Adani Mining Pty Ltd

NORTH GALILEE BASIN RAIL PROJECT

Environmental Impact Statement

Appendix N Economics

November 2013

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The Report may only be used and relied on by Adani for the purpose of informing environmental assessments and planning approvals for the proposed North Galilee Basin Rail Project ("the Purpose") and may not be used by, or relied on by any person other than Adani.

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The Report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report. Assumptions made by GHD are contained through the Report, including (but not limited to) concept design and operations information provided by Adani.

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Executive summary

This economics report describes the regional economic and demographic baseline relevant to the North Galilee Basin Rail Project (NGBR Project). This report provides a description of key economic indicators, industry trends and structure of the existing regional economy relevant to the NGBR Project.

The study area for this report includes regions directly and indirectly affected by the NGBR Project and is defined at two levels:

- The Mackay, Isaac and Whitsunday (MIW) region which consists of the Mackay Regional Council (MRC), Whitsunday Regional Council (WRC) and Isaac Regional Council (IRC) Local Government Areas (LGA)
- The State of Queensland.

Economic indicators are described on the basis of an input-output (I-O) analysis method which provides a numerical picture of the economy and its essential features.

The NGBR Project will be constructed within the MIW region. The MIW region is the largest regional economy in Queensland and had the third largest Gross Regional Product (GRP) in Queensland in 2011/12 behind Brisbane and the Gold Coast.

Mining is the dominant sector in the MIW region, accounting for just over 50 per cent of GRP in the MIW region in 2011/12. The construction (4.1 per cent) and manufacturing (3.6 per cent) sectors are also important in terms of their contribution to GRP.

Between 2007/08 and 2011/12, GRP in the MIW region declined slightly in real terms. Severe weather events which have hindered mining and agricultural production during these periods and falling coal prices have contributed to this decline. Recent reports of significant job losses across the Queensland coal sector provide an indication that the coal industry is under some pressure.

Agriculture is a prominent industry in the MIW region in terms of land use, accounting for approximately 89 per cent of land use in the MIW region in 2009. Land use across the MIW region is dominated by grazing activities (87 per cent).

I-O modelling estimates that the NGBR Project will generate approximately 6,150 jobs (1,700 direct and 4,452 indirect) in the MIW region and just under 7,000 jobs (2,017 direct and 4,981 indirect) in total across Queensland during the peak construction year of 2015. In 2015, I-O modelling estimates that the NGBR Project will contribute $791 million to GRP in the MIW region and $909 million to Queensland's Gross State Product (GSP) in 2015.

Once fully operational, I-O modelling estimates that the NGBR Project will contribute $209 million to GRP in the MIW region per annum and $369 million per annum to Queensland's GSP. Operation of the NGBR Project is also estimated to generate 1,097 (277 direct and 820 indirect) full time equivalent positions each year in the MIW region and 1,940 (369 direct and 1,571 indirect) full time equivalent positions each year across Queensland over the life of the project.

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Terms and abbreviations

Terms and abbreviations	Definition
ABS	Australian Bureau of Statistics
Adani	Adani Mining Pty Ltd
Basic price	The price received for a good or service by the producer. It is also known as the producers' price. It excludes indirect taxes and transport, trade and other margins.
Changes in inventories (stocks)	"Stocks of outputs that are held at the end of a period by the units that produced them prior to their being further processed, sold, delivered to other units or used in other ways and stocks of products acquired from other units that are intended to be used for intermediate consumption or for resale without further processing" (ABS 2008b).
DECON model	A demographic-economic model based on a traditional input-output model. The introduction of a population 'sector' (or row and column in the model) makes it possible to estimate the impact on the population levels of employment growth or decline. The introduction of an unemployed 'sector' makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.
ess	An estimate of the proportion of employed persons who are not eligible for welfare benefits when they lose their job.
Exports (other)	A measure of the value of goods and services sold from the region/state of interest to consumers in other regions, interstate and overseas, net of sales to visitors to the region.
Final demand quadrant	Component of final demand quadrant include household and government consumption expenditure, gross fixed capital formation, changes in inventories (stocks), tourism expenditure and 'other' exports.
Final NGBR Project footprint	The final NGBR Project footprint will accommodate all rail infrastructure required for construction and operation, scalable to accommodate 100 mtpa product coal transport, including passing loops, a maintenance road, rolling stock maintenance (provisioning, fuel storage and refuelling, maintenance, etc.), water supply and pipeline, track and signalling maintenance facilities, staff crib, accommodation and training facilities and other necessary infrastructure associated with the operational functions of the NGBR Project. Temporary construction facilities are expected to include laydown areas, construction depots (warehousing, fuel storage, vehicle storage, administration facilities, etc.), sleeper manufacturing yards, construction accommodation camps, quarries and borrow pits, access tracks into the corridor and other necessary infrastructure associated with the construction functions of the NGBR Project.

Terms and abbreviations	Definition
Final rail corridor	The final rail corridor is a nominal 100 m wide corridor
First round impacts	Estimates of the requirement for (or purchases of) goods and services from other sectors in the economy generated by the initial economic activity.
Flow-on impacts	The sum of production-induced impacts, consumption-induced impacts and offsetting consumption effects.
Government consumption expenditure	"Net expenditure on goods and services by public authorities, other than those classified as public corporations, which does not result in the creation of fixed assets or inventories or in the acquisition of land and existing buildings or second-hand assets. It comprises expenditure on compensation of employees (other than those charged to capital works, etc.), goods and services (other than fixed assets and inventories) and consumption of fixed capital. Expenditure on repair and maintenance of roads is included. Fees, etc., charged by general government bodies for goods sold and services rendered are offset against purchases. Net expenditure overseas by general government bodies and purchases from public corporations are included. Expenditure on defence assets that are used in a fashion similar to civilian assets is classified as gross fixed capital formation; expenditure on weapons of destruction and weapon delivery systems is classified as final consumption expenditure" (ABS 2008b).
GRP	Gross Regional Product A measure of the value of a region's outputs minus the cost of inputs. It is therefore able to measure the net contribution of the NGBR Project to the relevant economies (i.e. the MIW region and Queensland).
GSP	Gross State Product
IRC	Isaac Regional Council
LGA	Local Government Area
MIW	Mackay, Isaac and Whitsunday
MRC	Mackay Regional Council
mtpa	Million tonnes per annum
NGBR Project	North Galilee Basin Rail Project
OESR	Office of Economic and Statistical Research
Preliminary investigation corridor	The preliminary investigation corridor is a 1,000 m wide corridor
REDC	Regional Economic Development Corporation
rho	An assumption in the input- output economic model of the proportion of employees who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs filled by previously unemployed locals (positive employment impact).

Terms and abbreviations	Definition
TOR	Terms of Reference
WRC	Whitsunday Regional Council

1. Introduction

1.1 NGBR Project overview

Adani Mining Pty Ltd (Adani) proposes the construction and operation of the North Galilee Basin Rail Project (NGBR Project), a multiuser, standard gauge, greenfield rail line that will transport coal from mines in the northern Galilee Basin to the Port of Abbot Point. The NGBR Project is approximately 300 km in length and connects the proposed Carmichael Coal Mine and Rail Project's east-west rail corridor, approximately 70 km east of the proposed Carmichael Coal Mine in the vicinity of Mistake Creek, with supporting infrastructure at the Port of Abbot Point (refer Figure 2-1). The NGBR Project will have an operational capacity of up to 100 million tonnes per annum (mtpa) of coal product expected to be sourced from both Adani and third-party mines in the northern Galilee Basin. Key features of the NGBR Project include:

- Approximately 300 km of standard gauge, bi-directional rail track located within a nominal 100 m wide rail corridor (the final rail corridor)
- A rail maintenance access road running parallel to the rail track for approximately 300 km and wholly within the final rail corridor
- Seven passing loops, each 4.3 km in length
- Signalling infrastructure
- Approximately 4.5 km of fill greater than 15 m in depth (11 locations) and approximately 3.4 km of cut greater than 15 m in depth (nine locations)
- At-grade and grade-separated road, rail, stock and occupational crossings
- Bridge and culvert structures at major waterways and drainage lines, and various other longitudinal and cross drainage structures
- A rolling stock maintenance facility near the Port of Abbot Point including provisioning line, train maintenance line, wagon and locomotive service sheds, wash bay and queuing line
- Five temporary accommodation camps for construction workers
- A temporary construction depot at the southern end of NGBR Project
- Temporary construction yards, concrete batching plants, bridge and track laydown areas and heavy vehicle turning circles.

During construction, quarries and borrow pits within acceptable haulage distances will be required to provide a cost effective source of fill, gravel, aggregate and ballast. The number and location of borrow pits and quarries will be investigated further during detailed design and each may require screening and crushing plants to process material.

1.2 Scope of report

This report describes the regional baseline economies that are expected to be directly and indirectly affected as a result of developing the NGBR Project. The report:

- Provides a snapshot of the demographic characteristics of the Mackay, Isaac and Whitsunday (MIW) region. The MIW region consists of the Mackay Regional Council

(MRC), Whitsunday Regional Council (WRC) and Isaac Regional Council (IRC) Local Government Areas (LGA).

- Identifies trends in key economic indicators, such as Gross Regional Product (GRP) (a measure of the value of a region's outputs minus the cost of inputs), employment by sector and property value
- Describes the structure of the economy of the MIW region, including trends in key industries
- Undertakes input output (I-O) analysis modelling to best quantify the size and shape of the MIW region economy, it's essential features and the importance of, and interrelationships between, individual sectors.

This report was prepared in accordance with the Terms of Reference (TOR) for the NGBR Project. A table that cross-references the contents of this report and the TOR is included as Volume 2 Appendix A TOR cross-reference.

2. Methodology

2.1 Study area

The study area for this report includes the regions directly and indirectly affected by the NGBR Project. Due to its nature and scale it was determined that the NGBR Project will primarily affect the economies of:

- The MIW region, which consists of the MRC, WRC and IRC LGAs
- The State of Queensland.

It is expected that the majority of NGBR Project inputs, including labour, equipment and materials, will be sourced from the MIW region. It is also expected that other areas within Queensland will supply inputs, including labour, to the NGBR Project and is therefore included within the wider study area for this report. .

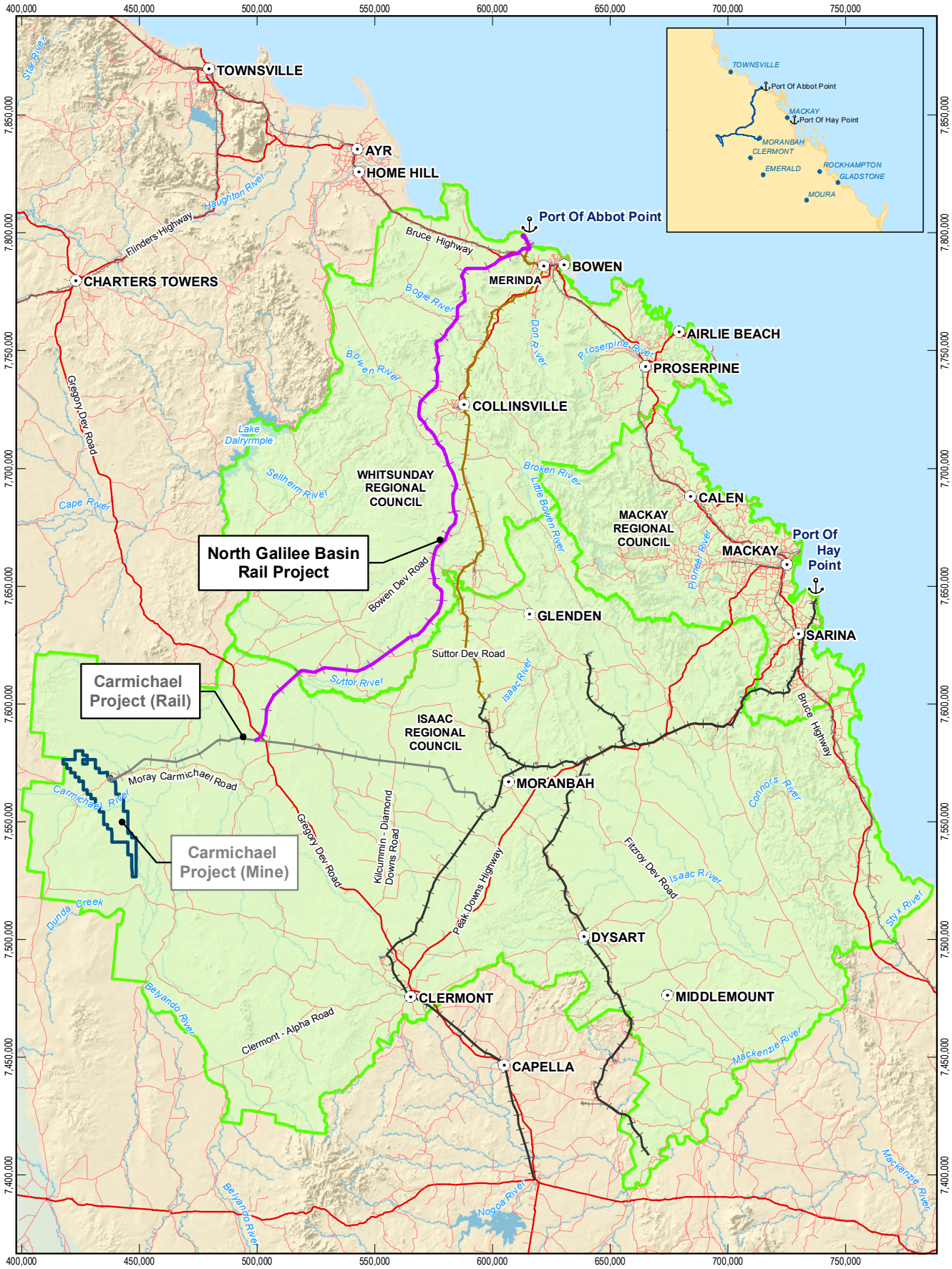
It is expected that NGBR Project inputs including labour, equipment and materials will be sourced from Mackay—the regional hub and a key mining service support centre in the region. The MIW region has also been chosen as the study area for this report as the economic model outputs are presented at this level. It is also expected that other areas within Queensland will supply inputs to the NGBR Project including labour.

The study area for the purpose of the economic assessment is depicted in Figure 2-1.

2.2 Data sources

Data was collected from a range of sources including:

- Australian Bureau of Statistics (ABS), 2011 Census of Population and Housing (ABS 2012a)
- ABS Australian National Accounts, 2011/12 State Accounts (ABS 2012b)
- ABS Australian National Accounts, Input-Output Tables - Electronic Publication 2008/09 (ABS 2012c)
- ABS 2011 Agricultural Census (ABS 2012d) and AgStats data for 2010/11 (ABS 2012e)
- ABS 2009/10 Household Expenditure Survey (ABS 2011)
- ABS Regional Population Growth, Australia (ABS 2012f)
- Office of Economic and Statistical Research (OESR), population projections (OESR 2013)
- Publications by Mackay Whitsunday Regional Economic Development Corporation (REDC) including:
  - Regional Report Card (2012)
  - Regional Economics Profile (2013).



LEGEND

- Town
- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- Major Road
- Minor Road
- Watercourse
- Local Government Area
- Carmichael Project (Rail)
- Carmichael Project (Mine)
- North Galilee Basin Rail

1:2,300,000 (at A4)

0 10 20 30 40 50

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd

North Galilee Basin Rail Project

Study Area

Job Number 41-26457
Revision A
Date 29 Aug 2013

Figure 2-1

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment Opt9 Rev3 (2012), NGBR: Alignment Opt6 Rev 2 (2013).

2.3 Legislation, policies and guidelines

Legislation, guidelines and policies relevant to this report include:

- *Queensland Government Coal Plan 2030* – the Plan recognises the importance of coal to both the Queensland economy as well as the national and international economy and seeks to:
  - Ensure that the Government has a sound understanding of coal production forecasts so that supporting infrastructure requirements can be planned for and delivered
  - Ensure infrastructure is delivered in a coordinated manner
  - Ensure an understanding of infrastructure needs in emerging resource regions (Queensland Department of Infrastructure and Planning, 2010).
- State Planning Policy 1/1992 Development and the Conservation of Agricultural Land – the Queensland Government recognises that good quality agricultural land is a critical resource for the state and that being finite it requires protection to ensure that future development does not lead to diminished agricultural productivity. Policy principles include:
  - Development should not be allowed if a viable alternative exists
  - If a farm or agricultural business is not currently viable it does not justify further subdivision or re-zoning for non-agricultural purposes
  - The development of strategic plans should give consideration to other forms of development and significant weight should be given to the reservation of good quality agricultural land
- Queensland Resources Council Queensland Resources and Energy Sector Code of Practice for Local Content 2013 – In association with the Queensland Government, the Queensland Resources Council has developed a Code of Practice designed to ensure local suppliers are well positioned to continue to service the resources sector (Queensland Resources Council, 2013).

The above publications are further described in Volume 1 Chapter 20 Legislation and approvals.

2.4 Desktop assessment

2.4.1 Economic baseline

Establishing the existing economic environment involves collecting, analysing and presenting data for the study area. This information is used to develop an economic baseline which reflects the 'without project' economic conditions. This information provides a point from which the impacts of the NGBR Project can be reported against.

Information was collected on the current status of the region's population and the state of its economy. Historical data was analysed to identify trends as required under the TOR.

2.4.2 Input output analysis

Estimates of economic change associated with the NGBR Project are based on the use of an I-O modelling method. I-O analysis provides a comprehensive economic framework that provides a numerical picture of the size and shape of the economy and its essential features. Economic indicators, which are used to describe the economic activity in a region resulting from a specific activity, can be considered at two levels, direct / initial change or indirect / flow-on change.

Direct/initial change is the change in final demand or level of economic activity generated by the development. Indirect/flow-on change is the total of:

- Production induced change – purchasing goods and services from other industries and employment
- Consumption induced impacts – additional output and employment stemming from the consumption of additional goods and services by households that are the result of increased wages or employment in the development and associated activities
- Offset consumption effects – the lost consumption by the local unemployed before they take a new job and the lost consumption of those who have lost a job before they start receiving welfare payments.

Direct and indirect flows into affected economies are aggregated in order to ascertain the total impact. Economic impacts (GRP and employment) are assessed at the regional and state levels during both the construction and operations phases of the NGBR Project.

The indirect (flow-on) impacts were calculated using the I-O models constructed for the NGBR Project and they measure the economic effects in other sectors of the economy generated by direct activities, that is, the multiplier effects. In addition to the assumptions embodied in the I-O model itself (see Appendix A), it was necessary to make a number of other general assumptions in estimating the economic effects:

- The impacts were measured using models that represent the structure of the regional and state economies for the year in which the most recent data are available (2011/12). However, over time there are likely to be improvements in primary factor productivity in these economies. To allow for these improvements, an across-the-board (all sectors) labour productivity improvement rate of 1 per cent per annum for subsequent years has been incorporated into the modelling.
- When new jobs are created, it should be determined where the people come from to fill those jobs. In some cases, these jobs will be taken by previously unemployed locals or by someone who is currently employed locally but whose own job is taken by a previously unemployed local. In both cases, the impact of the newly created job and associated income is partially offset by the fact that someone who was previously receiving unemployment benefits is no longer doing so. To calculate this effect requires estimates of the parameter *rho* (refer Appendix A). Rho represents the proportion of new jobs that are likely to be filled by previously unemployed locals. For the construction phase, it was estimated to be 50 per cent for the local area and 60 per cent for Queensland as a whole.

Model outputs can be used to predict changes to:

- GRP – a measure of the value of a region's outputs minus the cost of inputs. It is therefore able to measure the net contribution of the NGBR Project to the relevant economies (i.e. the MIW region and Queensland).

- Employment - identifies the number of Full Time Equivalent (FTE) persons engaged in work within a region. In this assessment, employment is measured by place of remuneration rather than place of residence.

It was assumed that over the life of the NGBR Project 75 per cent of the capital investment for the construction of the NGBR Project will occur in the MIW Region and 10 per cent elsewhere in Queensland. The remaining capital expenditure (15 per cent of the total) is assumed to occur outside of Queensland (i.e. interstate and overseas). This is consistent with other rail projects including the assumption made for Adani's proposed Carmichael Coal Mine and Rail Project's (Carmichael Project's) rail line to connect from the Carmichael Coal Mine to the existing Goonyella rail system.

It was assumed that over the life of the NGBR project, 70 per cent of operations expenditure will occur in the MIW region, 23 per cent outside the MIW region but still in Queensland and 7 per cent outside Queensland and overseas.

The impact of the NGBR Project on these indicators at the regional level and for the State of Queensland is presented separately in Volume 1 Chapter 16 Social and economic impacts within the Environmental Impact Statement (EIS).

2.5 Limitations

This report and the economic modelling have been underpinned by the following assumptions:

- Industries in the model have a linear production function, which implies constant returns to scale and fixed input proportions
- Firms within a sector are homogeneous, which implies they produce a fixed set of products that are not produced by any other sector and that the input structure of the firms are the same. Thus it is preferable to have as many sectors as possible specified in the models and the standard models for this study were compiled with 66 sectors
- The model is a static model that does not take account of the dynamic processes involved in the adjustment to an external change, such as a permanent change in natural resources management.

Further details are presented in Appendix A.

3. Existing environment

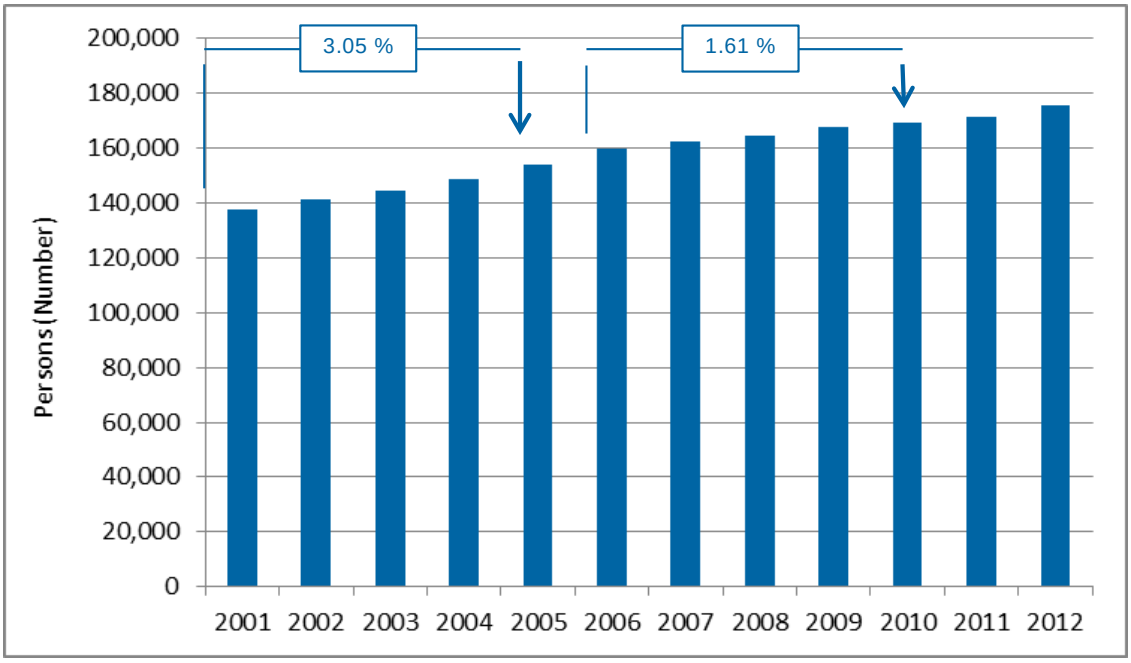
3.1 Demographic profile

3.1.1 Population growth trend

The following section provides a high level demographic profile of the MIW region, which covers the three LGAs of Mackay, Isaac and Whitsunday. The social baseline presented within Volume 2 Appendix M Social baseline, provides a more detailed demographic profile at the LGA level.

The OESR, reports that the population of the MIW region was 175,702 in 2012. Between 2001 and 2012, the region experienced an average annual population growth rate of 2.25 per cent. Between 2001 and 2006 the population grew slightly faster at a rate of 3.05 per cent per annum whereas between 2007 and 2012, growth was slower at 1.61 per cent per annum (refer Figure 3-1).

Figure 3-1 MIW region historical population growth



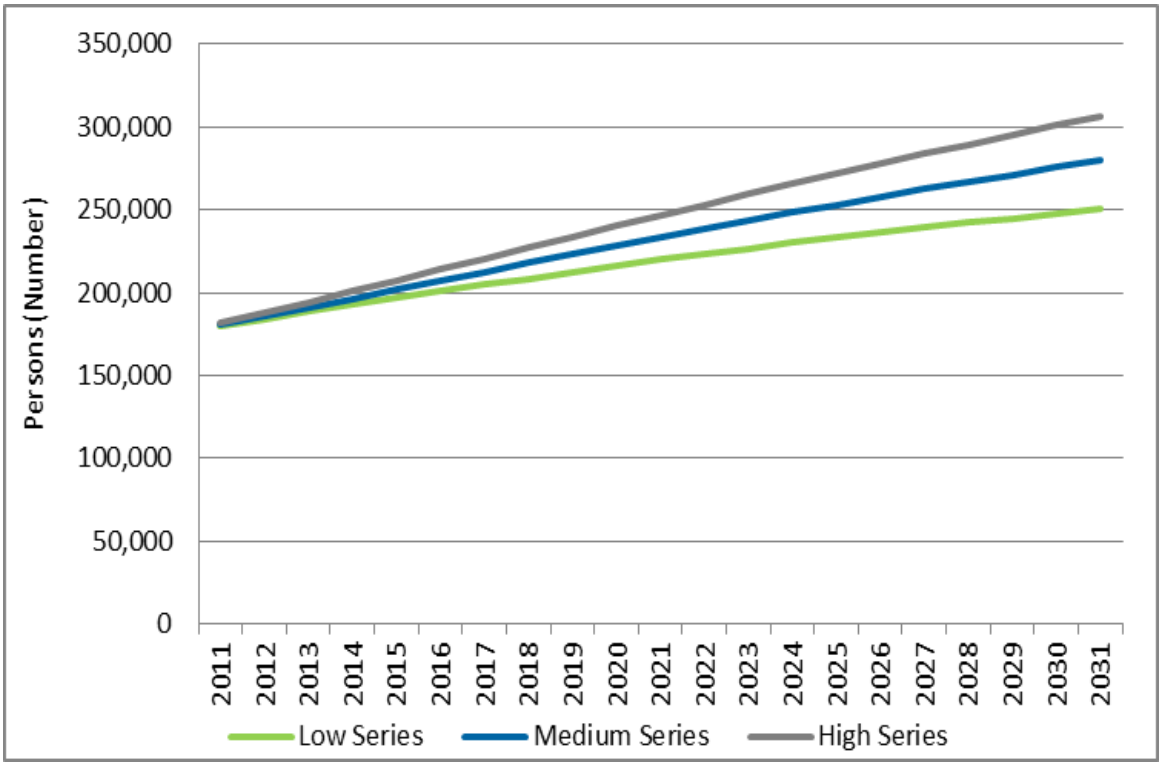
Source: OESR, 2013(a)

The population of the MIW region increased by 4,405 persons (2.57 per cent) between 2011 and 2012. This was higher than population growth in Queensland over the same period which increased by 1.92 per cent.

Population growth within the region is forecast to continue to increase. Average annual population growth between 2011 and 2031 as projected by the OESR under a high, medium and low growth scenario is depicted in Figure 3-2:

- High OESR growth scenario – 2.64 per cent per annum
- Medium OESR growth scenario – 2.22 per cent per annum
- Low OESR growth scenario – 1.67 per cent per annum

Figure 3-2 MIW region projected population growth



Source: OESR, 2013(b)

3.2 Labour market

3.2.1 Employment profile

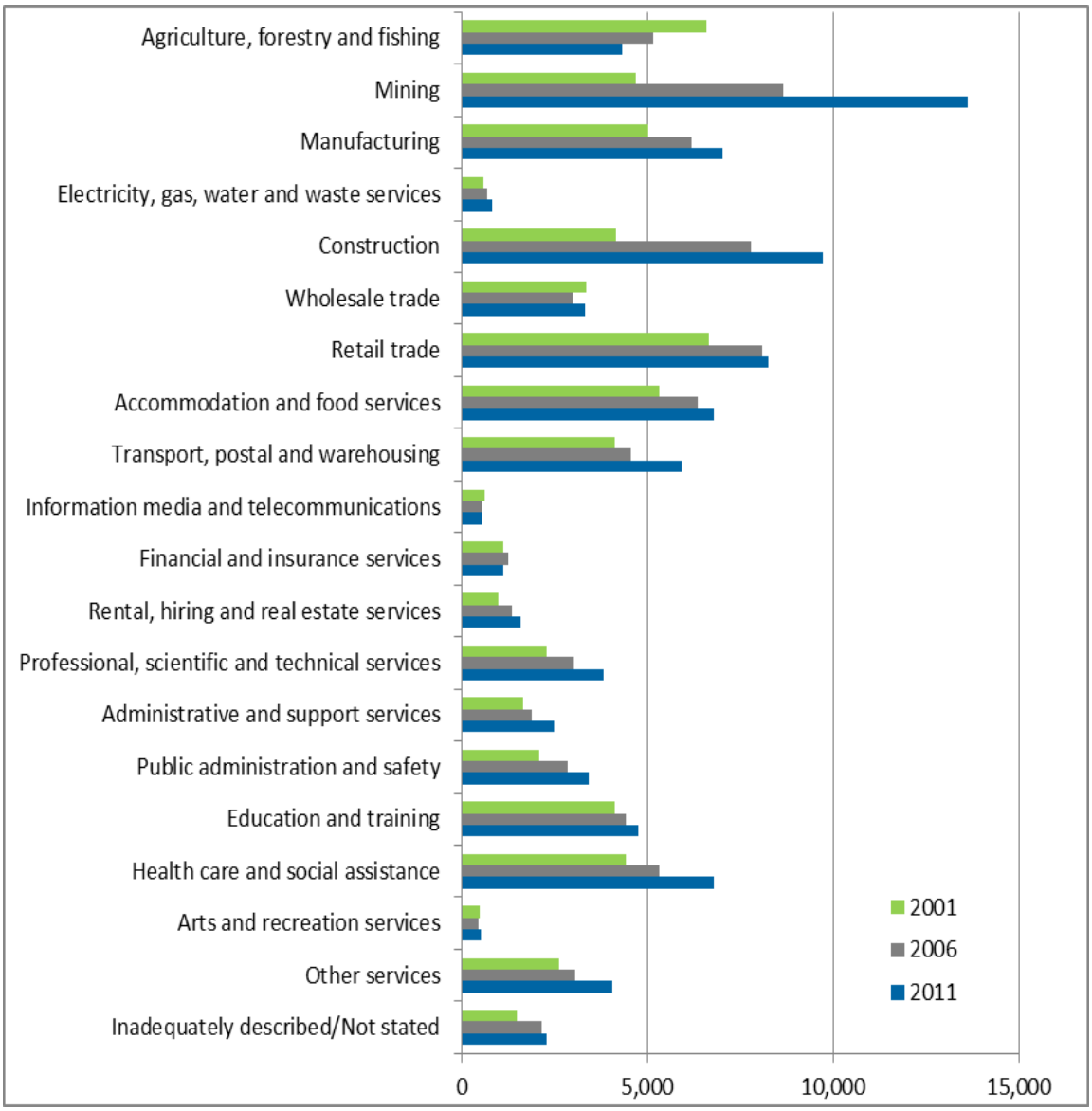
In 2011, there was an estimated 91,153 persons working in the MIW region. This is an increase from 76,758 in 2006. Between 2006 and 2011, employment within the region grew by 14,401 workers representing 19 per cent growth (ABS, 2012). These figures include workers who travel into the region for work.

The major industries of employment in the MIW region in 2011 were mining (14.94 per cent), construction (10.67 per cent), retail trade (9.06 per cent), manufacturing (7.69 per cent), accommodation and food services (7.46 per cent) and health care and social assistance (7.46 per cent) (refer Figure 3-3) (OESR, 2013(c)). For comparative purposes, the unemployment rate in the MIW region was 4.3 per cent in 2012 (refer section 3.2.2).

Employment has increased in absolute terms in most industries in the MIW region between 2006 and 2011. Only the agriculture, forestry and fishing and the financial and insurance services sectors have experienced a decline in the number of people employed in the MIW region. Figure 3-3 shows the change in the labour market across each sector between 2001, 2006 and 2011.

The proportion of the workforce employed in the mining sector increased by 57 per cent in the period between 2006 and 2011 and increased by 190 per cent during the ten years to 2011. The proportion of the workforce employed in the agriculture, forestry and fishing industry decreased by 16 per cent during this time (OESR, 2013(c)).

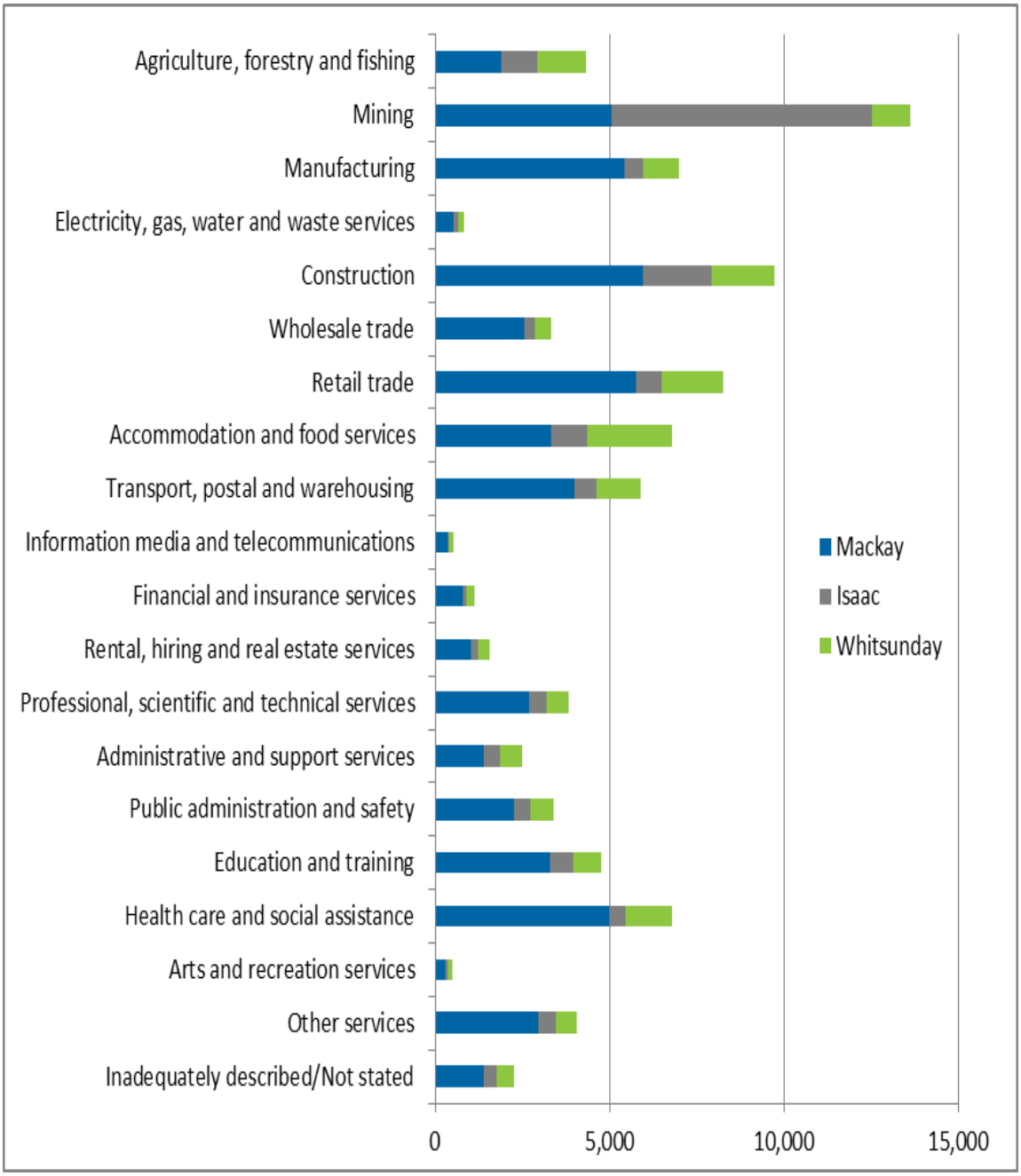
Figure 3-3 Employment by industry MIW region – 2001, 2006 and 2011



Source: OESR, 2013(d)

The 2011 employment composition (refer Figure 3-4) indicates that 61 per cent of people employed in the MIW region reside in the Mackay LGA. This is consistent with the population distribution between the Mackay, Isaac and Whitsunday LGAs where 67.6 per cent of the total population reside in the Mackay region. The majority of people employed within the mining sector (55 per cent) reside in the Isaac LGA.

Figure 3-4 Employment by industry MIW region - 2011

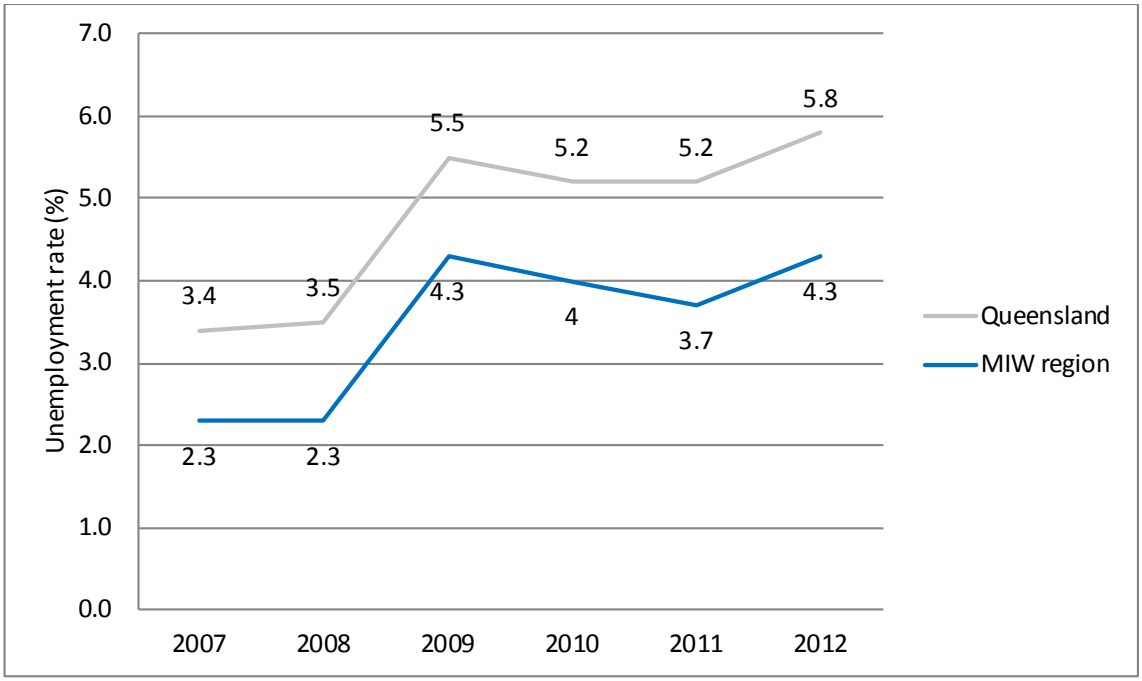


Source: OESR, 2013(d)

3.2.2 Unemployment profile

The unemployment rate in the MIW region has historically followed a similar trend as the unemployment rate across Queensland. Figure 3-5 shows the unemployment rate in the MIW region is around 1.1 to 1.5 per cent lower than unemployment rate in Queensland.

Figure 3-5 Unemployment rate MIW region and Queensland 2007 – 2012

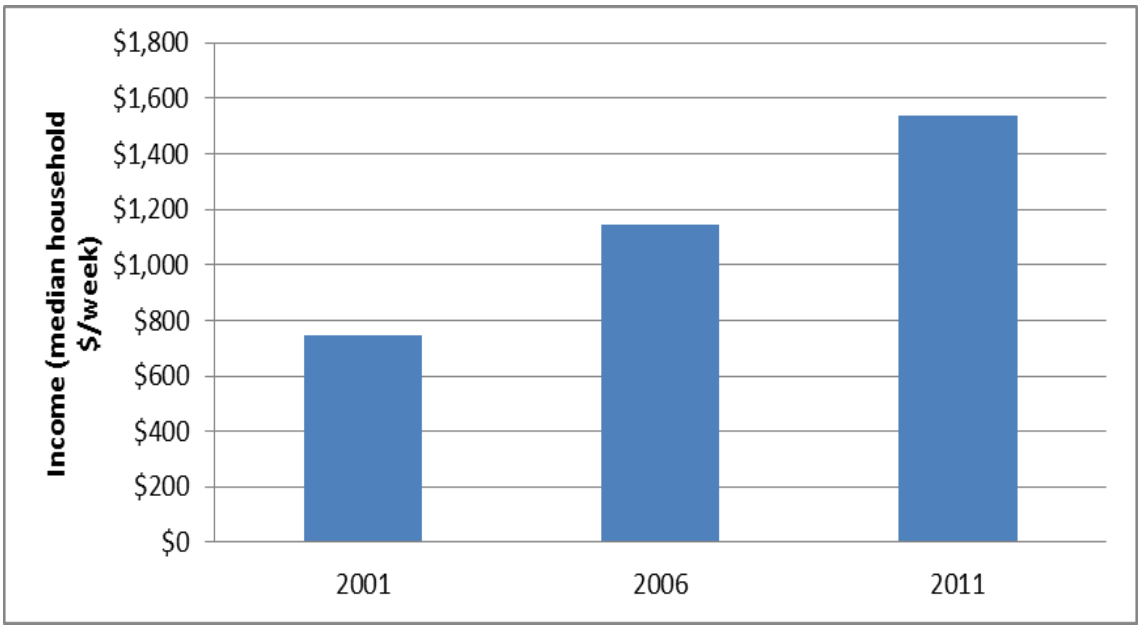


Source: OESR, 2013(c)

3.3 Wages

Median weekly household income in the MIW region increased between 2001 and 2006 and again between 2006 and 2011 (refer Figure 3-6). Overall, median household income in the MIW region has increased by 107 per cent over this period. Wage increases of this magnitude are broadly consistent with a booming or lead sector such as the mining sector.

Figure 3-6 Median weekly household income – 2001 – 2011 – MIW region



Source: ABS, 2013

3.4 Economic baseline

3.4.1 Economic output and trends

The MIW region is the largest regional economy in Queensland. The region has the third largest GRP in Queensland behind Brisbane and the Gold Coast. Table 3-1 presents industry contributions to GRP across each of the three LGAs that make up the MIW region.

Mining activities account for 52 per cent of the MIW region's overall economic production. GRP for the MIW region was estimated to be approximately $20.6 billion (in 2011/12 dollar terms).

Table 3-1 GRP – MIW region 2011/12*

Sector	Mackay LGA	Isaac LGA	Whitsunday LGA	GRP	
	$m	$m	$m	$m	%
Agriculture, forestry and fishing	163	134	97	394	1.9
Mining	1,028	565	9,107	10,700	51.9
Manufacturing	600	111	59	770	3.7
Electricity, gas, water and waste services	89	28	22	139	0.7
Construction	480	155	212	847	4.1
Wholesale trade	552	84	62	698	3.4
Retail trade	338	108	44	490	2.4
Accommodation and food services	137	113	51	301	1.5
Transport, postal and warehousing	439	158	69	666	3.2
Information media and telecommunications	66	18	7	91	0.4
Financial and insurance services	222	56	25	303	1.5
Rental, hiring and real estate services	139	44	27	210	1.0
Professional, scientific and technical services	296	60	37	393	1.9
Administrative and support services	86	43	39	168	0.8
Public administration and safety	220	58	45	323	1.6
Education and training	224	58	45	327	1.6
Health care and social assistance	324	78	31	433	2.1
Arts and recreation services	11	6	2	19	0.1
Other services	155	30	29	214	1.0

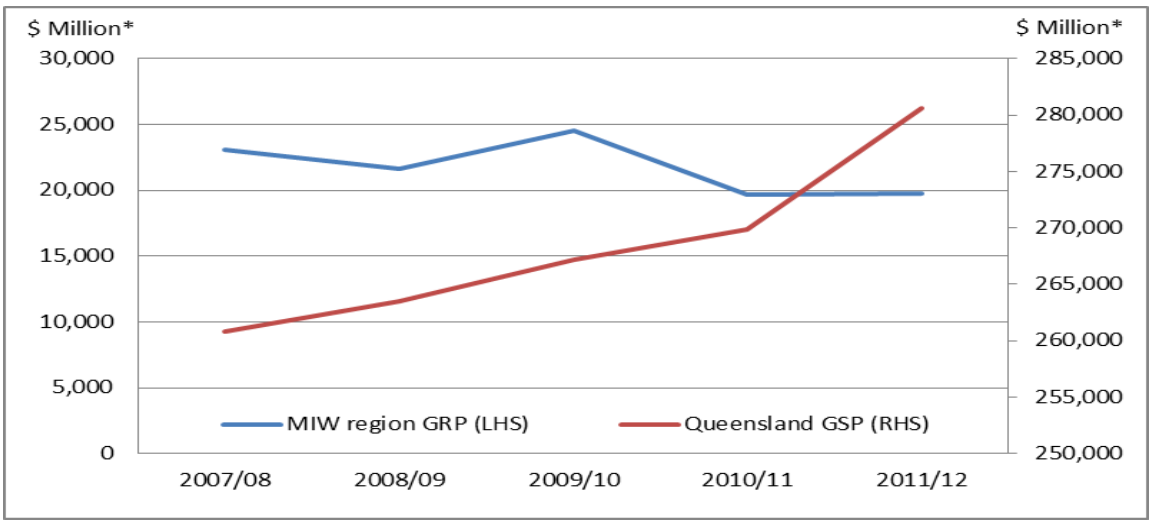
Sector	Mackay LGA	Isaac LGA	Whitsunday LGA	GRP	
	$m	$m	$m	$m	%
Non classifiable industry	55	23	17	95	0.5
Total Industry Value Added	5,623	1,930	10,026	17,579	
Ownership of dwellings	566	194	1,009	1,769	
Taxes less subsidies on production and imports	413	142	737	1,292	
Statistical discrepancy	-4.9	-1.7	-8.7	-15.2	
GRP	6,597	6,597	11,763	20,624	
GSP, Queensland				283,604	

Note: * Current prices, denominated in 30 June 2012 dollars
Source: Adapted from Mackay Whitsunday REDC (2012) Regional Report Card 2006-2011

GRP in the MIW region declined by 14.3 per cent in real terms between 2007/08 and 2011/12 (2010/11 dollar terms) (refer Figure 3-7). This represents a decline of approximately 3.8 per cent per annum since 2007/08 despite an 18.8 per cent increase in the number of people employed in the region during this time. The decline in GRP growth in both 2008/09 and 2010/11 illustrates the effects of severe weather events hindering agricultural and mining production during these periods. Declining coal prices have also affected the contribution of the mining sector to the MIW region's GRP.

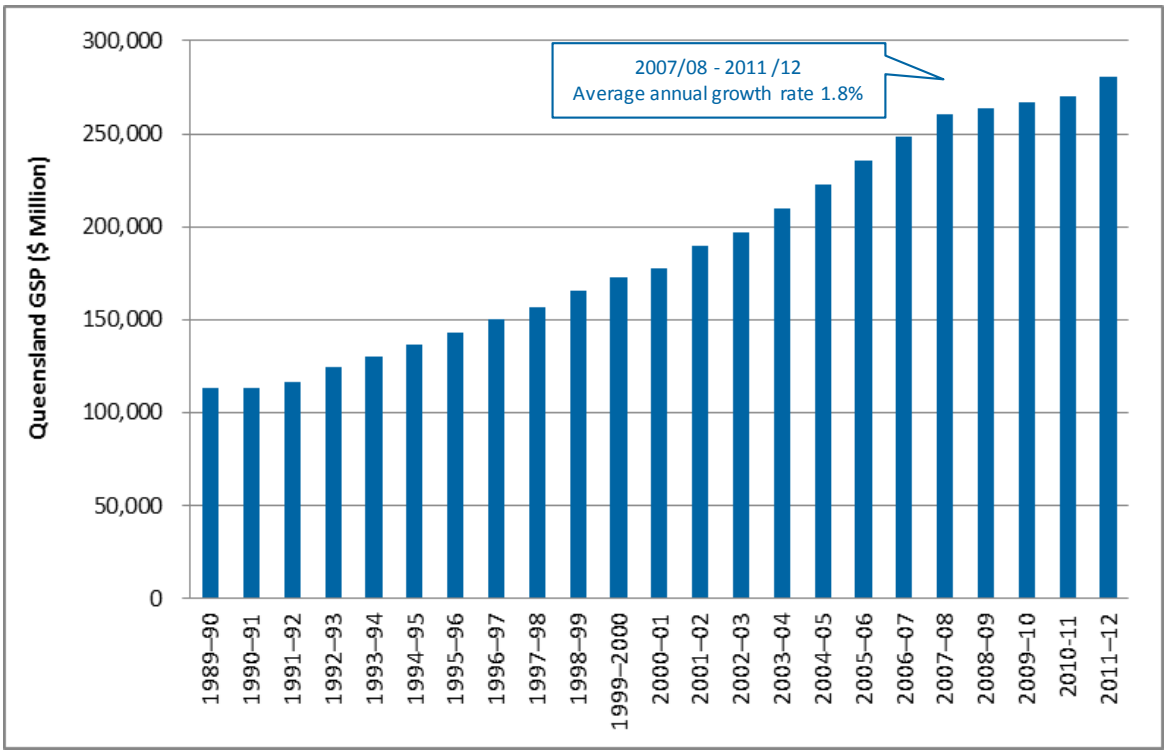
In contrast, over the same period, Queensland GSP grew at an average of 1.8 per cent per annum (refer Figure 3-7 and Figure 3-8), highlighting the extent of the downturn in the MIW regional economy during this period.

Figure 3-7 MIW Region GRP trend vs. Queensland GSP trend 2007/08 – 2011/12*



Note: * Chain volume measures are used to estimate the value of economic growth over time by keeping the prices of goods produced and consumed constant – thereby removing the effect of inflation, denominated in 30 June 2011 dollars
Source: Mackay Whitsunday REDC correspondence

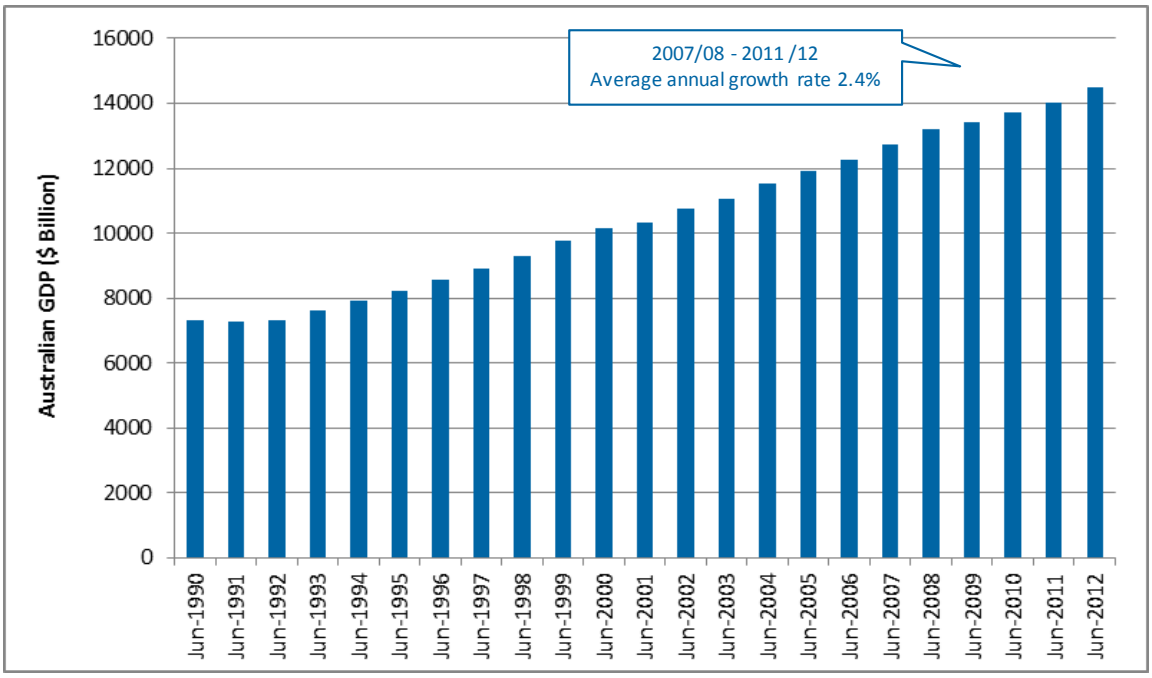
Figure 3-8 Queensland GSP 1989/90 – 2011/12*



Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: ABS (2012)

Australian Gross Domestic Product (GDP) over the preceding 20 years has steadily increased (refer Figure 3-9). Growth in GDP between 2007 and 2012 occurred at an average annual rate of 2.4 per cent—higher than Queensland GSP and GRP in the MIW region.

Figure 3-9 Australian GDP 1990-2012*

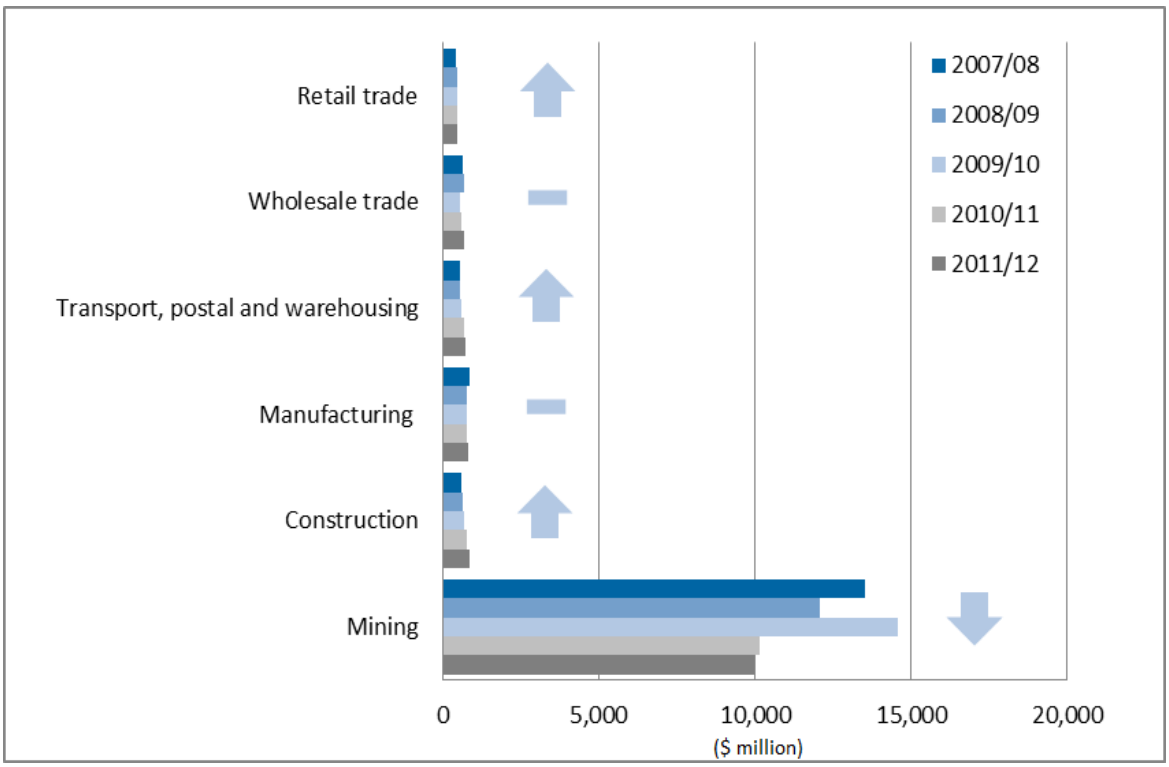


Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: ABS (2012)

3.4.2 Key industry profile

In 2011/12, the mining sector accounted for 52 per cent of the region's GRP. Construction (4.4 per cent), manufacturing (4.1 per cent), transport, postal and warehousing (3.6 per cent), wholesale trade (3.4 per cent) and retail trade (2.4 per cent) were the other key contributing sectors to GRP (refer Figure 3-10).

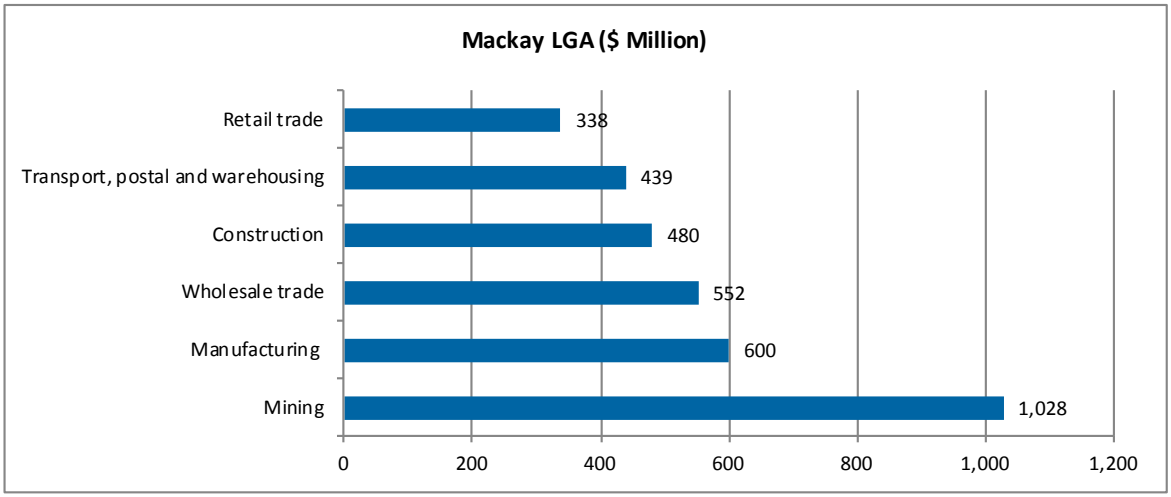
Figure 3-10 Industry contribution to GRP in the MIW region, 2007/08 – 2011/12*

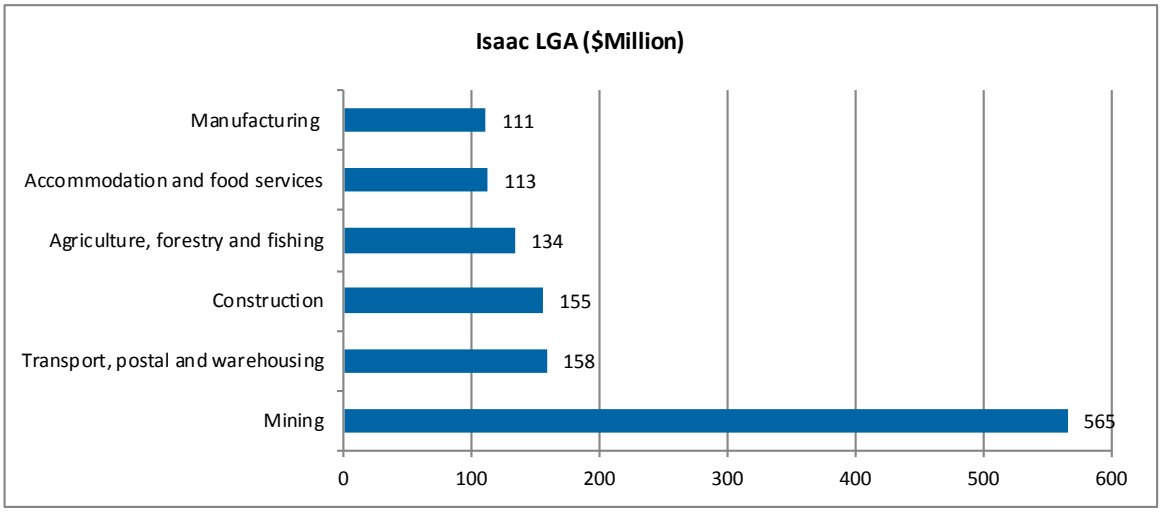


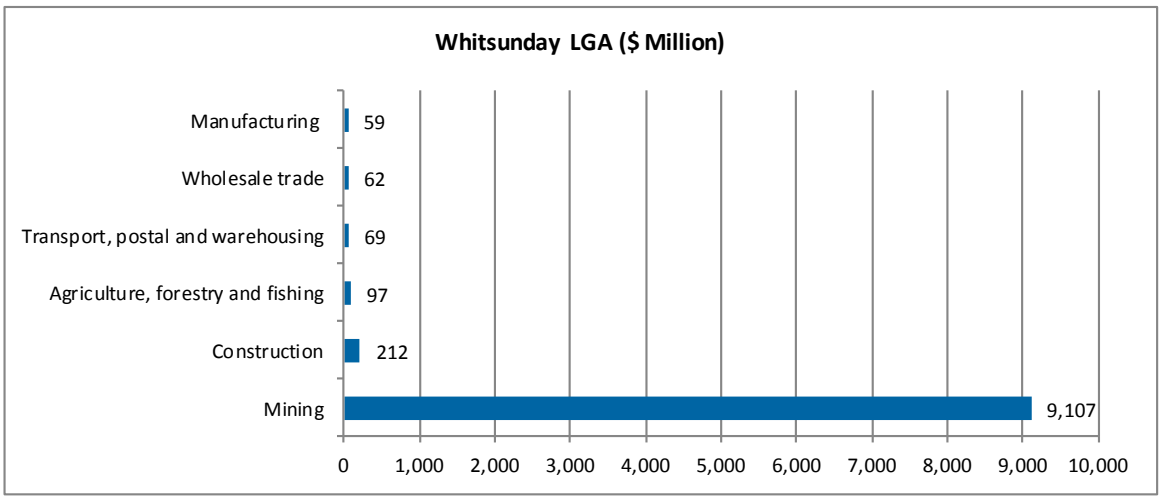
Note: * Chain volume measures, denominated in 30 June 2011 dollar
Source: Mackay Whitsunday REDC correspondence

At the LGA level, there is some variation in terms of the contribution of each sector to GRP. As identified, the mining sector is the most significant contributor to GRP in the MIW region; especially in the Whitsunday LGA where it accounts for 77 per cent of GRP. Agriculture is an important industry within the Isaac and Whitsunday LGAs as is accommodation and food services. With Mackay city being the region's main urban centre, retail trade is an important contributor to GRP in the Mackay LGA. Figure 3-11 identifies the six largest GRP contributors in the three LGAs in 2011/12.

Figure 3-11 Largest six GRP contributors, Mackay, Isaac and Whitsunday LGAs, 2011/12*







Note: * Current prices, denominated in 30 June 2012 dollar
Source: Mackay Whitsunday REDC (2012) Regional Report Card 2006-2011

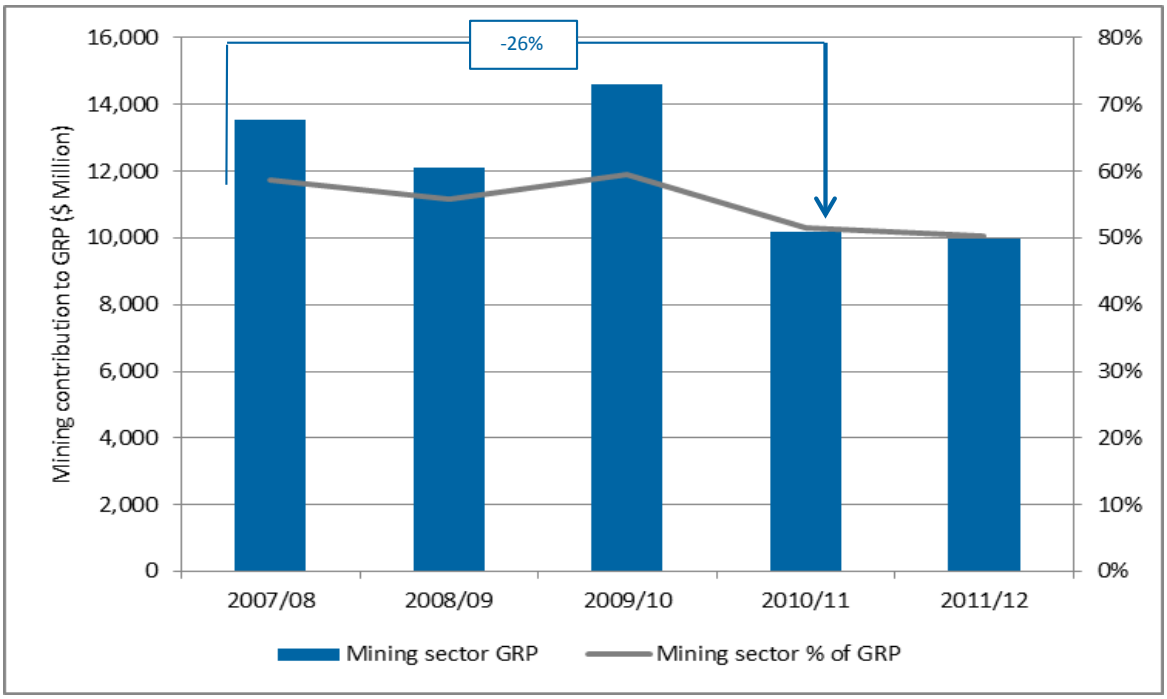
The following sections look at these key industries that drive (in dollar output) GRP within the MIW region and provide the most employment opportunities.

Mining

The mining sector is the main economic driver of the MIW region, with high quality coking and thermal coal production being the main mining output. Approximately half of Queensland's total coal production originates from this region and represents three quarters of its total value in Queensland (Isaac Regional Council, 2013). Other mining operations in the region include coal seam gas operations in Moranbah (Isaac LGA), gold and silver mining operations north of Collinsville (Whitsunday LGA) and hard-rock quarries in Mackay (Mackay LGA) (Mackay Whitsunday REDC, 2012)

Between 2007/08 and 2011/12, the mining industry accounted for between 50 to 60 per cent of the MIW region's GRP (refer Figure 3-12). The mining sector typically has a high exposure to global market fluctuations in commodity demand, prices and exchange rates. The contraction in real terms of the mining sector in the MIW region since 2007/08 coincides with the downturn of the global economy and the reduced demand for coal exports, in the order of 265 per cent between 2007/08 and 2011/12.

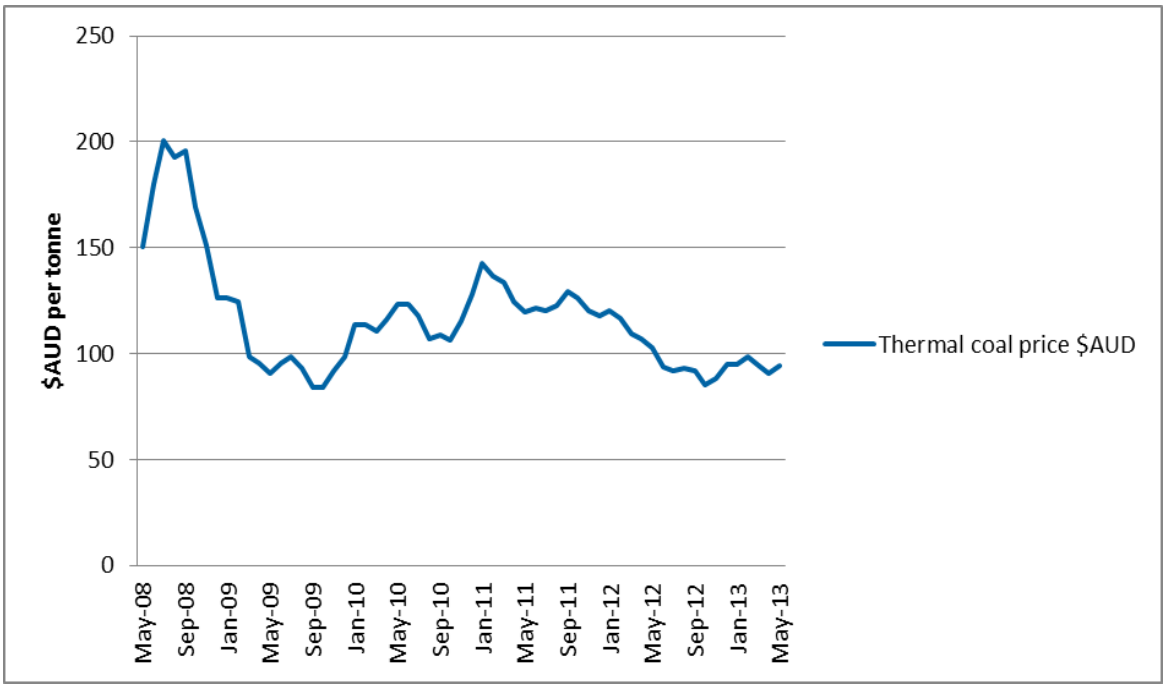
Figure 3-12 Mining sector contribution to GRP in the MIW region*



Note: * Chain volume measures, denominated in 30 June 2011 dollar
Source: Mackay Whitsunday REDC correspondence

The decrease in the contribution of the mining sector to GRP in 2010/11 and 2011/12 can be partly attributed to the combined effects of bad weather and declining coal prices. As can be seen in Figure 3-13, thermal coal prices have declined significantly between 2008 and 2013. The appreciation of the Australian dollar and a slow-down in global economic growth has placed downward pressure on the contribution of the mining sector to GRP.

Figure 3-13 Thermal coal price - $AUD May 2008 – May 2013



* Prices are Free On Board out of Newcastle/Port Kembla
Source: Indexmundi, 2013

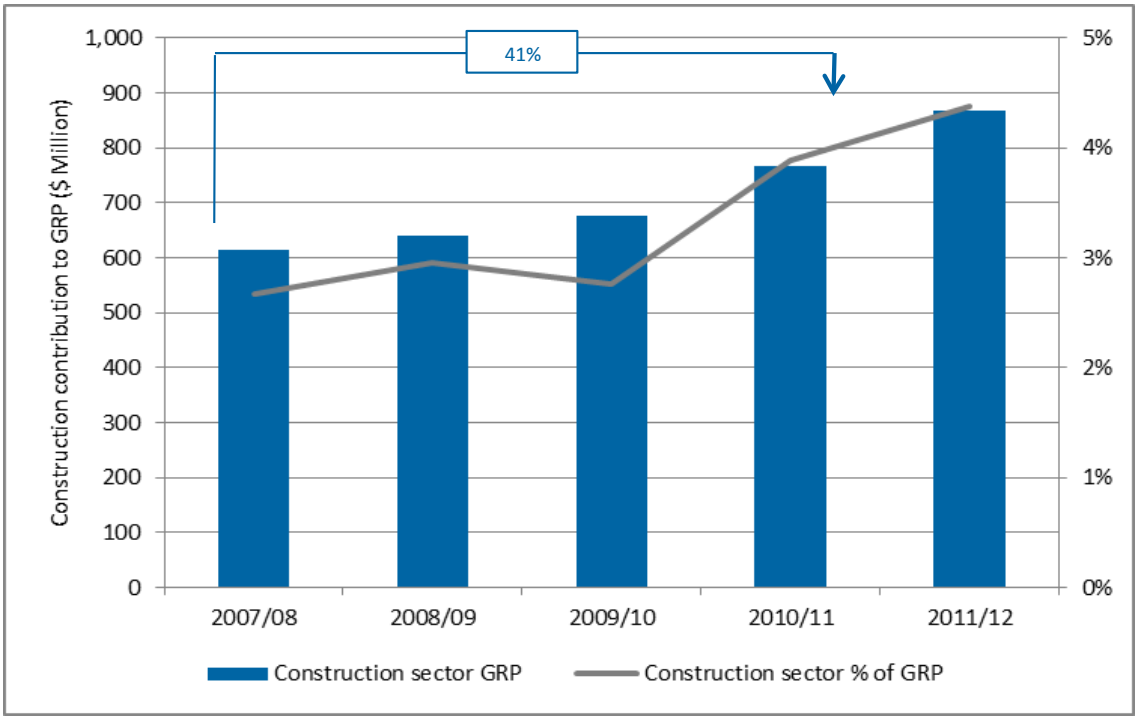
Low coal prices are beginning to impact on employment in coal mines located in the MIW region. This was reflected in consultation undertaken for the NGBR Project in Moranbah, Collinsville and Bowen (refer Volume 2 Appendix B Public consultation).

Construction

Between 2007/08 and 2011/12, the contribution of the construction sector to GRP in the MIW region grew from 2.7 per cent to 4.4 per cent—an increase of 41 per cent during this time period. Output from the construction sector was valued at $867 million in 2011/12 (refer Figure 3-14).

Strong population growth in the region combined with growth in the mining sector has underpinned demand for residential and non-residential construction. Infrastructure investment at Abbot Point, Dalrymple Bay and Hay Point coal terminals has also supported growth in the construction sector (Mackay Whitsunday REDC, 2012).

Figure 3-14 Construction sector contribution to GRP in the MIW region*

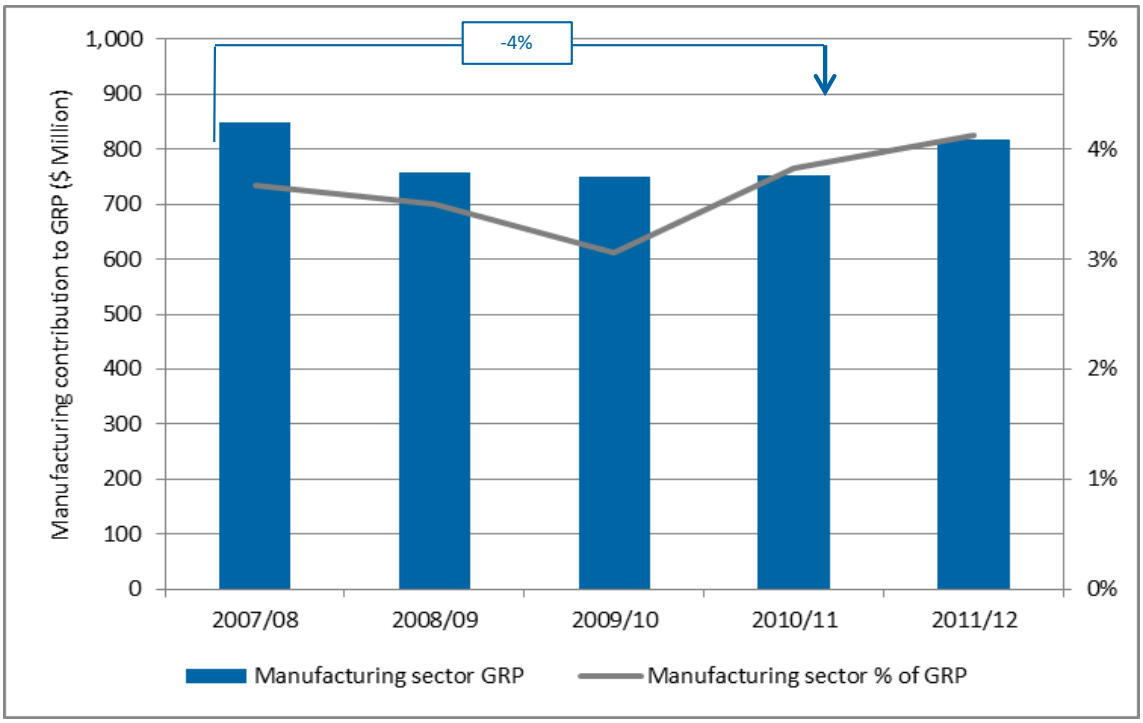


Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: Mackay Whitsunday REDC correspondence, May 2013

Manufacturing

The manufacturing sector in the MIW region experienced a slowdown during the five year period of four per cent. In 2007/08 the contribution of the manufacturing sector to GRP in the MIW region was $848 million. This contribution declined by 10 per cent between 2007/08 and 2008/09 before rebounding in 2011/12 to reach $817 million— 4 per cent lower than the 2007/08 level (refer Figure 3-15). A decrease in productivity within the sector has been identified as a possible reason for this decline (Mackay Whitsunday REDC, 2012). However, despite this fall, the proportion of the contribution of the manufacturing sector to GRP grew from 3.7 per cent to 4.1 per cent between 2007/08 and 20011/12. This indicates that the manufacturing sector has become slightly more important to the economy of the region.

Figure 3-15 Manufacturing sector contribution to the MIW region*



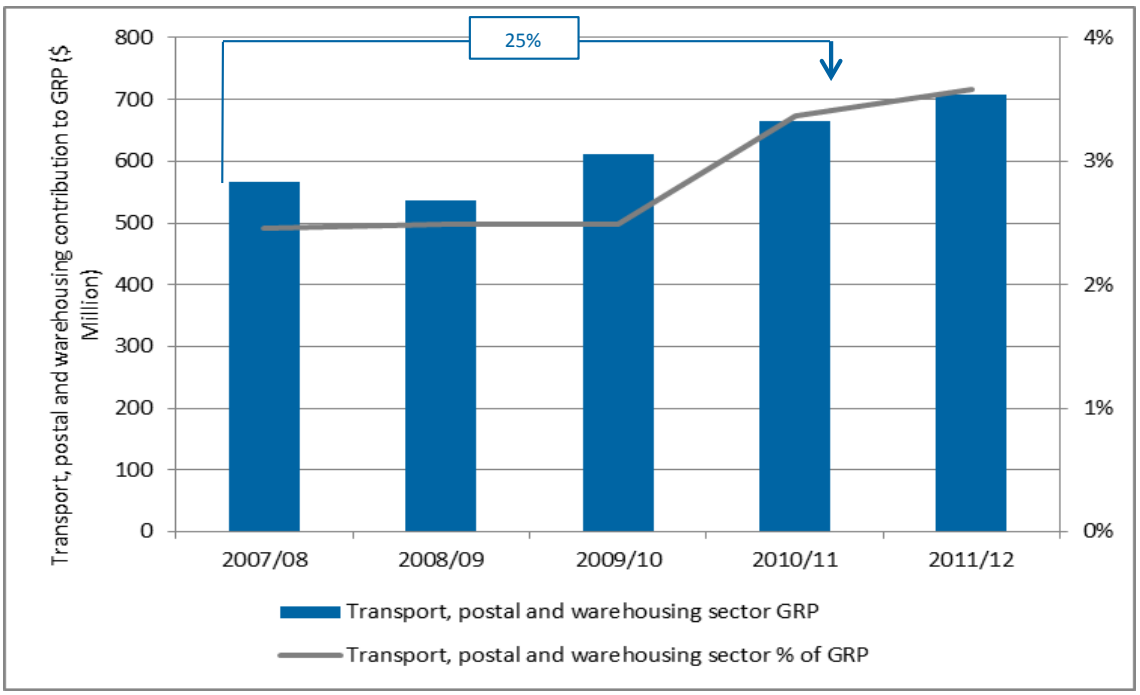
Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: Mackay Whitsunday REDC correspondence, May 2013

Transport, postal and warehousing

The transport, postal and warehousing industry grew by 25 per cent between 2007/08 and 2011/12; contributing $709 million to MIW region's GRP in 2011/12 (refer Figure 3-16). The share of transport, postal and warehousing industry to GRP also grew significantly from 2.5 per cent to 3.6 per cent of the region's GRP, which is a 46 per cent increase between 2007/08 and 2011/12.

Growth in the transport, postal and warehousing sector is supported by the mining industry. Road, rail and port operators who facilitate the transport of commodities to export markets benefit from mining activity in the region.

Figure 3-16 Transport, postal and warehousing sector contribution to GRP in the MIW region*

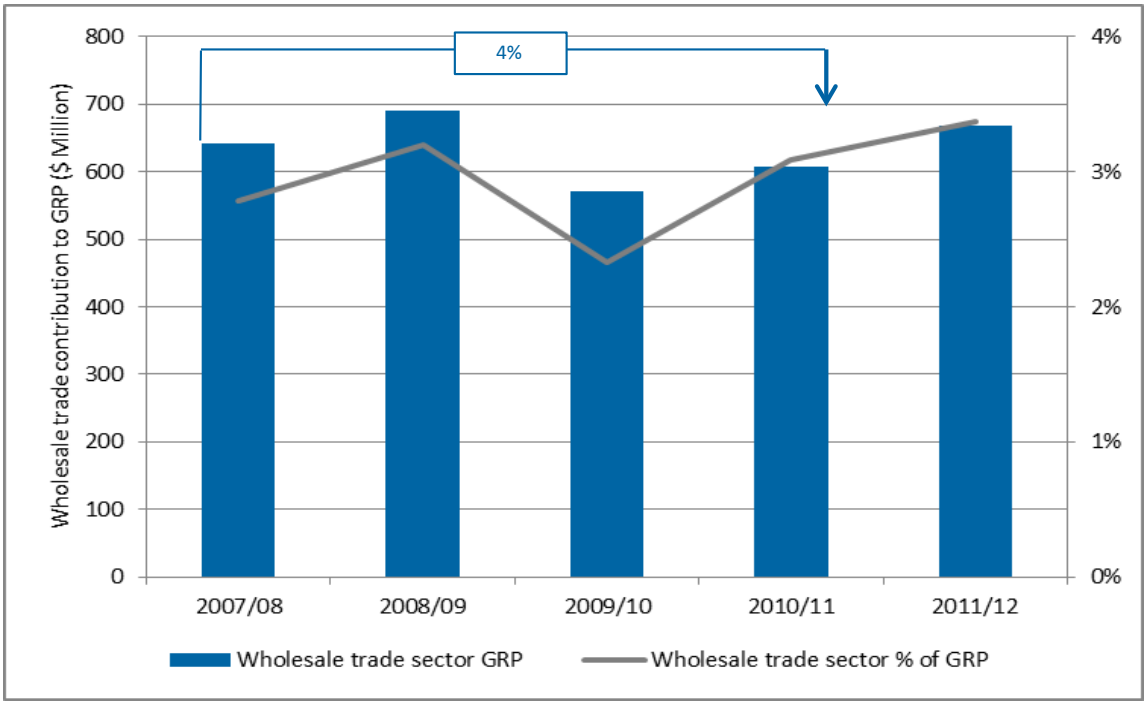


Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: Mackay Whitsunday REDC correspondence, May 2013

Wholesale trade

Between 2007/08 and 2011/12, the contribution of the wholesale trade industry to GRP grew from $643 million to reach $667 million. This represents a 4 per cent increase (refer Figure 3-17). The proportion of the contribution of the wholesale trade industry to total GRP increased from 2.7 per cent in 2007/08 to 3.4 per cent in 2011/12. Mackay currently relies heavily on local and regional business for consumption of its output. It has been identified that in order to grow the wholesale trade sector and increase its sustainability, new markets will need to be developed (Mackay Whitsunday REDC, 2012).

Figure 3-17 Wholesale trade sector contribution to GRP in the MIW region

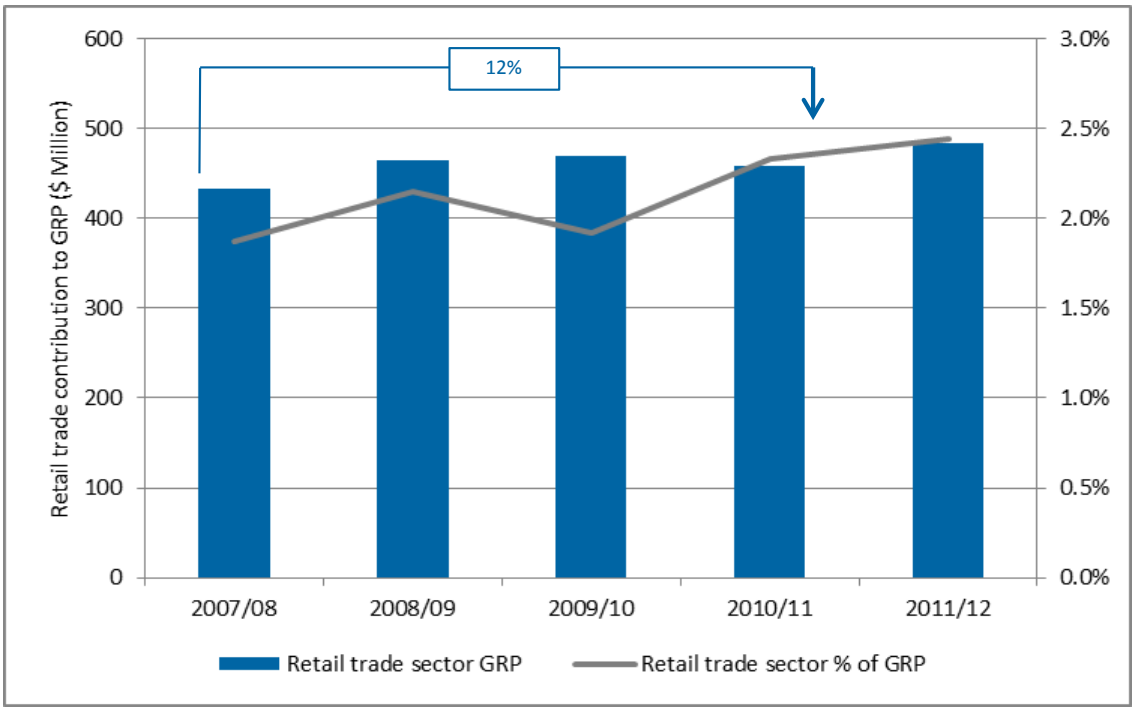


Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: Mackay Whitsunday REDC correspondence, May 2013

Retail trade

The retail trade industry experienced growth of 12 per cent between 2007/08 and 2011/12 (refer Figure 3-18). The contribution of retail trade to GRP grew from 1.9 per cent in 2007/08 to 2.4 per cent by 2011/12. In 2011/12, the contribution of retail to GRP was valued at $485 million.

Figure 3-18 Retail trade sector contribution to GRP in the MIW region

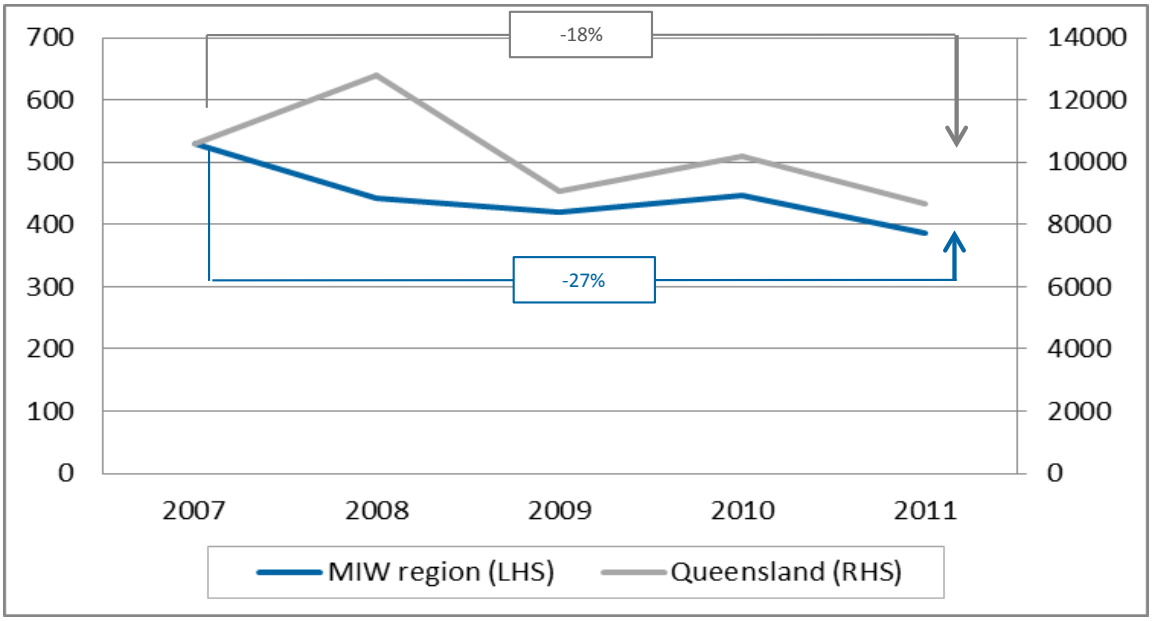


Note: * Chain volume measures, denominated in 30 June 2011 dollars
Source: Mackay Whitsunday REDC correspondence, May 2013

3.4.3 Residential building approvals

The value of total residential building approvals in the MIW region declined between 2006/07 and 2010/11. The total value of residential building approvals declined by 27 per cent in the MIW region compared to an overall decline of 18 per cent across Queensland between 2007 and 2011 (refer Figure 3-19). This decline could be due to a number of factors including a softening in the property market and changes to government incentives in certain sections of the property industry (e.g. reduction in first home owners grant).

Figure 3-19 Value of total residential building approvals – MIW region and Queensland – 2007 – 2011 ($ Million)

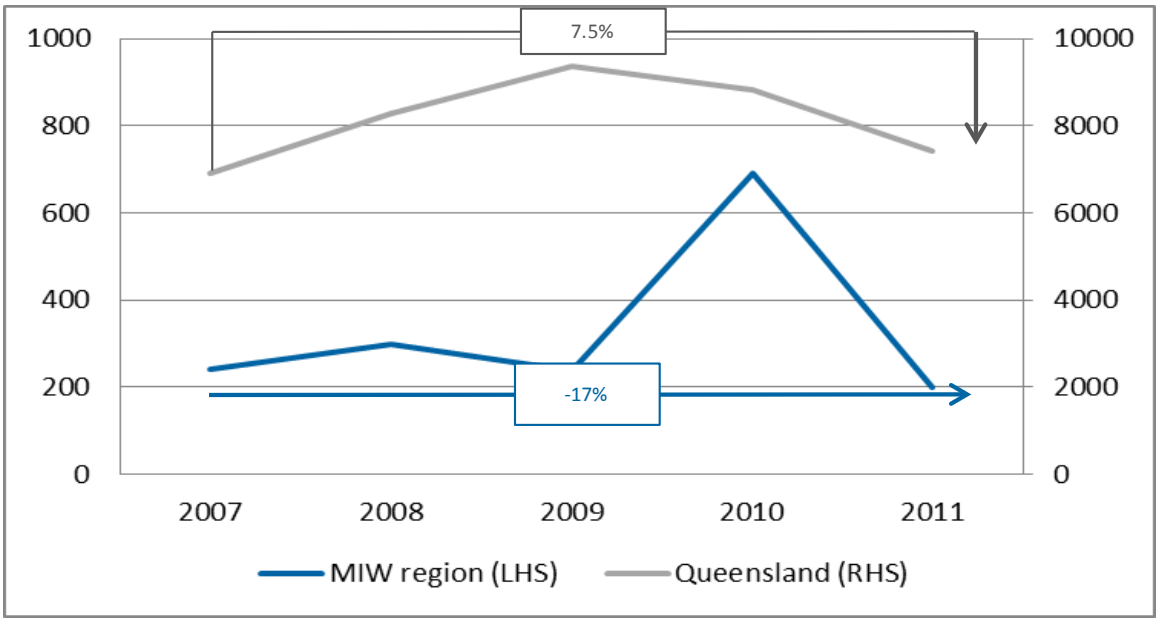


Source: ABS, 2013

3.4.4 Non-residential building approvals

The value of total non-residential building approvals in the MIW region declined by $40.9 million or 17 per cent between 2006/2007 and 2010/2011 (ABS, 2013). This weakness can be attributed to a significant decline in non-residential building approvals in the coastal Whitsunday region (Proserpine, Cape Conway and Airlie - Whitsundays) since 2006/07 (ABS, 2013). In the rest of the MIW region, growth in the value of total non-residential building approvals has been quite steady with the exception of a large increase in 2009/10 for Mackay LGA, as shown in Figure 3-20.

Figure 3-20 Value of total non-residential building approvals – MIW region – 2007 – 2011 ($ Million)



Source: ABS, 2013

3.4.5 Land use

Land use in the MIW region is dominated by the agricultural sector. Currently, 89.8 per cent of the region's land area is currently being used for agricultural activities, the majority of which is used for grazing (85.3 per cent of the region's land) (Table 3-2). Other key industries along the coastal strip in the Mackay and Whitsunday LGA include sugarcane, horticulture (primarily vegetables, mangoes, bananas, lychees and amenity horticulture) and grazing. In the Isaac LGA, cropping, primarily sorghum in summer and legumes or wheat in winter, occurs extensively around Clermont and Dysart and around the junction of the Isaac and Connors rivers (Queensland Department of Agriculture, Fisheries and Forestry, 2013). Land use patterns are also presented within Volume 2 Appendix C Land use and tenure.

Table 3-2 Land use – MIW region 2009

Land use	Area (ha)	Percentage of region
Grazing	7,642,642	85.28%
Broadacre cropping	225,269	2.52%
Sugarcane	168,105	1.88%
Annual horticulture	8,580	0.10%

Land use	Area (ha)	Percentage of region
Perennial horticulture	1,534	0.02%
Aquaculture	778	0.00%
Intensive livestock	226	0.00%
Other land use (non-agricultural including forestry)	914,201	10.20%
Total	8,961,335	100%

Note: * Forestry includes land, irrespective of tenure, that has been established as forestry (native or plantation), but can also be used for other purposes such as grazing.
Source: Queensland Department of Agriculture, Fisheries and Forestry (2013).

All agricultural land use types have seen market value increases for the period from 2001 to 2012, ranging from 36 to 45 per cent. The market value of grazing land in the region varies between $500 and $2,000 per hectare depending on the quality of improvements and the quality of the land. Established houses, stockyards, fencing and water supply infrastructure all contribute to the value of grazing land.

The highest land value for irrigated sugarcane land in the Mackay LGA during 2012 was $18,000 per hectare, which is the highest price for that land type in the state (the range is between $13,000 to $18,000 per hectare) (Queensland Department of Agriculture, Fisheries and Forestry, 2013). Similarly, dryland cane land in Mackay LGA and the Whitsunday LGA have been relatively high at $17,000 and $15,000 per hectare respectively. In more recent times, there has been a departure in the correlation between land value and its productive use. Along the coastal zone, urban expansion and demand for lifestyle blocks have influenced market values for agricultural land as developers snap up valuable coastal grazing areas in anticipation of urban, tourism and industrial expansion (Queensland Department of Agriculture, Fisheries and Forestry, 2013).

3.4.6 Land valuation

Under the *Land Valuation Act 2010*, the Queensland Valuer-General has a general duty to make an annual valuation of all land within a LGA. The Queensland Valuer-General's annual land valuation findings for the Mackay, Isaac and Whitsunday LGAs were released in March 2013. The valuation report found that the property market in Central Queensland (which includes Rockhampton, Gladstone, Banana, Mackay, Whitsunday, Isaac and Central Highlands Regional Councils) is stable with values showing only minor changes or remaining static. The resources sector continues to have a major influence on property values in the region. However, recent declines in thermal coal prices have resulted in weaker mining activity with some mine closures, industry rationalisation and reduced expansion. While there has not yet been evidence of sales softening in the vacant residential land market, major softening in the residential rental market has already occurred (Queensland Department of Natural Resources and Mines 2013).

3.4.7 Economic viability

As outlined in section 3.3, the MIW region is the largest regional economy in Queensland and had the third largest GRP in Queensland behind Brisbane and the Gold Coast. In 2011/12, the MIW region contributed 7.3 per cent to Queensland's GSP.

The Bowen Basin coalfields which are situated in the hinterland area to the West of Mackay City are a key natural resource for the MIW region. In 2011/12, the contribution of the mining sector to GRP in the MIW region was just over 50 per cent. The mining sector has been the largest

contributor to the economy of the MIW region since 2007/08—the period for which GRP data is available.

However, the contribution of the mining sector to GRP in the MIW region has declined by 26 per cent since 2007/08 as shown in Table 3-3. Declining coal prices, unfavourable weather conditions and the high Australian Dollar have contributed to this trend. This decline in the mining sector has contributed to the average annual decline in GRP across the MIW region of 3.8 per cent shown in Figure 3-7.

Table 3-3 Contribution of the mining sector to GRP in the MIW region – 2007/08 – 2011/12 ($m)

Sector	2007/08	2008/09	2009/10	2010/11	2011/12
Mining	13,529	12,088	14,593	10,161	9,962

Source: Mackay Whitsunday REDC, 2013 and 2012

3.4.8 Mineral resources

Approximately 59 per cent of Australia's identified black coal resources occur in Queensland. The Galilee Basin and Bowen Basin account for 8 per cent and 35 per cent of Australia's identified black coal resource respectively (Geoscience Australia, 2012).

In 2012, there were 32 coal mines operating in the MIW region. Available data suggests that collectively, these mines produced over 94 million tonnes of coal. Close to 80 per cent of the coal produced in the MIW region was higher value coking coal (Mackay Whitsunday REDC, 2013). The vast coal resources in the Galilee Basin suggest coal mining will remain a significant industry in the MIW region.

4. Modelling results

4.1 Economic indicators

4.1.1 Construction related indicators

The NGBR Project will involve a capital investment of approximately $2.2 billion which includes capital expenditure on earthworks, drainage, bridges, road works, rail track and signalling, communications and construction management costs. Assumptions regarding where construction expenditure will occur are outlined in Section 2.4.2.

Construction is due to commence in 2014 subject to approvals being obtained and is expected to be complete by December 2016. Direct construction expenditure is presented in Table 4-1.

Table 4-1 Direct expenditure – construction ($m)

Year	2014	2015	2016	Total
MIW region	335	921	418	1,674
Elsewhere in Queensland	45	123	56	224
Outside Queensland	67	184	84	335
Total	447	1,228	558	2,233

Employment is an important indicator of economic activity and household welfare. The estimated employment change in terms of direct and flow-on employment has been modelled at the MIW regional level and across Queensland for the construction phase of the NGBR Project.

As shown in Table 4-2, it is estimated that the NGBR Project will generate approximately 6,150 jobs (1,700 direct and 4,452 indirect) in the MIW region in 2015; the peak construction year. For comparison, the ABS estimates that there were just over 91,000 persons employed in the MIW region in 2011/12.

It is estimated that the NGBR Project will generate in excess of 750 direct and 1,650 indirect jobs in the MIW region in 2014 and 2016. Across Queensland, the NGBR Project is expected to generate just under 7,000 jobs (2,017 direct and 4,981 indirect) in 2015.

Table 4-2 Direct and indirect effects on employment during construction

Year	2014 (FTE)*	2015 (FTE)	2016 (FTE)
MIW region			
Direct	775	1,700	785
Indirect	1,669	4,452	2,006
Total	2,444	6,152	2,791
Queensland			
Direct	891	2,017	927
Indirect	1,864	4,981	2,244
Total	2,755	6,998	3,171

* Employment numbers are expressed in Full Time Equivalent (FTE) terms

GRP and GSP are measures of the net contribution of an activity or industry to the economy. GRP and GSP represent payments to the primary inputs of production (labour, capital and land). GRP is the regional level and GSP the state level equivalent of GDP. Estimates of the change of the NGBR Project on GRP and GSP during the construction phase are presented in Table 4-3. In 2015, the peak construction year, it is estimated that the NGBR Project will contribute $791 million to GRP in the MIW region and $909 million to Queensland's GSP. This represents a 3.8 per cent change against baseline GRP and a 0.3 per cent change against baseline GSP.

Table 4-3 Direct and indirect effects on GRP and GSP during construction ($m)

Year	2014	2015	2016
MIW region (GRP)			
Direct	70	153	71
Indirect	238	638	290
Total	308	791	361
Queensland (GSP)			
Direct	85	195	90
Indirect	265	714	325
Total	350	909	415

4.1.2 Operations related indicators

Operations on the NGBR Project are expected to commence in 2016. Operations activity is expected to peak around 2027. Operations expenditure includes fuel, labour, track refurbishment, maintenance and costs to purchase locomotives and wagons. It was assumed that 70 per cent of operations expenditure will occur in the MIW region, 23 per cent outside the MIW region but still in Queensland and 7 per cent outside Queensland (i.e. interstate and overseas).Expenditure that was assumed to occur in the Mackay region includes a large proportion of labour, fuel and maintenance costs and approximately 50 per cent of track maintenance costs. A large proportion of overheads, finance and business administration costs as well as some track maintenance are assumed to occur outside the MIW region but still in Queensland. Some track maintenance and finance/overhead costs are assumed to occur interstate and overseas. Direct expenditure through the operations phase of the NGBR Project is presented in Table 4-4. For presentation purposes, operations expenditure is presented only between 2016 and 2022 and for 2027 when operations are expected to be at their peak. Operations expenditure is assumed to remain constant at $730 million between 2027 and the end of the project in 2117.

Table 4-4 Direct expenditure – operation ($m)

Year	2016	2017	2018	2019	2020	2021	2022	2027
MIW region	94	162	203	246	289	331	386	509
(Other) Queensland	31	53	67	81	95	109	127	168

Year	2016	2017	2018	2019	2020	2021	2022	2027
Outside Queensland	10	17	21	26	30	34	40	53
Total	135	232	291	353	414	474	553	730

At the peak of operational expenditure (2027 and onwards for the life of the NGBR Project), total (direct plus indirect) employment in the MIW region is expected to reach 1,097 FTE positions each year which represents almost 1.2 per cent of the estimated employment for the MIW region for 2011/12 (90,514 full time equivalent positions). For Queensland, direct and indirect employment is expected to be 1,940 FTE in 2027 which would account for a 0.1 per cent increase of total FTE employment in Queensland compared to 2011/12 levels (2.02 million FTE).

Table 4-5 Direct and indirect effects on employment during operation

Year	2016	2017	2018	2019	2020	2021	2022	2027
MIW region								
Direct	50	77	106	130	157	191	236	277
Indirect	169	287	356	427	498	563	647	820
Total	219	364	462	557	655	754	883	1,097
Queensland								
Direct	66	103	141	173	209	254	315	369
Indirect	324	550	683	818	955	1,079	1,239	1,571
Total	390	653	824	991	1,164	1,333	1,554	1,940

Economic effects resulting from operations on the NGBR Project are expected to rise as expenditure and production increases. The impact of the NGBR Project on GRP and GSP is presented in Table 4-6.

In 2027, the peak year for operational expenditure, modelling estimates that the direct and indirect effects of the NGBR Project on GRP in the MIW region is expected to be $209 million. The contribution to GRP between 2027 and the end of the NGBR Project is predicted to remain steady at $209 million per annum. For Queensland, the NGBR Project is expected to generate GSP of $369 million in 2027 and each year after between 2027 and the end of the NGBR Project in 2117. In the context of Queensland's GSP in 2011/12 ($283.6 billion), the estimated GSP effect attributable to the NGBR Project would represent an increase of almost 0.2 per cent (ABS 2012b).

Table 4-6 Direct and indirect effects on GRP and GSP during operation ($m)

Year	2016	2017	2018	2019	2020	2021	2022	2027
MIW region (GRP)								
Direct	13	22	27	33	39	44	52	68
Indirect	26	45	56	68	80	91	106	140
Total	39	67	83	101	119	135	158	208
Queensland (GSP)								
Direct	17	29	36	44	52	59	69	91
Indirect	51	88	111	134	158	180	210	277
Total	68	117	147	178	210	239	279	368

5. Key findings

The NGBR Project will be constructed within the MIW region. The MIW region is the largest regional economy in Queensland and had the third largest Gross Regional Product (GRP) in Queensland in 2011/12 behind Brisbane and the Gold Coast.

Mining is the dominant sector in the MIW region, accounting for just over 50 per cent of GRP in the MIW region in 2011/12. The construction (4.1 per cent) and manufacturing (3.6 per cent) sectors are also important in terms of their contribution to GRP.

Between 2007/08 and 2011/12, GRP in the MIW region declined slightly in real terms. Severe weather events which have hindered mining and agricultural production during these periods and falling coal prices have contributed to this decline. Recent reports of significant job losses across the Queensland coal sector provide an indication that the coal industry is under some pressure.

Agriculture is a prominent industry in the MIW region in terms of land use. Land use across the MIW region is dominated by grazing activities.

I-O modelling estimates that the NGBR Project will generate approximately 6,150 jobs (1,700 direct and 4,452 indirect) in the MIW region and just under 7,000 jobs (2,017 direct and 4,981 indirect) in total across Queensland during the peak construction year of 2015. In 2015, I-O modelling estimates that the NGBR Project will contribute $791 million to GRP in the MIW region and $909 million to Queensland's Gross State Product (GSP) in 2015.

Once fully operational, I-O modelling estimates that the NGBR Project will contribute $209 million to GRP in the MIW region per annum and $369 million per annum to Queensland's GSP. Operation of the NGBR Project is also estimated to generate 1,097 (277 direct and 820 indirect) full time equivalent positions each year in the MIW region and 1,940 (369 direct and 1,571 indirect) full time equivalent positions each year across Queensland over the life of the project.

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Appendices

Appendix A – An overview of Economic Impact Analysis using the Input-Output method

An overview of Economic Impact Analysis using the Input Output method

Economic impact analysis based on an input-output (I-O) model provides a comprehensive economic framework that is extremely useful in the resource planning process. Broadly, there are two ways in which the I-O method can be used.

First, the I-O model provides a numerical picture of the size and shape of an economy and its essential features. The I-O model can be used to describe some of the important features of an economy, the interrelationships between sectors and the relative importance of the individual sectors.

Second, I-O analysis provides a standard approach for the estimation of the economic impact of a particular activity. The I-O model is used to calculate industry multipliers that can then be applied to various development or change scenarios.

The input-output database

I-O analysis, as an accounting system of inter-industry transactions, is based on the notion that no industry exists in isolation. This assumes, within any economy, each firm depends on the existence of other firms to purchase inputs from, or sell products to, for further processing. The firms also depend on final consumers of the product and labour inputs to production. An I-O database is a convenient way to illustrate the purchases and sales of goods and services taking place in an economy at a given point in time.

As noted above, I-O models provide a numerical picture of the size and shape of the economy. Products produced in the economy are aggregated into a number of groups of industries and the transactions between them recorded in the transactions table. The rows and columns of the I-O table can be interpreted in the following way:

- The rows of the I-O table illustrate sales for intermediate usage (i.e. to other firms in the region) and for final demand (e.g. household consumption, exports or capital formation).
- The columns of the I-O table illustrate purchases of intermediate inputs (i.e. from other firms in the region), imported goods and services and purchases of primary inputs (i.e. labour, land and capital).
- Each item is shown as a purchase by one sector and a sale by another, thus constructing two sides of a double accounting schedule.

In summary, the I-O model can be used to describe some of the important features of a state or regional economy, the interrelationships between sectors and the relative importance of the individual sectors. The model is also used for the calculation of sector multipliers and the estimation of economic impacts arising from some change in the economy.

Using input-output analysis for estimation of economic impacts

The I-O model conceives the economy of the region as being divided up into a number of sectors and this allows the analyst to trace expenditure flows. To illustrate this, consider the example of a vineyard that, in the course of its operation, purchases goods and services from other sectors. These goods and services would include fertiliser, chemicals, transport services, and, of course, labour. The direct employment created by the vineyard is regarded in the model as an expenditure flow into the household sector, which is one of several non-industrial sectors recognised in the I-O model.

Upon receiving expenditure by the vineyard, the other sectors in the regional economy engage in their own expenditures. For example, as a consequence of winning a contract for work with vineyard, a spraying contractor buys materials from its suppliers and labour from its own employees. Suppliers and employees in turn engage in further expenditure, and so on. These indirect and induced (or flow-on) effects, as they are called, are part of the impact of the vineyard on the regional economy. They must be added to the direct effects (which are expenditures made in immediate support of the vineyard itself) in order to arrive at a measure of the total impact of the vineyard.

It may be thought that these flow-on effects (or impacts) go on indefinitely and that their amount adds up without limit. The presence of leakages, however, prevents this from occurring. In the context of the impact on a regional economy, an important leakage is expenditure on imports, that is, products or services that originate from outside the region, state or country (e.g. machinery).

Thus, some of the expenditure by the vineyard (i.e. expenditure on imports to the region) is lost to the regional economy. Consequently, the flow-on effects get smaller and smaller in successive expenditure rounds due to this and other leakages. Hence the total expenditure created in the regional economy is limited in amount, and so (in principle) it can be measured.

Using I-O analysis for estimation of regional economic impacts requires a great deal of information. The analyst needs to know the magnitude of various expenditures and where they occur. Also needed is information on how the sectors receiving this expenditure share their expenditures among the various sectors from whom they buy, and so on, for the further expenditure rounds.

In applying the I-O model to economic impact analysis, the standard procedure is to determine the direct or first-round expenditures only. No attempt is made to pursue such inquiries on expenditure in subsequent rounds, not even, for example, to trace the effects in the regional economy on household expenditures by vineyard employees on food, clothing, entertainment, and so on, as it is impracticable to measure these effects for an individual case, here the vineyard.

The I-O model is instead based on a set of assumptions about constant and uniform proportions of expenditure. If households in general in the regional economy spend, for example, 13.3 per cent of their income on food and non-alcoholic beverages, it is assumed that those working in vineyards do likewise. Indeed, the effects of all expenditure rounds after the first are calculated by using such standard proportions (i.e. multiplier calculations). Once a transactions table has been compiled, simple mathematical procedures can be applied to derive multipliers for each sector in the economy.

Input-output multipliers

Input-output multipliers are an indication of the strength of the linkages between a particular sector and the rest of the state or regional economy. As well, they can be used to estimate the impact of a change in that particular sector on the rest of the economy.

Detailed explanations on calculating I-O multipliers, including the underlying assumptions, are provided in any regional economics or I-O analysis textbook (see, for example, Jensen and West[1]). They are calculated through a routine set of mathematical operations based on coefficients derived from the I-O transactions model, as outlined below.

[1] Jensen, R.C. and West, G.R. 1986, Input-Output for Practitioners, Vol.1, Theory and Applications, Office of Local Government, Department of Local Government and Administrative Services, AGPS, Canberra.

The transactions table may be represented by a series of equations thus:

$$X_1 = X_{11} + X_{12} + \ldots\ldots\ldots\ldots\ldots + X_{1n} + Y_1$$
$$X_2 = X_{21} + X_{22} + \ldots\ldots\ldots\ldots\ldots + X_{2n} + Y_2$$
$$X_n = X_{n1} + X_{n2} + \ldots\ldots\ldots\ldots\ldots + X_{nn} + Y_n$$

Where Xi = total output of intermediate sector i (row totals)

Xij = output of sector i purchased by sector j (elements of the intermediate quadrant)

Yj = total final demand for the output of sector i

It is possible, by dividing the elements of the columns of the transactions table by the respective column totals to derive coefficients, which represent more clearly the purchasing pattern of each sector. These coefficients, termed 'direct' or 'I-O' coefficients, are normally denoted as aij, and represent the direct or first round requirements from the output of each sector following an increase in output of any sector.

In equation terms the model becomes:

$$X_1 = a_{11}X_1 + a_{12}X_2 + \ldots\ldots\ldots\ldots\ldots + a_{1n}X_n + Y_1$$
$$X_2 = a_{21}X_1 + a_{22}X_2 + \ldots\ldots\ldots\ldots\ldots + a_{2n}X_n + Y_2$$
$$X_n = a_{n1}X_{11} + a_{n2}X_2 + \ldots\ldots\ldots\ldots\ldots + a_{nn}X_n + Y_n$$

Where aij (the direct coefficient) = Xij /Xj. This may be represented in matrix terms:

$X = AX + Y$

Where A = [aij], the matrix of direct coefficients

The previous equation can be extended to:

$(I-A)X = Y$

Where (I-A) is termed the Leontief matrix

Or $X = (I-A)^{-1}Y$

Where (I-A)-1 is termed the 'general solution', the 'Leontief inverse' or simply the inverse of the open model.

The general solution is often represented by:

$Z = (I-A)^{-1} = [zij]$

The I-O table can be 'closed' with respect to certain elements of the table. Closure involves the transfer of items from the exogenous portions of the table (final demand and primary input quadrants) to the endogenous section of the table (intermediate quadrant). This implies that the analyst considers that the transferred item is related more to the level of local activity than to external influences. Closure of I-O tables with respect to households is common and has been adopted in this project.

The 'closed' direct coefficients matrix may be referred to as A*. The inverse of the Leontief matrix formed from A* is given by:

$Z^* = (I- A^*)^{-1} = [z^*ij]$

Z* is referred to as the 'closed inverse' matrix.

A multiplier is essentially a measurement of the impact of an economic stimulus. In the case of I-O multipliers the stimulus is normally assumed to be an increase of one dollar in sales to final demand by a sector. The impact in terms of output, contribution to GRP, household income and employment can be identified in the categories discussed below.

(i) The initial impact: refers to the assumed dollar increase in sales. It is the stimulus or the cause of the impacts. It is the unity base of the output multiplier and provides the identity matrix of the Leontief matrix. Associated directly with this dollar increase in output is an own-sector increase in household income (wages and salaries, drawings by owner operators etc.) used in the production of that dollar. This is the household income coefficient hj. Household income, together with Other Value Added (OVA), provide the total GRP from the production of that dollar of output. The GRP coefficient is denoted vj. Associated also will be an own-sector increase in employment, represented by the size of the employment coefficient. This employment coefficient ej represents an employment/output ratio and is usually calculated as 'employment per million dollars of output'.

(ii) The first round impact: refers to the effect of the first round of purchases by the sector providing the additional dollar of output. In the case of the output multiplier this is shown by the direct coefficients matrix [aij]. The disaggregated effects are given by individual aij coefficients and the total first-round effect by $\sum_i a_{ij}$. The household income effects are calculated by multiplying the first-round output effects by the appropriate household income coefficient (hj). Similarly, the first-round GRP and employment effects are calculated by multiplying the first-round output effects by the appropriate GRP (vj) and employment (ej) coefficients.

(iii) Industrial-support impacts. This term is applied to 'second and subsequent round' effects as successive waves of output increases occur in the economy to provide industrial support, as a response to the original dollar increase in sales to final demand. The term excludes any increases caused by increased household consumption. Output effects are calculated from the open Z inverse, as a measure of industrial response to the first-round effects. The industrial-support output requirements are calculated as the elements of the columns of the Z inverse, less the initial dollar stimulus and the first-round effects. The industrial support household income, GRP and employment effects are defined as the output effects multiplied by the respective household income, GRP and employment coefficients. The first-round and industrial-support impacts are together termed the production-induced impacts.

(iv) Consumption-induced impacts: are defined as those induced by increased household income associated with the original dollar stimulus in output. The consumption-induced output effects are calculated in disaggregated form as the difference between the corresponding elements in the open and closed inverse (i.e. z*ij - zij, and in total as $\sum_i (z^*_{ij} - z_{ij})$). The consumption-induced household income, GRP and employment effects are simply the output effects multiplied by the respective household income, GRP and employment coefficients.

(v) Flow-on impacts: are calculated as total impact less the initial impact. This allows for the separation of 'cause and effect' factors in the multipliers. The cause of the impact is given by the initial impact (the original dollar increase in sales to final demand), and the effect is represented by the first-round, industrial-support and consumption-induced effects, which together constitute the flow-on effects.

Each of the five impacts are summarised in It should be noted that household income, GRP and employment multipliers are parallel concepts, differing only by their respective coefficients hj, vj and ej.

The output multipliers are calculated on a 'per unit of initial effect' basis (i.e. output responses to a one dollar change in output). Household income, GRP and employment multipliers, as described above, refer to changes in household income per initial change in output, changes to GRP per initial change in output and changes in employment per initial change in output. These multipliers are conventionally converted to ratios, expressing a 'per unit' measurement, and described as Type I and Type II ratios. For example, with respect to employment:

Type I employment ratio = [initial + first round + industrial support]/initial

and

Type II employment ratio = [initial + production induced[2] + consumption induced]/initial

Table 6-1 The structure of input output multipliers for sector[3]

Impacts	General formula
Initial	1
First-round	$\Sigma_i a_{ij}$
Industrial-support	$\Sigma_i z_{ij}$-1-$\Sigma_i a_{ij}$
Consumption-induced	$\Sigma_i z^*_{ij}$-$\Sigma_i z_{ij}$
Total	$\Sigma_i z^*_{ij}$
Flow-on	$\Sigma_i z^*_{ij}$-1
Household income multipliers ($)	
Initial	h_j
First-round	$\Sigma_i a_{ij} h_i$
Industrial-support	$\Sigma_i z_{ij} h_i$- h_j-$\Sigma_i a_{ij} h_i$
Consumption-induced	$\Sigma_i z^*_{ij} h_i$-$\Sigma_i z_{ij} h_i$
Total	$\Sigma_i z^*_{ij} h_i$
Flow-on	$\Sigma_i z^*_{ij} h_i$-h_j
GRP multipliers ($)	
Initial	v_j
First-round	$\Sigma_i a_{ij} v_i$
Industrial-support	$\Sigma_i z_{ij} v_i$- v_j-$\Sigma_i a_{ij} v_i$
Consumption-induced	$\Sigma_i z^*_{ij} v_i$-$\Sigma_i z_{ij} v_i$
Total	$\Sigma_i z^*_{ij} v_i$
Flow-on	$\Sigma_i z^*_{ij} v_i$-v_j

[2] Where (first round + industrial support) = production induced.
[3] In a DECON model, Z* (the 'closed inverse' matrix), includes a population and an unemployed row and column (see below for details).

Impacts	General formula
Employment multipliers (full time equivalents)	
Initial	e_j
First-round	$\Sigma_i a_{ij} e_i$
Industrial-support	$\Sigma_i z_{ij} e_i - e_j - \Sigma_i a_{ij} e_i$
Consumption-induced	$\Sigma_i z^*_{ij} e_i - \Sigma_i z_{ij} e_i$
Total	$\Sigma_i z^*_{ij} e_i$
Flow-on	$\Sigma_i z^*_{ij} e_i - e_j$

Model assumptions

There are a number of important assumptions in the I-O model that are relevant in interpreting the analytical results.

Industries in the model have a linear production function, which implies constant returns to scale and fixed input proportions.

Another model assumption is that firms within a sector are homogeneous, which implies they produce a fixed set of products that are not produced by any other sector and that the input structure of the firms are the same. Thus it is preferable to have as many sectors as possible specified in the models and the standard models for this study were compiled with 66 sectors.

The model is a static model that does not take account of the dynamic processes involved in the adjustment to an external change, such as a permanent change in natural resources management.

Extending the standard economic impact model as a DECON model

Based on work undertaken by EconSearch (2009 and 2010a) and consistent with Mangan and Phibbs , the I-O model developed for this project was extended as demographic-economic (DECON) model. The two key characteristics of the DECON model, when compared with a standard economic model, are as follows.

1. The introduction of a population 'sector' (or row and column in the model) makes it possible to estimate the impact on local population levels of employment growth or decline.
2. The introduction of an unemployed 'sector' makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

The population 'sector'

The introduction of a population 'sector' to the standard I-O model allows for the calculation of population multipliers. These multipliers measure the flow-on population impact resulting from an initial population change attributable to employment growth or decline in a particular sector of the regional economy.

Calculation of population multipliers is made possible by inclusion of a population row and column in the 'closed' direct coefficients matrix of the I-O model.

Population row: the population coefficient (pj) for sector j of the DECON model is represented as:

pj = -*rho*j * ej * family sizej

Where *rho*j = the proportion of employees in sector j who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs in sector j filled by previously unemployed locals (positive employment impact)

ej = the employment coefficient for sector j

family sizej = average family size for sector j

Population column: the population column of the DECON model is designed to account for growth or decline in those sectors of the economy that are primarily population-driven (i.e. influenced by the size of the population) rather than market-driven (i.e. dependent upon monetary transactions). Clearly, many of the services provided by the public sector fit this description and, for the purpose of this analysis, it was assumed that the following intermediate sectors were primarily population-driven:

- public administration and defence
- education
- health and community services
- cultural and recreational services

Thus, the non-market coefficient for sector j of the DECON model is represented as expenditure on that non-market service (by governments) in $million per head of population.

The population multiplier for sector j is represented as: z*pj / ppj

Where z*pj = coefficient of the 'closed inverse' matrix in the population row for sector j

ppj = coefficient of the direct coefficients matrix in the population row for sector j

Sources of local data for the population sector of the DECON models used in this project included the following:

- rho: little or no published data are available to assist with estimation of this variable, particularly at a regional level. The DECON models have been constructed to enable the analyst to estimate this variable on the basis of the availability superior data or assumptions.
- Family size: in order to estimate average family size by industry, relevant data were extracted from the Australian Bureau of Statistics 2006 Census of Population and Housing using the TableBuilder database. These data were modified by the consultants in order to ensure consistency with the specification and conventions of the I-O models.

The unemployed 'sector'

As outlined above, the introduction of an unemployed 'sector' to the standard I-O model makes it possible to account for the consumption-induced impact of the unemployed in response to economic growth or decline.

Through the inclusion of an unemployed row and column in the 'closed' direct coefficients matrix of the standard I-O model it is possible to calculate Type III multipliers (for output, GRP, household income and employment).

The key point to note is that, in the situation where at least some of the unemployed remain in a region after losing their job (negative employment impact) or some of the new jobs in a region are filled by previously unemployed locals (positive employment impact), Type III multipliers will be smaller than the more frequently used Type II multipliers.

Unemployed row: the unemployed coefficient (uj) for sector j of the DECON model is represented as:

Where uj = *-rho*j * (1-essj) * ej

*rho*j = the proportion of employees in sector j who remain in the region after they lose their job (negative employment impact) or the proportion of new jobs in sector j filled by previously unemployed locals (positive employment impact)

essj = the proportion of employed in sector j who are not eligible for welfare benefits when they lose their job

ej = the employment coefficient for sector j

Unemployed column: the unemployed column of the DECON model is an approximation of total consumption expenditure and the consumption pattern of the unemployed. It is represented as dollars per unemployed person rather than $million for the region as a whole, as is the case for the household expenditure column in a standard I-O model.

Sources of local (i.e. state and regional) data for the unemployed sector of the DECON models used in this study included the following:

- ess: in order to estimate the proportion of employed by industry who are not eligible for welfare benefits when they lose their job, relevant data were extracted from the Australian Bureau of Statistics 2006 Census of Population and Housing using the Table Builder database. These data were modified in order to ensure consistency with the specification and conventions of the I-O models.
- Unemployed consumption: total consumption expenditure by the unemployed was based on an estimate of the Newstart Allowance whilst the pattern of consumption expenditure was derived from household income quintiles in the 2003/04 Household Expenditure Survey (ABS 2006).

Incorporating a tourism demand profile in the I-O model

Tourism expenditure is a measure of the value of sales of goods and services to visitors to the state or region. The following method and data sources were used to estimate tourism expenditure by industry sector for the region.

The primary data were sourced from Tourism Research Australia (TRA) .

Base datasets included total tourism expenditure by TRA tourism region and average expenditure profiles, by region, across a range of goods and services (e.g. food and drink, fuel, shopping, etc.).

Estimates were available for domestic day, domestic overnight and international visitor expenditure.

The first adjustment to the base data was the development of a concordance between the TRA tourism regions and I-O model regions and the allocation of these base data to the relevant I-O model region. These allocations were based, in turn, on an ABS concordance between TRA tourism regions and SLAs.

The second adjustment to the base data was the application of a more detailed expenditure breakdown from the ABS Australian National Accounts: Tourism Satellite Account for both domestic and international visitor expenditure.

The third adjustment to the base data was the conversion of tourism expenditure estimates from purchasers' to basic prices (i.e. reallocation of net taxes (taxes minus subsidies) and marketing and transport margins) to make the data consistent with accounting conventions used in the national, state and regional I-O models. Purchasers' to basic price ratios for tourism expenditure categories were derived from ABS data.

The final adjustment to the base data was the allocation of the tourism expenditure data in basic prices to the relevant input-output sectors (intermediate sectors, taxes less subsidies or imports) in which the expenditure occurred, thus compiling a profile of sales to final demand. This process was undertaken for each type of tourism expenditure (domestic day, domestic overnight and international visitor) and the results aggregated to form a single tourism demand profile. Profiles were developed at the state and regional levels.

Constructing a RISE v3.0 economic impact model

In the final model construction stage the data described above were incorporated into a Microsoft Excel spread sheet based economic impact model for the region and state (i.e. RISE v3.0) . This model allows for description of the structure of the economy. It can also be used for the estimation of economic impacts over time in response to the introduction of a new industry or a change in the final demand for the output of one or many sectors. Model assumptions can be modified to account for:

- Price changes between the model construction year (2009/10) and the base year for the analysis
- Labour productivity change over time (as above and for the subsequent years)
- The level of regional migration (e.g. for a positive employment impact, the proportion of new jobs filled by previously unemployed locals)

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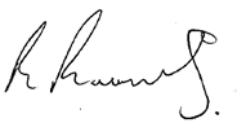
B	R Coulton	R Rawnsley		P Bradley		26/08/2013

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