA analysis which is focussed on the direct effects of the Project itself.

The CGE model has been customised for this analysis to incorporate three distinct Australian modelling regions. These include:

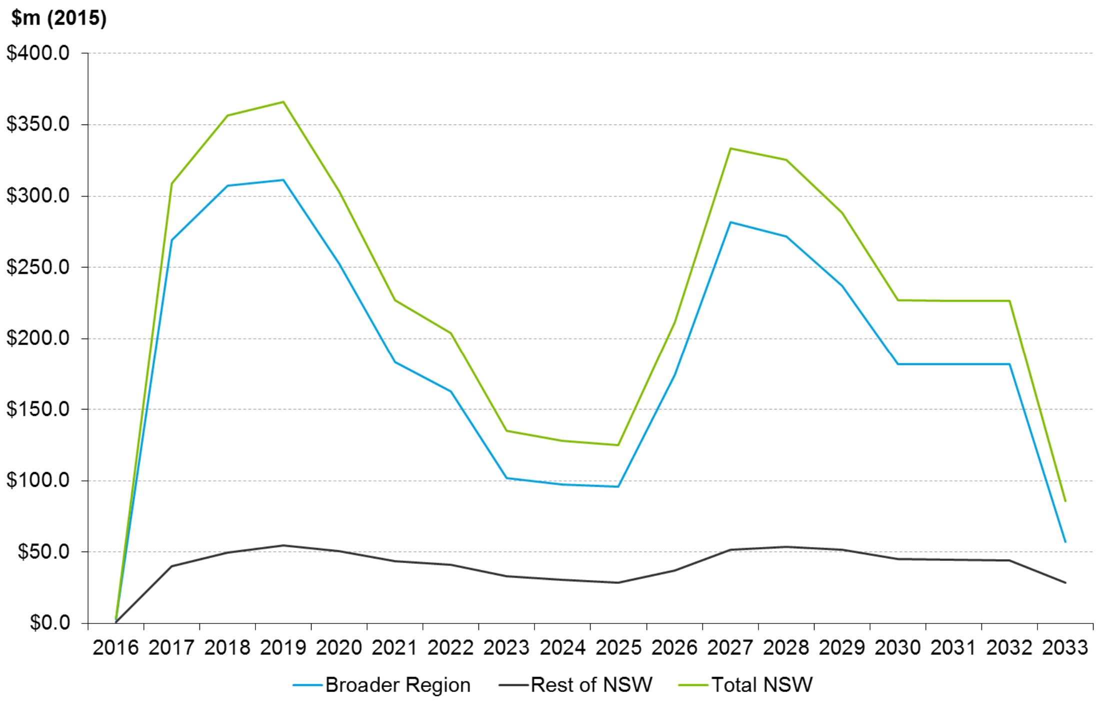
- broader region — contains Bathurst Regional, Lithgow, Mid-Western Regional, Muswellbrook, Singleton and Upper Hunter LGAs;
- NSW; and
- the rest of Australia.

We have modelled the overall economic impacts of the Project and find that, over the life of the Project, the broader region's GRP is projected to increase by almost $1.8 billion and NSW's GSP (including the region) is expected to increase by around $2.2 billion (both of these are in NPV terms). These results are shown in the table and chart below.

Table iv: Project economic impacts

	Total (NPV)
Broader Region (GRP $m)	$1,780.0
Rest of NSW (GRP $m)	$370.8
Total NSW (GSP $m)	$2,150.8

Chart i: GRP/GSP impacts by region, 2016 – 2033 (real 2015 $m)

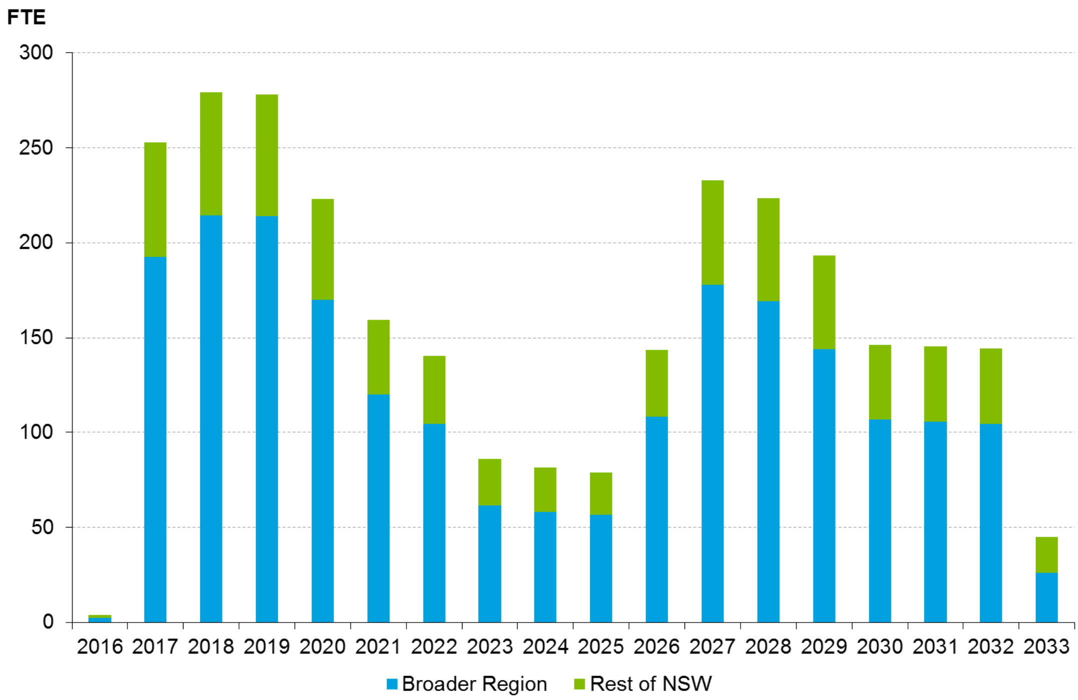


Note: All values are in real 2015 terms

Source: Deloitte Access Economics

The report also provides an estimate of the incremental projected employment impacts of the Project. State-wide incremental employment peaks in 2018 with 278 FTE workers. Of this, around 77% are estimated to be employed in the broader region and 23% in the rest of the state. These estimates are of total incremental employment including that at the Project and further employment generated in the economy.

Chart ii: Incremental employment impacts by region, 2016 – 2033



Source: Deloitte Access Economics

Our analysis also incorporated three sensitivities to take into account the uncertainty over future export coal prices. To understand the potential implications of different coal price trajectories for the Wilpinjong Coal Mine, the economic impact analysis was conducted for three modelling scenarios:

- Scenario 1 – Central estimate of export coal price forecasts.
- Scenario 2 – Lower export price scenario (15% lower below central estimates).
- Scenario 3 – Higher export price scenario (30% higher above the central estimates).

GRP impacts are proportionate to the coal price inputs. Broader regional GRP is modelled to decrease from about $1.8 billion in the central case to about $1.5 billion in the low case and increase to almost $2.3 billion in the higher price scenario.

More detail on the year-on-year GSP and employment impacts are outlined in Section 7, along with more information on the CGE modelling framework used.

1 Introduction

Deloitte Access Economics has been commissioned to undertake a Cost Benefit Analysis and Economic Impact Analysis of the proposed Wilpinjong Extension Project ('the Project').

The Wilpinjong Coal Mine is an existing open cut coal mining operation situated in the Western Coalfield approximately 40 kilometres (km) north-east of Mudgee, within the Mid-Western Regional Local Government Area (LGA), in central New South Wales (NSW).

Wilpinjong Coal Pty Limited (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Limited (Peabody Energy), is the owner and operator of the Wilpinjong Coal Mine.

WCPL is seeking development consent to extend the Wilpinjong Coal Mine, including both physical extensions to the mine footprint to gain access to additional run-of-mine (ROM) coal reserves, and an extension to the approved life of the mine.

The Project will involve approximately 800 hectares (ha) of open cut extensions, with continued use of the Wilpinjong Coal Mine Coal Handling and Preparation Plant (CHPP) and general coal handling and rail loading facilities. It will also involve construction of additional mine access roads, relocation of a section of the TransGrid Wollar to Wellington 330 kilovolt (kV) electricity transmission line (ETL), and various local infrastructure relocations including realignment of a road and associated rail level crossings.

An indicative Project general arrangement, showing the open cut extension areas and key infrastructure relocations, is provided on Figure 1.1.

In accordance with the NSW *Environment Planning and Assessment Act 1979*, an Environmental Impact Statement (EIS) is required for the Project. The objective of the EIS is to ensure that approval bodies, government authorities (including local councils), the applicant and the broader public have sufficient material to properly consider the potential environmental consequences of a proposal (NSW Government, 2000).

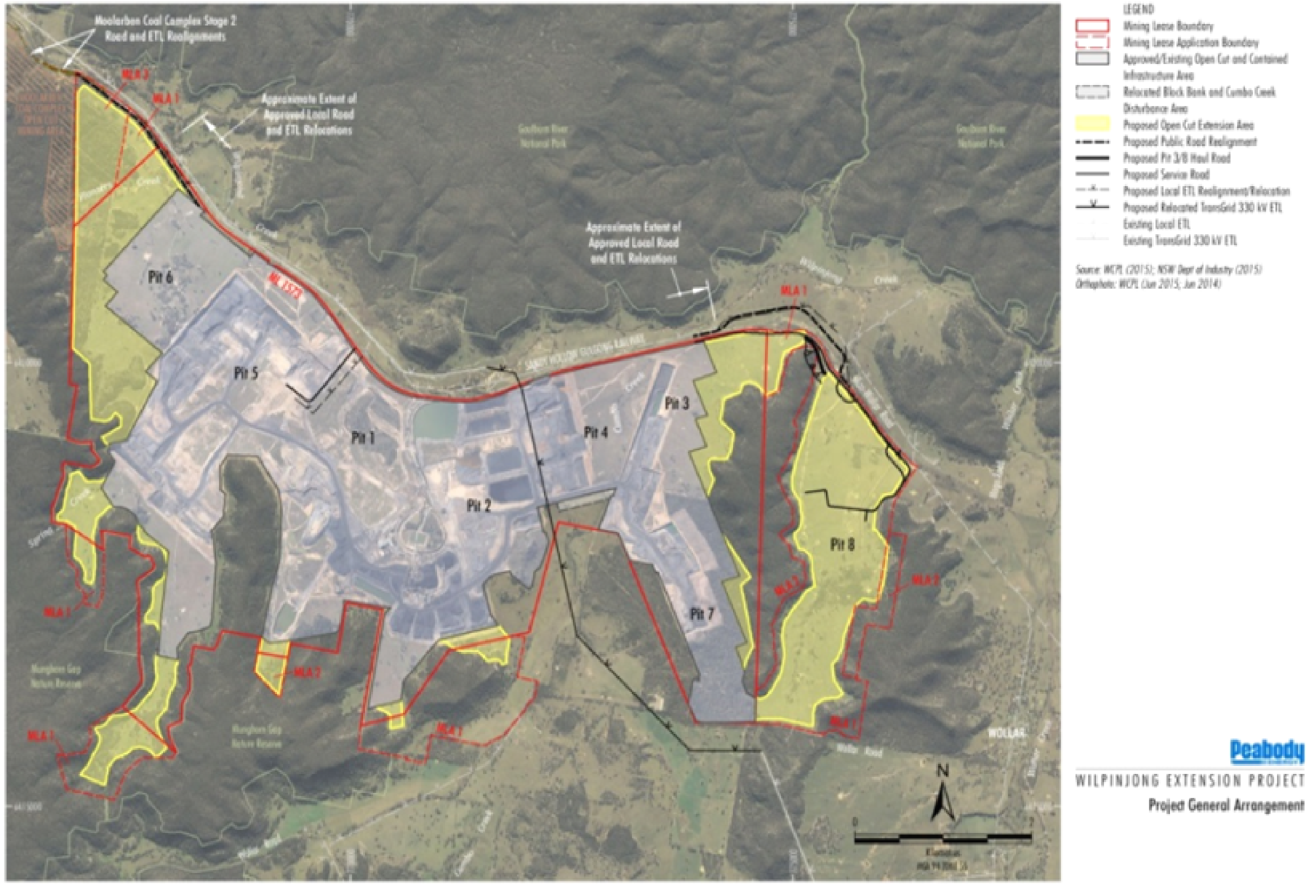
The content and matters to be addressed in the EIS are identified in the Secretary's Environmental Assessment Requirements (SEARs) for the Project issued by the NSW Department of Planning and Environment (DP&E).

A required component of the EIS is an analysis of economic issues. Specifically, the SEARs include the need for an assessment of the significance of the resource, the economic costs and benefits of the Project and the demand for the provision of local infrastructure and services.

This report therefore undertakes an assessment of the impacts of the Project within a cost benefit analysis (CBA) framework to address the economic costs and benefits of the Project, relative to a baseline, 'business as usual' scenario. This baseline case involves restricting operations at the Wilpinjong Coal Mine to currently approved operations (i.e. production to primarily focus on domestic coal, over the period to 2026), should the Project not receive approval.

This framework allows for the measurement of the incremental costs and benefits of the Project, in order to determine the net economic value of the Project. A Computable General Equilibrium (CGE) model is then used to analyse the impact of the Project on the regional and NSW community as measured by changes in economic activity and employment.

Figure 1.1: Wilpinjong Extension Project – Project General Arrangement



Source: WCPL (2015); WCPL - Orthophoto (June 2015 and June 2014)

1.1 Report structure

Sections 4 to 6 of this report are structured in accordance with relevant CBA guidelines (Section 2.2). An additional analysis using CGE modelling is provided in Section 7 to outline the anticipated impact of the Project on the broader regional and NSW community as measured by changes in economic activity and employment. The CGE analysis can be understood as an extension to the CBA. Accordingly, the CGE results may not be directly comparable to the CBA results or other projections outlined in the EIS. This is because it encompasses a broader range of impacts than the initial economic, environmental, or financial analysis.

The structure of this report is as follows:

- Section 2 outlines the methodology employed in this report, including how the approach used addresses the SEARs and aligns with relevant guidelines.
- Section 3 provides a background of the Mid-Western Regional LGA, presenting a brief demographic and employment profile of the region.
- Section 4 details the Project, defines the base case and the expected scenario under the Project case and discusses the significance of the resource.
- Section 5 presents the results of the CBA, including a disaggregation of all the anticipated impacts included in the analysis.
- Section 6 presents a detailed analysis of the regional breakdown of costs and benefits.
- Section 7 presents the results of an analysis of the impacts of the Project on the broader regional economy, using CGE modelling.
- Appendix A provides a checklist illustrating how this report has met the requirements of relevant guidelines.
- Appendix B outlines relevant valuation techniques that are often employed in CBA.
- Appendix C discusses the variety of approaches that may be used to value specific costs and benefits.
- Appendix D presents an overview of the CGE model.

2 Methodology

Deloitte Access Economics has established a methodology for undertaking this CBA and economic impact analysis for the Project that addresses the SEARs and aligns to relevant guidelines. This chapter reviews the SEARs and relevant guidelines before discussing how these have been applied to develop the methodology.

2.1 Secretary's Environmental Assessment Requirements

The SEARs for the Project were issued in December 2014. Specifically, the SEARs include the need for an assessment of the significance of the resource and the economic costs and benefits of the Project. In addition, consideration of potential impacts on demand for local infrastructure and services is required to be addressed and is considered in the Social Impact Assessment for the Project (Elliot Whiteing, 2015). The SEARs also require relevant guidelines to be considered during the assessment of potential impacts of the Project.

While the remainder of the requirements in the SEARs cover topics beyond the scope of an economic assessment, there are particular areas which are potentially relevant to the methodology adopted, including impacts on land resources, water resources, biodiversity, heritage, air quality, greenhouse gases, noise, traffic and visual impacts. These are considered as part of the analysis in Section 5.

2.2 Relevant guidelines

The following documents have been used as the most relevant guidelines for this CBA and economic impact analysis:

- NSW Treasury (2007), "NSW Government Guidelines for Economic Appraisal";
- NSW Department of Urban Affairs and Planning (2002), "Guideline for economic effects and evaluation in EIA"; and
- NSW Government (2012), "Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals".

These three documents move from high level issues around CBA through to how CBA should be applied to an EIS and then also cover the application of CBA to coal mines in particular.

We have also had regard to the recently released draft *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government, 2015). While these draft guidelines do not bind on the current proposal we acknowledge that they do provide some useful information when assessing the costs and benefits associated with mining projects and also provide an indication of the type of analysis the NSW Government is seeking.

A full account of the requirements of these guidelines is given in Appendix A and the relevant requirements are cross referenced to sections of this report.

2.3 Implications of these guidelines

Together, these guidelines set the key requirements for this economic assessment. While Appendix A contains an item by item reconciliation of how these guidelines have been addressed or considered, it is first worth considering their implications qualitatively. Overall, they require that the CBA should be carried out using a set of standard approaches and also must include consideration of certain topics.

Looking first at the standard approach, the guidelines suggest that the CBA should involve:

- identification of the characteristics of the proposal and any alternatives;
- defining the spatial boundaries of analysis (e.g. local, regional, state, national);
- identification of the environmental impacts of the Project;
- identification of costs and benefits, including:
  - economic resource costs (e.g. capital expenditure);
  - externalities; and
  - base case benefits given up;
- quantification of costs and benefits, using market prices where available, otherwise using imputed prices or a qualitative assessment;
- consolidation of values by applying a discount rate;
- applying decision criteria such as a benefit cost ratio; and
- analysis of results at a state and local geographical level.

This standard approach has been applied throughout this report. The definition of the proposal and spatial boundaries of analysis are covered in Section 4. Section 5 then covers the identification, discussion, quantification and consolidation of costs and benefits of the Project.

Moreover, the guidelines suggest that the economic analysis must consider a broad range of issues, costs, benefits and distributional matters. Beyond the costs and benefits of the Project itself (such as revenue, capital investment and operating expenditure) the issues broadly fall into two main categories:

- **Externalities:** these externalities cover areas where the Project will create costs or benefits, which cannot be captured in current market transactions, for third parties not involved in the production, sale or purchase of coal. These are mostly relevant in areas where property rights are non-existent or difficult to enforce. Key potential externalities here include effects on agricultural productivity; surface and groundwater; carbon emissions; air pollution; noise pollution; visual amenity; traffic; biodiversity and ecosystem conservation; quality of open space; rural amenity and culture and heritage.

- **Regional and industry flow-on economic effects:** as with the externalities, flow-on effects involve parties who are not directly transacting in the production or consumption of coal, and encompass any market-based responses to the presence of the Project. Flow-on effects are indirect impacts due to adjustments in the economy, such as price movements. For example, if the Project increases demand for a certain type of labour this may affect the price of labour in the region which will have flow-on consequences for other local industries. These are not externalities, but are rather seen as the mechanisms by which the economy re-adjusts in response to changed patterns of supply and demand. Key potential effects here include: increases in mine worker wages; profits of mine suppliers; impacts on the agricultural industry; impacts on labour supply and local tourism effects.

The following section sets out our approach for ensuring that all the relevant requirements of the SEARs and relevant guidelines are covered within this CBA and economic impact analysis.

2.4 Our Methodology

Taking the aforementioned guidelines together creates a complex set of requirements which encompass topics that are handled well by a CBA as well as other issues which do not fit neatly into a CBA framework. A traditional CBA, which focuses mainly on the Project itself therefore may not be able to provide sufficient analysis of the range of issues identified above.

To address this Deloitte Access Economics has developed a methodology which first analyses items amenable to CBA modelling within a CBA framework applied at the project level. The project level CBA results are then disaggregated into costs and benefits for different geographic areas. CGE modelling is then used to look at further issues relating to flow-on effects. This three stage process is important as a CBA at the project level cannot identify costs and benefits to particular regions or groups within the community and does not take into account the flow-on effects described above. This is because both of these economic effects are essentially benefits to some parts of the economy which are offset by costs elsewhere and so do not appear in a project level CBA. The three stage process has therefore been designed to analyse the issues identified in the guidelines and requirements in an accurate and meaningful manner.

For example, the issues discussed above under externalities are amenable to modelling within a CBA framework. In contrast, those relating to regional and industry flow-on economic effects are best dealt with in a CGE model.

CGE modelling can be seen as an addition and extension of the CBA but with a particular focus. That is, the CBA focuses on the direct effects of the Project including effects that take place in a market (such as the sale of coal) and effects which do not take place in a market (such as the creation of dust). The CGE model is then used to trace these immediate effects through the economy more broadly. For example, increased capital expenditure may lead to increased demand for steel and fuel as inputs. This, in turn, can increase demand for labour in iron mines and oil refineries. This chain of events will create complex interactions between supply and demand in each market which will ultimately be resolved by changes in prices and outputs across the economy. The CGE model provides a way to trace this chain of events through to its final result.

It should be noted that the CGE model is, fundamentally, built on the national accounting system and so focuses on outputs that are traded in markets and contribute to gross domestic product (GDP) – it does not capture environmental and other externality costs that are captured as part of the CBA.

It should also be noted that CGE modelling is a substitute for Input-Output (IO) modelling. Both approaches can provide estimates of increases in economic output, value added and employment in the broader economy flowing from the Project. CGE modelling uses a more complex set of techniques and involves different assumptions about the state of the economy. One central difference between the two approaches is that IO modelling generally assumes that there is an unlimited source of resources available in the economy to meet increases in demand. In contrast, CGE modelling generally assumes that the economy and sectors within the economy are competing for the use of resources. This means that increases in demand from the Project may result in effects such as increased prices in other markets and crowding out effects (rather than just increased output). In this sense, CGE modelling is likely to provide more conservative estimates of economic impacts than those provided by IO modelling.

2.5 Scope of the cost benefit analysis

A final methodological issue is the geographic scope of the CBA. This is important as it draws a line for which benefits and costs are included in the analysis and which are excluded. For example, if the scope of the CBA is defined as the State of NSW, rates payable to the Mid-Western Regional Council, and royalties payable to the NSW Government are simply transfer payments between different parties within NSW and so are not genuine costs or benefits as the cost to WCPL is offset by the benefits to the government, these transfer payments cancel out. These transfer payments will then only appear in the regional CBA.

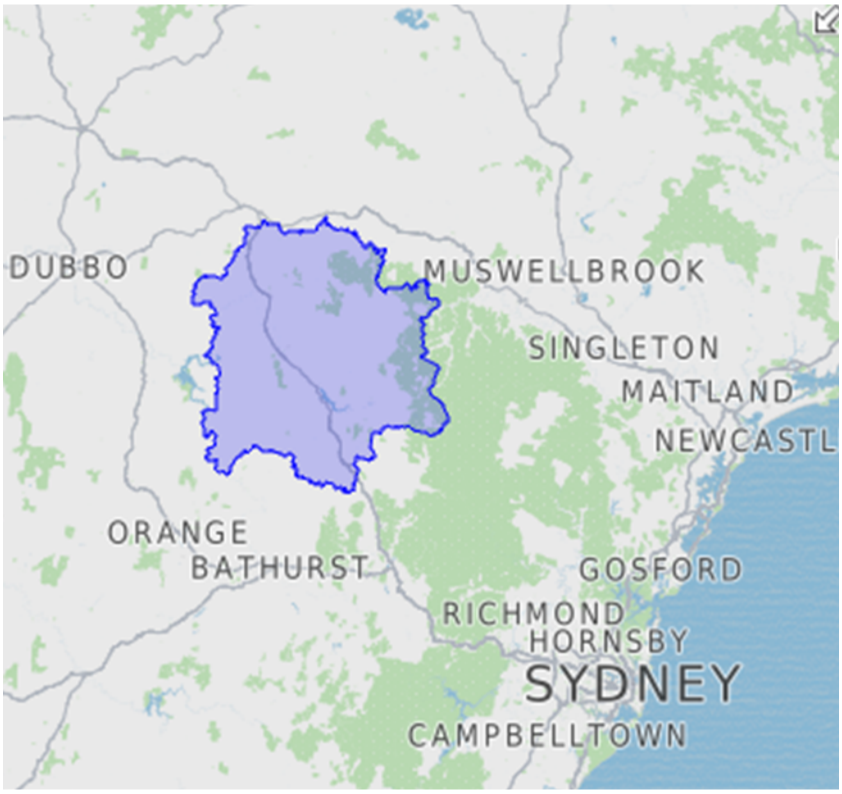
As the CBA is being developed to assist with NSW Government assessment processes, the scope of the CBA will generally be the State of NSW. However, the fact that the guidelines and requirements discussed in Section 2 do not fit neatly into a traditional CBA framework means that the analysis will sometimes require consideration of effects for particular groups within the scope. This report therefore provides a whole-of-Project CBA in Section 5 and a subregional analysis of the CBA in Section 6.

3 Background on Project location

This chapter provides an overview of the economic and demographic characteristics of the regional location of the Project. The Mid-Western Regional LGA is used as the unit of analysis in this chapter as it provides an appropriate scale on which to give a picture of regional social and economic conditions. Section 6 disaggregates the results of the CBA to isolate the net benefit derived by the local community within the Mid-Western Regional LGA as well as the remainder of NSW more broadly. Section 7 provides detailed analysis on a broader region using CGE modelling.

The Mid-Western Regional LGA is located in the Central West Region of NSW, approximately 200 km west-north-west of Newcastle, as shown in Figure 3.1. The LGA consists of a number of towns, including Mudgee, Gulgong and Kandos, as well as numerous surrounding smaller localities.

Figure 3.1: Mid-Western Regional LGA



Source: Australian Bureau of Statistics (ABS) (2015a)

3.1 People

At the time of the 2011 Census, the population of the Mid-Western Regional LGA was 22,318, a 5.8% increase in population from 2006. This is lower than the population increase state wide which was 12.1%. The median age across the LGA is approximately 41 years, which is slightly higher than the NSW average of 38 years. A comparison of population characteristics in 2001, 2006 and 2011 is provided in Table 3.1.

Table 3.1: Population characteristics of the Mid-Western Regional LGA

	2001	2006	2011	2001-2011 change
Population (usual residence)	-	21,086	22,318	-
Population (enumeration)	21,357	21,116	22,193	3.9%
Mean household size	2.6	2.4	2.4	
Median age	38	41	41	
Total occupied private dwellings	8,250	8,460	8,929	8.2%
Median monthly housing loan repayment	800	1,083	1,551	93.9%
Median rent ($/week)	110	148	200	81.8%
Median household income ($/week) - Mid-Western Regional LGA	603	721	938	55.6%
Median household income ($/week) - NSW	826	1039	1233	49.3%

Source: ABS, 2011 Census Time Series Profile Cat. 2003.0

Note: Mid-Western Regional LGA was formed in 2004 through an amalgamation of the former Mudgee Council with a majority of the former Rylstone Council and a small proportion of the former Merriwa Council.

Note: All dollar values reflect nominal figures gathered in the census.

Note: There may be some small differences to sections of the EIS due to revisions by the ABS subsequent to preparation of the EIS.

Based on the 2014 State and LGA Population Profiles as forecast by the DP&E, the population of the Mid-Western Regional LGA is expected to increase by 5.1% between 2011 and 2021, after which point it is anticipated to increase at a slower rate of 0.4% per annum over the period to 2026, followed by a slower increase of 0.3% on average per annum out to 2031. These estimates imply an overall increase in the population of the Mid-Western Regional LGA between 2011 and 2031 of around 8.9%.

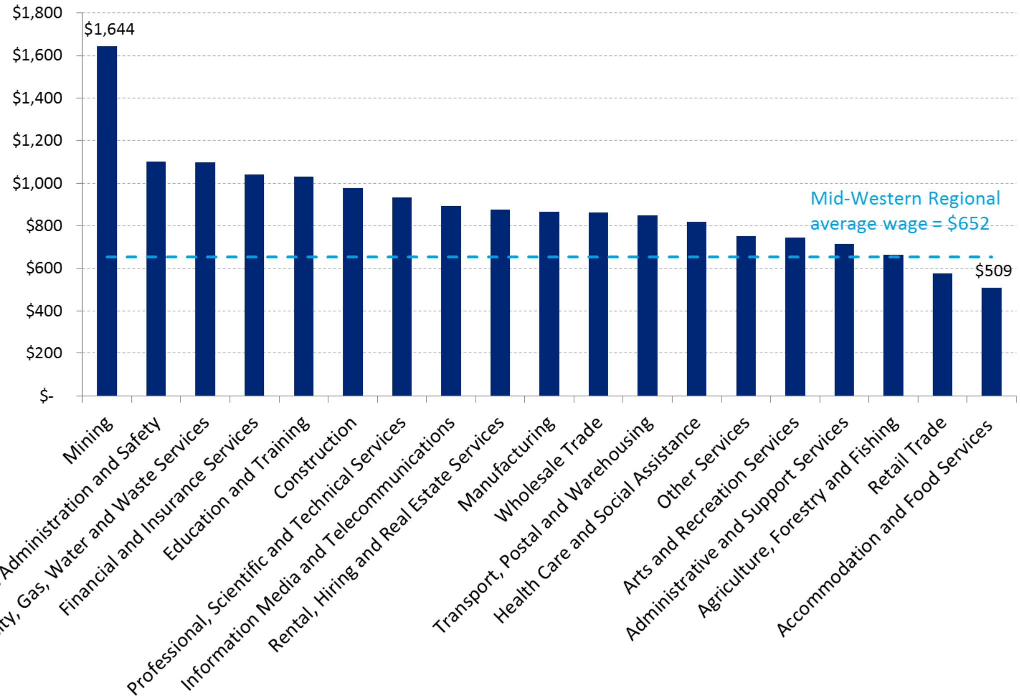
The number of occupied private dwellings in the Mid-Western Regional LGA increased by 8.2% over the ten years between 2001 and 2011, an average annual growth rate of 0.8%. Approximately 680 additional dwellings were established in the Mid-Western Regional LGA over the same period. This trend is a reflection of both the population growth in the region and the decline in average household size observed between 2001 and 2011.

In the 2014-15 financial year, there were 52 new residential dwellings approved in the Mid-Western Regional LGA. The value of residential building approvals over the financial year was $15.9 million and the value of total building approvals was $24.7 million (ABS Building Approvals, 2015b).

The median weekly household income in Mid-Western Regional LGA in 2011 was $938 which is lower than the NSW median of $1,233.

A breakdown of the average weekly wage by industry is provided in Chart 3.1. As illustrated, 'Mining' and 'Public Administration and Safety' are the two highest paying industries in the Mid-Western Regional LGA. 'Mining' employs 1,338 people in the Mid-Western Regional LGA while 'Public Administration and Safety' employs less than 400 people.

Chart 3.1: Mid-Western Regional LGA average weekly personal income by industry – 2011 (in 2011 dollars)



Source: ABS (2015a)

3.2 Education

The average educational attainment in Mid-Western Regional LGA is lower than the NSW average, as evidenced by Table 3.2. For example, in the 2011 Census, only 12.7% of the population indicated they held a tertiary level qualification, compared with 22.8% of the NSW population.

Table 3.2: Highest level of education attained

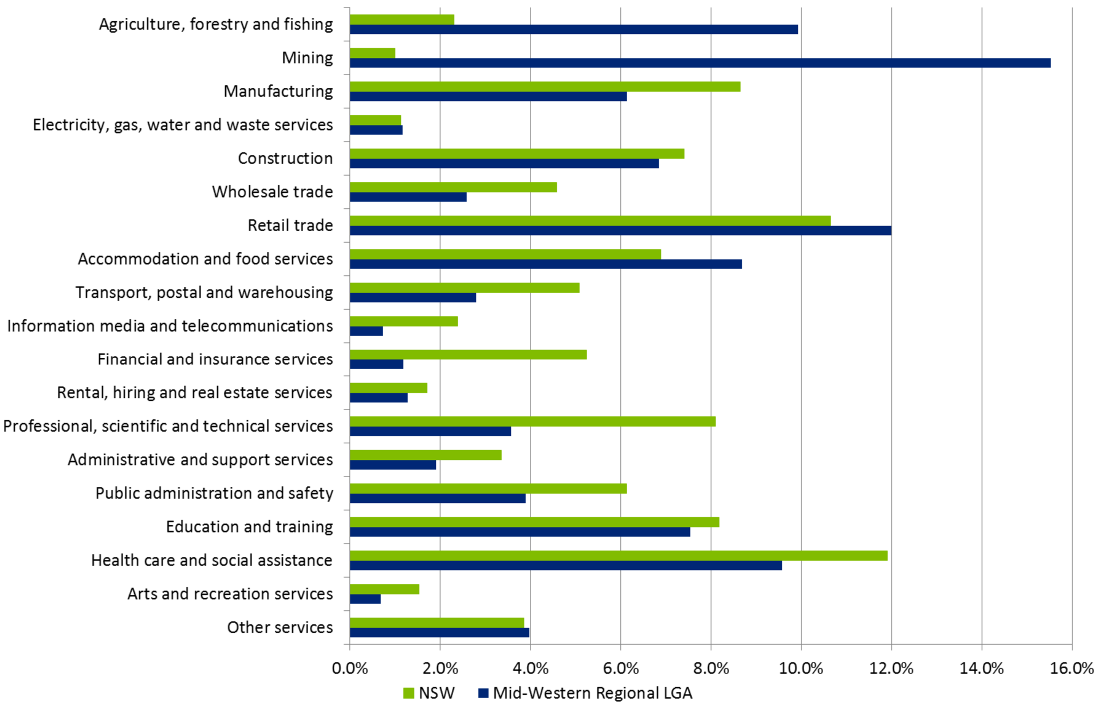
Highest level of education	Mid-Western Regional LGA	NSW
Tertiary level		
Postgraduate degree level	0.83%	3.50%
Graduate diploma and graduate certificate level	0.88%	1.20%
Bachelor degree level	6.08%	11.40%
Advanced diploma and diploma level	4.91%	6.70%
Certificate level		
Year 12 or equivalent	24.25%	38.40%
Year 11 or equivalent	4.77%	4.80%
Year 10 or equivalent	26.14%	19.50%
Year 9 or equivalent	7.81%	5.90%
Year 8 or equivalent	5.92%	4.50%
Did not go to school	0.00%	0.80%
Highest year of school not stated	0.36%	6.90%

Source: ABS, 2011 Census (2015a)

3.3 Industries of employment

Mining is the major industry of employment in the Mid-Western Regional LGA, employing 15.5% of the employed population. This is much higher than in NSW as a whole, where just 1.0% of the employed population work in the mining sector. The retail trade and agriculture, forestry and fishing industries are the next highest employers in the Mid-Western Regional LGA, at 12.0% and 9.9% respectively.

Chart 3.2: Industry of employment in Mid-Western Regional LGA and New South Wales



Source: ABS 2011 Census (2015a)

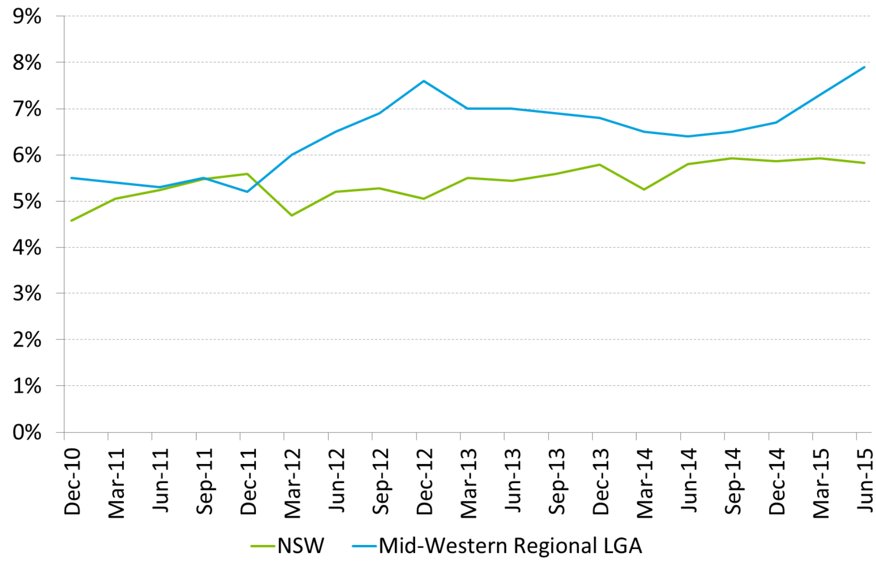
3.3.1 Mining

In the Mid-Western Regional LGA the mining industry employs 1,338 people. The majority of these jobs are in Coal Mining, with the next highest sub-industry employment in non-metallic Minerals. The major approved mines and operations in the area are Charbon, Moolarben Coal Complex, Ulan Mine Complex and Wilpinjong Coal Mine.

3.4 Unemployment

According to the Commonwealth Department of Employment small area labour markets data, the unemployment rate for the quarter preceding June 2015 in the Mid-Western Regional LGA was 7.9%. Chart 3.3 below illustrates a general trend of unemployment being fairly steady in NSW over the past three years. The unemployment rate in the Mid-Western Regional LGA has been more volatile over the period.

Chart 3.3: Unemployment rate in Mid-Western Regional LGA and NSW, %



Source: Department of Employment (2015), Small Area Labour Markets Data, ABS Cat. 6202

4 The Wilpinjong Extension Project

The purpose of a CBA is to provide a structured approach to assessing whether or not a project is likely to result in overall benefits to the economy. To carry out this economic assessment, the costs and benefits associated with the Project are compared to those under a baseline, 'business as usual' case. This comparison allows for an incremental analysis, to reach a clear conclusion on the net benefits of the Project.

Accordingly, for the purposes of the CBA, it is important to clearly define the baseline case and the Project case. This chapter defines both the baseline case and the Project case in turn.

4.1 Baseline case

The Wilpinjong Coal Mine is currently approved to produce 16 million tonnes per annum (Mtpa) of ROM coal and transport 12.5 Mtpa of thermal coal products. The mine, including its CHPP and associated general coal handling and rail loading facilities operates 24 hours a day, seven days a week.

Under the baseline case, open cut mining activities will continue at the Wilpinjong Coal Mine within the approved open cut and contained infrastructure area. It is expected that around 78.8 Mt of product coal will be produced over the period from 2016 to 2026. The majority of the coal produced will be sold to domestic customers for use in electricity generation, with the exception of approximately 5.8 Mt of thermal coal that will be transported to the Port of Newcastle for export between 2016 and 2017.

During this period, employment at the Wilpinjong Coal Mine will gradually decline over time from an estimated 497 full-time equivalent employees (FTEs) in 2017, to 150 FTEs in 2026, as the mine transitions to the decommissioning phase in 2027 and 2028.

The mine site will undergo progressive rehabilitation over the period to 2026, consistent with the requirements of the current Project Approval. This will include minimisation of the extent of the final voids, establishment of final landforms that are generally consistent with the topography of the surrounding area, establishment of agricultural land in specific areas and restoration of the ecosystem function in the adjacent Enhancement and Conservation Areas and Regeneration Areas.

4.2 Project case

The Project will include the following activities:

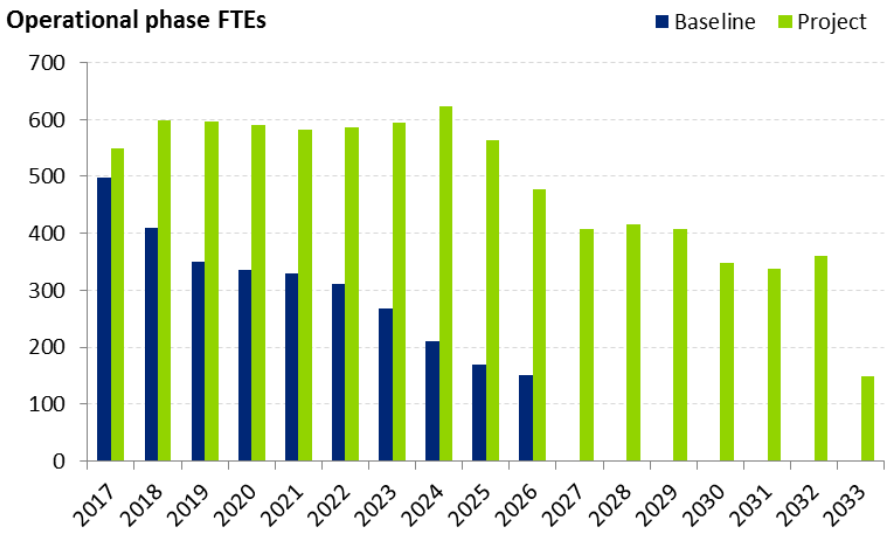
- open cut mining of ROM coal from the Ulan Coal Seam and Moolarben Coal Member in Mining Lease (ML) 1573 and in new Mining Lease Application areas in Exploration Licence (EL) 6169 and EL 7091;
- approximately 800 ha of open cut extensions, including:
    - approximately 500 ha of incremental extensions to the existing open cut pits in areas of ML 1573 and EL 6169;
    - development of a new open cut pit of approximately 300 ha in EL 7091 (Pit 8);
- continued production of up to 16 Mtpa of ROM coal;
- continued use of the Wilpinjong Coal Mine CHPP and general coal handling and rail loading facilities and other existing and approved supporting mine infrastructure;
- rail transport of approximately 13 Mtpa of thermal product coal to domestic and export customers (within existing maximum and annual average daily rail limits);
- relocation of a section of the TransGrid Wollar to Wellington 330 kV ETL to facilitate mining in Pit 8;
- various local infrastructure relocations to facilitate the mining extensions (e.g. realignment of Ulan-Wollar Road and associated rail level crossing, relocation of local ETLs and services);
- construction and operation of additional mine access roads to service new mining facilities located in Pits 5 and 8;
- construction and operation of new ancillary infrastructure in support of mining including: mine infrastructure areas, ROM pads, haul roads, electricity supply, communications installations, light vehicle roads, access tracks, remote crib huts, up-catchment diversions, dams, pipelines and other water management structures;
- extension of the approved mine life by approximately seven years (i.e. from approximately 2026 to 2033);
- a peak operational workforce of approximately 625 people;
- ongoing exploration activities; and
- other associated minor infrastructure, plant and activities.

The proposed Project General Arrangement is presented in Figure 1.1.

Overall, it is expected that the Project will employ an operational workforce of 549 FTE in 2017, before peaking at 623 FTE in 2024, and gradually declining to 149 FTE in 2033. In addition, the Project is anticipated to employ 75 and 30 FTE in 2017 and 2018 respectively during the primary construction phase with further, once-off, construction phase employment of 30 FTE in 2024.

Baseline and Project case operational phase employment levels are presented in Chart 4.1.

Chart 4.1: Comparison of operational phase employment (FTEs)



Source: WCPL

4.3 Project options

In addition to clearly defining the baseline case and the Project case, completion of the CBA also requires a consideration of other project options

A number of alternatives were considered for the Project, but not identified as the preferred case, due to feasibility and/or the nature of broader impacts. Accordingly, these options were not incorporated in the CBA. These considerations are described in turn below.

- **Project location:** the location of the Project has been determined with reference to the presence of coal seams able to be economically mined in the vicinity of the Wilpinjong Coal Mine and within WCPL's mining tenements. The Project seeks to maximise the use of the existing CHPP and other supporting facilities, and to provide new mining areas that are largely contiguous with approved mining areas, potentially minimising new disturbance areas.
- **Scale:** resource definition and exploration drilling conducted by WCPL indicates that the proposed scale of the Project (approximately 95 Mt of ROM coal) is optimal within WCPL's existing mining tenements.
- **Mining method:** it is considered that open cut mining is more suitable than underground methods, due to the shallow coal seams relative to the land surface and the relatively low strip ratios.
- **Mining and processing rate:** similar processing rates to the current approval (ROM coal production of up to 16 Mtpa and coal transport of approximately 13 Mtpa) have been proposed in consideration of the existing CHPP facilities, coal quality and extent of the open cut extension areas.

4.4 Significance of the resource

The SEARs include the need for an assessment of the significance of the resource.

The repealed clause (cl) 12AA of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (the Mining SEPP) provides an indication of items that could be considered in relation to assessing the 'significance of the resource'.

In particular, the repealed cl 12AA of the Mining SEPP required consideration of the economic benefits, both to the State and the region in which the development is proposed to be carried out, of developing the resource. This includes items such as employment generation, expenditure and the payment of royalties. Each of these items is considered in detail in this report. In particular, the economic benefits to the State and region are considered through both a CBA (Section 5) and economic impact analysis (Section 7). The economic impact analysis provides estimates of employment generation after taking into account any 'crowding-out' effects. Capital investment is considered in both the CBA and economic impact analysis. Finally, royalties are specifically addressed in Section 6.1.

While the remainder of clause 12AA is directed at the State Government itself, we do note that the Project will develop additional recoverable resources from an existing mine and is able to make use of existing infrastructure and land currently used for mining purposes. Further, the Project will allow for continued production of a significant volume of coal from one of the lowest cost mine sites in NSW. This will allow continued supply of coal for both domestic uses (in generating electricity) and will enable exports from NSW to international customers.

Consideration of the potential employment generation and economic benefits of the Project to the State and the region are provided in Section 7.5.

5 Cost benefit analysis

This section presents the first stage of our methodology, consisting of a CBA of the Project. This involves identifying the incremental costs and benefits of the Project relative to the baseline case and quantifying those items wherever possible to obtain a consolidated estimate of the net economic value of the Project.

Overall, it is concluded that the Project leads to a total net benefit of approximately $735 million (in 2015 NPV terms) and provides a benefit cost ratio (BCR) of 1.43. The steps involved in this analysis are described in the following sub-sections.

5.1 Identifying costs and benefits

The economic, environmental and social costs and benefits considered in this analysis are set out in Table 5.1.

Table 5.1: Wilpinjong Extension Project – direct costs and benefits

	Costs	Benefits
Production	Other onsite revenue forgone	Gross mining revenue
	Exploration costs	Deferred decommissioning costs
	Capital investment costs	
	Operating costs excluding royalties, rates and taxes	
	Rehabilitation costs	
	Residual value of capital forgone	
	Residual value of land forgone	
Externalities	Related public expenditure*	
	Offsite agricultural revenue	
	Groundwater quality*	
	Surface water quality*	
	Air pollution – carbon emissions	
	Air pollution – particulate matter	
	Air pollution – other pollutants*	
	Noise pollution	
	Visual amenity*	
	Traffic impacts	
	Biodiversity – flora and fauna*	
	Conservation*	
	Quality of open space*	
	Rural amenity and culture*	
	Aboriginal heritage*	
	Historical heritage*	
	Health*	

* Item has been considered qualitatively

Note: As the Project involves open-cut mining activity, there are no subsidence impacts which need to be valued in this analysis. Nevertheless, this item is discussed qualitatively in Section 5.2.14 in accordance with NSW Government Guidelines (2012)

In recognition of the broad range of impacts of the Project, the costs and benefits shown have been separated into two categories:

- internal effects of production – costs and benefits that affect the financial outcomes of the proponent; and
- externalities – the broader implications of the Project for third party stakeholders, such as residents and external businesses from the Mid-Western Regional LGA, the broader region, and beyond.

Section 5.2 describes the techniques used to value each of these items and provides the justification behind the classification of each as a cost or benefit.

As recommended in CBA guidelines such as NSW Treasury (2007), where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. The items considered qualitatively are identified in Table 5.1 and are discussed in Section 5.2. In some cases these items have been considered qualitatively because there is expected to be no significant difference in outcomes under the baseline and Project case (such as related public expenditure or quality of open space) or because there is no reliable method available to value them in these particular circumstances (such as Aboriginal and historical heritage).

5.2 Valuing costs and benefits

This section details the approach taken to provide a value for each of the costs and benefits identified in Table 5.1. For the costs and benefits that fall within the production category, a market value can usually be assigned using the financial information provided by WCPL, with validation from other sources where possible. In contrast, it is generally more difficult to attach a monetary value to the non-priced externalities.

The approach to valuation taken in this analysis is described below. Further discussion on the advantages and disadvantages associated with the different valuation techniques mentioned can be found in Appendix B.

First, in cases where there is a market price available, this price is used. Alternatively, if a standard industry approach is available, then this value is used. For example, transport costs are outlined in publications from Transport for NSW (2013). When neither of these options are available, there are then two alternative possible approaches. The first is to undertake a literature review and apply benefit transfer techniques to the local context if required. This can be achieved using databases of non-market values such as ‘Envalue’, which was maintained by the NSW Department of Environment and Climate Change up until 2004, or its more recently updated international equivalent, the Environmental Valuation Reference Inventory (EVRI) developed by Environment Canada. These databases can be augmented by a direct review of the relevant literature for non-market valuations. Current literature on non-market valuations involves a number of specialised methodologies (e.g. the travel cost method, contingent valuation or choice modelling), which all require extensive surveys or, alternatively, empirical analysis such as hedonic pricing, which uses existing market data from an affected sector (e.g. residential property market).

In the event where there is insufficient literature available, a final alternative is to undertake original research into non-market values.

The discussion throughout the chapter draws on the findings in Appendix C, which reviews the unit value evidence for each item considered in this report.

All present values reported in this section are calculated using a 7% discount rate, and are discounted back to the start of 2015.

5.2.1 Gross mining revenue

Gross revenue from mining activity at the Wilpinjong Coal Mine is calculated using forecasts of annual production quantities and annual prices for each coal product.

For each year of operation under the baseline and Project cases, WCPL has provided production quantity forecasts for three product coal types: mid ash thermal export coal, high ash thermal export coal and thermal coal that will be sold to domestic customers for electricity generation purposes.

As illustrated in Chart 5.1, under the baseline case, a total of 78.8 Mt of saleable coal will be produced between 2016 and 2026. This predominantly comprises thermal coal that will be sold to domestic customers as part of existing contracts (73.0 Mt), with the remaining 5.8 Mt of product coal being high ash export coal that is transported between 2016 and 2017.

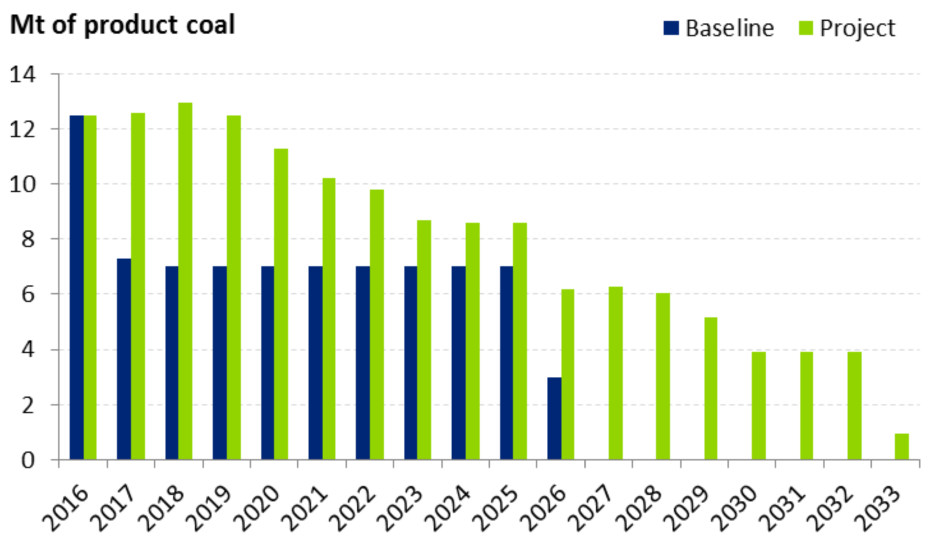
Should the Project receive approval, production will continue as per the baseline case in 2016. From 2017 to 2026, the annual production profile at the Wilpinjong Coal Mine will be expanded, relative to the baseline, enabling production of mid ash thermal export coal and additional high ash thermal coal. Production of domestic coal during this period is expected to be broadly consistent with the baseline case.

During the seven year extension period from 2027 to 2033, the Project is anticipated to solely produce high ash thermal export coal. Overall, a total of 144.1 Mt of saleable coal will be produced between 2016 and 2033 under the Project case.

Chart 5.1 presents the profile of total product coal between 2016 and 2033 in each case.

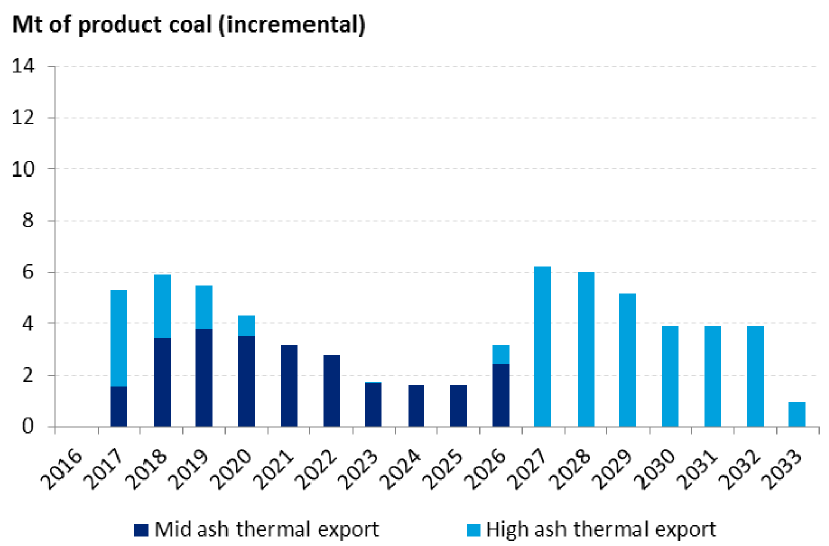
Chart 5.2 presents the incremental production by coal product type in the Project case.

Chart 5.1: Production profile – Wilpinjong Coal Mine, 2016 – 2033



Source: WCPL

Chart 5.2: Incremental Project case production, by product type, 2016 – 2033



Source: WCPL

This analysis has applied different price forecasts for each of the three coal product types to calculate gross mining revenue associated with the baseline and Project cases.

The price for thermal coal sold to domestic customers was set at $32.90 per tonne, being the weighted average coal cost for AGL Macquarie, as reported by AGL (2014) ($32.60 per tonne), scaled up to 2015 price terms based on movements in the ABS Consumer Price Index (CPI).

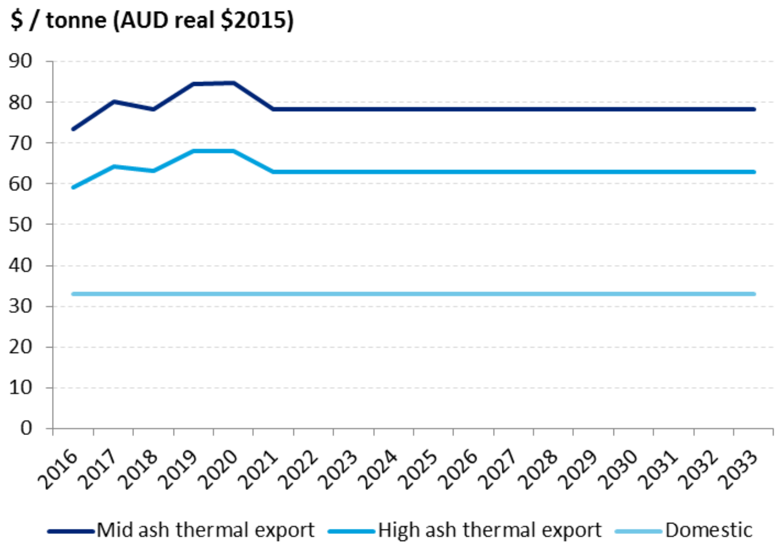
Meanwhile, the prices for each export coal product were derived from the consensus forecast for thermal coal spot prices, compiled by Consensus Economics in August 2015.

This benchmark forecast, reported in nominal $US per tonne, was converted to real $AUD in 2015 price terms using inflation rate and exchange rate forecasts reported by the Department of Industry and Science in its September 2015 publication from 2015-16 to 2019-20. We have assumed no changes in these variables beyond 2020.

Based on advice from WCPL, discounts of 8% and 26% were then applied to this benchmark consensus price series to take into account differences in the quality of mid ash thermal export and high ash thermal export coal respectively, relative to the standard thermal coal exports from the Port of Newcastle.

The coal price forecasts used in this analysis are illustrated in Chart 5.3 below. These have been applied in both the baseline and Project cases.

Chart 5.3: Coal price forecasts by product type, 2016 – 2033



Source: Deloitte Access Economics, derived from Consensus Economics (2015); Department of Industry and Science (2015); WCPL

In recognition of the inherent difficulties associated with forecasting coal prices over the long term, the sensitivity analysis presented in Section 5.4 includes scenarios that vary the export coal prices upwards by 30% and downwards by 15%. A justification for these coal price variations is also provided in Section 5.4.

Applying these values and assumptions gives a central present value estimate of $1,857 million for gross mining revenue in the baseline case, and $4,293 million in the Project case.

In undiscounted terms, gross mining revenue is estimated at $2,749 million in the baseline and $7,323 million in the Project case.

5.2.2 Other onsite revenue (e.g. agriculture)

It is also necessary as part of the CBA, to incorporate the impact of the Project case on any additional net revenue streams derived from land owned by WCPL.

WCPL has advised that some areas of land within and adjacent to the Project site can be potentially used for grazing, and in some cases has been done so through lease agreements. There are two main impacts to be considered under this item, being:

- Expected temporary removal of land from potential agricultural production in both the baseline and Project cases; and
- Permanent sterilisation of approximately 346 ha of land without remnant vegetation, and accordingly, potentially suitable for agricultural production, under the Project case only.

The opportunity cost estimates rely on two main variables: the gross margins that could be generated from agricultural activities in the absence of mining activity, and the area of land where agricultural production could occur if not for mining activity in each year, for both the baseline and Project cases.

The Land and Soil Assessment for the Project undertaken by McKenzie Soil Management (2015) suggests that the land within the open cut extension areas has the potential to generate gross margins in the order of $53.06 per ha per year, when used for beef cattle production.

In relation to land areas, it has been conservatively assumed that:

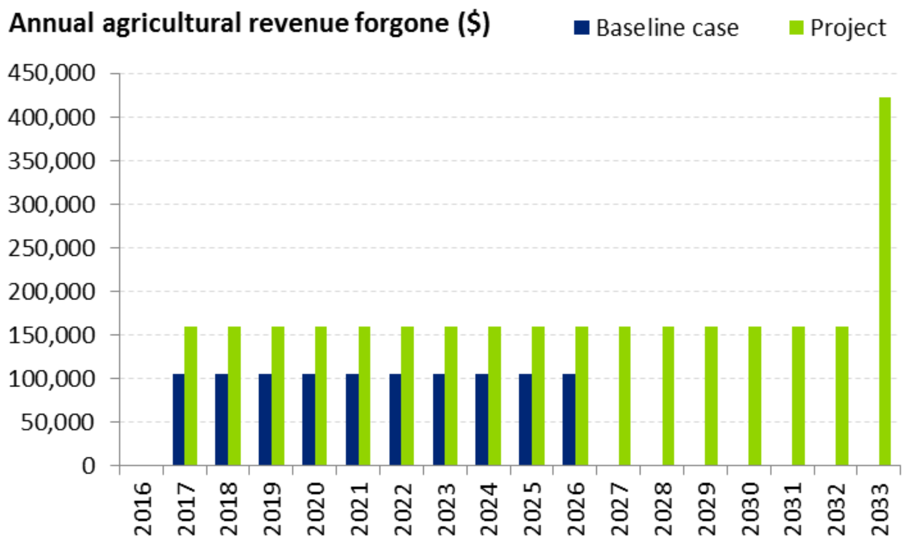
- **Baseline case:** if not for mining activity, around 2,000 ha of land could otherwise be used for agricultural production from 2017 to 2026, being the total area of the approved open cut and contained infrastructure area and the Cumbo Creek block bank.
- **Project case:** if not for mining activity, around 3,022 ha of land could otherwise be used for agricultural production from 2017 to 2033, being the total area of the Project open cut and contained infrastructure area, the Cumbo Creek block bank and Project ancillary development areas. From 2033 onwards, 346 ha of additional land would be permanently removed from agricultural production.

These are conservative assumptions, made in the absence of detailed data on the changes in land potentially available for agricultural activity during the course of mining activity. It is noted that, in practice, there are parts of these areas that are not suitable for agricultural activities (such as vegetated ridgelines) and that in some years, some areas will be available for agricultural purposes. As there is expected to be no additional disturbance under the Project case in 2016, revenue forgone for this year has not been estimated.

Nevertheless, on this basis, it is estimated that during mining activity, up to $106,120 and $160,347 in revenue might be forgone for each year, under the baseline and Project cases respectively. In addition it is estimated that around $18,359 per annum in revenue might be foregone each year under the Project case beyond 2033.

The assumed timing of these potential losses in revenue is presented in Chart 5.4. The revenue forgone in 2033 of the Project case includes the ongoing revenue forgone in perpetuity associated with the 346 ha area of additional land that is expected to be permanently sterilised by the Project.

Chart 5.4: Potential annual agricultural revenue forgone, 2016 – 2033



Source: Deloitte Access Economics, derived from WCPL

Note: The revenue forgone in 2033 of the Project case includes the ongoing revenue forgone in perpetuity associated with the 346 ha area of land that is expected to be permanently sterilised.

In present value terms, this equates to $0.65 million in onsite agricultural revenue forgone under the baseline case, and $1.44 million in onsite agricultural revenue forgone under the Project case.

These conservative estimates are likely to overstate the agricultural revenue forgone in each case. However, it is noted that the actual size of agricultural land (or revenue) forgone for both the base and Project cases is difficult to estimate and therefore the incremental revenue forgone may vary from that implied by the above estimates. Nevertheless, we note that these variations in assumptions do not have a material impact on the results of the CBA.

Accordingly, the additional onsite agricultural revenue forgone of $0.79 million is attributed as a cost of the Project.

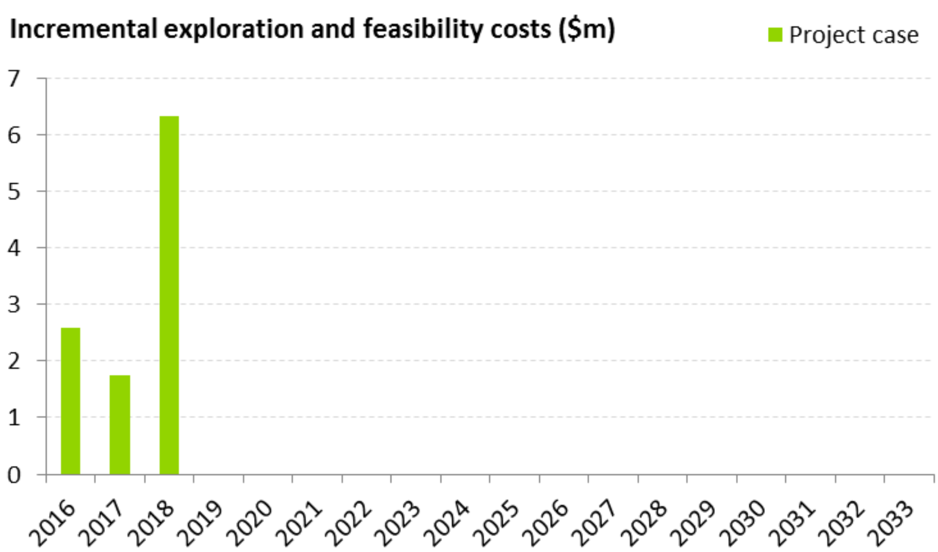
5.2.3 Exploration costs

Exploration expenditure consists of any costs associated with preparatory activities before extraction commences. Where these costs are yet to be incurred, it is appropriate to include them in a CBA.

While there may be some minor exploration costs associated with the baseline case, WCPL has indicated that it expects to incur $10.67 million in incremental exploration and feasibility costs from 2016 should the Project receive approval. The distribution of these costs over time is shown in Chart 5.5.

In present value terms, using a 7% discount rate, these costs are valued at $8.52 million as at the start of 2015.

Chart 5.5: Project case incremental exploration and feasibility costs, 2016 – 2033



Source: WCPL

5.2.4 Capital investment costs

Capital investment costs encompass expenditures on mine development, infrastructure and the purchase of mining equipment associated with the baseline and Project operations. It excludes sustainment expenditure, which has been included in the operation cost estimates discussed in Section 5.2.5.

WCPL has advised that it expects to incur total capital investment costs of $69.75 million under the baseline case, between 2016 and 2025. This includes investment associated with the CHPP, road and other services infrastructure, Cumbo Creek relocation civil works, and the purchase of equipment currently under lease.

Should the Project receive approval, capital investment of approximately $172.50 million is expected to be incurred between 2016 and 2029.

This comprises the majority of planned capital investment under the baseline case, as well as additional investment to:

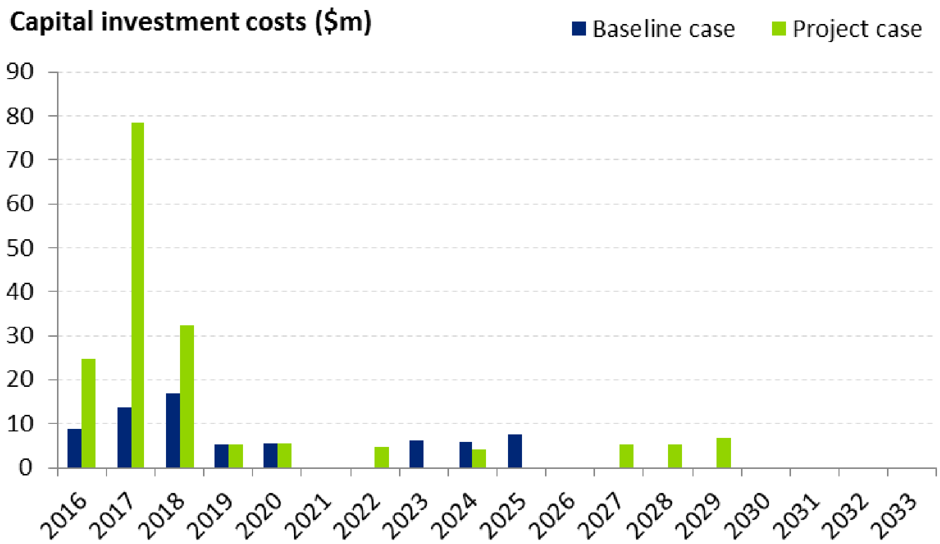
- construct new ancillary infrastructure in support of mining including: mine infrastructure areas, ROM pads, haul roads, electricity supply, communications installations, light vehicle roads, access tracks, remote crib huts, up-catchment diversions, dams, pipelines and other water management structures;
- relocate of a section of the TransGrid Wollar to Wellington 330 kV ETL;
- relocate various local infrastructure to facilitate the mining extensions (e.g. realignment of Ulan-Wollar Road and associated rail level crossing, relocation of local ETLs and services);
- construct additional mine access roads to service new mining facilities; and
- purchase additional mining equipment for the Project.

The Project case also involves slightly lower capital investment for the Cumbo Creek relocation civil works, which is expected to be delayed for approximately four years, relative to the baseline case.

The anticipated timing of this investment in each case is illustrated in Chart 5.6.

In present value terms, capital investment is therefore estimated at $49.11 million under the baseline, and $129.31 million in the Project case. Overall, the additional capital investment of $80.20 million, in present value terms, is attributed as a cost of the Project.

Chart 5.6: Capital investment costs, 2016 - 2033



Source: WCPL

The positive flow-on impacts of incremental Project capital investment on the broader regional and NSW economies are presented in Section 7.

5.2.5 Operating costs excluding royalties, rates and taxes

Operating costs encompass the expenditure incurred as a direct result of extracting ROM coal, processing it into saleable product and delivering it to a port before loading (known as free on board [FOB] costs) as well as ongoing expenditure on the maintenance of equipment and machinery necessary for production.

For this analysis, initial FOB cost estimates have been calculated based on econometric modelling undertaken by Shafiee, Nehring and Topal for open cut coal mines in Australia (2009). The authors define per tonne operating costs as a function of deposit average thickness, the stripping ratio, capital cost and the daily production rate.

WCPL has provided estimates for these parameters in the baseline and Project cases, including any variations over the course of mining activity. The estimates produced by the model based on these inputs have then been increased by:

- $5 per tonne and $1 per tonne for full cycle wash and bypass product coal respectively, to reflect the additional CHPP costs;
- an additional $5 per tonne of product coal to account for other overheads; and
- an additional $12 per tonne of exported product coal, to account for distribution and selling expenses.

These cost add-ons have been assumed based on experience with other projects, with guidance from WCPL.

For the central case of the CBA, these costs were then discounted by 10% in both the baseline and the Project case. This conservative adjustment has been made in recognition that the Wilpinjong Coal Mine is at the low end of the industry range for operating costs, particularly due to the low stripping ratio associated with the operations. This has been publically reported by both Peabody Energy (2014) and independent analysts, such as Wood Mackenzie (2015). It was considered appropriate to apply this discount in the central case given that the average stripping ratios associated with the baseline and Project cases are lower than the range used by Shafiee, Nehring and Topal (2009) to develop the operating cost model.

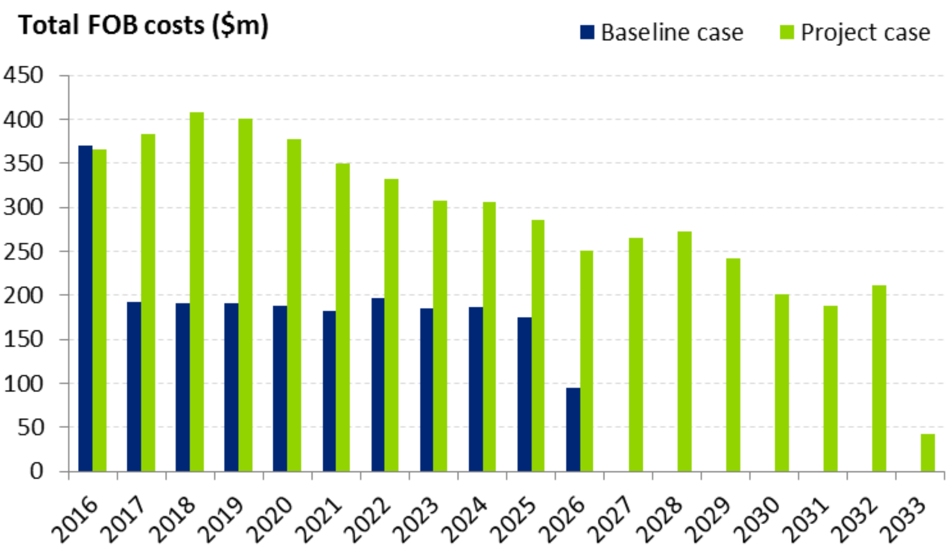
Furthermore, WCPL considers that the operating costs under the Project case could be up to 20% lower than the initial cost estimates produced using the econometric model (including the cost add-ons noted above). As Deloitte Access Economics is unable to independently verify WCPL's budgeted costs for the Project, the conservative 10% discount has been used for the central case.

The sensitivity analysis presented in Section 5.4 examines two further operating cost scenarios, being:

- a higher operating cost scenario using the initial cost estimates produced using the industry cost model developed by Shafiee, Nehring and Topal (2009), including cost add-ons (11% increase on the central case); and
- a lower operating cost scenario reflecting an additional 11% discount on the central case.

The profiles of total FOB costs under each case, in the central CBA, are illustrated in Chart 5.7 below.

Chart 5.7: Total FOB costs, 2016 – 2033

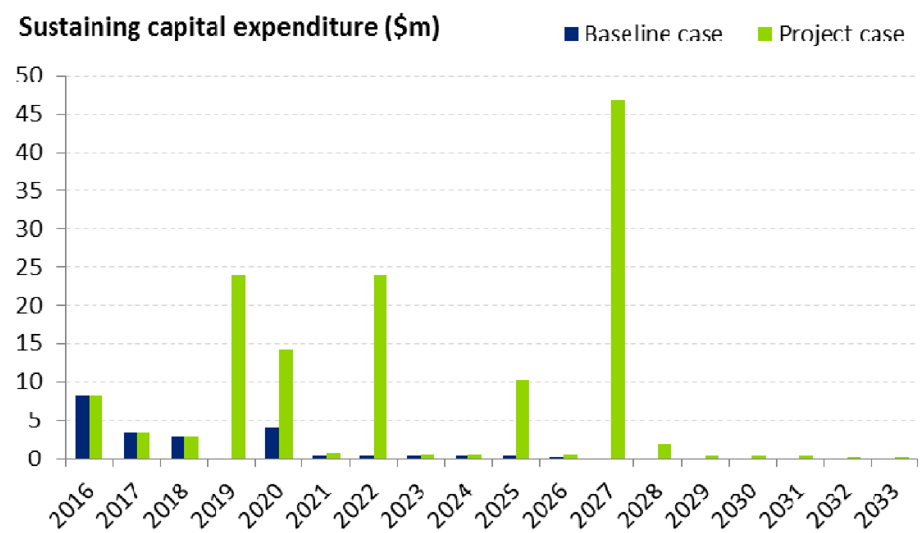


Source: Deloitte Access Economics, derived from Shafiee, Nehring and Topal (2009), WCPL

Estimates of ongoing expenditure on sustaining capital were also provided by WCPL. This includes miscellaneous infrastructure sustainment, mine sustainment and the sustainment or replacement of equipment.

It is noted that the Project sustainment cost estimates include mobile equipment noise attenuation costs and establishment and management costs associated with the anticipated biodiversity offset package that may be incurred. The anticipated profiles of sustainment expenditure under the baseline and Project cases are presented in Chart 5.8.

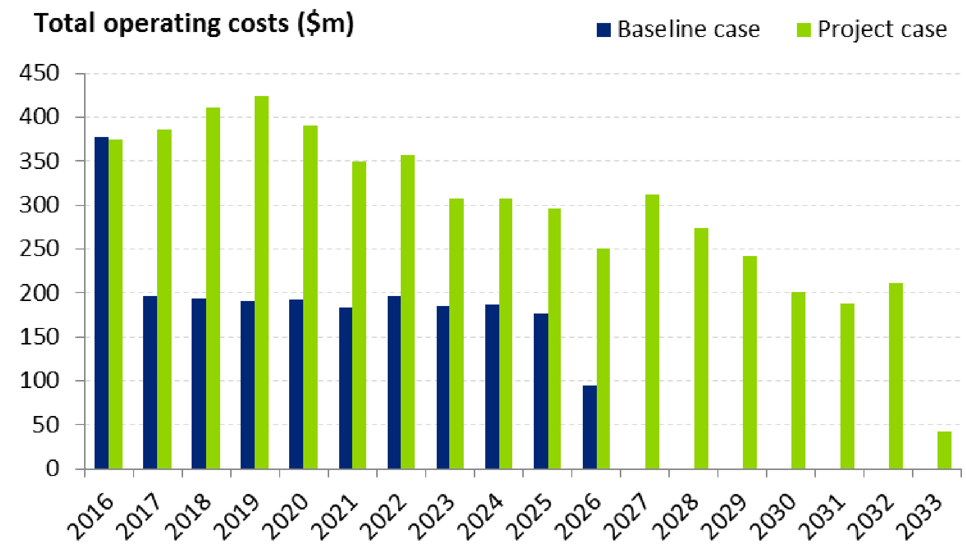
Chart 5.8: Ongoing expenditure on sustaining capital, 2016 - 2033



Source: WCPL

Overall, total operating costs from 2016 under the baseline case are estimated at $2,176 million ($1,454 million in present value terms). Under the Project case, operating costs are estimated at $5,329 million, equivalent to $3,047 million in present value terms. The time series of these total cost estimates are presented in Chart 5.9.

Chart 5.9: Total operating costs, 2016 - 2033



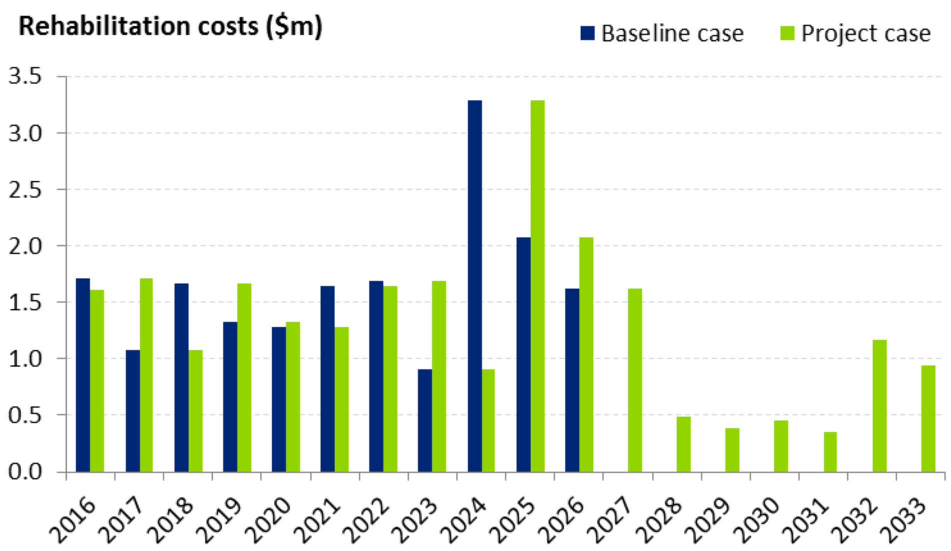
Source: Deloitte Access Economics & WCPL

5.2.6 Rehabilitation costs

Under both the baseline and Project cases, land rehabilitation works will be undertaken progressively over the life of the mine. WCPL has provided estimates of these costs over time, as shown in Chart 5.10.

In undiscounted terms, total anticipated rehabilitation costs are estimated at $18.29 million under the baseline case, and $23.69 million under the Project case. In present value terms, these costs equate to $11.33 and $13.19 million in the baseline and Project cases respectively.

Chart 5.10: Progressive rehabilitation costs, 2016 – 2033



Source: WCPL

5.2.7 Decommissioning costs

Decommissioning costs comprise costs associated with the conclusion of mining operations and the removal of old assets or infrastructure – in general, the costs involved in the closure of the mine within the Project Area. Under this item we also include the costs associated with monitoring activities required to be undertaken for a set timeframe following closure of the mine.

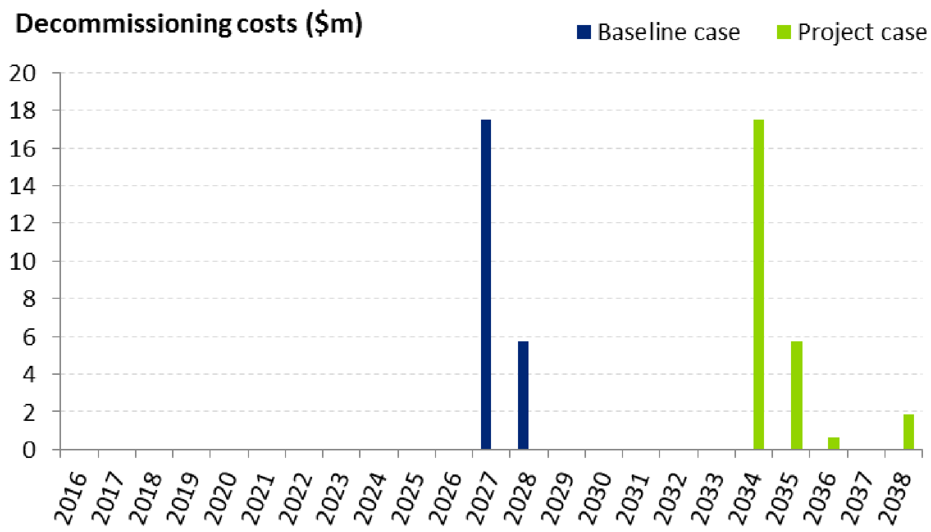
WCPL has provided data on the anticipated timing and magnitude of these costs under the baseline and the Project case. These are presented in Chart 5.11 and Chart 5.12 on the following page.

As indicated, WCPL expects to incur around $23.21 million in decommissioning costs between 2027 and 2028 under the baseline case, with the majority of expenditure taking place in 2027. Therefore, baseline decommissioning costs are valued at $9.48 million in present value terms.

Meanwhile, post-closure monitoring activities will be undertaken between 2027 and 2041 under the baseline case, at a total (undiscounted) cost of $29.32 million. This is valued at $8.88 million in present value terms.

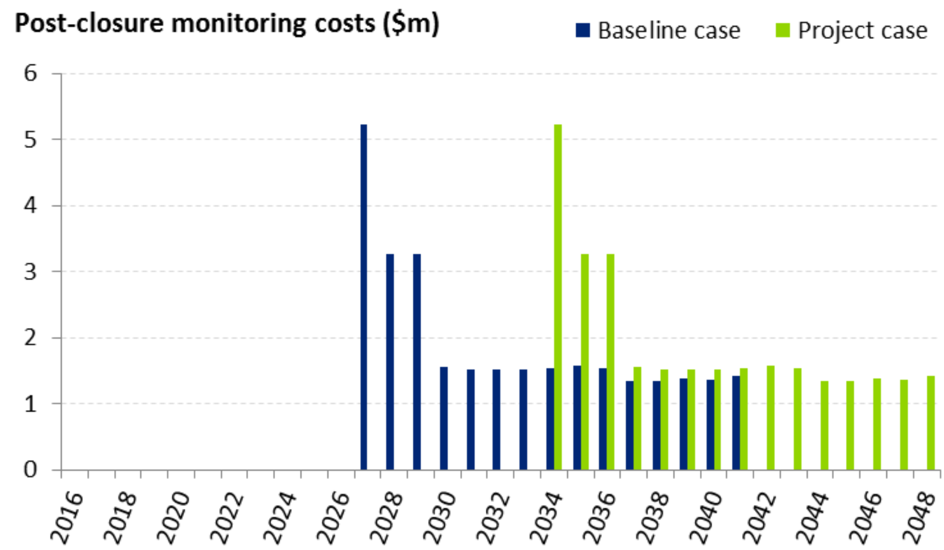
Under the Project case, decommissioning costs are estimated at $25.74 million. It is expected that these costs will be incurred over the period from 2034 to 2038. This is equivalent to $6.42 million in present value terms. Furthermore, the post-closure monitoring costs under the Project case will be delayed, relative to the baseline, commencing in 2034 and concluding in 2048. In present value terms, these costs are valued at $5.53 million.

Chart 5.11: Decommissioning costs, 2016 – 2038



Source: WCPL

Chart 5.12: Post-closure monitoring costs, 2016 – 2048



Source: WCPL

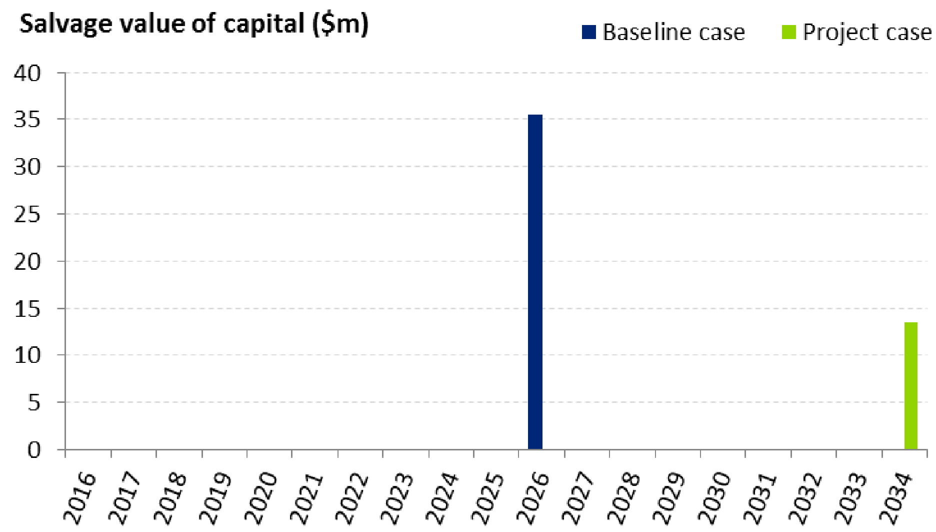
Overall, the NPV of decommissioning and post-closure monitoring costs is estimated at $18.35 million under the baseline case and $11.95 million under the Project case. The saving of $6.41 million generated from the deferral of these costs under the Project case is attributed as a benefit of the Project.

5.2.8 Residual value of capital

Upon completion of mining, companies often generate additional revenue from the sale of remaining capital assets.

In the context of this Project, WCPL has advised that a number of assets are likely to have remaining productive capacity at the conclusion of the operational phase in each case. It is estimated that under the baseline case, $35.55 million will be realised in 2026 as the salvage value of capital, while $13.51 million will be realised as the residual value of capital under the Project case in 2034. These values are presented in Chart 5.13.

Chart 5.13: Residual value of capital, 2016 – 2034



Source: WCPL

Overall, the NPV of the residual value of capital is estimated at $15.78 million under the baseline case and $3.49 million under the Project case. The difference between these two estimates of $12.29 million is attributed as an opportunity cost of the Project.

5.2.9 Residual value of land

As part of a CBA, it is also important to take account of changes in potential land use as a result of a project. This value primarily depends on the ability of the land to support future activities of economic or social value, whether that is in terms of revenue-generating potential or other broader uses such as conservation.

For the purpose of this analysis, WCPL has advised that the relevant land area for consideration spans 5,695 ha, being the Project Development Application (DA) Area. Under the baseline case, this land area encompasses the current approved DA Area of 4,045 ha, and an additional 1,650 ha of adjacent land that would not be impacted by mining activity without the Project. While mining activity under the baseline case will be undertaken in a smaller area compared to the Project, it is important to compare the same total land area in the baseline and Project cases to ensure a consistent calculation which does not suggest that the Project creates new land.

The residual value of this land, at the conclusion of mining activity, has been estimated at a rate of $2,750 per ha. WCPL has advised that this value is generally representative of local land values for areas with similar land use characteristics to the Project site. It is assumed that there will be no difference in the residual value of the land between the baseline and Project cases, with the land areas (at the conclusion of mining activity in each case) comprising a combination of remnant vegetation and other land suitable for low level grazing. The residual value of $15.66 million is expected to be realised in 2027 in the baseline case, and 2034 in the Project case.

Taking this timing difference into account, the residual value of land is estimated at $6.50 million and $4.05 million in present value terms, for the baseline and Project cases respectively (Table 5.2). The residual value of land forgone, of $2.45 million under the Project case is included as an opportunity cost in the CBA.

Table 5.2: Residual value of land estimates

	Land area (ha)	Land value ($ / ha)	Residual value of land estimate ($m)	Year realised	NPV ($m)
Baseline case	5,695	2,750	15.66	2027	6.50
Project case	5,695	2,750	15.66	2034	4.05

Source: Deloitte Access Economics estimates, derived from WCPL
Note: NPVs are calculated using a 7% discount rate

5.2.10 Related public expenditure

In some cases, a project may generate additional costs for government. Where this is the case, these external costs should be included in a CBA.

WCPL has advised that should the Project receive approval, it is expected that it will continue to make financial contributions to the Mid-Western Regional Council for the purposes of the existing Voluntary Planning Agreement and Ulan Road Strategy, as detailed in the existing Project Approval.

In addition, WCPL will cover the costs of all upgrades and relocations of public infrastructure required for the Project, such as the Ulan-Wollar Road relocations.

On this basis, it is expected that the Project will not generate any significant additional public expenditure, relative to the baseline case. As payments associated with the Voluntary Planning Agreement and Ulan Road Strategy are transfer payments between WCPL and the Mid-Western Regional Council, they have not been included in the CBA.

5.2.11 Offsite agricultural revenue

Mining activity can potentially affect the productivity of agriculture in surrounding areas, ultimately reducing the revenue earned by these activities. This can include sterilisation of agricultural land for biodiversity offsets. Where appropriate, it is important to account for these impacts in a CBA. The method of valuing the impacts of mining on agricultural revenue is described in Appendix C.

Given that the impact of the Project on agricultural revenue on land within the Project open cut and contained infrastructure area and ancillary development areas has been examined in Section 5.2.2, this item focuses on the impacts of the Project on agricultural activity beyond these boundaries.

Specifically, WCPL has advised that approximately 310 ha of land currently suitable for agricultural production will be permanently removed under the Project case, as a result of the establishment of the potential biodiversity offset area. It is assumed that under the baseline case, this land could generate gross margins of around $53.06 per ha per year, consistent with the estimates presented in the Land and Soil Assessment for the Project (McKenzie Soil Management, 2015). This implies that $16,449 in potential revenue will be lost each year as a result of the creation of the biodiversity offset area.

Assuming that this removal takes place in 2019, the perpetual loss of agricultural revenues at this site is valued at $0.18 million in present value terms. This is treated as an opportunity cost of the Project in the CBA.

5.2.12 Groundwater quality

Mining activity can potentially impact the quality and quantity of groundwater supplies, with implications for other users that are not adequately captured in market transactions. As a result, it is necessary to assign a value to the costs borne by third parties as part of a CBA.

The Wilpinjong Coal Mine is located in the Sydney Basin – Upper Hunter Groundwater Management Area which will be managed under the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources* (not yet commenced). The groundwater resources in the Wilpinjong Coal Mine area are located mainly within the porous and fractured rock groundwater systems and the small areas of alluvium located along watercourses.

A Groundwater Assessment for the Project has been undertaken by HydroSimulations (2015) and has considered a number of potential groundwater related issues. The Groundwater Assessment has found that the incremental effects of the Project, compared with the existing approved operations are considered to be minimal, with the main differences that:

- drawdown will persist for slightly longer due to the proposed increase in mine life (2026 to 2033);
- the cone of depressurisation will extend further east, through Wollar, as a result of the development of Pit 8 (Slate Gully); and
- baseflow capture from Wollar Creek will increase slightly as a result of the proposed extension into Pit 8.

The licences currently held by WCPL are expected to be sufficient to cover the modelled groundwater inflows from the alluvial and hard-rock groundwater sources.

The Project will have negligible impact on access to water in known registered production bores licensed to external parties, with no privately-owned bores predicted to experience >2 metres (m) drawdown related to the activities of the Project. There is only one state-owned registered bore, located at the Wollar Public School, predicted to experience >2 m drawdown related to the activities of the Project. In accordance with the NSW Aquifer Interference Policy, 'make good' provisions would apply for this bore.

Furthermore, it is expected that there would be no discernible deterioration in groundwater quality as a result of mining, including in the long-term.

Overall, these findings indicate that the Project will not have a significant incremental impact on groundwater flows and quality, relative to the baseline case. Any groundwater extractions will be subject to existing water licences, and it is not anticipated that any further licenses will need to be purchased by WCPL. Accordingly, no value has been assigned to this item in either the baseline or Project case in the CBA.

5.2.13 Surface water quality

Changes in the quality of surface water should also be valued as part of a CBA where those changes are caused by a project and generate substantive impacts on third parties and the surrounding environment.

The Wilpinjong Coal Mine is located within the Upper Goulburn River catchment, part of the Hunter River basin. The Hunter River basin has a catchment area of approximately 22,000 square kilometres (km^2). The Wilpinjong Coal Mine is located to the south of Wilpinjong Creek, a headwater tributary of Wollar Creek which joins the Goulburn River approximately 8 km to the north-east. The catchment area of Wollar Creek at the confluence with the Goulburn River is approximately 530 km^2. The catchment area of the Goulburn River at the confluence is approximately 1,149 km^2.

WRM Water & Environment (2015) has prepared the Surface Water Assessment for the Project. The main findings of this Assessment are that:

- All water captured in the site water management system is considered to be exempt from licencing requirements.
- With the implementation of management measures in the existing Wilpinjong Coal Mine Water Management Plan, the potential impacts of the Project on downstream water quality are immeasurable.
- Water use from construction activities will be very small compared to the operational water requirements.
- The risk of potential geomorphological changes to Wilpinjong and Wollar Creeks due to the Project final landform are considered to be negligible.
- The Project would have no measurable incremental impact on flow in Wilpinjong Creek.
- While the Project is anticipated to have some small incremental increase in the baseflow losses of Wollar Creek and the Goulburn River, the significant additional catchment of these larger streams means potential impacts on flow frequency are expected to be negligible.
- As there are no private surface water users on Wilpinjong or Wollar Creeks downstream of the Wilpinjong Coal Mine, any impact on other private water users (i.e. downstream on the Goulburn River) will be too small to measure.

These findings indicate that the impact of the Project on surface water is anticipated to be negligible, relative to the baseline case. The implications of the Project on surface water are acknowledged, but not considered quantitatively in the CBA. Nevertheless, the evidence suggests that these impacts are unlikely to be significant in the context of the estimated net benefits of the Project.

5.2.14 Subsidence

In instances where mining activity is likely to lead to subsidence, the implications of this effect should be included in a CBA.

In the context of this analysis, the Project is an open cut mine. Accordingly, no costs have been included for this item in the CBA.

5.2.15 Carbon emissions

The continuation of mining activities will generate additional carbon emissions relative to the baseline case, and these have been quantified and valued for inclusion in the CBA. Although not binding on the Project, this analysis has applied the valuation approach outlined in the recently released draft *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government, 2015). These guidelines provide useful information and guidance in relation to NSW Government expectations regarding assessment of carbon emissions costs in future CBAs, which has accordingly been adopted here.

An estimate of the total level of Scope 1 and 2 emissions associated with the construction, operation and closure stages of the Project were obtained from the Air Quality and Greenhouse Gas Assessment for the Project (Todoroski Air Sciences, 2015).

It is estimated that, over the life of the Project, the Wilpinjong Coal Mine will generate an additional 1,087,694 tonnes of carbon dioxide equivalent (t CO_2-e) of Scope 1 emissions during the continued operations from 2017 to 2033, and an additional 136,422 t CO_2-e Scope 2 emissions. These figures have been calculated on the basis of the average emissions per tonne of ROM coal estimated in the Air Quality and Greenhouse Gas Assessment, applied to the annual ROM coal figures under the baseline and Project case. The average Scope 1 and Scope 2 t CO_2-e per t ROM coal used was 0.013.

Next, these carbon emissions are valued at the forecast European Union Emission Allowance Units price provided in the Workbook accompanying the draft *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government, 2015). The alternative prices noted in these draft guidelines have also been considered in the sensitivity analysis presented in Section 5.4.

Overall, the cost of carbon emissions is valued at $6.12 million under the baseline case, and $12.78 million in the Project case, in present value terms (using a 7% discount rate). This implies that the additional cost of carbon emissions under the Project case is $6.66 million.

5.2.16 Air pollution – particulate matter

The air pollution produced by mining activity and its impact on the built and natural environment, and the health of people in the surrounding area, is a key issue in the assessment of any mining project. Given that the health impacts of reduced air quality are generally considered to be most significant, the quantification of health costs is the focus of this analysis.

Particulate matter (PM) is often classified into one of the following three size ranges:

- TSP – total suspended particulate matter, which refers to all suspended air particles, with an aerodynamic diameter typically up to 30-50 micrometers;
- PM_{10} – coarse particulate matter, which includes all particles with an equivalent aerodynamic diameter of less than 10 micrometers; and
- $PM_{2.5}$ – all particulate matter with an equivalent aerodynamic diameter of less than 2.5 micrometers, often referred to as fine particles.

As described in Appendix C, these pollutants are strongly correlated. To bypass the difficulties associated with attributing health costs to the emissions of each pollutant, and avoid the risk of double-counting, this analysis values the health externalities associated with $PM_{2.5}$ emissions.

This approach has been taken on the basis that the best available unit damage cost estimates for particulate matter in Australia, developed for use in economic appraisal and policy assessment, relate to $PM_{2.5}$ emissions (PAEHolmes, 2013). It is also noted that $PM_{2.5}$ has been considered to be the best index for quantitative assessments of the effects of particulate matter in international research (PAEHolmes, 2013). In any case, this approach indirectly encompasses part of the costs associated with other correlated pollutants, such as PM_{10}.

The first step in this valuation approach is to estimate the quantity of $PM_{2.5}$ emitted under the baseline and Project cases.

The Air Quality and Greenhouse Gas Assessment undertaken by Todoroski Air Sciences (2015) reports estimated TSP emissions for five representative years of the Project, as shown in the first column of Table 5.3. On a weighted-average basis, this data suggests that 0.49 kilograms (kg) of TSP will be emitted per tonne of ROM coal produced during the Project.

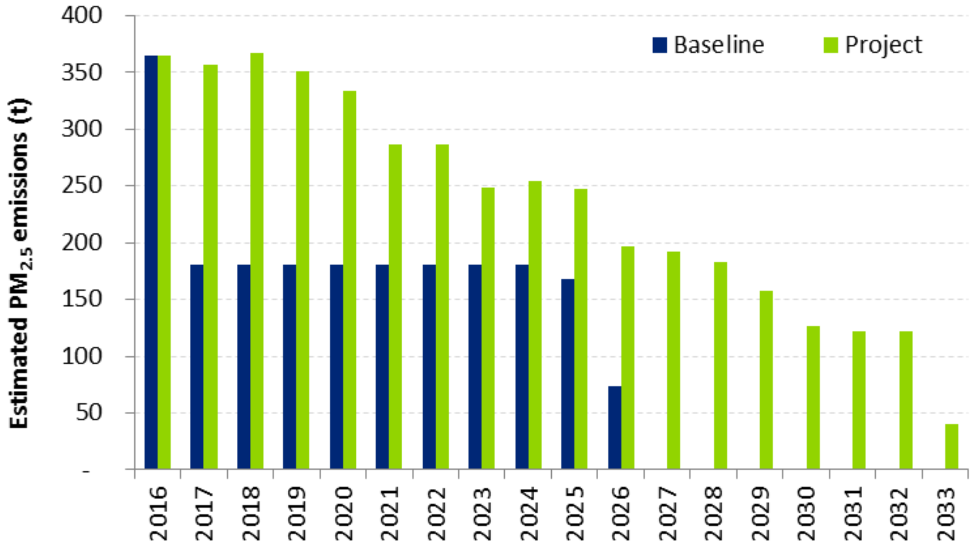
Table 5.3: Estimated Project case TSP emissions

Year	Estimated TSP emissions (kg)	Estimated ROM coal (t)	TSP per tonne of ROM (kg/t)
2018	7,254,499	15,950,000	0.45
2020	6,494,003	14,530,000	0.45
2024	5,888,466	11,080,000	0.53
2028	4,179,306	7,950,000	0.53
2031	3,081,133	5,290,000	0.58
All years	**26,897,407**	**54,800,000**	**0.49**

Source: Todoroski Air Sciences (2015); Deloitte Access Economics

Using this average ratio, and the time series of ROM coal production provided by WCPL, an estimate of TSP emissions for each year of production under the baseline and Project cases was calculated. These estimates were then converted into estimates of $PM_{2.5}$ for each year of production under each case, by applying the assumption used in the Air Quality and Greenhouse Gas Assessment that $PM_{2.5}$ accounts for roughly 4.68% of TSP emissions (Todoroski Air Sciences, 2015:34). The resulting estimates of $PM_{2.5}$ for each case are presented in Chart 5.14.

Chart 5.14: Estimated $PM_{2.5}$ emissions (t), 2016 - 2033



Source: Deloitte Access Economics, derived from Todoroski Air Sciences (2015)

Next, an estimate of the health costs associated with $PM_{2.5}$ emissions in the Mid-Western Regional LGA was generated using the unit damage cost estimates presented in a PAEHolmes (2013) report undertaken for the NSW Environment Protection Authority (EPA). This report presents estimates of the health costs per tonne of $PM_{2.5}$ emissions for different Significant Urban Areas (SUAs) across NSW, accounting for differences in population density. For the purpose of this analysis, the damage cost estimate of $360 per tonne of emissions was utilised, being the value for locations not in any SUA. This was converted to 2015 prices, and adjusted to take account of the higher population density in the Mid-Western Regional LGA. The $360 per tonne valuation from PAEHolmes (2013) uses a population density of 1.3 people per km^2 while the Mid-Western Regional LGA has a population density of 2.7 people per km^2. This produced a unit damage cost estimate of $807.00 per tonne of $PM_{2.5}$ in 2015.

As recommended by PAEHolmes (2013), this cost estimate was indexed over time to account for changes in the population of the Mid-Western Regional LGA and rising willingness to pay for health over time. For this purpose, the analysis utilised the population growth forecasts for the Mid-Western Regional LGA produced by the DP&E (2014) and assumed that willingness to pay would rise by 2.5% per annum, in line with the forecast real growth in Gross State Product (GSP) reported in the NSW Intergenerational Report (2012).

There is some uncertainty associated with these cost estimates, such that it may overstate or understate the costs of $PM_{2.5}$ emissions from the Wilpinjong Coal Mine. On one hand, as the population density of the areas immediately surrounding the mine is substantially lower than the density of the broader Mid-Western Regional LGA, the cost estimate may overestimate the health impacts of $PM_{2.5}$ emissions in the local community. For example, the Social Impact Assessment for the Project indicates that in 2011, the population density of the local study area, the Wollar State Suburb Code was 0.27 people per km^2 (Elliott Whiteing, 2015:28).

The Social Impact Assessment also indicates that the Wollar community is small and likely to experience population decline over time under the Project case, in contrast to the projections for modest population growth in the broader Mid-Western Regional LGA. That said, it is also noted that air dispersion from the Wilpinjong Coal Mine may also contribute somewhat to $PM_{2.5}$ emissions at a regional level.

Nevertheless, applying the conservative cost estimates described above to the estimated profiles of $PM_{2.5}$ emitted for the purposes of this CBA suggested that the impacts from $PM_{2.5}$ emissions of the Wilpinjong Coal Mine are valued at $1.28 million and $2.44 million for the baseline and Project cases respectively, in present value terms.

In considering the air quality impacts of the Project, it is also useful to note the results of the Air Quality and Greenhouse Gas Assessment which accompanies this analysis. Specifically, the modelling undertaken by Todoroski Air Sciences (2015) indicated that:

- there are no privately-owned receptor locations predicted to experience levels above the applied assessment criteria; and
- there is low potential for cumulative 24 hour average PM_{10} impacts to occur at sensitive receptor locations.

Overall, the Air Quality and Greenhouse Gas Assessment found that continued implementation of the updated Air Quality and Greenhouse Gas Management Plan management measures, including real-time controls with implementation of the best practice mitigation measures identified in the Pollution Reduction Program, will be suitable to manage potential air quality impacts from the Project.

5.2.17 Air pollution – other pollutants

Mining activity is also associated with emission of other air pollutants, such as oxides of nitrogen (including nitrogen dioxide), sulfur dioxide and carbon monoxide. Common sources of these pollutants include blasting fumes, diesel powered equipment and vehicle exhausts.

The Air Quality and Greenhouse Gas Assessment for the Project undertaken by Todoroski Air Sciences (2015) notes that the emissions of carbon monoxide, nitrogen dioxide and sulfur dioxide associated with diesel powered equipment are generally considered too low to generate any significant off-site concentrations. Accordingly, these emissions were not assessed in detail in the report.

Meanwhile, the impacts of potential emission of carbon monoxide and oxides of nitrogen associated with blasting activity were assessed qualitatively in the Air Quality and Greenhouse Gas Assessment.

Todoroski Air Sciences (2015) considered that the potential impacts from blast fume emissions during the Project could be readily managed and adverse impacts in the surrounding environment can be minimised through the implementation of appropriate blast practices and management measures.

As some health impacts produced by oxides of nitrogen and sulfur dioxide are partly correlated with particulate matter, it is reasonable to expect that some of the impacts described above would be captured by the externalities calculated in Section 5.2.16.

While nitrogen oxides also interact with volatile organic compounds (emitted mostly from chemical processing) increasing ozone formation and leading to additional health impacts, these effects are expected to be minimal as chemical industries are not located within the surrounding mining region. Other air pollutants and sulfur oxides may affect the natural and built environment; however there are limited economic estimates for the region that would be applicable to quantify these additional impacts.

Overall, the potential costs of additional nitrogen dioxide, sulfur dioxide and carbon monoxide are acknowledged, but not considered quantitatively in this analysis. Nevertheless, the evidence suggests that these impacts are unlikely to be significant in the context of the estimated net benefits of the Project.

5.2.18 Noise pollution

As part of the CBA, it is necessary to place a value on the level of noise pollution expected to be borne by local residents.

The first step of the valuation process is to estimate the level of noise pollution associated with mining activity at the Wilpinjong Coal Mine under the Project case, compared to the baseline.

The Noise and Blasting Assessment for the Project undertaken by SLR Consulting Australia (2015) notes that noise impacts from the Wilpinjong Coal Mine would occur for an additional seven years as a result of the Project. It is anticipated that eight residential properties will fall within the Noise Management Zone for the Project (35 to 40 dB(A)), with no properties expected to fall within the Noise Affectation Zone (greater than 40 dB(A)). Furthermore:

- no community facilities have been identified as being in either the Noise Management Zone or Noise Affectation Zone due to the Project;
- the Project will involve minor traffic noise increases, measured relative to baseline activity in 2017 and 2024, estimated to be less than 2 dB(A), a level that is considered barely perceptible; and
- there are no rail related noise level increases under the Project case, relative to current activity, as the Project will not involve any change to currently approved rail movements or rail loading hours at the Wilpinjong Coal Mine.

The next step of the valuation process involves applying a monetary value representing the costs of those impacts. The recently released draft *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government, 2015) notes that there is a lack of conclusive evidence regarding impacts at noise levels below 45 dB(A). Although these draft guidelines are not binding on the Project, they suggest that the costs associated with the noise impacts of the Project are likely to be immaterial.

Nevertheless, Deloitte Access Economics has calculated an estimate of the noise pollution costs drawing on operational intrusive noise level estimates reported by SLR Consulting (2015) for residential properties within the vicinity of the mine, the majority of which are currently owned by resource companies.

While the NSW Voluntary Land Acquisition and Mitigation Policy enables management of industrial noise impacts through negotiated agreements and land acquisitions, this analysis has conservatively quantified the impacts on both private and resource company owned receivers, to acknowledge the externalities imposed on occupants of those residents.

Nevertheless, this analysis suggests that noise pollution costs of up to $0.11 million could be generated by the Project, in present value terms. This has been included in the central case of the CBA.

This estimate is based on a number of conservative assumptions, including:

- Applying a background noise level of 30 dB(A) for most properties, being the minimum rating background level (RBL) used in the EPA's Industrial Noise Policy.[1]
- Utilising the maximum additional noise level across the annual average day, evening and night periods for each property, to represent the worst case scenario of the additional noise experienced by each property over the course of the year.
- Assuming that residents would not experience any additional noise exposure over the background level under the baseline case, despite that mining activity will occur out to 2026.

It is also noted that WCPL has committed to implement a range of potential noise mitigation measures to restrict the impacts of the Project at private receivers, generally consistent with current approvals for the Wilpinjong Coal Mine. These measures may include the use of low noise mobile equipment and real-time noise controls, such as equipment stand-downs under adverse meteorological conditions. The additional costs associated with these actions have been incorporated in the operating cost estimates, to be borne by WCPL. This also includes mobile equipment noise attenuation costs which may be incurred.

5.2.19 Visual amenity

It is recognised that mining activity has the potential to detract from the visual amenity of a community. The visual effects of converting an existing landscape to an area featuring emplacement areas, machinery, vehicles and artificial light are therefore important considerations for a CBA.

[1] A marginally higher RBL of 31 dB(A) was applied to privately-owned residential properties within the Village of Wollar during day time periods, as assessed by SLR Consulting Australia in the Noise and Blasting Assessment (see Table 15).

The Visual Assessment (Marc&Co and Resource Strategies, 2015) undertaken for the Project found that the Project is expected to result in very low to low visual impacts at relevant sensitive receivers. The nature and scale of these visual impacts would be generally consistent with the existing Wilpinjong Coal Mine. No private residences have been identified with views of the proposed open cut extensions under the Project case, and consistent with the existing operations, public viewpoints would be largely limited to the immediate local road network.

These impacts are acknowledged, but are only considered qualitatively in this analysis. Nevertheless, the evidence suggests that these impacts are unlikely to be significant in the context of the estimated net benefits of the Project.

5.2.20 Traffic

The effect of the Project on traffic constitutes another element for consideration in a CBA.

The Road Transport Assessment for the Project (GTA Consultants, 2015) found that the Project will have acceptable impacts on the operation of the surrounding road system. It was found there will be no change to the level of service in three priority intersections evaluated, and that Project traffic would not come into any significant conflict with the school buses currently using the relevant parts of the road network, and no additional mitigation measures or roadworks will be needed to deal with traffic impacts of the Project (noting that the future road network in the region will benefit from currently underway upgrades to Ulan Road and Cope Road).

Nevertheless, this section includes the quantification in monetary terms (for inclusion in the CBA) delays to road traffic at railway level crossings as a result of the Project.

GTA Consultants (2015) quantified the probability of delay and number of vehicles per hour (being the maximum of the vehicles per hour at either the AM or PM peak hour) for eight railway level crossings in the Project area both with and without the Project.

This information has been used to calculate total delays per year, assuming that each delay lasts for 180 seconds, and there are two peak hours per day for 365 days per year. The calculation of total delays during peak hours per year at each railway level crossing is performed as follows:

$$Peak\ hour\ delays\ per\ year = vehicles\ per\ hour \times marginal\ probability\ of\ delay \times seconds\ delay\ per\ train\ crossing \div seconds\ per\ hour \times days\ per\ year \times 2$$

Each hour of delay is valued at prices obtained from *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives* (Transport for NSW, 2013). Traffic delays are priced at $36.16 per year, being the sum of the idling vehicle operating cost and the weighted sum of the travel time cost of private cars and heavy commercial vehicles in rural settings, with the weighting based on the percentage of heavy vehicles travelling through the road sections identified in Table 3.1 in GTA Consultants (2015). The prices in Transport for NSW (2013) have been converted to 2015 dollars using ABS CPI data.

The total cost of delays per year is calculated to be $2,822 (in 2015 dollars). The NPV of these delays over the period 2017 to 2033 (using a 7% discount rate) is $0.02 million. While this cost is immaterial relative to the total benefits and costs of the Project, it has nevertheless been included in the CBA.

When interpreting these estimates it should be noted that:

- Delays experienced in non-peak hours have not been included due to estimates of traffic and probabilities of delay not being available, but it is likely these would be small given that most Project traffic will be travelling in peak hours.
- Delays are calculated as if every vehicle delayed at a railway level crossing is delayed for three minutes – in reality only a vehicle that reaches the level crossing at the same time the train blocks the level crossing will be delayed for this long, all others arriving afterwards will be delayed less than three minutes.

5.2.21 Biodiversity (flora and fauna)

It is also necessary to compare the risks to biodiversity in both the baseline and Project case as part of a CBA.

The Biodiversity Assessment Report undertaken for the Project by Hunter Eco (2015) found that the Project will require clearance of around 354 ha of native vegetation in the Project open cut extension and infrastructure areas resulting in the clearance of 9.5 ha of Box-Gum Woodland Endangered Ecological Community/Critically Endangered Ecological Community.

Potential indirect impacts from the Project on vegetation (such as *the Ozothamnus tesselatus*) and other terrestrial biodiversity (such as the Regent Honeyeater and Koala) have been assessed and it was concluded that with proposed measures to avoid, mitigate and offset it is appropriate for those impacts to occur without further modifications to the Project.

Assessments of significance under section 5A of the NSW *Environmental Planning and Assessment Act 1979* were also undertaken for one threatened ecological community, one threatened flora species and a total of 32 threatened fauna species listed under the NSW *Threatened Species Conservation Act 1995*. It was concluded that the Project is unlikely to significantly impact any threatened species or communities listed under the NSW *Threatened Species Conservation Act 1995*.

Overall, it was found that while there is likely to be a short to medium impact on a number of threatened species due to the loss of woodland/forest habitat but there would be no net impact on any threatened species over the medium to long-term when taking into consideration the measures proposed to mitigate and offset impacts. Furthermore, the Biodiversity Assessment Report indicated that the Project Biodiversity Offset Strategy will address the potential residual impacts on biodiversity values associated with the Project such that biodiversity values of the region are maintained and improved in the medium to long-term.

Accordingly, a Biodiversity Offset Strategy that is consistent with Commonwealth and State Government policies has been developed to mitigate and offset potentially significant biodiversity impacts. Specifically, five potential offset areas have been identified, to hold a similar biodiversity value as the areas affected by the Project. Accordingly, no quantitative valuation is placed on the risks to biodiversity.

However, these offsets do incur management costs. While the offset costs will not be known until the biodiversity offset conditions are set by the NSW Government and the biodiversity offset package has been finalised for the Project, WCPL has advised that conservative establishment and ongoing management costs for the offset strategy should be allocated. An estimate of these costs has been included in the analysis as part of operating costs. There are no additional risks to biodiversity expected under the baseline.

5.2.22 Conservation

It is not anticipated that the Project will have an impact on any existing conservation or biodiversity offset areas. In particular, the Biodiversity Assessment Report undertaken for the Project by Hunter Eco (2015) found that the Project would avoid direct impacts on the Munghorn Gap Nature Reserve and minimise potential indirect impacts that would be temporal in nature.

As noted above, it is anticipated that a biodiversity offset area will be established and maintained in perpetuity under the Project case. To avoid double counting against the treatment of these areas under the biodiversity item, no separate costs or benefits have been attributed to the conservation item in this analysis.

5.2.23 Quality of open space

As described in Appendix C, valuation of impacts on the quality of open space incorporates two main elements – the visual amenity associated with the space, and the types of activities that are undertaken in the space. To avoid double-counting, this item is focused on the second component, since the visual amenity impacts of the Project have been discussed in Section 5.2.19.

In the context of this Project, it is noted that the Village of Wollar is the closest village to the existing mine and the Project will be approximately 1.5 km from the village boundary. Peabody Energy has purchased the majority of residential property in the Village of Wollar and the surrounding rural area, some of which now accommodate Wilpinjong Coal Mine employees. Key features of the Project area and surrounds include:

- the existing approved Wilpinjong Coal Mine;
- Sandy Hollow Gulgong Railway;
- Goulburn River National Park;
- large vegetated Crown land parcels on ridgelines;
- Munghorn Gap Nature Reserve; and
- Wilpinjong Creek.

As part of the Project, a section of Ulan-Wollar Road to the west of Wollar will be re-aligned and upgraded to provide a sealed road. This will cause temporary traffic disruptions during construction, however sealing the road will be a benefit to local road users in terms of road safety and ease of use.

The Project includes extensions to the mine's existing open cut pits which will expand the existing use of areas proximal to the Munghorn Gap Nature Reserve. These extensions will not displace existing access to, or use of, the Munghorn Gap Nature Reserve from public locations. The Project also includes land between Ulan-Wollar Road and the Goulburn River National Park to accommodate ancillary development; however material impacts on the Goulburn River National Park are not anticipated.

Based on this evidence, it is considered that the Project is unlikely to cause a material change in the ability of local residents or visitors to use the open spaces surrounding the Project Area for other activities. Accordingly, no quantitative values have been assigned to this item in the baseline or Project case.

5.2.24 Rural amenity and culture

The impact of continuing the Project on rural amenity and culture should also be considered where possible. The impacts on rural amenity and culture can be valued in terms of the social costs associated with families relocating out of the local area. For example, these costs have been assessed in a choice modelling study undertaken by Bennett, van Bueren and Whitten (2004), which found that:

- Australian households were willing to pay an average of $0.09 per year, over a twenty year period for every 10 people that are retained in country communities, based on a national survey; and that
- households in Rockhampton were willing to pay $2.24 per year over twenty years, for every ten people retained in the Fitzroy Basin region, based on a region-specific survey.

The Social Impact Assessment performed by Elliot Whiteing (2015) for the Project provides qualitative assessment of Project impacts on rural amenity and culture in a range of areas, including:

- population;
- housing;
- employment;
- Wollar businesses;
- social infrastructure;
- social sustainability;
- amenity;
- quality of life and wellbeing; and
- sense of place.

These potential impacts are summarised in Table 5-4 of the Social Impact Assessment (Elliot Whiteing, 2015). It should be noted that a number of the impacts and opportunities identified in the Social Impact Assessment are contingent on acquisition of the privately-owned properties by Peabody Energy. Further, the air quality and noise impact assessments undertaken for the Project identify that no privately-owned properties would meet the criteria for acquisition by WCPL upon the request of the landholder.

Accordingly, in the context of this Project, potential rural amenity and culture costs are acknowledged qualitatively, rather than quantitatively, as it is uncertain whether any of the owners of residential property in the vicinity of the Project will seek to sell their property for the purpose of relocation. Furthermore, it is also noted that some of the costs included in this CBA, such as the cost of attenuating equipment to manage noise impacts, might not be required should properties be acquired by Peabody Energy.

5.2.25 Aboriginal heritage

Aboriginal heritage sites can be associated with substantial historical, cultural and scientific value. Where a proposal is anticipated to affect these sites, these impacts should be considered in a CBA to account for the costs of the Project. Aboriginal heritage issues have been assessed in the Aboriginal Cultural Heritage Assessment prepared by South East Archaeology Pty Ltd (2015).

293 sites have been identified in the Heritage Study Area investigated by South East Archaeology Pty Ltd. 156 of these have been previously recorded on the Aboriginal Heritage Information Management System Site Register, Navin Officer reports and site records and data provided by Kayandel. The present survey has resulted in the identification of another 137 Aboriginal sites, comprising:

- 73 rock shelters with potential archaeological deposits;
- 60 open artefact sites;
- two waterhole/wells;
- one rock shelter with artefacts and art; and
- one rock shelter with artefacts and ochre quarry.

In overall terms, impacts are expected to occur to approximately 31% of the identified Aboriginal heritage sites and cultural values, while impacts are not expected to occur to 22% of the identified heritage sites, and the remaining 47% of the identified heritage sites may or may not be subject to total or partial impacts, depending on the detailed design of ancillary infrastructure.

South East Archaeology Pty Ltd (2015) has developed a range of management and mitigation measures for the Project that have been adopted by WCPL. South East Archaeology found that, in the absence of appropriate management and mitigation measures, it is concluded that the impacts of the Project on Aboriginal heritage would be moderate to low within a local context and low within a regional context. With the implementation of mitigation measures, the impacts will be low within a local context and very low within a regional context.

Overall, given the difficulty in placing a quantitative value on Aboriginal heritage, the impact of the Project on Aboriginal heritage is analysed qualitatively in this analysis. Nevertheless, the evidence suggests that these impacts are unlikely to be significant in the context of the estimated net benefits of the Project.

5.2.26 Historical heritage

Similarly, it is also important to consider the impacts of a proposal on European heritage sites, relative to the baseline. To do so, this analysis relies on the findings of the Historical Heritage Assessment prepared by Niche Environment and Heritage (2015).

The Historical Heritage Assessment has found that:

- 24 potential historical items were identified within, or near, the Project area. Of these, 21 have been assessed to be items of local heritage significance.
- No cultural landscapes were identified within, or associated with, the Project area.
- One historical heritage item, the Historical Shale Oil Mine is partially located within open pit areas and will be directly impacted by the Project.
- One historical heritage item, a Road Embankment, may be impacted by the relocation of the TransGrid Wollar to Wellington 330 kV ETL.
- The Historical Shale Oil Mine, the Road Embankment, Pine Park and William Carr's Hut could experience indirect impacts from blasting.

Niche Environment and Heritage (2015) has developed a range of management and mitigation measures for the Project that have been adopted by WCPL.

Overall, while there are some historical heritage items that may be affected by the Project, in the absence of appropriate values for the individual sites, these impacts have not been quantified. The challenges of quantitative analysis of historical heritage are discussed further by the Productivity Commission (2006:145). Nevertheless, the evidence suggests that these impacts are unlikely to be significant in the context of the estimated net benefits of the Project.

5.2.27 Health

The final element which should be considered in a CBA is the impact of mining activity on the health of local residents and employees of the mine.

However, it is not appropriate to consider this item separately in this analysis, given that health impacts are explicitly captured in the valuation of air pollution, and to some extent, implicitly captured in the costs of noise pollution.

5.3 Overall cost benefit analysis results

Given the values assigned to each cost and benefit in Section 5.2, the next stage of the CBA is to compare the baseline and Project cases and obtain a consolidated estimate of the net economic benefit of the Project.

Table 5.5 presents the incremental benefits and costs associated with each item considered in Section 5.2, measured in NPV terms as at the start of 2015 using a 7% discount rate. A 7% discount rate is the standard discount rate recommended by the NSW Government (2007).

The additional gross mining revenue expected as a result of the open cut mining is the main incremental benefit of the Project in relation to the baseline case. The key incremental costs of the Project are the additional operating costs and capital investment borne by WCPL, along with the externalities associated with carbon emissions, particulate matter and costs associated with establishment and management of the biodiversity offset area.

These outcomes lead to a total net benefit of approximately $735 million and a BCR of 1.43, as shown in Table 5.4.

Table 5.4: CBA results

Discount rate	Total net benefits ($m)	Benefit Cost Ratio
7%	735.07	1.43

Source: Deloitte Access Economics

As recommended in CBA guidelines such as NSW Treasury (2007), where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. The results indicate that these non-quantified externalities would need to generate costs of around $78 million per year (in real terms) over the operational phase of the Project from 2016 to 2033 to fully offset the estimated net benefits of the Project. This is equivalent to undiscounted costs of $1,407 million over the period. This is considered to be unlikely, given the nature of the evidence regarding these impacts.

It is important to note that the calculation of the BCR is sensitive to a number of assumptions. For example, the BCR outlined in the NSW Government Guidelines for Economic Appraisal (NSW Treasury, 2007) is calculated using initial capital costs in the denominator of the ratio, with ongoing costs subtracted from incremental benefits in the numerator. The purpose of this measure is to ensure that the return to scarce capital is maximised. However, when applied to this Project, this calculation method produces a significantly higher result (specifically, a ratio of 10.17) than a standard ratio which divides all incremental benefits by all incremental costs.[2] As such, the BCR reported in Table 5.4 is the more conservative estimate of the benefits delivered by the Project. In any case, Deloitte Access Economics considers that the total net benefit figures presented in this report are an appropriate measure for Project evaluation.

[2] This alternative BCR of 10.17 is calculated by dividing the net benefits of the Project in present value terms (excluding incremental capital costs) by the incremental capital costs of the Project in present value terms.

Table 5.5: Incremental benefits and costs

No.	Item	Baseline NPV ($m)	Proposal NPV ($m)	Incremental benefit ($m)	Incremental cost ($m)
1	Gross mining revenue	1,856.99	4,293.41	2,436.42	-
2	Other onsite revenue	-0.65	-1.44	-	0.79
3	Exploration costs	0.00	8.52	-	8.52
4	Capital investment costs	49.11	129.31	-	80.20
5	Operating costs excluding taxes	1,453.62	3,047.14	-	1,593.51
6	Rehabilitation costs	11.33	13.19	-	1.86
7	Decommissioning costs	18.35	11.95	6.41	-
8	Residual value of capital	15.78	3.49	-	12.29
9	Residual value of land	6.50	4.05	-	2.45
10	Related public expenditure*	-	-	-	-
11	Offsite agricultural revenue	0.00	-0.18	-	0.18
12	Groundwater impacts*	-	-	-	-
13	Surface water impacts*	-	-	-	-
14	Subsidence	0.00	0.00	-	0.00
15	Air pollution – carbon emissions	6.12	12.78	-	6.66
16	Air pollution – particulate matter	1.28	2.44	-	1.16
17	Air pollution – other pollutants*	-	-	-	-
18	Noise pollution	0.00	0.11	-	0.11
19	Visual amenity*	-	-	-	-
20	Traffic	0.00	0.02	-	0.02
21	Biodiversity*	-	-	-	-
22	Conservation*	-	-	-	-
23	Quality of open space*	-	-	-	-
24	Rural amenity and culture*	-	-	-	-
25	Aboriginal heritage*	-	-	-	-
26	European heritage*	-	-	-	-
	Total			**2,442.83**	**1,707.76**

Source: Deloitte Access Economics calculations – note numbers may not add due to rounding

NPV measured in real 2015 dollar terms, using a 7% discount rate

* Considered qualitatively

5.4 Sensitivity analysis

The CBA results presented in Section 5.3 are subject to the assumptions and valuations applied to each cost and benefit, as outlined in Section 5.2. Accordingly, it is necessary to test the sensitivity of the estimate of net economic benefit and the benefit cost ratio by also considering upper and lower bound discount rates, and varying the size of a number of parameters of interest. This provides an insight into the range of possible outcomes that could be expected from the project, given a number of different scenarios.

The sensitivity analysis results reported in this section utilise a lower bound discount rate of 4%, and an upper bound discount rate of 10%. As noted in Appendix A, these are the values recommended in the NSW Government Guidelines for Economic Appraisal published by the NSW Treasury (2007). It is noted that this lower bound rate of 4% is recognised in the literature as a reasonable discount rate to use when there is an interest in incorporating intergenerational concerns (Arrow et al, 2012).

Table 5.6 illustrates the variation in the results of the CBA using these alternative discount rates.

Table 5.6: Central CBA results

Discount rate	Total net benefits ($m)	Benefit Cost Ratio
4%	911.82	1.41
7%	735.07	1.43
10%	604.06	1.45

Source: Deloitte Access Economics calculations

As shown, the BCR remains greater than 1 for all three discount rates, indicating that the costs of the Project, including the quantifiable externality costs, are more than offset by the expected benefits.

The estimate of net economic benefits range from around $604 million to $912 million, a respective 18% decrease and 24% increase on the central estimate produced using the standard discount rate of 7%. The fact that net benefits are higher under the 4% discount rate indicates that a large share of the costs of the Project occur early in the period of analysis with benefits being generated throughout the period.

The second necessary component of a sensitivity analysis is to also vary the estimates for different inputs. The importance of testing scenarios is also recognised in the NSW Government Guidelines for Economic Appraisal (NSW Treasury, 2007).

The variations undertaken as part of this analysis include:

- increasing export coal price forecasts by 30%;
- decreasing export coal price forecasts by 15%;
- increasing Project capital investment by 25%;
- decreasing Project capital investment by 25%;
- increasing operating costs per tonne to those produced based on the industry cost model, without the central case discount (an 11% increase on the central case);
- applying an additional 10% discount to the operating costs per tonne based on the industry cost model (for a total 20% discount), consistent with WCPL's expectations for operating costs (an 11% reduction on the central case);
- pricing the cost of carbon according to alternative prices used in the Australian Treasury Clean Energy Future Policy Scenario (288% higher than the prices used in the central case scenario, on average); and
- pricing the cost of carbon according to alternative US EPA Social Cost of Carbon estimates (87% higher than the prices used in the central case scenario, on average).

The sensitivity ranges for the export coal prices were arrived at through an analysis of data over the period from January 1995 to September 2015. Specifically, the range used covers 67% of the range of historical monthly coal prices over this period. The minimum price in the lower sensitivity scenario, forecast for 2016, is placed at the 16th percentile of historical coal prices. Meanwhile, the maximum price in the upper sensitivity scenario, forecast for 2020, is placed around the 84th percentile. Domestic coal prices were not varied in this analysis given that they are expected to remain constant at contract levels.

The alternative prices for the cost of carbon were obtained from the recently released draft *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government, 2015). Although not binding on the Project, these guidelines provide useful information and guidance in relation to NSW Government expectations regarding assessment of carbon emissions costs in future CBAs.

A comparison of the total net benefits obtained in each of these scenarios, using a 4%, 7% and 10% discount rate is presented in Table 5.7.

Table 5.7: Sensitivity Analysis – comparison of net benefits

Parameter	Variation in Parameter	Net Benefits ($m)		
		4%	7%	10%
Central CBA	N/A	$912	**$735**	$604
Export coal price forecasts	+ 30%	$1,852	**$1,466**	$1,186
	- 15%	$442	**$370**	$313
Project capital investment	+ 25%	$876	**$703**	$575
	- 25%	$948	**$767**	$633
Operating costs per tonne	Industry cost model (without 10% central case discount) (+ 11%)	$688	**$565**	$472
	WCPL expected costs (with 20% discount on industry cost model) (- 11%)	$1,136	**$905**	$737
Social cost per tonne of carbon emissions	Australian Treasury Clean Energy Future Policy Scenario prices (+ 288%)	$885	**$716**	$590
	US EPA Social Cost of Carbon prices (+ 87%)	$904	**$729**	$600

Source: Deloitte Access Economics calculations

These results indicate that the quantified benefits of the Project are likely to exceed the quantified costs, including any negative externalities imposed on broader society, in all scenarios. It should be noted that the scenario where there is a 15% reduction in export coal prices represents an extreme case whereby prices remain at historically low levels throughout the life of the Project, fluctuating between the 16th and 31st percentiles of historical export coal prices. This scenario also assumes that WCPL is fully exposed to the spot market rather than longer term contracts – a conservative assumption.

6 Regional cost benefit analysis

While a CBA provides a clear picture of the overall benefits and costs of the Project, it is not well suited to show that the costs and benefits are not evenly distributed between the different stakeholders within the scope of the CBA. For example, some of the costs of the externalities are borne by the regional community (i.e. the Mid-Western Regional LGA), while the NSW Government captures some of the benefits of increased production through taxation. These regional benefits are considered in the following sections.

CBA calculations are not easily disaggregated into regional assessments. There is currently not a common approach among practitioners or detailed guidance available on how to geographically disaggregate results from a CBA (particularly when compared to the maturity of CBA or CGE modelling, for example). However, recognising the importance of being able to understand costs and benefits to particular geographic areas and groups, we have developed an approach to disaggregate CBA results.

The disaggregation of CBA results is produced using the following methods:

- the regional community's share of the net benefits from capital investment was estimated using data provided by WCPL in relation to the geographic distribution of capital expenditure and a Frontier Economics (2009) estimate of the weighted average cost of capital in mining, which is borne by WCPL;
- the regional community's share of the net benefits from operating costs was estimated using data provided by WCPL in relation to the location of employees and geographic distribution of other costs during the operational phase of the Project. In order to illustrate the range of outcomes that could be achieved in the absence of the Project, it was assumed that these businesses and workers could earn the average level of income in the Mid-Western Regional LGA in the baseline case. As illustrated in Chart 3.1, the average level of income in Mid-Western Regional LGA is approximately 40% of the income from mining. Industries which provide this average level of income include agricultural and administrative industries;
- the regional community's share of the national costs of carbon pollution was estimated using the Mid-Western Regional LGA's share of the national population;
- the regional community was attributed 100% of the health costs associated with additional $PM_{2.5}$ pollution, consistent with the regional level modelling approach; and
- the regional community was attributed all of the costs associated with additional noise pollution.

This approach allows us to produce a geographic disaggregation of the CBA results that is internally consistent and accounts for all costs and benefits. The need to ensure consistency between the whole of project CBA and the regional disaggregation somewhat restricts the methodology used to undertake the disaggregation. This means that while the results shown in Table 6.1 may not reflect a perfect allocation of costs, they represent an allocation that we consider is reasonable and consistent with the CBA as a whole.

Note that the overall net benefit figure does not align with that reported in Section 5.3 as this regional analysis treats some of the operating and capital costs in the project level CBA as a benefit for particular regions.

Table 6.1: NPV of costs and benefits ($m, 2015 prices) assuming supplier benefits from mine operation

	Region	NSW	Rest of World
Benefits			
Modelled profit after tax			371.7
Payments from Capital expenditure	4.4	44.4	44.4
Payments from Wages	266.9	296.5	0.0
Payments from other operating expenditure	168.6	804.1	492.9
Royalties		190.5	
Company tax			173.3
Rates	1.8	1.8	
Other	0.0	16.1	6.4
Total benefits	**441.7**	**1353.4**	**1088.6**
Costs			
Residual value of land			12.3
Rehabilitation			1.9
Residual value of capital			12.3
Capital expenditure related costs	3.9	39.5	49.3
Operating expenditure related costs	172.7	436.5	195.5
Externalities	1.5	3.6	4.5
Total costs	**178.1**	**479.6**	**275.7**
Net Benefit	**263.5**	**873.8**	**813.0**

Note: categories listed above are different from those listed in the CBA as this analysis must take into account different and additional items. However, figures in this table can be reconciled to those in the original CBA.

There are also likely to be additional benefits to the region as a result of the continuation of financial contributions made by WCPL to the Mid-Western Regional Council for the purposes of the existing Voluntary Planning Agreement and Ulan Road Strategy, as detailed in the existing Project Approval. These have not been quantified in the estimates above.

When considering the results above it is also important to take into account specifics of the local economic circumstances. In particular, the analysis presented in Section 3 indicates that the Mid-Western Regional LGA has higher levels of unemployment than the state and that mining jobs pay significantly more than other jobs in the LGA.

6.1 Expected royalties

One important benefit is the generation of taxation revenue for the NSW Government. Although tax payments are normally treated as a transfer payment within a CBA model, we estimate that the Project would generate around $190.5 million (in NPV terms) in additional royalties for the NSW Government, relative to the baseline. In undiscounted terms, this is equivalent to an additional $358.3 million in government revenue over the life of the Project.

This estimate of royalties incorporates allowable deductions of $3.50 per tonne of product coal that is subjected to full cycle washing, and $0.50 per tonne of product coal that is crushed and screened, but not washed. However, the potential for further deductions related to payment of levies, insurance and other items such as bad debts and bank commissions have not been accounted for in this estimate, due to the variability in such payments and the difficulty to forecast them accurately over time. Further, these deductions are unlikely to have a large effect on the estimated royalties as they are removed from gross revenue before calculating royalties payable, not removed from royalties payable (that is, only 8.2% of deductions are removed from royalty payments).

The key inputs to this calculation over the lifetime of the Project (from 2016) in NPV terms, are presented in Table 6.2.

Table 6.2: Estimation of additional royalties ($m, 2015 prices)

Estimate	Baseline NPV	Project NPV	Additional NPV
Coal Production (Mt)	78.80	144.06	65.26
Gross mining revenue (R)	$1,857	$4,293	$2,436
Total allowable deductions for beneficiation (D1) (@ $3.50 per tonne)	$37.9	$149.8	$111.9
Total allowable deductions for beneficiation (D2) (@ $0.50 per tonne)	$20.7	$21.7	$1.0
Net disposal value (R – D1 – D2)	$1,798.3	$4,121.8	$2,323.5
Total royalties (R – D1 – D2) * 8.2%	$147.5	$338.0	$190.5

Note: NPVs have been calculated using a 7% discount rate

To provide further clarification on our royalty calculations, the process used to produce our estimate of royalties involved:

- Year-on-year estimation of the revenue to be generated from the sale of coal product over the life of the Project (from 2016) based on the price and quantity assumptions detailed in Section 5.2.1.

- Year-on-year estimation of the allowable deductions for beneficiation, due to the subjection of various proportions of product coal to a full cycle of washing or a crushing and screening process. These deductions were calculated at the rates of $3.50 and $0.50 per tonne of product coal respectively, as prescribed by the NSW Coal Mining Guidelines for Royalty Compliance[3].
- For each year of analysis the net disposal value was calculated as the difference between annual revenue and the total value of allowable deductions.
- Annual royalty payments were then calculated using the ad valorem Open Cut Royalty rate of 8.2% of the net disposal value for each year.
- The undiscounted value of royalty payments was obtained by taking the total sum of annual royalty payments. The NPV estimate was produced by taking the present value of the stream of annual royalty payments back to 2015 terms, using a 7% discount rate.

These calculations were made for both the baseline and Project case and so indicate the net increase in royalties that could be received by the NSW Government.

[3] NSW Trade and Investment (no date), *NSW Coal Mining Guidelines for Royalty Compliance*, available at: http://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/399562/royalty-and-statistics-guidelines-coal.pdf

7 Impact on broader regional economy

This chapter examines the economic impact of the Project operating to 2033 on both the broader regional economy and the NSW economy. The approach uses CGE modelling to estimate how the Project's capital investment, operational expenses and revenues are distributed across the broader economy over time.

Over the period to 2033 the Project is projected to impact the broader regional economy (i.e. the GRP) by $1.8 billion from around $2.4 billion in coal sales (in NPV terms). The total GSP impact to NSW is projected to be $2.2 billion over the same period. The Project is also projected to impact employment, with additional economy-wide employment peaking in 2018 at 214 FTEs in the broader region and 65 FTEs in the rest of NSW for a total of 278 FTEs. These results capture the direct and indirect impacts of the development (accounting for any crowding out of other activity). More detail on the impacts to the broader region and NSW are outlined in the following sections.

7.1 Analytical methodology

This study adopts a bottom up framework to determine the likely size, timing and location of the additional activity generated by the design and construction and operational phases of the Project to the region and the rest of NSW. For this, we have relied on comprehensive project data on the capital expenditure and the operational activity associated with the Project. This commercial information includes forward development and operational expenditures, production volumes and workforce requirements over the design and construction, and operational phases of the Project.

How we modelled the impacts

Two main techniques are used to measure the economic impacts of a major project, namely; IO multiplier analysis or CGE.

CGE analysis is an extension of IO analysis, in that it is based on a database that incorporates input output tables and the transactional detail between economic agents. In addition, CGE models also incorporate a system of equations and modelling parameters, based on a widely accepted body of economic theory, that model competition for resources (particularly in labour and capital markets) between economic agents and allows for economy-wide modelling impacts incorporating any “crowding-out” impacts of the development.

One central difference between the two approaches is that IO modelling generally assumes that there is an unlimited source of resources available in the economy to meet increases in demand. In contrast, CGE modelling generally assumes that the economy and sectors within the economy are competing for the use of resources. This means that increases in demand from the Project may result in effects such as increased prices in other markets and crowding out effects (rather than just increased output). In this sense, CGE modelling is likely to provide more conservative estimates of economic impacts than those provided by IO modelling.

The economy-wide impacts of the Project have been projected using the Deloitte Access Economics Regional General Equilibrium Model (DAE-RGEM). The model projects macroeconomic aggregates such as GDP, employment and wages for the Project scenario against a reference case for each of the modelling years from 2016 to 2033. More technical detail regarding CGE modelling can be found in Appendix D.

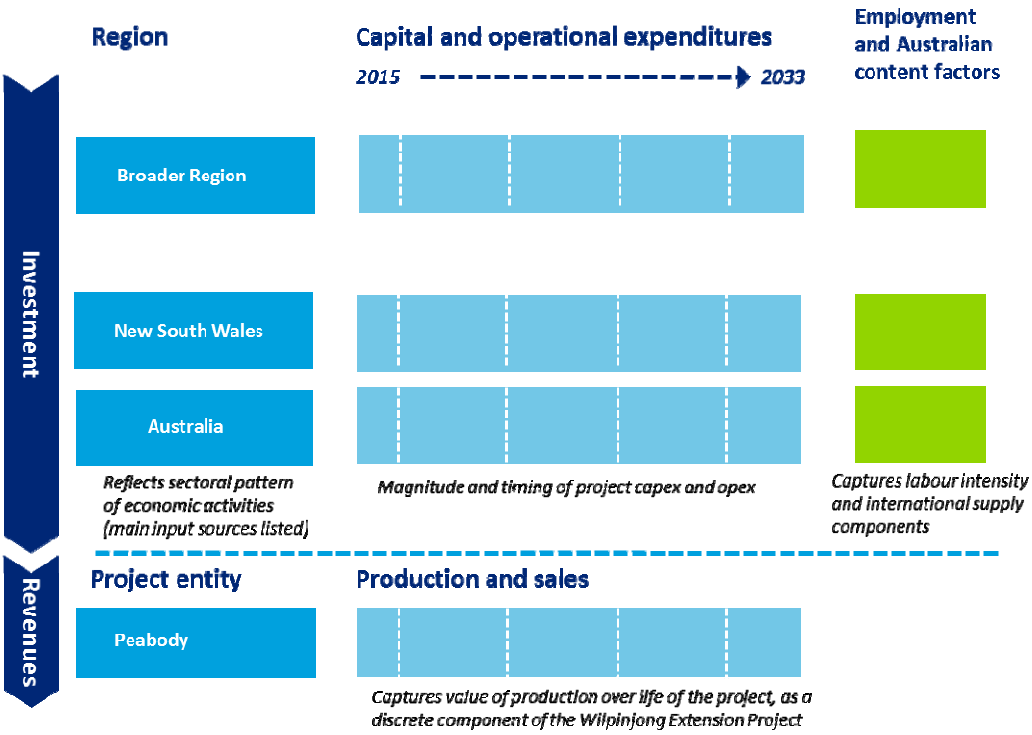
The model has been disaggregated and customised to match the attributes of the broader regional economy. To disaggregate the broader region from the rest of NSW in the model, information was used from the most recent 2011 Census on the workforce population.

Modelling has been undertaken for the period to 2033 for the following economic regions:

- **Broader regional area** — contains the Bathurst Regional, Lithgow, Mid-Western Regional, Muswellbrook, Singleton and Upper Hunter LGAs. The features of this region are described further in Section 7.2.
- **New South Wales** — includes the broader regional area and rest of the State.

The results from the economic impact analysis are presented as percentages and absolute deviations in output, employment and wages from a baseline scenario in which the Project does not exist. The broad approach to the economic impact analysis is shown in Figure 7.1. The results are provided for the broader region, rest of NSW and total NSW.

Figure 7.1: Modelling framework



Based on the capital and operational expenditures, the modelling gauges the wider economic impacts of the development and operation of the Project at two levels:

- **Direct impacts** — the economic gains associated with 'core' commercial operations, namely the coal extraction and processing, and revenues generated by the sale of coal exports from the mine.
- **Indirect, induced and crowding out impacts** — the economic gains in related upstream or downstream industries where the benefits associated with increased resource activity are typically the highest. As outlined above, the CGE modelling also captures any crowding out of activity in other sectors of the economy as a result of the Project.

Because of these two distinct elements, the results presented in this section may not necessarily be comparable to the output value and employment projections outlined in other areas of this CBA and economic impact analysis, which take a narrower financial view.

7.2 Background to the broader region

As noted above, the CGE modelling presented in this chapter presents the economic impacts of the Project for a broader region made up of the Bathurst Regional, Lithgow, Mid-Western Regional, Muswellbrook, Singleton and Upper Hunter LGAs.

The CGE modelling examines a broader region than the Mid-Western Regional LGA, which is the focus of Sections 3 and 6. The region used for CGE modelling also expands on the broader regional area examined in the Social Impact Assessment undertaken by Elliot Whiteing (2015) by also including the Bathurst Regional and Lithgow LGA. The larger geographic area used in the CGE modelling is for both technical and economic reasons. From a technical point of view, CGE models generally provide more reliable results when larger geographic regions are analysed. From an economic point of view, when analysing flow on effects from the Project it is preferable to analyse the broader region where these flow on effects are likely to occur. Accordingly, the expansion of the broader regional area relative to the Social Impact Assessment was required to ensure robust modelling results.

Some of the population characteristics of these LGAs are presented in Table 7.1.

Table 7.1: Population characteristics of the broader region

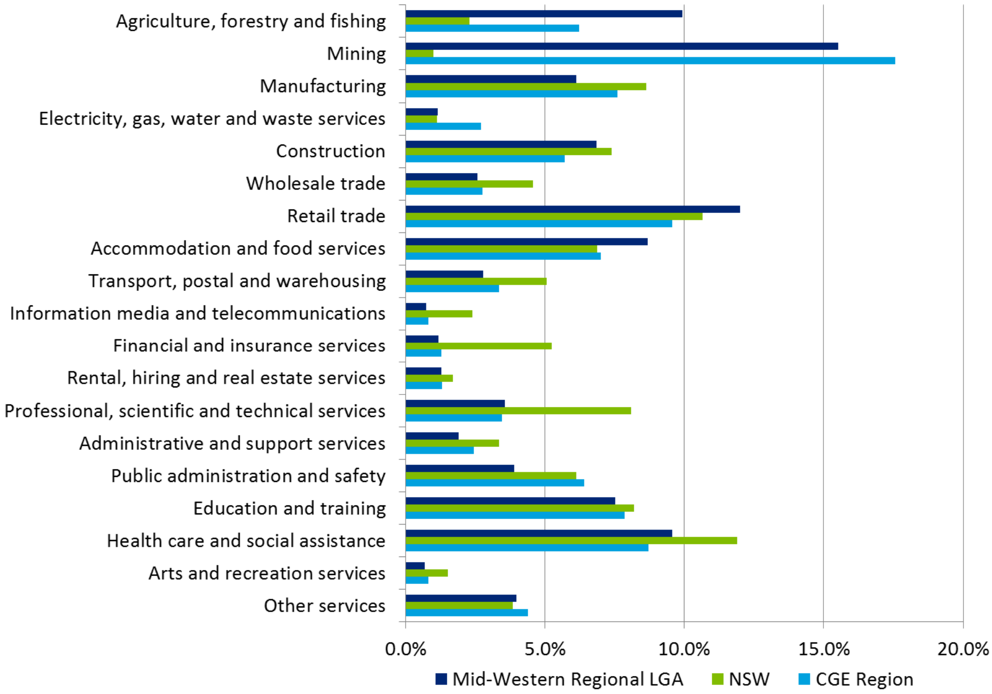
	2001	2006	2011
Population	123,658	127,124	133,858
Median Age	35	37	38
Average household size	2.6	2.5	2.5
Median household income ($/week)	745	942	1191
Median household income ($/week) - NSW	826	1039	1233

Source: ABS, 2011 Census (2012) Time Series Profile Cat. 2003.0 *All data in this table is based on enumeration for consistency purposes in Section 3, Table 3.1.**Deloitte Access Economics estimates

The data suggest that the median age of the broader region is lower than Mid-Western Regional LGA. Furthermore, we estimate the broader region to have a larger mean household size and median household income when compared to the Mid-Western Regional LGA.

From an employment by industry perspective, the broader region has a similar focus on mining, with the industry accounting for the largest share of employment. Further details on this can be found in Chart 7.1.

Chart 7.1: Industry of employment in the Mid-Western Regional LGA, the broader region and in NSW



Source: ABS 2011Census (2012)
Note: There may be some small differences to sections of the EIS due to revisions by the ABS subsequent to preparation of the EIS.

7.3 Modelling scenarios

The analysis captures Project construction and the majority of production, including ramp up in the new mine area and stabilisation of resource extraction. The sale of thermal coal has been considered to assess the output of the Project.

One of the realities of an extended analytical horizon is that projections contain an element of uncertainty. Forecasting economic growth, advances in technology, external political dimensions and other dynamic factors, which are likely to impact on commodity prices and the investment climate over the long-term, is a complex task. The key variable for the Project is export coal prices.

To understand the potential implications of different coal price trajectories for the Project, the economic impact analysis will be conducted for three modelling scenarios:

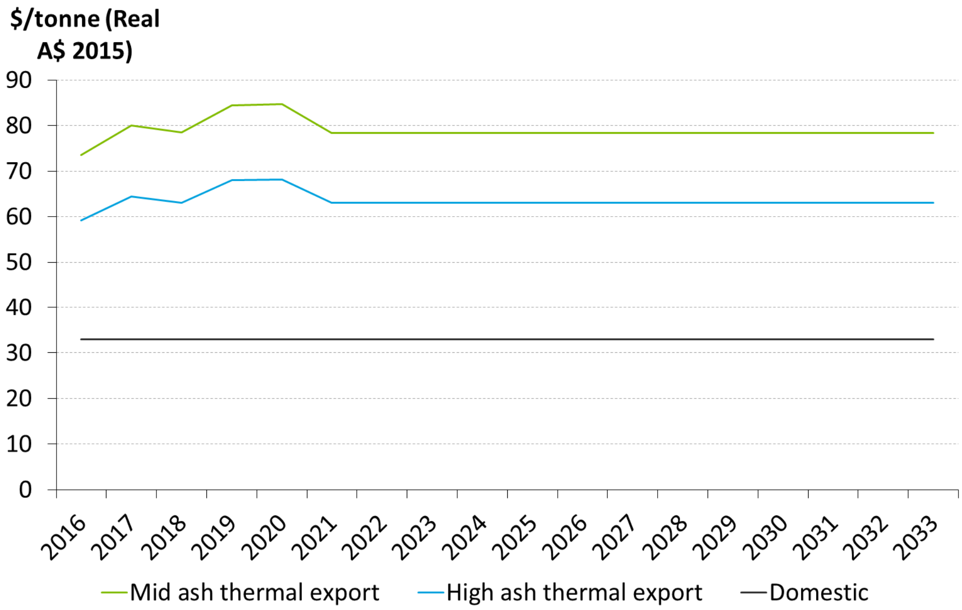
- Scenario 1 – Central estimate of coal price forecasts;
- Scenario 2 – Lower export price scenario (15% lower than the central estimates); and
- Scenario 3 – Higher export price scenario (30% higher than the central estimates).

All scenarios are based on the same assumptions around the design, construction and operation of the Project for which approval is being sought. The results for Scenario 1 are outlined in Section 7.5 while a discussion on the sensitivities is outlined in Section 5.4.

Coal price – revenue per tonne

Three series of price forecasts are required: mid ash thermal export coal, high ash thermal export coal and coal sold to domestic customers for electricity generation purposes, as set out in Chart 7.2. These have been obtained from Consensus Economics and AGL, as described in Section 5.2.1.

Chart 7.2: Coal price forecasts, 2016 to 2033



Source: Deloitte Access Economics, derived from Consensus Economics (2015); Department of Industry and Science (2015); WCPL

To gauge the economic impacts of varying levels of coal production, each scenario is compared against a baseline, or counterfactual. The baseline case sets out a story of how the economy would have evolved over time in the absence of the Project. Other planned and approved developments in proximity to the modelling area (and indeed across Australia) that are unrelated to the Project have been considered to form part of the baseline. In this respect, each scenario represents the incremental gains to the economy above and beyond what would have occurred without further capital and infrastructure investments from the construction and operation of the Project.

7.4 Phases of the Project

Two distinct phases of economic activity drive the economic impacts of the Project: construction and ongoing operations:

- **Construction phase** —involves periods where capital works are undertaken to develop the Project. This includes the creation of production capacity supported by additional infrastructure. Undiscounted incremental Project capital expenditure amounts to $107.2 million ($80.2 million discounted to today's dollars using a 7% discount rate).
- **Operational phase** —involves the operational costs incurred over the life of resource production from the Project. In this phase, capacity is brought online and incremental coal production commences at scale (e.g. processing operation, maintenance costs, water management systems, mobile equipment purchases etc.).

The construction phase will primarily occur in 2017 with further construction activity occurring in 2024. Other periods of capital investment expenditure will occur in 2022 and from 2027 to 2029 (Chart 5.6). The operational phase modelled in the economic impact analysis encompasses the period from 2017 to 2033 (inclusive). The Project will result in an additional 65.3 Mt of saleable coal. The timing of expected incremental production volumes is shown in Chart 5.2.

7.5 Economic impacts – Central case

The following discussion provides the economic impacts of the Project over the modelling period to 2033. This section outlines the projected impacts to the broader regional economy and the NSW state-wide impacts.

Economic impacts – Gross Production

Chart 7.3 shows the full temporal profile of production impacts on economy output levels in real 2015 terms as a result of the Project.

GRP is projected to increase by $268.9 million in 2017 as a result of both peak construction activity and the commencement of incremental coal production. The GRP impacts increase further in subsequent years, peaking at over $311 million in 2019 in the broader region (see Table 7.2). The total annual state-wide GSP impacts peak at around $366 million in 2019 (see Chart 7.3). The second peak in incremental gross production (GRP and GSP) in 2027 is associated with a rise in incremental coal production (Chart 5.2) due to the completion of the approved Wilpinjong Coal Mine in 2026 under the baseline, and some additional capital investment expenditure in 2027 (Chart 5.6).

In NPV terms, over the modelling period total broader regional GRP is projected to increase by just below $1.8 billion (Table 7.2). There is also an impact on the rest of the NSW economy with an increase of $371 million in NPV terms over the period to 2033. Therefore, GSP is projected to be $2.2 billion greater over the modelling period under the Project scenario.

Chart 7.3: Gross production impacts by region

Note: All values are in real 2015 terms

Source: Deloitte Access Economics

Table 7.2: Regional economic impacts (2015 $m)

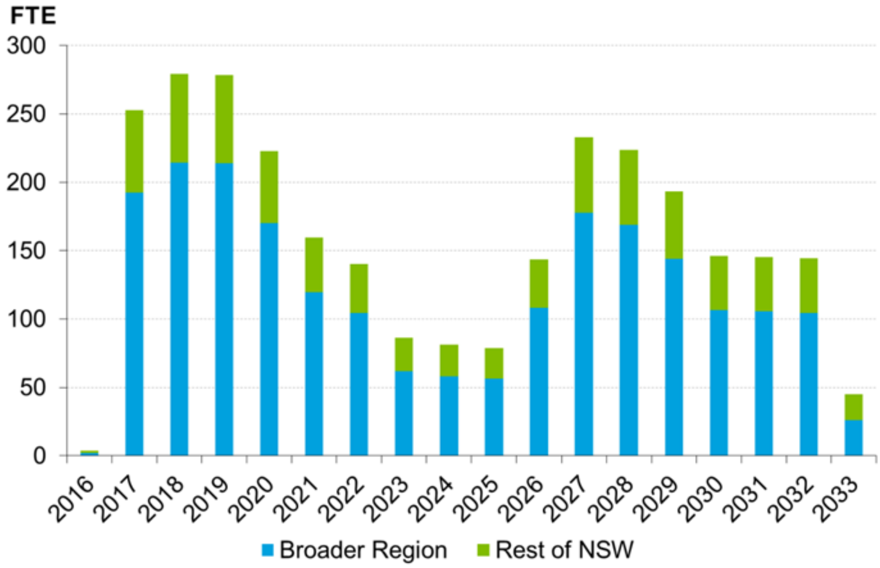
	NPV	2016	2019	2023	2027	2031
GRP/ GSP ($m 2015)						
Broader Region	$1,780.0	$2.9	$311.1	$102.0	$281.6	$181.8
Rest of NSW	$370.8	$0.8	$54.7	$33.0	$51.8	$44.9
Total NSW	$2,150.8	$3.7	$365.8	$135.0	$333.3	$226.7
Deviation from the reference case (%)						
Broader Region	0.9%	0.0%	1.7%	0.5%	1.3%	0.8%
Rest of NSW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note: All values are in real 2015 terms. The NPV discount rate is 7%.
Source: Deloitte Access Economics

Employment and Wages

The complete temporal profile of projected incremental employment impacts in the broader region and the rest of NSW is shown in Chart 7.4.

Chart 7.4: Incremental employment impacts by region



Source: Deloitte Access Economics

The broader regional employment includes the incremental effects of direct employment at the Project, flow on effects throughout the economy and any crowding out that might occur in other sectors of the economy. This means that the results reported below take into account the fact that many of those directly employed by the Project would find employment elsewhere in the economy if the Project did not go ahead. This is why the incremental employment figures below are lower than the direct figures reported in Section 4.

Total projected incremental employment in the broader region peaks in 2018, at 214 FTEs. Employment impacts in the broader region are predicted to remain positive throughout the modelling period. As the incremental indirect employment effects of the Project on the broader region are limited, it is anticipated there will also be limited incremental indirect employment effects in the Mid-Western Regional LGA.

The incremental NSW employment impact of the Project is expected to peak in 2018 at 278 FTEs (Table 7.3). Note that total NSW employment is projected to be higher in all years of the modelling period under the Project scenario.

The second peak in incremental employment in 2027 is associated with increases in incremental coal production in 2027 (Chart 5.2), due to the completion of the approved Wilpinjong Coal Mine in 2026 under the baseline, and some additional capital investment expenditure in 2027 (Chart 5.6).

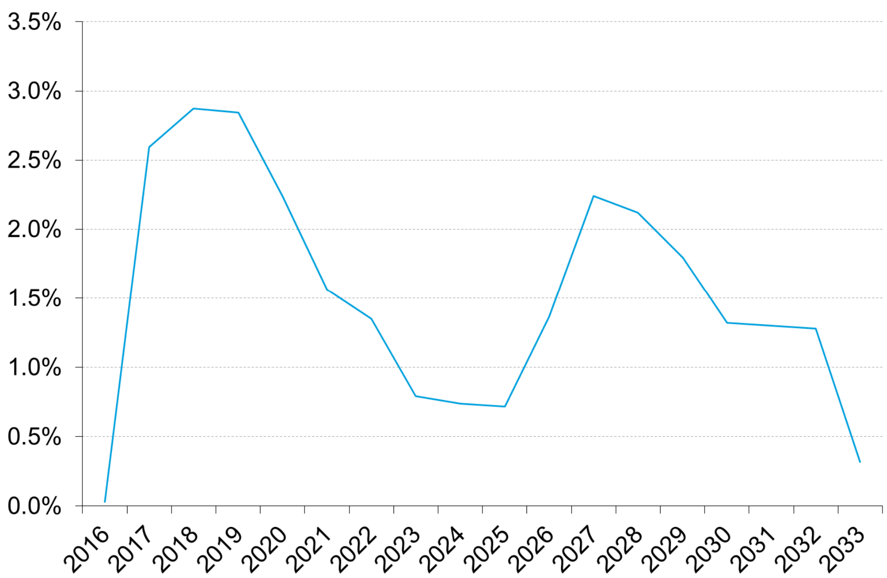
Table 7.3: Incremental employment impacts, 2016 – 2033

	2016	2019	2023	2027	2031
Employment (FTE)					
Broader Region	2.3	214.02	61.7	177.8	105.6
Rest of NSW	1.6	64.25	24.5	55.2	39.9
Total NSW	3.9	278.28	86.22	233.0	145.5
Deviations from the baseline					
Broader Region	0.0%	0.3%	0.1%	0.2%	0.1%
Rest of NSW	0.0%	0.2%	0.1%	0.2%	0.1%

Source: Deloitte Access Economics

Growth in employment associated with the Project is also accompanied by an increase in real wages (see Chart 7.5). This occurs because there is increased competition for labour resources brought about by the Project which puts upward pressure on wages in the broader region. The Project is predicted to have a negligible impact on wages in NSW as a whole.

Chart 7.5: Broader regional real wages impact

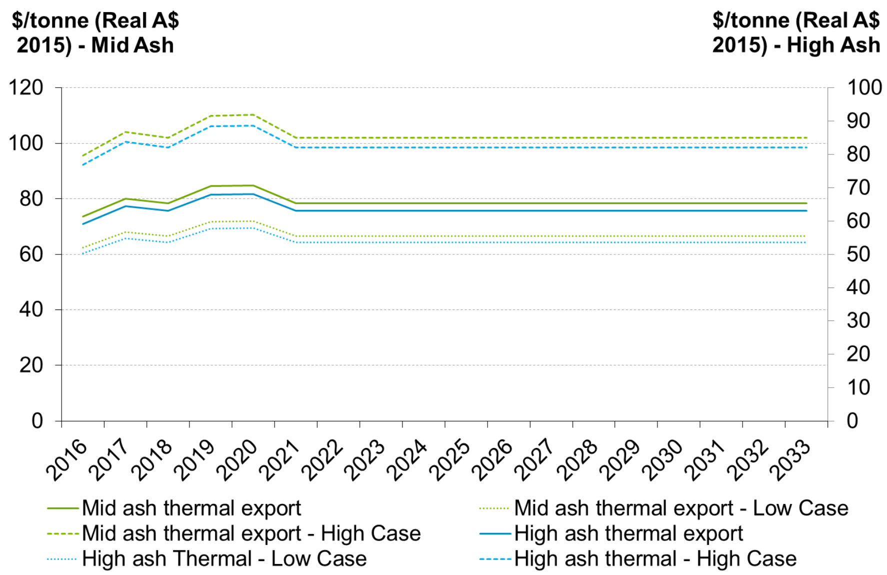


Source: Deloitte Access Economics

7.6 Sensitivities

This section outlines the economic impacts under three modelling scenarios. As outlined in Section 7.2, the additional scenarios are based on a 30% increase and a 15% decrease of export coal prices sustained over the modelling period. Chart 7.6 shows the export price variations on which the sensitivity analysis scenarios are based.

Chart 7.6: Alternative coal price scenarios



Source: Deloitte Access Economics

Table 7.4 outlines the impact of the three modelling scenarios on gross production for the broader region and rest of NSW. As expected, the projected impacts on gross production are proportionate to the coal price inputs.

The NPV of projected GRP impacts of the Project on the broader region range from $1.5 billion in the low coal price scenario to $2.3 billion in the high coal price scenario in present value terms. With the addition of impacts on the rest of the state, the impact on NSW GSP ranges from $1.8 billion to $2.7 billion.

Table 7.4: Sensitivity analysis of GRP impacts, NPV, 2016-33 ($m)

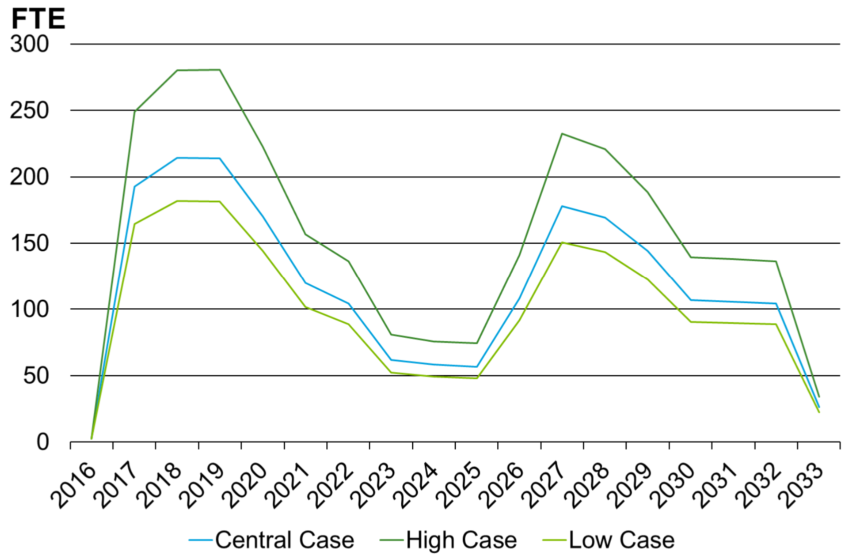
NPV	Central	Low	High
Broader Region	$1,780.0	$1,518	$2,305
Rest of NSW	$370.8	$314	$486
Total NSW	$2,150.8	$1,832	$2,791

Note: All values are in real 2015 terms. The NPV discount rate is 7%.

Source: Deloitte Access Economics

Chart 7.7 outlines the incremental employment impacts for the broader region under the three coal price scenarios.

Chart 7.7: Incremental employment impacts for the broader region, 2016 – 2033



Source: Deloitte Access Economics

7.7 Other economic impact considerations

The CGE modelling results above identify the cumulative impact of the Project on the broader regional and NSW economies. However, they do provide insight on the issues of the cumulative economic impact of the Project and on the potential economic effects of mine closure.

- **Cumulative economic impacts**

  Deloitte Access Economics estimates that the mining sector currently directly generates around $2 billion of GRP per year in the broader region out of a total of around $5 billion of GRP per year.

  The modelling results above identify the effect that the Project would have on the broader regional economy after taking into account this current level mining and industry activity. That is, the modelling accounts for the fact that the Project must compete with the other mines and industries in the broader region for inputs such as labour and machinery. This means that the economic impact estimated above provides a good indication of the effect of the Project relative to the cumulative output from the mining industry.

  In particular, the modelling results indicate that the peak deviation in GRP for the broader region is around $366 million or roughly 1.6% of total GRP. This number cannot be directly compared to current economic activity in the industry as this figure incorporates all flow on activity throughout the economy (not just activity in the mining sector).

- **Economic effects of mine closure**

  The establishment and operation of the Project would stimulate demand in the regional and NSW economy leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the mining operations would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts of cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time. However, the modelling results above provide an indication of the effects that could be experienced.

If the Project was not approved and the current operations continued as under the base case then the immediate economic effect would be to reduce current employment levels. In particular, employment at the Wilpinjong Coal Mine would gradually decline over time from an estimated 497 FTEs in 2017, to 149 FTEs in 2026, as the mine transitions to the decommissioning phase in 2027 and 2028.

The modelling results above (which show employment benefits less than these reductions) indicate that many of these workers would likely find employment elsewhere in the broader region. However, the results also indicate that this employment would likely be in lower paying jobs (this can be seen as the incremental effect on wages is greater than the incremental effect on employment).

The modelling results above also indicate that if Project was not approved then and the current operations eventually were drawn to a close then there would also be a reduction in GRP of around $1.8 billion (NPV at 7% discount rate) and a loss to the state.

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Appendix A: Checklist against guidelines

NSW Treasury (2007) NSW Government Guidelines for Economic Appraisal

Table A.1: Key issues mentioned in NSW Treasury (2007)

Draft Guidelines	Addressed	Reference
Identify Options		
"Do nothing" option	Yes	4.1
Option development	Yes	4.3
Identify Benefits		
Avoided Costs	Yes	5
Savings	Yes	5
Revenues	Yes	5
Benefits to consumers not reflected in revenue flows	Yes	5
Benefits to the broader community	Yes	5
Identify Costs		
Identify all relevant cost items	Yes	5
Stream of costs should cover full project period	Yes	5.2
Identify Qualitative Factors		
Identify costs and benefits that cannot be quantified	Yes	5
Other impacts include environmental considerations, industrial relations, social or regional impact, safety, public relations, resource availability	Yes	5
Assess Net Benefits		
Assessment of benefits in real terms	Yes	5.3
Discount at 7% rate, with 4% and 10% for sensitivity testing	Yes	5.4
Net Present Value	Yes	5.3
Net Present Value per $ of capital outlay	NA	
Benefit-Cost Ratio (BCR)	Yes	5.3
Internal Rate of Return (IRR)	NA	
Sensitivity Testing		
Projected outcomes under alternative scenarios	Yes	5.4
Emphasis given on pessimistic alternatives	Yes	5.4
Ecologically Sustainable Development		
Inter-generational equity principle	Yes	5.4
Identification of Environmental Impacts	Yes	5
Valuation of Environmental impacts	Yes	5
Sensitivity and Threshold Analyses	Yes	5.4
Use of ENVALUE	Yes	Appendix C

Note: NAs in this table reflect summary measures that were not assessed as being necessary to reach conclusions.

NSW Department of Urban Affairs and Planning (2002) Guideline for economic effects and evaluation in EIA

Table A.2: Key issues mentioned in NSW Department of Urban Affairs and Planning (2002)

Draft Guidelines	Addressed	Reference
Conduct Preliminary Assessment		
Review main elements of proposed projects, alternatives and surrounding environment	Yes	3, 4
Review information on environmental impacts of proposal	Yes	5
Determine spatial and temporal boundaries for analysis	Yes	2.5
Specify relevant community and major groups affected	Yes	6
Specify the kinds of economic values affected	Yes	5.1
Obtain preliminary estimates of likely magnitude of benefits and costs	NA	
Assessment of scale of economic effects relative to regional or local economy	Yes	7
Determine whether an economic impact assessment is required	Yes	7
Scoping the economic study		
Consider environmental impacts and economic values predicted in preliminary analysis	Yes	5
Consider time, skills and budget for analysis	NA	
Determine values to be quantified in benefit-cost analysis, sources of information and methodology	Yes	5.1
Determine extent and approach to community consultation	NA	
Identify level and extent of other economic assessments	NA	
Derive economic values and conduct efficiency analysis		
Specification of baseline scenario	Yes	4.1
Valuation of direct benefits and costs of proposal and alternatives	Yes	5
Valuation of environmental effects	Yes	5
Set up benefit-cost assessment framework	Yes	2
Summarise all economic values	Yes	5.3
Calculate NPV and other criteria specified by State Treasury	Yes	5.3
Conduct incidence analysis identifying distribution of costs and benefits	Yes	6
If required, conduct economic impact analysis to assess economy wide-effect		
Specify economic boundaries for assessment	Yes	7
Specify linkages between project and economy	Yes	7
Apply relevant economic impact assessment model	Yes	7
Estimate results, including changes in output, employment and income for sectors of the economy	Yes	7
Incorporate any results into BCA	NA	
Apply ESD principles		
Ensure predicted changes in natural resources and environment have been comprehensively valued	Yes	5
Assess risk, uncertainty and irreversible environmental impacts	Yes	5
Address intra- and inter- generational equity issues	Yes	5.4
Conduct integrated assessment of options		
Summarise results on economic efficiency	Yes	5.3
Summarise results on intra- and inter-generational equity	Yes	5.4
Document and report main findings	Yes	Entire report

Note: NAs in this table reflect tasks completed elsewhere in the EIS

NSW Government (2012), "Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals"

Table A.3: Key issues mentioned in the Guideline

Draft Guidelines	Addressed	Reference
Key features		
Scope: all first round impacts	Yes	5.1
Net public benefit or cost	Yes	5.3
Discount rate of 7% with sensitivity analysis	Yes	5.4
Appropriate timeframe	Yes	4
Risk Neutral approach	Yes	5.4
Discussion of unquantified factors	Yes	5
Stages of analysis		
Identify the Base Case	Yes	4.1
Define Project and Develop Options	Yes	4.2
Estimate the Impacts of the Project	Yes	5
Estimate the monetary value of these impacts	Yes	5.2
Estimate the Overall Net Value of the project	Yes	5.3
Test for Uncertainty and Risk	Yes	5.4
Prepare Report Including CBA Results and Qualitative Impacts	Yes	Entire report
Distribution effects	Yes	6
CBA at the regional or catchment level	Yes	6
Costs and benefits		
Revenues from mining or CSG per annum	Yes	5.2.1
Any other revenues from the land use during or after mining	Yes	5.2.2
Capital expenses	Yes	5.2.4
Exploration expenses	Yes	5.2.3
Infrastructure contributions	Yes	5.2.7, 5.2.10
Operating expenses per annum	Yes	5.2.5
Remedial costs post mining	Yes	5.2.6, 5.2.7, 5.2.8, 5.2.9
Value of rural output forgone	Yes	5.2.11
Value of residential amenity forgone	Yes	5.2.19, 5.2.23, 5.2.24
Cost of changes in infrastructure	Yes	5.2.10
Air quality	Yes	5.2.15, 5.2.16, 5.2.17
Health	Yes	5.2.27
Groundwater	Yes	5.2.12
Noise	Yes	5.2.18
Biodiversity	Yes	5.2.21, 5.2.22
Heritage	Yes	5.2.25, 5.2.26
Other economic impacts		
Increased wages for workers	Yes	7
Increased profits for suppliers to the mining sector	Yes	7
Changes in incomes in tourism or other local businesses	Yes	7

NSW Government (2015), "Guidelines for the economic assessment of mining and coal seam gas proposals"

Table A.4: Key issues mentioned in the Guideline

Draft Guidelines	Addressed	Reference
Establish the base case	Yes	4.1
Existing land use on the project site	Yes	4.1, 5.2.2
Assess interactions with projects in the surrounding area	Yes	4
Define project	Yes	4
Cost benefit analysis		
Estimate royalties payable	Yes	6.1
Estimate company income tax	Yes	6
Net producer surplus (and attribution to NSW)	Yes	5.2.1-5.2.9
Indirect benefits (and attribution to NSW)	Yes	5, 6
Indirect costs to NSW	Yes	
Aboriginal cultural heritage	Yes	5.2.25
Air quality	Yes	5.2.16, 5.2.17
Ambient noise	Yes	5.2.18
Biodiversity	Yes	5.2.21, 5.2.22
Greenhouse gas	Yes	5.2.15
Groundwater	Yes	5.2.12
Non-Aboriginal heritage	Yes	5.2.26
Surface water	Yes	5.2.13
Traffic	Yes	5.2.20
Visual amenity	Yes	5.2.19
Net present value	Yes	5.3
Sensitivity analysis	Yes	5.4
Local Effects analysis	NA	

Note: A local effects analysis has not been undertaken, rather, a more detailed analysis has been undertaken using a CGE model. The results of this analysis are reported in Section 7.

Appendix B: Valuation techniques

This appendix provides a general overview of the range of possible approaches to valuing items in a cost benefit analysis (CBA) that have been used in this report. There are a range of techniques available for valuing items in a CBA, including:

- project financials;
- market prices;
- forgone revenue;
- hedonic pricing;
- stated preference;
- travel time costs;
- defensive expenditure; and
- value of statistical life.

These techniques cover direct approaches where either financial or market information is available as well as indirect approaches where values have to be discerned from behaviour. A subset of these techniques have been applied in this report and are discussed in further detail below.

Project financials

Project financials or other information provided by a project's proponent can be used to value many of the expected inputs and outputs associated with the proposal. Minimal analysis is required to derive this data, as the values are usually stated explicitly and provided by a project's proponent. This approach is particularly useful when attempting to estimate values like the expected size of the work force, scale of operations or output produced.

However it is important to note and critique the validity of assumptions used to generate the projected values provided as the proponent has an interest in the implications of the data.

It should be noted that project financial data is sometimes chosen to serve as a "best estimate", and is therefore prospective in nature. Thus, in undertaking any critique of the information, it may be more valid to compare projected financials to other prospective data sources such as futures prices, rather than historical data.

Observable market prices

Market prices – the price of goods actually traded on the market – represent the revealed value of an object as determined by those who buy and sell it. For commoditised items (e.g. a tonne of coal), this price can be readily observed in the spot market. An idea of future price movements can also be gained through futures markets. For goods that are less commoditised (e.g. housing or land), market prices are derived by looking for comparable goods traded on the market and estimating a market price for a good. Market prices are thus best used for commodities that are regularly traded, or have comparable goods that are regularly traded.

Market prices are seen as the most reliable way to estimate the value of an item as, in the presence of a relatively efficient market, prices are empirically based; do not require the use of any theoretical assumptions; are normally free from extreme influence by any one individual or organisation, and involve actual cash transactions rather than statements of preference or policy.

An important property of market prices is that they are affected by future expectations. This means that prices can be affected by announcements or the perceived likelihood of future events happening. When calculating the impact of a project on market prices, it may be important to correct for the fact that prices may have already reacted to announcements regarding the project, and thus partially account for the expected future impact. A further implication of the forward looking nature of prices is that, if a project is likely to dramatically affect the cost of a good (e.g. wages in a local economy), it may not be appropriate to use pre-project prices to estimate the cost of such a good.

A constraint of market prices is that they necessarily reflect *effective* demand, that is to say, a person must be both willing and *able* to purchase a product for the market to reflect their valuation. Thus, if people's purchasing decisions are constrained then their valuation may not be reflected in market prices. For example, if people in an area experiencing pollution are unable to access credit to move away, the cost of pollution to such people may not be reflected in the market price of housing.

Having noted these considerations and limitations, it is still the case that a valuation on market prices is the most preferable way to value items within a CBA.

Forgone revenue or increased costs

Forgone revenue or increased cost are attempts to make a comparison between a proposal and a counterfactual, by observing the revenue that would have been earned by a particular entity (or entities) as a result of the proposal, or the increased costs faced as a result of the proposal. Both techniques require modelling scenarios with and without the proposal. Furthermore, they require explicit mention of the means by which the proposal could affect the party involved. As examples, a project could distort prices of inputs (price effects), create secondary consequences (externalities) or even compete directly with local entities (direct competition).

It should be noted that measures such as forgone revenue and increased costs are not, necessarily, themselves measures of overall costs. Forgone revenue and increased costs can sometimes represent transfers of wealth between different segments in a community and may thus overstate the impact of a project on the overall community. In this case, an advantage consideration of forgone revenue or increased costs allows for an assessment of the distributional impact of a project.

Stated preference, willingness to pay, choice modelling and similar

As opposed to revealed preference approaches which are based on prices, such as hedonic pricing, this methodology determines the maximum value assigned by an individual, that is, their willingness to pay, using a structured survey. Stated preference approaches are particularly useful for the valuation of externalities – costs or benefits which are not incorporated in market transactions, such as the environmental, cultural and social impacts of economic activity.

Stated preference valuations are undertaken using one of two techniques – contingent valuation, or choice modelling (Fujiwara & Campbell, 2011). The main difference between the two is that contingent valuation surveys generally relate to the overall valuation of a non-market good, while choice modelling surveys aim to ascertain valuations of certain characteristics of that good. When multiple attributes are considered in choice modelling, an overall valuation can also be obtained (Fujiwara & Campbell, 2011). Both contingent valuation and choice modelling surveys can take a number of different forms. These vary according to the manner in which respondents are asked to indicate their preferences.

In the case of choice modelling, each survey question asks respondents to rank, rate or choose between multiple hypothetical scenarios, including a status-quo option. These scenarios vary according to the state of different attributes, generally including non-market impacts, such as the extent of the effect on flora, fauna or water quality, and an associated level of cost to be borne by the individual which limit the effects to this level. Depending on the complexity of the scenario, a large number of questions may be required. Statistical methods are then applied to quantify the trade-offs between each characteristic, establishing estimates of willingness to pay and implicit prices for marginal changes in each attribute. Specifically, discrete choice models such as multinomial, nested or mother logit models are utilised in this analysis process.

While stated preference methods can provide useful insights on the valuations of non-market impacts, they are associated with a number of important practical considerations. In particular:

- the process of developing an appropriate questionnaire involves substantial costs;
- the scenarios posed in question sets should be realistic and reflect local circumstances; and
- an adequate sample size of data must be collected to provide statistically significant results.

Even if these methodological challenges are overcome, the computation of model parameters and the resulting willingness to pay estimates is another complex process, which requires an understanding of underlying assumptions and the issues relating to aggregation of results for the entire population.

Further details regarding these matters are outlined in the summary guide prepared by the United Kingdom Department for Transport, Local Government and the Regions (2002) and the accompanying manual (Bateman et al., 2002).

Value of statistical life, DALY, wage differential and similar

The health impacts of economic activity can be valued according to human capital or willingness to pay approaches, although the latter is most common and is considered most appropriate (Jalaludin et al, 2009 & OBPR, 2008). There are also a number of health-specific valuation concepts useful for placing values on the cost of mortality and morbidity. These include the value of statistical life, and the disability-adjusted life year.

The value of statistical life (VSL) represents an "estimate of the financial value society places on reducing the average number of deaths by one" (OBPR, 2008). As noted by the World Bank (2003), the measure is not intended to reflect the fundamental value of human life. Although the VSL is a well-established economic concept, there is a great deal of variability in estimates. According to the OBPR (2008), the most appropriate measurement technique for VSL is willingness to pay – that is "estimating how much society is willing to pay to reduce the risk of death". Using this framework, it was estimated that the VSL in an Australian context is approximately $3.5 million (OBPR, 2008).

An alternative health metric is the disability-adjusted life year (DALY). This is a measure of the burden of disease, incorporating the effects of mortality and morbidity, with a single DALY representing "one lost year of healthy life" (World Health Organisation, 2015). The inclusion of the mortality component in the DALY calculation implies that if used in a CBA, it should substitute, rather than complement VSL measures to avoid double-counting (BTRE, 2005). However, it appears that a number of practical issues constrain this transition, including a lack of data on DALY monetary valuations (Jalaludin et al., 2009).

Hedonic pricing analysis of wage differentials is another technique which has been applied to obtain valuations of health impacts. These models analyse wage differentials with the aim of ascertaining a value for risk exposure. Specifically, wages are modelled as a function of individual characteristics and job characteristics, to derive an estimate of the compensation paid for risk of fatal and nonfatal injury (World Bank, 2003). However, the accuracy of this technique relies on a number of theoretical assumptions relating to employee mobility and access to information which may not hold in practice (Jalaludin et al., 2009).

The final method used for valuing health impacts is the human capital approach (Planning NSW, 2002). This technique estimates the economic output forgone as a result of reduced productivity caused by "absenteeism, temporary or permanent disability and premature mortality" (Jalaludin et al., 2009). While this methodology is often used to value the health impacts of environmental degradation, such as pollution, the estimates are not alternative measures of the VSL (Planning NSW, 2002). However, lost earnings due to premature mortality could be considered as a minimum estimate of VSL (World Bank, 2003).

References for Appendix B

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Appendix C: Approaches to valuing specific costs and benefits

This appendix provides a general outline of the available approaches to valuing the various costs and benefits identified in the guidelines for CBA published by the NSW Government, and summarises the evidence produced by quantitative valuations. It is intended as a guide to the approach taken in the CBA and to provide views on alternative data sources.

Gross mining revenue

Gross mining revenue would be provided by the project proponent or evident in the project financials. This mining revenue would be based on the value of output, a factor of both the volume of output and the relevant coal price. Relevant coal prices can be estimated using the spot price of coal or through the price of coal futures. The volume of output is usually estimated by the project proponent themselves. It is important to note that the volume of output is selected to match the marginal cost of production with the current market price of coal.

Coal prices

Coal prices are observable market prices – Australian thermal coal was valued at $82.21 per metric ton in September 2015, measured in Australian dollars (Index Mundi, 2015). The current price of coal is observable on the spot market. The future price of coal is observable in the futures market, although that may not be necessary as efficient commodities markets should result in current prices of coal taking into account future expectations.

Mine related costs

Mining exploration costs are also data which the project proponent would have on hand. Expenditure on mining capital investment and operating costs would be detailed on project financials. Rehabilitation expenses, such as landform reconstruction and revegetation, would also be accounted for as project costs on financial statements.

Forgone agricultural revenue

Forgone agricultural revenue can be estimated based on financial information on agricultural land use prior to mine development. Open cut coal mining competes directly with agricultural land use as it removes land with agricultural potential to reach coal underneath. Furthermore, both open cut coal mining and underground coal mining can impact on the local water system and thus affect agriculture across a given water system.

The effect of a mining activity on agriculture can be assessed by first considering the productivity of the agricultural land in regions of interest. This land productivity data can then be combined with information on the area of land that is likely to be affected by mining activity to provide a decrease in agricultural activity that can be attributed to increased mining activity.

We believe that this process of estimating the effect on agricultural production from coal mining is likely to be generous. Previous analysis undertaken by Deloitte Access Economics suggests that mining operations often take place in areas of grazing, cropping and forestry which will have significantly lower productivity than average.

As there is no empirical evidence on the relationship between agricultural productivity and the noise or dust impacts of mining activity, it is difficult to quantify the extent of these externalities in monetary terms. In addition, impacts are generally:

- highly dependent on the local geology;
- often manifests as a risk, rather than an event; and
- not clearly established in scientific literature.

Therefore, any estimates of declines in agricultural productivity should be seen as indicative, included to ensure that the issue is taken into account, without being interpreted as a precise quantification of the effects of mining on agriculture.

Changes in related public expenditure

Changes in related public expenditure would be information specific to each project and would be provided by the project proponent. For example, public expenditure on water or sewerage may change, where a region is transformed from residential to mining. Further, public investment in transport or road infrastructure may change, with the possibility of increased spending on roads to facilitate movement of coal to ports in key mining areas.

This may also manifest as a potential benefit, as some mining projects may include upgrades or construction of new infrastructure. This infrastructure may be usable by the general public either during or after the operation of the mine.

Water quality

The impact of mining on water quality varies according to the form of mining activity (open cut or underground), the proximity of the mine to water sources and the properties of aquifer systems. These factors influence the way in which fracturing of hard rock, mine runoff and dust pollution can lead to a reduction in the overall quality of ground and surface water.

This section reviews the literature on the use values of water quality, given its importance for households and industry. The valuation of groundwater and surface water are considered separately.

Quality of groundwater

Groundwater refers to water that has accumulated within soil or cracks or pores in rocks, known as aquifers (Geoscience Australia, 2013a). Some mining activity has been associated with the in-flow of saline groundwater, degradation of alluvial aquifers and an overall reduction in the quantity of groundwater supplies (Department of Planning, 2005; R.W. Corkery & Co, 2009; Smith, 2009). It is important to assess the implications of these effects for other groundwater users.

Groundwater is a critical source of drinking water in various locations across Australia, particularly in Western Australia (Geoscience Australia, 2013a). The primary methods utilised to assess the value of drinking water quality are the contingent valuation and defensive expenditure approaches. As described by Koteen, Alexander and Loomis (2002:9), it is difficult to estimate household demand for water quality, 'as households cannot directly purchase water of varying quality'. Nevertheless, it is important to consider the benefits that individuals gain from the awareness that the water they receive is of high quality.

Very little research has been undertaken in Australia on the values that households assign to the quality of drinking water, with the available evidence fairly dated. The appropriateness of these findings is contingent on the relevance of the measures listed, which in turn depends on the nature of any anticipated change in water quality caused by mining activity.

There is also little evidence in an Australian context of the value of groundwater for agriculture, irrigation and other industrial uses, at different quality levels. Instead, the literature has focused on valuation of the costs that would be incurred by these commercial users of groundwater, in the instance that the groundwater supply was completely depleted (Marsden Jacob Associates, 2012). This is known as the deprival value approach, with values representing the cost of a worst case scenario where total degradation of water quality takes place.

Nevertheless, it may be possible to estimate the value of water in its existing state by observing prices in the water markets. In addition, it is important to note that the impact of a reduction in water quality on the agricultural industry is likely to be captured by estimates of forgone agricultural revenue.

In some parts of Australia, groundwater is also used for other residential purposes, such as watering gardens, as well as other public purposes such as the maintenance of parks. Given that these purposes might also be captured in the value of open space or visual amenity, they are not considered in this section.

Quality of surface water

Rivers, lakes, wetlands and other forms of surface water can also be affected by mining activity. The quality of water can be reduced as a result of runoff or dust pollution. It may also be affected as an indirect result of mining impacts on groundwater, although the interaction between groundwater and surface water varies according to topography, geology and climate (Geoscience Australia, 2013b).

The majority of Australia's water supply is derived from surface water. Therefore, changes to the quality of surface water will impact households and industry. Valuation of the impact of changes to surface water quality is subject to the same issues discussed above. However, there is substantially more evidence on the value of water quality specific to recreation at surface water sites.

Within Australian literature, stated preference approaches such as contingent valuation and choice modelling are the predominant methodologies employed. When transferring these values to a new context, it is important to consider the similarity of waterway characteristics, population characteristics, the scale of the change in quality and whether the focus is on quality improvements or maintenance of existing standards (van Bueren & Bennett, 2004).

It is likely that, in most instances, these factors will not align exactly. In those cases, the use of benefit transfer values should be seen as indicative, included to ensure that the impact of changes in water quality is taken into account, rather than as a precise estimate.

Particulate matter

The main methods of valuing the costs of air pollution are hedonic pricing, stated preference techniques or through use of a direct costing approach.

Hedonic pricing is usually measured by examining the price differential associated with distance to a project, in order to determine the cost associated with the externalities generated. It is particularly useful as it is a form of revealed preference and is very difficult to manipulate. However, hedonic pricing, if undertaken without a direct measure of air pollution (e.g. measures of particulate matter in the air), cannot disaggregate the price difference caused by a project into its components such as air pollution, noise pollution, loss of visual amenity and convenience. Furthermore, hedonic pricing relies on the fact that individuals are aware of and can appropriately value the cost of air pollution to their utility (Abelson, 2007). Therefore, hedonic pricing serves as a way to measure the aggregate impact of a variety of measures, a point that should be noted to avoid double counting costs or benefits.

Contingent valuation studies involve asking individuals regarding their willingness to pay to reduce the impact of air pollution. Similarly to hedonic pricing, this valuation methodology assumes that individuals are sufficiently aware of and can appropriately value the impact of air pollution to their utility. The life-satisfaction approach was used by Ambrey et al. (2012) to estimate the cost of air pollution from particulate matter in South East Queensland. This study yields an implicit willingness to pay of $6,000 per household for a one day decrease in the number of days pollution exceeds health guidelines in their local area.

An alternative method of measuring the impact of air pollution is to measure its medical impact on health and life expectancy of the population exposed to it. One method of valuing health and life is use of Quality Adjusted Life Years (QALY). The effects of air pollution can thus be measured in the number of QALYs lost as a result of the pollution (Coyle et al., 2003). This value can then be combined with an appropriate monetary value placed on life as determined elsewhere.

Recently, PAEHolmes published unit damage cost estimates per tonne of $PM_{2.5}$ emissions in a report for the NSW Environment Protection Authority (PAEHolmes, 2013). These estimates were developed for specific locations using the ABS Significant Urban Area structure for urban centres with more than 10,000 people. This analysis was undertaken to provide health cost estimates that take into account population-weighted exposure, for use in economic appraisals.

Cost estimates produced by this study are reported for a Significant Urban Areas in Australia. It is considered that these are the best available estimates of the cost of particulate matter for cost-benefit analysis in NSW. Although we note that, in some cases, where emission sources are located on the boundary of a Significant Urban aArea, the approach used by PAEHolmes may provide significant over or underestimates of the likely costs associated with emissions.

Beyond TSP, PM_{10} and $PM_{2.5}$, a core component of the particulate emission of any coal mining project is dust. It is created by the disturbance of particles which occurs throughout the mining process by activities such as blasting, handling and transporting. However, mine dust rarely presents a serious threat to the wider environment. In the majority of situations the dust produced is chemically inert and deposition rates tend to decrease rapidly away from the source (Environment Australia, 1998). Buffer zones have evolved to become common practice in an effort to mitigate the effect of dust, noise and vibration on surrounding agricultural lands.

Carbon pollution

The cost of carbon emissions can be estimated in a variety of ways. It is important to note that the cost of carbon is usually measured as the marginal social cost of emitting one metric ton of carbon (or one metric ton of carbon dioxide). The main methods of pricing carbon emissions are based on modelling, observed market prices and defensive expenditure.

Considering market prices, while Australia no longer enforces a carbon pricing mechanism, there are market systems in place overseas. The recent Review of the NSW Energy Savings Scheme determined the appropriate carbon price is the forecast European Union Emission Allowance Units price based on futures derivatives published by the European Energy Exchange.

Noise

Noise pollution can be measured in a variety of ways. It is important to note however, that most studies of noise pollution have looked at noise from a particular source (e.g. road traffic, rail). As annoyance varies depending on the type of noise produced and individual sensitivities, noise valuation studies usually vary by source. This difficulty is noted in the recent NSW Government draft *Guidelines for the economic assessment of mining and coal seam gas proposals* – particularly for noise levels less than 45 dB(A).

A primary means of valuing noise pollution is to use hedonic pricing methods to compare house prices based on proximity to a source of noise (e.g. highway, airport). While this methodology is useful for assessing the marginal willingness-to-pay (WTP) associated with noise costs, there is no expectation that the marginal WTP will be stable across contexts.

Thus, while hedonic pricing is very useful where applicable, it may not be appropriate to generalise the cost derived from hedonic pricing studies to a broader context.

As an alternative, contingent valuation methods can be used to assess the cost of noise pollution. The values derived for contingent valuation studies however, vary quite greatly with estimates for road traffic noise varying between $3.82 and $189.05 per decibel per household per year. The Final Report to the European Commission DG Environment recommended valuing road traffic noise at $3.82 to $61.11 per dB per household per year (Navrud, 2002).

Traffic

The costs and benefits associated with nearby traffic can be broken down into several categories. Traffic can produce several externalities, including noise pollution, air pollution and traffic congestion. Proximity to traffic however can also generate benefits due to the time and travel benefits associated with proximity to a mode of transport.

Valuations of the costs and benefits associated with traffic should also note that the costs and benefits do vary depending on mode of transport (Navrud, 2002) and time of day (Carlsson et al., 2004). Traffic can also be measured in intensity, either by frequency of occurrence or through a measure of the traffic density on a route (Ossokina and Verweij, 2011).

Valuing the net cost (or benefit) of traffic can thus be done using hedonic pricing by measuring property prices and proximity to particular modes of traffic, for example, railway lines, highways or airports (Ossokina and Verweij, 2011). However, hedonic pricing based on proximity to a transport line is problematic as it does not necessarily disaggregate the costs and benefits into noise pollution, air pollution, congestion and convenience. Without actual measurement of noise or air pollution levels, hedonic pricing studies tend to measure the net cost or benefit associated with living close to a mode of transport. This is something to be noted, to avoid double counting costs and benefits, and may not be a problem if a study is only interested in the net effect of traffic.

Transport for NSW (2013) provides a thorough guideline for values to use when assessing economic costs associated with traffic. These guidelines draw on a range of approaches such as willingness to pay, market prices and hedonic pricing.

Health

A consideration in the impact of a development, such as a coal mine, on an area is the impact of the development on the health of those that live near it. This cost is primarily borne by the residents that live near the mine. Most of this externality is likely to be picked up by measurements of other externalities, such as air pollution or through methods of valuation that aggregate across externalities such as hedonic pricing.

A study by Hendryx and Ahern (2008) identifies significant increases in a range of diseases due to coal production. According to Hendryx and Ahern (2008), living near a coal mine raises the incidence of Cardio-Pulmonary disease, diabetes, kidney disease, cancer and arthritis/osteoporosis.

However, this valuation is based on data from West Virginia and does not appear to be easily translatable into the NSW context, particularly due to potential differences in the regulatory regimes between the two locations.

Visual amenity

The term ‘visual amenity’ is not clearly defined in the literature. This review applies Brodbeck’s definition of scenic quality, being ‘the degree to which the visual aesthetics of a landscape are valued from a human point of view’ (2005). It is acknowledged that exposed spoil heaps and light emitted by mines can detract from the visual amenity of an area. In order to avoid overlap with the benefits of open space, discussed below, the valuation of visual amenity impacts could be restricted to those of properties that will have a direct view of the mining area.

The process of valuing visual amenity requires consideration of a number of factors including the visual characteristics of the site, the surrounding environment, the scale of the project and the current beneficiaries of the visual amenity aspects of the site. Hedonic pricing and stated preference techniques are the most common methods of quantifying visual amenity (Ambrey & Fleming, 2011).

In instances where local residents are the primary beneficiaries of visual amenity, hedonic pricing is the preferred method of valuing visual amenity (University of Hawaii Economic Research Organisation [UHERO], 2013). Controlling for other factors that influence property prices, such as number of bedrooms, backyard size and proximity to schools and parks, this methodology can infer a value for the price impact of the presence or quality of a view.

Hedonic pricing techniques are commonly used to estimate the value of amenity. Within Australia, this method has been used to value the amenity of river views, ocean views, national parks and urban wetlands (Ambrey & Fleming, 2011). Since the values obtained directly reflect the visual characteristics of specific sites, they cannot be applied to the CBA of mining projects. Instead, the process of analysis would have to be replicated in the mining context.

Hedonic pricing studies that have considered the impact of mining activity on property prices in Australia have tended to place a focus on valuing the impact of pollution. For example, Neelawala, Wilson & Athukorala (2012) assessed the impact of mining- and smelting-related lead pollution on residential house prices. This highlights the difficulties associated with isolating the visual element of amenity from other aspects such as the level of noise or dust pollution.

Alternatively, stated preference surveys can be used to obtain estimates of the value of visual amenity. This methodology is most relevant when the view of the site is primarily enjoyed by visitors to an area (UHERO, 2013). While it might be possible to pose questions in a manner which will help provide a direct estimate of the value of the visual aspect of amenity, it should be noted that there may remain a difficulty in distinguishing the value of visual amenity from the value of biodiversity or conservation, in the case of natural environments. In addition, care should be taken to ensure against double-counting, given the visual amenity benefits of open space, discussed below.

Overall, the difficulties associated with obtaining quantitative estimates of the value of amenity are acknowledged by the NSW Government. It is noted in the 2012 Guidelines that these impacts may have to be considered qualitatively in a CBA. In that case, the likely size of impacts on visual amenity should be discussed relative to the overall net public benefit of the project.

Quality of open space

Where a proposed mining development or expansion is intended to impede on open space, it is necessary to account for the loss of benefits derived by individuals who use that space. The two main ways in which individuals benefit from open space are through the visual amenity of the space and the activities that take place in the area (McConnell & Walls, 2005).

The main methods used to value the quality of open space are hedonic pricing and stated preference techniques. After reviewing the literature on the topic, McConnell and Walls note that there is substantial variation in the estimated value of open space as a result of differences in location, the type of space, the services provided by the space and the methodology utilised by the study (2005).

It is recommended that values for the quality of open space be ascertained by considering the value of the activities that take place in potential areas of impact. In some cases, this value will be captured in measurements of forgone agricultural revenue, or the value of recreational activities that take place at water sites.

Rural amenity and culture

The development or expansion of a mine may also have negative social impacts through the reduction of rural amenity and culture. The noise, light and dust pollution generated by mining activity can alter the overall rural amenity of the surrounding area by establishing an industrial ambience. Where this change causes people to leave the area, the remaining residents may experience a loss of their sense of community.

Stated preference techniques are the main method used to value rural amenity and culture.

Bennett, van Bueren and Whitten (2004) present the results of two choice modelling studies investigating household willingness to pay to maintain rural communities, within the context of environmental protection strategies.

The first study considered the value of retaining farm populations in the Murrumbidgee River Floodplain, given different wetland protection strategies. Survey respondents from Wagga Wagga, Griffith, Canberra and Adelaide were told that implementation of these strategies might cause farmers to leave the floodplain region. The responses indicated that, on average, households were willing to pay a one-off sum of $5.73 to prevent a farmer from leaving. The 95% confidence interval for this estimate was $4.21-$7.35. It was found that this valuation did not vary significantly according to the different locations.

The second study undertook three different surveys. The first was framed to ascertain values at a national level, while the two others referred to case studies of the Great Southern region in Western Australia and the Fitzroy Basin region in Queensland. The national survey was distributed to samples of households from Albany, Rockhampton and the general population. The Great Southern survey was distributed to another sample of households in Albany, while the Fitzroy Basin survey was issued to a sample of households in Rockhampton.

Estimates of household willingness to pay to prevent rural populations from declining were ascertained from the responses in each survey-sample combination. These values were measured in terms of an annual payment to be made over a 20 year period, in order to prevent 10 people from leaving a rural community. The results are summarised in Table C.1 below.

Table C.1: Willingness to pay to maintain rural communities

Survey	Sample	Annual household cost of 10 people leaving rural communities
National	National	$0.09
	Albany	$0.11
	Rockhampton	$0.06
Great Southern	Albany	$0.56
Fitzroy Basin	Rockhampton	$2.24

Source: Bennett, van Bueren & Whitten (2004)

It is evident that the benefit of maintaining rural communities varies according to the context of the analysis, with regional-based surveys generating higher willingness to pay values. This is likely to be reflective of framing or scoping effects (Bennett, van Bueren & Whitten, 2004). In addition, it is plausible that these values underestimate the value of rural culture in the context of mining, given that individuals might be more accepting of costs to the community as a result of environmental protection requirements than they are for mining developments or expansions.

A choice modelling survey was also undertaken by Ivanova et al. (2007) to assess the social effects of coal mining in the Bowen Basin in Queensland. The authors found that while residents of Blackwater were not largely concerned by changes in the size of the population, a 1% increase in the ‘proportion of jobs held by people who don’t live in the town’ was equivalent to a reduction in welfare of $41.88 per household.

The importance of rural amenity and culture in the Hunter region was identified in a choice modelling survey undertaken by Gillespie and Bennett (2012). A sample of households in NSW were distributed an online questionnaire about how they valued different impacts of the Warkworth Mine. From the 2,354 responses, the authors identified that, on average, a household was willing to pay $33.32 to prevent one rural family from being displaced from the community. The 95% confidence estimate for this estimate was $29.31-$37.72. Although of relevance for the coal mining industry, criticisms have been made of the methodology employed in this study in decisions by the Land and Environment Court. This means that Bennett, van Bueren and Whitten (2004) is likely the most relevant study in this area.

Heritage – Aboriginal

The use values of heritage sites are derived primarily from the value associated with visiting such sites. However, the value associated with such visitation often cannot be measured through a market price and thus relies on stated preference data. As a consequence, it is difficult in practice to separate the use and non-use values associated with a heritage site. Furthermore, the value of a particular heritage site will vary depending on the demographics of the community surveyed.

For example, in a study measuring the value of protecting an additional 1% of Aboriginal heritage sites in Central Queensland, the willingness to pay of various communities was determined as per Table C.2.

Table C.2: Willingness to pay for protection of Aboriginal heritage sites

Community	Rockhampton Indigenous Community	Rockhampton General Community	Brisbane General Community
Willingness to pay for protection of further 1% of Aboriginal heritage sites (2003 Dollars)	3.22	-2.08	-1.78

Source: Rolfe and Windle (2003)

It is important to note that the Indigenous community and the general population appear to value Aboriginal heritage sites very differently. Thus the assessment of the value of Aboriginal heritage sites necessarily presents issues of equity that involve balancing the interests of different groups in the community. These results are also quite different from those in a study by Gillespie Economics (2009). As a result, it is likely that the most appropriate treatment of Aboriginal heritage in a CBA is through qualitative analysis.

Heritage – Historical

There is also an extensive literature valuing heritage sites that are residential buildings, commercial buildings and tourist places (Allens Consulting Group [Allens], 2005). Results from choice modelling studies indicate that the average willingness to pay for the protection of additional places from loss is estimated to be $5.53 per person each year for every 1000 places protected (Allens, 2005). This is equivalent to an annual willingness to pay of $0.007 per person per site protected, in 2013 dollars.

As mentioned in Appendix B, there are uncertainties involved with aggregating these individual valuations beyond the choice modelling survey sample. Table C.3 illustrates the variation in valuations according to three different levels of aggregation.

Table C.3: Variations in the value of protecting one local heritage site ($2014)

Aggregation level	Annual value of protecting one site ($m)	NPV of protecting one site in perpetuity ($m)
All residents in the Hunter and Central Coast region	0.01	0.09
All residents in NSW	0.05	0.67
All residents in Australia	0.15	2.14

It should be noted that the Productivity Commission's Inquiry into the Conservation of Australia's Historic Heritage Places (2006:145) found that these values are of little relevance for individual sites, due to the difficulty in interpreting these values and applying them in different contexts. As a result, it is likely that it is most appropriate treatment of historical heritage in a CBA is through qualitative analysis.

Biodiversity and conservation

The non-use valuation of ecological systems requires the use of stated-preference valuations, the most common of which would be contingent valuation studies. It should be noted that while such studies may not produce consistent measures of values (Dutton et al., 2010), they are a useful way to measure non-use values of an ecological site. It should be noted that non-use valuations of ecological systems often do not disaggregate value into the components of an ecosystem. Thus the valuation of a water system, ecological habitat and the biodiversity supported by it will usually be lumped together in such a valuation.

Furthermore, to ensure that the items being valued can be understood by the general population, abstract properties of ecosystems such as clean water or an absence of pollutants are usually translated into more meaningful indicators such as the number of individuals of species saved (MacDonald et al., 2011).

By virtue of the contingent valuation methodology, it may not always be possible to separate non-use values from the declared valuations in a survey. People may implicitly value an ecological site due to a future use (e.g. visiting it in the future). Although surveys may attempt to disaggregate a declared value based on motivation (Subade, 2005), not all of them do so. This is important to note to avoid double counting when summing values.

It is also important to note that the per person valuation of an ecological system is heavily dependent on the community being surveyed. Communities geographically closer to an ecosystem tend to value that ecosystem more highly (Kumar, 2010). It is therefore important to discount per person values from surveys taken of communities close to a particular ecosystem when attempting to generalise the value of an ecosystem (Bennett et al., 2007).

Lastly, an alternative means of valuing biodiversity is through the NSW Office of Environment and Heritage's BioBanking scheme. The valuations within that scheme rely on a fixed formula, as detailed in the Biobanking Assessment Methodology (NSW Department of Environment and Climate Change, 2008). A review of the BioBanking scheme found that credits were sold at a value between $2,500 and $9,500 per credit (NSW Office of Environment and Heritage, 2012). Assuming that the Office of Environment and Heritage has represented the preferences of the community in the Assessment Methodology, any damage to species or ecosystems can be offset through the program.

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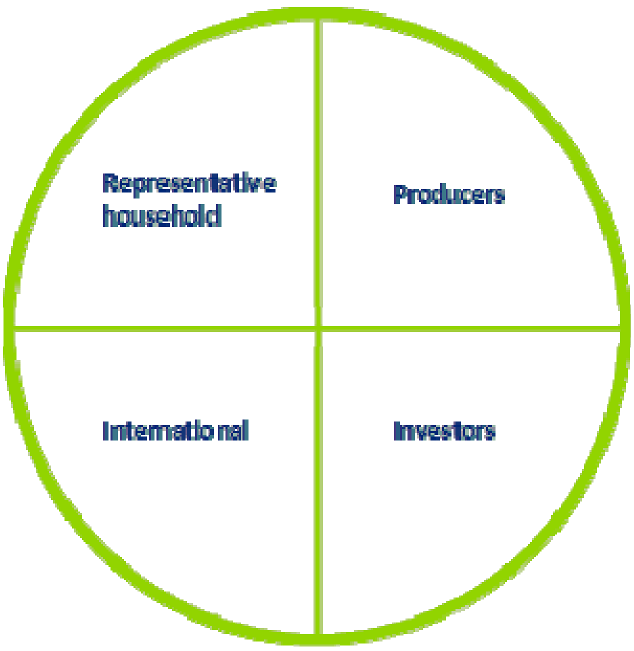
Appendix D: Computable general equilibrium modelling

The Deloitte Access Economics – Regional General Equilibrium Model (DAE-RGEM) is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as gross domestic product, employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various components of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works.

Figure D.1 shows the key components of the model for an individual region. The components include a representative household, producers, investors and international (or linkages with the other regions in the model, including other Australian States and foreign regions). Below is a description of each component of the model and key linkages between components. Additional technical detail is also provided.

Figure D.1: Key components of DAE-RGEM



DAE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas (C-D) utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a C-D utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a constant elasticity of substitution production function.
- Producers are cost minimisers, and in doing so, choose between domestic, imported and interstate intermediate inputs via a CRESH production function.
- The model contains a more detailed treatment of the electricity sector that is based on the 'technology bundle' approach for general equilibrium modelling developed by ABARE (1996).
- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply.
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for Australia, aggregate investment in each Australian sub-region is determined by an Australian investor based on: Australian investment and rates of return in a given sub-region compared with the national rate of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).

- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But, in relative terms, imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.
- The model accounts for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded, at a value equal to the carbon tax avoided, where a region's emissions fall below or exceed their quota.

The representative household

Each region in the model has a so-called representative household that receives and spends all income. The representative household allocates income across three different expenditure areas: private household consumption; government consumption; and savings.

Going clockwise around Figure D.1, the representative household interacts with producers in two ways. First, by allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives all income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as inputs into production along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

The representative household's relationship with investors is through the supply of investable funds – savings. The relationship between the representative household and the international sector is twofold. Firstly, importers compete with domestic producers in consumption markets. Secondly, other regions in the model can lend (borrow) money from each other.

Some detail:

- The representative household allocates income across three different expenditure areas – private household consumption; government consumption; and savings – to maximise a C-D utility function.
- Private household consumption on composite goods is determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. Private household consumption on composite goods from different sources is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a C-D utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of generating capital.

Producers

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector or the steel manufacturing sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers interact with international markets in two main ways. Firstly, they compete with producers in overseas regions for export markets, as well as in their own region. Secondly, they use inputs from overseas in their production.

Some detail:

- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. As mentioned above, the exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply (is assumed to be 0.2). This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as DAE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and any changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

Investors

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destinations based on two factors: current economic growth and rates of return in a given region compared with global rates of return.

Some detail:

- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

International

Each of the components outlined above operate simultaneously in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions must be met such as global exports and global imports are the same and that global debt repayments equals global debt receipts each year.

References for Appendix D

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