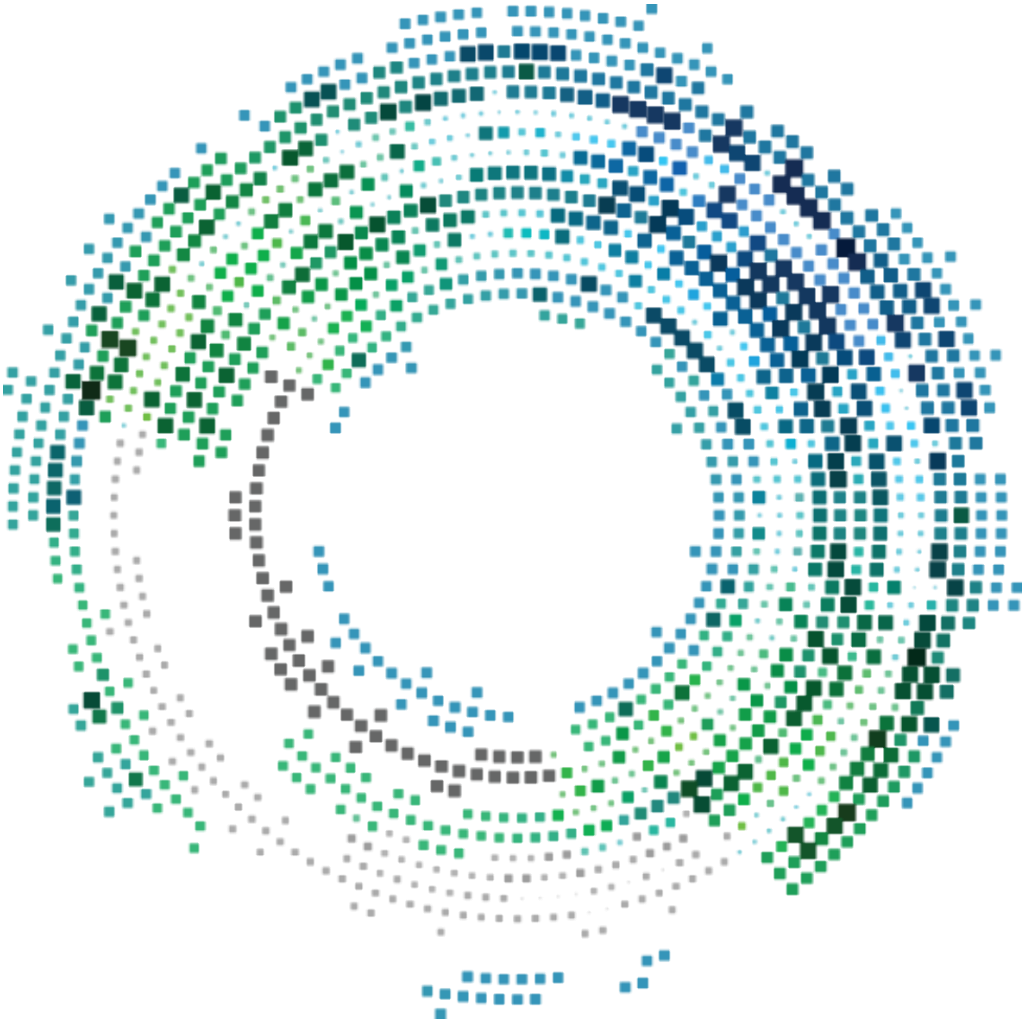
MALABAR COAL

MAXWELL PROJECT

APPENDIX M

Economic Assessment

Deloitte.



Economic assessment of the Maxwell Project

Malabar Coal Limited

2019

Deloitte Access Economics

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Abbreviations

ABS	Australian Bureau of Statistics
AUD	Australian dollar
CHPP	Coal Handling and Preparation Plant
CBA	Cost Benefit Analysis
CGE	Computable General Equilibrium
CIC	Critical Industry Cluster
CL	Coal Lease
CO2-e	Carbon dioxide equivalent
DAE-RGEM	Deloitte Access Economics Regional General Equilibrium Model
dB	decibels
DIIS	Department of Industry, Innovation and Science (Commonwealth)
EIS	Environmental Impact Statement
EL	Exploration Lease
EP&A Act	*Environmental Planning and Assessment Act 1979 (NSW)*
FOB	Free On Board
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GRP	Gross Regional Product
GSP	Gross State Product
GVA	Gross Value Added
ha	hectares
IO	Input-Output
km	kilometres
kV	kilovolt
LEA	Local effects analysis
LGA	Local Government Area
Locality	Upper Hunter SA3 as shown on Figure 5.1
m	metres
mm	millimetres
ML	Mining Lease
Mt	million tonnes
Mtpa	million tonnes per annum
NEFBCGS	New England Fold Belt Coast Groundwater Source
NPV	Net Present Value
NSW	New South Wales
PM	Particulate Matter

$PM_{2.5}$	Fine particles smaller than 2.5 micrometres
ROM	Run-of-Mine
SA3	Statistical Area 3
SEARs	Secretary's Environmental Assessment Requirements
SUA	Significant Urban Area
the NSW Government Guidelines	NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals*
US EPA	US Environmental Protection Agency

Definitions

Cumulative impacts	Cumulative impacts can occur where there are multiple projects in a given region and the impact of the projects taken together is greater than the sum of the impacts of each undertaken individually. One example of cumulative impacts is if there are thresholds above which impacts cannot be meaningfully 'reversed' or impacts significantly intensify (e.g. the extinction of a threatened species population).
Locality	For the purpose of the cost benefit analysis and the local effects analysis, the Locality for the Maxwell Project is defined as the Upper Hunter Statistical Area 3 (SA3). This SA3 includes the Muswellbrook and Upper Hunter Shire Councils.
Net Present Value	The net present value, or NPV, is the difference between cash inflows and outflows in present terms. The conversion to present terms is done by applying a discount rate to future cash flows, a rate which recognises that money in the present is worth more than the same amount in the future due to inflation and to earnings from alternative investments.
Net producer surplus	The net producer surplus of a project is the economic rent attributable to owners of the project (i.e. the shareholders). This is equivalent to the owner's share of the producer gain, as a return for their investment, excluding all opportunity costs of inputs and the economic benefits to all other parties. The net producer surplus is equal to revenue less costs, taxes and royalties.
Net public infrastructure costs	Net public infrastructure costs are those costs borne by government (local, state and Commonwealth) for providing public infrastructure.
Opportunity cost of land	The opportunity cost of land encompasses its value of future output, housing and lifestyle uses. In the case where a proponent purchases land, the opportunity cost is equivalent to the forgone revenue less costs of the existing land use as estimated when defining the base case.
Payment to existing landholders	In the context of a mining project, the payment to existing landholders is the purchase cost or access fee made to existing landholders to undertake the mining activities.
Reservation wage	The reservation wage is the minimum wage a worker has to be paid to work in a particular industry. The figures in this report are net of taxes and superannuation. In view of the hours of work and working conditions, there is a reasonable possibility that workers' reservation wages in mining are higher than in other industries, and take into account hours of work and working conditions.
Statistical Area	Statistical Areas are defined by the Australian Bureau of Statistics as part of the Australian Statistical Geography Standard. SA3s have been constructed to represent functional areas of regions and are therefore a good basis for analysing local effects from mining and coal seam gas projects.

Executive summary

Deloitte Access Economics has been commissioned to undertake an economic assessment of Malabar Coal Limited's (Malabar) proposed Maxwell Project (referred to as the Project Case, or the Project). This report is prepared solely for the use of Malabar and its contractor Resource Strategies Pty Ltd pursuant to its contract. The economic assessment comprises a cost benefit analysis (CBA) and a local effects analysis (LEA) in line with the *NSW Government Guidelines for the economic assessment of mining and coal seam gas proposals* ('the NSW Government Guidelines'). This report has been prepared for the purpose of addressing the Secretary's Environmental Assessment Requirements (SEARs) for the Project.

The Locality is defined as the Upper Hunter Statistical Area 3 and includes the Muswellbrook and Upper Hunter local government areas.

Key findings

- The Project is estimated to increase Gross Regional Product (GRP) in the Locality by $3.10 billion and increase Gross State Product in the rest of New South Wales by $0.23 billion respectively, both in net present value (NPV) terms.
- Incremental employment, including direct Project employment and flow-on employment effects (including any crowding out that might occur in other sectors) is estimated to average 894 full time equivalents (FTE) a year and peak at 1,439 FTE in the Locality in 2039.
- Assessment of costs and benefits indicates that the Project is expected to generate net benefits of $1,010 million to New South Wales (NSW) over its life, assuming a 7% discount rate.
- The net benefits to NSW excludes some costs and benefits that could not be valued. As recommended under the NSW Government Guidelines, qualitative analysis was undertaken for these items, including impacts on visual amenity, Aboriginal and non-Aboriginal heritage.
- In all sensitivity analyses the incremental net benefits of the Project to NSW exceed the costs.
- The Project is estimated to directly employ an average of 42 people from the Locality during the establishment phase and 121 people from the Locality during ongoing operations, measured in FTE, incremental to the Base Case.
- Local suppliers in the Muswellbrook and Upper Hunter LGAs are expected to receive $2 million a year during the establishment phase and $43 million a year during ongoing operations from ongoing non-labour expenditures.

About the Project

In February 2018, Malabar Coal Limited (Malabar) formally acquired Exploration Licence (EL) 5460 and existing infrastructure within Coal Lease (CL) 229, Mining Lease (ML) 1531 and CL 395 (now known as the Maxwell Infrastructure). These tenures are wholly-owned by subsidiaries of Malabar, an Australian unlisted public company.

The Project involves the development of a new underground coal mine within EL 5460. It would also include the use of the substantial existing Maxwell Infrastructure, along with the development of some new infrastructure. The Project would facilitate the underground mining, process and sale of run-of-mine (ROM) coal from EL 5460. The Project is anticipated to recover approximately 148 million tonnes (Mt) of ROM coal over a 26 year period.

The Project is in the Upper Hunter Valley of NSW, east-southeast of Denman and south-southwest of Muswellbrook. EL 5460 encompasses two local government areas: the Project is located wholly within the Muswellbrook Local Government Area (LGA), while an area to the east lies within the Singleton LGA.

Net benefit to NSW

The cost benefit analysis (CBA) estimates the direct and indirect impacts of the Project on the NSW community. The CBA compares the Project Case to a Base Case, which involves rehabilitation and maintenance of the area referred to as Maxwell Infrastructure and continuing agricultural activities on Malabar-owned properties. The net economic value of the incremental costs and benefits of the Project are estimated relative to the Base Case. These costs and benefits are estimated using information provided by Malabar and the findings of the Environmental Impact Statement (EIS).

The items considered in the CBA are listed in Table i. These items have been drawn from the NSW Treasury (2017) *Government Guidelines for Economic Appraisal* and the NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals* which attributes costs and benefits of a project to members of a specified community. From these components, the share of the net benefits that accrue to the NSW community are then aggregated.

Table i: Benefit and cost items for the CBA

Item	Benefit components	Cost components
Net producer surplus	Gross mining revenue Residual value of capital Residual value of land	Operating costs Capital costs Rehabilitation costs Environmental mitigation costs Transport management costs Local contributions Taxes (Federal, state & local) Royalties
Royalties	Royalties payable to NSW Government	
Company income tax	Company income tax payable to the Australian Government	
Local government rates	Council rates payable to NSW local governments	
Economic benefit to existing landholders	Payments to existing landholders	Opportunity cost of land Potential reduction in agricultural production
Economic benefit to workers	Wages paid to workers	Reservation (minimum) wage for workers in the mining sector
Economic benefit to suppliers	Revenue paid to suppliers	Cost of supplying goods and services
Net environmental, social & transport-related costs		Air quality Greenhouse gas emissions Traffic and transport Ambient noise Biodiversity Water Aboriginal heritage* Non-Aboriginal heritage* Subsidence* Visual amenity*
Net public infrastructure costs	Local contributions	Incremental costs for government associated with provision of public infrastructure, net of payments made by Malabar.

Note: * These items have been considered qualitatively.

Assessment of these costs and benefits indicates that the Project is expected to generate net benefits of $1,010 million in NPV terms to NSW over its life, assuming a 7% discount rate. This net benefit is comprised of:

- Net producer surplus attributable to NSW of $524 million
- Royalties payable to the NSW Government of $342 million
- Company income tax attributable to NSW of $168 million
- Economic cost to existing landholders (Malabar) of $0.4 million associated with foregone revenue from a potential reduction in grazing activity
- Environmental, social and transport costs to NSW valued at $24 million.

Within the EIS, the Project was found to have minimal impacts to existing landholders. Current land use within the Project Area consists primarily of previous mining areas and mining infrastructure associated with the former Drayton Mine (now the Maxwell Infrastructure) undergoing rehabilitation, and areas for cattle grazing and small areas of opportunistic fodder cropping (under favourable conditions). For the operation of the Project, a relatively small net area of agricultural land owned by Malabar and hence production will be required for surface infrastructure for the life of the Project and for biodiversity offsets *in-perpetuity*.

The Agricultural Impact Statement undertaken for the Project concludes that changes to existing land management practices could be used to offset any potential short-term agricultural productivity loss, improve overall land condition and improve agricultural productivity in the long-term. In the absence of any changes in land management practices, the Agricultural Impact Statement estimates a conservative upper range for potential reductions in agricultural income of approximately $44,286 per annum.

For the purposes of the CBA, it is assumed that local suppliers will earn similar margins relative to what they receive under the Base Case such that there are no additional benefits to suppliers in NSW. This is a conservative estimate given that suppliers might otherwise be affected by a decline in mining activity in the region. Similarly, it is also conservatively assumed that, on average, workers employed by the Project would not receive a wage premium. This assumes that workers will receive a net wage consistent with market rates.

It is also assumed that there are no additional public infrastructure costs under the Project Case as any public infrastructure costs induced by Project will be covered by a Voluntary Planning Agreement with the Muswellbrook Shire Council.

The net benefits to NSW do not include some costs and benefits that could not be valued. As recommended under the NSW Government Guidelines, qualitative analysis was undertaken for these items, including impacts on visual amenity, Aboriginal and non-Aboriginal heritage.

These impacts that are considered qualitatively would need to generate costs of $105 million per year (in real terms) for NSW over the mining life of the Project from 2021 to 2046 in order to fully offset its net benefits. This is equivalent to undiscounted costs of $2,720 million over the period and is considered to be unlikely given the evidence regarding the nature and scale of these impacts.

The CBA results rely on a number of assumptions and valuations. Consequently, the sensitivity of the results to a number of parameters were analysed, including variation in the discount rate, export coal price forecasts, royalty and tax payments and carbon prices. In all scenarios, the incremental net benefits of the Project to NSW exceed the costs. For example, in considering the potential for significantly lower coal prices over the operating period (that is, a sustained decrease in export coal price forecasts by 25%) the net economic benefits of the Project to NSW are estimated at $1,010 million (Table ii).

Table ii: Net benefit to NSW community

Item	Value (NPV $m)
Incremental benefits to NSW	$1,034
Incremental costs to NSW	($24)
Overall net benefit of Project for NSW community	$1,010

Source: Deloitte Access Economics calculations

Effects on local community

The LEA estimates the social and economic impacts of the Project to the communities located near the Project Area. The Locality is defined as the Upper Hunter Statistical Area 3 (SA3) and includes the Muswellbrook and Upper Hunter LGAs. The results of the LEA are complementary to the CBA and translate effects to NSW to those relevant to communities located near the Project area.

Local employment and income effects

The Project is estimated to directly employ an average of 42 people from the Locality during the establishment phase and 121 people from the Locality during ongoing operations, measured in full time equivalents (FTE), incremental to the Base Case. The local share of employment has been estimated by Malabar at around 36% in the establishment phase and 46% in the operations phase.

The net local employment effect is estimated as the additional employment income from the Project in excess of average wages in the Locality. This is calculated to be between $3 million to $8 million per year over the life of the Project.

Other local industry effects

Beyond labour effects, the Project will generate ongoing additional expenditure on other non-labour inputs, such as mining consumables, equipment spares, fuel and professional services, a share of which will directly contribute to the local economy. The Locality is expected to benefit from $2 million a year during the establishment phase and $43 million a year during ongoing operations from ongoing non-labour expenditures.

The Project is likely to have a limited impact on existing land uses, tourism and business travel.

Considering that the Project employment effects are small relative to the labour force in the Locality, there are not anticipated to be any short run adjustments in the cost of living for local residents.

Environmental and social changes in community

With the exception of greenhouse gas emissions, most of the environmental and social impacts evaluated in the CBA will accrue to the Locality. These include impacts on air quality, noise, traffic and transport and visual amenity. The most notable local costs are in terms of traffic and transport impacts in the Locality which is conservatively valued at $208,000 on average per year during the establishment phase and $243,000 on average per year during ongoing operations.

State-wide economic impacts

Labour and non-labour expenditure is expected to have flow-on impacts for the local economy. These effects are estimated using computable general equilibrium (CGE) modelling. A CGE model represents the dynamic relationship between economic agents and illustrates how changes in one part of the economy (such as the production of more coal) have flow-on impacts for other parts (such as effects on employment, income and exports). These impacts were estimated using Deloitte Access Economics Regional General Equilibrium Model (DAE-RGEM).

The Project is estimated to increase Gross Regional Product (GRP) in the Locality by $3.10 billion and increase Gross State Product in the rest of New South Wales by $0.23 billion respectively, both expressed in NPV terms. Over the life of the Project, the increase in GRP in the Locality averages $0.29 billion annually, and totals $8.21 billion in undiscounted terms. Incremental employment, including direct Project employment and flow-on employment effects (including any crowding out that might occur in other economic sectors) is estimated to average 894 FTE a year and peak at 1,439 FTE in 2039 in the Locality.

1 Introduction

Deloitte Access Economics has been commissioned to undertake an economic assessment of Malabar Coal Limited's (Malabar) proposed Maxwell Project (referred to as the Project Case, or the Project).

In February 2018, Malabar formally acquired Exploration Licence (EL) 5460 and existing infrastructure within Coal Lease (CL) 229, Mining Lease (ML) 1531 and CL 395 (now known as the Maxwell Infrastructure). These tenures are wholly-owned by subsidiaries of Malabar, an Australian unlisted public company.

The Project involves the development of a new underground coal mine within EL 5460. It would also include the use of the substantial existing Maxwell Infrastructure, along with the development of some new infrastructure. The Project would facilitate the underground mining, process and sale of run-of-mine (ROM) coal from EL 5460. The Project is anticipated to recover approximately 148 million tonnes (Mt) ROM coal over a 26 year period.

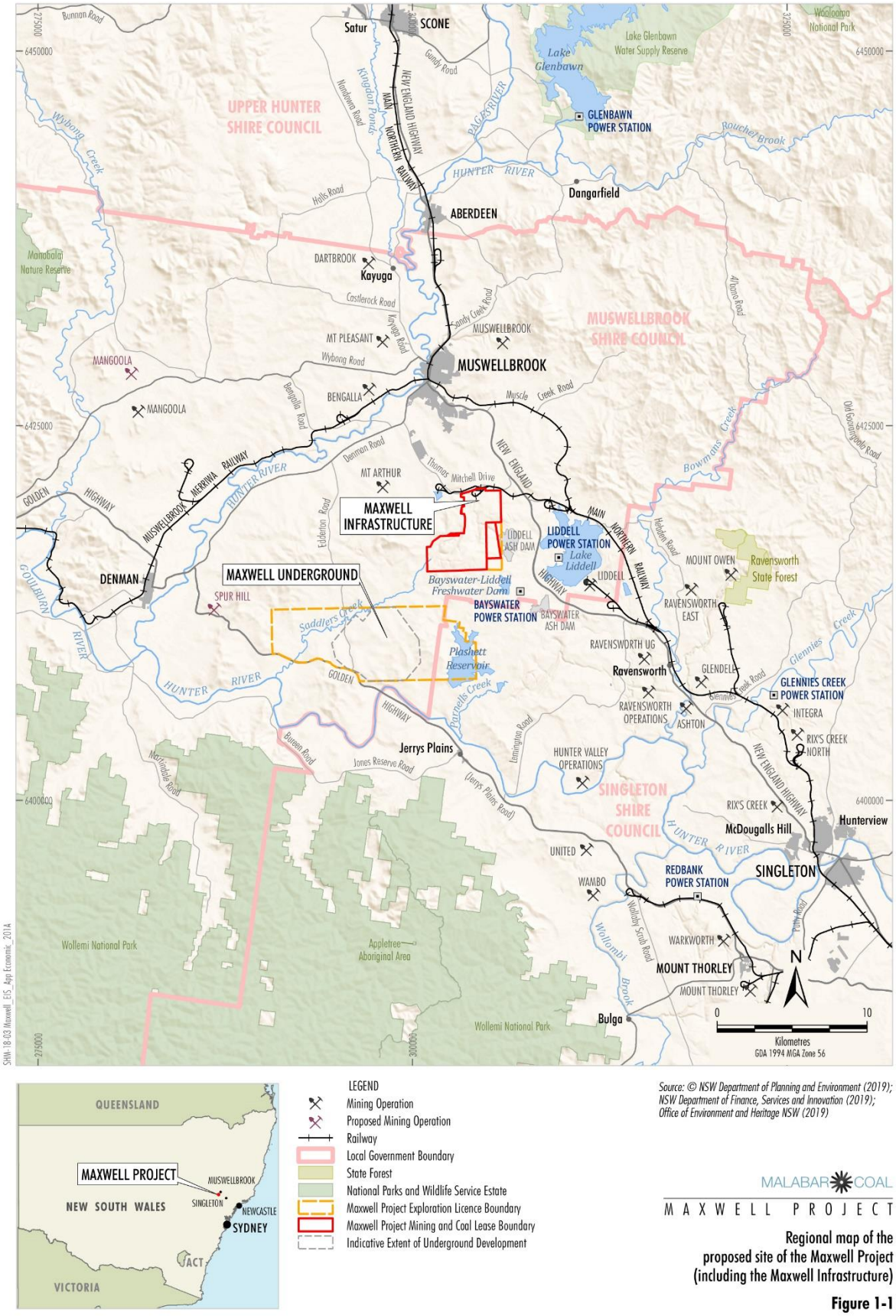
The Project is in the Upper Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook (Figure 1.1). EL 5460 encompasses two local government areas: the Project is located wholly within the Muswellbrook Local Government Area (LGA), while an area to the east lies within the Singleton LGA.

In accordance with the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act), this economic assessment has been prepared as part of the Environmental Impact Statement (EIS) required to accompany the application for a State Significant Development. The required components of the EIS, including the economic assessment requirements, are outlined in the Secretary's Environmental Assessment Requirements (SEARs) for the Project. Based on the NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals* (the NSW Government Guidelines), this report undertakes an assessment of the net economic benefits of the Project to the NSW community, within a cost benefit analysis (CBA) framework. It considers the economic costs and benefits of the Project, relative to a baseline or 'business-as-usual' scenario — which involves rehabilitating previous open cut mining areas within CL 229, ML 1531 and CL 395.

The CBA is accompanied by a local effects analysis (LEA) to assess likely effects of the Project on the Locality, defined for the purpose of the analysis as the Upper Hunter Statistical Area 3 (SA3).

A Computable General Equilibrium (CGE) model is also used to explore how the Project changes the regional and NSW economy, as measured by changes in economic activity and employment. The CGE analysis can be used as an extension to the CBA and LEA. However, the CGE results may not be directly comparable, or additional, to the CBA results or other projections outlined in the EIS. This is because it takes a more focused view at considering the costs and benefits of the Project based on how it changes the size of the economy and the flow-on effects from such changes, while the CBA takes a much broader view by assessing all costs and benefits related to the Project.

Figure 1.1: Regional map of the proposed site of the Maxwell Project (including the Maxwell Infrastructure)



Source: Malabar

1.2 Report structure

This report is structured in accordance with the NSW Government Guidelines for the economic assessment of mining and coal seam gas proposals.

The structure of this report is as follows:

- **Chapter 2** outlines the methodology employed in this report including how the approach used aligns with the NSW CBA guidelines.
- **Chapter 3** outlines the details of the Base Case, defines the Project Case and the expected scenario under the Project Case.
- **Chapter 4** presents the results of the CBA, identifying the net benefits of the Project Case for the NSW community.
- **Chapter 5** presents the results of a LEA, including the use of CGE modelling for second round and flow-on effects.
- **Appendix A** provides a checklist illustrating how this report has met the requirements of various guidelines.
- **Appendix B** presents an overview of the CGE model.

2 Methodology

Deloitte Access Economics has established a methodology for undertaking the CBA and economic impact analysis for the Project. The methodology 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 for this Project.

2.1 Secretary's Environmental Assessment Requirements

The SEARs are requirements for the EIS, which must accompany a development application for State Significant Development, in accordance with clause 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000 (NSW)*.

The SEARs for the Project were first issued in September 2018 and were revised in January 2019. The SEARs require an assessment of the likely economic impacts of the development, in accordance with the NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals*. The SEARs require that for the economic assessment particular attention is given to:

- the significance of the coal resource;
- the costs and benefits of the project, identifying whether the development as a whole would result in a net benefit to NSW, including consideration of fluctuations in commodity markets and exchange rates; and
- the demand on local infrastructure and services.[1]

The remainder of the SEARs cover topics beyond the scope of an economic assessment; however, there are particular areas that are potentially relevant to the methodology adopted in this report. These include impacts (including cumulative impacts) of subsidence, and on land resources, air quality, rehabilitation and final landform, noise, visual, waste, water, biodiversity, heritage, traffic and transport, and hazards (such as risk to public safety and health risks). It is noted that the cumulative impacts are not captured in the CBA, and where applicable, are discussed qualitatively in each section of the environmental, social and transport costs. However, the CGE modelling, an extension to the CBA, considers the impact from cumulative activities in its operation.

2.2 Relevant guidelines

The following guidelines have been used in preparing this report:

- NSW Treasury (2017) *NSW Government Guide to Cost-Benefit Analysis* (the NSW Treasury Guidelines).
- NSW Government (2015) Guidelines for the economic assessment of mining and coal seam gas proposals (the NSW Government Guidelines).

The NSW Treasury Guidelines provide a high-level framework for a CBA. The NSW Government Guidelines specify two components for the economic assessment of a mining proposal: a CBA to assess the public interest by estimating the net present value (NPV) of the Project to the NSW community, and a LEA to assess the likely impacts of the Project on the relevant locality. These guidelines provide a framework for the application of CBA and LEA that is specific to mining developments, to assist in the preparation of a development application and is used by the NSW Government in its assessment of the application.

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

[1] Department of Planning and Environment (NSW), *State Significant Development – Revised Environmental Assessment Requirements* (January 2019) <https://majorprojects.accelo.com/public/d9a370919942d272fa8bb8f3db53c383/6.%20Maxwell%20Revised%20SEARs%20January%202019.pdf>.

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 economic assessment be carried out using a set of standard approaches and with consideration of certain topics.

Following the NSW Treasury Guidelines, our analysis involves:

- establishing a Base Case against which to assess the economic and other impacts of changes due to the Project
- defining the scope of the Project including the inputs required to achieve the Project's objectives
- quantifying changes resulting from the Project relative to the Base Case with respect to both benefits and costs, including:
  - economic benefits such as revenues from additional coal output
  - economic costs such as capital expenditure and operating costs
  - externalities including environmental and social impacts.
- estimation of the monetary value of these changes using market prices, where available, otherwise using imputed prices or a qualitative assessment
- consolidation of values by applying an appropriate discount rate to estimate the NPV of the Project's future net benefits
- undertaking a sensitivity analysis on the key variables in consideration of uncertainties related to specific benefits and costs
- assessing the distribution of benefits and costs across different groups and geographic levels
- reporting of results, including unquantified impacts, so as to include all material that may be relevant to the decision-maker.

This CBA has been prepared with respect to the net benefits attributable to the NSW community, which is the spatial unit of interest specified in the NSW Treasury Guidelines. Defining the geographic scope of the CBA is important as it draws a line for which benefits and costs are to be included in the analysis and which are to be excluded. For example; if the scope of the CBA is defined as the State of NSW, rates payable to Muswellbrook Shire Council and royalties payable to the NSW Government should not be included in the analysis in Chapter 5 (local effects analysis). This position has been adopted as the cost to Malabar is offset by the benefits to the government, and hence these transfer payments cancel out.

As the CBA is being developed for compliance with NSW Government processes, the scope of the CBA will generally be the State of NSW. However, it should be noted that the guidelines and requirements discussed in this chapter do not fit neatly into a traditional CBA framework.

The purpose of a CBA is to identify and analyse the incremental impacts of a project. This is because the net position of the incremental costs and benefits of the project are the critical decision making item from an economic point of view. This means that CBA, which is the focus of Chapter 4, is not well suited to identification of transfer payments within NSW and cumulative effects on the Locality.

The LEA, considered in Chapter 5 is better placed to consider the effects for particular groups within the geographic scope. For example, Chapter 5 mostly focusses on transfer payments within NSW, including the cumulative effects on the local and state economies, and translates estimated state-wide level impacts into impacts on the communities located near the Project. The LEA contains analysis of the flow-on benefits of the Project to the local and state economies and does this using a CGE model. A CGE model takes into account the current production capacity of the economy, such as the spare machinery and labour available, as well as the likely demand for new outputs from the coal industry. This means that the CGE model considers the economic impact of the project in a cumulative sense: the Project must compete with other similar projects for scarce economic resources as inputs and also must compete internationally in output markets.

Section 4.15 of the EP&A Act requires consideration to be given to the likely impacts of the development, including social and economic impacts in the Locality, defined for the purpose of the analysis as the Upper Hunter SA3. In meeting this requirement in accordance with the NSW Government Guidelines, our analysis includes:

- defining the spatial area and population groups to be included and analysed
- quantitatively and qualitatively analysing the local effects relating to
  - local employment, such as workers employed by the Project who are ordinarily residents in the Locality, as well as the expenditure of additional labour earnings by both local and non-local workers in the local economy
  - non-labour Project expenditure, such as purchases made in the Locality relating to the construction and operations activity attributable to the Project
  - other local industries, such as the impact of the Project on agriculture or tourism in the Locality, and potential temporary impacts on food and housing markets for local residents
  - the positive and negative externalities that the Project could create in the Locality, including environmental and social impacts
- an analysis of flow-on effects, including indirect impacts resulting from the Project due to adjustments in the economy such as price movements or changes in labour supply and demand.

The LEA draws on material presented in the CBA – for example, the CBA already requires that externalities relating to the Project are identified and quantified. The LEA includes the portion of these externality benefits or costs that are incurred within the Locality. Costs and benefits that are addressed qualitatively are also discussed in the LEA where they are incurred in the Locality. CGE modelling is used to explore how the Project changes the regional and NSW economy.

2.4 Our methodology

Taking the above guidelines together creates a set of requirements, which require a specialised methodology to ensure each of the guidelines and corresponding requirements are addressed in a meaningful and transparent manner.

Our CBA methodology involves three steps as detailed below:

- estimate the net benefits to the NSW community through the analysis and aggregation of the share of costs and benefits attributable to NSW (Chapter 4)
- estimate the net benefits to the local community through the analysis and aggregation of the share of costs and benefits attributable to the community (the first component of the LEA) (Chapter 5)
- estimate the flow-on effects for the local community using CGE modelling (the second component of the LEA) (Section 5.7).

The first two steps focus 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 third step in our methodology uses CGE modelling to analyse flow-on effects. It is an extension of the CBA; as results from the CBA are used as inputs to the CGE model to trace the immediate effects through to the rest of the economy. 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 ore 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.

The CGE model is fundamentally built on national and regional economic relationships. As such, it focuses on outputs that are traded in markets and contribute to Gross Domestic Product (GDP),[2] and does not capture environmental and other externality costs that are captured as part of the CBA.

The NSW Treasury Guidelines suggest that flow-on effects may be estimated using CGE modelling, Input-Output (IO) multiplier analysis or qualitatively. Compared to other approaches, CGE modelling uses a more complex set of techniques and imposes assumptions that can better simulate activities resembling a real economy. For example, CGE modelling assumes that the economy and sectors within the economy compete for the use of resources. This means that the 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). This differs from IO modelling, which does not take into account that resources are finite, and tends to overstate the impacts. In this sense, CGE modelling is likely to provide relatively more conservative, and in Deloitte Access Economics' view, more realistic estimates of economic impacts than those provided by IO modelling.

[2] GDP is the standard measure of the value of final goods and services produced in a country less imports. The Gross Regional Product (GRP) of an area is the equivalent of GDP, in concept and measurement, but for a smaller regional area. The Gross State Product (GSP) is the equivalent of GDP, in concept and measurement, but for a state/territory.

3 The Maxwell Project

The CBA methodology described in Section 2.4 provides a structured approach to assessing whether the Project is likely to result in overall net benefit to the communities of interest. To carry out this assessment, the costs and benefits associated with the Project are compared to those under a Base Case that represents 'business as usual'. This comparison allows for an incremental analysis, to reach a clear conclusion on the net benefits of the Project.

This chapter defines both the Base Case and the Project Case in turn.

3.1 Base Case

Malabar formally acquired EL 5460 and the Drayton Mine and infrastructure (renamed to Maxwell Infrastructure) from Anglo American plc and its partners in February 2018. The Maxwell Infrastructure encompasses the mined areas along with the existing infrastructure within CL 229, ML 1531 and CL 395.[3] Open cut mining operations at the Drayton Mine began in 1983 supported by mining approvals CL 229, ML 1531, and CL 395.[4] Operations at the Drayton Mine ceased in October 2016 following the depletion of economically mineable coal within the leases.[5]

Through the acquisition, Malabar assumed the rehabilitation obligations for the site.[6] Under the Base Case, the works required and assumed timetable to complete are:

- Completion of the rehabilitation of overburden emplacement areas within CL 229, ML 1531 and CL 395 over two years from 2019.
- Rehabilitation of surface development area, Maxwell Infrastructure and reject emplacement areas over 3 years between 2021 and 2023.
- Ongoing monitoring of rehabilitated emplacement areas over 11 years from 2019 to 2029.
- Management and maintenance of the Antiene Rail Spur.
- Continuing agricultural activities on Malabar-owned properties.

3.2 Project Case

The Project involves the development of a new underground coal mine in EL 5460. It would include the use of the substantial existing Maxwell Infrastructure, along with the development of some new infrastructure. Malabar owns and manages the existing infrastructure within CL 229, ML 1531 and CL 395. The Maxwell Infrastructure includes an existing coal handling and preparation plant (CHPP), train load-out facilities and other infrastructure and services. These include water management infrastructure, administration buildings, workshops and services. The Maxwell Infrastructure will be used for the handling, processing and transportation of coal mined from EL 5460 over the life of the Project.

The total measured, indicated and inferred coal resource within EL 5460 is approximately 770 Mt. At least 75% of total extracted product coal could be sold as coking/metallurgical coal that is used in the production of steel. As metallurgical coal is necessary for the production of steel, the industry has a strong outlook over the coming decades. Coal not sold into the metallurgical market would then be produced as export thermal coal, suitable for the new-generation high efficiency, low emissions power generators.

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[3] Malabar Coal Limited, *Scoping report in support of a request for Secretary's Environmental Assessment Requirements* (2018), <https://majorprojects.accelo.com/public/4b18e3f0d85dc1da05d7846547e80441/Maxwell%20Project_%20Scoping%20Report.pdf>.
[4] Ibid.
[5] Elliott Whiteing Social Planning Solutions, *Maxwell Project – Social Impact Assessment* (report commissioned by Malabar Coal Limited, 2019).
[6] Malabar Coal Limited, *Scoping report in support of a request for Secretary's Environmental Assessment Requirements* (2018), <https://majorprojects.accelo.com/public/4b18e3f0d85dc1da05d7846547e80441/Maxwell%20Project_%20Scoping%20Report.pdf>.

The Project is proposed to produce an annual average of 5.7 million tonnes per annum (Mtpa) and up to 8 Mtpa of ROM coal over 26 year period—using a mix of "bord and pillar" and "longwall" methods.[7] Total ROM coal extraction would be approximately 148 Mt over the life of the Project. There is potential to recover additional ROM coal beyond the life of the Project. However, this would be subject to separate assessments and approvals. Malabar has advised the Project is not expected to significantly impact the future recovery of coal in either deeper seams or beyond the proposed underground area.

The key elements associated with Project are summarised in Table 3.1.

Key infrastructure required to be developed for the Project would include:

- site access road
- mine access drifts
- surface conveyors, ROM coal surge stockpiles and coal sizing facilities
- administration, meeting rooms, bathhouse, workshop, fuel storage, laydown, first aid, parking facilities and helipad (primarily for emergency use)
- ventilation and gas management infrastructure
- electrical distribution infrastructure
- site water management infrastructure (including water storages, pumps and pipelines, water treatment facilities and a sewage treatment facility).

The underground mine site will be operated on a continuous basis — 24 hours per day, seven days per week. The Project would generate employment for approximately 350 personnel during operation. Additional employment would be generated during project establishment and other activities during operation, through the employment of cleaners, security personal, and other support services.

At Malabar's request, the NSW Government has amended the exploration licence to relinquish the portion of the EL 5460 located beneath and to the south of the Golden Highway, and restrict any future mining development to underground mining only. In addition to this, and with the full support of Malabar, the NSW Government amended the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*, to prohibit development applications for open cut mining within EL 5460.

[7] Malabar Coal Limited, *Maxwell Project Environmental Impact Statement Section 3– Project Description* (2019).

Table 3.1: Summary of key elements of the Project

Proposed project element	Description	
Extraction approach	Underground using a mix of "bord and pillar" and "longwall" methods.	
Project life	Approximately 26 years.	
ROM coal	Approximately 148 Mt.	
Direct employment	Approximately 350 employees.	
Mining Areas	• Development of underground mining operation within EL 5460; and • Utilise existing infrastructure within the areas covered by CL 229, ML 1531 and CL 395 (known as the 'Maxwell Infrastructure').	
Interaction with other industrial operations	Heavy reliance on integration with existing mining infrastructure at the Maxwell Infrastructure site. Interaction with existing Mt Arthur Mine, Bayswater and Liddell Power Stations.	
Key mining infrastructure	• Existing CHPP, train load-out facilities, rail loop, offices, workshop and water management will continue to be used; and • Development of infrastructure for mine access, power reticulation surface facilitates, ventilation and gas management for the underground mine.	
Coal transport	Annual average of 4.8 Mtpa and up to 7 Mtpa of product via rail.	
Key sensitivities	Neighbours to the north of the Maxwell Infrastructure and equine businesses to the south of the Maxwell Underground including the Coolmore Stud and Godolphin Woodlands Stud.	
Seam characteristics	Depth of cover (m)	Working section thickness (m)
Whynot*	40–180	1.3–2.3 (average 2.0)
Woodlands Hill	125–365	1.7–3.5 (average 2.7)
Arrowfield	165–415	2.1–3.7 (average 2.9)
Bowfield	225–425	2.2–3.3 (average 2.8)

* Partial pillar extraction would not occur at depths of cover less than 50m.

Source: Malabar.

3.3 Project options

In addition to clearly defining the Base Case and the Project Case, completion of the CBA also requires a consideration of other project options and the geographic scope of the analysis. This assessment only evaluates the Project Case put forward by Malabar. Deloitte Access Economics was not engaged to consider alternative project options. In relation to options regarding traffic management where multiple options are possible, Deloitte Access Economics has adopted the higher cost option in each instance.

A number of other alternatives for the Project Case were considered by Malabar in order to maximise resource recovery and operational efficiencies, while also aiming to minimise environmental and social impacts. This included consideration of alternative mining footprint options, panel layouts, mine access locations and infrastructure arrangements to optimise the Project Case final design.

3.4 Significance of the resource

The SEARs include the need for an assessment of the significance of the resource in relation to the Project.

The repealed clause 12AA in Part 3 of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* provides an indication of items that could be considered in relation to assessing the 'significance of the resource'. This includes considering the economic benefits (both to the State and the Locality) of developing the resource, including benefits in terms of employment generation, expenditure and the payment of royalties. These items are considered in detail in this report.

The net economic benefits to NSW are considered in the CBA presented in Chapter 4 (with royalties specifically addressed in Section 4.3.2), while the regional benefits associated with the proposed development are analysed in the LEA in Chapter 5.

While the remainder of clause 12AA is directed at the State Government itself, we note that the Project will develop additional recoverable resources within an existing exploration tenement and will make use of existing infrastructure and land that has already been used for mining purposes. Further, the Project will enable additional exports from NSW to international customers.

4 Net benefits to NSW

This chapter presents the results of the CBA, which assesses the NPV of the Project Case to the NSW community. This involves identifying incremental costs and benefits of the Project Case relative to the Base Case, quantifying those items wherever possible, and deriving the share of each item that is attributable to NSW.

The Project Case is estimated to provide a total net economic benefit to the NSW community of approximately $1,010 million (in present value terms).

The steps to this analysis and the detailed results are described in this chapter.

4.1 Scope of the cost benefit analysis

The scope of any CBA for a project is defined by:

- A Base Case – identifying the 'business as usual' scenario against which to assess the potential economic, social and environmental changes due to the project.
- A Project Case – full specification of the project scenario to be assessed, this is compared relative to the base case.
- The Community of interest – defining the community for which the benefits and costs of the project should be assessed.

The definitions of the Base Case and Project Case for this CBA are described in Sections 3.1 and 3.2 respectively. The community of interest for the CBA is the NSW community, as prescribed by the NSW Government Guidelines (See Section 2.2).

4.2 Identifying costs and benefits

The costs and benefits considered in this analysis are set out in Table 4.1.

In recognition of the broad range of predicted impacts (positive and negative) of the Project, costs and benefits have been separated into eight categories according to the part of the community that they accrue to. For instance, the owners of Malabar will receive the net producer surplus, while royalties and company income tax will be paid to the NSW and Australian Governments respectively. Other third parties that may be affected by the Project include landholders, local workers, suppliers, residents in the local community and adjacent LGAs. This categorisation assists in apportioning the share of the net benefits of the Project to the NSW community.

Section 4.3 describes the techniques used to value each of these items and provides the justification behind the classification of each as a net cost or net benefit.

Table 4.1: Benefit and cost items considered in the CBA

Item	Benefit components	Cost components
Net producer surplus	Gross mining revenue Residual value of capital Residual value of land	Operating costs Capital costs Rehabilitation costs Environmental mitigation costs Transport management costs Local contributions Taxes (Federal, state & local) Royalties
Royalties	Royalties payable to NSW Government	
Company income tax	Company income tax payable to the Australian Government	
Local government rates	Council rates payable to NSW local governments	
Economic benefit to existing landholders	Payments to existing landholders	Opportunity cost of land Potential reduction in agricultural production
Economic benefit to workers	Wages paid to workers	Reservation wage for workers in the mining sector
Economic benefit to suppliers	Revenue paid to suppliers	Cost of supplying goods and services
Net environmental, social & transport-related costs		Air quality Greenhouse gas emissions Traffic and transport Ambient noise Biodiversity Water Aboriginal heritage* Non-Aboriginal heritage* Subsidence* Visual amenity*
Net public infrastructure costs	Local contributions	Incremental costs for government associated with provision of public infrastructure, net of payments made by Malabar.

* Item has been considered qualitatively.

As recommended in the 2015 guidelines, where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken. These items considered qualitatively are described in Section 4.3. In some cases, these items have been considered qualitatively because there is expected to be no significant difference in outcomes under the Base and Project Case (such as non-Aboriginal heritage) or in others because there is no accepted methodology available to value them in these particular circumstances (such as Aboriginal heritage impacts).

4.3 Costs and benefits to NSW

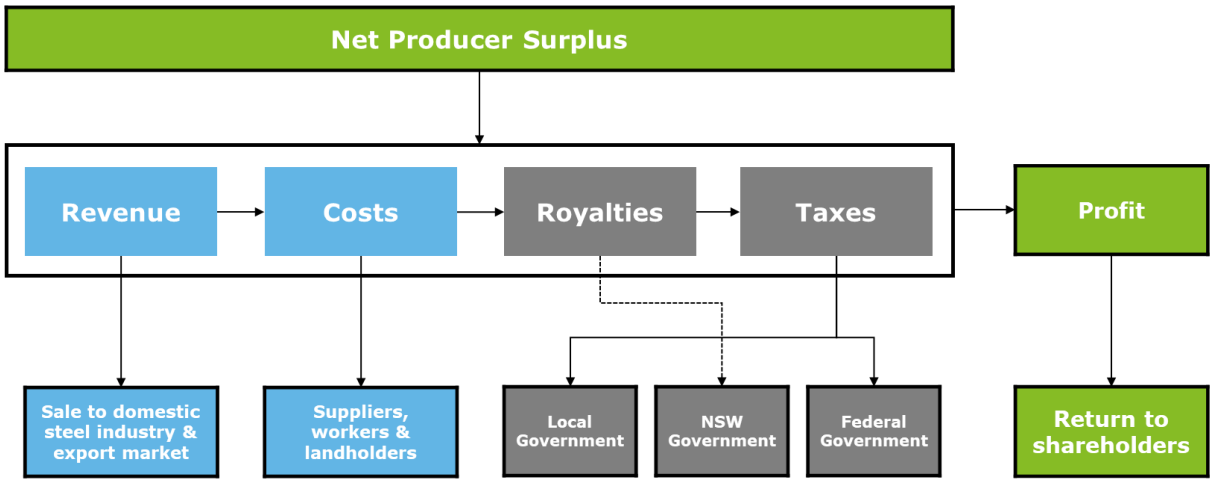
This section details the methods used to value the costs and benefits under each item identified in Table 4.1. To estimate the net benefit to the NSW community, each cost and benefit has been apportioned by a share of value. The quantification of costs and benefits has relied on a range of approaches and data sources. These include financial information provided by Malabar, government data publications and non-market values published in the literature.

All present values reported in this section are calculated using a 7% discount rate, are reported in 2018 price terms, and are discounted back to the start of 2018. Undiscounted estimates of each cost and benefit are reported in the text in brackets. In most cases, numbers have been rounded to the nearest whole number, so some numbers may not add up.

4.3.1 Net producer surplus attributable to NSW

The total incremental net producer surplus of the Project is estimated at $1,101 million in present value ($4,107 million in undiscounted) terms. This represents the additional value of the Project to Malabar, calculated as total revenue net of all direct costs, taxes and royalty payments, relative to the Base Case. Figure 4.1 shows the contribution of net producer surplus to different stakeholders, including the owners of the Project, Australian governments, and suppliers and workers that provide input support to the Project Case. Table 4.2 presents the calculation of the net producer surplus.[8]

Figure 4.1: Contribution of net producer surplus to different stakeholders



Following the NSW Government Guidelines, it is necessary to determine the share of the net producer surplus attributable to the NSW community, based on the ownership structure of the Project in the Base Case and Project Case.

As noted in Chapter 1, the Project is wholly owned by Malabar, an Australian-based unlisted public company. As at November 2018, Malabar advised that approximately 48% (rounded to the nearest whole number) of the shareholding of Malabar is held in NSW, therefore around 48% of the net producer surplus is attributable to the NSW community (see Table 4.3). Based on this, the net incremental producer surplus of the Project Case attributable to the NSW community is estimated at $524 million in present value terms ($1,956 million in undiscounted terms).

The assumptions underlying each component of the total net producer surplus estimate are documented on the following pages.

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[8] The NSW share of net producer surplus, determined consistent with the NSW Government Guidelines, should be interpreted as a mix of dividend payments to shareholders and future earnings (as a result of reinvestment of retained profits). It is noted that Malabar's dividend policy is likely to reflect outcomes for the company overall, rather than relate to specific project outcomes. It is therefore not possible to determine the proportion of the Project's net producer surplus that would be paid out in dividends or retained for future earnings, respectively.

This calculation assumes that 100 per cent of the Project is owned by Malabar. Should Malabar seek a joint venture partner(s) for the Project, the NSW share of estimated cash profits attributable to the Project would change (increase or decrease) proportionally with the NSW share of the joint venture partner(s)' Australian ownership.

Table 4.2: Calculation of total net producer surplus

Item		Base case (NPV)	Project case (NPV)	Incremental (NPV)
Revenue				
Gross mining revenue	$m	-	$4,873	$4,873
Residual value of land	$m	-	-	-
Residual value of capital	$m	-	-	-
Total	$m	**-**	**$4,873**	**$4,873**
Costs				
Operating costs*	$m	($69)	($2,411)	($2,342)
Capital costs	$m	-	($524)	($524)
Environmental mitigation costs#	$m	-	($11)	($11)
Transport management costs	$m	-	-	-
Purchase costs for land	$m	-	-	-
Total	$m	**($69)**	**($2,947)**	**($2,878)**
Taxes				
Local government rates	$m	($1)	($5)	($5)
Payroll tax	$m	-	($22)	($22)
Corporate income tax	$m	-	($525)	($525)
Total	$m	**($1)**	**($553)**	**($552)**
Royalties				
Ad valorem coal royalties	$m	-	($342)	($342)
Total	$m	**-**	**($342)**	**($342)**
Net producer surplus	$m	**($70)**	**$1,031**	**$1,101**

* The majority of rehabilitation costs, environmental management costs and transport management costs in the Base Case and Project Case are included in ongoing operating cost estimates, and have not been separately itemised.

Environmental mitigation costs includes costs for ongoing monitoring and mitigation and one-off biodiversity offset costs.

Note: Numbers in the table may not add up due to rounding.

Source: Deloitte Access Economics calculations.

Table 4.3: Share of the net producer surplus attributable to NSW community

Item		Base case (NPV)	Project case (NPV)	Incremental (NPV)
Net producer surplus	$m	($70)	$1,031	$1,101
NSW share of project's ownership	%	48%	48%	48%
Value of net producer surplus attributable to NSW	$m	**($33)**	**$491**	**$524**

Note: Numbers in the table may not add up due to rounding.

Source: Data provided by Malabar and Deloitte Access Economics calculations

4.3.1.1 Revenue

Gross mining revenue is estimated at $4,873 million in present value terms in the Project Case ($14,145 million in undiscounted terms). It should be noted that while Deloitte Access Economics uses Consensus Economics forecasts, Malabar forms its own assessment of future coal prices and its estimate of undiscounted gross mining revenue is in the order of $17,000 million (real terms).

Malabar has provided the production estimates for the modelling. As the Base Case mainly involves the rehabilitation of acquired tenures, it involves no coal production activities. Under the Project Case, underground mining operations will produce approximately 148 Mt of ROM coal over 26 years, between 2021 and 2046. Of these, approximately 124 Mt of product coal will be made available, comprising approximately 75% high quality semi-soft coking coal (also referred to as metallurgical coal) and approximately 25% high quality (low ash) thermal coal.

The underlying prices for projecting revenue were developed from price forecasts published by Consensus Economics in November 2018 – which are published in nominal US dollars. Specifically; contract price forecasts were used to project revenue for metallurgical coal and forecast spot prices were used to project revenue for thermal coal. These benchmark prices were converted to Australian dollars using the annual average foreign exchange forecasts published by the Department of Industry, Innovation and Science (Commonwealth) (DIIS) in December 2018. Nominal price forecasts from 2019 to 2024 were converted to real 2018 price terms using inflation rate assumptions published by the DIIS.[9]

The benchmark prices were then adjusted based on coal quality information provided by Malabar to account for variations in product types (based on the predicted energy content for thermal coal and the quality of coking coal) in each year of production. In addition, the price for semi-soft coking coal was calculated at 71% of the reported price forecast for hard coking coal. This figure is the average conversion rate used in external studies and past assessments on mines producing metallurgical coal.[10] Overall, the weighted average prices for each coal product type used in the analysis are presented in Chart 4.1 and Chart 4.2.

The **residual value of land and capital** at the conclusion of mining operations was also considered.

Malabar has advised that the land within the Project Area would be progressively rehabilitated into a combination of grazing land and areas used for biodiversity purposes under both cases. As the timing and extent of any land sales are uncertain and the market value likely to be negligible in

[9] Department of Industry, Innovation and Science (Commonwealth), *Resources and Energy Quarterly – December Quarter 2018* (2018) <https://www.industry.gov.au/data-and-publications/resources-and-energy-quarterly-all/resources-and-energy-quarterly-december-2018>.

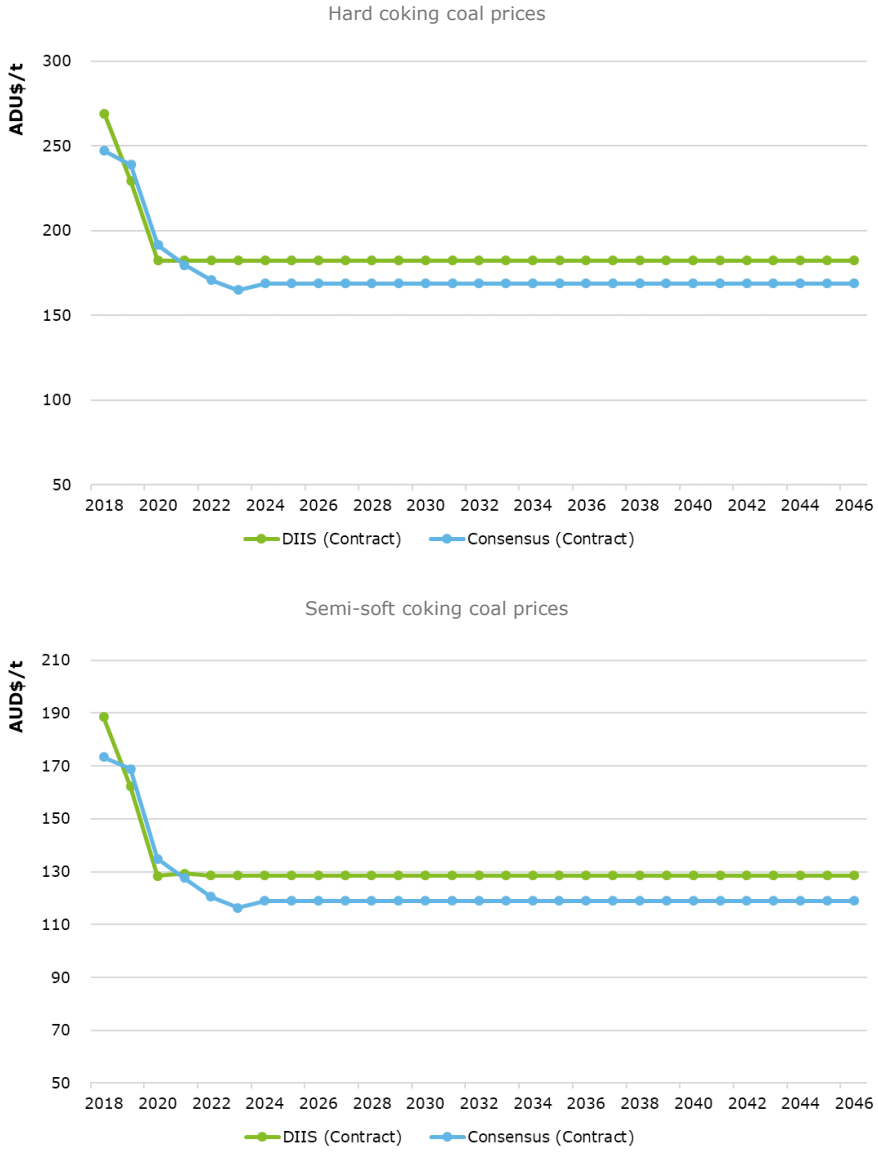
[10] KPMG, *Coal Price and FX market forecasts – December 2017/January 2018* <https://home.kpmg/content/dam/kpmg/au/pdf/2018/coal-price-fx-market-forecast-december-2017-january-2018.pdf>.

present value terms, the residual value of land under each case is assumed to be zero for the purpose of calculating net producer surplus.

Similarly, Malabar has advised that it is reasonable to assume that all capital assets will be fully depreciated over the life of the mine under the Base Case and Project Case. Accordingly, no residual asset values have been incorporated in the net producer surplus estimates.

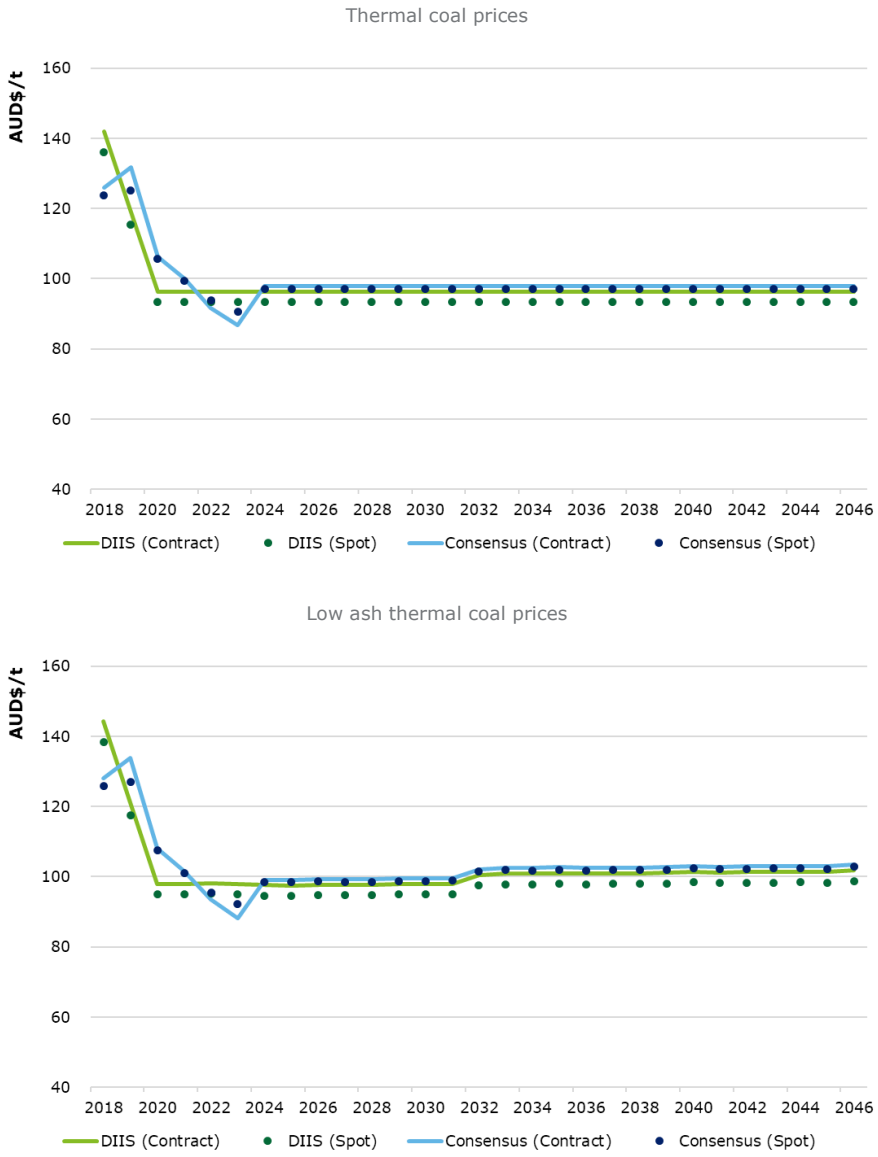
This is considered to be a conservative approach, as the above assumptions result in a lower net incremental economic benefit to the NSW community, than if values were included for these items.

Chart 4.1: Comparison of hard coking coal and semi-soft coking coal price forecasts, 2018 to 2046



Source: Deloitte Access Economics, adjusted from Consensus Economics (2018) and DIIS (2018).

Chart 4.2: Comparison of thermal coal and low ash thermal coal price forecasts, 2018 to 2046



Source: Deloitte Access Economics, adjusted from Consensus Economics (2018) and DIIS (2018).

4.3.1.2 Costs

Operating costs associated with mining operations from 2021 are estimated at $2,411 million in present value terms ($6,305 million in undiscounted terms) in the Project Case. This encompasses 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). Additionally, operating cost includes rehabilitation activities, local contributions, operational resources and the maintenance of mining equipment and machinery necessary for production and other indirect operating costs that relate specifically to the Project Case. That is, rehabilitation expenses and local contributions are included in operating costs and are not separately itemised.

Under the Base Case, there are still operating costs incurred by Malabar from 2021 to 2029, albeit the amount is smaller relative to the Project Case. These costs include: land tax, fees under the *Mining Act 1992 (NSW)*, and rehabilitation costs in 2019 and 2020, which totals to $69 million in present value terms ($91 million in undiscounted terms).

The **FOB cost** estimates have been calculated based on data provided by Malabar and include the items in ongoing expenditure as outlined above. The estimates are validated using an independent

data set sourced from Metalytics. Metalytics provides cost curves for metallurgical and thermal coal production for each Australian mine site, outlining their production cost per tonne by various cost activities such as mining, processing, inland transport and port costs. Comparable benchmark mines have been selected as appropriate proxies for the Project's coking and thermal coal operation respectively, and their production cost per tonne is used to estimate the Project's FOB cost. Ongoing expenditure data provided by Malabar for the Project was also added to the estimates as Metalytics does not provide such cost.

Calculations using Metalytics data amounts to $1,999 million in present value terms ($5,838 million in undiscounted terms) under the Project Case, incremental to the Base Case. This is slightly lower than using data provided by Malabar, totalling $2,342 million in present value terms ($6,214 million in undiscounted terms) under the Project Case, incremental to the Base Case.

Rehabilitation costs arise from a few rehabilitation and decommissioning activities. In 2019 to 2020, Malabar will rehabilitate overburden emplacement area within CL 229, ML 1531 and CL 395, which will occur regardless of whether the Project is approved or not.

Should the Project not receive approval, it is assumed that the Maxwell Infrastructure will remain closed, and the land at the Maxwell Infrastructure will be rehabilitated. Malabar will therefore undertake a three year rehabilitation program for the Maxwell Infrastructure and surface development area (i.e. years 2021 to 2023). Running in parallel to this is the ongoing rehabilitation and care activity commencing from 2019 to 2029.

In contrast, under the Project Case, the Project Area will be progressively rehabilitated, and these costs are included in the estimates of ongoing operating costs. The rehabilitation and decommissioning activities from the Base Case will also occur, but are deferred to the conclusion of underground mining operations, as the existing facilities would continue to be utilised by the proposed underground mining operation. For example; under the Project Case, rehabilitation and decommissioning of the Maxwell Infrastructure and surface development area is deferred to 2047. The overall rehabilitation program in the Project Case commences from 2047 and finishes in 2055.

Malabar has also advised that it intends to negotiate in good faith with the Muswellbrook Shire Council to reach agreement on **local contributions** for the purpose of compensating the council for costs induced as a result of the mining activity should the Project proceed. These local contributions would occur under a Voluntary Planning Agreement and have been included as part of operating costs.

Incremental **capital costs** over the life of the Project Case have been estimated at $524 million in present value terms ($963 million in undiscounted terms), based on data provided by Malabar.

The life of Project capital costs estimated for the Project Case includes a combination of mine establishment expenditure between 2019 and 2025 (pre-construction expenditure, equipment purchases, upgrade to the mine infrastructure area, surface infrastructure development and onsite and offsite infrastructure) and sustaining capital to maintain the mine's productive capacity from 2026 through to 2046.

In addition, costs associated with the purchase of water licences required for the Project Case are included as a capital costs by Malabar.

The annual water licensing volumes required for the Project have been predicted based on groundwater modelling by HydroSimulations. Where sufficient licences are not already held, Malabar would obtain the appropriate water access licences required for the Project under the *Water Management Act 2000 (NSW)*. The NSW Government Guidelines state that the market price of water should be considered the primary way to value the impacts on water quantity (described further in Section 4.3.7.6). Estimated water access licence values for each of the water sources relevant to the Project as provided by Malabar is shown in the table below.

Table 4.4: Estimated water access licensing requirements for the Project Case

Water Sharing Plan	Water Source	Market Value per Share (AUD)	Existing Malabar Entitlements available for the Project (units)	Maximum Project Licensing Requirements (units)	Additional Entitlements Required (units)	Source
Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016	New England Fold Belt Coast Groundwater Source (NEFBCGS)	$500	860	-	-	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019). Minimum bid-price in latest Controlled Allocation order: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/178585/Gazette-2017-53.pdf
	Sydney Basin-North Coast Groundwater Source	$1,500	527	846	319	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019). 3 x premium on the minimum bid-price in latest Controlled Allocation order for NEFBCGS: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/178585/Gazette-2017-53.pdf
Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009	Upstream Glennies Creek Management Zone in the Hunter Regulated River Alluvial Water Source	$1,500	125	38	-	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019). Latest trade value for Hunter Regulated River Alluvial Water Source reported on 'licence transfer statistics' from NSW Water Register.
	Jerrys Management Zone of the Jerrys Water Source	$1,600	50	25	-	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019). Latest trade value for Jerrys Water Source reported on 'licence transfer statistics' from NSW Water Register.
	Muswellbrook Water Source	$500	207	-	-	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019).

Water Sharing Plan	Water Source	Market Value per Share (AUD)	Existing Malabar Entitlements available for the Project (units)	Maximum Project Licensing Requirements (units)	Additional Entitlements Required (units)	Source
						Latest trade value for Jerrys Water Source reported on 'licence transfer statistics' from NSW Water Register.
Water Sharing Plan of the Hunter Regulated River Water Source 2016	Management Zone 1A (Hunter River from Glenbawn Dam to Goulburn River Junction) of the Hunter Regulated River Water Source	$2,000	925	-	-	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019). Latest trade value for Hunter Regulated River Water Source reported on 'licence transfer statistics' from NSW Water Register.
	Management Zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction) of the Hunter Regulated River Water Source	$2,000	198	55	-	Malabar, *Attachment 8 – EIS: Aquifer Interference Policy and Water Licensing Considerations* (2019). Latest trade value for Hunter Regulated River Water Source reported on 'licence transfer statistics' from NSW Water Register.

A number of costs related to **environmental mitigation** have been included as a direct cost for the Project Case. Costs associated with the ongoing environmental monitoring of air, traffic, noise, biodiversity, visual amenity, meteorological conditions and rehabilitation progress are included. This also includes mitigation practices such as installation of noise controls on equipment, installation of barriers for road marking and protection where required, and temporary rehabilitation to minimise dust and reduce visual impacts. Remaining environmental mitigation costs have been separately quantified (i.e. one-off expense to the NSW Biodiversity Conservation Fund to offset impacts on biodiversity values from the Project Case, see discussion below). This is estimated at $5.5 million in present value terms.

In the Project Case, an additional one-off expense of $7.2 million for **biodiversity offsets** has been included in 2021. This is valued at $5.5 million in present value terms. This cost includes $5.8 million to offset loss of ecological values for the clearance of vegetation and $1.4 million for species credits. Based on data provided by Hunter Eco on the ecosystem and species credit requirements generated by the Project using Biodiversity Assessment Method Credit Calculator, in accordance with the *Biodiversity Conservation Act 2016 (NSW)*. The cost of the biodiversity offset package included in the Project Case assumes the offset is met entirely through a contribution to the NSW Biodiversity Conservation Fund as a conservative upper limit (i.e. meeting the offset obligations through land-based offsets and rehabilitation would be lower cost options). Ongoing consultation will occur with the NSW and Commonwealth Governments regarding the implementation of the biodiversity offset package for the Project.

Transport management costs are not anticipated in the Base Case and the Project Case. While some transport management will be required during the potential realignment of the southern portion of Edderton Road and its intersection with Golden Highway, these expenses have been included in the capital cost and operating cost estimates associated with this infrastructure work.

There will be no requirement for Malabar to **purchase land** from private landowners in either the Base Case or Project Case. However, there are four properties that may have "marginal exceedances", and would therefore be afforded mitigation upon request rights. Another 10 properties would experience "negligible exceedances". The 4 properties that would experience marginal exceedances would also have had marginal exceedances during operation of the former Drayton Mine.

4.3.1.3 Taxes

Total taxes accrued as a result of underground mining operations are estimated at $552 million in present value terms ($1,845 million in undiscounted terms) in the Project Case, incremental to the Base Case. These estimates are inclusive of projections for company income tax to the Australian Government, payroll tax payable to the NSW Government and local government rates payable to the Muswellbrook Shire Council.

Company income tax payable is estimated at $525 million in present value terms ($1,775 million in undiscounted terms) in the Project Case, incremental to the Base Case. The method used to develop these estimates is outlined in Section 4.3.3.

Payroll tax has been estimated as a function of expected employee wage costs and data on the number of full-time equivalent (FTE) employees to be employed to support mining operations provided by Malabar. Annual payroll tax payable on these labour expenditures has been estimated by applying the current 5.45% payroll tax rate to annual labour expenditure in excess of the schedule of annual threshold (see Table 4.5) reported by the NSW Office of State Revenue (2019) in accordance with the 2018 NSW Budget.[11] Overall, payroll tax is estimated at $22 million in present value terms ($56 million in undiscounted terms) in the Project Case, incremental to the Base Case.

[11] NSW Office of State Revenue, *Taxes, duties, levies and royalties* (22 April 2019) <https://www.revenue.nsw.gov.au/taxes-duties-levies-royalties/payroll-tax>.

Table 4.5: NSW payroll tax thresholds

Tax year	Threshold
1 July 2018 to 30 June 2019	$850,000
1 July 2019 to 30 June 2020	$900,000
1 July 2020 to 30 June 2021	$950,000
1 July 2021 to 30 June 2022	$1,000,000

Source: NSW Office of State Revenue (2019).

With regards to **local government rates**, Malabar has advised that around $600,000 would be payable to the Muswellbrook Shire Council each year under the Project Case for landholdings owned by Malabar that overlap with the Project Area. Under the Base Case, Malabar would pay $100,000.

This analysis has assumed that the rating classification of the landholdings will remain the same under each scenario and that there will be no real increase in rates payable over time. On this basis, it is assumed that the current real rates will be an ongoing expense, over the period to 2046. Overall, local government rates are estimated at $5 million in present value terms ($15 million in undiscounted terms) in the Project Case, incremental to the Base Case.

4.3.2 Royalties

Royalties for the extraction and sale of product coal have been estimated by applying the ad valorem royalty rate for underground mines to the anticipated coal revenue, after accounting for the allowable deductions related to beneficiation costs. The royalties rate of 7.2% has been applied for the majority of the Project. In the year 24, Malabar anticipates that there is approximately 500kt of coal that has a cover in excess of 400m, and will attract a lower royalty rate of 6.2%. Project Case royalties are estimated at $342 million in present value terms ($993 million in undiscounted terms), incremental to the Base Case. It should be noted that Deloitte Access Economics uses Consensus Economics forecasts, while Malabar forms its own assessment of future coal prices and its estimate of undiscounted royalties is in the order of $1,200 million (real terms).

This estimate incorporates allowable deductions for coal beneficiation, including of $3.50 per tonne of product coal subject to a full cycle of washing and $0.50 per tonne for the product coal bypassed (not washed, crushed and screened). However, the estimate excludes potential for further deductions related to payment of levies, insurance and other items such as bad debts and bank commissions, due to the variability in such payments and the difficulty to forecast them accurately over time. These deductions are unlikely to have a large effect on the estimated royalties as they are removed from gross revenue before calculating royalties payable, and not removed from royalties payable.

The components used to estimate royalties are presented in Table 4.6. These include:

- Revenue from the sale of coal product over the life of mining operations in the Project Case (from 2021) using the price and quantity assumptions detailed previously.
- Allowable deductions for different levels of beneficiation based on information provided by Malabar on the proportion of product coal that will be bypassed in each year. It is assumed that all product coal not bypassed will be subject to a full cycle of washing. The value of allowance deductions for full cycle wash and coal not washed are as outlined above, as prescribed in Schedule B of the Determination under Section 283(5) of the *Mining Act 1992 (NSW)* by the Minister for Mineral Resources in 2008.
- Net disposal value, calculated as the difference between annual gross mining revenue and the total value of allowable deductions.

- Annual royalty payments, calculated using the ad valorem rate for coal recovered by underground mining of (mostly) 7.2%[12] of the net disposal value for each year, as specified in clause 74 of the *Mining Regulation 2016 (NSW)* (with the exception of a small volume of coal [500 kt] extracted at a cover in excess of 400m).
- The undiscounted value of royalty payments was obtained by taking the total sum of annual royalty payments. The present value estimate was produced by taking the annual royalty payments and applying a 7% annual discount rate.

Comparing estimates for the Base Case and Project Case shows net increase in royalties payable to the NSW Government.

Table 4.6: Estimation of additional royalties ($m, 2019 prices, undiscounted)

Item		Base Case	Project Case	Incremental
Coal Production	Mt	-	123,770	123,770
Gross mining revenue (R)	$m	-	$14,145	$14,145
Total allowable deductions for beneficiation (D) (@ $3.50 per tonne)	$m	-	$346	$346
Net disposal value (R – D)	$m	-	$13,799	$13,799
Total royalties (R – D) x 7.2%	$m	**-**	**($993)**	**($993)**

Note: Numbers in the table may not add up due to rounding.
Source: Deloitte Access Economics calculations.

4.3.3 Company income tax payable

Total company income tax payable is estimated at an additional $525 million in present value terms ($1,775 million in undiscounted terms) in the Project Case, incremental to the Base Case.

These estimates were reviewed for reasonableness by PwC, Malabar's tax advisors; and take into account the financial information described in Section 4.3.1. Specifically, taxable income was estimated as gross mining revenue, less total costs (inclusive of FOB costs, environmental mitigation costs, residual value of physical assets and local contribution costs), royalties and depreciation. Calculations of annual income tax payable also takes into account tax shield on interest expenses and accrued tax losses for the Project.

The approach taken approximates an effective tax rate of 30%.[13]

Applying the proportion of Australia's population based in NSW of approximately 32%, the share of company income tax attributable to NSW is estimated to be $168 million in present value terms ($567 million in undiscounted terms) in the Project Case. In other words, the Project generates additional tax revenue for the NSW community through company income tax payments.

[12] Based on information provided by Malabar, there will be around 500 kt of product coal in 2044 that would attract a lower royalty rate of 6.2%.
[13] The effective tax rate is defined as the average tax rate that a corporation pays. It is calculated by dividing the total tax by the total taxable income base (effectively earnings before taxes).

4.3.4 Net benefit to existing landholders

Net benefits of the Project related to Malabar's landholdings in the Project Area and for existing landholders in the surrounding area depend on any changes to the productivity of land, potential for land use incompatibility and/or purchases of landholdings.

Current land use within the Project Area consists primarily of previous mining areas and mining infrastructure associated with the former Drayton Mine (now the Maxwell Infrastructure) undergoing rehabilitation, and areas for cattle grazing and small areas of opportunistic fodder cropping (under favourable conditions).[14]

The Agricultural Impact Statement[15] (refer to Appendix Q of the EIS) undertaken for the Project reports subsidence impacts to agricultural land use in the Project Area would be short-term, with minimal to no impacts to production.[16] A relatively small net area of agricultural land and hence production will be required for surface infrastructure for the life of the Project and for biodiversity offsets *in-perpetuity*. Changes in land available for agricultural use would result from:

- development of surface infrastructure in support of the Project that would remove some areas temporarily from agricultural land use
- rehabilitation of the Project surface development areas to a combination of agricultural and woodland land uses
- conservation of the potential biodiversity offset areas that would reduce the agricultural productivity of these areas
- continued rehabilitation of previous mining areas at the Maxwell Infrastructure and the return of these area to agricultural use.

The Agricultural Impact Statement concludes that changes to existing land management practices could be used to offset any potential short-term agricultural productivity loss, improve overall land condition and improve agricultural productivity in the long-term. In the absence of any changes in land management practices, the Agricultural Impact Statement estimates an upper range for potential reductions in agricultural income of approximately $44,286 per annum.

The Noise Impact Assessment for the Project (refer to Appendix I of the EIS) concludes that noise contributions from the Project at all privately owned residential properties to the south of the Project would be indistinguishable from background noise. Marginal to negligible exceedances in noise level, relative to background noise, are predicted for the properties to the north of the Project. Measures to mitigate these impacts have been incorporated into the operating cost of the Project. No properties would be afforded acquisition rights under NSW Government policy.

4.3.5 Benefits to workers

Information provided by Malabar indicates that while the majority of the Project employees are anticipated to be drawn from NSW, the Project will also attract people interstate to relocate to NSW. Of the employees to be employed by the Project, it is estimated that 50% of these employees are expected to be new to the mining industry.

Net benefits to workers include any wage premiums paid to workers in the Project above the minimum (reservation) wage that workers would accept elsewhere in the mining sector. This is particularly true given the skilled mining workforce available in the Upper Hunter region, which is within driving distance from the Project.[17]

For the purposes of the CBA, it is conservatively assumed that on average, workers employed by the Project would not receive a wage premium. This assumes that workers will receive a net wage consistent with market rates. To provide an indicative estimate, this net wage after tax and

[14] 2rog Consulting, *Maxwell Project – Agricultural Impact Statement* (report commissioned by Malabar Coal Limited, 2019).
[15] Ibid.
[16] Ibid.
[17] Elliott Whiteing Social Planning Solutions, *Maxwell Project – Social Impact Assessment* (report commissioned by Malabar Coal Limited, 2019).

superannuation is estimated to be around $76,593, that being the average annual income for a full-time worker in the mining industry in the Upper Hunter SA3. This estimate is based on Australian Bureau of Statistics (ABS) Census data scaled up to 2018 prices using the mining industry Wage Price Index[18] and discounted for predicted income tax payable using information provided by the Australian Taxation Office.[19]

This approach assumes that there is no wage increase for workers already working in the mining sector and any wage increase accrued from gaining employment in the Project from outside the mining sector or from other areas of NSW is conservatively excluded from the CBA.

4.3.6 Benefits to suppliers

It has been assumed for the CBA, that the Project would not generate any significant additional producer surplus for suppliers in NSW providing service to the underground mining operation. In excess of 75 local suppliers are currently providing goods and services to Malabar under the Base Case, and significantly more suppliers would be involved under the Project Case.

As the outcomes for suppliers under the Base Case are not readily observable, this benefit is difficult to measure. Accordingly, it is conservatively assumed that suppliers to the Project Case would earn similar margins relative to what they could have received from other sources under the Base Case.

4.3.7 Net environmental, social and transport costs

It is estimated that the Project will generate net environmental, social and transport costs of approximately $65 million in present value terms ($191 million in undiscounted terms) (see Table 4.7) relative to the Base Case. Around $24 million in present value terms ($68 million in undiscounted terms) of these costs are attributable to the NSW community (see Table 4.8). These estimates incorporate the quantified costs associated with particulate matter and greenhouse gas emissions, noise impacts and impacts on traffic. There are also potentially other external impacts of the Project, including those associated with Aboriginal and non-Aboriginal heritage and visual amenity.

The remainder of this section discusses the approach used to quantify external impacts, and discusses the significance of other external impacts in qualitative terms.

[18] Australian Bureau of Statistics, *Wage Price Index Australia, December 2018,* Cat. No. 6435.0 (20 February 2019).
[19] Australian Taxation Office, *Individual income taxes (2018-19)* <https://www.ato.gov.au/Rates/Individual-income-tax-rates/>.

Table 4.7: Calculation of net environmental, social and transport costs

Item		Base case (NPV)	Project case (NPV)	Incremental (NPV)
Aboriginal heritage*	$m	-	-	-
Air quality	$m	-	($1.5)	($1.5)
Ambient noise	$m	-	($0.1)	($0.1)
Biodiversity	$m	-	-	-
Greenhouse gas emissions	$m	-	($60)	($60)
Water	$m	-	-	-
Non-Aboriginal heritage*	$m	-	-	-
Subsidence*	$m	-	-	-
Traffic and transport	$m	-	($2.9)	($2.9)
Visual amenity*	$m	-	-	-
Net environmental, social and transport costs	$m	**-**	**($65)**	**($65)**

* Potential impacts have been considered qualitatively.

Note: NPVs have been calculated using a 7% discount rate. Numbers in the table may not add up due to rounding.
Source: Deloitte Access Economics calculations.

Table 4.8: Calculation of net environmental, social and transport costs to NSW

Item	Total net cost (NPV $m)	NSW community share (%)	Net cost to NSW (NPV $m)
Aboriginal heritage*	-	-	-
Air quality	($1.5)	100%	($1.5)
Ambient noise	($0.1)	100%	($0.1)
Biodiversity	-	-	-
Greenhouse gas emissions	($60)	32%	($19)
Water	-	-	-
Non-Aboriginal heritage*	-	-	-
Subsidence*	-	-	-
Traffic and transport	($2.9)	100%	($2.9)
Visual amenity*	-	-	-
Net environmental, social and transport costs	**($65)**		**($24)**

* Potential impacts have been considered qualitatively.
# Based on NSW population relative to Australian population.

Note: NPVs have been calculated using a 7% discount rate. Numbers in the table may not add up due to rounding.
Source: Deloitte Access Economics calculations.

4.3.7.1 Aboriginal Heritage

The Aboriginal Cultural Heritage Assessment undertaken for the Project (refer to Appendix G of the EIS) identified 275 Aboriginal archaeological sites identified in a 23.3 square kilometre study area. These sites comprised of 274 open artefact sites (i.e. artefact scatters and isolated artefacts) and one stone quarry.[20]

Of the sites considered, 254 were assessed as having low scientific significance and 20 of moderate scientific significance. The stone quarry site was assessed as of high scientific significance. However, it is noted that this site would not be directly impacted by the Project. [21]

Two hundred and twenty eight sites are located above the proposed underground mining area. Two of these sites are also located in the surface development area. Sites located within the proposed underground mining area may be impacted by cracking of surface soils due to mining-induced subsidence. There are potential for impacts associated with subsidence or surface remediation, although these are unlikely.[22]

The mine entry area and portions of the transport and services corridor will be visible from two areas defined as culturally significant landscape features — Mount Arthur and Saddlers Creek. However, these visual impacts are expected to minor due to the small size of the mine entry area and transport and services corridor. Both landscape features are located outside the study area and not be directly impacted by the Project.[23] In particular, there is currently no public access to Mount Arthur.

In regards to Aboriginal heritage, intergenerational equity concerns can be considered in terms of the cumulative impacts to Aboriginal objects and places in the region. Alongside sites identified within the study area, existing open artefact sites in the study region offer opportunities for future research, conservation and education.[24]

An assessment of the Project's potential impact on the potential Aboriginal archaeological resource of the region concluded the impact would not be significant. As it was estimated that the proposed development would result in an approximate 0.18% decline in the regional potential open artefact resource. Furthermore, it can confidently be concluded that the land outside the current study area, but in the wider region, contains a significant but as yet unidentified, open artefact site resource.[25]

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. Management options have been proposed to manage the impacts of the Project, with potentially impacted sites to be salvaged by surface collection and all visible surface artefacts recorded.

4.3.7.2 Air quality

A conservative estimate of the incremental impact on air quality under the Project Case amounts to $1.5 million in present value terms ($4.3 million in undiscounted terms), incremental to the Base Case, and this is attributable to the Muswellbrook LGA.

The Project's air quality impacts have been quantified in terms of the health cost associated with emissions of fine particulate matter of less than 2.5 micrometres ($PM_{2.5}$) using the impact pathway approach outlined in the technical notes supporting the NSW Government Guidelines.[26] The approach attributes a dollar-per-tonne cost to emissions and does not directly consider the

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[20] AECOM Australia Pty Ltd, *Maxwell Project Aboriginal cultural heritage assessment* (report commissioned by Malabar Coal Limited, 2019).
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] Ibid.
[25] Ibid.
[26] Department of Planning and Environment (NSW), *Technical notes supporting the guidelines for the economic assessment of mining and coal seams gas proposals (Apr 2018)* <https://www.planning.nsw.gov.au/-/media/Files/DPE/Other/technical-notes-supporting-the-guidelines-for-the-economic-assessment-of-mining-and-coal-seam-gas-proposals-2018-04-27.pdf?la=en>.

separation distance between the emissions sources and sensitive receptors. The approach draws from the PAEHolmes 2013 report,[27] using their unit damage cost to quantify the dollar-per-tonne cost, which are significant urban area (SUA) and non-SUA dependent.[28]

From the technical assessments, there are emissions generated from both the mine entry area (located in outside of an SUA) and the Maxwell Infrastructure (located in Muswellbrook SUA).[29] These emission activities are used as the weights to calculate the weighted average unit damage cost for each year of the Project. Where emission activities are not estimated for that year, it is assumed that it is constant and equal to the previous year, resulting in the same unit damage cost. It is noted that although part of the Project is located within the Muswellbrook SUA, it is removed from the urban area and complies with all relevant air quality criteria.

For the purpose of quantifying the impact of $PM_{2.5}$ emissions, assumptions have been made to the data provided by the Air Quality and Greenhouse Gas Assessment[30] (refer to Appendix J of the EIS) in order to convert it to a time series for modelling. The timing assumptions are set out in Table 4.9 below:

Table 4.9: Timing assumptions for air quality emissions on Project timelines

Scenario	Years applied in the Project Case
Scenario 1	2021
Scenario 2	2022 to 2023
Scenario 3	2024 to 2046

Using the time series of forecasted emissions, the tonnes emitted per year is multiplied by the unit damage cost, converting it to dollar terms. The unit damage cost changes each year as the population within the affected SUAs and Gross State Product (GSP) are expected to grow. Population growth for Muswellbrook and GSP are estimated by and retrieved from the Department of Planning and Environment (NSW)[31] and ABS[32] respectively. Where there are gaps in the years, the growth rate is assumed to be equal to the most recent year.

A Human Health Risk Assessment (refer to Appendix R of the EIS) has separately been prepared for the Project.[33] This assessment concluded that the calculated change in population health incidence values are very low and would never be measurable within the population surrounding the Project. Therefore, the cost estimated using the approach in the NSW Government Guidelines is seen to be conservative for this Project.

The Air Quality and Greenhouse Gas Assessment also considered other air pollutants such as carbon monoxide (CO), hydrogen sulfide (H_2S) and sulfur dioxide (SO_2), which typically arises as a result of mining activities that use diesel powered equipment and the exposed coal seam. The

[27] PAEHolmes, *Methodology for valuing the health impacts of changes in particle emissions – final report* (2013) <http://www.epa.nsw.gov.au/resources/air/HealthPartEmiss.pdf>.
[28] The Maxwell Infrastructure is located within the boundary of the Muswellbrook SUA, as defined by the Australian Bureau of Statistics, while the mine entry area for the underground mine is not located in a non-SUA.
[29] Emissions of fine particulate matter of less than 2.5 micrometres ($PM_{2.5}$) estimated for the Project are separated into those that relate to the Maxwell Infrastructure and those that relate to the mine entry area and other operations outside of the Muswellbrook SUA.
[30] Todoroski Air Sciences, *Maxwell Project Air Quality and Greenhouse Gas Assessment* (report commissioned by Malabar Coal Limited, 2019).
[31] Department of Planning and Environment (NSW) - 2016 New South Wales State and Local Government Area Population and Household Projections, and Implied Dwelling Requirements (2016).
[32] ABS 5220.0 Australian National Accounts: State Accounts, Table 1. Gross State Product, Chain volume measures and current prices
[33] Environmental Risk Sciences, *Human Health Risk Assessment (Maxwell Project)* (report commissioned by Malabar Coal Limited, 2019).

overall emissions of these pollutants under the Project Case are considered to be too low to generate any material off-site concentrations.

Similarly, the Air Quality and Greenhouse Gas Assessment also considered NO_2 emissions from diesel powered equipment and gas management activities and does not expect it to have material offsite impacts on air quality. [34]

In addition to the estimated dust emissions from the Project, emissions from nearby approved open cut mining operations were also modelled and considered against background dust concentrations in order to assess the cumulative dust impact. This include the emission of dust from the mining operations of Mount Pleasant Operation, Muswellbrook Coal, Ravensworth North, Liddell Mine, Mangoola Mine and other sources such as the Liddell and Bayswater Power Stations. All these operations are located a reasonable distance from the Project. The Air Quality and Greenhouse Gas Assessment therefore concluded that for the assessed sensitive receptors no additional exceedances of relevant cumulative criteria are predicted due to the operation of the Project.[35]

4.3.7.3 Ambient noise

Ambient noise impacts caused by the Project have been estimated to be $0.05 million in present value ($0.15 million in undiscounted terms). This cost is wholly attributed to the NSW community in the CBA. Under the Base Case, there is no impact, as there is no material change in noise levels compared to current noise levels.

The data provided in the Noise Impact Assessment (refer to Appendix I in the EIS) reports the noise impact of 146 receivers. Of these, 130 receivers are privately-owned dwellings, and 16 are mine-owned dwellings. This valuation uses the data on the 130 privately-owned dwellings presented across three representative years under the Project Case, and excludes the 16 mine-owned dwellings.[36]

Given the Project may operate concurrently with the Mt Arthur Mine, an open cut coal mine operating south of Muswellbrook, nearby receivers may potentially be exposed to simultaneous noise from both industrial sources. The Noise Impact Assessment indicates that with the implementation of proactive and reactive noise management measures, the cumulative noise levels, resulting from the concurrent operations of the Project and the Mt Arthur Mine, would comply with the relevant amenity noise levels at all identified receivers.[37]

Due to their locations relative to the Project, Liddell Power Station, Bayswater Power Station, the Bengalla Mine, Hunter Valley Operations, Greater Ravensworth Area Operations and other mining operations further afield are expected to have a negligible impact on the receivers in the vicinity of the Project and therefore cumulative noise calculations do not include them.[38] Of the 130 receivers, the CBA considers and values those that have a material noise impact at any given time of the day. That is, when the industrial noise level exceeds the background noise by more than 5 decibels (dB) either in the day, evening or night. This is determined by undertaking the following:

- Subtract the Rating Background Noise Levels from the Predicted Project Noise Levels for each receiver and for the corresponding time of the day (i.e. day, evening and night).
- Identify the maximum noise exposure across the day, evening and night periods for each receiver.
- Compare the values to the threshold value of 5 dB. Convert the receivers that exceed the threshold into a time series for quantifying the noise impact under the Project Case. The timing assumptions are specified in Table 4.10 below.

[34]Todoroski Air Sciences, *Maxwell Project Air Quality and Greenhouse Gas Assessment* (report commissioned by Malabar Coal Limited, 2019).
[35]Ibid.
[36] Wilkinson Murray Pty Ltd, *Maxwell Project: Noise Impact Assessment* (report commissioned by Malabar Coal Limited, 2019).
[37] Ibid.
[38] Ibid.

Table 4.10: Timing assumptions for noise modelling data on Project timelines

Noise modelling year	Years applied in the Project Case
Year 1	2021
Year 3	2022 to 2023
Year 4	2024 to 2046

The estimate for cost per dB per household each year used for quantifying the additional noise impact is a constant unit cost of $67.06. The original value was provided by Navrud (2002) in his report for the European Commission DG Government, in which the author reports the cost of noise impact ranges from 2 to 32 euros per dB per household each year. The upper limit is used as a conservative estimate for quantifying the noise impact. For the purposes of modelling, the cost per dB is first scaled and converted to 2018 dollars using the inflation rates reported by the European Central Bank[39], and then converted to Australian dollars using the exchange rates reported by the Reserve Bank of Australia.[40]

It is also noted that, should the Project be approved, Malabar intends to undertake mitigation activities for residential properties that fall within the noise management zone. An estimate of this up-front cost has been included in the net producer surplus estimates for the Project Case.

4.3.7.4 Biodiversity

The Biodiversity Development Assessment Report undertaken for the Project has focussed on assessing the impacts on biodiversity on the proposed surface development area for the Project.

The Assessment identifies the disturbance footprint of the Project is mostly derived native grassland (approximately 136 ha, 42.4% of surface development area) with some fragmented native woodland/forest vegetation (totalling approximately 25.6 ha, 7% of surface development area). The remainder is located within post-mine landforms undergoing mine rehabilitation or has previously been disturbed (e.g. for the construction of farm dams). The impacts of Project disturbance would include loss of native vegetation and fauna habitats, including habitat for threatened species.

Where possible the Project has been located and designed to avoid and minimise impacts on biodiversity values, including native vegetation and potentially occurring threatened species.

The NSW *Biodiversity Assessment Method Order 2017* was used to determine the biodiversity offset requirement for unavoidable clearance of native vegetation (woodland, forest and secondary/derived native grasslands) and for the unavoidable clearance of potential habitat for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis. It is proposed that these offset requirements would be met through retirement of biodiversity credits, ecological mine rehabilitation and/or contribution to the Biodiversity Conservation Fund. These biodiversity offset costs have been included in the net producer surplus under environmental mitigation costs in Section 4.3.1.

The Assessment has found that the direct loss of habitat associated with the Project in combination with offset provisions would result in no net loss in biodiversity. This is because the biodiversity offset would be a greater area of land, multiple times the size of the Biodiversity Assessment Development Footprint, which will be conserved and managed to achieve a gain in biodiversity values.

[39] European Central Bank, *Statistical Data Warehouse* - HICP - Overall index <https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=122.ICP.M.U2.N.000000.4.ANR>
[40] Reserve Bank of Australia, *Historical data – Exchange rates* <https://www.rba.gov.au/statistics/historical-data.html#exchange-rates>
Due to the absence of exchange rate data for EUR to AUD, DIIS was not used in this instance.

4.3.7.5 Greenhouse gas emissions

The social costs of additional greenhouse gas emissions to Australia under the Project Case are estimated at $60 million in present value ($179 million in undiscounted terms), in addition to that under the Base Case. On the basis of the NSW population share of Australia of 32%, the additional cost to the NSW community as a result of the Project is $19 million in present value ($57 million in undiscounted terms). Further, the assumption of no costs under the Base Case presents a conservative estimate of the incremental impact of the Project Case.

The impacts of greenhouse gas emissions are estimated using the projections of the Scope 1 and Scope 2 carbon emissions for each year of mining activity in the Project Case, as well as the average cost per tonne of carbon dioxide (CO_2) emissions. The Air Quality and Greenhouse Gas Assessment (refer to Appendix J of the EIS) provides this data in the form of annual estimates of carbon dioxide-equivalent (CO_2-e) emissions under the Project Case.

In quantifying the impact into monetary terms, there are a number of reference price series used to value average cost per tonne of CO_2 emissions. Of these, the technical notes supporting the NSW Government Guidelines recommend using the forecast European Union Emission Allowance Units price, which is based on future derivatives published by the European Energy Exchange. Furthermore, this price series was used in the review of the NSW Energy Savings Scheme.[41] The series assumes that the cost of carbon is included in wholesale electricity prices from years 2021 and onwards.

Adjustments have been made to the reference price series to convert it into 2018 values. This is done by scaling the values using the inflation rates reported in the Resources and Energy Quarterly publications[42], a consistent approach with all other inflationary adjustments computed in the CBA, unless specified otherwise. This adjustment results in the cost of carbon amounting to $9.62 per t CO_2-e in 2018 and $25.57 per t CO_2-e in 2046.

The forecast European Union Emission Allowance Units price, however, can be seen as a conservative estimate relative to other reference price series such as the Australian Treasury Clean Energy Future Policy Scenario prices and US Environmental Protection Agency (US EPA) Social Cost of Carbon. These cost of carbon under these two reference price series, on average across the Project period, are 366% and 73% higher than that of forecast European Union Emission Allowance Units price over the project period respectively. These two series are considered and presented in the sensitivity analysis in Section 4.5.

The value of externalities from indirect (Scope 3) greenhouse gas emissions are not considered in the CBA. This is consistent with conventional CBA, where the potential, direct negative and positive economic impacts of an activity are considered together, in the country where the activity takes place (e.g. economic positives and externalities of Japanese steel manufacturing in a customer industrial facility, including the Scope 1 greenhouse gas emissions of that facility).

4.3.7.6 Surface water and Groundwater

The impacts of the Project on surface water and groundwater resources have been considered in the Surface Water Assessment undertaken by WRM Water & Environment Pty Ltd[43] and the Groundwater Assessment undertaken by HydroSimulations.[44]

WRM Water & Environment Pty Ltd has considered the potential impacts of the Project on surface water and concluded that with the implementation of appropriate management and mitigation measures:

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[41] Department of Planning and Environment (NSW), *Review of the NSW Energy Savings Scheme, Part 2: Options Paper* (2015).
[42] Department of Industry, Innovation and Science (Commonwealth), *Resources and Energy Quarterly March 2019* (2019).
[43] WRM Water & Environment Pty Ltd, *Surface Water Assessment Maxwell Project* (report commissioned by Malabar Coal Limited, 2019).
[44] HydroSimulations, *Maxwell Project Groundwater Assessment – In support of EIS* (report commissioned by Malabar Coal Limited, 2019).

- Nil subsidence consequences to the Hunter River and Saddlers Creek are predicted as the Project mine layout has been designed to avoid these watercourses.
- All drainage lines within the Maxwell Underground area are ephemeral, as identified through the Geomorphology Assessment.[45] Subsidence impacts to ephemeral drainage lines would be remediated as required to prevent erosion (e.g. through the installation of rock control grade structures or use of wood structures).
- Potential impacts on flow and water quality for surface water users would be negligible.

An extensive water monitoring program would be maintained for the Project to monitor surface water quantity and quality in the Hunter River and Saddlers Creek.

Longwall mining can potentially result in a reduction in potentiometric head and/or changes to water quality in groundwater aquifers accessed by privately-owned bores. Numerical modelling of potential drawdown due to the Project has been undertaken by HydroSimulations for the Groundwater Assessment. The results of the modelling show:

- Minimal impact as defined in the *NSW Aquifer Interference Policy* (the AIP) (i.e. less than 2 m drawdown) is predicted in the 'highly productive' alluvium.
- Minimal impact (i.e. less than 2 m drawdown) is predicted at all bores in highly productive aquifers.
- A privately-owned bore in a 'less productive' hard rock aquifer may experience cumulative drawdowns exceeding the AIP minimal harm impact criterion (i.e. greater than 2 m drawdown due to the Project and other surrounding mining operations).

The Project is anticipated to have negligible adverse impact on groundwater water quality.

A Groundwater Management Plan would be developed and implemented for the Project, and would define a groundwater monitoring strategy, groundwater level triggers and a trigger action response plan. Malabar would implement appropriate contingency measures (i.e. make good provisions) for Project related drawdown greater than 2 m at any privately-owned bores so that the Project would result in no more than minimal impact on existing extractions. There is adequate capacity in the sustaining capital allowance to meet costs of make good provisions for groundwater bores, if required.

The Groundwater Assessment for the Project also concluded that there would be no changes in the beneficial use of groundwater in or around the Project area as a result of mining, including over the long term. With the implementation of the Project water management plans, there would be negligible impact on surface water quality in local water courses.

Based on the technical assessments, the Project is anticipated to have negligible adverse impacts on water available for beneficial use over the long term as Malabar would hold sufficient water licences for the Project. Costs associated with acquiring water licences have been included in the net producer surplus under environmental mitigation costs in Section 4.3.1.2. In accordance with the NSW Guideline, the market price for water is considered the most appropriate proxy of the value of water in competing uses as discussed in Section 4.3.1.2.

A cumulative assessment of potential impacts of the Project on groundwater and surface water was also conducted. The assessment found that no material adverse impacts on urban communities, regional agriculture, fisheries, industry or recreation are predicted to occur due to the Project.

4.3.7.7 Non-Aboriginal Heritage

The Historic Heritage Assessment for the Project (refer to Appendix H of the EIS) has identified non-Aboriginal historical heritage sites contained within and in the vicinity of the Project Area and assessed the significance of any potential impacts on those sites due to the Project.

[45] Fluvial Systems, *Maxwell Project, Environmental Impact Statement, Technical Study Report, Geomorphology Assessment* (report commissioned by Malabar Coal Limited, 2019).

The Assessment focuses on eight heritage sites and two sites of interest. Some of the sites considered are located outside of the Project Area but were considered part of the broader cultural landscape. Overall, the Assessment concludes that no heritage sites would be directly impacted by the Project. It has also been assessed that the Project will not result in any material adverse cumulative impacts to heritage places. As a result, no specific actions are required by Malabar.[46]

4.3.7.8 Subsidence

The subsidence assessment for the Project suggests that the maximum predicted subsidence impacts in the Whynot, Woodlands Hill, Arrowfield and Bowfield Seams are:[47]

- Vertical subsistence of 5,600 millimetres (mm) or 58% of the total mining height in all seams.
- Tilt of 50 mm/metre.
- Hogging and sagging curvatures of 2 kilometre.
- Strains typically between 10 and 20 mm/metre, localised strains greater than 20 mm/metre.

The proposed underground mining includes workings associated with the partial pillar extraction and longwalls. These will result in subsidence that develops predominately above the area of secondary extraction. Specifically; the following third-party built infrastructure may be affected by subsidence associated with the Project:[48]

- **Edderton Road -** management of potential subsidence impacts on Edderton Road is described under Section 4.3.1.2.
- **Golden Highway** – technical assessment predicts the Golden Highway would remain in a safe and serviceable condition throughout mining. Monitoring would occur during mining to confirm predictions.
- **11 kilovolt (kV) powerline owned by Ausgrid** – potential subsidence impacts on this minor powerline would be either managed in its current location through the implementation of preventive measures (such as the provision of cable rollers, guy wires or additional poles), or realignment around the area of active subsidence.
- **Survey control marks** – Malabar would manage the impacts of subsidence on survey marks in accordance with the NSW *Surveying and Spatial Information Regulation 2017 (NSW)*, which involves notification of NSW Spatial Services and re-surveying if required.

Relative to other underground mining operations in NSW, the Project would have limited impacts on built features. Monitoring and management of subsidence impacts have been included in the ongoing operating cost estimates for the Project Case.

4.3.7.9 Traffic

Under the Project Case, there will be an increased number of vehicles in the vicinity of the Project. This may result in minor additional travel time for background traffic along a number of roads, for example at intersections near the Project. Furthermore, additional delays can be expected as a result of undertaking one of the two options to manage the subsidence impact on Edderton Road. In total, the incremental impact is estimated to be $2.9 million in present value ($6.7 million in undiscounted terms), and is wholly attributed to the NSW community.

In the absence of any management options for subsidence impact, the incremental cost of delay from increased traffic volumes are estimated to be $1.6 million in present value ($3.2 million in undiscounted terms). This is based on the traffic volume and vehicle classification data provided in the Appendix B of the Road Transport Assessment (refer to Appendix K in the EIS) and excludes the vehicles turning in and out of the Maxwell Infrastructure road.[49] The data contains data points

[46] Extent Heritage Pty Ltd, *Maxwell Project, near Muswellbrook, New South Wales Historic Heritage Assessment and Statement of Heritage Impact* (report commissioned by Malabar Coal Limited, 2019).
[47] Mine Subsidence Engineering Consultants, *Maxwell Project: Environmental Impact Statement – Subsidence Assessment* (report commissioned by Malabar Coal Limited, 2019).
[48] Ibid.
[49] Vehicles turning in and out of the Maxwell Infrastructure road are excluded as these are typically employees and contractors travelling to work at the Project, and their travel time is compensated for as part of their wages and other benefits.

for four years: 2018, 2020, 2026 and 2033, for both the Base Case and Project Case. Delays experienced by traffic at key intersections are presented for the AM and PM peak hour.

To undertake an estimate of travel time delays, Deloitte Access Economics has assumed that the proportion of heavy vehicles and average delay time remain constant throughout the day and has applied this peak hour average delay time to the estimated average weekday traffic volumes. The average weekday traffic volumes are then converted to a yearly figures for subsequent calculations. Where there are gaps between the assessed years, it is assumed that the number of vehicles will grow/ decline at a constant rate between each data point. At the last data point, year 2033, traffic volumes for the subsequent years have been assumed to grow/ decline at the same rate as in that year. Other parameters, such as % of heavy vehicles and average delay time, are expected to remain constant and equal to the most recent data point.

With all adjustments as outlined above, the cost of additional travel time is quantified into monetary terms for each vehicle classification: light and heavy vehicles. This is done by using the average hourly cost of travel time. These costs, as reported by Transport for NSW, are $34.06 and $49.98 per hour for light and heavy vehicles respectively.[50] Moreover, the Transport for NSW reports an hourly cost of $9.25 for all vehicle types in an idling state. As these cost estimates are reported in 2018 terms, they do not require further adjustments.

Considering the methods for mitigating subsidence impacts, there are two potential options Malabar is deciding between:

1. Performing road maintenance along the existing road alignment on Edderton Road and associated speed reductions, or
2. Constructing a realignment of the road around the Maxwell Underground area.

The first option involves extracting 18 longwalls beneath Edderton Road across a number of years between 2025 and 2042. It is estimated that during the periods of extraction, speed restriction would be imposed and increased travel time in both directions of Edderton Road by up to approximately 140 seconds. The incremental cost of delay is quantified using the same method as detailed above and is estimated to be $1.2 million in present value ($3.4 million in undiscounted terms).

While the method of valuation adopted is the same as above, there are additional assumptions imposed due to fewer data points. In particular, there is only one year (2026) of vehicle traffic expressed as a daily figure. Proceeding with the method, the modelling process backcasts and forecasts the number of vehicles entering and exiting Edderton Road via Denman Road over time (as provided in the traffic volume and vehicle classification data). The number of vehicles are assumed to grow in a straight line, based on a constant growth rate. Malabar has also provided information on the percentage of heavy vehicles and the proportion of vehicles travelling eastbound and westbound on the Golden Highway, which has been assumed to be constant through the duration of the management options.

Alternatively, the second option is to construct a realignment of the southern portion of Edderton Road from 2025 and will be effective for the duration for the Project. This would relocate the intersection between Edderton Road and Golden Highway by approximately 1.16 kilometres (km) to the west of Golden Highway. The distance required for a vehicle to travel from the point of realignment to Golden Highway has increased from 3.16 km to 3.28 km as a result of this construction. This translates to a decrease in travel time of 18 seconds for vehicles travelling to and from Golden Highway west of Edderton Road, and would increase the travel time for vehicles travelling to and from Golden Highway east of Edderton Road by 66 seconds. Using the same valuation process and additional assumption as outlined above, the incremental cost of delay is estimated to be $1.1 million in present value ($3.5 million in undiscounted terms).

In comparing the two options, we note that while the second option of constructing a realignment of the road is higher in undiscounted terms, its present value is lower. This suggests that, while

[50] NSW Government – Transport for NSW, *Principles and guidelines for economic appraisal of transport investment and initiatives* (2018).

the overall cost to delay due to realignment is high, the option of road maintenance faces higher costs in the shorter term. As such, the option of road maintenance is assumed to be adopted for the purposes of the CBA, to present a conservative estimate of the cost of delay.

The Road Transport Assessment has considered and reviewed the realignment of the northern part of the Edderton Road in relation to the Mt Arthur Mine to identify cumulative impacts. This realignment alongside the realignment of the southern part of Edderton Road for this Project, is expected to result in the largest cumulative impact for vehicles travelling in this area. In particular, the impact is particularly pertinent for those vehicles travelling between Jerry Plains and Muswellbrook via Edderton Road. These vehicles could expect to travel longer distances and longer travel times.

4.3.7.10 Visual amenity

Assessment of the likely landscape and visual impacts of the Project on surrounding locality and key public vantage points has been prepared by Van Pelt & Allen Visual Planning and Assessment (refer to Appendix L of the EIS)[51]. The Assessment has found that the Project would have low/minimal to limited localised visual amenity impacts. In the absence of appropriate monetary values to quantify the visual impacts of the Project, these are acknowledged qualitatively in the CBA.

Overall, the Project comprises the following main domains with the potential to alter existing views and visual amenity values within the surrounding areas:

- The proposed area of underground mining operations (the underground mine)
- The mine entry area and transport and services corridor
- Maxwell Infrastructure area
- Potential realignment of Edderton Road.

The visual impact associated with the underground mine would have inherently low visual impacts because the mining operation would be underground.

Impacted views to the mine entry area and transport and services corridor are limited to the following locations in the west and distant south:

- Edderton Homestead on Edderton Road (a residence owned by BHP).
- A short section of Edderton Road west of the mine entry area, where low-lying areas along Saddlers Creek allow views to the coal stockpiles, some coal loading facilities and infrastructure, and the more elevated sections of the transport and services corridor and covered overland conveyor as they cross the adjacent ridge to the east. These impacts would be experienced briefly along a 600 m stretch of Edderton Road, typically from a moving vehicle.
- Elevated locations on Coolmore Stud and Godolphin Woodlands Stud properties, where there are distant views to the more elevated sections of the infrastructure within the transport and services corridor at distances of between 7.5 km and 7.7 km from the viewer, and taking up a very small portion of the primary view (<1%), which significantly reduces discernible components. The mine entry area would not be visible from anywhere on the horse stud properties, including the elevated locations.
- Views from the air (i.e. arriving and departing the Coolmore Stud by plane or helicopter and arriving and departing the Godolphin Woodlands Stud by helicopter).

The visual impacts associated with additions to the Maxwell Infrastructure area are anticipated to be minimal. All changes occur within the existing site boundary. There would be minimal to no impacts associated with additional components within this existing area. Night-lighting from the mine entry area and transport and services corridor would contribute to the existing sky glow in this region. It would have localised effects in an area with few sensitive receptors. Distance would

[51] Van Pelt & Allen Visual Planning and Assessment, *Maxwell Project Landscape and Visual Impact Assessment* (report commissioned by Malabar Coal Limited, 2019).

reduce the visual impacts from more distant sensitive view locations in the south as it becomes part of the greater sky glow prevalent in this area.

Visual impacts associated with the potential realignment of Edderton Road would be localised and limited to the construction phase of the alignment. Impacts would be minimised following progressive rehabilitation of disturbed areas. As vegetation becomes established, impacts would be further reduced and become insignificant.

The Landscape and Visual Impact Assessment report also indicates that the topography of the region surrounding the Project, in the vicinity of the Muswellbrook-Jerrys Plains Landscape Conservation Area and equine and viticulture enterprises provides mitigation against a cumulative visual impact from most viewing locations. Being an underground mine, the Project has minimal visual impact on sensitive receptors. The mine entry area and transport and services corridor were also designed to minimise the potential visual impacts. As the visual impacts of these components are considered low, there would be minimal increase in cumulative visual impacts from the Project.

4.3.8 Net public infrastructure costs

It is also relevant to consider the extent to which the Base Case and Project Case will require additional expenditure on public infrastructure by government, after accounting for any portion of those costs which are to be paid for by Malabar.

In the context of the Project, it is noted that the cost of all proposed infrastructure relocations will be paid for by Malabar. These costs have been included in the capital cost estimates. In addition, it is anticipated that any further public infrastructure costs will be covered by a Voluntary Planning Agreement with the Muswellbrook Shire Council. This is covered in Section 4.3.1. No net public infrastructure costs are anticipated for the Base Case.

4.4 Overall cost benefit analysis results

Given the values assigned to each item in 4.3, it is estimated that the Project will deliver a net incremental economic benefit to the NSW community of approximately $1,010 million in present value terms over the period from 2019 to 2055.

Table 4.11 presents the overall results of the CBA for the NSW community, while Table 4.12 provides a detailed summary of the results by item. Each estimate is presented in 2018 price terms and measured in NPV terms assuming cashflows occur at the end of the year and is discounted back to the start of 2018 using a 7% discount rate.

The additional royalties to the NSW Government is the main incremental benefit to NSW of the Project in relation to the Base Case. The key incremental costs of the Project (within the NSW community) are the additional external costs, such as the cost of greenhouse gas emissions.

As recommended in NSW Government Guidelines, where it is difficult to place a value on a particular cost or benefit of the Project, a qualitative analysis has been undertaken.

Table 4.11: Overall CBA results for NSW community

Item	Value (NPV $m)
Incremental benefits to NSW	$1,034
Incremental costs to NSW	($24)
Overall net benefit of Project for NSW community	$1,010

Note: Numbers in this table may not add up due to rounding.

Source: Deloitte Access Economics calculations.

Table 4.12: Breakdown of CBA results by item

Item	Base Case (NPV $m)	Project Case (NPV $m)	Incremental (NPV $m)	NSW community share (%)	Incremental benefit to NSW (NPV $m)	Incremental cost to NSW (NPV $m)
Net producer surplus	($70)	$1,031	$1,101	48%	$524	-
Royalties	-	$342	$342	100%	$342	-
Company income tax	-	$525	$525	32%	$168	-
Net benefit to existing landholders+	-	($0.4)	($0.4)	100%	-	($0.4)
Economic benefit to workers*	-	-	-	-	-	-
Economic benefit to suppliers*	-	-	-	-	-	-
Net environmental, social and transport-related benefits	-	($65)	($65)	See Table 4.7	-	($24)
Net public infrastructure costs	-	-	-	-	-	-
Total	**($70)**	**$1,833**	**$1,903**	**-**	**$1,034**	**($24)**

Based on NSW population relative to Australian population.

* These items are discussed qualitatively in Sections 4.3.5 and 4.3.6.

+ Net benefit to existing landholders includes assessment of foregone revenue from reduction in grazing activity.

Note: Numbers in this table may not add up due to rounding.

Source: Deloitte Access Economics calculations.

4.5 Sensitivity analysis

The CBA results presented above are subject to the assumptions and valuations applied to each cost and benefit, as outlined in Section 4.3. Accordingly, it is necessary to test the sensitivity of the estimate of net economic benefit by also considering upper and lower bound discount rates. 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.

Sensitivity analysis has been undertaken in accordance with the recommendations in the Guidelines (see Section 2.2) - using a lower bound discount rate of 4% and an upper bound discount rate of 10%. 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.[52]

Table 4.13: Central CBA results – alternative discount rates

Discount rate	Overall net incremental benefit of Project Case for NSW community ($m, NPV)
4%	1,672
7%	1,010
10%	625

Source: Deloitte Access Economics calculations.

In all three scenarios, the Project is estimated to deliver a net benefit for the NSW community, that is, the benefits for NSW are estimates to exceed the costs of the Project borne by NSW, including the quantifiable externality costs. The estimate of net economic benefits for NSW range from around $625 million to $1,672 million, a respective 38% decrease and 66% 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 relevant CBA guidelines.

The variations undertaken as part of this analysis include (Table 4.14):

- Sustained increase in export coal price forecasts by 25% (upper sensitivity scenario).
- Sustained decrease in export coal price forecasts by 25% (lower sensitivity scenario).
- Increase in incremental royalties by 25%.
- Decrease in incremental royalties by 25%.
- Increase in Project Case company tax by 50%.
- Decrease in Project Case company tax by 50%.
- Pricing the cost of carbon according to alternative prices used in the Australian Treasury Clean Energy Future Policy Scenario (366% higher than the prices used in the central case scenario, on average).
- Pricing the cost of carbon according to alternative US EPA Social Cost of Carbon estimates (73% 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 May 2018, or approximately 23 years – the longest period of prices available as reported on IndexMundi.[53] The analysis involved testing different sensitivity

[52] Arrow, K J, Cropper, M L., Gollier, C, Groom, B, Heal, G, M, Newell, R, G, Nordhaus, W, D, Pindyck, R, S, Pizer, W, A., Portney, P, R., Sterner, T, Tol, R.S.J, and Weitzman, M, L. 'How Should Benefits and Costs Be Discounted in an Intergenerational Context?' (2012), <http://www.rff.org/RFF/Documents/RFF-DP-12-53.pdf>.
[53] IndexMundi, *Australian thermal coal monthly price* <https://www.indexmundi.com/commodities/?commodity=coal-australian&months=360&currency=aud visited on 23 April 2019>.

rates to ensure that the range of prices could capture a representative range of historical monthly coal prices. Deloitte Access Economics has arrived at using a lower (upper) sensitivity scenario of -25% (25%), placing the minimum (maximum) contract price for thermal coal at the 44th (99th) percentile. This achieves a range that covers 55% of the range of historical monthly coal prices over this period.

The alternative prices for the cost of carbon have been identified in the Review of the NSW Energy Savings Scheme.[54] As the cost of carbon series used in both the central case of the CBA and this sensitivity analysis rely on assumptions that are not completely transferable to the Australian context, the sensitivity analysis series have been used to provide a range of the potential costs associated with greenhouse gas emissions.

Table 4.14: Sensitivity Analysis – comparison of net benefits for NSW

Parameter	Variation in parameter	Net benefits ($m)		
		4%	7%	10%
Central CBA	N/A	$1,672	$1,010	$625
Export coal price forecasts	(25)%	$714	$384	$199
	25%	$2,630	$1,636	$1,052
Incremental royalties	(25)%	$1,603	$965	$595
	25%	$1,740	$1,055	$656
Project Case company income tax	(50)%	$1,739	$1,051	$651
	50%	$1,605	$969	$599
Social cost per tonne of carbon emissions	366%	$1,565	$943	$581
	73%	$1,649	$995	$615

Source: Deloitte Access Economics calculations.

[54] NSW Government 'Review of the NSW Energy Savings Scheme, Part 2: Options Paper' (2015), <http://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0010/558865/part-2-options-paper-april-2015.pdf>.

5 Local effects analysis

This chapter sets out the LEA for the Project Case. The LEA addresses the requirement of section 4.15(2) of the EP&A Act, which specifically requires an assessment of employment effects of the Project Case with reference to the "Locality".

The LEA is a complement to the CBA for NSW and is largely based on information already presented in the CBA. The LEA translates the effects estimated at the state level to the impacts on the communities located near the Project site.

There are a number of important points when considering the results of the LEA. First, the results are not additive to those in the state-level CBA. Second, it is not intended that the components of an LEA can be added together to provide a single summary measure – each item reported below presents a different local effect. Finally, the LEA does not measure economic welfare outcomes.

This chapter starts with a description of the Locality, defined as the Upper Hunter SA3. This is followed by an analysis of the four areas covered by the LEA: local employment effects, local non-labour expenditure effects, effects on other local industries, and environmental, social and transport externalities. The chapter concludes with the results of CGE modelling of the flow-on effects for the Locality.

5.1 Background on the Locality and population

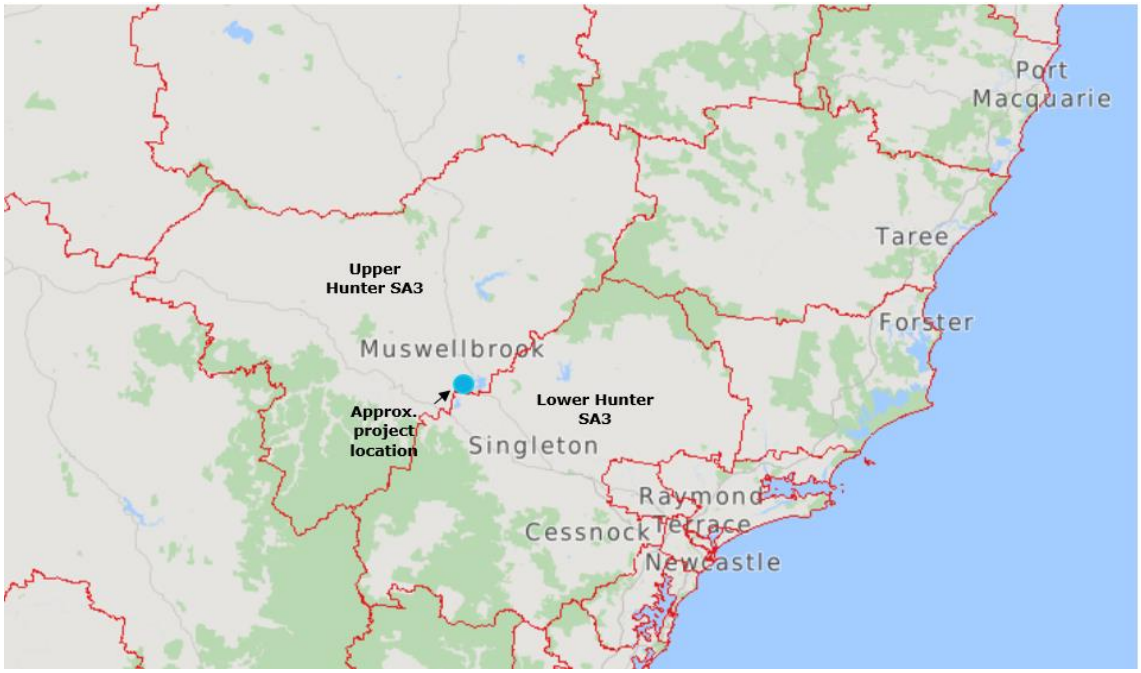
The Project is located about 16 km south of Muswellbrook in the Upper Hunter Valley.

The NSW Government Guidelines indicate that the locality used for the LEA should be defined as the SA3 containing the Project. The Project lies entirely within the Upper Hunter SA3. Accordingly, the Upper Hunter is the region used for the LEA. The area includes Muswellbrook and Upper Hunter LGAs.

However, the Project lies within close proximity to the Lower Hunter SA3 (as can be seen from Figure 5.1, which maps the approximate location of the Project, and the surrounding SA3 boundaries). Accordingly, by undertaking the LEA in accordance with the Guidelines, there are likely to be direct and flow-on effects to the Lower Hunter (including Singleton LGA) not captured in the LEA. Indeed, the workforce required to establish and operate the mine will come from the broader Hunter region – which has a skilled mining workforce.[55]

[55] Elliott Whiteing Social Planning Solutions, *Maxwell Project – Social Impact Assessment* (report commissioned by Malabar Coal Limited, 2019).

Figure 5.1: Project location and borders of relevant and nearby SA3s



Source: Australian Bureau of Statistics, Deloitte Access Economics.

5.1.1 Population

The population of the Upper Hunter SA3 was just over 30,000 (or 0.4% of NSW's population) at the time of the 2016 Census. Average population growth in the region in the 10 years to 2016 was approximately 0.7% per annum, which is lower than the average annual population growth in NSW (1.4%) and in the neighbouring Lower Hunter SA3 (1.5%) over the same period.[56]

Several other population statistics for the Upper Hunter SA3 are outlined in Table 5.1 below.

Table 5.1: Population characteristics of Upper Hunter SA3, 2006, 2011, 2016

Population characteristics	2006	2011	2016	2006-2016 change
Population	28,208	29,548	30,196	7.05%
Average household size	2.5	2.5	2.5	0.00%
Median age	36	36	38	5.56%
Total occupied private dwellings*	10,842	11,504	11,833	9.14%
Median mortgage repayment ($/monthly)	$1,200	$1,733	$1,700	41.67%
Median rent ($/week)	$140	$200	$240	71.43%
Median total household income ($/week) – Upper Hunter SA3	$983	$1,242	$1,291	31.33%
Median total household income ($/week) – NSW	$1,039	$1,233	$1,482	42.64%

* Calculated from the count of occupied private dwellings, dwelling structure by household composition and family composition.

Source: Australian Bureau of Statistics, *2016 Census of Population and Housing, Time Series Profile*, Cat No. 2003.0.

[56] Australian Bureau of Statistics, *2016 Census of Population and Housing, Time Series Profile*, Cat No. 2003.0.

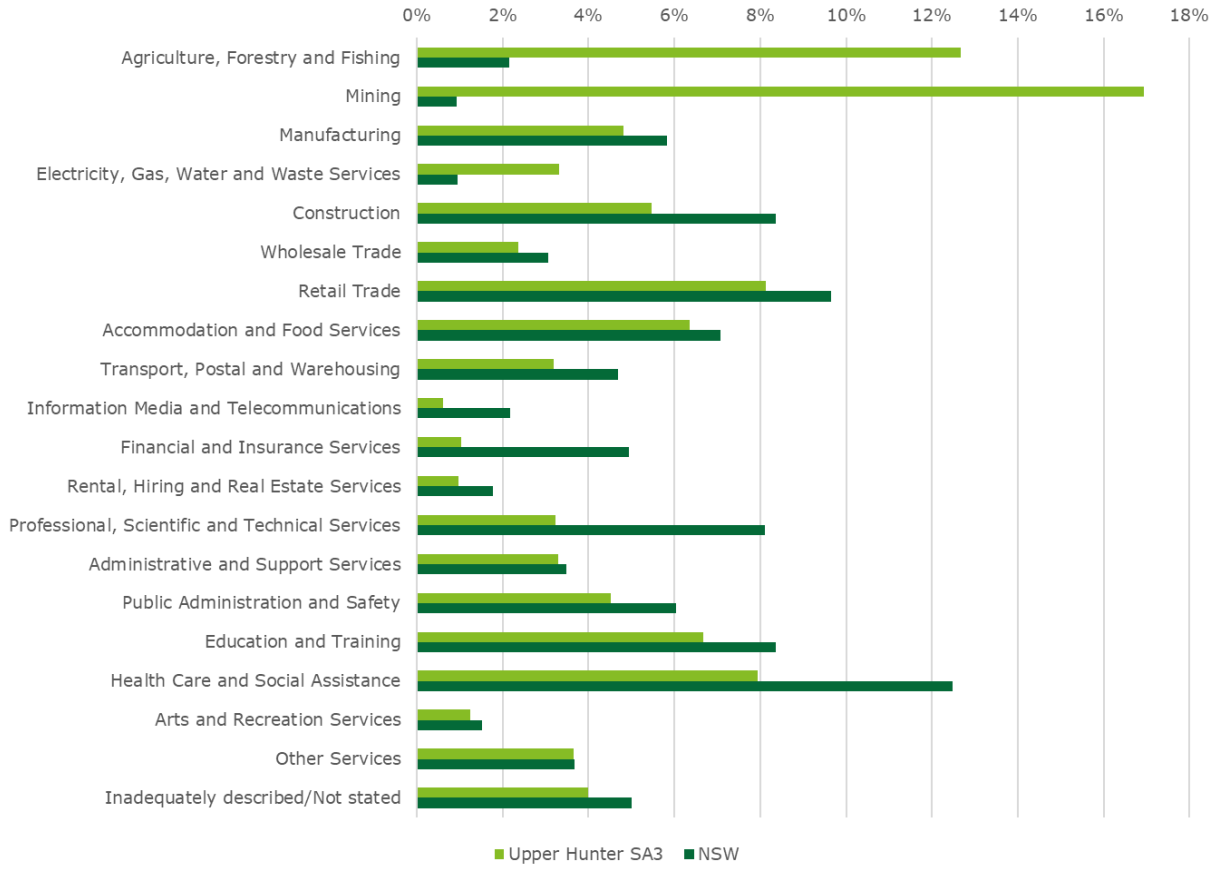
5.1.2 Industries of employment

Mining is the major industry of employment within the Locality, employing 17% of the employed population at the time of the 2016 Census (see Chart 5.1). This is similar to the neighbouring Lower Hunter SA3, where the mining industry accounted for 13% of the total employed population.[57] For both localities, employment in the mining industry in substantially higher than in NSW as a whole where just 1% of the total employed population works in the mining industry.

Further, at the time of the 2016 Census, mining was the highest paying industry in the Locality, with an average weekly wage substantially higher than the average across all industries (see Chart 5.2). Within the mining industry, the vast majority of employment is in coal mining (accounting for 92% of mining industry employment in the Upper Hunter, and 91% in the Lower Hunter).[58]

Coal mining has a long history in the Hunter region. Coal mining in Australia commenced in Newcastle during the 1790s, and a coal shipment from Newcastle in 1799 was Australia's first commodity export.[59] More recently, as reported in a 2018 report, the Hunter Valley accounted for more than half (64%) of NSW's coal production.[60]

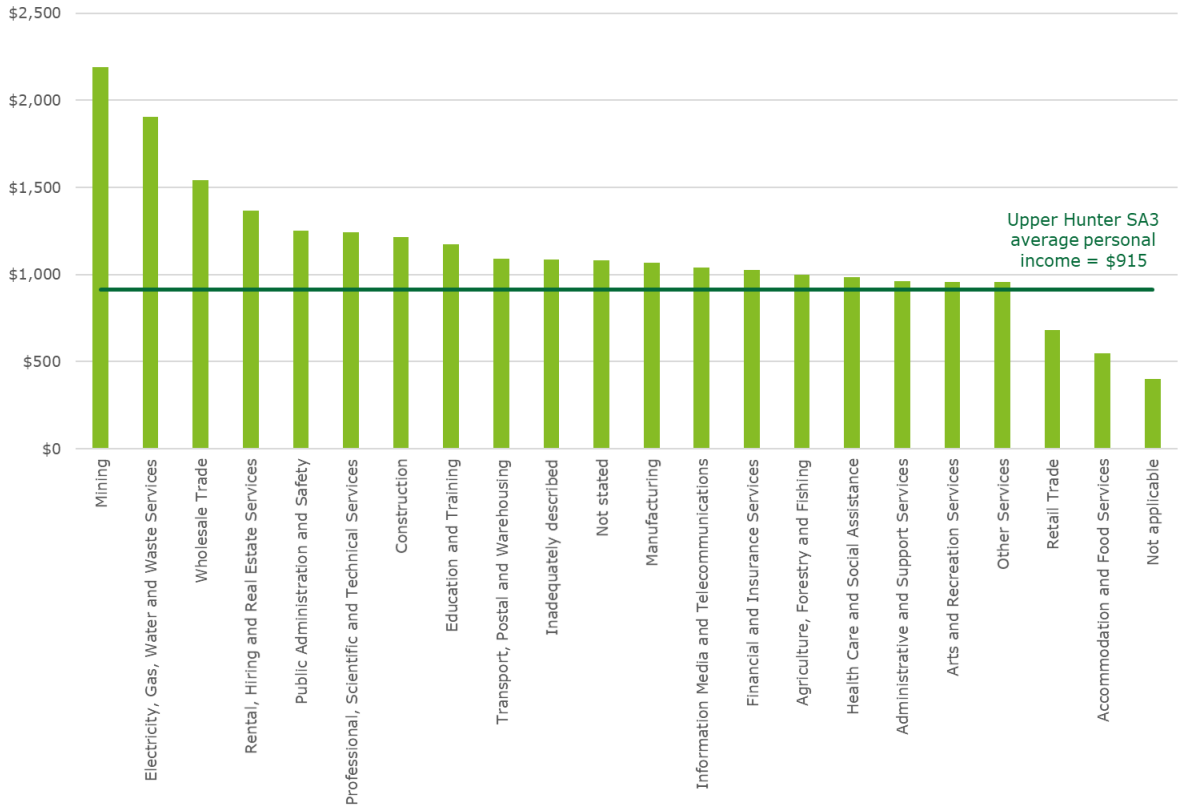
Chart 5.1: Industry of employment, Upper Hunter SA3 and New South Wales



Source: Australian Bureau of Statistics, *2016 Census of Population and Housing, Time Series Profile*, Cat No. 2003.0.

[57] Australian Bureau of Statistics, *2016 Census of Population and Housing, Time Series Profile*, Cat No. 2003.0.
[58] Australian Bureau of Statistics, *2016 Census of Population and Housing*.
[59] NSW Minerals Council, *NSW Mining History* (2013), NSW Mining, <http://www.nswmining.com.au/industry/nsw-mining-history>.
[60] Austrade, *Australian capability across the coal supply chain* (2018).

Chart 5.2: Upper Hunter SA3 average weekly personal income by industry – 2016 ($2016)



Source: Australian Bureau of Statistics, *2016 Census of Population and Housing*.

The agriculture, forestry and fishing industry is the second largest employer in the Locality. Agriculture, forestry and fishing employed 13% of the employed population at the 2016 Census (see Chart 5.1). This is substantially higher than in the Lower Hunter SA3 (3% of the total employed population) and the whole of NSW (2%).[61]

Within the agriculture, forestry and fishing industry, the Upper Hunter is particularly well-regarded for equine and viticulture. The Upper Hunter's equine industry is concentrated in Scone, and extends into Muswellbrook and Murrurundi.[62] The Locality is internationally renowned for thoroughbred breeding.[63] With 75 studs, the Locality has the second largest concentration of thoroughbred breeding studs in the world (behind Kentucky, US),[64] and is recognised as one of three international centres of 'thoroughbred breeding excellence' (alongside Kentucky, US and Newmarket, UK).[65] Supporting the Locality's thoroughbred breeding is a number of equine health, training and research services including the largest equine hospital in the southern hemisphere

[61] Australian Bureau of Statistics, *2016 Census of Population and Housing, Time Series Profile*, Cat No. 2003.0.
[62] Regional Development Australia Hunter, *2019 Hunter Investment Prospectus* (Hunter Business Publications), <http://rdahunter.org.au/hunter-region/hunter-investment-prospectus>.
[63] Department of Planning and Infrastructure (NSW), *Upper Hunter Strategic Regional Land Use Plan* (2012), <https://www.planning.nsw.gov.au/-/media/Files/DPE/Plans-and-policies/strategic-regional-land-use-plan-upper-hunter-2012-09.pdf?la=en>.
[64] Regional Development Australia Hunter, *2019 Hunter Investment Prospectus* (Hunter Business Publications), <http://rdahunter.org.au/hunter-region/hunter-investment-prospectus>.
[65] Regional Development Australia Hunter, *2019 Hunter Investment Prospectus* (Hunter Business Publications), <http://rdahunter.org.au/hunter-region/hunter-investment-prospectus>; Department of Primary Industries (NSW), *Upper Hunter Region Equine Profile* (2013), <https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/471027/equine-profile-upper-hunter-region.pdf>; Scone Chamber of Commerce and Industry Inc, Hunter Thoroughbred Breeders Association (2018), <https://www.sconechamber.com.au/member-directory/hunter-thoroughbred-breeders-association/>.

(the Scone Equine Hospital) and the Hunter Valley Equine Research Centre; and specialist education and training at Scone TAFE and Tocal Agricultural College.[66]

In recognition of the competing land-uses between agriculture and resource development in the Upper Hunter, the NSW Government has defined equine and viticulture 'critical industry clusters' (CICs) in the Upper Hunter. According to the NSW Government, classification as a CIC is recognition that there is a concentration of highly productive and related industries within a region, which contribute to the region's identity and are a source of significant employment opportunities.[67] The CICs create a link between the region's major industries, agriculture and mining, with mining subject to additional approvals within these defined CICs.[68]

5.1.3 Unemployment

At the end of March 2019, the unemployment rate in the Upper Hunter SA3 was approximately 5.4%.[69] This compares to the regional NSW average of 5.4%, and the state-wide average of 4.5% over the same period.[70]

As shown in Figure 5.2, the unemployment rate has been substantially higher in the Muswellbrook SA2, where the Project is located, as compared to other SA2s in the Locality, and the averages across regional NSW and the state.[71]

[66] Regional Development Australia Hunter, *2019 Hunter Investment Prospectus* (Hunter Business Publications), <http://rdahunter.org.au/hunter-region/hunter-investment-prospectus>; Department of Primary Industries (NSW), *Upper Hunter Region Equine Profile* (2013), <https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/471027/equine-profile-upper-hunter-region.pdf>; Scone Chamber of Commerce and Industry Inc, Hunter Thoroughbred Breeders Association (2018), <https://www.sconechamber.com.au/member-directory/hunter-thoroughbred-breeders-association/>.

[67] Department of Planning and Environment (NSW), *Critical Industry Clusters in the Upper Hunter* (2018), <https://www.planning.nsw.gov.au/Policy-and-Legislation/Mining-and-Resources/Critical-Industry-Clusters-in-the-Upper-Hunter>.

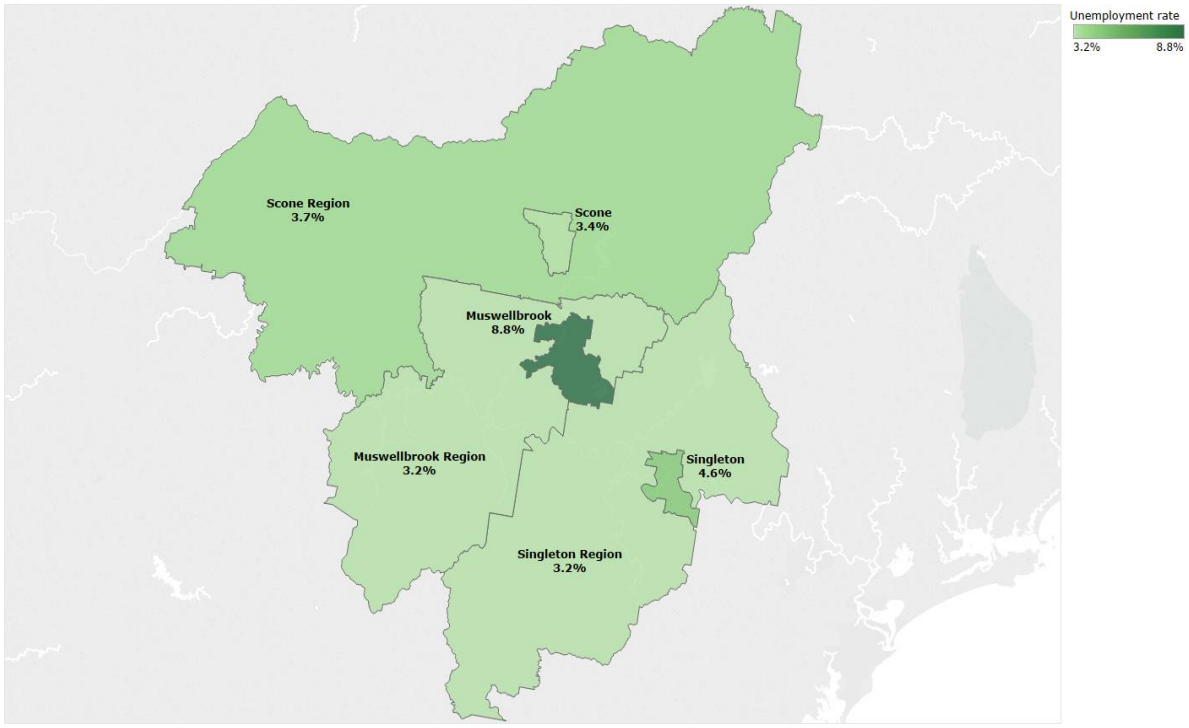
[68] For further information about the implications for mining in CICs see: Department of Planning and Environment (NSW), *Critical Industry Clusters in the Upper Hunter* (2018), <https://www.planning.nsw.gov.au/Policy-and-Legislation/Mining-and-Resources/Critical-Industry-Clusters-in-the-Upper-Hunter>.

[69] This is a weighted average of the four SA2s that lie within the Upper Hunter SA3. The weights applied represent each SA2's share of the sum of the labour force across the four SA2s.

[70] Department of Jobs and Small Business (Commonwealth), *Small Area Labour Markets - March quarter 2019* (2019), <https://www.jobs.gov.au/small-area-labour-markets-publication>.

[71] Australian Bureau of Statistics, *2016 Census of Population and Housing, Time Series Profile*, Cat No. 2003.0.

Figure 5.2: Average unemployment rate, SA2s in the Upper Hunter Locality and NSW, September 2017 – September 2018



Source: Department of Jobs and Small Business (Commonwealth), *Small Area Labour Markets - September quarter 2018* (2018).

5.2 Local employment effects

One of the primary effects of a mining project is generating employment within the Locality.

The Project will directly employ people. Of these, a portion will ordinary reside in the Locality; the remainder will temporarily reside in, or commute to, the Locality for their employment.

The **direct local employment effects** capture the benefits associated with the Project's employment of those that ordinarily reside within the Locality. In the LEA, the Guidelines require estimation of the **net effect** – that is, the additional employment and income generated by the Project, above what would have occurred in the absence of the Project (i.e. in the Base Case). This approach recognises that many of the potential employees of the Project would find employment elsewhere, if the Project is not to go ahead. For instance, in the absence of the Project, they may work at a different mine in a similar role, or they may find employment in another industry.

The **local flow-on or second round effects** captures the effects associated with the Project's direct employment of those that ordinarily live in, or would temporarily reside in, or commute to, the Locality. Additional expenditure within the Locality from these employees leads to additional second-round employment within the Locality. For example, workers at the site may spend some of their additional income at shops within the Locality, which in turn, helps to support additional employment at these shops.

This section presents the results of the (net) direct local employment effects. Section 5.7 presents the results of the local flow-on and second round effects.

As set out in the NSW Government Guidelines, the measurement of the direct local employment effects involves:

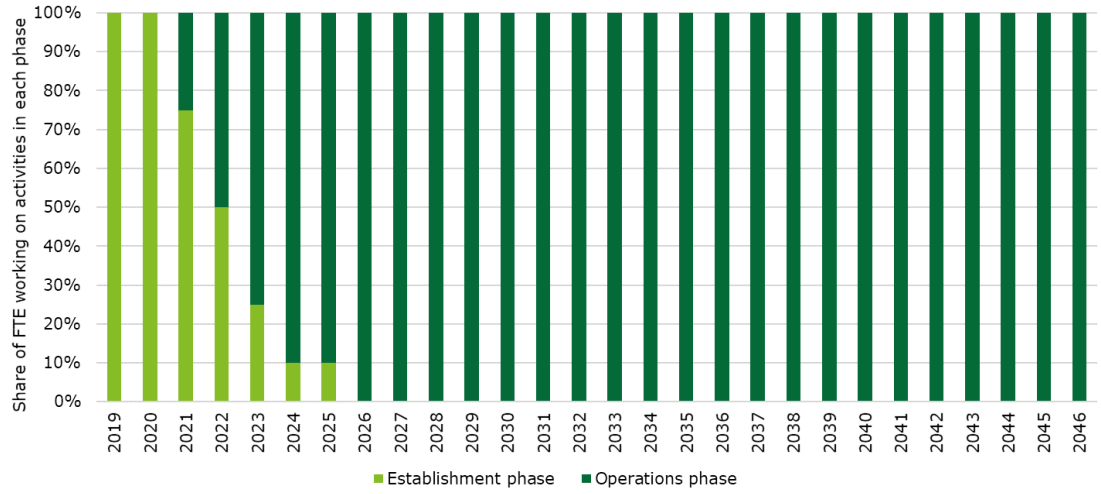
- identifying the direct employment by the Project of those that would ordinarily reside in the Locality
- comparing average incomes for Project employees to average incomes in the Locality to estimate a net increase in income from employment at the Project.

The local employment effects, using this approach, are reported in Table 5.2 and Table 5.3 below. The analysis compares the average income for Project employees with the average income for mining employees in the Locality and the average income in the Locality overall.

The results provided are an average for the Project in the establishment phase and ongoing operations phase, respectively. For the purposes of this analysis, the establishment phase is defined as being from 2019 to 2025, while the ongoing operations phase is defined as being from 2021 to 2046. In those overlapping years, assumptions have been made about the share of FTE. More specifically, FTEs are calculated using data on direct employment and the share of this employment held by those ordinarily residing with the Locality. Malabar provided the data, with the data on employment being in FTE terms.

Over time, the share of FTE working on establishment phase activities are expected to gradually decline, while the share of operations phase employees increases. Chart 5.3, below, captures this.

Chart 5.3: Share of FTE by working on establishment and operations phase activities



Source: Deloitte Access Economics calculations.

Project employees' wages are based on information provided by Malabar. The average income in the mining industry in the Locality and average income in the Locality across all industry sectors was sourced from the 2016 ABS Census adjusted to 2018 prices using the Private Sector Mining Wage Price Index.[72] Estimates of net (post-tax) income were then developed using the individual income tax rates provided by the Australian Taxation Office.[73]

The Project is estimated to directly employ 42 local people on average annually during the establishment phase and 121 people during the ongoing operations, measured in FTE terms, incremental to the Base Case. The local share of employment has been estimated by Malabar at around 36% in the establishment phase and 46% in the operations phase (it is important to note that these figures exclude people employed by the Project in the Singleton LGA).

[72] Australian Bureau of Statistics, *Wage Price Index, Australia, December 2018,* Cat. No. 6345.0 (20 February 2019).
[73] Australian Taxation Office, *Individual income tax rates* <https://www.ato.gov.au/Rates/Individual-income-tax-rates/>.

This local employment is estimated to boost net income in the Locality. On the assumption that the employees ordinarily residing in the Locality would otherwise earn the average income across all industries if they were not employed by the Project, the incremental, per annum increase in income is $2.7 million during the establishment phase and $7.6 million during the ongoing operations phase.

The incremental, per annum increase in income is lower, if it is assumed that the employees would ordinarily earn the average income in the mining industry in the Locality as in Table 5.2. To be conservative, the additional income relative to average income in the mining industry is applied in the LEA summary results presented in Section 5.6.

Table 5.2: Estimated local employment effects relative to mining industry employment in the Locality – Incremental to Base Case

		Establishment phase		Operations Phase	
		Ordinarily resident in Locality	Not ordinarily resident in Locality	Ordinarily resident in Locality	Not ordinarily resident in Locality
Direct employment*	FTE/year	42	76	121	142
Average net FTE income for Project employees	$/year	$100,840	$100,840	$100,840	$100,840
Average net FTE income in mining industry	$/year	$76,593	$76,593	$76,593	$76,593
Average increase in net income per employee	$/year	$24,247	$24,247	$24,247	$24,247
Increase in net income per year due to direct employment	$m	$1.0	$1.8	$2.9	$3.4
FTE equivalent of the incremental wage	FTE/year	13	24	38	45

* Note: These FTE numbers are averaged over the respective phases of the Project. The establishment phase is defined as being from 2019 to 2025, while the ongoing operations phase is defined as being from 2021 to 2046.
Source: Deloitte Access Economics calculations.

Table 5.3: Estimated local employment effects relative to average employment in the Locality – Incremental to Base Case

		Establishment phase		Operations Phase	
		Ordinarily resident in Locality	Not ordinarily resident in Locality	Ordinarily resident in Locality	Not ordinarily resident in Locality
Direct employment*	FTE/year	42	76	121	142
Average net FTE income for Project employees	$/year	$100,840	$100,840	$100,840	$100,840
Average net FTE income in Locality	$/year	$37,569	$37,569	$37,569	$37,569
Average increase in net income per employee	$/year	$63,271	$63,271	$63,271	$63,271
Increase in net income per year due to direct employment	$m	$2.7	$4.8	$7.6	$9.0
FTE equivalent of incremental wage	FTE/year	72	127	203	239

* Note: These FTE numbers are averaged over the respective phases of the Project. The establishment phase is defined as being from 2019 to 2025, while the ongoing operations phase is defined as being from 2021 to 2046.
Source: Deloitte Access Economics calculations.

5.3 Non-labour expenditure effects

In addition to employment, the other major economic effect of the Project on the Locality is expenditure on ongoing non-labour inputs[74] which will have broader economic impacts. The Project will require a range of ongoing non-labour inputs such as mining consumables, equipment spares, fuel and professional services, which will be sourced from businesses within the Locality. Expenditure on such ongoing non-labour inputs within the Locality will generate local economic activity.

The NSW Government Guidelines restrict the estimated effects of non-labour expenditure in an LEA to the direct expenditure made by the Project in the Locality. The NSW Government Guidelines do not require consideration of the net effect of local non-labour expenditure.

Table 5.4 below shows the breakdown of the total direct non-labour operating expenditure in the establishment and ongoing operations phases that is expected to be incurred in, and outside of, the Locality. Direct non-labour operating expenditure is estimated as a function of deposit average thickness, capital costs, and the daily production rate, with adjustments for coal processing costs, overheads and distribution and selling expenses. The share of expenditure in the Locality was calculated with reference to supplier expenditure location data provided by Malabar.

[74] Ongoing expenditure is useful for considering the ongoing benefit to the locality as a result of the Project. Ongoing non-labour expenditure is equal to total ongoing expenditure (includes operating expenditure and other ongoing costs) less total ongoing labour expenditure.

Table 5.4: Estimated local operating expenditure effects – incremental to Base Case

		Establishment phase		Operations Phase	
		In Locality	Outside Locality	In Locality	Outside Locality
Total direct expenditure	$m/year	$2	$6	$43	$114

Source: Deloitte Access Economics calculations.

As can be seen above, Malabar is estimated to directly spend $2 million a year on average during the establishment phase and $43 million a year on average during ongoing operations on non-labour operating expenditure associated with the Project. The local share of total expenditure is around 28% in the establishment phase and 28% in the operations phase. This is likely to underestimate the local share of operating expenditure, given that the proportions are based on the location of non-labour supplier expenditure that is directly reliant on the Project. Data on the location of supplier employees indicate that the share of supplier expenditure concentrated in the Locality could be higher than assumed here.

There would also be some additional local expenditure effects associated with the capital expenditure to be incurred by Malabar. In the absence of data on the geographical distribution of capital expenditure, these effects are acknowledged qualitatively in this analysis.

5.4 Effects on other local industries

The development of a mining project can have effects on other local industries, even when there are no direct monetary links between the Project and the local economy. This may occur through the purchase of goods and services or through the generation of additional labour earnings.

The Guidelines provide some examples of where a mining relating project can have effects on local industries:

- displacement of a specific land use
- tourism and business travel
- short-run market adjustments in the cost of living for local residents particularly in food and housing markets.

The NSW Government Guidelines require a qualitative discussion of these issues, and where possible, identification of who is affected and strategies to mitigate the impact.

The Project does not represent a significant change from current land use practices. The Maxwell Project will continue make use of the substantial existing mining facilities that are available at the Maxwell Infrastructure site.[75] The landform above the underground mine area is open paddock grazing land. Agricultural activities would continue during the Project above proposed underground mining areas with a relatively small net area of agricultural land and hence production will be required for surface infrastructure for the life of the Project and for biodiversity offsets *in-perpetuity*. [76]

Based on current agricultural land management practices, this can potentially contribute to foregone revenue from agricultural grazing of $44,286 per annum. With improved agriculture and other land management activities, these potential impacts can be completely ameliorated or production could even be increased with negligible impact on agricultural production at the property, site or regional scale.

A number of key design measures and constraints have been incorporated as part of the Project by Malabar in response to stakeholder feedback and to avoid and mitigate potential impacts on other land uses and tourism. For example, placement of the mine entry area in a natural valley, and

[75] Malabar Coal Limited, *Maxwell Project – Scoping Report* (2018).
[76] 2rog Consulting, *Maxwell Project Agricultural Impact Statement* (report commissioned by Malabar Coal Limited, 2019).

reducing the height of infrastructure components, to restrict direct views of the mine entry area from the Golden Highway and neighbouring horse studs. The Agricultural Impact Statement concludes that any potential residual land use conflicts with surrounding agricultural and mining land uses can be adequately mitigated through the proposed management strategies.[77]

Finally, employment effects from the Project are expected to be small relative to the current available labour force in the Locality, as the majority of workers required are to be drawn from the broader Hunter area. Therefore, there would not be any material change to supply or demand in local markets and so it is not expected that there would be any short run market adjustments in the cost of living for local residents.

The potential impacts on the Coolmore Stud and Godolphin Woodlands Stud properties has been analysed in detail in other parts of the EIS. In particular, visual impacts of the Project have been analysed by Van Pelt & Allen Visual Planning and Assessment. Views of the Project's surface components would be largely screened at nearby equine enterprises by the topography to the north of the Golden Highway. There would be no views of the mine entry area from anywhere on the Coolmore Stud and Godolphin Woodlands Stud properties. At the highest vantage points on these properties, a section of the transport and services corridor and covered overland conveyor would be potentially visible (at a distance between 7.5 km and 7.7 km from the viewer) and would take up a very small portion of the primary view (<1%), which significantly reduces discernible components. Air quality, noise, subsidence, road transport, social impact, health risks, surface water and ground water have also been considered with the conclusion in all cases that there will be negligible effects on the studs' operations resulting from the Project. The Agricultural Impact Statement analysed potential impacts on surrounding land uses based on the other specialist studies and concluded that any potential residual land use conflicts with surrounding agricultural and mining land uses can be adequately mitigated through the proposed management strategies.

5.5 Environmental, social and transport effects

Externalities (both positive and negative) are a major way in which the Locality is affected by the Project. For example, much of the increased employment, improved incomes, noise, dust and additional traffic generated by the Project affect those normally residing in the Locality. Similarly, any infrastructure investment made by the Project also benefits those normally residing in the Locality.

The NSW Government Guidelines indicate that an LEA should start with the externalities investigated in the CBA and identify those that create material, un-mitigated effects within the Locality. The portion of the costs measured in the CBA that are incurred within the Locality should then be reported in an LEA. Similarly, for externalities acknowledged qualitatively in the CBA, the local effects should be discussed qualitatively in the LEA.

Of the environmental, social and transport effects discussed in Section 4.3.7, those that create local effects are:

- Aboriginal heritage
- air quality
- ambient noise
- biodiversity
- greenhouse gas emissions
- surface water and groundwater
- non-Aboriginal heritage
- subsidence
- traffic and transport
- visual amenity.

Table 5.5 below shows the effects that can be quantified and attributed to the Locality. The process to attribute these costs to the Locality has generally been to identify what percentage of

[77] 2rog Consulting, *Maxwell Project Agricultural Impact Statement* (report commissioned by Malabar Coal Limited, 2019).

the consequences would be felt within the Locality and then apply this percentage to the total cost estimated in Section 4.3.7. In particular, air quality, noise, traffic and transport costs were entirely allocated to the Locality. Greenhouse gas costs were apportioned to the Locality based on its share of the Australian population.

Table 5.5: Estimated local externality effects ($m/year) – incremental to Base Case

	Establishment phase		Operations Phase	
	In Locality	Outside Locality	In Locality	Outside Locality
Aboriginal heritage*	-	-	-	-
Air quality	($0.1)	-	($0.2)	-
Ambient noise	($0.0)	-	($0.0)	-
Biodiversity	-	-	-	-
Greenhouse gas emissions	($0.0)	($1.2)	($0.0)	($7.2)
Water	-	-	-	-
Non-Aboriginal heritage*	-	-	-	-
Subsidence*	-	-	-	-
Traffic and transport	($0.2)	-	($0.2)	-
Visual amenity*	-	-	-	-

* Potential impacts have been considered qualitatively.

Source: Deloitte Access Economics calculations.

In summary, the externalities which are dealt with qualitatively are:

- Aboriginal heritage: The affected sites are all within the Locality however, these costs may be more broadly spread among individuals who feel a cultural or historical connection to the affected sites.
- Non-Aboriginal heritage: the Historic Heritage Assessment for the Project concludes that no heritage sites would be directly impacted by the Project. It has also been assessed that the Project will not result in any material adverse cumulative impacts to heritage places.
- Subsidence: the analysis provided in Section 4.3.7 indicates that the Project would have limited impacts on built features and that proposed monitoring and management of subsidence would be able to mitigate any potential impacts. In this sense, it is unlikely that there will be significant costs borne by the Locality.
- Visual amenity: The underground mine would have inherently low visual impacts because the mining operation would be underground. Further, impacted views to the mine entry area and transport and services corridor are minimal and limited to a few locations in the west and distant south areas to the Project. Being an underground mine, the Project has minimal visual impact on sensitive receptors. As the visual impacts of these components are considered low, there would be minimal increase in cumulative visual impacts for the Locality from the Project.

5.6 LEA results

The combination of results from the above analysis of local employment effects, local non-labour expenditure effects, effects on other local industries, and environmental, social and transport externalities provides a view as to the effects of the Project on the Locality, that is, the Upper Hunter SA3.

When referring to, and interpreting, the LEA results, it is important to note that:

- The LEA results are not additive to those in the state-level CBA; the LEA results are a subcomponent of that already largely covered in the CBA.
- The LEA components should not be added together to provide a single summary measure; each item captures a different local effect.
- The LEA does not measure economic welfare outcomes.

It is important to also note that the two phases in the Project overlap, which affects the number of FTE employed for either construction or operations related activities. Figure 5.3 below illustrates the timeline in which the phases are active and overlap.

Figure 5.3: Project timeline, by phase

Source: Malabar.

The Project is expected to employ approximately 42 FTE per year from the Locality during the establishment phase (Table 5.6) and 121 FTE per year from the Locality during the ongoing operations phase (Table 5.7), incremental to the Base Case. This direct employment is expected to result in a net increase in income in the Locality of $3 million a year during the establishment phase and $8 million a year during ongoing operations, equivalent to 72 and 203 additional FTEs, respectively. This assumes that these individuals would earn the average wage in the Locality if they were not employed at the Project.

In addition, the Project is expected to spend $2 million per year in the Locality on non-labour inputs during the establishment phase and $43 million per year during ongoing operations.

The Project also generates externality costs for the Locality. The largest externality cost is expected to be from traffic and transport for both phases of the Project individually and collectively. The total quantified value of externalities is estimated to be around $0.3 million per year during the establishment phase and $0.4 million per year during ongoing operations for the Locality.

Table 5.6: Estimated local effects – establishment phase

	Project direct (Total)	Project direct (Local)	Net income effect at Locality average wages (Local)
Employment			
FTE (per year)	118	42	72
Income ($m/year)			$3
Other non-labour expenditure ($m/year)			
Other non-labour expenditure	$9	$2	
Externalities ($m/year)			
Aboriginal heritage*	-	-	
Air quality	($0.1)	($0.1)	
Ambient noise	($0.0)	($0.0)	
Biodiversity	-	-	
Greenhouse gas emissions	($1.2)	($0.0)	
Non-Aboriginal heritage*	-	-	
Subsidence*	-	-	
Traffic and transport	($0.2)	($0.2)	
Visual amenity*	-	-	
Water	-	-	

* Potential impacts have been considered qualitatively.

Source: Deloitte Access Economics calculations.

Table 5.7: Estimated local effects – ongoing operations phase

	Project direct (Total)	Project direct (Local)	Net income effect at Locality average wages (Local)
Employment			
FTE (per year)	262	121	203
Income ($m/year)			$8
Other non-labour expenditure ($m/year)			
Other non-labour expenditure	$157	$43	
Externalities ($m/year)			
Aboriginal heritage*	-	-	
Air quality	($0.2)	($0.2)	
Ambient noise	($0.0)	($0.0)	
Biodiversity	-	-	
Greenhouse gas emissions	($7.2)	($0.0)	
Non-Aboriginal heritage*	-	-	
Subsidence*	-	-	
Traffic and transport	($0.2)	($0.2)	
Visual amenity*	-	-	
Water	-	-	

* Potential impacts have been considered qualitatively.

Source: Deloitte Access Economics calculations.

5.7 Economic impacts

This section estimates the flow-on impacts of the Project for the local and NSW economies. The section adopts a bottom up framework to determine the likely size, timing and location of the additional activity generated by the establishment and ongoing operations of the Project to the Locality and the rest of NSW. For this, we have relied on comprehensive data on the gross mining revenue and capital expenditure associated with the Project, described in Section 4.3.1. This commercial information includes forward development capital expenditures, production volumes and workforce requirements over the design and construction, and operational phases of the Project.

5.7.1 CGE methodology

Two main techniques used to measure the flow-on economic impacts of a major project are Input Output (IO) multiplier analysis or Computable General Equilibrium (CGE) modelling.

IO modelling is based on a system of accounts that shows the flow of economic resources between different industries and groups in the economy. IO modelling and the multipliers derived from it generally assume that there is an unlimited source of resources available in the economy to meet increases in demand.

CGE modelling is an extension of IO modelling, in that it is based on a database that incorporates input output tables and the transactional detail between economic agents. CGE models build on this by incorporating 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. This allows for economy-wide modelling of economic impacts that incorporates any "crowding-out" effects of the development.

In contrast to IO modelling, 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.

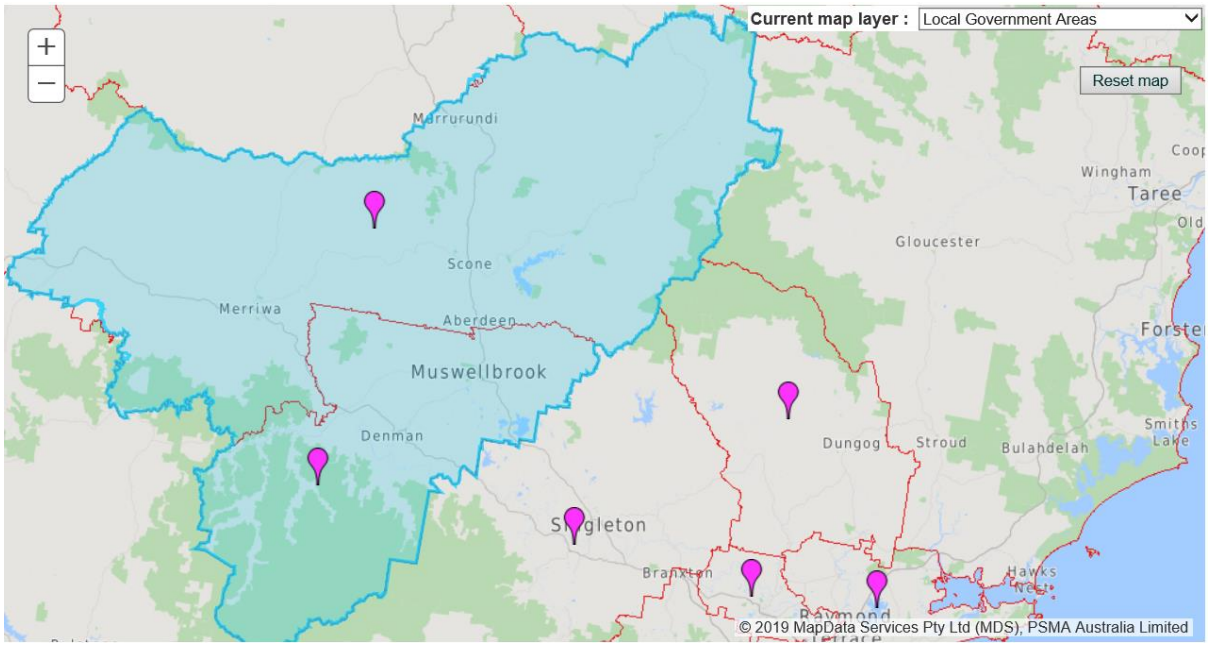
The economy-wide impacts of the Project have been projected using the Deloitte Access Economics Regional General Equilibrium Model (DAE-RGEM). The model projects macroeconomic aggregates such as GDP, employment and wages for the Project scenario against a reference case for each of the modelling years from 2019 to 2046. More technical detail regarding CGE modelling can be found in Appendix B.

The model has been disaggregated and customised to match the attributes of the broader Upper Hunter SA3 regional economy. To disaggregate the broader region from the rest of NSW in the model, information was used from the most recent 2016 Census on the workforce population.

Modelling has been undertaken for the period to 2039 for the following economic regions:

- **The Locality** — we have modelled a Locality as close to the Upper Hunter SA3 as is possible. The CGE model can be disaggregated at the level of LGAs and so we have represented the Locality using the LGAs of Upper Hunter and Muswellbrook.
- **New South Wales** — includes the rest of the State of New South Wales.

Figure 5.4: The Locality modelled in the CGE model compared to the Lower Hunter SA3



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 results are provided for the broader region, rest of NSW and total NSW.

Based on the gross mining revenue and capital expenditure, 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 Project.
- **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 local effects analysis, which take a narrower financial view.

5.7.2 Estimated changes in economy and flow-on effects

The following discussion provides the economic impacts of the Project over the modelling period to 2046. This section outlines the projected impacts to the Locality and the NSW state-wide impacts.

Results are most often presented in terms of changes in output, employment and industry gross value added (GVA). These changes measure the difference between the Project Case and the Base Case.

5.7.2.1 Economic impacts – gross production

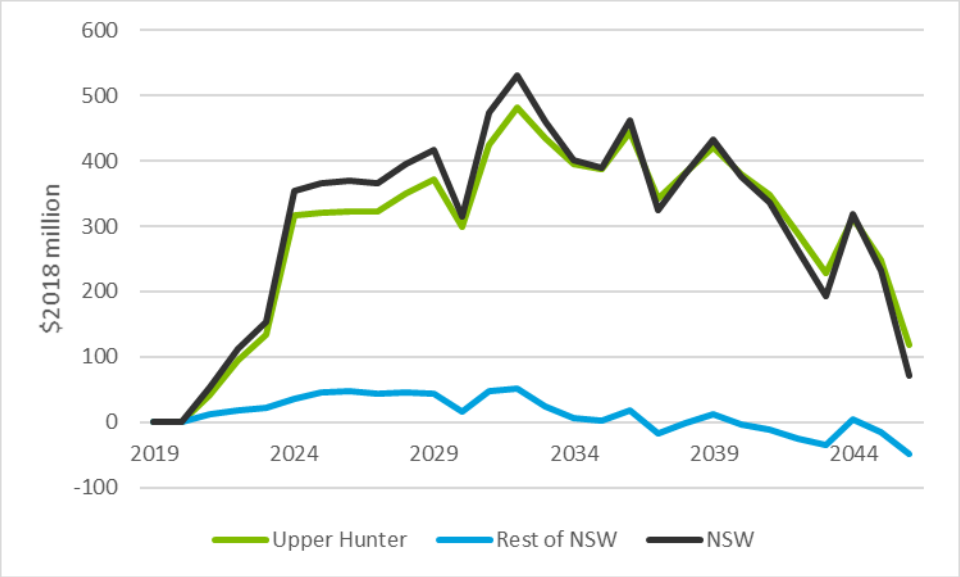
GVA is the primary variable used to measure the change in economic activity, based on changes in economic output. At the national level GVA is known as Gross Domestic Product (GDP); at the state level, Gross State Product (GSP); and at the regional level, Gross Regional Product (GRP).

Chart 5.4 shows the full temporal profile of production impacts on economic output levels in real 2018 terms as a result of the Project Case.

The impact on GRP is projected to be positive from 2019 to 2046 as a result of increase in capital expenditure and coal production relative to the Base Case. The positive GRP impact peaks at around $481 million in 2032 in the Locality. The state-wide GSP impact across the rest of the State is projected to be marginally positive on average over the life of the Project relative to the Base Case due to crowding out in some industries. Together, the state-wide GSP impact for the whole of NSW is projected to be strongly positive during the establishment phase and for the most part of the operations phase. For NSW as a whole, the GSP impact in subsequent years declines as the positive impact from the increase in capital expenditures dilutes and crowding out in other industries combined with regional relocations occur.

In NPV terms, over the modelling period, total Locality GRP is projected to increase by $3.10 billion. Over the life of the Project, the increase in GRP in the Locality averages $0.29 billion annually, and totals $8.21 billion in undiscounted terms. There is also an impact on the rest of the NSW economy with an expected increase of $0.23 billion in NPV terms over the period to 2046. Therefore, GSP for the whole of NSW is projected to be $3.33 billion greater, in NPV terms, over the modelling period under the Project Case scenario.

Chart 5.4: Gross Regional Production impacts for locality and Rest of NSW ($2018 million)



5.7.2.2 Employment and wage impacts

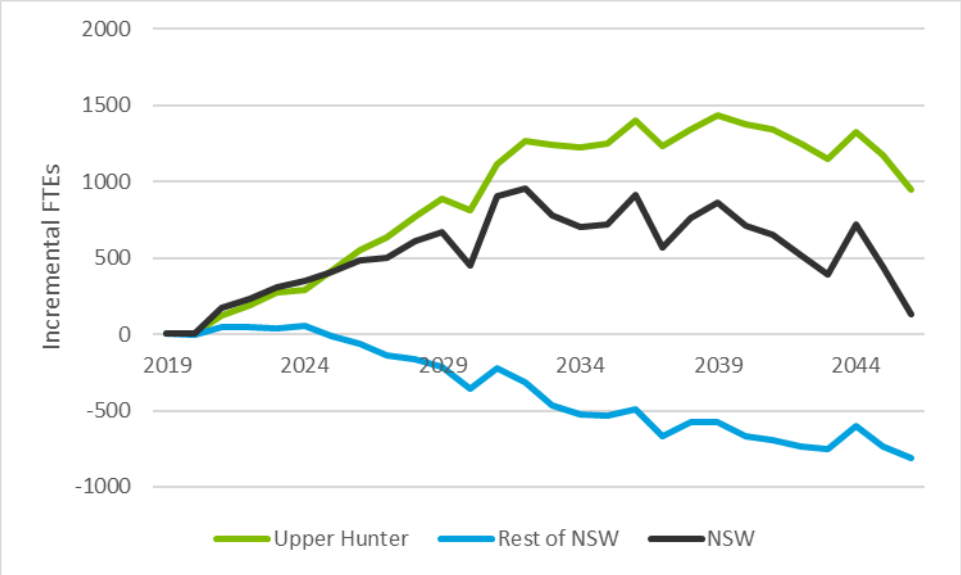
The Locality employment includes the incremental effects of direct employment at the Maxwell Mine, flow-on effects throughout the rest of the economy and any crowding out that might occur in other sectors of the economy.

Similar to the impact on GRP, total employment in the Locality is expected to remain roughly the same in the first few years and then increase strongly over the remaining life of the Project. Throughout the life of the Project, employment is expected to increase in the Locality by an annual average of 894 FTE per year, relative to the Base Case, peaking in 2039 at 1,439 FTE. This change in local employment involves a significant migration impact as a result of the Project that draws workers in from elsewhere in the state. This effect is made stronger by the relatively small size of the Upper Hunter economy and that it is a resource-dependent region which can see significant changes in the local economy reflecting changes in the level of investment and coal production activities.

Taking into account the employment impacts in the Locality and across the rest of NSW, the average annual increase in employment for the whole of NSW is 533 FTE as a result of the Project, relative to the Base Case. This represents the overall increase in employment taking into account employment directly from the Project, crowding out within the locality and state and state migration. By the end of the Project's life, the net impact of employment at the state level approaches zero. This suggests that, in the longer run, the project shifts the location of some workers towards the Upper Hunter economy.

Overall, the increase in economic activity from the Project Case will create second round and flow-on effects throughout the Locality and in the rest of NSW. The analysis of the economy of the Locality indicates that household income in the Locality is slightly lower than the state-wide average, and it has been growing steadily consistent with the state-wide average. In addition, the unemployment rate in the Locality is slightly higher than the state-wide average. This indicates that the economy in the Locality is likely able to expand to support the increase in economic activity estimated under the Project Case.

Chart 5.5: Incremental employment impacts, FTEs



Appendix A: Checklist

NSW Treasury (2017) NSW Government Guide to Cost-Benefit Analysis

Table A.1: Key issues mentioned in NSW Treasury Guidelines

Guideline requirements	Addressed	Reference
Define the Base Case and Develop Options		
Base Case "Do nothing" option	Yes	3.1
Option development	Yes	3.2, 3.3
Identify and forecast benefits		
Avoided Costs	Yes	4
Savings	Yes	4
Revenues	Yes	4.3.1.1
Benefits to consumers not reflected in revenue flows	Yes	4.3
Benefits to the broader community	Yes	4.3
Identify and forecast costs		
Identify all relevant cost items	Yes	4.2
Stream of costs should cover full project period	Yes	4.3
Identify qualitative factors and distributional impacts		
Identify costs and benefits that cannot be quantified	Yes	4.2
Inter-generational equity principle	Yes	4.3.7
Identification of Environmental Impacts	Yes	4.3.7
Valuation of Environmental impacts	Yes	4.3.7
Other impacts include environmental considerations, industrial relations, social or regional impact, safety, public relations, resource availability	Yes	4.3.7
Assess Net Benefits		
Assessment of benefits in real terms	Yes	4
Discount at 7% rate, with 4% and 10% for sensitivity testing	Yes	4.5
Net Present Value	Yes	4.3
Net Present Value per $ of capital outlay	N/A	
Benefit-Cost Ratio (BCR)	N/A	
Internal Rate of Return (IRR)	N/A	
Assess risks and test sensitivities		
Projected outcomes under alternative scenarios	N/A	
Sensitivity and Threshold Analyses	Yes	4.5
Emphasis given on pessimistic alternatives	Yes	4.5

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

Table A.2: Key issues mentioned in the NSW Government Guidelines

Draft Guidelines	Addressed	Reference
Establish the base case	Yes	3.1
Existing land use on the Project Area	Yes	4.3.4
Assess interactions with projects in the surrounding area	Yes	4.3.4, 5.4
Define project	Yes	3.2
Cost benefit analysis	Yes	4
Estimate royalties payable	Yes	4.3.2
Estimate company income tax	Yes	4.3.3
Net producer surplus (and attribution to NSW)	Yes	4.3.1
Indirect benefits (and attribution to NSW)	Yes	4.3.4, 4.3.5, 4.3.6,4.3.7
Indirect costs to NSW	Yes	4.3.7
Aboriginal cultural heritage	Yes	4.3.7
Air quality	Yes	4.3.7
Ambient noise	Yes	4.3.7
Biodiversity	Yes	4.3.7
Greenhouse gas	Yes	4.3.7
Groundwater	Yes	4.3.7
Non-Aboriginal heritage	Yes	4.3.7
Surface water	Yes	4.3.7
Traffic	Yes	4.3.7
Visual amenity	Yes	4.3.7
Net present value	Yes	4.3, 4.4
Sensitivity analysis	Yes	4.5
Local effects analysis	Yes	5
Effects on local employment	Yes	5.2
Effects on non-labour project expenditure	Yes	5.3
Effects on other local industries	Yes	5.4
Environmental and social impacts on the local community	Yes	5.5
Flow-on effects	Yes	5.7

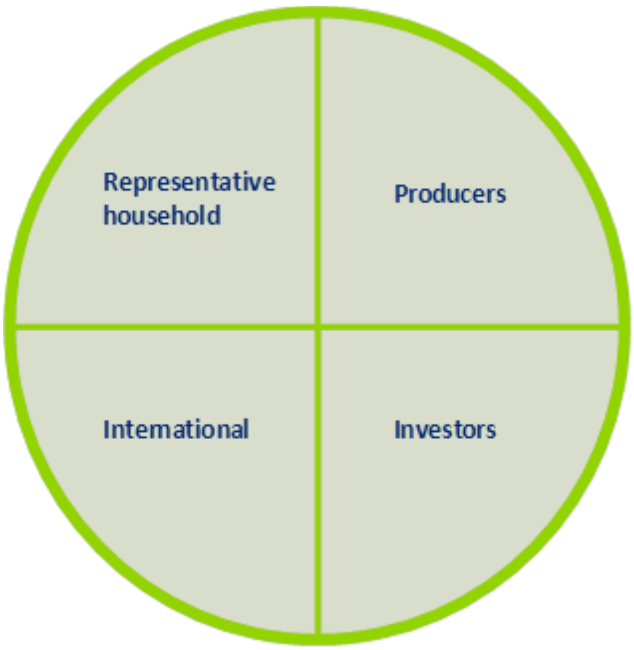
Appendix B: Computable General Equilibrium Modelling

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 B.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 B.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 B.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.

Limitation of our work

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