PEMBROKE

Olive Downs Coking Coal Project

Draft Environmental Impact Statement

Appendix I

Economic Assessment

Olive Downs Coking Coal Project
Economic Impact Assessment

Prepared for

Pembroke Olive Downs Pty Ltd

By

Gillespie Economics
Email: gillecon@bigpond.net.au

July 2018

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

This Economic Impact Assessment relates to the preparation of each of the following types of analyses of the Olive Downs Coking Coal Project (the Project):

- A Cost Benefit Analysis (CBA) of the Project;
- A regional impact analysis of the Project using Computable General Equilibrium (CGE) modelling for three regions:
  - Isaac Regional Council (Isaac), in which the Project is directly located;
  - a combination of the Mackay Regional Council and the Whitsundays Regional Council (MW Region), which represents the regions surrounding the Project; and
  - the rest of Queensland.

Cost Benefit Analysis

Australia

A CBA of the Project indicated that it would have net production benefits to Australia of $2,169M. Provided the residual environmental, social and cultural impacts of the Project that accrue to Australia are considered to be valued at less than $2,169M, the Project can be considered to provide an improvement in economic efficiency and, hence, is justified on economic grounds.

Environmental, social and cultural impacts of the Project have been minimised through Project design and mitigation, offset and compensation measures. The economic value of residual impacts is considered to be immaterial from an aggregated economic efficiency perspective. The main quantifiable environmental impacts of the Project that have not already been incorporated into the estimate of net production benefits via mitigation, offset and compensation costs, relate to greenhouse gas emissions. These impacts to Australia are estimated at $2M, considerably less than the estimated net production benefits of the Project. There may also be some market benefits of employment provided by the Project which are estimated to be in the order of $72M. Overall, the Project is estimated to have net social benefits to Australia of $2,239M and, hence, is desirable and justified from an economic efficiency perspective.

While the main environmental, cultural and social impacts have been quantified and included in the Project CBA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than between $2,239M for the Project to be questionable from an Australian economic efficiency perspective.

Queensland

The estimated net production benefits of the Project to Queensland are estimated at $1,328M, comprising $1,117M in royalties and $211M in company tax. Incorporating market employment benefits and greenhouse gas costs the net social benefits of the Project to Queensland are estimated at $1,400M. Any unquantified residual impacts of the Project to Queensland after mitigation, offsetting and compensation would need to be valued at greater than $1,400M, present value for the Project to be questionable from a Queensland economic efficiency perspective.

Any residual impacts would occur to people in the immediate vicinity of the Project, apart from greenhouse gas impacts which would be more dispersed. Most impacts would be immaterial with impacts on groundwater access of adjoining landholders, biodiversity and roads compensated for. Wage impacts would occur where the labour force for the Project live, which would be both in Isaac Local Government Area and the wider region of the Mackay and Whitsunday local government areas. The main benefits of the Project to Queensland, royalties, would accrue outside the region to the Queensland government and subsequently spent on government infrastructure and services across Queensland. Similarly, company tax benefits would initially accrue to the Commonwealth Government with subsequent redistribution of some of this benefit back to Queensland.

Economic Activity Analysis

CGE analysis was undertaken under three different labour supply assumptions for the Isaac Region, Mackay and Whitsunday local government areas and Queensland:

- Zero labour supply response - a full employment assumption, where all regions in the model operate at full employment, meaning no new employment is generated in response to the Project. In this case, any employment for the Project is drawn from the existing labour pool, but encouraged to change jobs as wages increase;
- Medium labour supply response - a labour supply elasticity of 0.15, adopted by Treasury at the National Level, which indicates a relatively 'inelastic' response from workers i.e. workers are slow to enter the workforce due to changes in wages because it is assumed that the economy is close to full employment or the project under consideration requires highly skilled workers; and
- High labour supply response - a labour supply elasticity of 0.30 which is still relatively 'inelastic' but more elastic than the above assumption, meaning that workers respond more readily to marginal changes in the wage rate by entering the workforce.

A summary of the economic impacts on each of the regions, under the three separate labour market response assumptions, is provided in Figure ES1.

Under each labour market scenario, the Project is projected to increase Gross Regional Income (GRI), which is a measure of economic welfare. In net present value (NPV) terms, the projected increase in GRI in the Isaac Region ranges from $5,286M under the Zero labour supply response to $4,201M under the High labour response assumption. The GRI result is influenced by the total increase in wages in the region. Under the Zero labour supply response, wages are modelled to increase by 16.7%, compared to 9.4% for the High labour supply.

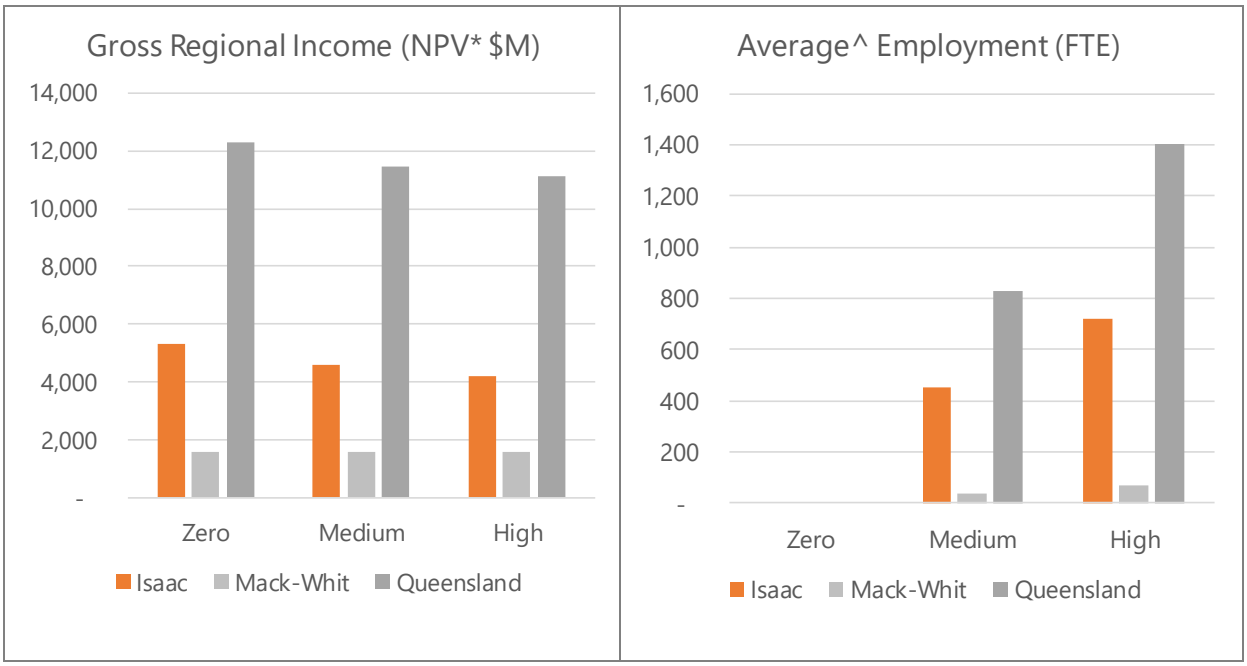
Total employment, which is also influenced by the labour supply response, averages 721 full-time equivalent (FTE) under the High labour response assumption and 454 FTE under the Medium assumption.

The economic benefits of the Project also accrue to the broader Queensland economy, influenced by royalty payments into the rest of Queensland. In NPV terms, the projected increase in GRI in Queensland ranges from $12,302M under the Zero labour supply response to $11,142M under the High labour response assumption. The associated employment effects are estimated at 1,401 FTE under the High labour response assumption, and 826 FTE under the Medium assumption.

The Zero response assumption is equivalent to assuming that the Isaac Region and Queensland economy are operating at full employment and, therefore, no new workers are available to service the Project. That is, workers are drawn from their existing jobs through the offer of higher wages. Under the Zero labour market response, wages in the Isaac Region increase by 16.65%, and by 0.27% across the State.

Under the other scenarios, the Isaac Region and Queensland economy are operating at below capacity, as evidenced for example by higher unemployment or underemployment, and it is more realistic to assume a relatively more 'elastic' labour supply whereby potential workers are encouraged into the workforce, again through increased wages. Under the High labour market response, wages in the Isaac Region increase by 9.4% and by 0.18% in Queensland.

Figure ES1 Projected Economy-Wide Impacts of the Project by Labour Market Response



* Net Present Value in 2017 Australian dollars calculated over the period 2018 to 2050 using a 7% real discount rate.

Source: Cadence Economics estimates based on information provided by Gillespie Economics.

1 INTRODUCTION

1.1 Background

Pembroke Olive Downs Pty Ltd (Pembroke) proposes to develop the Olive Downs Coking Coal Project (the Project), a metallurgical coal mine and associated infrastructure within the Bowen Basin, located approximately 40 kilometres (km) south-east of Moranbah, Queensland. The Project provides an opportunity to develop an open cut metallurgical coal resource within the Bowen Basin mining precinct that can deliver up to 20 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

The Project comprises the Olive Downs South and Willunga domains and associated linear infrastructure corridors, including a rail spur connecting to the Norwich Park Branch Railway, a water pipeline connecting to the Eungella pipeline network, an electricity transmission line (ETL) and access roads. The coal resource would be mined by conventional open cut mining methods, with product coal to be transported by rail to the Dalrymple Bay Coal Terminal (DBCT). Up to 20 Mtpa of ROM coal would be extracted over the anticipated Project operational life of approximately 79 years.

Gillespie Economics was engaged by Pembroke to provide an assessment of the economic impacts of the Project for inclusion in the Environmental Impact Statement (EIS).

1.2 Scope of Economic Impact Assessment

This Economic Impact Assessment has been prepared in accordance with the relevant sections of the Project Terms of Reference (Table 1.2) and the Coordinator-General's *Economic Impact Assessment Guideline* (the Coordinator-General's Guideline) (Coordinator-General 2017).

The Coordinator-General's Guideline identifies two separate types of assessments used in an Environmental Impact Assessment:

- cost benefit analysis (CBA), which is used to identify the costs and benefits of a project; and
- regional impact analysis (RIA), which is used to describe the size and nature of the effects on local, regional and state economies.

Refer to Attachments 1 to 3 for an introduction to these economic methods.

This Economic Impact Assessment comprises:

- a CBA which considers the net community welfare (economic efficiency) impacts of the Project;
- a characterisation of the existing local, regional and Queensland economies that the Project would impact; and
- the preparation of a RIA using Computable General Equilibrium (CGE), which considers the likely short-term and long-term regional economic contributions of the Project to the local area, region and State.

1.3 Source of Information

Key data and information sources for the Economic Impact Assessment are summarised in Table 1.1.

Table 1.1 Information Sources

Component of Economic Impact Assessment	Data Source
Cost Benefit Analysis	
Net production benefits - royalties, company tax, net producer surplus	Financial and employment data provided by Pembroke
Biophysical environmental, social and cultural impacts of the Project	Pembroke Olive Downs Pty Ltd and reports of technical specialists prepared for the EIS
Economic interpretation of biophysical environmental, social and cultural impacts of the Project	Gillespie Economics
Characterisation of the existing local, regional and Queensland economies	Australian Bureau of Statistics Census Data REMPLAN Profiles
Computable General Equilibrium Modelling	Financial and employment data provided by Pembroke Cadence proprietary models

1.4 Terms of Reference Reconciliation

The section of the report that addresses each individual Term of Reference is summarised in Table 1.2.

Table 1.2 Terms of Reference Reconciliation

Summary of Coordinator-General's Requirements	Section
Economic	
11.92 Assess the economic impacts of the project and identify measures to manage any negative impacts and capture the economic opportunities generated by the project. The economic impact assessment (EIA) should be consistent with the Coordinator-General's Economic impact assessment guideline or the guideline[6] in place at the time of delivery of the EIS.	3, 4 and 5
11.93 The EIA should include:	
(a) a description of the project	2
(b) the 'base case' local and regional economic environment without the project	4
(c) a summary of the predicted key economic impacts, measured against the 'base case'	3.4
(d) an impact management strategy to manage economic impacts and capitalise on economic opportunities, with consideration given to an adaptive management approach to adjust measures to changing economic circumstances	7
11.94 The EIA must use standardised methodologies and information and make all assumptions transparent. The EIS must:	3 and 5
(a) use the best current data available	3, 4 and 5
(b) use standard and consistent terms and methodologies at all stages of the project	3, 4 and 5
(c) cover the full life-cycle of the project	3 and 5
(d) specify the modelling methodologies used	1 and Attachments 1 to 3
(e) adopt an appropriate discount rate for costs and benefits occurring in the future	3.4
(f) document all key assumptions and their rationale	Table 2.1, 3 and 5

Summary of Coordinator-General's Requirements		Section
Economic		
(g)	*explain the methods used to gather information*	1.3
(h)	*describe how the key impacted stakeholders and communities were consulted and the data they provided*	See Appendix H of the EIS
(i)	*express monetary values in Australian dollars adjusted to a common date*	3 and 5
(j)	*use a risk management framework to focus on the impacts with the highest probability and consequential impacts*	3
(k)	*consider cumulative impacts of other developments in the region, where feasible*	6
(l)	*undertake the EIS as an integral component of the EIS, together with the social and environmental impact assessments for the project.*	3 (based on Appendices A-M of the EIS)
11.95	*The specific consideration of regional economic impacts must also provide an overview of:*	4 and 5
(a)	*the key stakeholders and communities of interest*	4
(b)	*the local, regional, state and national economies of interest*	4
(c)	*local business and industry content opportunities*	4
(d)	*source locations of employees and contractors*	5 Also see Appendix H of the EIS
(e)	*cost of living pressures such as impacts on housing supply and demand and household goods and services*	See Appendix H of the EIS
(f)	*demands for other essential services and facilities*	See Appendix H of the EIS
(g)	*expected timing and geographic distribution of impacts*	5
(h)	*any relevant positive and negative externalities.*	3
11.96	*Where possible, impact modelling should also describe and quantify the following:*	
(a)	*capital and operational expenditure*	3 and 5
(b)	*project revenues*	3 and 5
(c)	*direct impacts on gross regional product and gross state product*	5
(d)	*any relevant royalties, taxes and duties*	3 and 5
(e)	*any relevant site remediation costs*	3
(f)	*source of goods and services, Queensland, interstate and overseas*	4
(g)	*workforce and labour market impacts, including effects on wages and local labour supply and demand*	5
(h)	*direct and indirect full-time equivalent job numbers at each phase of construction and operation.*	5

6 Coordinator-General (2017) Economic impact assessment guideline. Brisbane: Office of the Coordinator-General.

2 PROJECT DESCRIPTION

2.1 Project Scope

The main activities associated with the development of the Project would include:

- up to 20 Mtpa of ROM coal production for an operational mine life of approximately 79 years (commencing approximately in 2020 or upon grant of all required approvals), including mining operations using conventional mining equipment (e.g. excavators, dozers, front end loaders and trucks) and strip mining, associated with:
  - development of the Olive Downs South domain open cut mine areas and out-of-pit waste rock emplacements within Mining Lease Application (MLA) 700032, MLA 700033 (within Mineral Development Licence (MDL) 3012 and MDL 3013), MLA 700035 and MLA 700036; and
  - development of the Willunga domain open cut mine areas and out-of-pit waste rock emplacements within MLA 700034 (within MDL 3014 and MDL 3025);
- exploration activities;
- progressive development of soil stockpiles, laydown areas and borrow areas (e.g. for road base and ballast material);
- use of local quarries to source road base and ballast material (e.g. in the case where material is unavailable from sources within MLA 700032, MLA 700033 and MLA 700034);
- drilling and blasting (daytime only) of competent waste rock material;
- progressive placement of waste rock in emplacements adjacent to and nearby the open cut mine extents;
- progressive backfilling of the mine voids with waste rock behind the advancing open cut mining operations;
- progressive rehabilitation of waste rock emplacement areas;
- construction of an access road from Annandale Road to the Olive Downs South domain infrastructure area including a crossing of the Isaac River, and a second access road from the Fitzroy Developmental Road to the Willunga infrastructure facilities;
- progressive development of new haul roads and internal roads, including an Isaac River road crossing to provide access between the Olive Downs South and Willunga domains;
- installation and operation of on-site coal handling and preparation plant (CHPP) at the Olive Downs South domain;
- installation and operation of on-site ROM coal handling and crushing facilities at the Willunga domain;
- transfer of crushed ROM coal from the Willunga domain to the CHPP at the Olive Downs South domain, via either haul road or overland conveyor with an Isaac River crossing;
- storage and disposal of CHPP rejects (coarse and fine rejects) during the initial years (until in-pit containment facilities become available) in initial rejects storage facilities including In line Flocculation (ILF) cells;
- disposal of CHPP rejects (coarse and fine rejects) on-site within appropriate in-pit containment facilities, including mine voids behind the advancing open cut mining operations and, where circumstances allow, disposal in other out-of-pit containment facilities;

- progressive development of sediment dams and water storage dams (including the North Western Water Dam, Central Water Dam, mine affected water dams, raw water dams, etc.) and installation of pumps, pipelines and other water management equipment and structures (including up-catchment diversions and temporary levees);
- wastewater and sewage treatment by package sewage treatment plants;
- installation of a raw water supply pipeline from the existing Eungella pipeline network;
- discharge of excess water off-site in accordance with relevant principles and conditions of the *Final Model Water Conditions for Coal Mines in the Fitzroy Basin* (DEHP, 2013);
- electricity supply from the existing regional power network, via construction of a 66 kilovolt (kV) ETL and switching/substation;
- construction of a rail loop and rail spur from the Norwich Park Branch Railway, and rail-loadout facility including product coal stockpiles at the Olive Downs South domain for rail transport of coking and Pulverised Coal Injection coal products and by-products (i.e. thermal coal) for the export market via the DBCT (subject to availability of rail and port allocation); and
- other associated minor infrastructure, plant, equipment and activities.

Existing local and regional infrastructure would be used to transport product coal to the port for export, including the Norwich Park Branch Railway and the DBCT.

Indicative general arrangements for Years 2027, 2043, 2066 and 2085 of the Project are shown on Figures 2-3 to 2-9 of the EIS. These indicative general arrangements are based on planned maximum production and mine progression. The mining layout and sequence may vary to take account of localised geological features, coal market volume and quality requirements, mining economics and Project detailed engineering design.

The detailed mining sequence and rehabilitation program over any given period would be documented in the relevant Plan of Operations as required by the Queensland *Environment Protection Act, 1994*.

The Indicative Mining Schedule is given in Figure 3.1. A more detailed description of the Project is provided in Section 2.5 of the Main Text of the EIS.

2.2 Key Assumptions

The Economic Impact Assessment was based on year by year financial and employment data provided by Pembroke. This year by year data is commercial-in-confidence but key assumptions are summarised in Table 2.1.

Table 2.1 Key Assumptions Underpinning the Economic Impact Assessment

Item	Assumption
Mining Methods	Open cut operations
Mining Rate	Up to 20 Mt of ROM coal per annum
Coal Production	459 Mt of product coal
	48 percent (%) semi-hard coking coal
	49% PCI coal
	3% thermal coal
Life of Mine	79 years
	Construction • Pre-construction period and Olive Downs South Domain – 2018-2021 • Willunga Domain construction – 2028 – 2032
	Operations – 2020 - 2098
Workforce	*Construction* • Pre-construction period and Olive Downs South Domain - average annual employment of 100 to 700, with average over the three period of 433 • Willunga Domain Construction - 200 *Operations* • Minimum operational workforce of 400, 2086 - 2098 • Maximum operational workforce of 1,300, 2028 - 2050 • An average of 873 during the operational phase, 2020 – 2098
	Total employment • An average total workforce of 881, 2020 – 2098 • Maximum total workforce of 1,300, 2028 - 2050
Coal Price	USD146/t semi-hard coking coal
	USD113/t PCI coal
	USD73/t thermal coal
AUD:USD Exchange Rate	0.77
Capital Expenditure	Life of Project capital expenditure - $1,009M
	Pre-construction period, Olive Downs South Domain – 2018-2020 - AUD437M
	Willunga Domain construction – 2028 – 2032 - AUD549M
Average operating costs (net of royalties)	AUD93/t product coal
Royalties	Average annual royalty of 8.3% of revenue

3 COST BENEFIT ANALYSIS OF THE PROJECT

3.1 Introduction

CBA is concerned with the costs and benefits of a project to all members of society (i.e. consumers, producers and the broader society as represented by the government). CBA can potentially be applied across different definitions of society such as a local area, State, nation or the world. However, most applications of CBA are performed at the National or State level. In doing so, both net production benefits and environmental costs that accrue to consumers, producers and governments outside of these definitions of society are not included in the analysis. This particularly applies to residual net producer surplus to foreign owners and GHG impacts.

The key steps in CBA are (Resource Assessment Commission 1992):

- identification of "without" Project or base case;
- identification of the Project and its implications – the "with" scenario;
- identification of incremental costs (capital expenditures, operating and maintenance costs, labour costs, opportunity costs, harmful effects on other parties and so forth) and benefits (value of outputs, avoided costs, productivity savings, health, social or environmental benefits and so forth) of the Project relative to "without" the Project;
- physical quantification and monetary valuation of incremental costs and benefits, including adjustment of private financial costs and benefits into economic values; that is, costs and benefits that reflect losses and benefits to the economy as a whole, rather than to individual persons or groups. For example, estimates of 'shadow' prices may be required when market prices do not reflect the true opportunity cost of using a resource;
- calculation of net present value (NPV); that is, total benefits less total costs occurring in each time period, discounted to present values;
- application of sensitivity analysis; that is, calculating the NPV using different assumptions about key determinants of costs and benefits; and
- consideration of equity issues (identification of groups or communities which loses or gains from the project or program) and "intangibles" (costs and benefits that cannot be assessed in monetary terms)".

This CBA of the Project is based on financial, technical and environmental advice provided by Pembroke and its specialist consultants.

Additional information on CBA is provided in Attachments 1 and 2.

3.2 Identification of the Base Case and the Project

Identification of the "base case", or "without", Project scenario is required in order to facilitate the identification and estimation of the incremental economic benefits and costs of the Project.

Land within the Project area is used predominately for cattle grazing. The land has been largely cleared through past agricultural practices; however, some tracts of remnant vegetation exist, particularly along the riparian corridor of the Isaac River. Surrounding land in the vicinity of the Project is owned predominantly by other mining companies.

Under the base case, land within the Project area would continue to be used primarily for agricultural purposes, and adjoining land would continue to be used for mining.

In contrast, the Project (as described in Section 2) comprises mine construction, coal mining, processing and transportation of product coal to the DBCT for an operational life of 79 years. At the end of the Project, it is assumed that the residual value of capital equipment and land would be realised through sale or alternative use and that the mine would be decommissioned and land rehabilitation would be finalised.

CBA is primarily concerned with the evaluation of a project relative to the counterfactual of no project. Where there are a number of alternatives to a project then these can also be evaluated using CBA. However, alternatives need to be feasible to the proponent, and to this end a number of alternatives to the Project were considered by Pembroke, including existing operations with expansion opportunities. Following a review of the available options, it was considered that the opportunities presented by a greenfield site such as the Project outweighed the potential benefits of purchasing an existing operation. This included considerations of the constraints typically encountered at existing mines, including inefficient operations and mine plans, and the benefits of designing a greenfield mine from the ground up to optimise the development of the asset.

Accordingly, given its location within the existing Bowen Basin mining region, the greenfield nature of the asset, the significant size of the coal resource and proximity to existing infrastructure, Pembroke considered that the Project would achieve its objective of developing a high-quality, long-term metallurgical coal asset.

The Project assessed in the EIS and evaluated in the CBA is considered by Pembroke to be the most feasible design for the greenfield site for minimising environmental, cultural and social impacts whilst maximising resource recovery and operational efficiency. It is therefore this alternative that is proposed by Pembroke and was subject to detailed economic analysis.

3.3 Identification of Benefits and Costs

Relative to the "base case", or "without", Project scenario, the Project may have the potential incremental economic benefits and costs shown in Table 3.1 The main potential economic benefit is the producer surplus (net production benefits) generated by the Project and any market[1] employment benefits it provides, while the main potential economic costs relate to any environmental, social and cultural costs.

[1] The Project may also provide nonmarket employment benefits - refer to Gillespie and Bennett (2012). However, despite considerable theoretical and empirical evidence for these values, they have conservatively been omitted from this analysis.

Table 3.1 Potential Incremental Costs and Benefits of the Project

Category	Costs	Benefits
Net production benefits	Opportunity cost of land and capital equipment. Development costs including labour, capital equipment and acquisition costs for potentially impacted properties and offsets[1]. Operating costs of the Project including labour and mitigation, offsetting and compensation measures. Rehabilitation and decommissioning costs at end of Project life.	Value of coal. Residual value of capital equipment and land at end of Project life.
Potential environmental, social and cultural impacts of the Project after mitigation, offsetting and compensation	Agricultural production impacts[1]. Noise impacts. Blasting impacts. Air quality impacts. Greenhouse gas impacts. Surface water impacts. Groundwater impacts. Ecology impacts. Road transport impacts. Aboriginal heritage impacts. Historic heritage impacts. Visual impacts.	Wage benefits to employment.

[1] The value of foregone agricultural production is included in the value of land.

Framed in another but equivalent way the potential incremental costs and benefits of the Project are as per Table 3.2. This approach breaks the net production benefits of the Project into its component parts - royalties, company tax and net producer surplus.

Table 3.2 Alternative Frame of Potential Economic Costs and Benefits of the Project

Costs	Benefits
Direct costs	***Direct benefits***
Nil	Net production benefits • *Royalties* • *Company tax* • *Net producer surplus*
Indirect costs	***Indirect benefits***
Net environmental, social, cultural and transport-related costs	Wage benefits to employment

It should be noted that the potential environmental, social and cultural costs listed in Table 3.1 are only economic costs to the extent that they affect individual and community wellbeing through direct use of resources by individuals or non-use. If the potential impacts do not occur or are mitigated, compensated or offset to the extent where community wellbeing is insignificantly affected (i.e. costs are borne by Pembroke), then no environmental, social or cultural economic costs should be included in the Project CBA apart from the mitigation, compensation or offsetting costs.

3.4 Quantification/Valuation of Benefits and Costs

The analysis was undertaken in real values with discounting at 7 % and sensitivity testing at 4% and 10%.

The analysis period is 81 years, coinciding with the Project life and including two years of pre-mine operation. Any impacts that occur after this period are included in the final year of the analysis as a terminal value[2].

Where competitive market prices are available, they have generally been used as an indicator of economic values.

The consideration of the potential environmental, social and cultural impacts relies on the assessment of other experts. The Economic Impact Assessment process results in detailed (non-monetary) consideration of the environmental, social and cultural impacts of a project and the proposed means of mitigating the impacts. Where impacts meet government assessment criteria and / or are deemed insignificant by technical experts it is reasonable to assume that they are also likely to have insignificant impacts on community well-being. In this respect, there is an important practical issue of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in CBA (Building Queensland, 2016) . Nevertheless, unquantified residual impacts can be considered via the threshold value method.

In this report, all environmental, cultural and social impacts have initially been left unquantified, and interpreted using the threshold value method. An attempt has then been made to estimate environmental, cultural and social impacts using market data and benefit transfer[3]. However, even with the inclusion of these values, the estimated net social benefits of the Project provide a threshold value that any residual or non-quantified economic costs would need to exceed to make the Project questionable from an economic efficiency perspective.

3.4.1 Production costs and benefits[4]

Production Costs

Opportunity Cost of Land and Capital

Pembroke has already acquired significant land holdings for the Project. There is an opportunity cost associated with using this land for the Project instead of its next best use (i.e. rural production). The acquisition costs of land are estimated in the order of $63M (present value). This includes premiums paid for land over and above its market prices and therefore encompasses both the agricultural value of land and any consumer surplus held by the owners of that land. This overstates the opportunity cost of land, since Pembroke would continue to facilitate agricultural activities on that part of its land not required for mining or mining-related purposes.

All capital equipment required for the Project would be purchased as part of the development costs of the Project or paid for via contractor payments and indirectly included in the operating costs of the Project.

[2] A terminal value includes ongoing impacts in perpetuity.
[3] Benefit transfer refers to borrowing economic values that have been determined for other study sites.
[4] All values reported in this section are undiscounted Australian dollars unless otherwise specified.

Development Cost of the Project

Development costs of the Project are associated with additional land purchases, mining equipment purchases, development of open-cut mine areas, exploration activities, development of onsite and offsite surface infrastructure including a CHPP, ROM coal handling and crushing facilities, rail loop and rail spur and roads. These costs include labour costs during the development of the Project.

Total capital expenditure is estimated by Pembroke at $1,009M over the Project life, within initial capital investment of $20M in 2018, $164M in 2019 and $253M in 2020. These development costs are based on financial modelling provided by Pembroke and include; an allowance for biodiversity offsets, funds for make good agreements with impacted landholders, funding for a road infrastructure arrangement with Isaac Council, and funding for impact management and monitoring.

An indicative breakdown of capital costs is provided in Table 3.3.

Table 3.3 - Indicative Breakdown of Development Costs

Capital Cost Breakdown	**$M**
Biodiversity offsets	$31
Transport - Rail	$98
Transport - Roads	$39
Water Supply	$59
Power Supply	$49
Mine Infrastructure Area - MIA Olive Downs South	$20
Mine Infrastructure Area - MIA Willunga	$10
Water Management Olive Downs South	$29
Water Management Willunga	$10
Coal Handling & TLO Area Olive Downs South	$117
Coal Preparation Plant Olive Downs South - Module A	$127
Coal Preparation Plant Olive Downs South - Module B	$108
Coal Handling Area Willunga	$39
Overland Conveyor	$117
Coal Preparation Plant for Willunga OLC - Module C	$156
Total	**$1,009**

Annual Operating Costs of the Project

The operating costs of the Project include those associated with mining (including impact mitigation and monitoring), CHPP operation, rail freight, port handling and loading, and general costs (including overheads and administration). These costs include operational labour costs.

While royalties are a cost to Pembroke, they are part of the overall net production benefit of the mining activity that is redistributed by government. Royalties are, therefore, not included in the calculation of the resource costs of operating the Project. Nevertheless, it should be noted that the Project would generate total royalties in the order of $5,685M ($1,117M present value at 7% discount rate). Royalties were calculated as per the following Government royalty rate per tonne of product coal:

- First $100/t - 7% of value;
- Next $50/t - 12.5% of value;

- Balance - 15% of value.

Depreciation has also been omitted from the estimation of operating costs, since depreciation is an accounting means of allocating the cost of a capital asset over the years of its estimated useful life. The economic capital costs are included in the development costs of the Project in the years in which they occur.

Rehabilitation and Decommissioning Costs

At the end of the Project life, the mine site would be decommissioned and rehabilitated at an estimated cost of $40M. It is noted the rehabilitation would be undertaken progressively over the Project life and these costs are included in the Project operating costs.

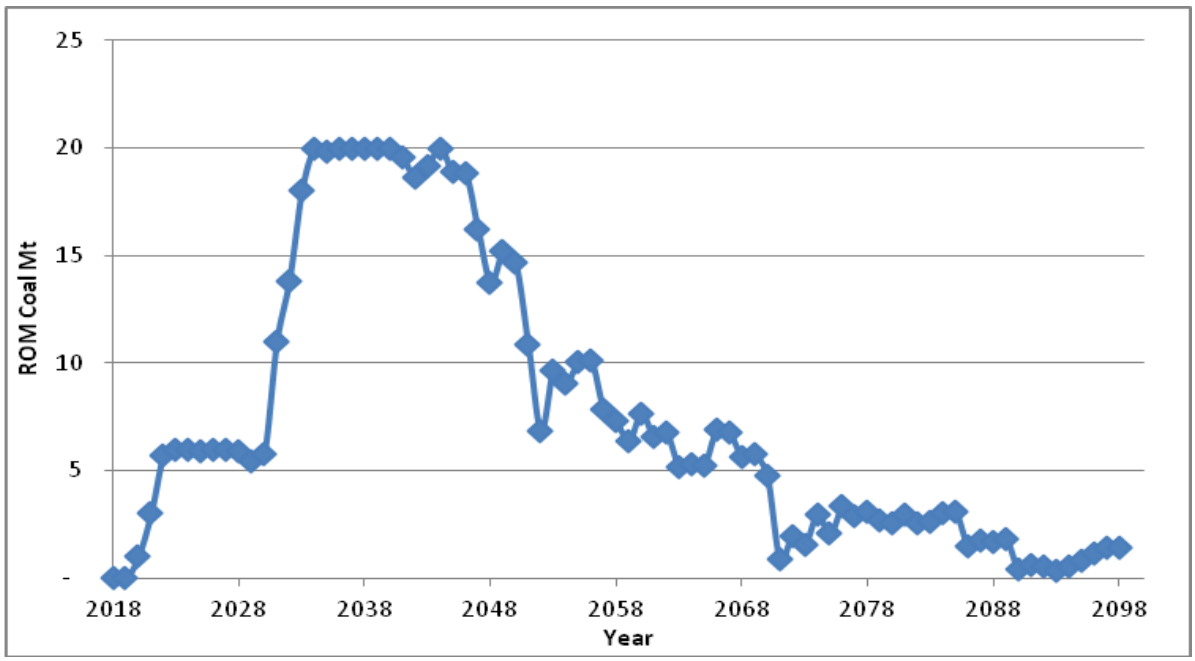
Production Benefits

Value of Coal

The main economic benefit of the Project is the market value of the coal produced.

Total ROM coal and product coal production is estimated at 611 Mt and 459 Mt, respectively, with annual production of up to 20 Mtpa ROM coal. The indicative mining schedule on which the CBA is based is provided in Figure 3.1.

Figure 3.1 Indicative Mining Schedule



Over the life of the Project, product coal is expected to be 48% semi-hard coking coal, 49% PCI coal and 3% thermal coal. All coal would be exported.

Both demand for and supply of coal influences current and projected prices. There is great uncertainty around future coal prices and publicly available coal price forecasts tend to be limited to a couple of years. For the purpose of this analysis, and based on advice from Pembroke a fixed coal price for each of the three coal products from the Project has been assumed i.e. USD 146/t for semi-hard coking coal, USD113/t for PCI and USD 73/t for thermal coal. An AUD:USD exchange rate of 0.77 was assumed.

These prices and exchange rate have been applied to the volume of each of the coal products recovered in each year of the Project.

There is uncertainty around future coal prices (valued in USD) as well as the AUD:USD exchange rate. Therefore, the assumed coal prices have been subjected to sensitivity testing as part of this assessment (see Section 3.7).

Residual Value at End of the Evaluation Period

At the end of the Project, capital equipment and land may have some residual value that could be realised by sale or alternative use. Conservatively, it is assumed that both land and capital equipment have zero residual value.

3.4.2 Environmental, social and cultural costs and benefits

The potential environmental, social and cultural impacts of the Project are fully assessed in the EIS. The environmental assessments included in the EIS have considered potential cumulative impacts where relevant. This Section considers these Project only and cumulative impacts from an economic perspective.

Agricultural Production

There is no Strategic Cropping Land (SCL) mapped within the Project MLAs or along the infrastructure corridors. Agricultural land classifications indicate the majority of the Project area lies on C1 (sown pastures, and native pasture on high fertility soils) and C2 (native pastures) class agricultural lands. This indicates that the land is suitable for pasture; however, is not suitable for wide-scale cropping. With the exception of small areas near the proposed new rail loop and spur line and rail-loadout facility, there is no other mapped good-quality agricultural land (GQAL) within the Project area.

The agricultural land that would be used for the Project is predominantly Land Suitability Class 3 and 4 and is used for cattle grazing (Table 3.4). Based on: a cattle gross margin of $225 per adult equivalent (DPIF 2007); a carrying capacity of 0.52 adult equivalent per hectare (ha) based on the highest carrying capacity of the properties in the Project area (Opteon Property Group Report 2017); a direct disturbance area ramping up over time to approximately 16,300 ha; rehabilitation of 13,582 ha to a reduced carrying capacity of 0.22 adult equivalent per ha based on the lowest carrying capacity of the properties in the Project area (Opteon Property Group Report 2017); the present value of foregone agriculture as a result of the Project is estimated at $13M. This value is insignificant compared to the net production benefit of mining. Significant changes in assumptions about the productivity of the land will not change this outcome.[5]

Table 3.4 Agricultural Land Suitability - Grazing

Land Suitability Class	Area (ha)	Soil Mapping Unit (SMU)
1	-	-
2	-	-
3	15,796	C1, S2, C2, S1, R1, R2, L1, L2, B1, B2
4	471	A1, A2
5	-	-

Source: GT Environmental (2018)

[5] Note that it is not the current productive use of the land that is relevant in a CBA but the potential productivity. This is determined here by an estimate of carrying capacity and gross margin for the land.

In economics, the significance of these impacts is determined by their opportunity cost which is the foregone net returns from the next best alternative use (e.g. agriculture). In a competitive market, the gross economic value of agricultural production is reflected in the prices received for the goods that are produced and the economic costs of production are reflected in the costs of inputs.

In a properly functioning land market, the present value of the potential net financial benefits of future potential agricultural production is reflected in land prices.

Unless there is a demonstrated failure in agricultural markets to adequately reflect the scarcity of agricultural products or a failure in land markets to adequately reflect the scarcity of agricultural land, then the market price of land reflects the opportunity cost of using that land for alternative uses.

In this analysis, the opportunity cost of foregone agricultural production, as a result of the Project, has been incorporated in the CBA through inclusion of the full value of land required for the Project (both the opportunity cost of land already in Pembroke ownership and the capital cost of land that would be acquired). Conservatively, it is assumed that no agricultural production occurs on this land for the life of the Project.

Noise and Vibration

The impact of the Project noise on nearby privately owned properties can potentially be valued using the property value method, where the change in property value as a result of the noise impacts are estimated, or the defensive expenditure method and damage cost method where the costs of mitigation are estimated.

A Noise and Vibration Assessment for the Project was prepared in accordance with the Project's Terms of Reference by Renzo Tonin Ron Rumble (2018). The Noise and Vibration Assessment is provided in Appendix K of the EIS.

The Noise and Vibration Assessment concluded that all sensitive receptors are predicted to comply with the relevant human noise limits during the day, evening and night for all modelling cases throughout the life of the Project. In addition, the Project is predicted to comply with relevant human overpressure and vibration criteria at all sensitive receptors for the life of the Project (Renzo Tonin Ron Rumble 2018).

As the Project is predicted to comply with relevant human noise, overpressure and vibration criteria, it is considered unlikely to have any significant adverse impact on surrounding livestock productivity. Further, any potential noise and blasting impacts to livestock are likely to be localised and temporary as mining progresses. It is noted that livestock production currently occurring in the region is already exposed to noise and blasting impacts from surrounding mining activities.

Notwithstanding the above, Pembroke would implement a range of mitigation and management measures to minimise the potential noise and blasting impacts of the Project.

Given the Noise and Vibration Assessment's conclusion that there would be no exceedances of relevant criteria and no significant impacts, there are no material impacts for valuation and inclusion in the CBA. All proposed noise management measures (e.g. sound attenuation of mobile fleet and fixed plant and noise monitoring) are incorporated into the capital and operating costs of the Project.

Air Quality

The impact of the Project on air quality at nearby privately-owned properties can potentially be valued using the property value method, where the change in property value as a result of the air quality impacts are estimated. Alternatively, it can be estimated using the damage costs method and cost of illness method.

The Air Quality and Greenhouse Gas Assessment (Katestone Environmental 2018) indicated that there are no properties that will be impacted by exceedances of the relevant air quality criteria. These criteria are set at levels to protect against health effects and nuisance dust effects. Consequently, it is assumed that there are no material economic costs for inclusion in the CBA.

Greenhouse Gases

The Air Quality and Greenhouse Gas Assessment for the Project (Katestone Environmental 2018) estimated Scope 1 and 2 emissions associated with the Project in accordance with the National Greenhouse Accounts Factors document published by the Commonwealth Department of Environment and Energy. It estimated approximately 72 Mt of Scope 1 and 2 emissions over the life of the Project with average annual emissions of approximately 0.9 Mt of Scope 1 and Scope 2 emissions.

To place an economic value on carbon dioxide equivalent (CO_2-e) emissions, a shadow price of CO_2-e is required. Three shadow prices were initially used, the Forecast European Union Emission Allowance Units price, the Australian Treasury Clean Energy Future Policy Scenario and the US Environmental Protection Agency (EPA) Social Cost of Carbon. However, these represent the global damage cost of carbon (i.e. the cost of carbon emissions to the population of the whole world).

For a CBA of the Project to Australia and Queensland, only the GHG impacts that accrue to Australia and Queensland are relevant[6]. Refer to Gayer and Viscusi (2016) and NSW Department of Planning and Environment (2017) for discussion of these issues. In the absence of any studies that have focused on the social damage cost of carbon emissions to Australian and Queensland residents, some means of apportioning global damage costs borne by Australians is required. For the purpose of the EIA, this has been undertaken using Australia's share of the global population (around 0.3%) and Queensland's share of the Australian population (20%).

On this basis, the present value of the cost of GHG emissions from the Project to Australia is estimated at between $0.8 million (M) and $3.9M. The present value of the costs of GHG emissions from the Project to Queensland is estimated at $0.2M and $0.8M. The mid-point has been used in the central analysis i.e. $2.3M and $0.5 M (present value) for Australia and Queensland, respectively.

Water

Impacts on surface water and groundwater can potentially be valued using an estimate of their market value or replacement costs.

However, the Surface Water Assessment (Hatch 2018) identified that there would be no significant impacts on surface water resources. Notwithstanding, the cost of surface water management measures (including the construction of the Ripstone Creek diversion), as well as monitoring costs, were included in the capital and operating costs of the Project.

Costs associated with the water supply agreement with SunWater (via the Project water pipeline) have also been considered in the operating cost for the Project.

[6] Just as only net production benefits that accrue to Australia and Queensland are included.

The Groundwater Assessment (HydroSimulations 2018) identified that the Project may impact groundwater bores for three landholders. This would require Pembroke to enter into "make good agreements" that ensure no adverse impact on the landholder. The costs of these, as well as other groundwater management measures, are included in the capital and operational costs of the Project.

Ecology

The Project would have a disturbance footprint of approximately 16,300 ha, which includes native vegetation and associated fauna (DPM Envirosicences 2018a, 2018b). These impacted vegetation and fauna are likely to have non-use values to the community that would be lost as a result of the Project. These values could potentially be estimated using non-market valuation methods. The Project biodiversity offset will be established in accordance with the Queensland *Environmental Offsets Act, 2014* and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*. The Queensland *Environmental Offsets Act, 2014* requires proponents to counterbalance significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets to provide a conservation outcome by maintaining the viability of the matters impacted. The Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* requires proponents to compensate for residual significant impacts on Matters of National Environmental Significance. The provision of offsets is also likely to have non-use values to the community that would be gained as a result of the Project. Provided the values held by the community for the offsets are equal or greater than values that would be lost, then no additional economic costs warrant inclusion in the CBA apart from the capital and operating costs of providing the offsets. The staged costs of offsets are included in the capital costs of the Project.

Road Transport

The Project would result in additional transport movements associated with the construction and operational workforce and site deliveries. The Road Transport Assessment (GTA Consultants 2018) found that the Project would have no significant impacts on performance, capacity, efficiency and safety of the road network. Pembroke will enter into a road infrastructure arrangement with the Isaac Regional Council for the upgrade and maintenance of local roads expected to be impacted by the Project, including upgrade of parts of Annandale Road. Costs associated with this agreement are included in the capital cost of the Project.

Two new intersections would also be required for the Project. The intersection of the Fitzroy Development Road and the Willunga domain access road and the intersection of the Peak Downs Highway and Daunia Road would be upgraded. The cost associated with these intersections has been included in the capital cost of the Project.

Aboriginal Heritage

Any impacts on Aboriginal heritage sites may impact the wellbeing of the Aboriginal community. Impacts on Aboriginal heritage sites have been shown in some instances to reduce the wellbeing of the broader community (Gillespie Economic 2008, 2009a, 2009b), while, in other instances, the impact on the community's wellbeing has been mixed (Windle and Rolfe 2003).

To manage potential impacts to sites and places of cultural heritage significance, Pembroke has formed a Cultural Heritage Management Plan and Indigenous Land Use Agreement with the Barada Barna People. Costs associated with the Cultural Heritage Management Plan and Indigenous Land Use Agreement have been included in the operating cost for the Project.

Historic Heritage

Impacts on historic heritage can potentially be estimated using non-market valuation methods, such as choice modelling, as well as the defensive expenditure method and damage cost method, depending on how items are impacted. However, no items of historic heritage would be impacted by the Project and, hence, no costs are included in the CBA.

Visual Impacts

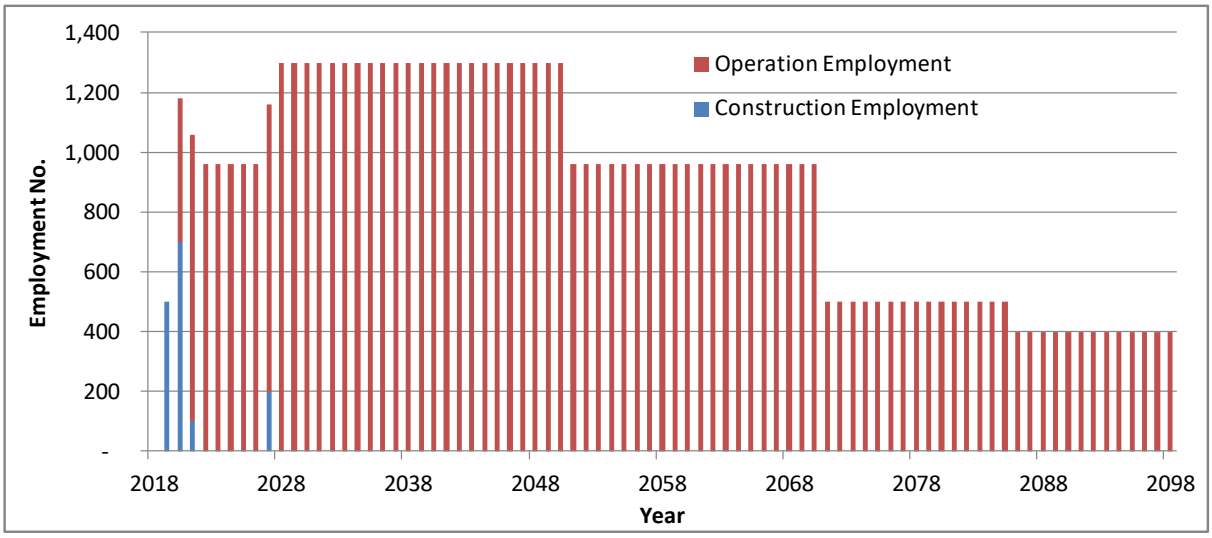
The impact of the Project on visual amenity at nearby properties can potentially be valued using the property value method, where the change in property value as a result of the visual impacts are estimated, or the defensive expenditure method and damage cost method where the costs of mitigation are estimated.

However, consideration of visual impacts found that the development and operation of the Project would have minimal visual and landscape impacts and, hence, no costs are included in the CBA.

Market Benefits to Workers

The Project would provide direct employment for the economy. An indicative employment profile is provided in Figure 3.2.

Figure 3.2 Indicative Employment Profile



In standard CBA, the wages associated with employment are considered an economic cost of production, with this cost included in the calculation of net production benefits (producer surplus). Where labour resources used in a project would otherwise be employed at a lower wage or would be unemployed a shadow price of labour is included in the estimation of producer surplus (net production benefits), rather than the actual wage (Boardman et al. 2005). The shadow price of labour is lower than the actual wage and has the effect of increasing the magnitude of the producer surplus (net production) benefit of a project.

Estimation of this potential economic value of employment from the Project requires a number of assumptions, such as the proportion of the Project workforce that would otherwise be unemployed or underemployed, the duration of time at which this would occur and the opportunity cost of labour in an unemployed or underemployed state (i.e. the reservation wage rate).

Some indication of the potential magnitude of these benefits can be gained by making a number of assumptions. Following the approach of Streeting and Hamilton (1991), if it were assumed that 50% of the additional direct operational workforce of the Project[7] (435 out of a total of 870 jobs) would otherwise be unemployed for three years and that the reservation wage for these people was $47,500[8] compared to a mining wage of $120,000, then the market employment benefit in terms of income would be $72M present value, at a 7% discount rate. Values at alternate discount rates and percentages of unemployed are provided in Table 3.5.

Table 3.5 Potential Economic Benefits to Workers Under Alternative Assumptions ($M)

% Unemployed for 3 years	Discount Rate		
	4%	7%	10%
50%	$81	$72	$65
25%	$40	$36	$32
75%	$121	$108	$97
Wage premium benefit	$1,258	$722	$471

Alternatively, if the economic benefit to workers is taken as the difference between the average wage in the region[9] ($65,140 p.a. [ABS 2016]) and the wage in the Project ($120,000 p.a.), over the life of the Project, then the potential economic benefit to workers would be $722M present value, at 7% discount rate (Table 3.5). These calculations exclude any consideration of search and retraining costs, scarring, stigma and physical and mental health effects of unemployment (Haveman and Weimer 2015). For the purpose of this CBA the more conservative (lower) estimate is used.

3.5 Consolidation of Value Estimates

The present value of costs and benefits, using a 7% discount rate, is provided in Table 3.6. The top half of Table 3.6 identifies production costs and benefits of the Project, which includes capital and operating costs associated with the mitigation, offset and compensation of environmental, social and cultural impacts. The bottom of Table 3.6 summarises the residual environmental, social and cultural impacts of the Project after mitigation, offset and compensation by Pembroke. Specific mitigation, offset and compensation costs are commercial-in-confidence and, hence, not separated out from the capital and operating costs of the Project. They are also immaterial compared to the direct mining capital and operating costs.

The Project is estimated to have total net production benefits of $4,624M. Assuming 100% foreign ownership, $2,169M of these net production benefits would accrue to Australia i.e. royalties and company tax. The estimated net production benefits that accrue to Australia can be used as a threshold value or reference value against which the relative value of the residual environmental impacts of the Project, after mitigation, compensation and offset, may be assessed. This threshold value is the opportunity cost to Australia of not proceeding with the Project. The threshold value indicates the price that the Australian community must value any residual environmental impacts of the Project (be willing to pay) to justify in economic efficiency terms the no-development option.

[7] All jobs sourced from Queensland.

[8] As estimated by the unemployment benefits plus income tax payable on a mining wage, following the reservation wage rate approach used by Streeting and Hamilton (1991).

[9] ABS does not publish data on average wages by industry sector and therefore it is not possible to estimate the average wage of those not in the mining or quarrying industry.

For the Project to be questionable from an economic efficiency perspective, all incremental residual environmental impacts from the Project, that impact Australia[10], would need to be valued by the community at greater than the estimate of the Australian net production benefits, i.e. greater than $2,169M. This is equivalent to each of the 9 M households in Australia valuing the residual environmental, social and cultural impacts at $249. If only the 1.8 M households located in Queensland hold values for the residual environmental, social and cultural impacts of the Project, then the threshold willingness to pay per household would be $1,238.

Instead of leaving the analysis as a threshold value exercise, an attempt has been made to quantitatively consider the environmental, social and cultural impacts of the Project. From Table 3.6 it can be seen that most of the potential impacts are internalised into the capital and operating costs of Pembroke via mitigation, offset or compensation and, hence, are incorporated into the estimate of net production benefits. Other impacts to Australia are estimated at approximately $2M, considerably less than the estimated $2,169M net production benefits of the Project to Australia.

Overall, the Project is estimated to have net social benefits to Australia of $2,239M (incorporating the market benefits of employment) and, hence, is desirable and justified from an economic efficiency perspective.

While the major environmental, cultural and social impacts have been quantified and included in the Project CBA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than $2,239M for the Project to be questionable from an Australian economic perspective.

[10] Consistent with the approach to considering net production benefits, environmental impacts that occur outside Australia would be excluded from the analysis. This is mainly relevant to the consideration of GHG impacts.

Table 3.6 National Cost Benefit Analysis Results of the Project (Present Values at 7% Discount Rate)

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M)**
Production	Opportunity cost of land and capital	$63	Value of the coal	$13,501
	Development costs	$612	Residual value of land and capital	$0
	Operating costs ex-royalties	$8,201		
	Decommissioning and rehabilitation costs	$0		
	Subtotal	***$8,876***	***Subtotal***	***$13,501***
	Global Net Production Benefits			**$4,624**
	Australian Net Production Benefits (Royalties and Co. Tax)			**$2,169**
Environmental, social and cultural impacts	Greenhouse gas	$2	Wage benefits to employment	$72
	Agriculture	Included in opportunity cost of land and capital costs (land acquisitions)		
	Noise	No exceedances of relevant criteria		
	Blasting	No exceedances of relevant criteria		
	Air quality	No exceedances of relevant criteria		
	Water	No significant impacts. Management and mitigation costs included in capital and operating costs.		
	Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital and operating costs		
	Road transport	No significant road network impacts. The cost of some local road upgrades included in capital costs of the Project.		
	Aboriginal heritage	Unquantified. Costs of CHMP and ILUA included in capital costs		
	Historic heritage	No impacts		
	Visual	No significant impacts		
	Non-market impacts subtotal	**$2**		**$72**
AUSTRALIAN NET SOCIAL BENEFITS				**$2,239**

Note: totals may have minor discrepancies due to rounding.

3.6 Queensland Costs and Benefits

Decision-makers have an interest in the costs and benefits to their legislative jurisdiction. Table 3.7 identifies the costs and benefits of the Project to Queensland. Impacts that have a national dimension are apportioned to Queensland, i.e.:

- 100% of royalties are attributed to Queensland;
- 20% of the estimated company tax generated from the Project is attributed to Queensland, based on Queensland's share of the Australian population;
- 100% of potential wages benefits are attributable to Queensland, based on an assumption that all incremental employment would be filled by Queensland residents;
- 20% of Australian GHG impacts are attributed to Queensland, based on Queensland's share of the Australian population; and
- all other potential environmental, social and cultural impacts would accrue to Queensland households. However, in accordance with Queensland and Commonwealth Government policy and regulation these impacts would be largely mitigated, compensated or offset by Pembroke.

On this basis, the costs and the benefits of the Project to Queensland are summarised in Table 3.7. The estimated Net Social Benefits of the Project to Queensland are $1,400M, present value at 7% discount rate. Consequently, as well as resulting in net benefits to Australia, the Project would also result in net benefits to Queensland.

Any unquantified residual impacts of the Project to Queensland after mitigation, offsetting and compensation would need to be valued at greater than $1,400M, present value for the Project to be questionable from a Queensland economic efficiency perspective.

Table 3.7 Queensland Cost Benefit Analysis Results of the Project (Present Values at 7% Discount Rate)

COSTS	NPV	BENEFITS	NPV
Direct costs		**Net direct benefits**	
		Net producer surplus	0
		Royalties	1,117
		Company tax	211
Total direct costs	**-**	***Total direct benefits***	***1,328***
Indirect costs		**Indirect benefits**	
Greenhouse gas	$0.5	Net economic benefits to workers	72
Agriculture	Included in opportunity cost of land and capital costs (land acquisitions).		
Noise	No exceedances of relevant criteria.		
Blasting	No exceedances of relevant criteria.		
Air quality	No exceedances of relevant criteria.		
Water	No significant impacts. Management and mitigation costs included in capital and operating costs.		
Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital and operating costs.		
Road transport	No significant road network impacts. The cost of some local road upgrades included in capital costs of the Project.		
Aboriginal heritage	Unquantified. Costs of CHMP and ILUA included in capital costs.		
Historic heritage	No impacts.		
Visual	No significant impacts.		
Total indirect costs	***0.5***	***Total indirect benefits***	***72***
Total costs	**0.5**	**Total benefits**	**1,400**
		Queensland net social benefits	**1,400**

Note: totals may have minor discrepancies due to rounding.

3.7 Distribution of Queensland Costs and Benefits

As identified in Attachment 1, CBA is only concerned with the single objective of economic efficiency. CBA and welfare economics provide no guidance on what is a fair, equitable or preferable distribution of costs and benefits. Nevertheless, CBA can provide qualitative and quantitative information for the decision-maker on how economic efficiency costs and benefits are distributed

The costs and benefits of the Project to Queensland are potentially distributed among a range of stakeholders, as identified in Table 3.8.

Table 3.8 Incidence of Queensland Costs and Benefits

COSTS AND BENEFITS	INCIDENCE OF COSTS AND BENEFITS	MAGNITUDE OF IMPACT ($M)
Share of Net Production Benefits		
Royalties	Queensland Government and Queensland households.	$1,117
Company tax	Queensland Government and Queensland households.	$211
Additional benefits		
Wage benefits to employment	Isaac, Mackay and Whitsunday Local Government Area (LGA) labour force.	$72
Environmental, social and cultural costs*		
Greenhouse gas impacts	Local and Queensland households	$0.5
Agricultural impacts	Agricultural enterprises (Note: These would be compensated).	$0
Noise impacts	Adjoining landholders.	No exceedances of relevant criteria.
Blasting impacts	Adjoining landholders.	No exceedances of relevant criteria.
Air quality impacts	Adjoining landholders.	No exceedances of relevant criteria.
Water impacts	Adjoining landholders.	No significant surface water impacts. Make good agreements for three landholders, in relation to groundwater bores, to ensure no adverse impact.
Ecology impacts	Local and Queensland households.	Some loss of values but offset by provision of biodiversity offsets.
Road Transport impacts	Local residents.	No material impacts.
Aboriginal Heritage	Aboriginal people and other local and Queensland households.	Unquantified.
Historic Heritage impacts	Local and Queensland households.	No impacts.
Visual Amenity	Adjoining landholders.	No significant impacts

* Queensland regulations require many impacts to be borne by the proponent via mitigation, offset and compensation. Where these measures perfectly mitigate, offset or compensate then no residual impacts occur and all impacts are borne by the proponent. This table identifies who bears residual impacts where mitigation, offset and compensation is imperfect.

3.8 Risk and Sensitivity Analysis

The main areas of environmental risks associated with coal mining projects relate to:

- the financial viability of a project from unexpected downturns in coal price and any consequent environmental impacts from premature cessation of operations;
- ecological risk associated with the ability of the biodiversity offsets to adequately compensate for the direct ecological impacts; and
- other environmental, social and cultural impacts estimations and required mitigation measures.

The financial viability of projects is a risk assumed by the mine investors. Pembroke is willing to invest in the order of $1 billion (B) in the Project. It is highly unlikely that a $1B investment would take place and then operations would cease, leaving residual environmental impacts at the site. However, the risk that this might occur is mitigated by the fact that Pembroke will be required to supply a financial assurance that is based on the likely costs and expenses that the Queensland Government may incur, to ensure that the legal requirements in relation to rehabilitation and safety of the site can be met following mine cessation.

The provision of biodiversity offsets can be associated with a number risks, including those that relate to the biodiversity benefits of additional management of offsets, success in reconstruction of ecological communities, time lags between impacts and provision of offsets as well as between management actions and achievement of ecological outcomes. These risks are mitigated through offset ratio requirements in the provision of offsets and commitment to the offset actions prior to the commencement of works under approval. In accordance with the Queensland Environmental Offset Policy, the biodiversity offset package will be committed to prior to the commencement of the Project.

There is some risk associated with the estimation of environmental, social and cultural impacts of the Project and the level of mitigation measures proposed. However, it should be noted that impacts have generally been assessed based on the maximum annual levels of production and hence are likely to be overstated. Ongoing monitoring would ensure that appropriate mitigation measures are implemented as required.

The NPVs of the Project presented in Table 3.6 and Table 3.7 are based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a CBA can be dealt with through changing the values of critical variables in the analysis (James and Gillespie 2002) to determine the effect on the NPV[11].

In this sensitivity analysis, the CBA results for Australia and Queensland were initially tested for 20% (+ and -) changes to the following variables at a 4%, 7% and 10% discount rate:

- opportunity costs of land;
- development costs;
- decommissioning and rehabilitation costs;
- operating costs;
- value of coal/Product coal production/exchange rate;
- greenhouse costs; and
- wage benefits.

[11] Quantitative risk analysis could also potentially be undertaken. However, this requires information on the probability distributions for input variables in the analysis. This information is not available and so the sensitivity testing is limited to uncertainty analysis.

Results are reported in Table 3.9 and Table 3.10. This analysis indicates that CBA undertaken at the National level is most sensitive to changes in revenue (reflecting production levels, the value of coal in USD and the AUD/USD exchange rate) and operating costs, with the former impacting royalties and company tax estimates and the latter impacting company tax estimates only. When CBA is undertaken at the Queensland level the analysis is most sensitive to changes in revenue (reflecting production levels, the value of coal in USD and the AUD/USD exchange rate). Analysis at the Queensland level is less sensitive to changes in operating costs, as this primarily impacts company tax estimates and only a small part of company tax accrues to Queensland.

Table 3.9 National Cost Benefit Analysis Sensitivity Testing (Present Value $M)

	4% Discount Rate	7% Discount Rate	10% Discount Rate
CENTRAL ANALYSIS	$4,128	$2,239	$1,332
INCREASE 20%			
Opportunity cost of land	$4,125	$2,236	$1,328
Development costs	$4,084	$2,203	$1,301
Decommissioning and rehabilitation costs	$4,128	$2,239	$1,332
Operating costs	$3,225	$1,747	$1,035
Value of coal/Product coal production/exchange rate	$5,891	$3,206	$1,916
GHG costs	$4,128	$2,239	$1,332
Wage benefits	$4,145	$2,254	$1,345
INCREASE 50% COAL PRICE	$8,535	$4,655	$2,793

	4% Discount Rate	7% Discount Rate	10% Discount Rate
DECREASE 20%			
Opportunity cost of land	$4,132	$2,243	$1,335
Development costs	$4,173	$2,276	$1,363
Decommissioning and rehabilitation costs	$4,128	$2,239	$1,332
Operating costs	$5,032	$2,731	$1,628
Value of coal/Product coal production/exchange rate	$2,366	$1,273	$747
GHG costs	$4,129	$2,240	$1,332
Wage benefits	$4,112	$2,225	$1,319
DECREASE 50% COAL PRICE	**$1,017**	**$558**	**$338**

In this respect, it should be noted that the estimated revenue from the Project is based on an assumed AUD/USD exchange rate of 0.77. At the time of report finalisation the AUD/USD exchange rate was in the order of 0.76 with forecasts suggesting that it would remain at or below this level in the longer term. The Project is a greenfield mining operation but is occurring in region where other coal mining operations are occurring and, hence, operating costs in this location and geological environment are known. Estimates of operating costs of the Project are, therefore, likely to be reasonably well-known, and a 20% increase in every year of the analysis as reported in the sensitivity analysis is highly unlikely.

The sensitivity analysis indicated that the CBA results are not sensitive to changes in capital costs, opportunity costs of land or environmental costs that have not already been internalised into production costs, such as GHG costs. Since mitigation, offset and compensation costs are a small component of the capital and operating costs of the Project, it is unlikely that large changes in these cost levels would have any significant impact on the CBA results.

Under all + or - 20% scenarios examined, the Project has net social benefits to Australia and Queensland.

At the request of the Department of State Development, Manufacturing, Infrastructure and Planning, sensitivity testing was also undertaken for a 50% variation in coal price. A 50% increase in coal price substantially increases the net social benefits of the Project to Queensland and Australia. A 50% reduction will still result in royalty benefits to Queensland and Australia if the Project went ahead.

Table 3.10 Queensland Cost Benefit Analysis Sensitivity Testing (Present Value $M)

	4% Discount Rate	7% Discount Rate	10% Discount Rate
CENTRAL ANALYSIS	$2,520	$1,400	$860
INCREASE 20%			
Opportunity cost of land	$2,519	$1,400	$859
Development costs	$2,511	$1,393	$854
Decommissioning and rehabilitation costs	$2,520	$1,400	$860
Operating costs	$2,338	$1,301	$801
Value of coal/Product coal production/exchange rate	$3,199	$1,773	$1,086
GHG costs	$2,519	$1,400	$860
Wage benefits	$2,536	$1,415	$873
INCREASE 50% COAL PRICE	**$4,218**	**$2,332**	**$1,424**

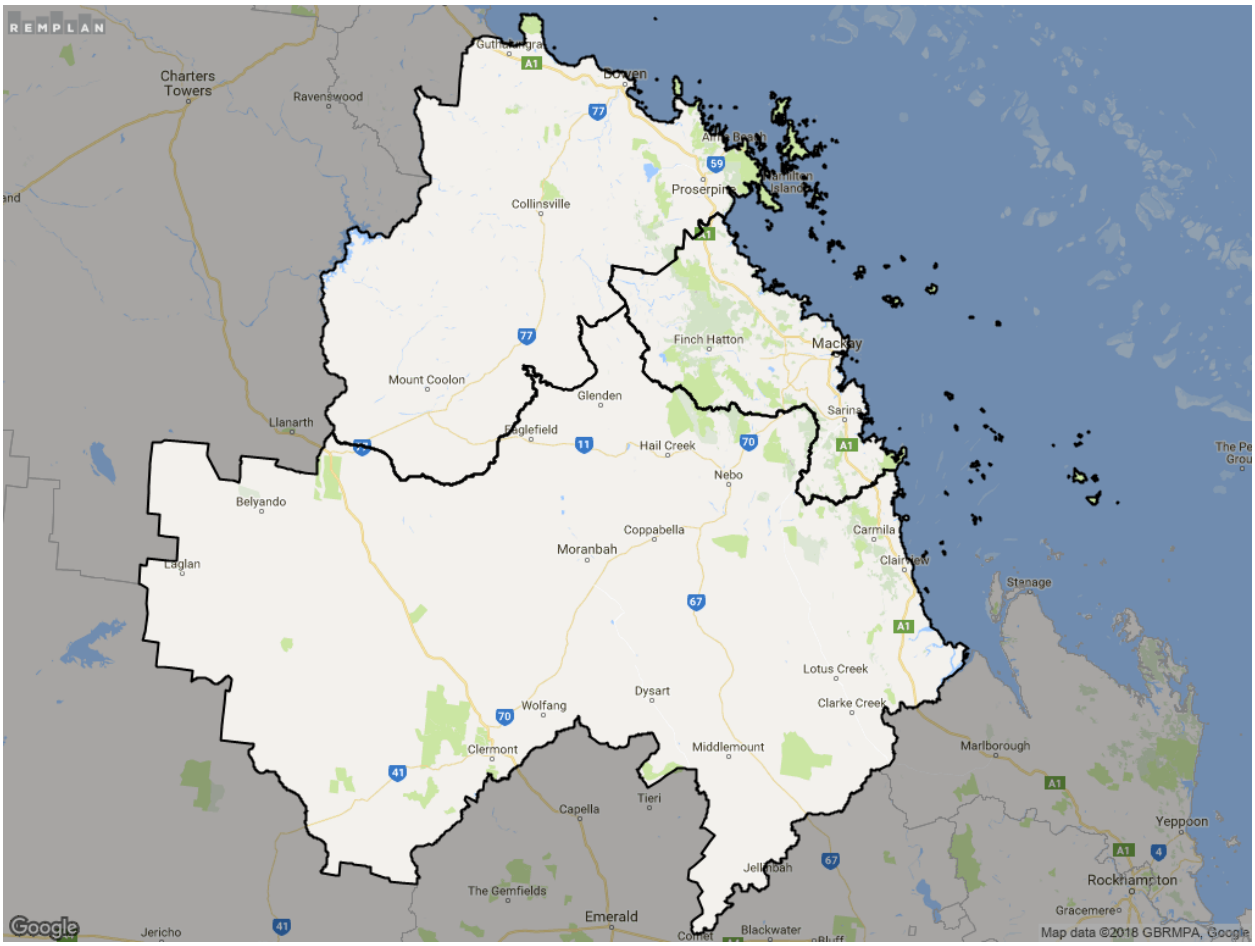
	4% Discount Rate	7% Discount Rate	10% Discount Rate
DECREASE 20%			
Opportunity cost of land	$2,520	$1,401	$861
Development costs	$2,529	$1,408	$866
Decommissioning and rehabilitation costs	$2,520	$1,400	$860
Operating costs	$2,701	$1,499	$920
Value of coal/Product coal production/exchange rate	$1,840	$1,028	$635
GHG costs	$2,520	$1,400	$860
Wage benefits	$2,503	$1,386	$847
DECREASE 50% COAL PRICE	**$1,017**	**$558**	**$338**

4 LOCAL, STATE AND REGIONAL ECONOMIES

4.1 Characterisation of the Existing Local, Regional and State Economy

The Project is located in the Isaac LGA and the larger Mackay-Isaac-Whitsunday (SA4) economy, within Queensland (Figure 4.1).

Figure 4.1 Local Area and Region



The Isaac LGA spans an area of approximately 58,000 square kilometres (km^2) in Central Queensland, and is located 1,000km north-west of Brisbane and 900km south of Cairns.

The total number of people usually resident in the Isaac LGA in 2016 was 21,563. This represents an increase of 1,191 people (5.85%) from the 2006 total of 20,372 people. This compares to an increase of 19,698 people usually resident (12.77%) in Mackay-Isaac-Whitsunday (SA4) between 2006 and 2016, and an increase of 840,885 people usually resident (20.98%) in Queensland (State). Notwithstanding, in contrast to the population of Queensland, both Isaac LGA and the Mackay-Isaac-Whitsunday (SA4) have experienced some recent population decline. From 2012 to 2016, the usual resident population of Isaac declined by 1,787 (7.65%), while from 2013 the usual resident population of Mackay-Isaac-Whitsunday (SA4) declined by 2,629 (1.49%).

While the Isaac LGA was home to 21,563 residents in 2016, an additional 11,085 resource sector workers travel there and are housed in temporary accommodation. Isaac LGA includes the modern mining towns of Moranbah, Middlemount, Dysart and Glenden, the historic communities of Nebo, Clermont and St Lawrence and small picturesque coastal villages and rural localities. Moranbah is the main service centre for the region with an estimated population of 9,120.

Key economic indicators for the Isaac LGA, Mackay-Isaac-Whitsunday (SA4) and Queensland are provided Table 4.1.

Table 4.1 Economic Indicators for the Local, Regional and Queensland Economies

	Isaac LGA	Mackay-Isaac-Whitsunday (SA4)	Queensland
Output ($B)	$14.041	$34.615	$661.090
Value-added ($B)	$5.828	$15.129	$305.603
Wages and Salaries ($B)	$2.230	$6.901	$851.225
Employment (No.)	21,462	85,165	2,130,837
Exports ($B)	$11.619	$11.697	$105.697
Imports ($B)	$6.662	$10.840	$99.261

It is estimated that 21,462 people work[12] in the Isaac LGA. The Isaac LGA employment represents 25.20% of the 85,165 people working in Mackay-Isaac-Whitsunday (SA4) and 1.01% of the 2,130,837 people working in Queensland.

Historically the Isaac LGA economy has been driven by the resource sector, producing primarily high grade metallurgical coal. The mining sector makes up 60.94% of employment in the Isaac LGA, 72.83% of wages and salaries, 78.35% of value-added, 79.28% of output, 90.99% of regional exports and 80.99% of imports.

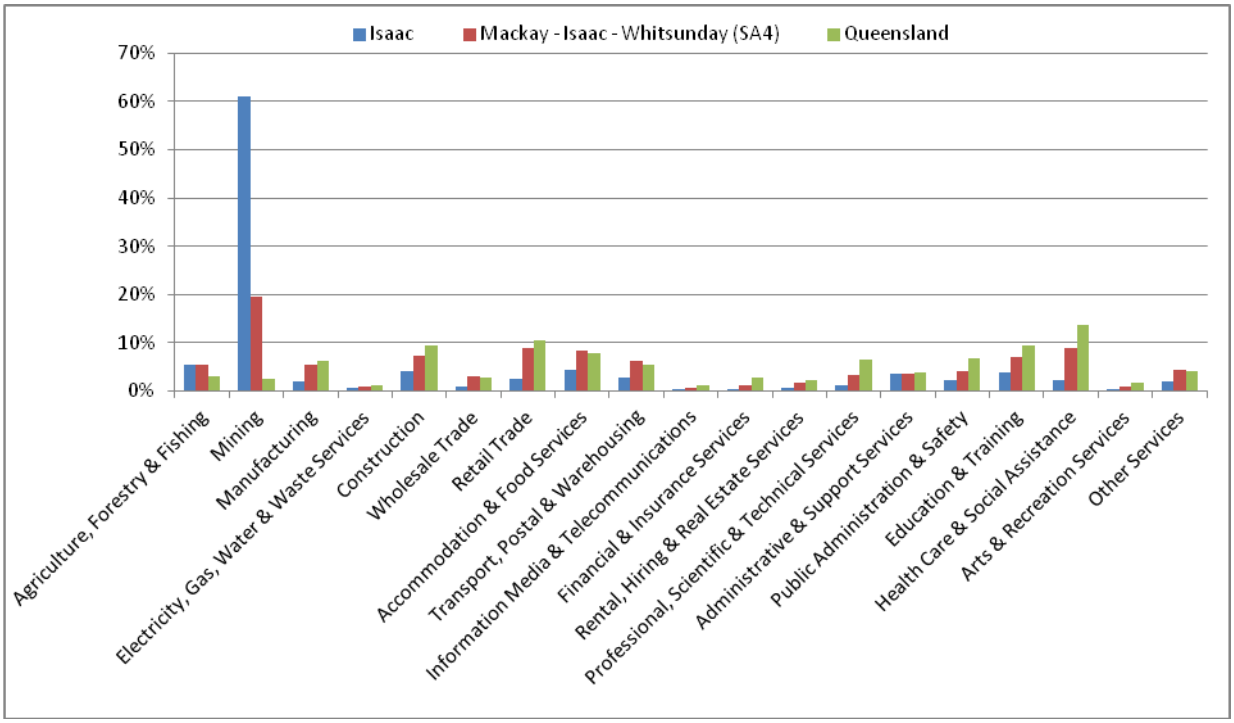
While the mining sector is still the most significant sector in the Mackay-Isaac-Whitsunday (SA4), its relative significance declines in the more diversified economy. The mining sector makes up 19.48% of employment in Mackay-Isaac-Whitsunday (SA4), 29.55% of wages and salaries, 37.66% of value-added, 40.16% of output, 73.31% of regional exports and 44.02% of imports.

For Queensland, the mining sector makes up 2.37% of employment, 3.94% of wages and salaries, 6.61% of value-added, 7.11% of output, 31.77% of regional exports and 10.36% of imports.

The relative shares of employment by industry for the Isaac LGA, Mackay-Isaac-Whitsunday (SA4) and Queensland are shown in Figure 4.2. This indicates the significance of the mining sector to the Isaac LGA and Mackay-Isaac-Whitsunday (SA4). For the Isaac LGA the next most significant sectors for employment are Agriculture, Forestry and Fishing, Accommodation and Food Services, and Construction. For Mackay-Isaac-Whitsunday (SA4), the next most significant sectors for employment are Retail Trade, Health Care and Social Assistance, and Accommodation and Food Services. For the Queensland economy the most significant sectors for employment are Health Care and Social Assistance, Retail Trade, Education and Training, and Construction.

[12] The employment data presented here represents the number of people employed by businesses/organisations in each of the industry sectors in the defined regions. In this report the employment data is place of work data and represents total numbers of employees without any conversions to full-time equivalence. Retail jobs, for instance, represent typical employment profiles for that sector, i.e. some full-time, some part-time and some casual.

Figure 4.2 Employment by Industry in the Local, Regional and Queensland Economy

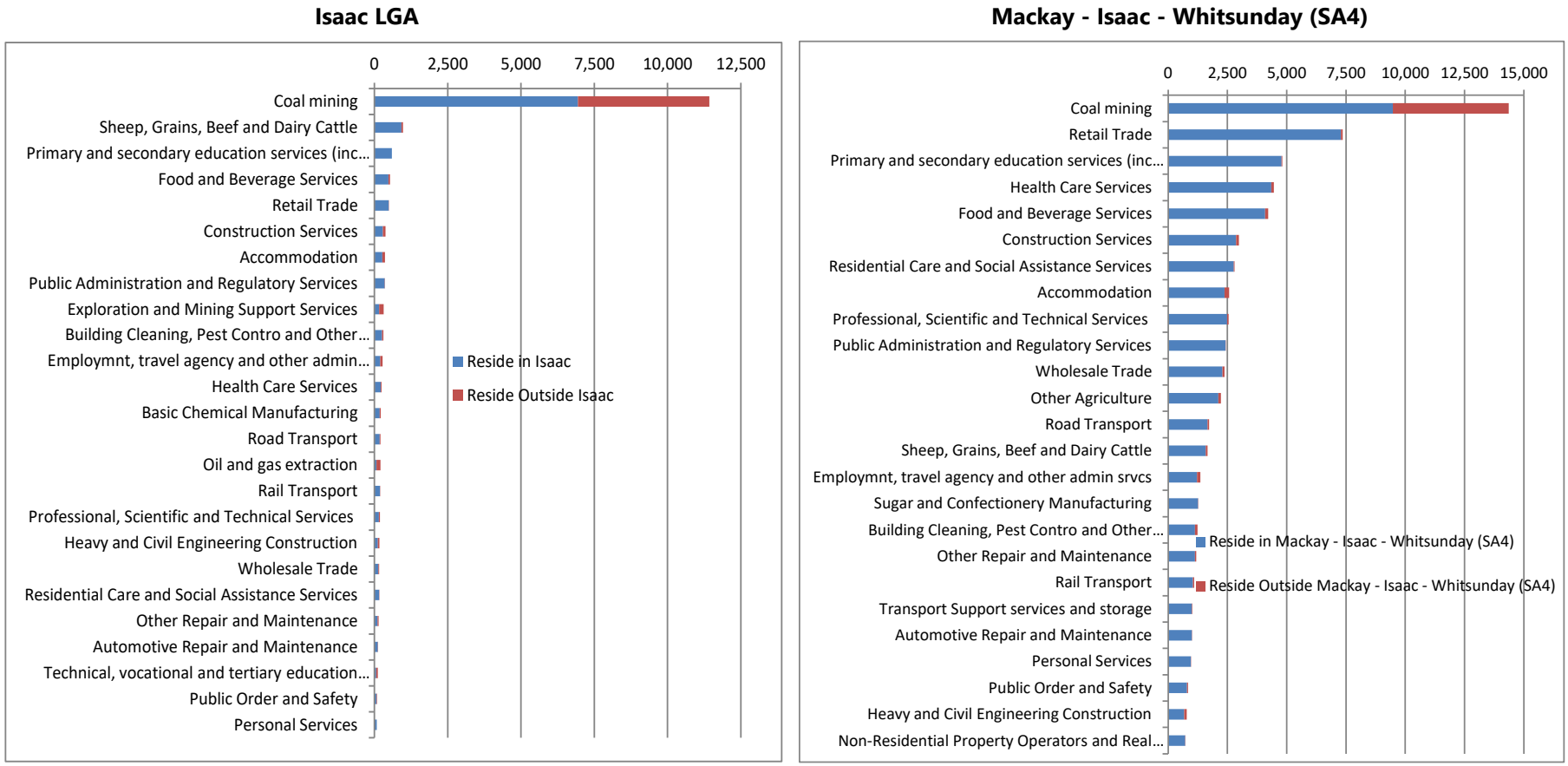


While Isaac LGA makes up 25.20% of the workers in Mackay-Isaac-Whitsunday (SA4), it contributes 37.34% of the Gross Regional Product. Similarly, while Mackay-Isaac-Whitsunday (SA4) makes up 4.00% of the workers in Queensland, it contributes 4.87% of the Gross Regional Product. This reflects the high value-added per worker in the mining sector.

A more detailed employment by industry breakdown for the Isaac LGA and Mackay-Isaac-Whitsunday (SA4) is provided in Figure 2.3. These identify the top 25 employment sectors in each economy by place of usual residents (inside or outside the region). The figures use Input-Output (IO) industry classifications.

The Coal Mining sector is by far the largest employer in the Isaac LGA with 39% of the workforce residing outside the region. The next most significant sectors are Sheep, Grains, Beef and Dairy Cattle sector, Primary and Secondary Education Services, Food and Beverage Services and Retail Trade. The Coal Mining sector is also the most significant sector in the Mackay-Isaac-Whitsunday (SA4), with a lower percentage (34%) commuting from outside the region. Mackay-Isaac-Whitsunday (SA4) has a more diverse economy than Isaac LGA, with other significantly sized sectors. After Coal Mining the next most significant employment sectors are Retail Trade, Primary and Secondary School Education Services, Health Care Services and Food and Beverage Services.

Figure 2.3 Main Employment Sectors in the Local and Regional Economies by Place of Usual Residence



Source: Generated from ABS 2016 Census 4 digit employment by industry by place of usual residence data.

4.2 Mine Expenditure Potentially Captured by the Local, Regional and State Economies

Economic activity benefits to an economy will arise from spending that is captured by that economy, rather than having it move outside to other economies. Expenditure from the Project that can potentially be captured by the local area, region and Queensland arises from:

- non-labour inputs to the Project; and
- expenditure of wages by labour.

4.2.1 Non-Labour Expenditure

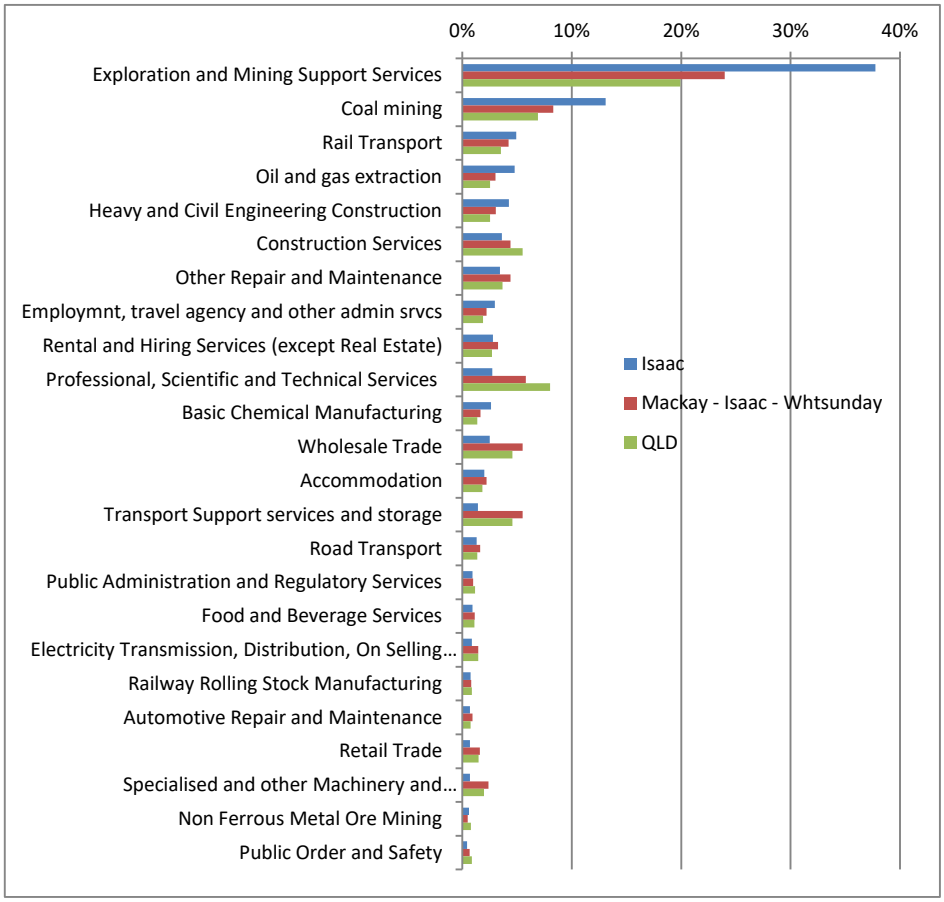
The Project is a greenfield development and hence there is uncertainty about the specific businesses that are located in the local area and region that are likely to directly benefit from the Project's operation expenditure. However, some indication of the main sectors of the local and regional economy that may directly benefit from the Project operation can be obtained by examining the regional expenditure pattern of the coal mining sector in the Isaac, Mackay-Isaac-Whitsunday (SA4) and Queensland IO tables. This has been developed based on the expenditure pattern of the coal mining sector in the Australian IO table and the application of location quotients[13] to assess the ability of sectors in the Isaac LGA, Mackay-Isaac-Whitsunday (SA4), and Queensland economies to supply the goods and services demanded. Based on this approach the Queensland economy is estimated to be able to supply 81% of the direct non-labour inputs to the Project, while the Mackay-Isaac-Whitsunday (SA4) and Isaac economies are estimated to be able to supply 67% and 43% of the direct non-labour inputs to the mine, respectively.

The main sectors in the different economies that are likely to benefit from direct non-labour expenditure are shown in Figure 4.4.

This indicates that of the expenditure captured by each economy, the majority accrues to the Exploration and Mining Support Services sector. For the Isaac LGA, the Coal Mining sector, Rail Transport sector, Oil and Gas Extraction sector and Heavy and Civil Engineering Construction sectors are the next main sectors to benefit. At the Mackay - Isaac - Whitsunday (SA4) level, the Coal Mining sector, Professional, Scientific and Technical services sector, Wholesale Trade and Transport support services are the next main sectors to benefit. For the Queensland economy the next main sectors to benefit are the Professional, Scientific and Technical services sector, Coal Mining sector, Construction services sector and Wholesale Trade sector.

[13] Location quotients are a way of quantifying how "concentrated" an industry is in a region compared to a larger geographic area, in this case, Queensland. They are calculated by comparing the industry's share of regional employment with its share of Queensland employment. A location quotient of one indicates that the concentration of an industry's employment in a region is the same as for the state. A location quotient of greater than one indicates the region has a greater concentration of employment in an industry as compared to Queensland and, hence, the likelihood of this sector in a region being able to provide the goods and services demanded by a Project are greater than where the concentration is less than one.

Figure 4.4 Percentage of Non-Labour Expenditure in the Region by Sector



4.2.2 Expenditure of Wages by Labour

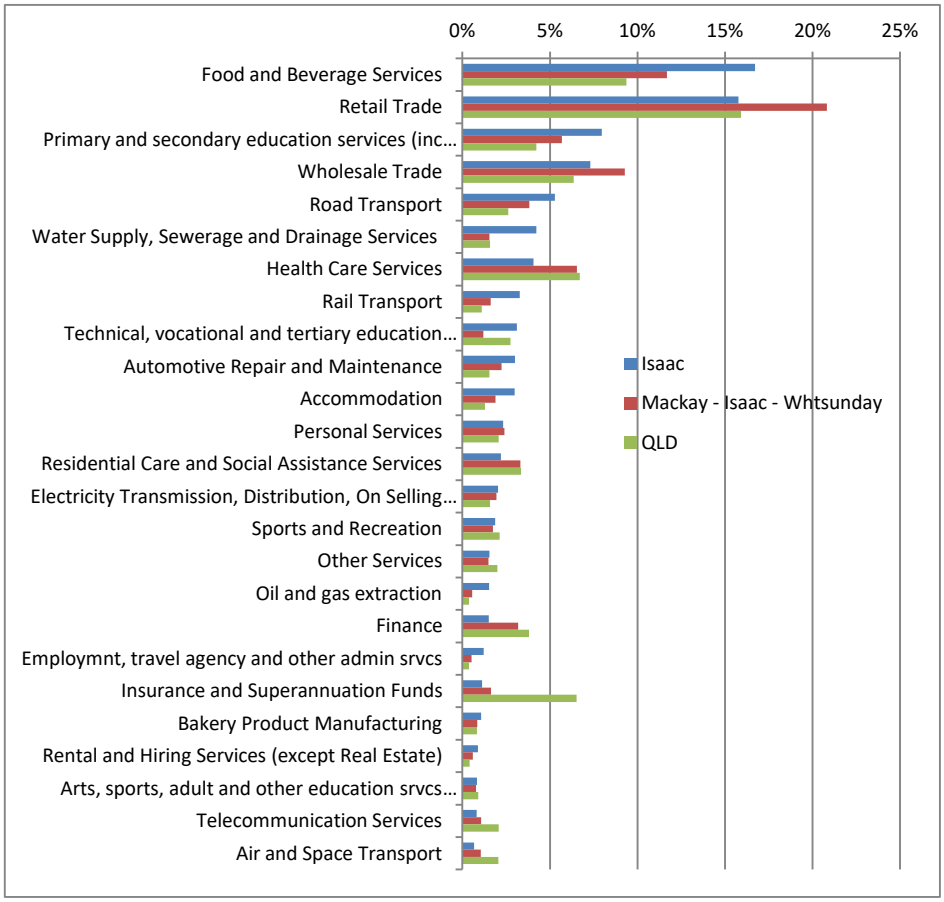
Economic activity in the region would also arise from the expenditure by the Project workforce in the region. It is estimated that the Project would have an initial average annual construction workforce of 375 and an average annual operational workforce of 873[14]. An indication of the main sectors of the regional economy that may benefit from employee expenditure can be obtained by examining the expenditure pattern of the household sector in the National IO table adjusted to the state, region and local areas using location quotients. Based on this approach the Queensland economy is estimated to be able to supply 62% of the goods and services demanded by households, while the Mackay-Isaac-Whitsunday (SA4), and Isaac LGA economies are estimated to be able to supply 43% and 15% of the goods and services demanded by employees.

Based on this approach the main sectors to benefit from direct expenditure of wages in the Isaac LGA, Mackay-Isaac-Whitsunday (SA4) and Queensland economies are shown in Figure 4.5.

This indicates that of the expenditure captured by each economy, the majority accrues to Retail Trade, Food and Beverage Services and Wholesale Trade. Primary and Secondary School Education Services also benefits, particularly at the Isaac LGA level. Health Care Services are a more significant beneficiary at the Mackay-Isaac-Whitsunday (SA4) and State levels.

[14] Although there would be a peak annual operational workforce of 1,300.

Figure 4.5 Percentage of Household Expenditure in the Region by Sector



5 REGIONAL IMPACT ANALYSIS OF THE PROJECT

5.1 Introduction

The CBA in Section 3 is concerned with whether the incremental benefits of the Project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the Project compared to 'without' it. This RIA examines economic activity impacts of the Project using CGE analysis. Cadence Economics was engaged to undertake a CGE analysis of the Project using the same input assumptions as the CBA.

The full CGE analysis is provided in Attachment 4.

5.2 CGE Modelling Framework

CGE modelling is a recognised method for assessing the impacts of large projects on the economy in the Coordinator-General's Guideline. It is based on detailed representation of the economy, including the complex interactions between different sectors of the economy.[15] A CGE model is able to analyse the impacts of the Project in a comprehensive, economy-wide framework, meaning the modelling captures (Attachment 4):

- ***Direct increases in demand*** associated with the Project, including short-term construction activity as well as the output attributable to Project coal production.
- ***Indirect increases in demand*** or flow-on effects associated with increased economic activity relating to both the construction phase of development and the Project coal production.
- ***Labour market displacement*** caused by the direct increase in demand from the Project (and the associated investment) on other sectors of the economy bidding up wages and 'crowding out' other sectors of the economy.
- ***Revenue leakage*** associated with the expropriation of:
  - profits from the mine to overseas interests in this case, the Project which is owned by Pembroke, a foreign-owned company; and
  - construction worker wages.

For this analysis, Cadence Economics used the Cadence Economics General Equilibrium Model (CEGEM) which is a large-scale, dynamic, multi-region, multi-sector model of the global economy, with an explicit representation of the three economies on which impacts were estimated:

1. Isaac LGA, in which the Project is located (Isaac Region);
2. a combination of the Mackay Regional Council and the Whitsundays Regional Council (MW Region), which represents the regions surrounding the Project; and
3. the rest of Queensland.

It was assumed that 75% of construction workers reside outside the Isaac Region and 50% of operational workers reside outside the Isaac Region. It is assumed that these workers are sourced from the MW Region. The Social Impact Assessment (Elliott Whiteing 2018) includes more information on the source of the Project workforce.

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

The modelling includes the both the construction phase and the operational phase of the Project from 2018 to 2050 (i.e. does not include the whole Project life). This was the technical limit of the modelling time frame but has little impact on the reported results, due to the effect of discounting on impacts far into the future. All other things being equal, truncation of modelling results in a slight underestimation of the economic activity benefits of the Project.

5.3 CGE Impact Scenarios and Measures

The CGE analysis was undertaken under three different labour supply assumptions:

- a full employment assumption (low labour supply scenario), where all regions in the model operate at full employment, meaning no new employment is generated in response to the Project. In this case, any employment for the Project is drawn from the existing labour pool, but encouraged to change jobs as wages increase;
- a labour supply elasticity of 0.15 (medium labour supply scenario), adopted by Treasury at the National Level, which indicates a relatively 'inelastic' response from workers i.e. workers are slow to enter the workforce due to changes in wages, because it is assumed that the economy is close to full employment or the project under consideration requires highly skilled workers; and
- a labour supply elasticity of 0.30 (high labour supply scenario), which is still relatively 'inelastic' but more elastic than the above assumption, meaning that workers respond more readily to marginal changes in the wage rate by entering the workforce.

The CGE focus was on three indicators of economic activity:

- Gross Regional Product (GRP)[16] = Consumption + Investment + Government Expenditure + Net Exports;
- Gross Regional Income (GRI)[17] = GRP + Net Income Flows; and
- Full-time Equivalent (FTE) employment.

Cadence Economics identifies that real GRI represents the preferable welfare measure to the commonly reported change in real GRP (a measure of production).

All results are reported as deviations from the reference case and represent the change in a particular variable as a result of investing in and operating under the Project assumptions.

5.4 Economic Activity Impacts

5.4.1 Medium Labour Supply Scenario (labour supply elasticity of 0.15)

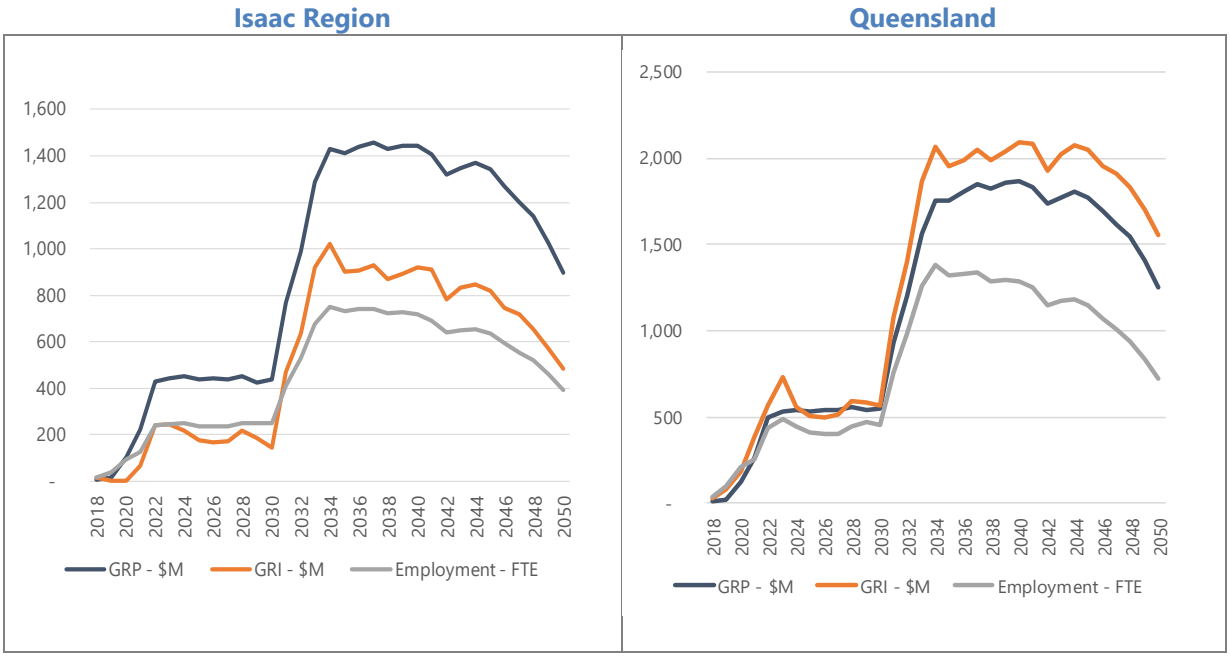
A summary of the key macroeconomic variables projected under the core scenario is shown in Figure 5.1.

The results for the Isaac Region are outlined on the left hand side of Figure 5.1 and Queensland on the right. Results for the MW Region are outlined in Table 5.1.

[16] GRP for Queensland is referred to as Gross State Product (GSP).
[17] GRI for Queensland is referred to as Gross State Income (GSI).

The annual results from the CGE model generally move in line with the Project capital expenditure and production activity. Real GRP for the Isaac Region is projected to peak at $1,455M, higher than the reference case in 2037, coinciding with peak coal output. This increase in real GRP is a function of the higher levels of activity within the LGA associated with output at the mine and the flow-on benefits of purchasing inputs to operate the mine.

Figure 5.1 Projected Economy-Wide Impacts of the Project, 0.15 Labour Supply Elasticity



Source: Cadence Economics estimates

Real GRI is also projected to peak in 2034 at $1,020M, which coincides with the end of the capital expenditure phase and the start of peak coal output levels. The increase in GRI is driven by the twin factors of higher wages for local workers and the repatriation of profits out of the LGA to the foreign owners of the mine, the company tax outflows and the royalty payments to the rest of Queensland.

Employment in the Isaac Region is expected to peak at 748 FTE, also in 2034, coinciding with the start of the ramp-up in saleable coal output. These results are driven by the direct employment within the Isaac Region, the flow-on impacts from local inputs and any of the crowding out of employment in other sectors. Given the increase in economic activity and a migration of workers into higher paying sectors, average wages in the Isaac Region are projected to increase by 11.98% over the modelling period, see Table 5.1.

Moving to the state-wide results, real Gross State Product (GSP) for Queensland is projected to peak at $1,865M, higher than the reference case in 2040, and real Gross State Income (GSI) peaks at $2,087M and employment of 1,383 FTE. State-wide average wage increases by a modest 0.21%.

Table 5.1 also provides an account of the economy-wide impacts for the MW Region. The region is expected to experience large income flows during the construction and operational phases of the Project, with 75% of construction and 50% of operational workers residing in the area. GRI is expected to increase by $1,540M over the life of the Project, a reflection of the repatriation of wages. Output in the region is expected to increase modestly, with an increase of GRP of $212M and employment increasing by an average of 36 FTE. Regional average wage increases by a modest 0.31%.

Table 5.1 Projected Regional Economy-Wide Impacts, 0.15 Labour Supply Elasticity

Gross Regional Product	$M (NPV*)
Isaac Region	8,028
Mackay-Whitsundays Region	212
Rest of Queensland	1,841
Queensland	10,080
Gross Regional Income	**$M (NPV*)**
Isaac Region	4,590
Mackay-Whitsundays Region	1,540
Rest of Queensland	5,351
Queensland	11,481
Employment	**Average FTE**
Isaac Region	454
Mackay-Whitsundays Region	36
Rest of Queensland	335
Queensland	826
Wages	**Average %**
Isaac Region	11.98
Mackay-Whitsundays Region	0.31
Rest of Queensland	0.09
Queensland	0.21

* Using a 7% real discount rate

Source: Cadence Economics estimates (Attachment 4)

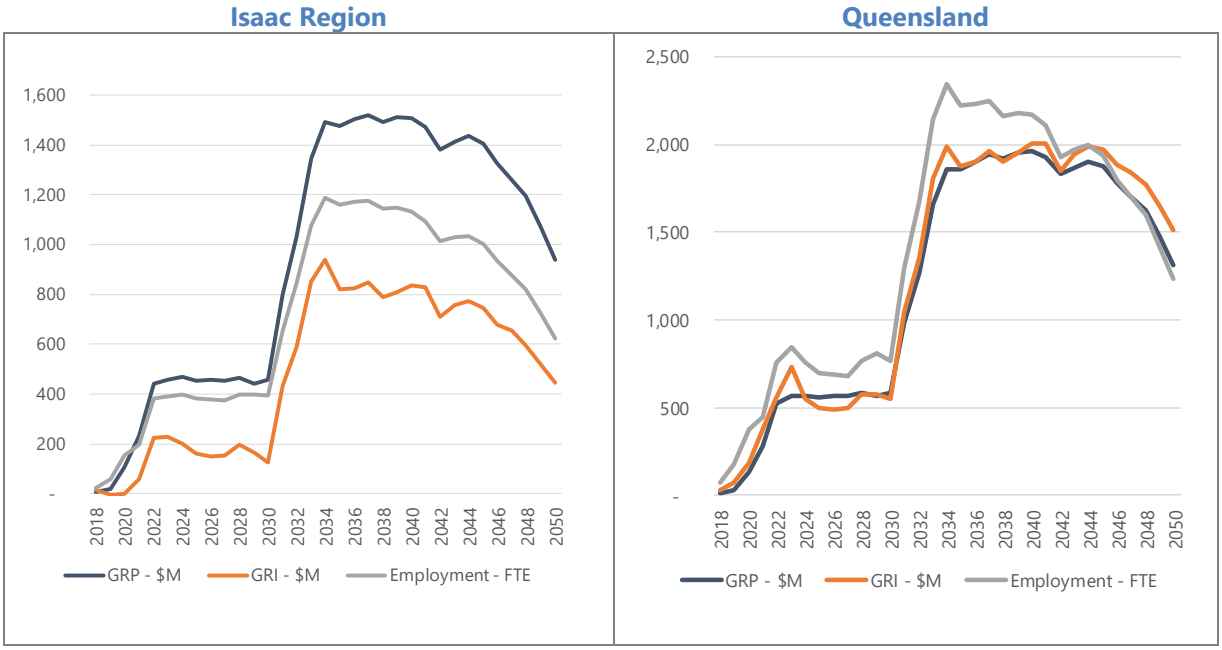
5.4.2 High Labour Supply Scenario (labour supply elasticity of 0.30)

This section provides an overview of the economic impacts, where the labour market responds more readily to marginal changes to the wage rate, under the High labour market assumptions i.e. a labour supply elasticity of 0.30.

The results indicate that the labour market assumptions have a relatively large impact to employment compared to the economy-wide impacts to GRP and GRI.

Real GRP for the Isaac Region is projected to peak at $1,512M higher than the reference case in 2037, where real GRI is projected to peak in 2034 at $940M, under the High labour market assumptions (see Figure 5.2).

Figure 5.2 Projected Economy-Wide Impacts of the Project, 0.30 Labour Supply Elasticity



Source: Cadence Economics estimates

The employment impacts are more pronounced: employment in the Isaac Region is expected to peak at 1,188 FTE, also in 2034. These results would be driven by the projected direct employment within the Isaac Region and the flow-on impacts from local inputs. It would also include any of the crowding out of employment in other sectors although, given the greater availability of workers, these impacts are lower than in the Medium scenario. Average wages in the Isaac Region are projected to increase by 9.4% over the Project life, lower than the Medium case assumptions.

Moving to the state-wide results, real GSP for Queensland is projected to peak at $1,967M, higher than the reference case in 2040. In the same year, real GSI is projected to peak at $2,004M. Employment peaks early in the ramp up phase at 2,346 FTEs. State-wide average wages increase by a modest 0.18%, as outlined in Table 5.2.

Table 5.2 also provides an account of the economy-wide impacts for the MW Region. The Region is expected to experience large income flows during the construction and operational phases of the Project, with 75% of construction and 50% of operational workers residing in the area. GRI is expected to increase by $1,549M over the life of the Project, a reflection of the repatriation of wages. Output in the region is expected to increase modestly, with an increase of GRP of $239M, and employment increasing by an average of 67 FTE. Regional average wages increase by a modest 0.28%

Table 5.2 Projected Regional Economy-Wide Impacts, 0.30 Labour Supply Elasticity

Gross Regional Product	$M (NPV*)
Isaac Region	8,381
Mackay-Whitsundays Region	239
Rest of Queensland	2,052
Queensland	10,672
Gross Regional Income	**$M (NPV*)**
Isaac Region	4,201
Mackay-Whitsundays Region	1,549
Rest of Queensland	5,392
Queensland	11,142
Employment	**Average FTE**
Isaac Region	721
Mackay-Whitsundays Region	67
Rest of Queensland	613
Queensland	1,401
Wages	**Average %**
Isaac Region	9.37
Mackay-Whitsundays Region	0.28
Rest of Queensland	0.08
Queensland	0.18

Source: Cadence Economics estimates (Attachment 4)

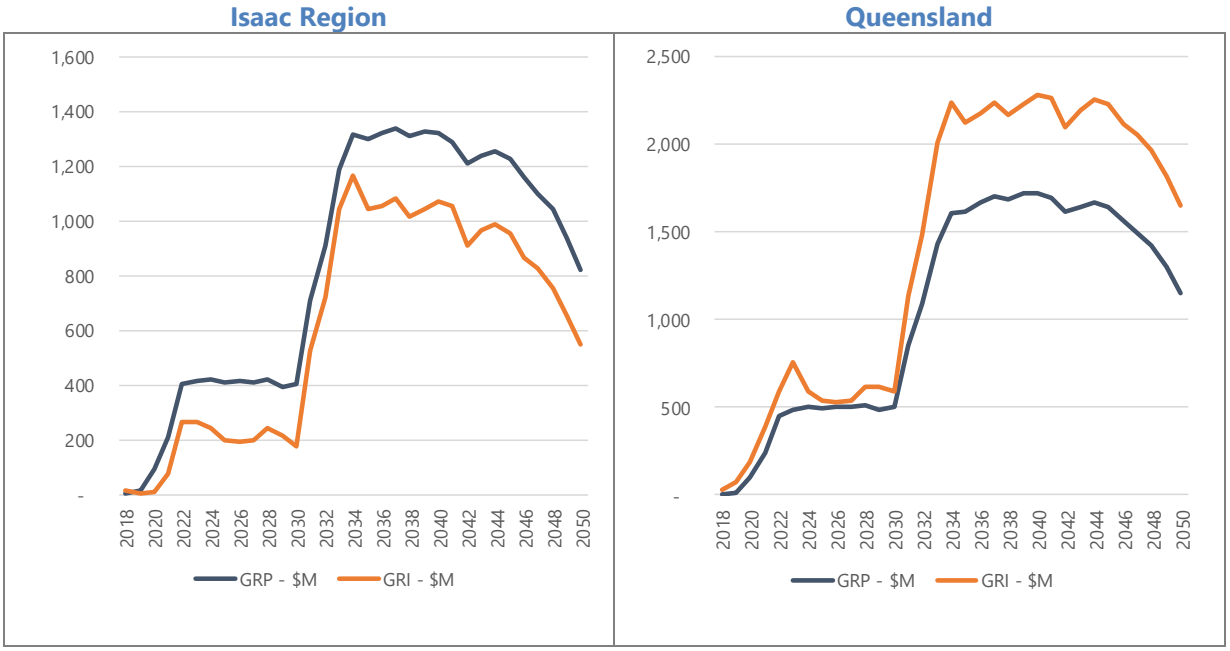
* Using a 7% real discount rate

5.4.3 Low Labour Supply Scenario (labour supply elasticity of zero)

This section provides an overview of the economic impacts, where the labour market does not respond to marginal changes to the wage rate, suggesting the regional and Queensland economies are at full employment.

Real GRP for the Isaac Region is projected to peak at $1,340M higher than the reference case in 2037, where real GRI is projected to peak in 2034 at $1,167M, under the zero labour supply assumptions (see Figure 5.3).

Figure 5.3 Projected Economy-Wide Impacts of the Project, Zero Labour Supply Assumption



Source: Cadence Economics estimates

Moving to the state-wide results, real GSP for Queensland is projected to peak at $1,724M higher than the reference case in 2040. In the same year real GSI is projected to peak at $2,279M.

Average wages in the Isaac Region are projected to increase by 16.7% over the Project life, higher than the Medium case assumptions, as outlined in Table 5.3. State-wide average wages increase by a modest 0.27%; again, this is higher than the Medium case assumptions. The higher wage response is the main driver for increasing gross regional income and gross state income above those modelled for the Medium case assumptions.

Table 5.3 also provides an account of the economy-wide impacts for the MW Region. GRI is expected to increase by $1,549M over the life of the Project, a reflection of the repatriation of wages. Output in the region is expected to increase modestly, with an increase of GRP of $189M. Employment in the region is fixed under the Zero labour market response, and wages increase by 0.34%.

Table 5.3 Projected Regional Economy-Wide Impacts, Zero Labour Supply Elasticity

Gross Regional Product	$M (NPV*)
Isaac Region	7,421
Mackay-Whitsundays Region	189
Rest of Queensland	1,667
Queensland	9,277
Gross Regional Income	**$M (NPV*)**
Isaac Region	5,286
Mackay-Whitsundays Region	1,549
Rest of Queensland	5,467
Queensland	12,302
Employment	**Average FTE**
Isaac Region	0
Mackay-Whitsundays Region	0
Rest of Queensland	0
Queensland	0
Wages	**Average %**
Isaac Region	16.65
Mackay-Whitsundays Region	0.34
Rest of Queensland	0.10
Queensland	0.27

* Using a 7% real discount rate

Source: Cadence Economics estimates

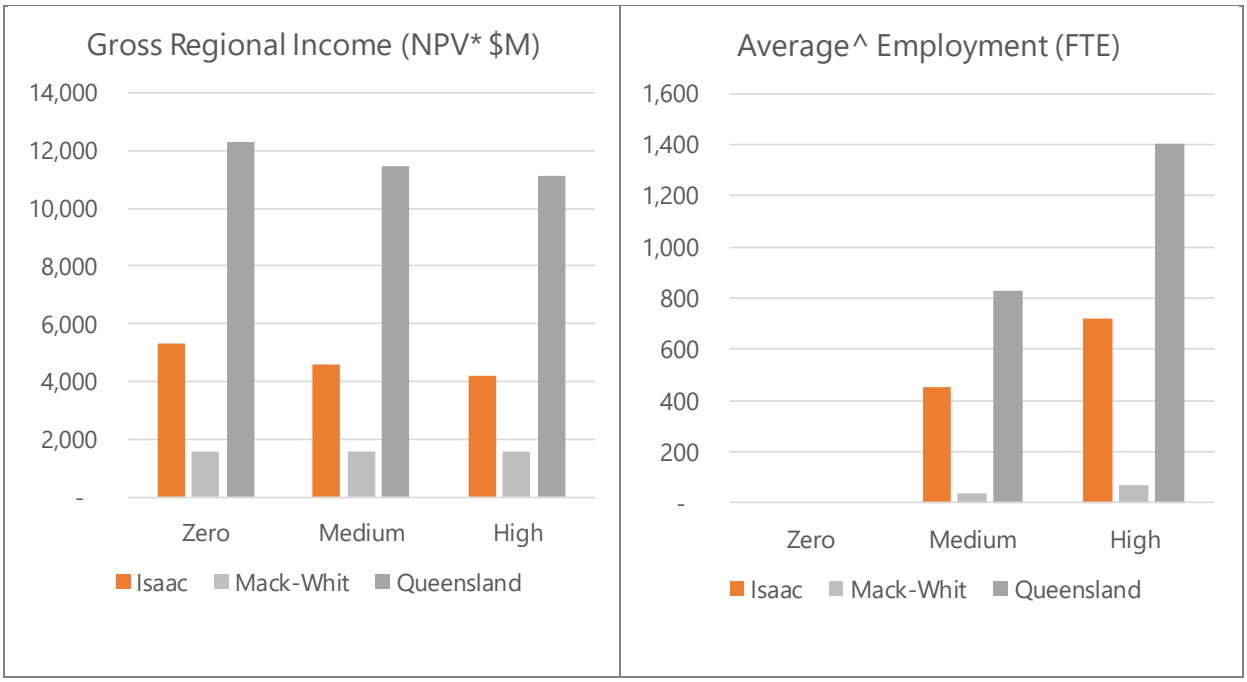
5.4.4 Summary of Impacts

A summary of the projected economy-wide impacts of the Project generated by the CGE model is provided in Figure 5.4 under three separate labour market response assumptions, including the Zero response labour market assumption.

Under each scenario the Project is projected to increase GRI, which is a measure of economic welfare, in both the Isaac Region and Queensland broadly. In NPV terms, the projected increase in GRI in the Isaac Region ranges from $5,286M under the Zero labour supply response to $4,201M under the High labour response assumption. The GRI result is influenced by the total increase in wages in the region; under the Zero labour supply response, wages are modelled to increase by 16.7% compared to 9.4% for the High labour supply.

Total employment, which is also influenced by the labour supply response, averages 721 FTE under the High labour supply response assumption, and 454 FTE under the Medium labour supply response assumption.

Figure 5.4 Projected Economy-Wide Impacts of the Project by Labour Market Response



* Net Present Value in 2017 Australian dollars, calculated over the period 2018 to 2050 using a 7% real discount rate.

Source: Cadence Economics estimates based on information provided by Gillespie Economics.

The economic benefits of the Project also accrue to the broader Queensland economy, influenced by royalty payments into the rest of Queensland. In NPV terms, the projected increase in GRI in Queensland ranges from $12,302M under the Zero labour supply response to $11,142M under the High labour response assumption. The associated employment effects would be 1,401 FTE under the High labour response assumption (826 FTE under the Medium labour response assumption).

The Zero response assumption is equivalent to assuming that the Isaac Region and Queensland economy are operating at full employment and, therefore, no new workers are available to service the Project. That is, workers are drawn from their existing jobs through the offer of higher wages. Under the Zero labour market response, wages in the region increase by 16.65%, and by 0.27% across the State.

Under the other scenarios, the Isaac Region and Queensland economy would be operating at below capacity, as evidenced for example by higher unemployment or underemployment, and it is more realistic to assume a relatively more 'elastic' labour supply whereby potential workers would be encouraged into the workforce, again through increased wages. Under the High labour market response, wages in the region increase by 9.4%, and in Queensland by 0.18%.

6 CUMULATIVE IMPACTS

A range of other developments would be expected to occur over the life of the Project. Table 6.1 provides a summary of existing, approved and proposed major projects in the region. However, others may arise.

Cumulatively these projects will compete for both capital and labour – the primary inputs into production. Capital is highly liquid and competition for capital is in a global market. The capital required for the cumulative Projects in the region is an infinitesimally small component of global capital and hence increased competition for capital, and hence higher cost of capital, is unlikely to occur as a result of the cumulative projects in the region.

Projects will also cumulatively compete for labour resources, both local labour resources as well as those in the wider region and State. Competition for local labour resources can result in local businesses having difficulty retaining and recruiting staff. This can result in increased wage levels and labour shortages. In short, demand for labour from mining projects can crowd-out other economic activity. The level of crowding-out depends on the elasticity of labour supply. The CGE analysis in Section 5 modelled the Project under three labour supply elasticity scenarios. All three of these labour supply elasticity scenarios can be considered to be relatively inelastic and reflect very tight labour supply conditions. They therefore already reflect conditions where multiple large projects compete for labour. The outputs under these labour supply scenarios included modelling of the crowding-out of economic activity of other businesses.

During construction and operation, the Project, along with other projects, will draw on a mix of local, new local and commuting personnel. The greater the share of new local and commuting personnel the less competition for local labour and the less the crowding-out effects. The ultimate cumulative impacts will driven by market forces. However, as identified in the Social Impact Assessment (Elliott Whiteing 2018), the Project will implement training and workforce development strategies which will address areas of skills needs and shortages, and effectively help increase the supply of skilled labour. This has potential for flow-on benefits to other local businesses.

Multiple projects in the region can also have consequences for the environmental, social and cultural impacts in a region. These impacts can have economic consequences. However, the technical impact assessments carried out for the Project were undertaken having regard to Project specific and cumulative impact assessment criteria set by Government policy. Future projects will also have to address these policy criteria and so ensure that cumulative impacts of multiple projects are not significant and manageable.

Table 6.1 Other Projects in the Region

Mine	Status	Type	Planned Start	Planned End	Distance from Project
Bowen Gas Project[1]	Proposed	Coal Seam Gas	~2017 (On Hold)	2055	Proposed wells in and around Project
Olive Downs North[1]	Approved	Open Cut	2019	2029	Adjacent, north
Lake Vermont[1]	Operating	Open Cut	2014	2045	12 km south-west
Lake Vermont North Extension Project[1]	Approved	Open Cut	2017	2044	5 km south-west
Saraji[1]	Operating	Open Cut	1974	2040	5 km south-west
Saraji East[1]	Proposed	Underground - Longwall	TBD	TBD	5 km south-west
Peak Downs[1]	Operating	Open Cut	1972	2075	12 km west
Eagle Downs[1]	Operating	Underground - Longwall	~2017 (On Hold)	2064	10 km north-west
Poitrel[1]	Operating	Open Cut	2006	2026	10 km north-west
Daunia[1]	Operating	Open Cut	2011	2034	10 km north-west
Millennium	Operating	Open Cut	2005	2018	15 km north-west
Millennium Expansion	Approved	Open Cut	2011	2027	15 km north-west
Moorvale	Operating	Open Cut	2003	2017+	18 km north
Coppabella	Operating	Open Cut	1998	2035	25 km north
Caval Ridge	Operating	Open Cut	2013	2043	25 km north-west
Isaac Plains	Operating	Open Cut	2006	2070	20 km north-west
Norwich Park	Care and Maintenance	Open Cut	1979	2012	25 km south-west
Moranbah South	Proposed	Underground – Longwall and Bord and Pillar	2017 (On Hold)	2060	20km north-west

Source: HydroSimulations (2018) Olive Downs Coking Coal Project Groundwater Assessment

7 ECONOMIC IMPACT MANAGEMENT STRATEGY

Pembroke proposes to work in partnership with the local and regional Councils and the local community so that, as far as possible, the benefits of the projected economic growth in the local area and region are maximised and impacts minimised. In this respect, a range of general economic impact mitigation and management measures are proposed and would include:

- Employment of regional residents preferentially where they have the required skills and experience and are able to demonstrate a cultural fit with the organisation.
- Working with recruitment, education and training providers in the region to encourage the provision of future employment and training opportunities for skills that would be directly and indirectly generated by mining projects.
- Participating, as appropriate, in business group meetings, events or programs in the regional community.
- Purchase local non-labour inputs to production, preferentially where local producers can be cost and quality competitive, to support local industries.

The Social Impact Assessment (Elliott Whiteing 2018) includes a detailed assessment of the potential social impacts of the Project. A Social Impact Management Plan has been prepared as part of the Social Impact Assessment that includes a:

- Workforce Management Strategy;
- Housing and Accommodation Management Strategy;
- Health and Community Wellbeing Management Strategy; and
- Local Business and Industry Content Management Strategy.

In addition to the above, a range of measures have been developed to mitigate, offset and compensate for the potential environmental, cultural and social impacts of the Project. A full outline of these measures is provided in the EIS main text.

8 CONCLUSION

Australia

A CBA of the Project indicated that it would have net production benefits to Australia of $2,169M. Provided the residual environmental, social and cultural impacts of the Project that accrue to Australia are considered to be valued at less than $2,169M, the Project can be considered to provide an improvement in economic efficiency and hence is justified on economic grounds.

Environmental, social and cultural impacts of the Project have been minimised through Project design and mitigation, offset and compensation measures. The economic value of residual impacts is considered to be immaterial from an aggregated economic efficiency perspective. The main quantifiable environmental impacts of the Project that have not already been incorporated into the estimate of net production benefits via mitigation, offset and compensation costs, relate to GHG emissions. These impacts to Australia are estimated at $2M, considerably less than the estimated net production benefits of the Project. There may also be some market benefits of employment provided by the Project which are estimated to be in the order of $72M. Overall, the Project is estimated to have net social benefits to Australia of $2,239M and, hence, is desirable and justified from an economic efficiency perspective.

While the main environmental, cultural and social impacts have been quantified and included in the Project CBA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than between $2,239M for the Project to be questionable from an Australian economic efficiency perspective.

Queensland

The estimated net production benefits of the Project to Queensland are estimated at $1,328M, comprising $1,117M in royalties and $211M in company tax. Incorporating market employment benefits and GHG costs the net social benefits of the Project to Queensland are estimated at $1,400M. Any unquantified residual impacts of the Project to Queensland after mitigation, offsetting and compensation would need to be valued at greater than $1,400M, present value for the Project to be questionable from a Queensland economic efficiency perspective.

Any residual impacts would occur to people in the immediate vicinity of the Project, apart from GHG impacts which would be more dispersed. Most impacts would be immaterial with impacts on groundwater access of adjoining landholders, biodiversity and roads resolved by compensation. Wage impacts would occur where the labour force for the Project live, which would be both in Isaac LGA and the wider region of Mackay and Whitsunday LGAs. The main benefits of the Project to Queensland (royalties) would accrue outside the region to the Queensland Government, and subsequently be spent on government infrastructure and services across Queensland. Similarly, company tax benefits would initially accrue to the Commonwealth Government, with subsequent redistribution of some of this benefit back to Queensland.

Economic Activity Analysis

CGE analysis was undertaken under three different labour supply assumptions for the Isaac Region, Mackay and Whitsunday LGAs and Queensland:

Under each labour market scenario the Project is projected to increase GRI, which is a measure of economic welfare. In NPV terms, the projected increase in GRI in the Isaac Region ranges from $5,286M under the Zero labour supply response to $4,201M under the High labour response assumption. The GRI result is influenced by the total increase in wages in the region; under the Zero labour supply response, wages are modelled to increase by 16.7% compared to 9.4% for the High labour supply.

Total employment, which is also influenced by the labour supply response, averages 721 (full-time equivalent (FTE) under the High labour response assumption, and 454 FTE under the Medium assumption.

The economic benefits of the Project would also accrue to the broader Queensland economy, influenced by royalty payments into the rest of Queensland. In NPV terms, the projected increase in GRI in Queensland would range from $12,302M under the Zero labour supply response to $11,142M under the High labour supply response assumption. The associated employment effects are 1,401 FTE under the High labour response assumption (826 FTE under the Medium labour response assumption).

The Zero response assumption is equivalent to assuming that the Isaac Region and Queensland economy are operating at full employment and, therefore, no new workers are available to service the Project. That is, workers are drawn from their existing jobs through the offer of higher wages. Under the Zero labour market response wages in the Isaac Region would increase by 16.65%, and by 0.27% across the State.

Under the other scenarios, the Isaac Region and Queensland economy would be operating below capacity, as evidenced for example by higher unemployment or underemployment, and it is more realistic to assume a relatively more 'elastic' labour supply whereby potential workers are encouraged into the workforce, again through increased wages. Under the High labour market response, wages in the Isaac Region would increase by 9.4% and by 0.18% in Queensland.

9 REFERENCES

Australian Bureau of Statistics (2016) *Census 4 digit employment by industry by place of usual residence data*.

Boardman, A., Greenberg, D., Vining, A. and Weimer, D. (2001) *Cost-Benefit Analysis: Concepts and Practice*, Prentice Hall, USA.

Building Queensland (2016) *Cost Benefit Analysis Guide: Supporting Business Case Development,* Building Queensland Business Case Development Framework.

Coordinator-General (2017) *Economic Impact Assessment Guideline*, State of Queensland, Department of State Development.

Department of the Environment and Heritage Protection (2013) *Model Water Conditions for Coal Mines in the Fitzroy Basin*.

Department of Primary Industries and Fisheries (2017) *The economics of beef in Central Queensland: Gross Marings and Production Notes*.

DPM Envirosciences (2018a) *Olive Downs Coking Coal Project - Terrestrial Flora Assessment.*

DPM Envirosciences (2018b) *Olive Downs Coking Coal Project - Terrestrial Fauna Assessment.*

Elliott Whiteing (2018) *Olive Downs Coking Coal Project - Social Impact Assessment.*

Gayer, T. and Viscusi, K. (2016) Determining the Proper Scope of Climate Change Policy Benefits in U.S. Regulatory Analyses: Domestic versus Global Approaches, *Review of Environmental Economics and Policy*, volume 10, issue 2, Summer 2016, pp. 245–263

Gillespie, R. and Bennett, J. (2012) Valuing the Environmental, Cultural and Social Impacts of Open Cut Coal Mining in the Hunter Valley of NSW, Australia, *Journal of Environmental Economics and Policy*, Volume 1, Issue 3, 1-13.

Gillespie Economics (2008) *Managing the Impacts of a Mine in the Southern Coalfield: A Survey of Community Attitudes*. Prepared for Helensburgh Coal Pty Ltd.

Gillespie Economics (2009a) *Socio-economic assessment: Bulli Seam Operations*. Prepared for BHP Billiton Pty Ltd.

Gillespie Economics (2009b) *Economic Assessment of the Warkworth Project*. Prepared for Coal and Allied Pty Ltd.

GT Environmental (2018) *Olive Downs Coking Coal Project - Soil and Land Suitability Assessment.*

GTA Consultants (2018) *Olive Downs Coking Coal Project - Road Transport Assessment.*

Hatch (2018) *Olive Downs Coking Coal Project – Surface Water Assessment*

HydroSimulations (2018) *Olive Downs Coking Coal Project - Groundwater Assessment.*

James, D. and Gillespie, R. (2002) *Guideline for Economic Effects and Evaluation in EIA*. Prepared for NSW Department of Urban Affairs and Planning.

Katestone Environmental (2018) *Olive Downs Coking Coal Project - Air Quality and Greenhouse Gas Assessment.*

NSW Department of Planning and Environment (2017) *Residual Matters Report: State Significant Development Wallarah 2 Coal Project (SSD 4974)*.

NSW Government (2012) draft *Guidelines for the economic assessment mining and coal seam gas proposals.*

NSW Treasury (2017) *NSW Government Guide to Cost-Benefit Analysis,* www.treasury.nsw.gov.au.

Optcon Property Group (2017) *Restricted Desktop Assessment Report: Various Rural Properties, Olive Downs Project, Valkyrie Queensland 4742*.

Productivity Commission (2006) *Waste Management*, Productivity Commission Inquiry Report No. 38, Commonwealth of Australia.

Queensland Treasury (2015) Project Assessment Framework: Cost Benefit Analysis.

Renzo Tonin Ron Rumble (2018) *Olive Downs Coking Coal Project - Noise and Vibration Assessment*

Resource Assessment Commission (1992) *Methods for Analysing Development and Conservation Issues: The Resource Assessment Commission Experience*, Research Paper Number 7.

Streeting, M. and Hamilton, C. (1991) *Economic analysis of the forests of south-eastern Australia*. Prepared for the Resource Assessment Commission.

US Environmental Protection Agency (2010) Guidelines for Preparing Economic Analyses.

West, G. and Jackson, R. (2005) *Simulating Impacts on Regional Economies: A Modelling Alternative,* University Of The Sunshine Coast Faculty Of Business Working Paper Series.

Windle, J. and Rolfe, J. (2003) Valuing Aboriginal cultural heritage sites in Central Queensland, *Australian Archaeology*, No. 56, p. 35-41.

ATTACHMENT 1 – INTRODUCTION TO ECONOMIC METHODS

Cost Benefit Analysis

- Cost Benefit Analysis (CBA) is the primary method by which economists evaluate projects and policies.
- CBA evaluates whether the wellbeing (**economic welfare**) of the community is in aggregate improved by a project. It does this by comparing the costs and benefits of a project to the community.
- The community whose welfare is included is broadly defined as anyone who bears significant costs and benefits of a project. However, in practice most CBA is undertaken at a national level. CBA at a sub-national level is not recommended however if undertaken at this level should provide decision-makers with estimates of all significant effects, including those to non-residents of the sub-national region.
- It is not possible to justify a project on economic grounds without doing a CBA.

Economic Activity Analysis

- Economists also often provide information to decision-makers on the **economic activity** that a project will provide to the regional, state or national economy. This is particularly relevant at the regional level since many regions and towns are experiencing long-term decline as a result of structural change in the economy. Additional economic activity can help the prosperity of these regions.
- **Direct** economic activity provided by a project can be estimated from financial and labour estimates for a project. Methods that can be used to estimate **direct** and **indirect** economic activity include Input-Output (IO) analysis and CGE modelling. Refer to Attachment 3 for a comparison of these methods and their assumptions.
- While economic activity measures from IO analysis and CGE modelling (e.g. direct and indirect output, value-added and income) are generally not measures of benefits and costs relevant to a CBA, this information can be of interest to decision-makers[18].

Economic Analysis and Decision-Making

- CBA and IO/CGE analysis are not mechanised decision-making tools, but rather means of analysis that provide useful information to decision-makers.
- Decision-making is multi-dimensional. CBA is concerned with the single objective of **economic efficiency** (economic welfare) while IO analysis and CGE are concerned with the objective of **economic activity** (growth). They do not address equity and other objectives of government. Decision-makers, therefore, need to consider the economic efficiency and economic activity implications of a project, as indicated by CBA and IO/CGE analysis respectively, alongside the performance of a project in meeting other, often conflicting, government goals and objectives.

[18] It should be noted that it is possible to analyse industry benefits and costs within a general equilibrium framework, where impacts are of a sufficient scale that they flow through into multiple sectors in the economy. However, for individual projects a partial equilibrium framework is the preferred approach for the estimation of costs and benefits (US EPA (2010) Guidelines for Preparing Economic Analyses, US EPA).

ATTACHMENT 2 – INTRODUCTION TO COST BENEFIT ANALYSIS

Background

Economic assessment is primarily concerned with identifying changes in aggregate wealth, from a national perspective, associated with alternative resource use patterns. CBA is the standard technique applied to estimate these wealth changes.

CBA has its theoretical underpinnings in neoclassical welfare economics. CBA applications in Queensland are guided by these theoretical foundations, and also by The State of Queensland (Queensland Treasury) (2015) *Project Assessment Framework: Cost Benefit Analysis*. CBA applications within the Queensland EIA framework are further guided by the Coordinator-General's (2017) *Economic Impact Assessment Guideline*.

CBA is concerned with a single objective of governments, i.e. economic efficiency. It provides a comparison of the present value of aggregate benefits to society, as a result of a project, policy or program, with the present value of the aggregate costs. These benefits and costs are defined and valued based on the microeconomic underpinnings of CBA. In particular, it is the values held by individuals in the society that are relevant, including both financial and non-financial values. Provided the present value of aggregate benefits to society exceed the present value of aggregate costs (i.e. a net present value of greater than zero), the project is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

Definition of society

CBA includes the consideration of costs and benefits to all members of society i.e. consumers, producers and the broader society as represented by the government.

As a tool of investment appraisal for the public sector, CBA can potentially be applied across different definitions of society such as a local area, State, nation or the world. However, most applications of CBA are performed at the national level. This national focus extends the analysis beyond that which is strictly relevant to a Queensland Government planning authority. However, the interconnected nature of the Australian economy and society creates significant spillovers between states. These include transfers between states associated with the tax system and the movement of resources over state boundaries.

Nevertheless, "where major impacts spill over national borders, then CBA should be undertaken from the global as well as the national perspective" (Boardman et al. 2001). For mining projects, impacts that spill over national borders include greenhouse gas costs (from mining activities) and benefits to foreign owners from production.

At the national and global levels, the focus of CBA is on primary costs and benefits i.e. first round impacts. Secondary net benefits that accrue to firms that sell to or buy from the mining project are ignored. This is because in a competitive market, all resources are assumed to be fully employed, and so increases in the production of goods and services required as inputs to the mining project will withdraw labour and raw materials from other industries. The additional net benefits (surpluses) to suppliers to the Project will be offset by decreases in net benefits in other industries and so there is no net secondary benefit to the economy as a whole.

CBA undertaken at a sub-national perspective requires attribution of primary costs and benefits to different geographic scales and results in a number of costs and benefits that accrue to people outside the region of analysis being excluded (Boardman et al. 2001). It may also result in additional costs and benefits, such as secondary net benefits, that are normally omitted from CBA, being included. This is because at a regional level, secondary net benefits that accrue to firms within a region may be offset by a reduction in economic activity outside the region of analysis. These secondary net benefits arise from an increase in economic activity in the region; this increase can be estimated using techniques such as IO analysis. However, adjustments to indicators of regional economic activity are required to provide an estimate of secondary net benefits in a region. CBA at the sub-national level, therefore, requires careful consideration of the distribution of the primary costs and benefits and inclusion of secondary net benefits.

CBAs of mining projects are often undertaken from a global perspective i.e. including all the costs and benefits of a project, no matter to whom they accrue to, and then truncated to assess whether there are net benefits to Australia. A consideration of the distribution of primary and secondary costs and benefits can then be undertaken to identify the benefits and costs that accrue to Queensland and other regions. However, a project is considered to improve the well-being of society if it results in net benefits to the nation, even if it results in net costs to the local area.

Definition of the project scope

The definition of the project for which approval is being sought has important implications for the identification of the costs and benefits of a project. Even when a CBA is undertaken from a global perspective, and includes costs and benefits of a project that accrue outside the national border, only the costs and benefits associated with the defined project are relevant. For mining projects, typically only the costs and benefits from mining the coal and delivering it to the port or domestic users, are relevant.

Coal is an intermediate good i.e. it is an input to other production processes such as production of electricity and steel production. However, these other production processes themselves require approval and, in CBA, would be assessed as separate projects.

Net production benefits

CBA of mining projects invariably involves a trade-off between:

- The net production benefits of a project; and
- The environmental, social and cultural impacts (most of which are costs of mining but some of which may be benefits).

Net production benefits can be estimated based on market data on the projected financial[19] value of the resource less the capital and operating costs of projects, including opportunity costs of capital and land already owned by mining companies. This is normally commercial-in-confidence data provided by the proponent. Production costs and benefits over time are discounted to a present value.

[19] In limited cases the financial value may not reflect the economic value and therefore it is necessary to determine a shadow price for the resource.

Environmental, social and cultural impacts

The consideration of non-market impacts in CBA relies on the assessment of other experts contributing information on the biophysical impacts. The EIA process results in detailed (non-monetary) consideration of the environmental, social and cultural impacts of a project and the proposed means of mitigating the impacts.

At its simplest level, CBA may summarise the consequences of the environmental, social and cultural impacts of a project (based on the assessments in the EIS), for people's wellbeing. These qualitatively described impacts can then be considered alongside the quantified net production benefits, providing important information to the decision-maker about the economic efficiency trade-offs involved with a project.

At the next level of analysis, attempts may be made to value some of the environmental, social and cultural impacts. These environmental, social and cultural impacts generally fall into three categories, those which:

1. Can be readily identified, measured in physical terms and valued in monetary terms;
2. Can be identified and measured in physical terms but cannot easily be valued in monetary terms; and
3. Are known to exist but cannot be precisely identified, measured or valued.

Impacts in the first and second categories can potentially be valued in monetary terms using benefit transfer or, subject to available resources, primary non-market valuation methods. Benefit transfer involves using information on the physical magnitude of impacts and applying per unit value estimates obtained from non-market valuation studies undertaken in other contexts.

Primary non-market valuation methods include choice modelling and the contingent valuation method where a sample of the community is surveyed to ascertain their willingness to pay to avoid a unit change in the level of a biophysical attribute. Other methods include the property valuation approach where changes in environmental quality may result in changes in property value.

Attempting to value the impacts of a project on the well-being of people also involves the practical principle of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in CBA (NSW Government 2012). The NSW Government (2012) suggests that values that are less than 5% of the quantified NPV of a project are unlikely to be material. Where benefits and costs cannot be quantified, these items should be included in the analysis in a qualitative manner (NSW Treasury 2017).

Consideration of net social benefits

The consideration of the net social benefits of a project combines the value estimate of net production benefits and the qualitative and quantitative estimates of the environmental, social and cultural impacts.

In combining these considerations, it should be noted that the estimates of net production benefits of a project generally include accounting for costs aimed at mitigating, offsetting or compensating for the main environmental, social and cultural impacts. This includes the costs of purchasing properties adversely affected by noise and dust, providing mitigation measures for properties moderately impacted by noise and dust or experiencing visual impacts, the costs of providing ecological offsets and the cost of purchasing groundwater and surface water entitlements in the water market. Including these costs in the capital and operating costs of a project effectively internalises the respective and otherwise non-monetary environmental, social and cultural costs of a project. To avoid double counting of impacts, only residual impacts, after mitigation, offset and compensation, require additional consideration.

Even when no quantitative valuation is undertaken of the environmental, social and cultural impacts of a project, the threshold value approach can be utilised to inform the decision-maker of the economic efficiency trade-offs. The estimated net production benefits of a project provides the threshold value that the non-quantified environmental, social and cultural impacts of a project (based on the assessments in the EIS), after mitigation, offset and compensation by the proponent, would need to exceed for them to outweigh the net production benefits.

Where the main environmental, social and cultural impacts of a project are valued in monetary terms, stronger conclusions can be drawn about the economic efficiency of a project, i.e. the wellbeing of society.

Any other residual environmental, cultural or social costs that remain unquantified in the analysis[20] can also be considered using the threshold value approach. The costs of these unquantified environmental, cultural and social impacts would need to be valued by society at greater than the quantified net social benefit of a project to make a project questionable from an economic efficiency perspective.

Consideration of the distribution of costs and benefits

While CBA, undertaken at different scales, can provide qualitative and quantitative information on how costs and benefits are distributed, welfare economics and CBA are explicitly neutral on intra and intergenerational distribution of costs and benefits. There is no welfare criterion in economics for determining what constitutes a fair and equitable distribution of costs and benefits. Judgements about intra and intergenerational equity are subjective and are therefore left to decision-makers.

Nevertheless, it should be noted that the costs and benefits in CBA are defined and valued based on the values held by individuals in the current generation. There is no way to measure the value that future generations hold for impacts of current day projects as they are not here to express it. However, as identified by Boardman et al., (2001) this is not considered a serious problem for CBA because:

- few policies involve impacts that will only become evident in the distant future. Consequently, the reactions to these impacts of people alive today, can be used to predict how future generations will value them;
- most people alive today care about the well-being of their children, grandchildren and great grandchildren, whether or not they have yet been born. They are, therefore likely to include the interests of these generations to some extent in their own valuations of impacts. Because people cannot predict with certainty the place that their future offspring will hold in society, they are likely to take a very broad view of future impacts; and

[20] Including potential impacts that were unknown at the time of the preparation of the EIS or arise during the EIA process due to differences in technical opinions.

- discounting used in CBA also reduces the influence of costs and benefits that occur a long way into the future.

Furthermore, increased wealth (e.g. royalties and taxes) generated by projects that have a net benefit to the current community can be used to improve the services (e.g. health, school and community services) and environment (e.g. protected areas) that are passed on to future generations.

As identified by the Productivity Commission (2006), a policy option that provides the highest net benefit, as indicated by BCA, would also be consistent with the principles of ecologically sustainable development.

Consideration of other objectives of government

CBA does not address other objectives of governments. Decision-makers therefore need to consider the economic efficiency implications of a project, as indicated by CBA, alongside the performance of a project in meeting other conflicting goals and objectives of governments.

ATTACHMENT 3 – INPUT-OUTPUT ANALYSIS AND COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

Input-Output Analysis

- IO analysis is a cost-effective and simple method for estimating the gross market economic activity, i.e. financial transactions and employment, in a specified region that is associated with a project.
- IO analysis is the most widely used model for regional impact assessment (West and Jackson 2005).
- IO analysis can be undertaken at the LGA or aggregation of LGAs levels.
- IO analysis can provide disaggregation of economic activity impacts across many sectors – 114 sectors based on current National IO tables.
- IO analysis was developed by Wassily Leontief, for which he received the Nobel Prize in Economics.
- IO analysis is a static analysis that looks at economic activity impacts in a particular year, e.g. a typical year of a projects operation.
- IO analysis has historically been applied at the regional level to assess the economic activity impacts of individual projects.
- IO analysis involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.
- IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of a number of indicators of economic activity – output, income, value-added[21] and employment.
- Economic activity measures used in IO are not measures of benefits and costs relevant to a CBA.
- IO analysis does not attempt to examine non-market environmental, social or cultural impacts.
- IO analysis does not depend on the assumption *"that there is a ghost pool of highly skilled yet unemployed people"* in a region, as suggested in a Queensland Land Court Judgement and NSW Land and Environment Court Judgement.
- The estimation of economic activity impacts in IO analysis are based on a number of simplifying assumptions; most notable is that the regional economy has **access to** sufficient labour and capital resources (from both **inside** and **outside** the region), so that an individual project does not result in any regional price changes, e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the region.
- For the assessment of the impacts of individual projects on small open regional economies, this is a reasonable assumption.
- Nevertheless, the results of IO modelling can be seen as representing an upper bound for the net economic activity associated with a project.

[21] Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

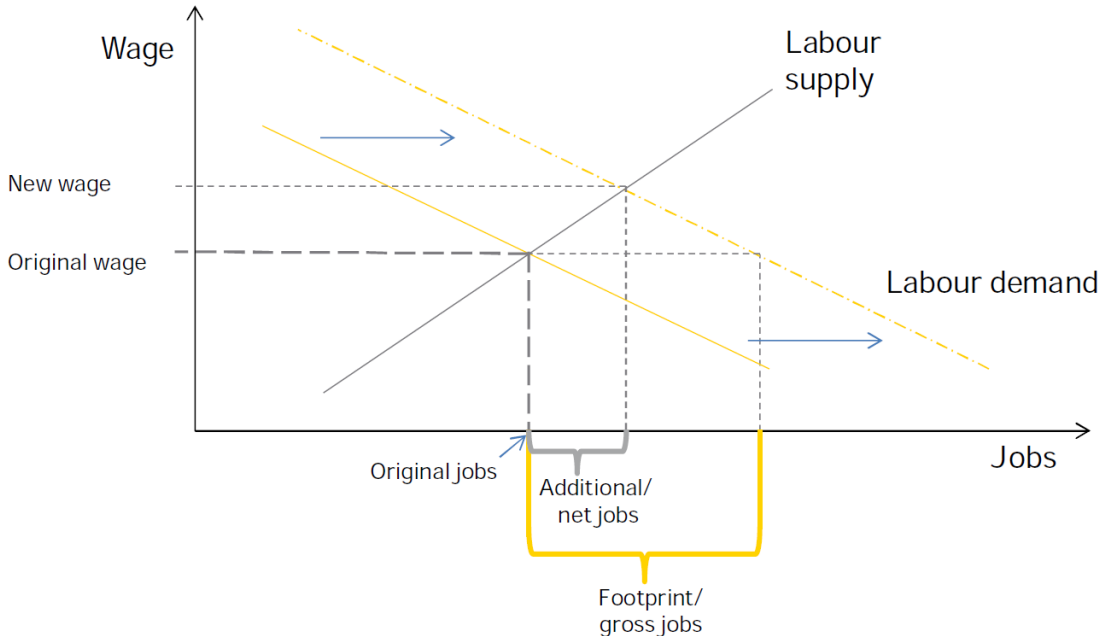
Computable General Equilibrium Modelling

- CGE modelling is a more expensive, complicated but theoretically more sophisticated alternative method for estimating the economic activity associated with a project.
- CGE modelling can be dynamic or comparatively static[22], and has historically been applied at the state and national level for determining the potential economic activity associated with the introduction of major government policy changes and investment in large infrastructure projects.
- CGE modelling can also be undertaken at a regional level but normally at no finer scale than the Statistical Subdivision level.
- CGE modelling estimates the additional net (positive and negative) economic activity associated with a project in terms of a number of economic indicators (including value-added and employment) but also real income, government tax revenue and components of value-added.
- Economic activity measures used in CGE modelling are not generally measures of benefits and costs relevant to a CBA, although CGE modelling can also be used to estimate market costs or market benefits as part of a CBA, where the magnitude of a project will affect a large number of sectors and the effects will be spread more broadly throughout the economy.
- Economic activity impacts can be disaggregated by sector but this is not normally as disaggregated as those in IO analysis.
- CGE modelling does not attempt to examine non-market environmental, social or cultural impacts.
- CGE modelling is underpinned by an IO database as well as a system of interdependent behaviour and accounting equations, which are based on economic theory (but mostly without econometric backing at the regional level).
- The equations in CGE models ensure that any change in demand in a region, no matter how small, translates into some change in prices and, hence, there is always some 'crowding out' of other economic activity in the region.
- At the regional level, CGE results can be very sensitive to changes in these behavioural assumptions.
- 'Crowding out' of other economic activities estimated via CGE modelling does not reflect losses of jobs but the shifting of labour resources to higher-valued economic activities.

[22] Comparative static models compare one equilibrium point with another but do not trace the impact path along the way. Dynamic models give year by year impacts of a shock.

Comparison of IO Analysis and CGE Modelling

Figure A4.1 – Comparison of Employment Estimates in IO Analysis and CGE Modelling



Source: Ernst Young (2014) Capital Metro Job Creation Analysis, p. 30.

- Figure A4.1 illustrates the difference between the output of IO analysis and the output of CGE with respect to employment. IO analysis estimates the employment footprint or gross jobs from a project. It can also be taken as an indicator of net jobs from a project where there is no or little upward pressure on wages for the region in question as a result of the individual project and, hence, no or little crowding out of other economic activity[23]. CGE modelling assumes upward pressure on wages and, hence, some crowding out of other economic activity in the region. Under this assumption, CGE estimates additional net jobs as being fewer than the employment footprint/gross jobs.
- Which modelling approach best represents the true situation depends on whether, and to what extent, price changes occur at a regional level as a result of individual projects. This is an empirical issue and would depend on the migration of labour into the region, commuting of labour and timely management of land releases by councils. Few studies exist that examine this issue.
- IO analysis provides decision-makers with information on the relative employment footprint/gross jobs of different projects, without going to the second and more complicated stage of trying to model wage rises and "crowding out" across all other sectors in the economy.
- Regional economic activity, estimated by IO analysis or CGE modelling, is just one piece of information that decision-makers may take into account in considering a project.

[23] This is akin to the marginal assumption in CBA.

ATTACHMENT 4 – CGE ANALYSIS

cadence|economics

ECONOMIC IMPACT ASSESSMENT OF THE OLIVE DOWNS COKING COAL PROJECT

PEMBROKE OLIVE DOWNS PTY LTD JULY 2018

Table of contents

Executive Summary

Pembroke Olive Downs Pty Ltd is seeking approval to develop the Olive Downs Coking Coal Project (the Project), a metallurgical coal mine within Queensland's Bowen Basin. The Project includes an open cut mining operation to extract up to 20 million tonnes (Mt) of ROM coal. Construction of the Olive Downs South Domain is planned for 2018 to 2019 and on the Willunga Domain from 2027 to 2030.

Cadence Economics was engaged to undertake a Computable General Equilibrium (CGE) economic impact analysis of the Project to the local, regional and Queensland economies. The modelling includes the both the capital expansion phase and the operational output of the Project from 2018 to 2050.

To assess the regional impacts of the Project, the following modelling regions where included:

1. Isaac Regional Council Local Government Area, in which the Project is directly located (Isaac Region).
2. A combination of the Mackay Regional Council and the Whitsundays Regional Council (MW Region), which represent the regions surrounding the Project.
3. The Rest of Queensland.

The CGE analysis was undertaken under three different labour supply assumptions:

- a full employment assumption, where all regions in the model operate at full employment meaning no new employment is generated in response to the Project. In this case, any employment for the Project is drawn from the existing labour pool, but encouraged to change jobs as wages increase;
- a labour supply elasticity of 0.15, adopted by Treasury at the National Level which indicates a relatively 'inelastic' response from workers i.e. workers are slow to enter the workforce due to changes in wages because it is assumed that the economy is close to full employment or the project under consideration requires highly skilled workers; and
- a labour supply elasticity of 0.30 which is still relatively 'inelastic' but more elastic than the above assumption, meaning that workers respond more readily to marginal changes in the wage rate by entering the workforce.

The CGE analysis found that the Project would have significant economic impacts on the Isaac Region, the MW Region and the Queensland economy. In particular, the projected increase in gross regional income (the preferred measure of economic welfare i.e. whether the region as a whole is better off or worse off) for the Isaac Region is $4,590 million under the mid-point labour supply elasticity of 0.15 (in net present value terms 2018 to 2050 using a 7 per cent real discount rate). For Queensland as a whole, the projected increase in gross regional income is $11,481 million under this scenario.

With regard to employment, peak incremental annual full-time equivalent (FTE) employment in the Isaac Region is in 2034 at 748 FTEs when the labour supply elasticity is assumed to be 0.15. The average real wage (over the period 2018 to 2050) in the Isaac Region is projected to increase by 12.0% over the Project life when the labour supply elasticity is 0.15. If the economy is assumed to be at full employment, then there are no additional labour impacts, but significant benefits in terms of wage increases across the economy of 16.7%

Labour impacts to the Queensland economy during the operation of the Project are greater than for the regional economy i.e. a peak of 1,383 FTEs when the labour supply elasticity is assumed to be 0.15 and a peak of 2,346 annual FTEs when the labour supply elasticity is assumed to be 0.30.

1. Introduction

Cadence Economics was commissioned by Gillespie Economics on behalf of Pembroke Olive Downs Pty Ltd (Pembroke) to undertake a Regional Impact Analysis of the Olive Downs Coking Coal Project (the Project).

To assess the regional impacts of the Project, the following modelling regions where included:

1. Isaac Regional Council Local Government Area, in which the Project is directly located (Isaac Region).
2. A combination of the Mackay Regional Council and the Whitsundays Regional Council (MW Region), which represent the regions surrounding the Project.
3. The Rest of Queensland.

The economic analysis in this report provides an estimation of the economy-wide impacts of the Project on the Isaac Region, MW Region and Queensland in total. This analysis is based on an application of a CGE model. The Cadence Economics General Equilibrium Model (CEGEM) is a large scale, dynamic, multi-region, multi-sector model of the global economy, with an explicit representation of the Isaac Region, MW Region and the rest of the Queensland economy. CEGEM is based on a substantial body of accepted microeconomic theory. More information on CEGEM is outlined in Chapter 2.

This report has been prepared using the similar inputs as the CBA analysis as set out in the Gillespie Economics (2018) report, although the timeframe of the CGE modelling presented in this report is to 2050. The reason for modelling to 2050 is twofold. First, there is an inherent trade-off in small regional CGE modelling terms of regional detail versus the timeframe of the scenario that should be considered. In other words, the detailed regions that are represented in the model come at the expense of the overall timeframe of the analysis undertaken. This is due to the inherent uncertainties in regional economic forecasting over the longer term that reduce the confidence in the results generated by the model.

Second, the results beyond 2050 in this analysis are deemed to be relatively insignificant, particularly once discounting has been applied. For example, this analysis focuses on the economic impacts of the development over the period 2018 to 2050, which coincides with the capital expansion phase and with peak coal output. This period of the analysis captures 100 per cent of the capital expenditure and 92 per cent of the net present value of coal sales over the life of the mine.

All figures in this report are expressed in 2017 dollars and all net present value calculations are discounted to 2018 using a 7 per cent real discount rate.

Table 1 provides a summary overview of the Project, used for the economic analysis.

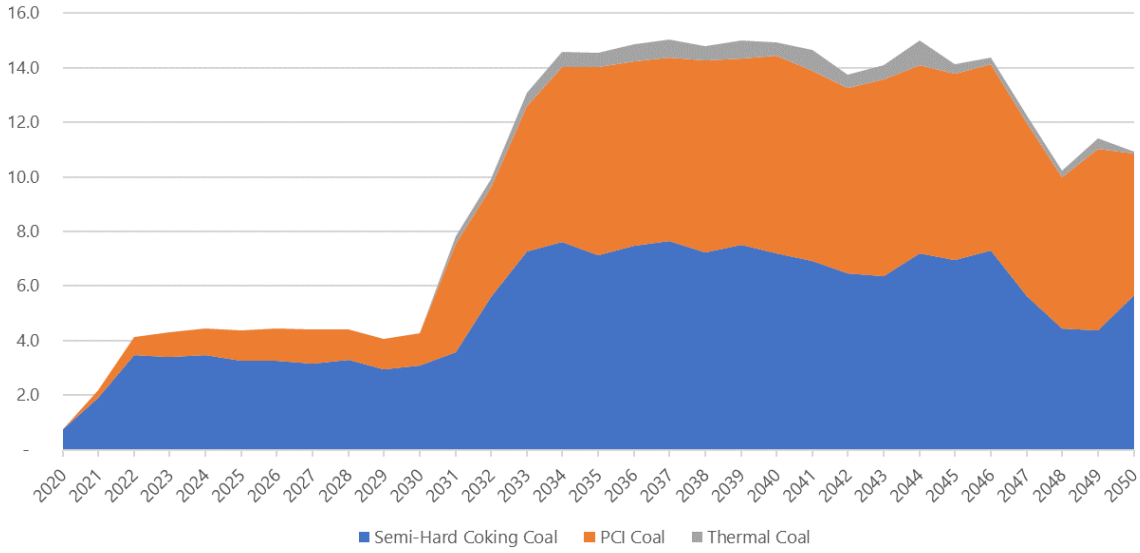
Table 1: Summary of operations under the Project (2020 – 2050)

	Description of operations
Run-of-Mine	414.2 Mt (2020 – 2050)
Product Coal	307.3 Mt of Product Coal (2020 – 2050) • 161.7 Mt of semi-soft coking coal • 136.1 Mt of PCI coal • 9.4 Mt of Thermal coal
Sales Revenue	Total Project revenue of $ 12,400 million (2020 – 2050). Based on the Pembroke Financial Model, including assumed coal prices and an AUD:USD exchange rate of 0.77
Capital Expenditure	Capital requirement is $675.2 million (in net present value terms using a real 7% discount rate) or $1,052.3 million undiscounted
Mining Methods	Open cut operations
Mining Rate	Up to 20 Mt of ROM coal per annum
Life of Mine	*Construction* • Pre-construction period and Olive Downs South Domain – 2018-2019 • Willunga Domain construction – 2027 – 2030 *Operations* – 2020 - 2098
Workforce	*Construction* • An average of 375 employees during both construction phases • Maximum construction workforce of 700 in 2020 *Operations* • An average of 873 during the operational phase, 2020 – 2098 • Maximum operational workforce of 1,300, 2028 - 2050 *Total employment* • An average total workforce of 881 FTE, 2020 – 2098 • Maximum total workforce of 1,300, 2028 - 2050

Source: Based on information provided by Gillespie Economics

Project production is influenced by the planned domain expansion outlined in the mine plan. Over the initial phase, 2020 to 2030, with the operation of the Olive Downs South Domain, product coal output peaks at approximately 4.4 Mt, see Figure 1. Once the Willunga Domain comes online production begins to ramp up from 2031, with average product coal of 13.8 Mt over 2031 to 2046. Coal output is expected to peak in 2037, with 15.05 Mt of product coal. Beyond 2050 ROM is expected to drop returning to pre-peak output levels.

Figure 1: Olive Downs Coking Coal Project – Coal output by product type (Mt) 2020 – 2050



Source: Pembroke

2. CGE modelling framework

The ultimate aim of this economic impact study based on applied CGE modelling is to estimate the net benefit of the Project on economic activity and the living standard of those residing within the Isaac Region and MW Region and in Queensland.

CGE modelling is a recognised method for assessing the impacts of large projects on the economy. It is based on detailed representation of the economy, including the complex interactions between different sectors of the economy.[1] A CGE model is able to analyse the impacts of the Project in a comprehensive, economy-wide framework meaning the modelling captures:

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

About Cadence Economics' CGE model

CEGEM is a large scale, dynamic, multi-region, multi-sector model of the global economy, with an explicit representation of the Isaac Region, the MW Region and the Queensland economy.

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

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

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

As noted by Pant et al (2000), in considering welfare results in global CGE models such as CEGEM, the main components are the change in: output (measured by real GSP); terms of trade; and payments to foreigners. Of particular relevance in the discussion around estimating the net benefits of the Project are the terms of trade effects. These can be closely linked to changes in labour market conditions because any increase in real wages as a result of higher levels of coal exports will result in an improvement in the terms of trade and, hence, welfare.

Box 1: An overview of CEGEM

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

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

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

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

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

That noted, real GSI does not capture some non-market effects that can impact on the living standards of Queensland residents.

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

Overview of scenarios

All scenarios outlined in the modelling below use the scenario as specified in the Gillespie Economics (2018) report, and summarised in Table 1. These assumptions include total Project capital expenditure of $675.2 million and coal sales revenue of $12,400 million, in NPV terms over the period 2018 to 2050.

In addition, we have also factored into our scenarios the benefits that flow from the Project outside of the Isaac Region and the Queensland economy. This includes, the repatriation of profits out of Queensland to foreign shareholders, along with the payments out of the Isaac Region for royalties to the Queensland Government and corporations tax to the Australian Government. We have assumed these royalty payments accrue to the Rest of Queensland. In addition, we have repatriated wages earnt by workers who reside outside the Isaac Region. Where;

- 75% of construction workers reside outside the Isaac Region
- 50% of operational workers reside outside the Isaac Region

It is expected that these workers are sourced from the MW Region.

The central consideration across the scenarios relates to the responsiveness of the Queensland labour market to the increase in expenditure (the labour supply response[2]) and to test the responsiveness we have incorporated into our modelling three labour market assumptions, as discussed below.

Conceptually, if the Queensland economy is operating at full employment and, therefore, no new workers were available to service the increase in expenditure (demand) associated either with the construction of the Project or the associated increase in coal output, the Project would not create a single additional job. That is, workers would be drawn from their existing jobs via the new Project offering higher wages. Similarly, if a new project required very specific highly trained and skilled workers and there were none readily available, the Project would not create a single additional job. We replicate this type of world by assuming an 'inelastic' – or Zero -labour supply elasticity.

[2] In economic jargon, the assumed labour supply elasticity.

On the other hand, in a world where the economy is operating at below capacity, as evidenced for example by higher unemployment and slower growth, it is more realistic to assume a relatively more 'elastic' labour supply whereby potential workers are encouraged into the workforce, again through increased wages. In terms of specifying the elasticity of labour supply, we follow the lead of the Australian Treasury and use a labour supply elasticity assumption of 0.15 under 'Medium' settings, which indicates a relatively 'inelastic' response from workers. This means workers are slow to respond to changes in wages because (it is assumed that) the economy is close to full employment or the project under consideration requires highly skilled workers.

To further test the results to the responsiveness of the Queensland labour market, under the 'High' scenario, a labour supply elasticity of 0.3 is assumed, which is relatively more 'elastic' and means that workers respond more readily to marginal changes in the wage rate.

3. Economy-wide modelling of the Project

Given the number of possible scenarios under consideration, this section focusses on annual impacts of the medium labour supply scenario, that is, based on the Project facing a labour supply elasticity of 0.15.

A summary of the key macroeconomic variables projected under the core scenario is shown in Figure 2. The results are reported as deviations from the reference case and represent the change in a particular variable as a result of investing in and operating under the Project assumptions.

The results for the Isaac Region are outlined on the left hand side of the figure and Queensland on the right. Results for the MW Region are outlined in Table 2.

The annual results from the CGE model generally move in-line with the Project capital expenditure and production activity. Real GRP for the Isaac Region is projected to peak at $1,455 million higher than the reference case in 2037, coinciding with peak coal output. This increase in real GRP is a function of the higher levels of activity within the Isaac Region associated with output at the mine and the flow-on benefits of purchasing inputs to operate the mine.

Real GRI is also projected to peak in 2034 at $1,020 million, which coincides with the end of the capital expenditure phase and the start of peak coal output levels. The increase in GRI is driven by the twin factors of higher wages for local workers and the repatriation of profits out of the Isaac Region to the foreign owners of the mine, the company tax outflows and the royalty payments to the Rest of Queensland.

Figure 2: Projected economy-wide impacts of the Project, 0.15 labour supply elasticity

Source: Cadence Economics estimates

Employment in the Isaac Region is expected to peak at 748 FTE, also in 2034, coinciding with start of the ramp-up in saleable coal output. These results are driven by the direct employment within the Isaac Region, the flow-on impacts from local inputs and any of the crowding out of employment in other sectors. Given the increase in economic activity and a migration of workers into higher paying sectors, average wages in the Isaac Region are projected to increase by 11.98% over the modelling period, see Table 2.

Moving to the state-wide results, real GSP for Queensland is projected to peak at $1,865 million higher than the reference case in 2040, and real GSI peaks at $2,087 million and employment of 1,383 FTE. State-wide average wage increases by a modest 0.21%.

Table 2: Projected regional economy-wide impacts, 0.15 labour supply elasticity

Gross Regional Product	$Million (NPV*)
Isaac Region	8,028
Mackay-Whitsundays Region	212
Rest of Queensland	1,841
Queensland	10,080
Gross Regional Income	**$Million (NPV*)**
Isaac Region	4,590
Mackay-Whitsundays Region	1,540
Rest of Queensland	5,351
Queensland	11,481
Employment	**Average FTE**
Isaac Region	454
Mackay-Whitsundays Region	36
Rest of Queensland	335
Queensland	826
Wages	**Average %**
Isaac Region	11.98
Mackay-Whitsundays Region	0.31
Rest of Queensland	0.09
Queensland	0.21

Source: Cadence Economics estimates
* Using a 7% real discount rate

Table 2 also provides an account of the economy-wide impacts for the MW Region. The region is expected to experience large income flows during the construction and operational phase of the Project, with 75% of construction and 50% of operational workers residing in the area. Gross Regional Income is expected to increase by $1,540 million over the life of the Project, a reflection of the repatriation of wages. Output in the region is expected to increase modestly, with an increase of GDP of $212 million and employment increasing by an average of 36 FTE.

High Labour Market Assumption

This section provides an overview of the economic impacts, where the labour market responds more readily to marginal changes to the wage rate, under the High labour market assumptions outlined above.

The results indicate that the labour market assumptions have a relatively large impact to employment compared to the economy-wide impacts to GRP and GRI.

Real GRP for the Isaac Region is projected to peak at $1,512 million higher than the reference case in 2039, where real GRI is projected to peak in 2034 at $940 million, under the High labour market assumptions, see Figure 3.

Figure 3: Projected economy-wide impacts of the Project, 0.30 labour supply elasticity

Source: Cadence Economics estimates

The employment impacts are more pronounced, employment in the Isaac Region is expected to peak at 1,188 FTE also in 2034. These results are driven by the direct employment within the Isaac Region, the flow-on impacts from local inputs. It will also include any of the crowding out of employment in other sectors, although given the greater availability of workers, these impacts are lower than in the Medium scenario. Average wages in the Isaac Region are projected to increase by 9.4% over the Project life, lower than the Medium case assumptions.

Moving to the state-wide results, real GSP for Queensland is projected to peak at $1,967 million higher than the reference case in 2040. In the same year real GSI will peak at $2,004 million. Employment peaks early in the ramp up phase at 2,346 FTEs. State-wide average wages increase by a modest 0.18%, as outlined in Table 3.

Table 3: Projected regional economy-wide impacts, 0.30 Labour Supply Elasticity

Gross Regional Product	$Million (NPV*)
Isaac Region	8,381
Mackay-Whitsundays Region	239
Rest of Queensland	2,052
Queensland	10,672
Gross Regional Income	**$Million (NPV*)**
Isaac Region	4,201
Mackay-Whitsundays Region	1,549
Rest of Queensland	5,392
Queensland	11,142
Employment	**Average FTE**
Isaac Region	721
Mackay-Whitsundays Region	67
Rest of Queensland	613
Queensland	1,401
Wages	**Average %**
Isaac Region	9.37
Mackay-Whitsundays Region	0.28
Rest of Queensland	0.08
Queensland	0.18

Source: Cadence Economics estimates
* Using a 7% real discount rate

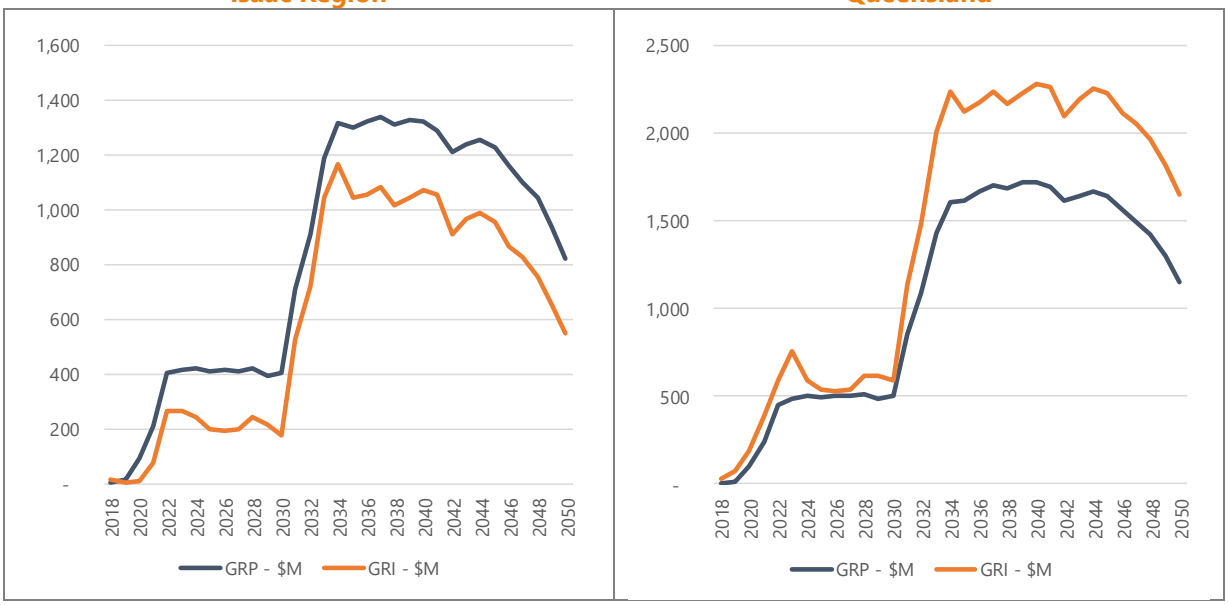
Table 3 also provides an account of the economy-wide impacts for the MW Region. The region is expected to experience large income flows during the construction and operational phase of the Project, with 75% of construction and 50% of operational workers residing in the area. Gross Regional Income is expected to increase by $1,549 million over the life of the Project, a reflection of the repatriation of wages. Output in the region is expected to increase modestly, with an increase of GDP of $239 million and employment increasing by an average of 67 FTE.

Zero Labour Market Assumption

This section provides an overview of the economic impacts, where the labour market does not responds to marginal changes to the wage rate, under the Zero labour market assumptions outlined above, suggesting the regional and Queensland economies are at full employment.

Real GRP for the Isaac Region is projected to peak at $1,340 million higher than the reference case in 2037, where real GRI is projected to peak in 2034 at $1,167 million, under the zero labour supply assumptions, see Figure 4.

Figure 4: Projected economy-wide impacts of the Project, zero labour supply assumption



Source: Cadence Economics estimates

Moving to the state-wide results, real GSP for Queensland is projected to peak at $1,724 million higher than the reference case in 2040. In the same year real GSI will peak at $2,279 million.

Average wages in the Isaac Region are projected to increase by 16.7% over the Project life, higher than the Medium case assumptions, as outlined in Table 4. State-wide average wages increase by a modest 0.27%, again, this is higher than the Medium case assumptions. The higher wage response is the main driver for increasing gross regional income and gross state income above those modelled for the Medium case assumptions.

Table 4: Projected regional economy-wide impacts, zero labour supply elasticity

Gross Regional Product	$Million (NPV*)
Isaac Region	7,421
Mackay-Whitsundays Region	189
Rest of Queensland	1,667
Queensland	9,277
Gross Regional Income	**$Million (NPV*)**
Isaac Region	5,286
Mackay-Whitsundays Region	1,549
Rest of Queensland	5,467
Queensland	12,302
Employment	**Average FTE**
Isaac Region	0
Mackay-Whitsundays Region	0
Rest of Queensland	0
Queensland	0
Wages	**Average %**
Isaac Region	16.65
Mackay-Whitsundays Region	0.34
Rest of Queensland	0.10
Queensland	0.27

Source: Cadence Economics estimates
* Using a 7% real discount rate

Table 4 also provides an account of the economy-wide impacts for the MW Region. Gross Regional Income is expected to increase by $1,549 million over the life of the Project, a reflection of the repatriation of wages. Output in the region is expected to increase modestly, with an increase of GDP of $189 million. Employment in the region is fixed under the Zero labour market response, and wages increase by 0.34%.

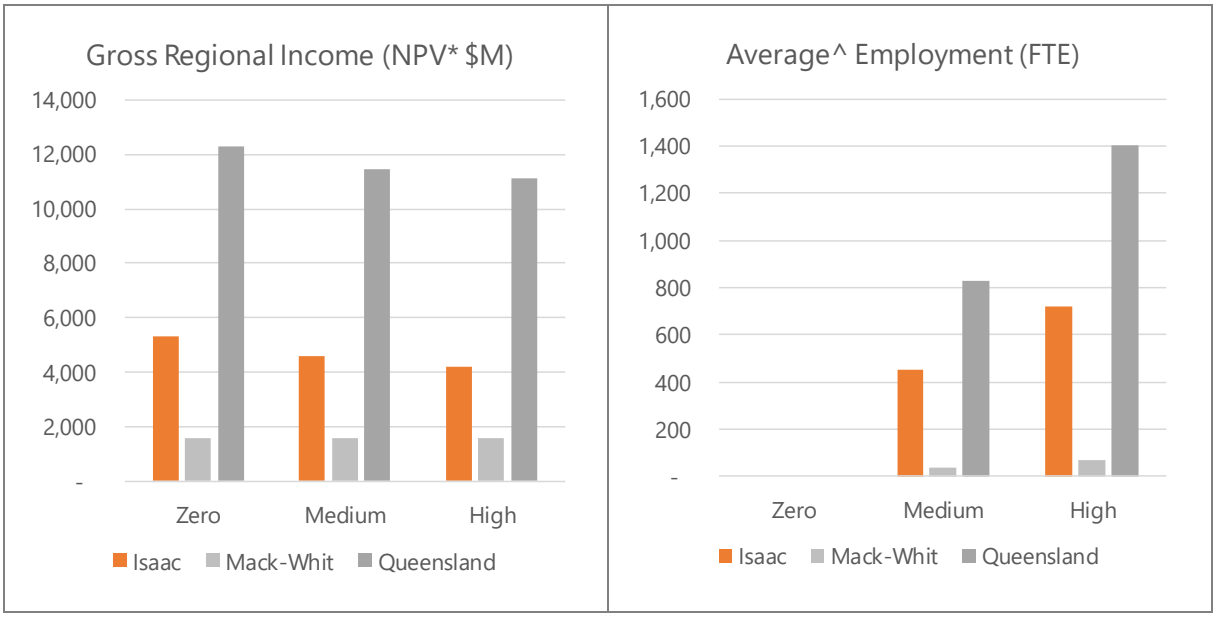
Overall summary

A summary of the projected economy-wide impacts of the Project generated by the CGE model are summarised in Figure 5 under three separate labour market response assumptions, including the Zero response labour market assumption.

Under each scenario the Project is projected to increase gross regional income (GRI), which is a measure of economic welfare, in both the Isaac Region and Queensland broadly. In NPV terms, the projected increase in GRI in the Isaac Region ranges from $5,286 million under the Zero labour supply response to $4,201 million under the High labour response assumption. The GRI result is influenced by the total increase in wages in the region, under the Zero labour supply response wages are modelled to increase by 16.7% compared to 9.4% for the High labour supply.

Total employment, which is also influenced by the labour supply response, averages 721 FTE under the High labour response assumption, 454 FTE under the Medium assumption.

Figure 5: Projected economy-wide impacts of the Project by labour market response



* Net Present Value in 2017 Australian dollars calculated over the period 2018 to 2050 using a 7% real discount rate.
^ Average, for the period 2018 to 2050
Source: Cadence Economics estimates based on information provided by Gillespie Economics.

The economic benefits of the Project also accrue to the broader Queensland economy, influenced by royalty payments into the rest of Queensland. In NPV terms, the projected increase in GRI in Queensland ranges from $12,302 million under the Zero labour supply response to $11,142 million under the High labour response assumption. The associated employment effects are 1,401 FTE under the High labour response assumption (826 FTE under the Medium assumption).

The Zero response assumption is equivalent to assuming that the Isaac Region and Queensland economy are operating at full employment and, therefore, no new workers are available to service the Project. That is, workers are drawn from their existing jobs through the offer of higher wages. Under the Zero labour market response wages in the region increase by 16.65%, and by 0.27% across the State.

Under the other scenarios, the Isaac Region and Queensland economy are operating at below capacity, as evidenced for example by higher unemployment or underemployment, and it is more realistic to assume a relatively more 'elastic' labour supply whereby potential workers are encouraged into the workforce, again through increased wages. Under the High labour market response wages in the region increase by 9.4% and by 0.18% in Queensland.

References

Gillespie Economics (2018), *Olive Downs Coking Coal Project Economic Impact Assessment*

Layman (2004) *CGE modelling as a tool for evaluating proposals for project assistance: a view from the trenches,* WA Department of Treasury and Finance, Staff Paper

Pant, Brown, Buetre and Tulpulé (2000) *Measurement and decomposition of welfare changes in GTEM,* paper presented to the Third Annual Conference on Global Economic Analysis, Monash University, Melbourne, 27-30 June 2000 http://www.copsmodels.com/2000gtapconf.htm