Socioeconomic report for the protection of environmental values in the Queensland Murray-Darling and Bulloo Basins

Report prepared for the Department of Environment and Heritage Protection

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Key Messages

Protecting the environmental values (EVs) of the waters of the Queensland Murray-Darling and Bulloo Basins is vital to the long-term prosperity of each region. Through a process of robust science and meaningful consultation, environmental values (EVs), aquatic ecosystems asset and protection mapping and water quality objectives (WQOs) are being established for each region.

Consultation and research undertaken by the Department of Environment and Heritage Protection (EHP), the Department of Science, Information Technology and Innovation, the Department of Natural Resource and Mines, the Department of Agriculture and Fisheries and the designated regional Natural Resource Management bodies (Condamine Alliance, Queensland Murray-Darling Committee and South West NRM) has consistently recognised the importance of maintaining the condition of freshwater aquatic ecosystems in the Queensland Murray-Darling and Bulloo Basins.

When the condition of the aquatic ecosystem declines, important ecosystem functions and services also decline, affecting key sectors such as tourism, agriculture, fishing and recreation and threatening critical assets such as the unique wetlands of the region.

There is a strong case for maintaining and enhancing waterway health in the Queensland Murray-Darling and Bulloo Basins in conjunction with facilitating sustainable regional development. The challenge for policy makers is recognising the trade-offs between regional development and waterway health and establishing development pathways that genuinely meet both objectives.

Queensland Murray-Darling and Bulloo Basins

For the Queensland Murray-Darling and Bulloo Basins there have been a number of benefits identified from maintaining EVs including:

Aquatic ecosystems, ecosystem function and services—<u>provision of direct use values</u>, providing jobs and income to the local, regional and national economy, including through the following channels, all largely reliant on waterway ecosystem health, for example:

- **maintaining a regionally significant and developing tourism sector**, largely reliant on the condition of waterway ecosystem health to continue to attract visitors. Tourism is a major sector in the Queensland Murray-Darling and Bulloo Basins, contributing an estimated $952 million per annum. The rapidly developing joint wine and tourism industries in the Southern Downs region, currently contributes $165 million to this total.
  - the *Queensland Ecotourism Plan (2015–2020)* recognises the key role played by the environment in ecotourism experiences. Ecotourism plays an important role in rural and remote communities, generating economic and social benefits and creating resilience through sustainable employment opportunities and local pride. Water quality of rivers, streams and wetlands underpins the tourism sector and outdoor recreation opportunities for all residents and visitors.
- **providing recreation, boating and other aesthetic benefits** to the community. Recreational amenity is of major significance to both local residents and enhancing eco-

tourism opportunities. The community value of water based recreational activities in the Queensland Murray-Darling and Bulloo Basins is estimated at $128 million per year.

– **ensuring a sustainable recreational fishing sector**, valued at $104 million annually, further enhancing recreation and eco-tourism opportunities.

Aquatic ecosystems, ecosystems function and services—provision of indirect use values, including through the following channels, for example:

– previous studies indicate that the community is willing to invest heavily in the protection and enhancement of wetlands in MDB catchments; and willingness to pay to keep the 1.287 million hectares of wetlands in Queensland Murray-Darling and Bulloo Basins is estimated to be in the order of $1.9 billion.

– biological support for biodiversity, fisheries, etc., and support for other ecosystems.

– physical protection of ecosystems.

Aquatic ecosystems, ecosystem function and services—provision of non-market or non-use values; for example existence, bequest, option (future direct and indirect use) and the cultural, spiritual and ceremonial values. The latter are of great significance to the Traditional Owners across the Queensland Murray-Darling and Bulloo Basins; for example:

– the importance of protecting cultural, spiritual and ceremonial values through the protection of water quality is recognised under state and federal legislation. Key risks to cultural, spiritual and ceremonial values in the Queensland Murray-Darling and Bulloo Basins are being identified in conjunction with the Northern Basins Aboriginal Nations and where possible, addressed through the Healthy Waters Management Plans and the Water Plans being established for each region.

Aquatic ecosystems protection through water quantity management under the *Murray-Darling Basin Plan 2012*—the protection and enhancement of the Murray-Darling Basin aquatic ecosystems is being addressed via sustainable diversion limits through water resource planning under the Basin Plan; with the Commonwealth Government investing $5.8 billion to purchase water for the environment, directly protecting aquatic ecosystems under the *Restoring the Balance in the Murray-Darling Basin*[1] programme and the *Sustainable Rural Water Use and Infrastructure Programme*[2]. The latter aims to modernise infrastructure throughout the Murray-Darling Basin, reducing leakage and evaporative losses and thereby increasing water use efficiency.

Agriculture and horticulture sectors—underpinned by water quality

– the quality of the Queensland Murray-Darling Basin's land and water resources is critical to sustainable agriculture and horticulture.

– the agricultural production value is $3,162 million, including horticultural production in the Southern Downs region that contributes approximately $296 million per annum. Amongst the key pathways to sustaining and expanding these critical industries includes

[1] Australian Government, 2017, http://www.agriculture.gov.au/water/markets/commonwealth-water-mdb, viewed 8/06/2017

[2] Australian Government, 2017, http://agriculture.gov.au/water/mdb/programmes/basin-wide/srwuip, viewed 8/06/2017

ensuring the water used for agriculture and horticulture purposes, such as irrigation and stock watering, is of a suitable quality that facilitates these uses.

Resource sector and water utilities--providing reliable and lower cost inputs to the key resource sectors and water utilities; for example:

- **mining and coal seam gas** are key industries in the region, contributing around $1,700 million and $1,190 million respectively. While these industries gain limited benefit from improved EVs, some elements – such as water supply costs would be reduced under the policy. In addition, community members employed by the industry benefit directly from protecting and improving EVs;
- **water treatment**; as water quality declines potable water treatment costs increase. Increased salinity can trigger significant water treatment costs and the presence of blue-green algae in water for treatment can jeopardize continued potable water supply.

Table 1: Summary of the economic contribution of key industry sectors within the Queensland Murray Darling Basin and the Bulloo Basin

Industry	Total value
Agriculture	$3,162 million
Horticulture (Southern Downs Region)[3]	$296 million
Tourism[4]	$952 million
○ Tourism and Wine (Southern Downs Region)[5]	$165 million
Recreation	$128 million
Mining	$1,700 million
Coal Seam Gas	$1,190 million
Fishing	$104 million
Total	**$7,415 million**

Source: Marsden Jacob analysis

Management actions to protect and enhance EVs

The costs of management actions to maintain EVs and meet WQOs in the region are material – but importantly, these costs are not imposed unilaterally.

The costs of managing urban diffuse and point source pollution are unlikely to change from their current levels. This is due to **urban diffuse and point source pollution** being managed and regulated by Local and State governments.

[3] Tancred, S. and McGrath, C., 2013, *Horticultural Production in Queensland's Southern Downs Region,* Southern Downs Regional Council.

[4] Queensland Government, 2016, *Tourism and Events Queensland- Southern Queensland Country Regional Snapshot.*

[5] Queensland College of Wine Tourism, 2017, *Direct Communication*.

Measures in place to address **urban diffuse and point source pollution** appear reasonable given the EVs in the region, including the major aquatic ecosystem function and the services they provide including the outstanding values of the Queensland Murray-Darling and Bulloo Basin wetlands.

Regulatory requirements under development approvals have been designed to mitigate costs from externalities. While meeting the environmental conditions of development approvals has imposed costs on developments, the conditions have been, and will be in the future, imposed to meet regulatory requirements. The costs of these initiatives are primarily borne by the development projects, as part of the conditions attached to the approval of the developments.

Given the nature of the risks and current regulatory and policy measures to mitigate risks to EVs for urban and point source pollution, the costs of maintaining EVs are likely to be manageable, particularly given that the costs will be primarily borne by the entities creating the risks.

Management actions targeting **rural diffuse pollution** will be undertaken through the continuation, and possible expansion of existing State and Commonwealth Government investments in natural resource management programs and best management practice programs.

The former investments will be informed by the results of catchment modelling for the Queensland Murray-Darling and Bulloo Basins, refer Tables 26-30. Findings from the modelling work have shown sediment contributions to waterways are predominantly sourced from streambank with minor contribution from open grazing land.

Research by Department of Science, Information Technology and Innovation (2015) has mapped riparian and grazing land groundcover. The dry-season groundcover will assist Natural Resource Management groups to target investments and assist landholder management of open grazing land; including through the implementation of best management practice programs for grazing and horticulture.

We note that the findings of socioeconomic analysis of the draft Basin Plan commissioned by the Murray-Darling Basin Authority included:

> ***"Although it is difficult to quantify, and provided that implementation options are carefully managed and coordinated, the evidence indicates that the long-term social, economic and environmental benefits of state and federal water planning and resultant management actions are likely to outweigh the long-term costs[6]."***

The current work generally concurs with the above findings of significant social and environmental benefits from the perspective of protecting the aquatic ecosystem EV, in this study via water quality planning and management. While there have been a number of studies into the non-market value and benefits of water quality of the Murray-Darling Basin, the studies do not allow for sophisticated and comprehensive economic analysis of the benefits and costs of enhancing water quality in the Queensland Murray-Darling and Bulloo Basins. **However, there is significant evidence to suggest that the benefits are substantial. The waterways and water quality are highly significant environmental assets, some with outstanding universal value, on which the broader community heavily relies for both commercial and non-commercial benefits.**

[6] Murray-Darling Basin Authority, 2011, *Socioeconomic analysis and the draft Basin Plan*, Australian Government

1. Introduction

Marsden Jacob Associates (Marsden Jacob) was commissioned by Queensland Department of Environment and Heritage Protection (the Department, DEHP) to assess and report on the economic and social impacts of protecting the environmental values of the waters in the Queensland Murray-Darling and Bulloo Drainage Basins in accordance with section 11 (3)(b) of the *Environmental Protection (Water) Policy 2009*.

This report has been prepared to support the Department's consultation on draft environmental values (EVs) and water quality objectives (WQOs) under the *Environmental Protection (Water) Policy 2009* (EPP Water) for the Queensland MDB region.[7]

The EPP Water achieves the objectives of the *Environmental Protection Act 1994* to protect Queensland's waters while supporting ecologically sustainable development. The Act covers both surface and groundwater across the state including water in rivers, streams, wetlands, lakes, aquifers, estuaries and coastal areas. The EPP Water achieves objectives by setting out the framework for developing EVs and WQOs:

- Environmental values (EVs) define the uses of the water by aquatic ecosystems and for human uses (e.g. drinking water, irrigation, aquaculture, recreation).
- Water quality objectives (WQOs) (e.g. for nitrogen content, dissolved oxygen, turbidity, biological indicators), are derived to protect environmental values of the water. They are based on technically derived water quality guidelines.

The Department's consultation process, including the key messages presented in this report, will inform the proposed establishment of both:

- Environmental values, aquatic ecosystems protection mapping and water quality objectives for the waters of the Queensland Murray-Darling and Bulloo Basins; and
- Water quality targets for the 57 water types established for the Queensland Murray-Darling and Bulloo Basins under the *Murray-Darling Basin Plan 2012* (informing the Healthy Waters Management Plans to be developed for the Condamine-Balonne-Maranoa, Border Rivers and the Moonie Basins.)

1.1 Terms of reference

The terms of reference for the study are to:

> *deliver a socioeconomic report for the protection of environmental values in Queensland Murray-Darling Basin catchments*

The aim of the report is to assess and report on the economic and social impacts of protecting the environmental values of the waters in the Queensland Murray-Darling and Bulloo Basins in accordance with section 11 (3)(b) of the EPP (Water).

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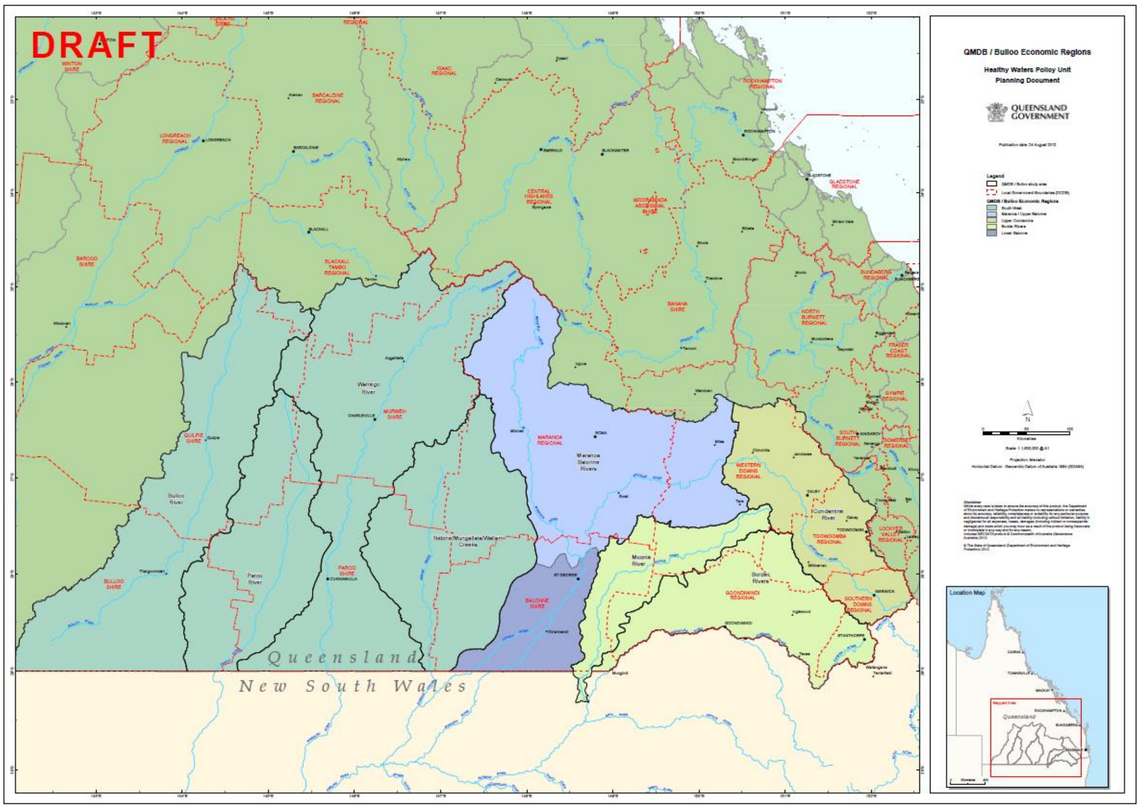
7 Information on the Department's consultation including draft EVs and WQOs for the Queensland MDB area is available on the Department's website. Refer to: http://www.ehp.qld.gov.au/water/policy/

Scope

The headwaters of the MDB are located in Queensland. For the purposes of this study, only economic and social impacts relevant to Queensland have been considered. The geographic scope of the project includes catchments of the Queensland MDB as well as the Bulloo drainage basins, as identified in Figure 1.

Figure 1: Map of Queensland MDB and South West catchments



Source: EHP, 2017

1.2 Approach

To fulfil the terms of reference, the economic and social impacts of protecting environmental values and measures required to achieve WQOs were identified, scoped and where possible quantified.

The approach adopted drew on program logic as presented below and environmental valuations using a total economic framework (detailed in Appendix 2).

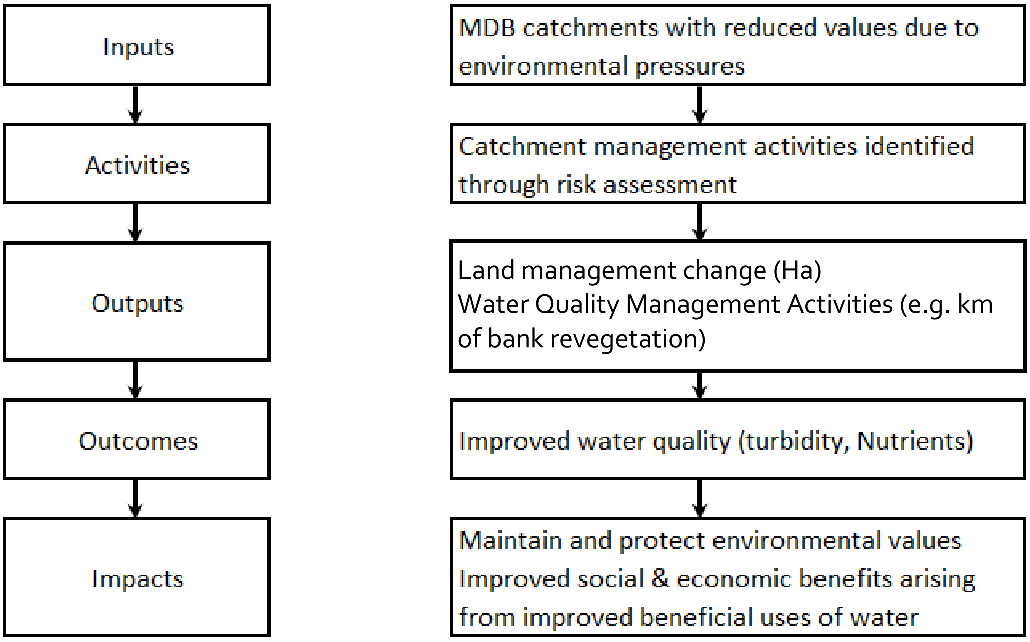
1.2.1 Program logic

In assessing and valuing the socio-economic impacts of management actions in the Queensland MDB it is necessary to consider the linkages between the management actions and the environmental outcomes. This is best considered in the form of a program logic that links Inputs to activities, activities to outputs, outputs to environmental outcomes, and environmental outcomes to changes in environmental values.

This program logic is set out in detail in Figure 2. The key outputs of the program are expected to be land management changes and water management activities. These will be identified based on the risk assessment and it is anticipated that these will result in improved environmental values.

The analysis will focus on the change in environmental values that will arise due to the management actions.

Figure 2: Program logic



Source: Marsden Jacob analysis, 2017

1.3 Structure of this report

The remainder of the report considers each of the Queensland MDB catchments in turn. The catchments are discussed in each of the following order:

1. Upper Condamine region
2. Border Rivers region
3. Maranoa-Balonne region
4. South West region
5. Lower Balonne region

For each of the five catchments, the report sets out the following elements:

- **Introduction**

  Provides an overview of the catchment and includes a map depicting the relevant sub-catchments and groundwater resources.

- **Socio economic profile**

  Based on the current available census data (2011) the report will summarise the:

  – demographic profile;

  - socio-economic profile; and
  - industry profile.

- **Water quality and identified management actions in the region**

  For each sub-catchment and groundwater area, this section will summarise the medium and high risks identified in the risk assessment and the proposed management actions.

- **Benefits of maintaining environmental values**

  Estimated benefit of maintaining environmental values using a Total Economic Value framework (set out in attachment 2) and utilising benefit transfer techniques.

- **Costs of improving or maintaining water quality objectives**

  Based on existing natural resource management and expanding best management practice - tailored to the medium and high risks - per ha change in practices based on management actions in similar catchments.

2. Upper Condamine region

2.1 Introduction

This section provides an overview of the Upper Condamine region and summarises the region's socio-economic profile, the relevant catchments and groundwater resources in the region.

Based on the risk analysis the section sets out the water quality issues and identified management actions in the region before summarising the benefits and costs arising from the management actions.

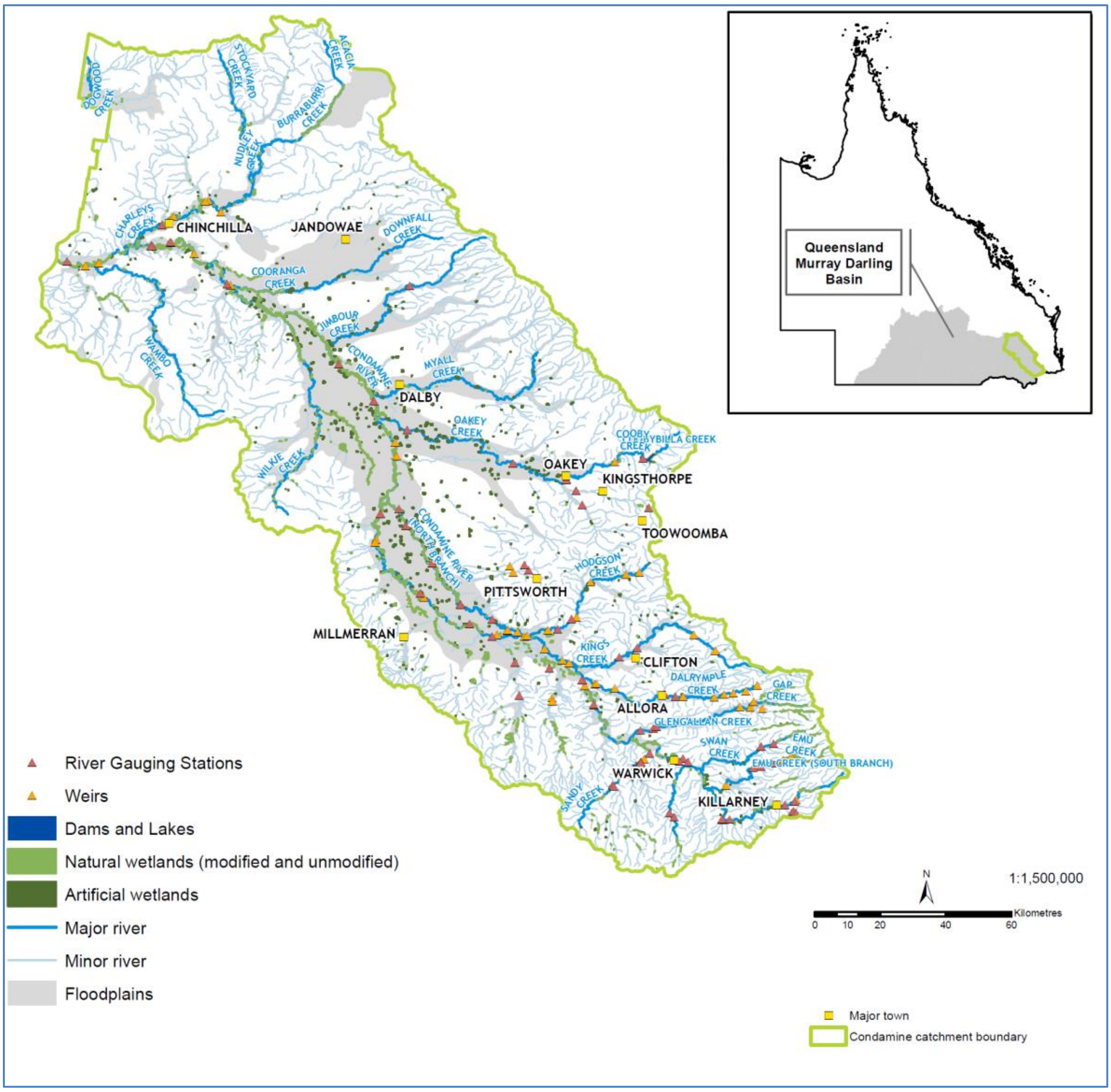
The Upper Condamine region covers an area of 2,500,000 hectares to the west of the Great Dividing Range, Queensland (CA 2010: 9) and is depicted in Figure 3. The major regional centre is Toowoomba (population 105,984 at the 2011 census) with Warwick (population 12,357) and Dalby (population 12,299) being the next biggest centres. Other towns in the catchment include: Pittsworth, Chinchilla, Clifton, Allora, Millmerran, Brigalow, Jandowae and Jondaryan.

The Condamine River is the major drainage system in the catchment. When it joins with Dogwood Creek (west of Condamine) it becomes the Balonne River.

There are several dams and weirs throughout the catchment that have various uses. The largest of these is Leslie Dam, near Warwick.

The catchment contains only one wetland of national importance: Lake Broadwater (DoEE 2005). Lake Broadwater is an example of a semi-permanent freshwater lake in an area where these are rare and provides habitat for migratory birds (protected under Japan Australia Migratory Birds Agreement and the China Australia Migratory Birds Agreement).

Figure 3: Map of the Upper Condamine catchment



Source: Adapted from Condamine NRM plan

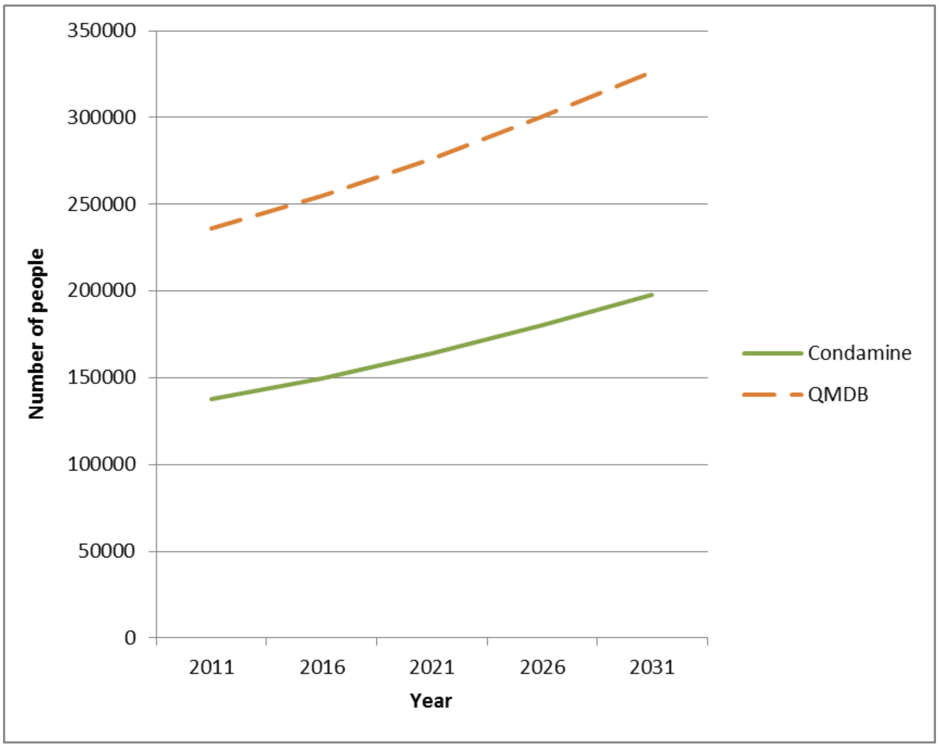
2.2 Socio economic profile

2.2.1 Demographic profile

In 2011, the population of the Upper Condamine region was estimated at 127,478 people (ABS 2011). This represents almost 58% of the QMDB's population.

Population growth is forecast to be 2.18% p.a. in the next 20 years, to reach an estimated 197 631 in 2031, as shown in Figure 4. This is higher than the QMDB's average growth of 1.87%. Of this population, Aboriginal and Torres Strait Islander peoples make up 1.83% of the Condamine population (ABS 2011).

Figure 4: Population projections for the Condamine and QMDB



Source: OESR, 2011

2.2.2 Summary of socio economic profile

The employment profile of the Upper Condamine (Table 2) is similar to the average for the QMDB, though agriculture employs proportionately less people. Retail, manufacturing and health and community services are the largest sectors of employment in the Upper Condamine. This reflects the influence of large urban centres such as Toowoomba, which provides retail and other services.

Table 2: Employment by sector, Upper Condamine region

Industry	Condamine (number)	QMDB (number)	Condamine (%)	QMDB (%)
Agriculture, Forestry & Fishing	4880	11890	8.5%	11.81%
Mining	1166	2328	2.0%	2.31%
Manufacturing	5177	8185	9.0%	8.13%
Utilities Services	688	1262	1.2%	1.25%
Construction	4542	7928	7.9%	7.87%
Wholesale trade	2002	3429	3.5%	3.41%
Retail	6394	10963	11.2%	10.89%
Accommodation	3422	5937	6.0%	5.90%
Transport and Storage	2774	4862	4.8%	4.83%
Communication Services	507	800	0.9%	0.79%
Financial & Insurance Services	1397	2159	2.4%	2.14%
Real Estate Services	697	1150	1.2%	1.14%
Professional Services	2310	3734	4.0%	3.71%
Administrative Services	1209	1925	2.1%	1.91%
Public Administration & Safety	3641	6406	6.3%	6.36%
Education & Training	5390	8889	9.4%	8.83%
Health & Community Services	7258	12002	12.7%	11.92%
Arts & Recreation Services	481	756	0.8%	0.75%
Other Services	2197	3730	3.8%	3.71%
Unknown	1213	2339	2.1%	2.32%
Total Persons	**57 346**	**100 675**		

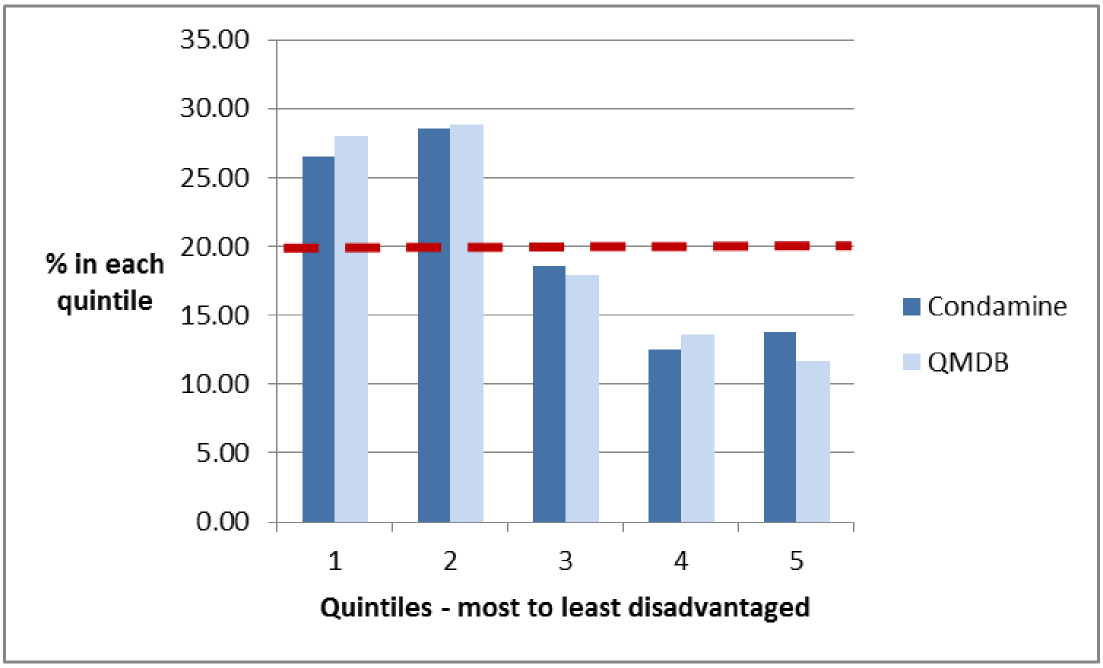
Source: ABS, 2011

Socio-Economic Disadvantage

Median family income in the Upper Condamine region is approximately $1254 a week (ABS 2011). This is similar to the QMDB average of $1245/week.

The Socio-Economic Disadvantage scores in Figure 5 are similar to the overall QMDB scores, which shows that there are more residents in disadvantaged quintiles than Queensland as a whole. This suggests the Condamine region has more households with low income, people with no qualifications, or people in low skilled occupations than the Queensland average. Similar to the QMDB as a whole, approximately 17.39% of families have low incomes (less than $600/week gross income).

Figure 5: Index of relative socio-economic disadvantage, Upper Condamine and QMDB



Source: OESR 2011, 2006 data

This relatively lower income and higher disadvantage may indicate that they are more vulnerable to losses of environmental values that increase their wellbeing.

2.2.3 Industry profile

Agriculture

Agricultural production in the Condamine region was worth approximately $1,315 million in 2015. This value is generated by a diverse range of agricultural enterprises including cereal crops, livestock, egg and milk production.

Cropping (including fruit and vegetable production) represented the most valuable industry, with gross value of $712 million generated by 2,031 businesses, of which $606 million was from broadacre crops. Sorghum was the most important grain cereal, with a gross value of $255 million produced by 952 businesses.

The most sizeable non-cereal crop was cotton (irrigated and non-irrigated) generating a gross value of $138 million. There are 30,528 ha under cotton production in total, of which 25,004 ha is irrigated and the remaining 5,523 ha is non-irrigated cotton. 117 businesses produce cotton using irrigation and 18 businesses farm non-irrigated cotton (12 businesses do both). Approximately 55,000 tonnes of irrigated cotton are produced at a yield of 2,200 kg/ha (slightly lower than the Queensland average of 2,427 kg/ha) while non-irrigated cotton has a production rate of 5,165 tonnes at a yield of 935 kg/ha (higher than the Queensland average of 849 kg/ha).

66 businesses generated $73 million through production of vegetables for human consumption.

Grazing is an important industry in the Condamine region. There were 2,476 agricultural businesses with meat cattle in the Condamine region in 2015, producing a gross value of $228 million. Other livestock industries were also significant contributors to overall agricultural value, including pig ($131 million) and poultry ($74 million) production.

Egg production is very significant in the Condamine region generating $95 million.

There are 223 dairy businesses located in the Condamine region and milk production had an approximate gross value of $67 million in 2015.

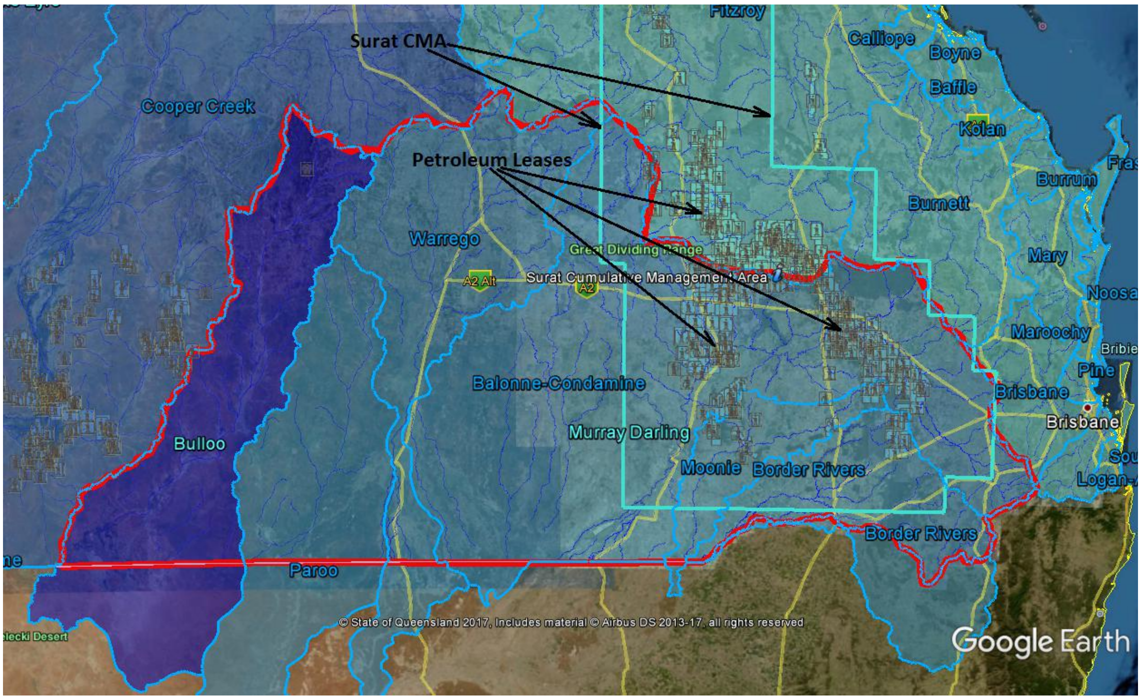
Resource industries

The Condamine region includes significant Coal Seam Gas (CSG) resource areas.

The region includes the Surat Cumulative Management Area (CMA) which has been declared due to the overlapping impacts of CSG dewatering operations – this is a result of the high level of petroleum activity in the region.

The Office of Groundwater Impact Assessment indicates that there were around 5,600 CSG wells in the Surat CMA in 2015. While, the exact number in the Upper Condamine cannot be determined with the information available, it is estimated to be around 2,000 wells. Figure 6 shows a map of petroleum leases and the Surat CMA in the Queensland MDB.

Figure 6: Map of petroleum leases and the Surat cumulative management area in the MDB



Source: Adapted from Google Earth using Queensland Globe information, accessed May 2017

The Condamine region also includes a small number of high value coal mines. The mines are thermal coal obtained from open cut mines. The mines include New Acland coal mine, Cameby downs and Aberdare Collieries.

2.3 Water quality and identified management actions in the region

Surface water and groundwater sub-catchments within the Upper Condamine region are identified in Table 3 below.

Table 3: Surface and groundwater sub-catchments within the Upper Condamine region

Surface water sub catchments used in risk assessment	Groundwater sub catchments used in risk assessment
Central Condamine North-western Condamine South-Eastern Condamine Southern Condamine South-western Condamine	Upper Condamine Alluvium (Central Condamine Alluvium) (GS64a) Upper Condamine Alluvium (Tributaries) (GS64b) Upper Condamine Basalts (GS65) Condamine Fractured Rock (GS53) Queensland MDB: Deep (GS56)

Source: DEHP, 2017, QMDB Risk Assessment.

The DEHP have undertaken a risk assessment to identify the risk factors that are ranked medium and high-level risks for each surface and groundwater sub-catchment.

2.3.1 Surface water sub catchments

Across the Upper Condamine region the risk assessment identified eight risk factors that are ranked as either medium or high risk as detailed in Table 4.

For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high. As can be seen from the table the widest spread risk factor is Elevated levels of salinity, which has a medium ranking across four of the five catchments.

Table 4: Assessment of identified risk factors for surface water sub-catchments, Upper Condamine region

Risk factor	Risk ranking in each sub-catchment				
	Central Condamine	North Western	South Eastern	Southern	South Western
Dissolved oxygen outside of natural range	High			High	
Water Temperature outside of natural range		High		High	
Elevated levels of salinity	Medium	Medium	High	Medium	Medium
Elevated levels of suspended solids	Medium				
Elevated levels of cyanobacteria		High	High	High	High
Elevated levels of pesticides and other contaminants	High				
Elevated levels of nutrients	Medium	Medium			High
Elevated pathogen counts	Medium				Medium

Source: DEHP, 2017, QMDB Risk Assessment.

2.3.2 Groundwater sub catchments

The Upper Condamine region overlies the following groundwater assets – note that the codes provided in brackets are the MDBA Sustainable Diversion Limit zones for Groundwater codes:

- Upper Condamine Alluvium (Central Condamine Alluvium) (GS64a)
- Upper Condamine Alluvium (Tributaries) (GS64b)
- Condamine Fractured Rock (GS53)
- Upper Condamine Basalts (GS65)
- Queensland MDB: Deep (GS56)

Of the groundwater assets identified, the risk assessment only identified medium or high risks in Upper Condamine Basalts – as shown in Table 5. For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high.

Table 5: Assessment of identified risk factors for groundwater sub-catchments, Upper Condamine region

Risk factor	Upper Condamine Basalts (GS65)
Elevated levels of nutrients, including phosphorus and nitrogen	High
Elevated levels of pesticides, heavy metals and other toxic contaminants	Medium
Elevated pathogen counts	Medium

Source: DEHP, 2017, QMDB Risk Assessment.

2.3.1 Management actions to address surface water and groundwater risks

The sources of the risks identified above can be urban diffuse, point source or rural diffuse. Section 8 describes the management actions that are available to address the risks depending upon the source of water quality degradation.

3. Border Rivers region

This section provides an overview of the Border Rivers region and summarises the region's socio-economic profile, the relevant catchments and groundwater resources in the region.

3.1 Introduction

The Border Rivers region catchment occupies an area of about 49,500 km^2, of which approximately half is situated in Queensland. The Dumaresq River, Macintyre River and part of the Barwon River downstream of the Weir River form the border between NSW and Queensland for approximately 470 km (DPI NSW 2012).

Principal rivers in the Queensland portion of the catchment are the Dumaresq River, Severn River, Macintyre Brook, Weir River and Pike Creek.

The major towns in the region are Goondiwindi (population of 6,397 at the 2011 ABS census) and Stanthorpe (with a population of 5,385). Smaller towns are Inglewood, Texas and Toobeah.

Several major water storages have been constructed in the Border Rivers region since the late 1960s for flood mitigation and irrigated agriculture. More than 90% of the water in the region used for irrigation is diverted from surface-water resources (MDBA 2010).

Significant industries within the region include irrigated agriculture (cereals, cotton, horticulture and vine fruits) and dryland agriculture (cereals and grazing, including pastoralism and mixed-farming systems).

The Border Rivers are regulated by three dams, two of which occur in Queensland: Glenlyon Dam on Pikes Creek and Coolmunda Dam on Macintyre Brook (Qld). Water stored in Glenlyon Dam is shared between New South Wales (up to 57%) and Queensland water users (up to 43%) (DPI NSW 2012). The main tributaries draining from Queensland are Pikes Creek and Macintyre Brook which enter the Dumaresq River, and the Weir River which enters the Macintyre River.

The nationally significant Morella Lagoon, Pungbougal Lagoon and Boobera Lagoon are all found along a remnant channel of the previous course of the Macintyre River. Boobera Lagoon is one of the few naturally permanent waterbodies in the Murray-Darling basin. These waterbodies are an important refuge for wildlife during periods of drought.

The Moonie River catchment is also included in the Border Rivers Catchment in this study. There are over 100 wetlands along the Moonie River floodplain. Even though the wetlands are not recognised as nationally or internationally important, they provide significant waterbird habitats within the Basin (MDBA undated).

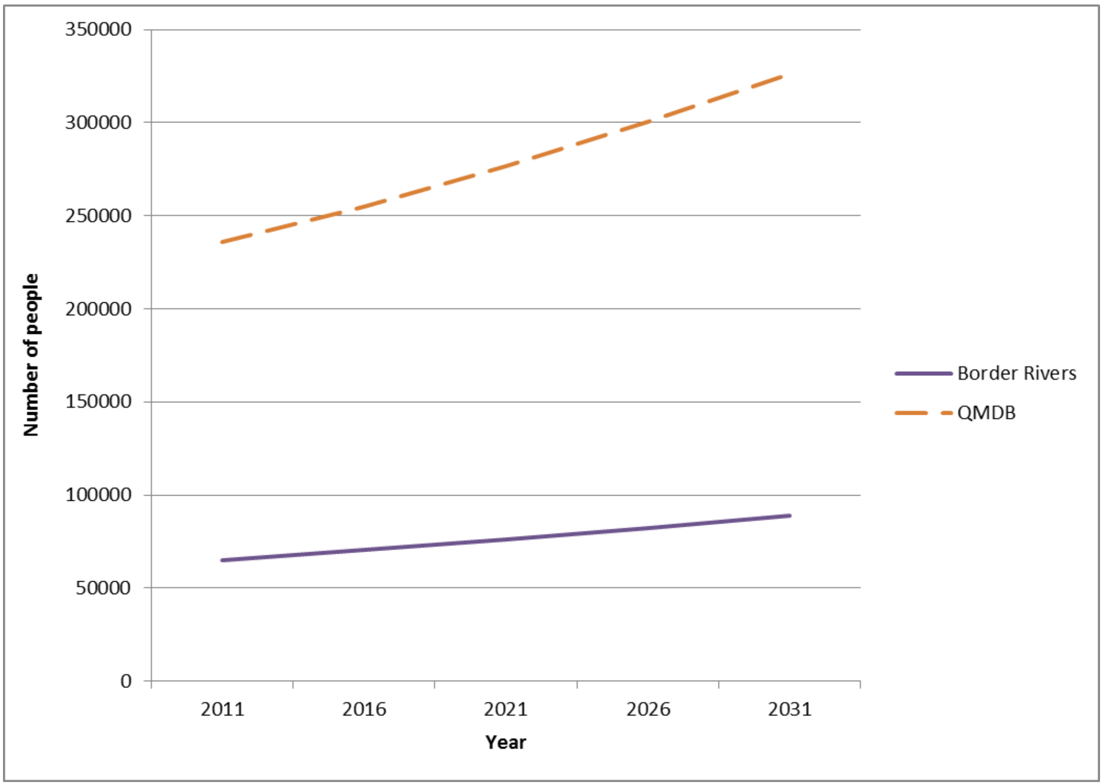
3.2 Socio economic profile

3.2.1 Demographic profile

The population of the Border Rivers region is approximately 60,626 people (ABS 2011). Population growth is forecast to be 1.84% p.a. in the next 20 years, to reach an estimated 197,631 in 2031 (Figure 7). This is higher than the QMDB's average growth of 1.63%.

Aboriginal or Torres Strait Islander peoples make up 1.98% of the Border Rivers population (ABS 2011).

Figure 7: Population projections for Border Rivers and QMDB



Source: OESR, 2011

3.2.2 Summary of socio-economic profile

Employment patterns in the Border Rivers region closely match those of the QMDB as a whole. The most important sector for employment is agriculture, closely followed by retail and health and community services (Table 6).

Table 6: Employment by sector, Border Rivers region

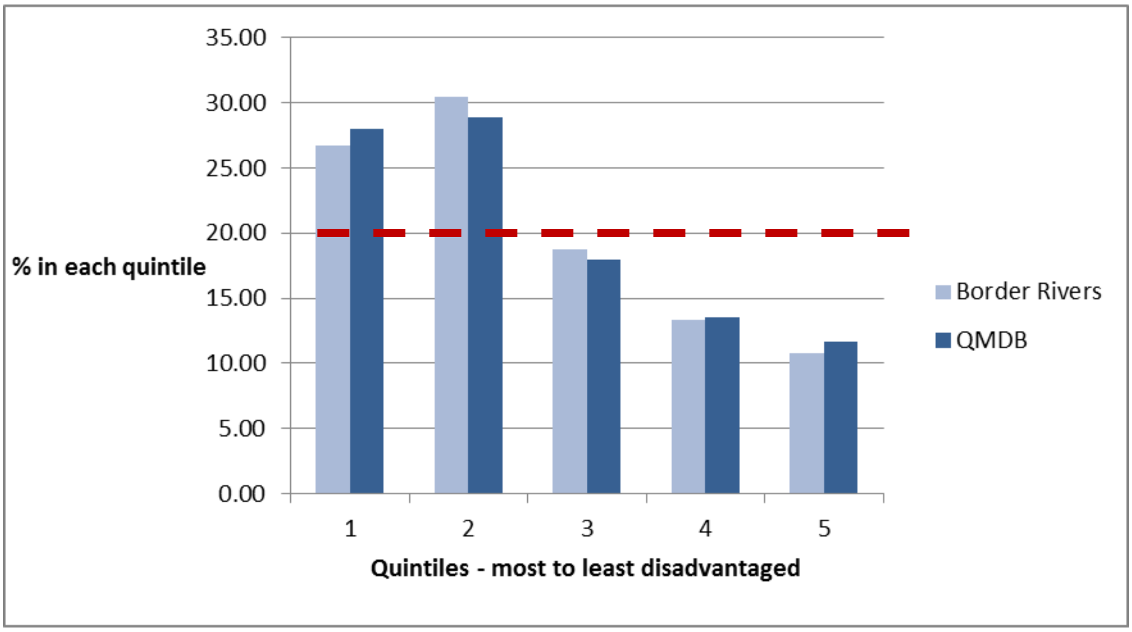
Industry	Condamine (number)	QMDB (number)	Condamine (%)	QMDB (%)
Agriculture, Forestry & Fishing	3460	11890	12.6%	11.81%
Mining	520	2328	1.9%	2.31%
Manufacturing	2231	8185	8.1%	8.13%
Utilities Services	309	1262	1.1%	1.25%
Construction	2093	7928	7.6%	7.87%
Wholesale trade	963	3429	3.5%	3.41%
Retail	3083	10963	11.2%	10.89%
Accommodation	1703	5937	6.2%	5.90%
Transport and Storage	1370	4862	5.0%	4.83%
Communication Services	220	800	0.8%	0.79%
Financial & Insurance Services	579	2159	2.1%	2.14%
Real Estate Services	304	1150	1.1%	1.14%
Professional Services	1059	3734	3.9%	3.71%
Administrative Services	515	1925	1.9%	1.91%
Public Administration & Safety	1558	6406	5.7%	6.36%
Education & Training	2404	8889	8.8%	8.83%
Health & Community Services	3198	12002	11.7%	11.92%
Arts & Recreation Services	204	756	0.7%	0.75%
Other Services	1035	3730	3.8%	3.71%
Unknown	631	2339	2.3%	2.32%
Total Persons	**27439**	**100675**		

Source: ABS, 2011

Social and economic disadvantage

Median family income in the Border Rivers region is approximately $1,129/week and personal income was $530/week (ABS 2011 census). These were slightly less than the QMDB average family income of $1,245/week and personal income of $533/week.

Figure 8: Index of relative socio-economic disadvantage, Border Rivers and QMDB



Source. OESR 2011, 2006 data

Border Rivers region is slightly more socio-economically disadvantaged than other regions in the QMDB. This is lower than the Queensland average (20% in each group, as shown by the red dashed line), which suggests the Border Rivers region has more households with low income, people with no qualifications, or people in low skilled occupations than the Queensland average.

The Border Rivers region has the highest proportion of low income families in the QMDB, with 20% of families making less than $600/week.

3.2.3 Industry profile.

Agricultural production was worth approximately $786 million in the Border Rivers region in 2011 (ABS 2012b). Crops (including fruit and vegetable production) generate the greatest proportion of agricultural gross value in the Border Rivers region, with almost three-quarters of the regional agricultural value coming from crop production (ABS 2012b). There were 2758 broadacre crop producers over 1.5 million hectares in the same year (ABS 2012). Cotton and wheat were important crops in 2011, with gross values of $228 million and $116 million respectively.

All the cotton production in the Border Rivers-Maranoa-Balonne region is irrigated. There are 52 businesses farming 25,812 ha of cotton lint in the region, producing approximately 76,222 tonnes per year, at a yield of 2,953 kg/ha (the average yield for Queensland is 2,427 kg/ha) (ABS 2016). The total value of cotton production in the region is approximately $174.79 million (ABS 2016b).

Fruit and vegetable production is another important agricultural industry in the Border Rivers region. These industries made up 20% of the Border River's gross value of agricultural production in 2011.

Poultry produced a gross value of $149 million, which was 19% of regional value.

There were approximately 943 agricultural enterprises with meat cattle in 2011. This industry contributed 11% to the gross value of agricultural production in the Border Rivers.

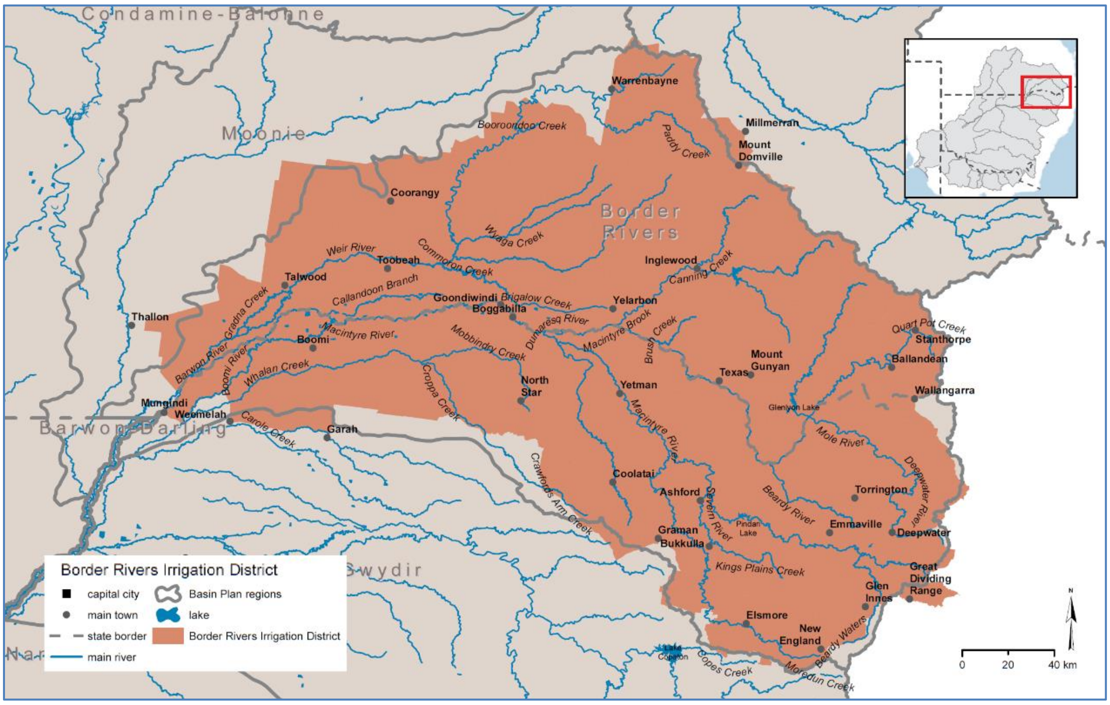
There are 49 wineries in the Border Rivers Maranoa-Balonne region[8] making up approximately 43% of Queensland's wine growing area. It is estimated that 541 ha is used for grapes for wine production, of which 232 ha occurs in the Border Rivers-Maranoa-Balonne region (ABS 2016). The total value of wine production in the region annually is estimated to be around $25 million from approximately $3.3 million worth of grapes (Queensland College of Wine Tourism, 2017).

The areas of Border River and Maranoa-Balonne contain over half the number of wineries in Queensland (ABS 2016). The joint wine and tourism industries in the Southern Downs region, currently contributes $165 million to the tourism discussed in Section 7.1.2.

Border Rivers irrigation area

The Border Rivers irrigation area straddles the Queensland / New South Wales border and so lies partly within the Border Rivers region of the QMDB. The irrigation area is depicted in Figure 9.

Figure 9: Border rivers irrigation area



Source: Guide to the proposed Basin Plan Technical Background Part III - Border Rivers community profile

The area uses broadacre furrow irrigation and cotton, is the major irrigated enterprise, with cereal crops, fodder crops, fruit and vegetables also grown in different parts of the catchment.[9]

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[8] As defined in the ABS data for *Agricultural Commodities 2014-2015*.

[9] Analysis of Australian Bureau of Statistics, Water use on Australian Farms, Australia –2014-15

3.3 Water quality and identified management actions in the region

Surface water and groundwater sub catchments within the Border Rivers region are identified in Table 7 below.

Table 7: Surface water and groundwater sub catchments, Boarder Rivers region

Surface water sub catchments used in risk assessment	Groundwater sub catchments used in risk assessment
Granite Belt (Stanthorpe) Upper Border Rivers Lower Border Rivers Upper Moonie Lower Moonie	Queensland Border Rivers Alluvium (GS54) Queensland Border Rivers Fractured Rock (GS67) Sediments above the GAB: Border Rivers (GS57) St George Alluvium: Moonie (GS62) Sediments above the GAB: Moonie (GS59) Queensland MDB: Deep (GS56)

Source: DEHP, 2017, QMDB Risk Assessment.

The DEHP have undertaken a risk assessment to identify the risk factors that are ranked medium and high-level risks for each surface and groundwater sub-catchment.

3.3.1 Surface water sub catchments

Across the Border Rivers region the risk assessment identified eight risk factors that are ranked as either medium or high risk as detailed in Table 8. For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high. As can be seen from the table the widest spread risk factor is 'elevated levels of nutrients', which has a medium ranking across three of the five sub catchments and a high ranking for the remaining two sub catchments.

Table 8: Assessment of identified risk factors for surface water sub-catchments, Border Rivers region

Risk factor	Risk ranking in each sub-catchment				
	Granite Belt (Stanthorpe)	Upper Border Rivers	Lower Border Rivers	Upper Moonie	Lower Moonie
Dissolved oxygen outside of natural range	Medium	High			Medium
Water Temperature outside of natural range	Medium	High			
Elevated levels of salinity			High		
Elevated levels of cyanobacteria				High	
Elevated levels of pesticides and other contaminants	Medium				
Elevated levels of nutrients	High	High	High	Medium	Medium
pH outside of natural ranges	Medium		Medium		
Elevated levels of suspended matter				Medium	Medium

Source: DEHP, 2017, QMDB Risk Assessment.

3.3.2 Groundwater sub catchments

The Border Rivers region overlies the following groundwater assets:

- Queensland Border Rivers Alluvium (GS54)
- Queensland Border Rivers Fractured Rock (GS67)
- Sediments above the GAB: Border Rivers (GS57)
- St George Alluvium: Moonie (GS62)
- Sediments above the GAB: Moonie (GS59)
- Queensland MDB: Deep (GS56)

Of the groundwater assets identified in the region, the risk assessment only identified medium or high risks in the Queensland Border Rivers Alluvium and the Queensland Border Rivers Fractured Rock (Table 9). For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high.

Table 9: Assessment of identified risk factors for groundwater sub-catchments, Border Rivers region

Risk factor	Queensland Border Rivers Alluvium (GS54)	Queensland Border Rivers Fractured Rock (GS67)
Elevated levels of nutrients, including phosphorus and nitrogen	Medium	Medium
Elevated levels of pesticides, heavy metals and other toxic contaminants	Medium	Medium
Elevated levels of salinity		Medium

Source: DEHP, 2017, QMDB Risk Assessment.

3.3.1 Management actions to address surface water and groundwater risks

The sources of the risks identified above can be urban diffuse, point source or rural diffuse. Section 8 describes the management actions that are available to address the risks depending upon the source of water quality degradation.

4. Maranoa-Upper Balonne region

This section provides an overview of the Maranoa-Upper Balonne region and summarises the region's socio-economic profile, the relevant catchments and groundwater resources in the region.

4.1 Introduction

The Maranoa and Upper Balonne region is part of the wider Condamine–Balonne region.

The major towns in the region is Roma (population 6,906 at the 2011 census) with smaller regional centres being Mitchell and Surat. The major rivers in the region include the Maranoa and Balonne Rivers. The Neil Turner Weir is situated on the Maranoa River at Mitchell. Town water supplies are sourced from both sub-artesian bores and surface water from local watercourses. (DIP 2009)

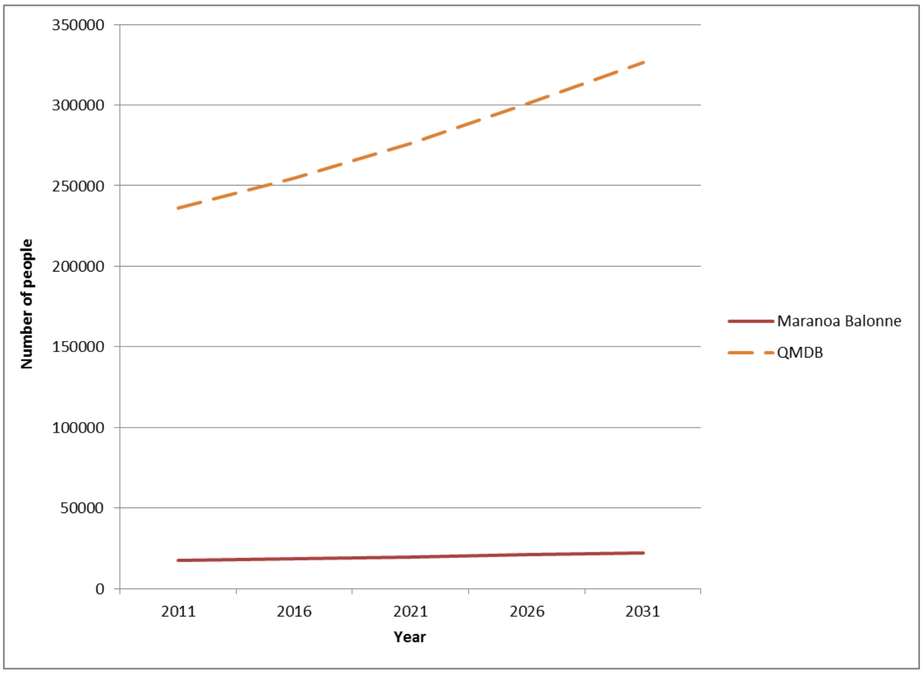
In the far east of the catchment is The Gums Lagoon which is considered a nationally important wetland and listed on the *Directory of Important Wetlands in Australia* (DoEE 2005).

4.2 Socio economic profile

4.2.1 Demographic profile

The population of the Maranoa-Balonne region was 16 991 people in 2011 (ABS 2011). The forecast population growth rate is lower than that of the QMDB as a whole at 1.37% p.a. until 2031 (OESR 2011).

Figure 10: Population projections for the Maranoa Balonne and QMDB



Source. OESR, 2011

Aboriginal or Torres Strait Islander peoples make up 2.94% of the Maranoa-Balonne population (ABS 2011).

4.2.2 Socio-economic profile

Agriculture is the most important source of employment in the Maranoa-Balonne region, employing almost a fifth of the working population. This is much higher than the QMDB (11.81%) or Queensland average (3.5%). Mining (5.9%) is still a relatively small employer compared to retail or service sectors such as health and community services.

Table 10: Employment by sector, Maranoa Balonne and QMDB

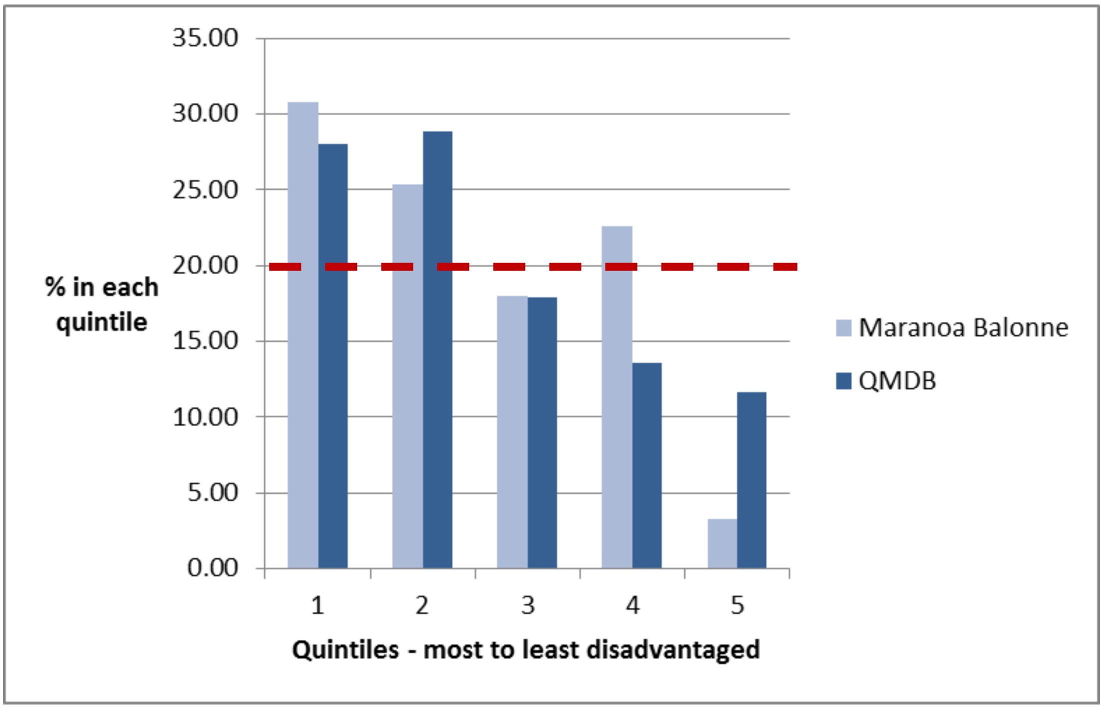
Industry	Maranoa (number)	QMDB (number)	Maranoa (%)	QMDB (%)
Agriculture, Forestry & Fishing	1567	11890	18.9%	11.81%
Mining	490	2328	5.9%	2.31%
Manufacturing	472	8185	5.7%	8.13%
Utilities Services	169	1262	2.0%	1.25%
Construction	771	7928	9.3%	7.87%
Wholesale trade	220	3429	2.7%	3.41%
Retail	788	10963	9.5%	10.89%
Accommodation	458	5937	5.5%	5.90%
Transport and Storage	386	4862	4.7%	4.83%
Communication Services	42	800	0.5%	0.79%
Financial & Insurance Services	111	2159	1.3%	2.14%
Real Estate Services	95	1150	1.1%	1.14%
Professional Services	223	3734	2.7%	3.71%
Administrative Services	115	1925	1.4%	1.91%
Public Administration & Safety	520	6406	6.3%	6.36%
Education & Training	542	8889	6.5%	8.83%
Health & Community Services	755	12002	9.1%	11.92%
Arts & Recreation Services	34	756	0.4%	0.75%
Other Services	288	3730	3.5%	3.71%
Unknown	240	2339	2.9%	2.32%
Total Persons	**8287**	**100675**		

Source: ABS, 2011

Social and economic disadvantage

Median family income in the Maranoa-Balonne region is $1,369/week, higher than the QMDB average of $1,245/week. Personal income is also higher at $593/week compared to $533/week. 17.1% of the families in the region have low incomes (<$600/week).

Figure 11 Index of relative socio-economic disadvantage, Maranoa-Balonne and QMDB



Source. OESR 2012, 2006 data

The index of relative disadvantage (Figure 11, above) illustrates that residents are generally worse off in the Maranoa-Balonne region than the Queensland average. As with the QMDB region as a whole, this relatively lower income and higher disadvantage may impact upon the ability of the community to adapt to new costs associated with protecting EVs.

4.2.3 Industry profile

Agriculture

Agricultural production had a gross value of $306 million in 2011 (ABS 2012b). Meat cattle produced over half of this value. There were approximately 644 agricultural businesses with cattle in 2011 (ABS 2012).

Crop production represented 39% of the total agricultural value of the Maranoa Balonne in 2011 (ABS 2012b). Wheat was the most important cereal crop at a value of $57 million. Cotton was the most significant non-cereal crop at $27 million. As discussed in Section 3.2.3, there are 49 wineries in the Border Rivers-Maranoa-Balonne region. However, it is not possible to split the data further, into the regions presented in this report, due to the way the data is presented in the ABS catalogues.

The same problem is encountered when viewing the information in relation to cotton production in the area. All the figures are presented for the larger catchment.

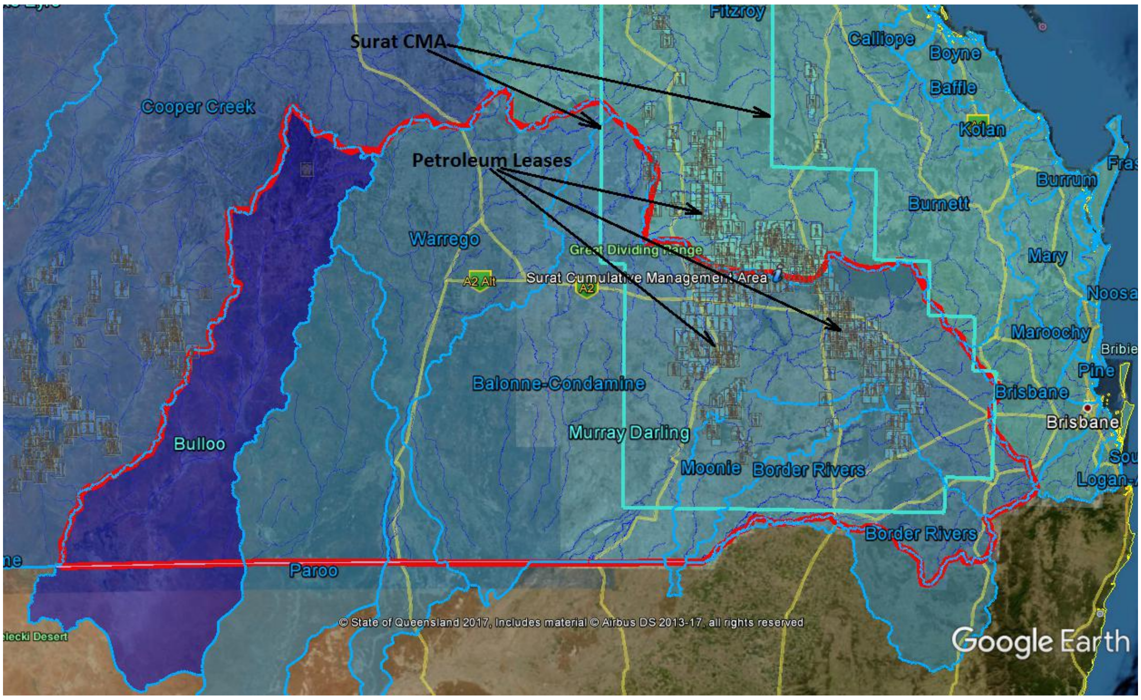
Resource industries

The Maranoa-Upper Balonne region includes significant Coal Seam Gas (CSG) resource areas.

The region includes the Surat Cumulative Management Area (CMA) which has been declared due to the overlapping impacts of CSG dewatering operations.

Within the CMA the Office of Groundwater Impact Assessment develops an Underground Water Impact Report on a tri-annual basis. The Office of Groundwater Impact Assessment indicates that there were around 5,600 CSG wells in the Surat CMA in 2015. Figure 612 shows a map of petroleum leases and the Surat CMA in the Queensland MDB.

Figure 12: Map of petroleum leases and the Surat cumulative management area in the MDB



Source: Adapted from Google Earth using Queensland Globe information, accessed May 2017

4.3 Water quality and identified management actions in the region

Surface water and groundwater sub-catchments within the Maranoa-Balonne region are identified in Table 11 below.

Table 11: Surface groundwater sub catchments, Maranoa-Balonne region

Surface water sub catchments used in risk assessment	Groundwater sub catchments used in risk assessment
Upper Balonne Maranoa	Upper Condamine Alluvium (Tributaries) (GS64b)10 St George Alluvium: Condamine-Balonne (GS61)11 Sediments above the GAB: Condamine-Balonne (GS58) Queensland MDB: Deep (GS56)

Source: DEHP, 2017, QMDB Risk Assessment.

The DEHP have undertaken a risk assessment to identify the risk factors that are ranked medium and high-level risks for each surface and groundwater sub-catchment within the Maranoa-Balonne region.

4.3.1 Surface water sub catchments

Across the Maranoa-Balonne region the risk assessment identified eight risk factors that are ranked as either medium or high risk as detailed in Table 12 (below). For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high.

As can be seen from the table the widest spread risk factors are 'water temperature outside of natural range' and 'elevated levels of cyanobacteria' which have a high risk ranking in both sub catchments. 'Elevated levels of salinity and 'elevated levels of nutrients' have a medium risk ranking across both sub catchments.

[10] Only a small amount of this groundwater asset occurs in this region – the majority occurs in the Upper Condamine region.

[11] The Murray-Darling Basin Plan recognises the St George Alluvium groundwater aquifers as a single SDL resource unit however under Queensland water resource planning, this resource unit is managed as the St George Alluvium (shallow) and the St George Alluvium (deep).

Table 12: Assessment of identified risk factors for surface water sub-catchments, Maranoa-Balonne

Risk factor	Risk ranking in each sub-catchment	
	Maranoa	Upper Balonne
Dissolved oxygen outside of natural range		High
Water Temperature outside of natural range		High
Elevated levels of salinity	Medium	Medium
Elevated levels of cyanobacteria	High	High
Elevated levels of pesticides and other contaminants	High	High
Elevated levels of nutrients		Medium
Elevated levels of suspended matter		Medium
Elevated pathogen counts		Medium

Source: DEHP, 2017, QMDB Risk Assessment.

4.3.2 Groundwater sub catchments

The Maranoa-Balonne region overlies the following groundwater assets:

- Upper Condamine Alluvium (Tributaries) (GS64b)
- St George Alluvium: Condamine-Balonne (GS61)
- Sediments above the GAB: Condamine-Balonne (GS58)
- Queensland MDB: Deep (GS56)

Of the groundwater assets identified, the risk assessment only identified medium risks in St George Alluvium: Condamine-Balonne, where the only risk factor identified was 'elevated levels of salinity' with a medium risk.

4.3.1 Management actions to address surface water and groundwater risks

The sources of the risks identified above can be urban diffuse, point source or rural diffuse. Section 8 describes the management actions that are available to address the risks depending upon the source of water quality degradation.

5. Lower Balonne region

This section provides an overview of the Lower Balonne region and summarises the region's socio-economic profile, the relevant catchments and groundwater resources in the region.

5.1 Introduction

The Lower Balonne region (approximately 357,000 ha) is part of the wider Condamine–Balonne region and is predominantly within the Shire of Balonne.

The major town in the region is St George (population 3,292 at the 2011 census) and includes the smaller centres of Dirranbandi, Bollon, Thallon, Mungindi and Hebel.

The major rivers in the region include the Balonne River, the Culgoa River, the Ballandool River, and the Bokhara River and Narran River.

The Maranoa and Balonne Rivers meet in the northern part of the catchment at Lake Kajarabie (the Beardmore Dam). The E.J. Beardmore Dam is situated to the north of St George and provides water for irrigation of crops as well as urban water to St George, for domestic and industrial use.[12] The Jack Taylor Weir is situated downstream from the dam, at St George.

The Lower Balonne River Floodplain System extends from Queensland into the New South Wales portion of the catchment. Although situated in New South Wales the Narran Lakes rely on the water flow from upstream. Both the floodplain system and Narran Lakes are key 'indicator assets' for the Murray-Darling Basin Plan (MDBA 2016).

5.2 Socio economic profile

5.2.1 Demographic profile

The population of Balonne[13] is 4,720 people (ABS 2011). It is forecast to have low population growth over the next twenty years at 0.89% p.a. growth until 2031, which is much lower than the QMDB's average of 1.87%.

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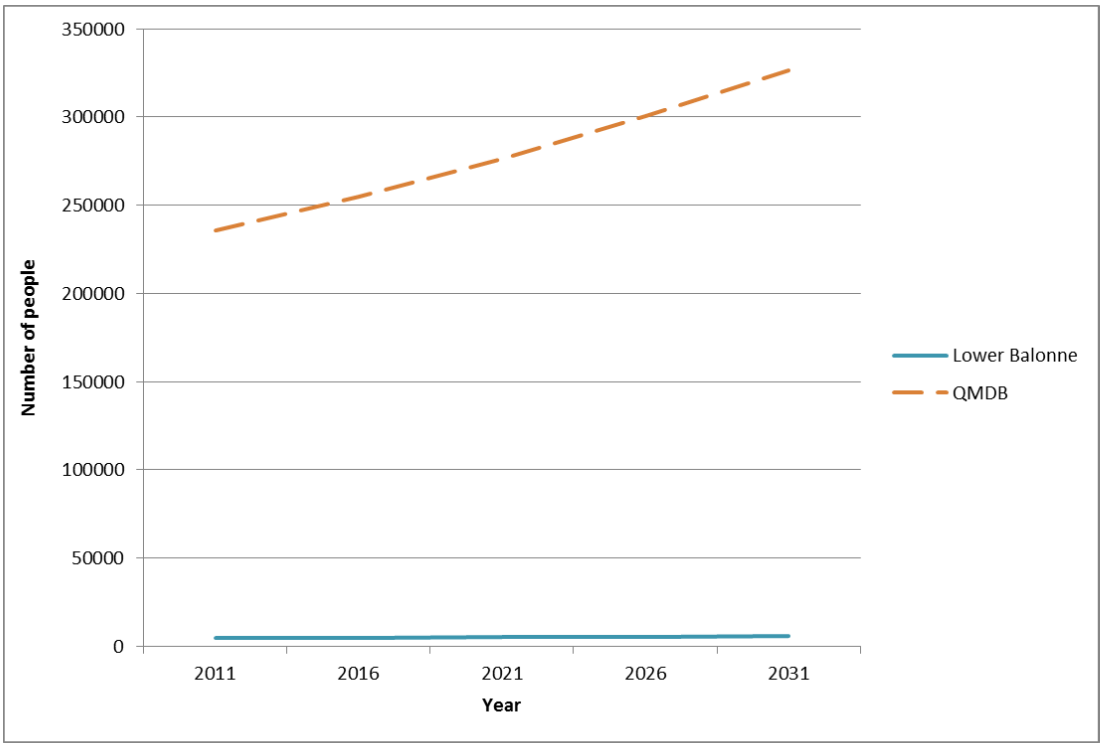
12 *Guide to the proposed Basin Plan Technical background Part III, Appendix C Lower Balonne community profile*

13 For the population and employment statistics, it is assumed the lower Balonne region is represented by Balonne local government area as most of the population resides in this area.

Figure 13: Population projections for the Lower Balonne and QMDB



Source: OESR, 2011

The proportion of the Aboriginal and Torres Strait Islander population is high compared to other regions in the QMDB. Almost 9% of the population are from Aboriginal and Torres Strait Islander descent which indicates that changes which impact environmental values associated with cultural, spiritual and ceremonial values will have a greater impact in this region.

5.2.2 Socio-economic profile

Agriculture is the most important employer in the Lower Balonne (Table 13, below). Over one-third of the employed population work in the agriculture, forestry and fishing sector (36.8%), which is higher than the proportion employed in the sector in the QMDB (11.81%) or Queensland as a whole. Any negative impact to agriculture is likely to have significant social and economic impacts in this region.

Table 13: Employment by sector, Lower Balonne and QMDB

Industry	Lower Balonne (number)	QMDB (number)	Lower Balonne (%)	QMDB (%)
Agriculture, Forestry & Fishing	845	11890	36.8%	11.81%
Mining	14	2328	0.6%	2.31%
Manufacturing	40	8185	1.7%	8.13%
Utilities Services	31	1262	1.3%	1.25%
Construction	119	7928	5.2%	7.87%
Wholesale trade	66	3429	2.9%	3.41%
Retail	202	10963	8.8%	10.89%

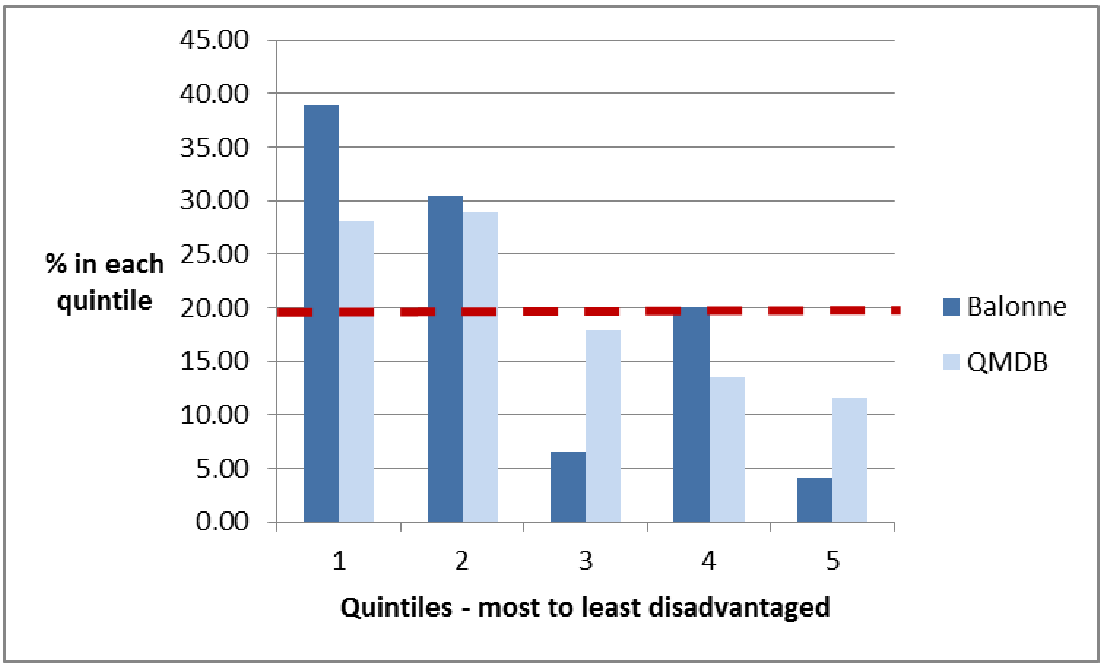
Industry	Lower Balonne (number)	QMDB (number)	Lower Balonne (%)	QMDB (%)
Accommodation	100	5937	4.4%	5.90%
Transport and Storage	80	4862	3.5%	4.83%
Communication Services	4	800	0.2%	0.79%
Financial & Insurance Services	22	2159	1.0%	2.14%
Real Estate Services	16	1150	0.7%	1.14%
Professional Services	48	3734	2.1%	3.71%
Administrative Services	33	1925	1.4%	1.91%
Public Administration & Safety	135	6406	5.9%	6.36%
Education & Training	170	8889	7.4%	8.83%
Health & Community Services	200	12002	8.7%	11.92%
Arts & Recreation Services	5	756	0.2%	0.75%
Other Services	72	3730	3.1%	3.71%
Unknown	96	2339	4.2%	2.32%
Total Persons	**2298**	**100675**		

Source: ABS, 2011

Social and economic disadvantage

Median family income in the Lower Balonne is $1,202/week, which is less than the QMDB average of $1,245. Personal income is slightly higher though, at $568/week compared to the QMDB's average of $533/week.

Figure 14: Index of relative socio-economic disadvantage, Lower Balonne and QMDB



Source: OESR 2012, 2006 data

The index of relative socio-economic disadvantage (Figure 14) suggests that the Lower Balonne region has more disadvantaged residents than the QMDB as a whole. This implies the Lower Balonne region has more households with low income, people with no qualifications, or people in low skilled occupations.

The Lower Balonne region has a relatively high proportion of low income families, with 18.6% of families making less than $600/week.

5.2.3 Industry profile

Agricultural production was worth $206 million in 2011 (ABS 2012b). Crop production was responsible for nearly all (83%) of this value. Cotton was the most valuable crop produced at $117 million in 2011, which was a substantial increase from the 2006 ($30 million). There were approximately 24 properties with cotton in the region in 2011. Wheat was another important crop in 2011, with a gross value of $28 million.

Cattle represents the other significant industry of the region, with approximately 103 businesses with cattle in 2011. Meat production generated $22 million in gross value.

As discussed in Section 3.2.3, there are 49 wineries in the Border Rivers-Maranoa-Balonne region. However, it is not possible to split the data further, into the regions presented in this report, due to the way the data is presented in the ABS catalogues.

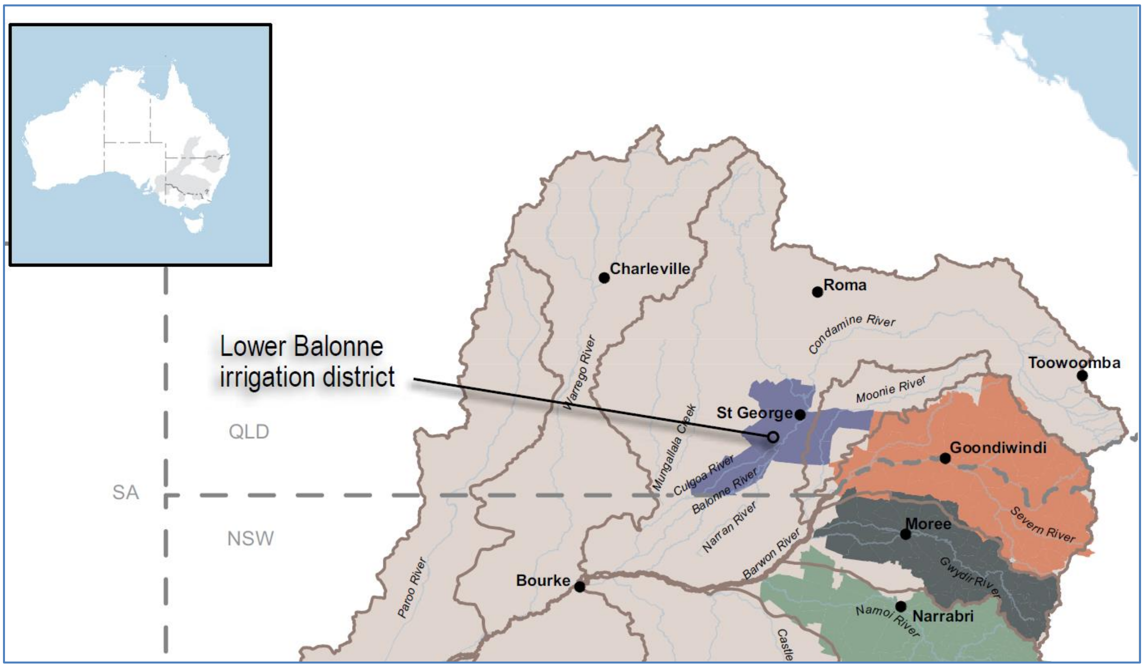
The same problem is encountered when viewing the information in relation to cotton production in the area. All the figures are presented for the larger catchment.

Lower Balonne irrigation district

Irrigation in the Lower Balonne irrigation district occurs from both farmers undertaking self-supply and from supplemented sources. The majority of irrigation is furrow irrigation, with water drawn from channel systems in supplemented areas and the river system or overland flow in un-supplemented areas. The area is depicted in Figure 15.

Beardmore Dam as well as several small dams (the Jack Taylor, Moolabah and Buckinbah Weirs) provide water to the St George irrigation scheme that is operated by SunWater.

Figure 15: Lower Balonne irrigation area



Source: Guide to the proposed Basin Plan Technical background Part III, Appendix C Lower Balonne community profile

5.3 Water quality and identified management actions in the region

Surface water and groundwater sub catchments within the Lower Balonne region are identified in Table 14 below.

Table 14: Surface and groundwater sub-catchments, Lower Balonne region

Surface water sub catchments used in risk assessment	Groundwater sub catchments used in risk assessment
Lower Balonne	St George Alluvium: Condamine-Balonne (GS61)[14] Sediments above the GAB: Condamine-Balonne (GS58) Queensland MDB: Deep (GS56)

Source: DEHP, 2017, QMDB Risk Assessment.

The DEHP have undertaken a risk assessment to identify the risk factors that are ranked medium and high-level risks for each surface and groundwater sub-catchment.

14 The Murray-Darling Basin Plan recognises the St George Alluvium groundwater aquifers as a single SDL resource unit however under Queensland water resource planning, this resource unit is managed as the St George Alluvium (shallow) and the St George Alluvium (deep).

5.3.1 Surface water sub catchments

Across the Lower Balonne region, the risk assessment identified six risk factors that are ranked as either medium or high risk as detailed in Table 15 (below). For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high.

Three factors, 'dissolved oxygen outside of natural range', 'water temperature outside of natural range' and 'elevated levels of cyanobacteria' are high risk factors.

Table 15: Assessment of identified risk factors for surface water sub-catchments, Lower Balonne region

Risk factor	Risk ranking in the Lower Balonne sub-catchment
Dissolved oxygen outside of natural range	High
Water Temperature outside of natural range	High
Elevated levels of suspended matter	Medium
Elevated levels of cyanobacteria	High
Elevated levels of nutrients	Medium
pH outside natural ranges	Medium

Source: DEHP, 2017, QMDB Risk Assessment.

5.3.2 Groundwater sub catchments

The Lower Balonne region overlies the following groundwater assets:

- St George Alluvium: Condamine-Balonne (GS61)
- Sediments above the GAB: Condamine-Balonne (GS58)
- Queensland MDB: Deep (GS56)

Of the groundwater assets identified, the risk assessment only identified medium risks in St George Alluvium: Condamine-Balonne, where the only risk factor identified was 'elevated levels of salinity' with a medium risk.

5.3.1 Management actions to address surface water and groundwater risks

The sources of the risks identified above can be urban diffuse, point source or rural diffuse. Section 8 describes the management actions that are available to address the risks depending upon the source of water quality degradation.

6. South West region

This section provides an overview of the South West region and summarises the region's socio-economic profile, the relevant catchments and groundwater resources in the region.

6.1 Introduction

The South West region is made up of four catchments: Bulloo catchment; Paroo catchment; Warrego catchment; and Nebine-Mungallala-Wallam catchment.

The Paroo, Warrego and Nebine-Mungallala-Wallam catchments are part of the Murray Darling Basin, while the Bulloo catchment is an internally draining system located between Lake Eyre and the Murray Darling Basins.

The four main local government areas covered by the South West region are the: Shire of Murweh, Shire of Bulloo, Shire of Paroo and Shire of Quilpie. Parts of the Shire of Balonne, Maranoa Regional Council and Blackall Tambo Regional Council are also located inside the boundaries of the region.

The consultation EVs and WQOs incorporate data from a variety of sources and builds upon the work previously undertaken across the catchments by the NRM Groups. To avoid confusion, EVs and WQOs for the Warrego, Paroo, Bulloo and Nebine are the same as in the finalised Healthy Waters Management Plan (DEHP 2016b) for this region but are included in the 2017 consultation period as part of the statutory process for the inclusion of EVs and WQOs under the EPP Water.

6.1.1 Bulloo catchment

The Bulloo catchment covers a total area of some 74 900 square kilometres, with approximately 74% of the catchment in Queensland (SWNR [undated]).

Quilpie is the major urban centre within the Bulloo River catchment which also contains the towns of Adavale and Thargomindah. At the 2011 census, Quilpie had a population of 574.

The major river is the Bulloo River and contains the tributaries Blackwater Creek, Winbin Creek and Gumbo Creek.

There are five wetlands within the Bulloo Catchment listed in the Commonwealth Government's *Directory of Important Wetlands in Australia*. These are: Bulloo Lake, Lake Bullawarra, Nooyeah Downs Swamps Aggregation, Bulloo Overflow, and Lake Altibouka (DoEE 2005).

6.1.2 Paroo catchment

The Paroo catchment covers 76 000 square kilometres, of which about half is within Queensland, and is the most westerly catchment in the Murray-Darling Basin.

The towns of Eulo and Hungerford are located in the catchment.

The major river in the catchment is the Paroo River and there are several tributaries. These are: Beechal Creek, Yowan Creek and Qulberry Creeks and a section of Cuttaburra Creek.

The Currawinya Lakes (Ramsar site 43 – the only Ramsar listed site in the Queensland Murray-Darling Basin) lie within the Paroo Catchment

Wetlands within the Paroo Catchment listed on the Commonwealth Government's *Directory of Important Wetlands in Australia* include the Lake Numalla Aggregation, Lake Wyara, Lake Bindegolly and Lake Toomaroo (DoEE 2005).

6.1.3 Nebine-Mungallala-Wallam catchment

The Nebine catchment covers a total area of 38 100 square kilometres of which 99% occurs in Queensland.

Bollon and Mungallala are the two townships located in the Nebine catchment.

The major creeks are the Nebine, Mungallala and Wallam Creeks with a tributary of the Nebine Creek; Paterson Creek.

6.1.4 Warrego catchment

The Warrego catchment covers approximately 78 400 square kilometres, of which 84% is within Queensland.

Charleville is the major urban centre in the catchment, which also includes the towns of Cunnamulla, Augathella, Wyandra, Morven, Barringun, Enngonia and Fords Bridge. Charleville had a population of 3,728 at the 2011 census (ABS 2011).

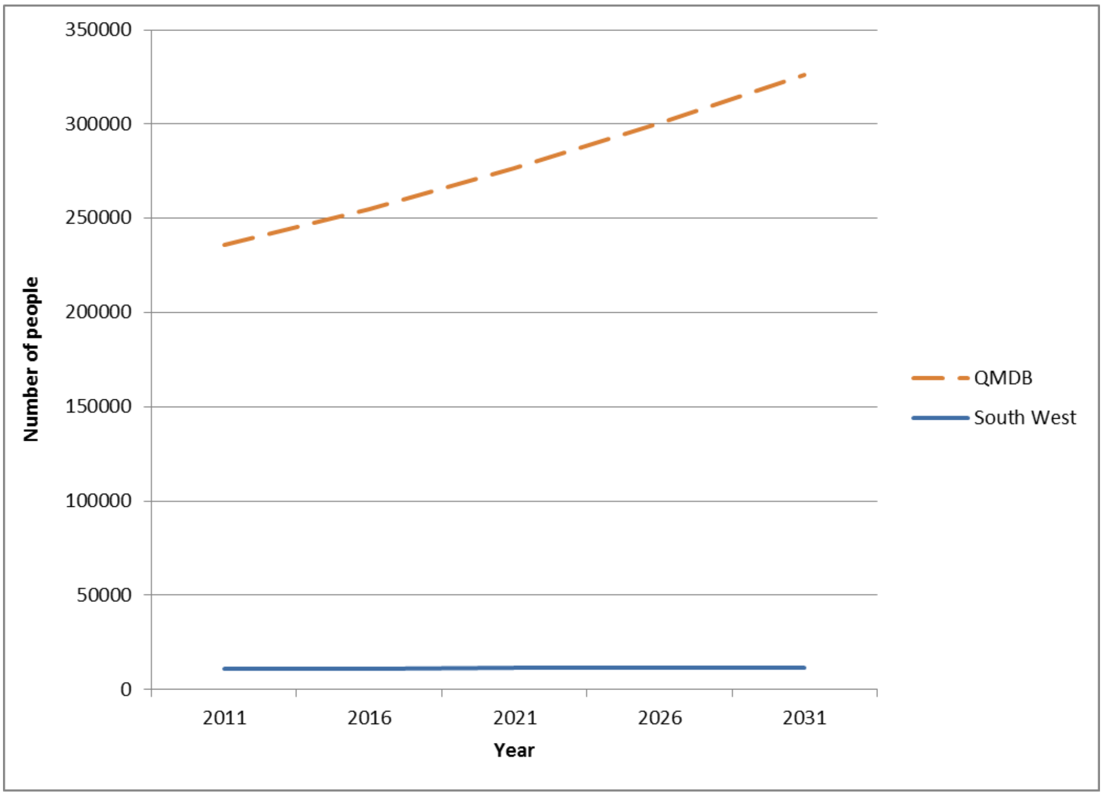
Warrego River is the major river in the catchment with the Ward, Langlo and Nive Rivers as tributaries.

6.2 Socio economic profile

6.2.1 Demographic profile

The population of the South West region was approximately 10 720 people in 2011 (ABS 2011). Forecast population growth is the lowest rate in the QMDB at 0.35% p.a. until 2031.

Figure 16: Population projections for the South West and QMDB



Source: OESR, 2011

Seven percent of the population are Aboriginal or Torres Strait Islander, which is relatively high in the QMDB.

6.2.2 Summary of socio-economic profile

Employment in the South West is dominated by agriculture meaning changes to agricultural production are likely to have a relatively large impact in the region. Other important sectors of employment are service industries including health and community services, and retail.

Table 16: Employment by sector, South West region

Industry	South West (number)	QMDB (number)	South West (%)	QMDB (%)
Agriculture, Forestry & Fishing	1141	11890	21.5%	11.81%
Mining	138	2328	2.6%	2.31%
Manufacturing	266	8185	5.0%	8.13%
Utilities Services	65	1262	1.2%	1.25%
Construction	403	7928	7.6%	7.87%
Wholesale trade	178	3429	3.4%	3.41%
Retail	497	10963	9.4%	10.89%
Accommodation	254	5937	4.8%	5.90%
Transport and Storage	253	4862	4.8%	4.83%

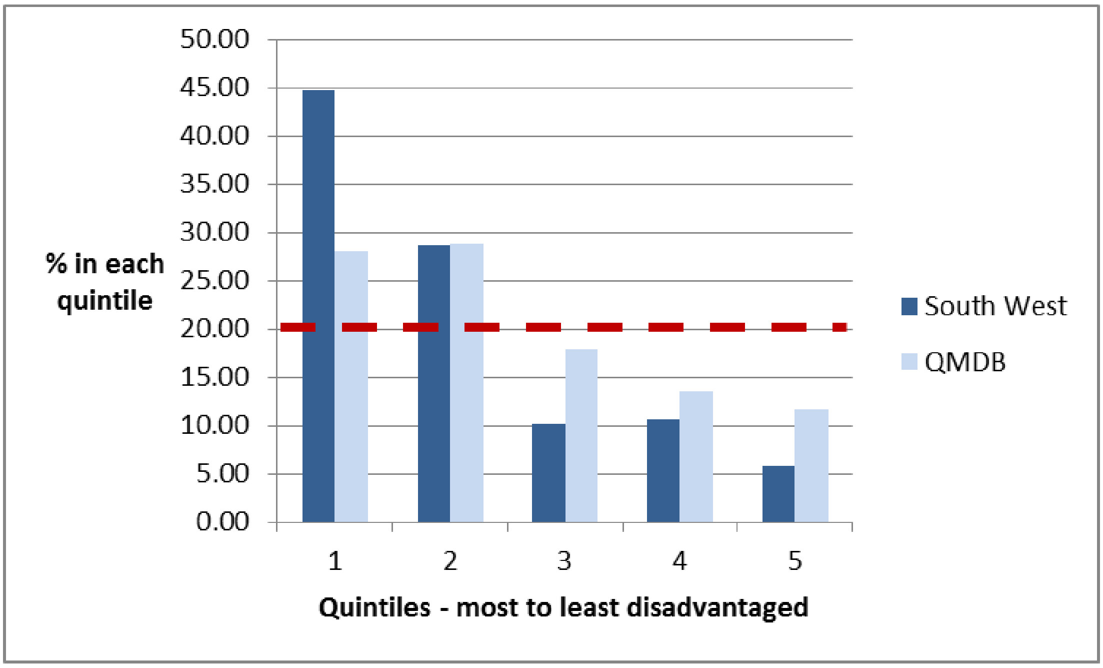
Industry	South West (number)	QMDB (number)	South West (%)	QMDB (%)
Communication Services	27	800	0.5%	0.79%
Financial & Insurance Services	49	2159	0.9%	2.14%
Real Estate Services	38	1150	0.7%	1.14%
Professional Services	95	3734	1.8%	3.71%
Administrative Services	54	1925	1.0%	1.91%
Public Administration & Safety	552	6406	10.4%	6.36%
Education & Training	382	8889	7.2%	8.83%
Health & Community Services	593	12002	11.2%	11.92%
Arts & Recreation Services	31	756	0.6%	0.75%
Other Services	139	3730	2.6%	3.71%
Unknown	158	2339	3.0%	2.32%
Total Persons	**5315**	**100675**		

Source: ABS, 2011

Social and economic disadvantage

The median family income is $1,281/week (slightly higher than the QMDB average of $1,245/week), while personal incomes are also higher at $576/week. The region has a similar level of low income families to the QMDB as a whole, with 17.5% of families making less than $600/week.

Figure 17: Index of relative socio-economic disadvantage, South West and QMDB



Source: OESR, 2011

Despite this higher median income, the index of relative socio-economic advantage reveals a greater proportion of residents in the most disadvantaged group compared to the QMDB or Queensland (latter shown by dotted red line). This suggests that the South West has more households with low income, people with no qualifications, or people in low skilled occupations.

6.2.3 Industry profile

Agricultural production was worth approximately $318 million in 2015 (ABS 2016). Just over three quarters of this value was generated through beef cattle, with 514 businesses producing a gross value of about $250 million. Sheep and lamb production for wool and meat products generated approximately $45 million. Grazing is, therefore, the predominant industry in the region.

The total value of crops to the region is approximately $3.5 million, which is made up of predominantly broadacre crops (valued at $2.3 million). The most significant crop was wheat production, with 5 businesses producing a gross value of $1.1 million. Tourism is also an important industry in the region, however, the value of tourism is not readily identified at the catchment level. The total value of tourism is presented in section 7.1.2.

6.3 Water quality and identified management actions in the region

The South West region comprises approximately 51% of the Queensland section of the Murray-Darling Basin, and as discussed above includes the Warrego, Paroo and Nebine drainage basins. It also includes the Bulloo drainage basin, a closed drainage system not connected to the Murray-Darling Basin.

The Currawinya National Park, in the Paroo catchment, includes the Currawinya Lakes (Ramsar site 43 – the only Ramsar listed site in the Queensland Murray-Darling Basin). Lake Numalla and Lake Wyara are the two largest lakes within the site. Lake Numalla, fed by the Paroo River is fresh and turbid while, only three kilometres away, Lake Wyara is saline and generally clear. Lake Numalla is also a semi-permanent water body while Lake Wyara dries regularly and becomes a vast saltpan (DoEE 2016).

The Currawinya Lakes are of international significance as part of an inland route for migratory shorebirds from East Asia, providing important summer feeding areas. They support breeding events (particularly for pelicans, gulls, terns, cormorants and swans), as well as providing refuge habitat in drought conditions for birds, amphibians, reptiles and native fish (DoEE 2016).

The DEHP have undertaken a risk assessment to identify the risk factors that are ranked medium and high-level risks for each surface and groundwater sub-catchment.

6.3.1 Surface water catchments

Across the South West region, the risk assessment identified two risk factors that are ranked as either medium or high risk as detailed in Table 17 (below). For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high. As can be seen from the table the widest spread risk factor is Elevated levels of suspended matter.

Table 17: Assessment of identified risk factors for surface water catchments, South West region

Risk factor	Risk ranking in each catchment			
	Bulloo	Paroo	Nebine	Warrego
Elevated levels of suspended matter—including deposited sediment	Very high	Very high	High	High
Dissolved oxygen outside natural (ambient) ranges	Medium	Medium		

Source: DEHP, 2017, QMDB Risk Assessment.

6.3.2 Groundwater SDLs

The South West region overlies three groundwater Sustainable Diversion Limit (SDL) resource units:

- St George Alluvium Warrego–Paroo-Nebine (GS63)[15]
- Warrego Alluvium (GS66)
- Sediments above the GAB: Warrego–Paroo–Nebine (GS60)
- Queensland MDB: Deep (GS56)[16].

Of these groundwater resources, the risk assessment only identified medium risks in St George Alluvium Warrego–Paroo-Nebine (GS63) (deep) (Table 18). For ease of reference the table only shows the sub catchments and risk factors that were rated to be medium or high.

Table 18: Assessment of identified risk factors for the groundwater sub-catchments, South West region

Risk factor	St George Alluvium (GS63) - deep
Elevated levels of salinity	Medium

Source: DEHP, 2017, QMDB Risk Assessment.

6.3.1 Management actions to address surface water and groundwater risks

The sources of the risks identified above can be urban diffuse, point source or rural diffuse. Section 8 describes the management actions that are available to address the risks depending upon the source of water quality degradation.

15 The Murray-Darling Basin Plan recognises the St George Alluvium groundwater aquifers as a single SDL resource unit however under Queensland water resource planning, this resource unit is managed as the St George Alluvium (shallow) and the St George Alluvium (deep).

16 This has not been included in the healthy rivers report (DEHP 2016b) but is ‘low risk’ from DEHP (2017) work.

7. Economic Contributions

7.1 Summary of Queensland Murray Darling Basin Region

7.1.1 Agriculture

It is estimated that there are 6,400 agricultural businesses in the Queensland MDB area. Total agricultural production in the Queensland MDB was worth approximately $3.162 billion in 2015. Of this 48% was generated in the Border Rivers Maranoa-Balonne region, 42% in the Condamine region and 10% in the South West region. Of this $1.489 billion (or 47%) is the total value of crops, which are predominately broadacre crops (valued at $1.158 billion).

Of the broadacre crops, the highest value crop in the QMDB is cotton, which contributes $383.16 million, while the highest value cereal crops are sorghum for grain ($310.20 million) and wheat for grain ($265.11 million).

The total value of cotton lint production (both irrigated and non-irrigated) to Queensland is $383.16 million, of which the Queensland Murray Darling Basin contributes $312.75 million. Approximately 56,340 ha of the region is used for cotton production by 175 businesses. The total area of cotton production in Queensland is in the order of 73,000 ha (225 businesses) so the QMDB is a major contributor to cotton production in Queensland.

There are around 50 wineries in the QMDB (all within the Border Rivers-Maranoa-Balonne region) which make up approximately 43% of Queensland's wine growing area and contributing $25 million (Queensland College of Wine Tourism, 2017).

Within the QMDB, cotton production occurs in the Condamine and the Border Rivers-Maranoa-Balonne region, with Condamine contributing $137.96 million, and the Border Rivers-Maranoa-Balonne region contributing $174.79 million.

Livestock for meat production contributes $1.391 billion to the region (of which $1.003 billion is generated through cattle production) while livestock products makes up a further $282 million. Grazing is therefore a major industry in the region.

Irrigated agriculture

Water for irrigated agriculture is taken from several options including creeks, rivers and lakes in the QMBD, Table 19.

Table 19: Water use by source

	Border Rivers Maranoa-Balonne	Condamine	South West Queensland	Grand Total
Water taken from irrigation channels or irrigation pipelines - Total volume used (ML)	129,962	3,600		**133,563**
Water taken from on-farm dams or tanks - Total volume used (ML)	364,289	177,620	11,082	**552,990**
Water taken from rivers, creeks, lakes, etc. - Total volume used (ML)	169,498	91,307	2,355	**263,159**
Water taken from rivers, creeks, lakes, etc. - Where a volumetric/usage charge occurs - Total volume used (ML)	147,184	40,564	1,036	**188,784**
Water taken from rivers, creeks, lakes, etc. - Where there is no volumetric/usage charge - Total volume used (ML)	22,314	50,743	1,318	**74,375**
Total	**833,247**	**363,834**	**15,791**	**1,212,872**

Source: Analysis of Australian Bureau of Statistics, Water use on Australian Farms, Australia –2014-15

Table 20 provides an overview of the uses of irrigated water across the region.

Table 20: Areas under irrigation

Irrigated crops	Border Rivers Maranoa-Balonne	Condamine	South West Queensland	Grand Total
Cotton - Area watered (ha)	51,624	50,009		101,633
Fruit trees, nut trees, plantation or berry fruits - Area watered (ha)	3,925	323		4,248
Grapevines - Area watered (ha)	759		50	809
Nurseries, cut flowers and cultivated turf - Area watered (ha)	345	43		388
Other broadacre crops - Area watered (ha)	4,194	9,613		13,806
Other cereals for grain or seed (e.g. wheat, oats, maize) - Area watered (ha)	33,262	55,238		88,500
Other crops n.e.c. - Area watered (ha)	107	4,893		5,000
Pastures (including lucerne) and cereal crops cut for hay - Area	1,772	9,761	30	11,563

Irrigated crops	Border Rivers Maranoa-Balonne	Condamine	South West Queensland	Grand Total
watered (ha) (c)				
Pastures (including lucerne) and cereal crops cut for silage - Area watered (ha) (d)	5,032	8,096		13,127
Pastures (including lucerne) and cereal crops used for grazing or fed off - Area watered (ha)	7,412	13,965	158	21,535
Vegetables for human consumption - Area watered (ha)	2,548	3,556		6,103
Total area watered (ha)	**110,979**	**155,497**	**238**	**266,713**
Total catchment area (ha)	**16,081,660**	**3,356,201**	**30,014,459**	**49,452,319**

Source: Analysis of Australian Bureau of Statistics, Water use on Australian Farms, Australia –2014-15

7.1.2 Tourism

People value many aspects of the towns, environment and its waterways with the Queensland MDB, whether they are local residents or visitors from outside the Basin. As illustrated in the previous sections, there are Ramsar wetlands that have been identified for their particular environmental value within *A Directory of Important Australian Wetlands* (Commonwealth of Australia, 2001) and these sites are likely to be used as tourism destinations and for recreational activities.

These tourism and recreation activities contribute to the local economy in terms of direct expenditure by visitors (e.g. venue entry fees, guided tours, accommodation, travel, souvenirs, food, etc) as well as social and wellbeing benefits of recreation and tourism, such as: physical recreation, education that may accompany tourist activities; and general wellbeing that may accrue from leisure time associated with tourism or recreation activities.

Tourism figures for the areas within the Murray-Darling Basin are difficult to quantify. Information provided by Tourism Research Australia is based on visitor surveys in local government areas (LGAs). In the region, tourism information is available for five of the relevant LGAs.

Table 21: Estimated number of visitors and amounts spent in Local Government Authorities within the Basin

	Bulloo, Paroo & Gilpie[1]	Murweh[2]	Maranoa	Goondiwindi	South Downs	Western Downs	Toowoomba
Visitors per year	110,000	66,000	243,951	144,643	787,000	722,000	2,602,000
Average spend/night ($)	117	121	98	87	101	78	118
Average spend/trip	205[2]	205[1]	205[2]	205[2]	213	205	200
Total $m	22.55	13.53	50.00	29.65	167.6	148.0	520.4

Source. Adapted from Tourism Research Australia (https://www.tra.gov.au/tra/2016/Tourism_in_Local_Government_Areas_2016/LGA_Profiles/index.html# (Accessed May 2017)) and Tourism and Events Queensland (http://teq.queensland.com/~/media/EDA6A5CB7ADF47ADBAD7B65847DEB435.ashx?la=en (Access May 2017))

Notes:

Blackall-Tambo Regional Council figures have not been included as only a small portion of the shire falls within the catchment boundaries. The Shires of Bulloo and Quilpie have been included as the Bulloo Catchment has been included in this study region.

Tourism and Events Queensland - http://teq.queensland.com/~/media/EDA6A5CB7ADF47ADBAD7B65847DEB435.ashx?la=en (Access May 2017)

Tourism and Events Queensland - https://cdn-teq.queensland.com/~/media/c0e7d5a2dcdb43a68397b00d5ff3ff70.ashx?la=en-au&vs=1&d=20140509T084802 (Accessed May 2017)

The average spend per trip has been assumed at $205 – an average of the known 'average spend per trip' in the region.

It is therefore estimated that tourism brings approximately $952 million to the Queensland Murray Darling Basin annually –refer 2012-2015 Local Government area profiles available http://teq.queensland.com/research-and-insights/domestic-research/tourism-profiles.

The Queensland Government recognises tourism as one of the four pillars of our economy and has a growth target for the tourism sector to reach $30 billion in overnight visitor expenditure by 2020[17][18]. Destination success: the 20 year plan for Queensland tourism outlines the direction for tourism in Queensland (refer http://www.destq.com.au/20-year-plan). The main goal of Destination success is to make Queensland the number one tourist destination in Australia, with a medium-term goal of achieving the national Tourism 2020 target (i.e. doubling 2010 visitor expenditure to $30 billion by 2020). Destination success contains six themes to direct efforts. The 2nd theme - Preserve our nature and culture - recognises the strong links between natural assets (including rivers, the Great Barrier reef, beaches, etc.) and tourism, stating 'To be competitive and successful over the next 20 years, we will preserve our nature and culture: Natural assets will continue to be the heart of the Queensland experience—able to be enjoyed

17 See http://www.business.qld.gov.au/industry/tourism/tourism-in-queensland/queenslands-tourismindustry/tourism-2020-strategy

18 Tourism and Events Queensland (2013) *Tourism and Events Queensland Strategic Plan 2013-17*.

by visitors and locals alike, and preserved for future generations…'. Water quality of rivers, streams, wetlands and coastal waters underpins the tourism sector and outdoor recreation opportunities for all residents and visitors. The Queensland Ecotourism Plan (2013–2020) has been prepared by the Queensland Government in recognition of the key role played by the environment in ecotourism experiences.[19].

The process to identify EVs and WQOs is consistent with the drivers and directions established in the plan, including: Recent international visitor research reveals Australia's biggest strength is its 'world class beauty' and natural environments, rated number one by visitor markets. Interest in nature is high amongst actual visitors to Australia, with 62% of international visitors engaging in nature-based activities. The strong interest of visitors in nature-based activities highlights the value of ecotourism to the Queensland economy. With nature-based activities across Queensland, ecotourism is an important driver of regional dispersal and contributor to regional economies. Successful ecotourism relies on the maintaining the natural values that are the basis for ecotourism: 'It is the quality of Queensland's unique natural environment with its rich biodiversity and wildlife that is the foundation of the state's tourism competitive advantage. Visitors' experiences are enriched by the outstanding natural and cultural values they encounter. Recognition of this advantage is the first step in making Queensland a world leader in ecotourism by 2020. Through best practice ecotourism, Queensland can deliver world-class experiences that retain the inherent natural values upon which the tourism industry depends and contribute to the sustainability of the natural areas as well as socially and economically to local communities. The need to conserve the natural values on which ecotourism is based is also reflected in the vision of the Queensland Ecotourism Plan, to be achieved by 2020:

> *'Queensland is Australia's number one ecotourism destination and recognised as a world leader in ecotourism, delivering best practice nature-based experiences that contribute to the conservation of our natural resources and cultural heritage….Underpinning the plan is acknowledgement that world-leading ecotourism is wholly dependent upon the conservation of Queensland's rich biodiversity and environmental and cultural resources. The plan demonstrates the commitment the Queensland Government, tourism industry and the community is making to balance preservation with presentation by providing best practice ecotourism.'*

7.1.3 Recreation for residents

The value of recreation is often measured by an approach known as the travel cost method. This approach is based on the premise that the value people ascribe to a site can be inferred from the amount of time and money they are willing to give up to access that site.

The travel cost methodology is a well-established economic technique that is suitable for valuing recreation sites such as the beaches and waterways. The value of the site can be inferred from the number of trips people make and the costs they incur, such as vehicle running costs and their own personal time.

There are limited studies that on the value of inland waterways in Queensland for recreation. But, in other parts of the MDB, Morrison and Hatton McDonald (2010) referred to studies

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19 (State of Queensland, 2013, Queensland Parks and Wildlife Service, available at http://www.nprsr.qld.gov.au/tourism/pdf/final-ecotourism-plan-2013.pdf)

valuing trips (in 2010 dollars) at "about $30-70 per visitor".[20] In addition, significantly higher values were identified for iconic sites such $561/trip for the Barmah Wetlands and $270/trip for the Coorong.

Based on the previous studies we have estimated the value of water based recreation to be around $58 (in 2017 values) per person per visit.[21] Based on the residential population 220,535[22] and an assumed average of 10 visits per year. This equates to a total value of $127.9 million per year.

Recreational fishing

An estimate of one form of recreation is recreational fishing. This recreation would include both tourists and locals, so should not be counted in addition to other estimates of tourism and recreation values. The estimates of the turnover arising from fishing are set out in Table 22. The table shows that the estimate of the turnover relating to recreation fishing is $104.1 million per year.

Table 22: Estimate of turnover arising from recreational fishing

MDB region	Annual economic expenditure (2012$)
Border Rivers	17,720,812
Condamine Balonne	79,767,104
Warrego	5,451,846
Paroo	1,188,192
Moonie	No info
Total	**104,128,000**

Source: Deloitte Access Economics, Benefits of the Basin Plan for the fishing industries in the Murray-Darling Basin, July 2012

7.1.4 Mining

The region includes four active thermal coal mines (New Acland Coal Mine, Cameby Downs, Commodore mine, Aberdare Collieries) which have a combined total production of 16.6 million tonnes per annum. This is estimated to be valued at around $1.7 Billion per annum.[23]

7.1.5 Coal Seam Gas

The QMDB overlies parts of the Surat basin – which is the focus of significant CSG production.

The Office of Groundwater Impact Assessment indicates that there were around 5,600 CSG wells in the Surat CMA in 2015. While, the exact number in the QMDB cannot be determined with the information available, it is estimated to be around 4,000 wells. The value and production from each well will vary. However, industry members have previously indicated that

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20 Professor Mark Morrison, Dr Darla Hatton MacDonald, *Economic Valuation of Environmental Benefits in the Murray-Darling Basin*, Report Prepared for the Murray-Darling Basin Authority 2010

21 Professor Mark Morrison, Dr Darla Hatton MacDonald, Economic Valuation of Environmental Benefits in the Murray-Darling Basin, Report Prepared for the Murray-Darling Basin Authority 2010

22 ABS – 2011 census

23 Based on average price for thermal coal for previous 5 years ($79USD per tonne) and the current exchange rate of $0.74USD per $1AUD.

a CSG well will cost around $1million to develop. Using this value and some other estimates[24] the annual average production per well can be estimated at around $300,000 per well. This gives a total estimated value of CSG in the region at $1.19 billion per year.

This estimation appears to be supported by published figures. The GasFields Commission's *Queensland's Coal Seam Gas (CSG) Industry Snapshot 2010-2016*[25] indicates the total industry spend in in 2015/16 was $909 million in the Darling Downs region and was $199 million in the South West region. This gives a total industry spend of $1.108 billion in the region. While this is an expenditure value, rather than income, the businesses must predict that income from sales will be greater than expenditure to undertake the investment.

7.1.6 Environmental values

The community benefits from the environment and from healthy waterways in a broad range of ways, including both as support for industry (such as agriculture), through recreation and property values and through sense of well-being.

Achieving WQOs in QMBD will benefit wetlands in the QMDB area as well as some wetlands in the NSW regions that are adjacent to the Queensland border.

Wetlands that are internationally significant are covered under the Ramsar convention and the proposed works would benefit a number of these wetlands. These include the Currawinya Lakes in Queensland and Paroo River Wetlands and Narran Lake Nature Reserve in New South Wales (as they are within the influence of Queensland waters). The total area of Ramsar wetlands and other wetlands that would benefit from water quality protection is set out in Table 23.

Table 23: Total area of wetlands that would benefit from water quality protection

	Queensland	New South Wales (within the influence of Queensland waters)	Total
Ramsar wetlands	150,864	146,645	**297,509**
Other wetlands	460,123	528,681	**988,804**
Total	**610,987**	**675,326**	**1,286,313**

Source: Analysis of data from Dept. of Environment & Energy, Interim Classification of Aquatic Ecosystems in the Murray Darling Basin based on the Australian National Aquatic Ecosystems (ANAE) Classification Framework - Wetlands

Previous studies have indicated that on average, respondents were willing to pay A$15.60 (in 2017 values) as a one-off payment per household for an extra 1,000 ha of healthy wetlands (Whitten and Bennett, 2001).

Using these values as best available estimates, these willingness to pay estimates suggest each household may be willing to pay $4,600 for the preservation of the Ramsar wetlands, and a further $14,800 for the preservation of the other wetlands. Note that this assumes that households have the same willingness to pay per every 1,000 hectares of wetlands. In reality,

[24] Wells are taken to have a short life (taken to be 5 years) and the company's cost of capital is estimated to be around 15%.

[25] http://www.gasfieldscommissionqld.org.au/resources/gasfields/csg-combined-snapshot-report-2010-16.pdf

households may be willing to pay more or less for every additional 1,000 hectares of wetland kept in good condition.

Based on the population there are estimated to be around 100,000 households in the QMDB and South West catchments. Under the assumptions set out above, this would give the total willingness to pay to keep the 1.287 million hectares of wetlands in QMDB and NSW healthy to be in the order of $1.95 billion for these households alone.

8. Description of management actions

The management actions that can be undertaken to protect and enhance water quality in the Queensland Murray-Darling Basin area fall under the following categories:

- Urban diffuse
- Point source
- Rural diffuse
- Water allocation

8.1.1 Urban diffuse

Increased population and expanded urban areas can potentially result in increased levels of pollution from diffuse sources. Urban areas can result in diffuse pollution such as elevated nutrients and sediment. However, this urban diffuse pollution can be reduced and managed through water sensitive urban design (WSUD)[26] and the use of stormwater quality 'treatment train' consisting of devices such as rainwater tanks, grassed swales, bio-retention basins and/or constructed wetlands increased pollutant loads from fertilising lawns etc. (DEHP 2016).

The requirements to ensure developments are undertaken that support environmental values making use of WSUD and stormwater quality 'treatment train' devices is set out in the current version of the *State Planning Policy code: Water quality* (Appendix 3) of the *State Planning Policy – April 2016* (DILGP 2016).

Note:

The Queensland government has recently consulted on an updated SPP[27] and it is proposed that the updated SPP (State Planning Policy 2017) commence in July 2017.

The most recent draft indicated that the requirements for WSUD in the MDB catchment (set out below) will not alter significantly

The State Planning Policy (SPP) defines the Queensland Government's policies about matters of "state interest" in land use planning and development. State interests are defined under the *Sustainable Planning Act 2009 (Qld)* and water quality is identified as a state interest.

The SPP seeks to ensure that 'the environmental values and quality of Queensland waters are protected and enhanced'. It includes provisions relating to planning schemes, acid sulphate soils and water supply buffer areas.

Appendix 3 of the SPP is the *SPP code: Water quality* and this effectively applies the code. The stated purpose of the SPP code is as follows:

> *Water quality is to ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in ways that support the protection of environmental values identified in the Environmental Protection (Water) Policy 2009. (DILGP 2016:69)*

26 Water sensitive urban design (WSUD) is a set of principles that can be applied to sustainably manage water, providing opportunities for the development industry, local government and their communities to achieve more liveable cities with vibrant and healthy waterways. (HLW 2017)

27 http://www.betterplanning.qld.gov.au/better-planning-home/planning-policy-review.html

The code is focussed particularly on urban diffuse pollution sources and contains detailed performance objectives town planning schemes as well as development and land use activities. These include stormwater management design objectives for construction (Table A) and post-construction (Table B) phases of urban development. The SPP is supported by the *State Planning Policy—State Interest Guideline – Water Quality*.

Construction Phase

Requirements for the construction phase apply to all urban development across all regions. The requirements set objectives relating to elements such as:

- Temporary drainage works
- Erosion control measures
- Sediment control measures
- Design storm for sediment control basins
- Sediment basin dewatering
- Litter and other waste, hydrocarbons and other contaminants
- Changes to the natural waterway hydraulics and hydrology

Post construction phase

The requirements for the urban developments under the post-construction phase are set out in Table B of the SPP.

The Queensland MDB catchment falls within the "Western Region" and in this region the post-construction stormwater management requirements apply to population centres greater than 25,000 persons. Table 24 sets out the minimum reductions in mean nutrient loads that are required.

Table 24: Design objectives - minimum reductions in mean annual load from unmitigated development (%)

Total suspended solids (TSS)	Total phosphorus (TP)	Total nitrogen (TN)	Gross pollutants >5 mm
85	60	45	90

Source: State Planning Policy code: Water quality (Appendix 3) of the State Planning Policy – April 2016, Table B

Due to the population threshold, post-construction stormwater management requirements would apply to Toowoomba Regional Council for the Toowoomba council area only (estimated residential population of 164,000)[28] within the Upper Condamine catchment. The area has undergrown steady grown and over the period from July 2002 to June 2016 the area has averaged 1,100 new residential dwellings per year.[29]

The management activities required to meet these criteria include management actions such as bio-retention basins.

28 http://profile.id.com.au/toowoomba/population-estimate

29 http://profile.id.com.au/toowoomba/building-approvals

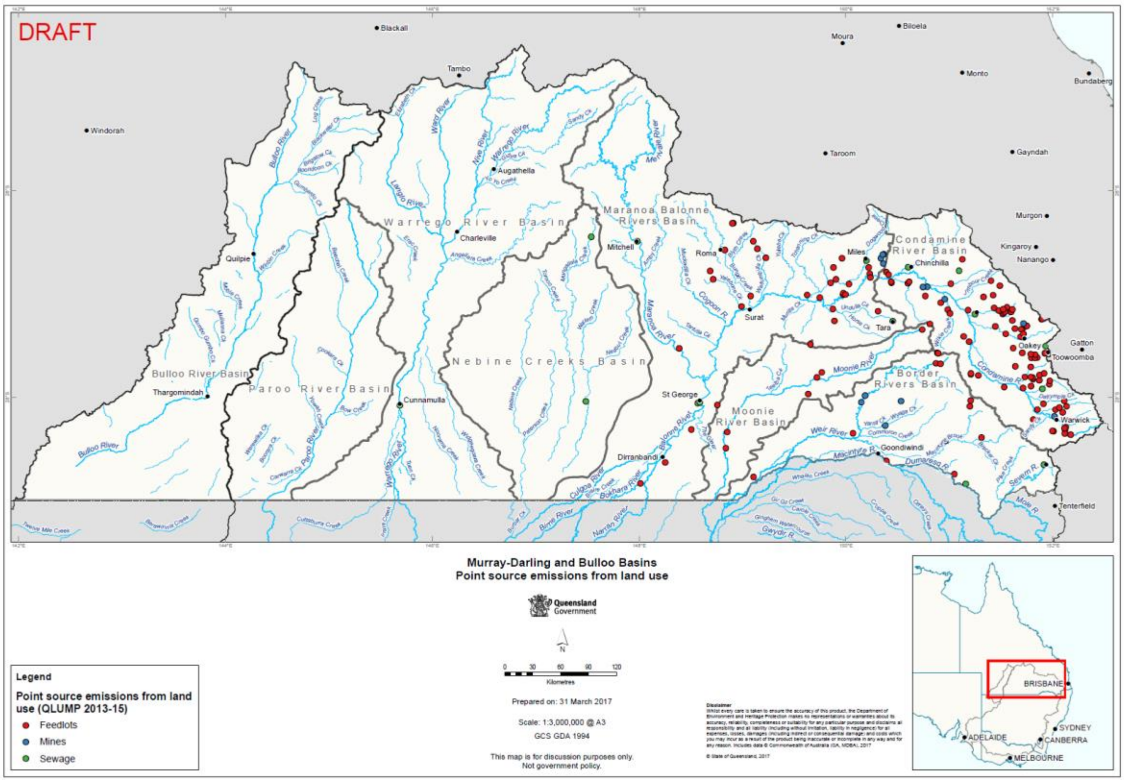
Other regional centres, in all other catchments in the study, fall below this threshold as they have a population of less than 25,000 people. It should be noted that councils below the threshold will still have a General Environmental Duty under the *Environmental Protection Act, 1994* and may still wish to implement post-construction phase actions to take reasonable and practical measures to reduce environmental damage.

8.1.2 Point source

Point source emissions arise from wastewater discharges from regulated activities such as wastewater treatment plants and industry such as cattle feedlots. Point sources are regulated under the *Environmental Protection Act, 1994* and are required to meet their water emission discharge limits.

A map of point sources across the Queensland MDB and South West catchments is provided in Figure 18 (below). It can be seen that feedlots make up the greatest number of point sources and all the point sources are focussed in the east of the region.

Figure 18: Map of point sources of emissions from land use



Source: DEHP, 2016 unpublished

8.1.3 Rural diffuse

Rural diffuse pollution arises from runoff in rural areas such as grazing and cropping land. Poor land management practices can result in both land management impacts such as loss of top soil and erosion, as well as water management impacts such as elevated nutrients, suspended solids (turbidity) and salinity.

Rural diffuse pollution is tackled on a voluntary basis through Natural Resource Management activities undertaken with the support of both Sate and Commonwealth funding as well as through implementation of best management practices such as Cotton MyBMP and Hort360.

In each catchment, the management actions will be tailored to align to the local land use and will be tailored to target the medium and high risks identified in the risk assessment. The existing Natural Resource Management plans for each of the regions will continue and, where necessary will be expanded to cover any new activities

Land uses

The predominant land use in each of the catchments is summarised in Table 25. From the table, it can be seen that grazing is a key land use across the region, with some irrigation in eastern catchments.

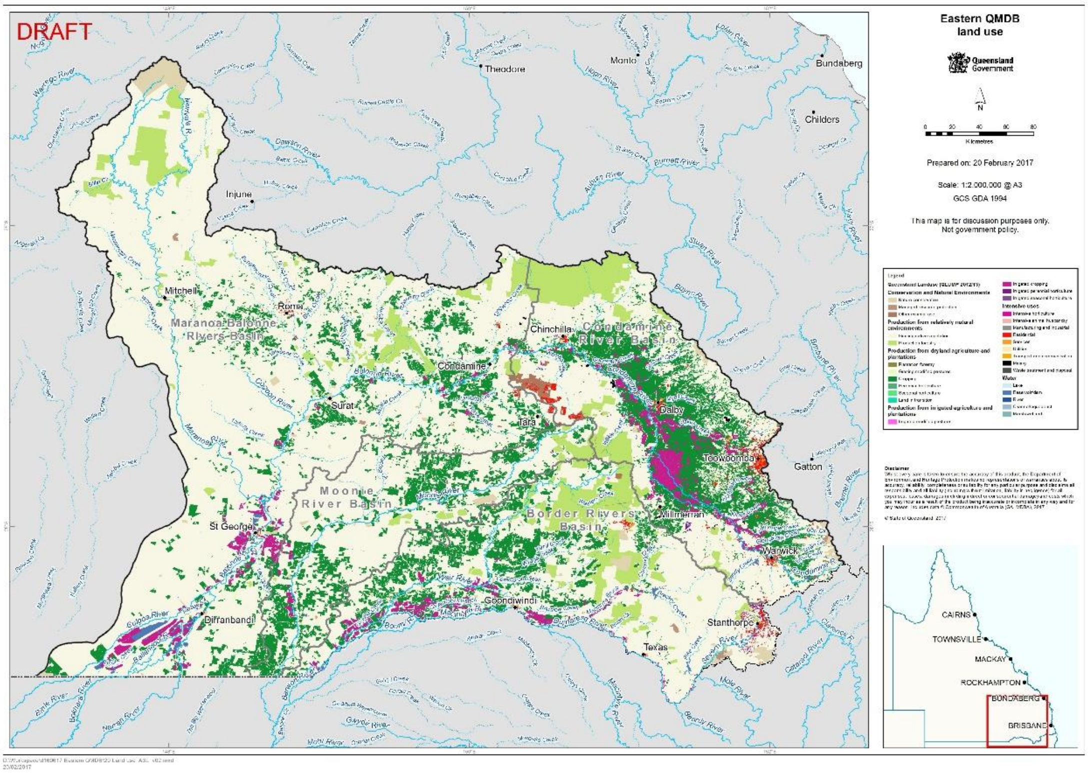
Table 25: Dominant land use in each catchment

Region	Rural diffuse land uses
Upper Condamine region	Dryland and irrigated agriculture, intensive livestock, forestry and grazing
Border Rivers region	Grazing, dryland and irrigated cropping and intensive livestock
Maranoa-Balonne region	Extensive grazing
South West region Warrego, Paroo, Bulloo and Nebine	Beef cattle grazing Sheep Grazing for wool production
Lower Balonne region	Dryland and irrigated agriculture, intensive livestock, forestry and grazing

Source: Collated from http://www.qmdc.org.au/module/documents/download/272 Lower Condamine, Maranoa, Balonne, Moonie and QLD Border rivers: QMDC NRM Plan and http://www.southwestnrm.org.au

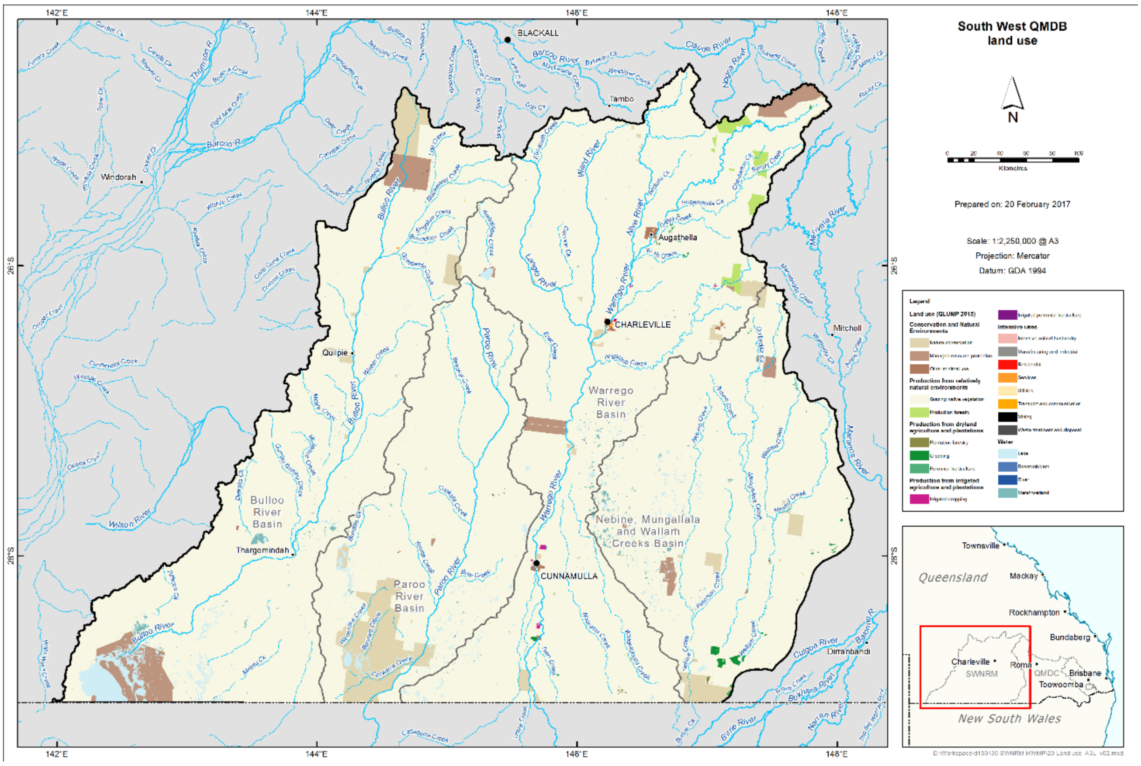
The land uses are also shown graphically in maps of the region in Figure 19 and Figure 20 (below).

Figure 19: Map of land uses in QMDB catchments



Source: DEHP, 2017

Figure 20: Map of land uses in South West catchments



Source: DEHP, 2017

Land forms

As the proportion of different landforms varies from one region to another, and the levels of pollutants that are transported also varies, the modelling of pollutants that will support the management planning considers a range of landforms:

- Gully;
- Hillslope surface soil;
- Streambank;
- Channel Remobilisation; and
- Other.

Modelled annual loads of sediment generation

DEHP are currently undertaking extensive modelling of each significant pollutant in order to identify the relative importance of each land use and each land form as the source of the pollution.

DEHP have completed modelling of sediment generation across each of the catchments by both land use and land form. These modelled sediment contributions (as a percentage) are presented for each of the catchments in Table 26 to Table 30 below.

Sediment runoff into the waterways is both a key pollutant (resulting in elevated readings of Total Suspended Solids) and is a useful indicator of the source of other pollutants across the catchment. Note in the tables below, the modelled output for system supply was proportionally allocated to the other functional units.

Table 26: Modelled Annual Loads as a Percent of Sediment Generation Process - Upper Condamine

Sediment Generation Process	Functional Unit used in Model															Grand Total
	Conservation	Dryland cropping	Forested grazing	Forestry	Horticulture	Intensive animal	Irrigated cropping	Mining	Open grazing	Other	Rural Residential	Stream	Urban	Waste Treatment	Water	
Gully	1.3%	28.9%	19.2%	8.6%	0.1%	0.1%	3.2%	0.3%	35.9%	0.3%	1.4%		0.1%	0.0%	0.5%	100%
Hillslope surface soil	4.1%		38.6%	13.3%					44.0%							100%
Streambank												100%				100%
Channel Remobilisation												100%				100%
All Sources %	**0.5%**	**6.2%**	**6.3%**	**2.6%**	**0.0%**	**0.0%**	**0.7%**	**0.1%**	**10.2%**	**0.1%**	**0.3%**	**73.0%**	**0.0%**	**0.0%**	**0.1%**	**100%**

Source: Unpublished DEHP analysis, 2017

Table 27: Modelled Annual Loads as a Percent of Sediment Generation Process - Lower Balonne

Sediment Generation Process	Functional unit used in model														Grand Total
	Conservation	Dryland cropping	Forested grazing	Forestry	Horticulture	Irrigated cropping	Mining	Open grazing	Other	Rural Residential	Stream	Urban	Waste Treatment	Water	
Gully	0.7%	16.6%	13.7%	0.1%	0.0%	8.3%	0.0%	55.9%	0.1%	0.0%		0.0%	0.0%	4.7%	**100%**
Hillslope surface soil	1%		20%	0%				79%							**100%**
Streambank											100%				**100%**
Channel Remobilisation											100%				**100%**
All Sources %	**0.5%**	**11.5%**	**9.8%**	**0.1%**	**0.1%**	**5.7%**	**0.0%**	**40.0%**	**0.1%**	**0.0%**	**28.9%**	**0.0%**	**0.0%**	**3.2%**	**100%**

Source: Unpublished DEHP analysis, 2017

Table 28: Modelled Annual Loads as a Percent of Sediment Generation Process - Maranoa Balonne

Sediment Generation Process	Functional Unit used in Model										Grand Total
	Conservation	Dryland cropping	Forested grazing	Forestry	Irrigated cropping	Open grazing	Other	Rural Residential	Stream	Water	
Gully	0.9%	13.1%	15.0%	2.9%	0.6%	66.8%	0.1%	0.1%		0.5%	**100%**
Hillslope surface soil	2.1%		25.8%	5.1%		67.0%					**100%**
Streambank									100%		**100%**
Channel Remobilisation									100%		**100%**
Other											
All Sources	**0.5%**	**6.0%**	**8.6%**	**1.7%**	**0.3%**	**35.3%**	**0.0%**	**0.1%**	**47.1%**	**0.2%**	**100%**

Source: Unpublished DEHP analysis, 2017

Table 29: Modelled Annual Loads as a Percent of Sediment Generation Process - Border Rivers /Moonie

Sediment Generation Process	Functional Unit used in Model												Grand Total
	Conservation	Cropping	Forested Grazing	Forestry	Horticulture	Irrigated Cropping	Mining	Open Grazing	Other	Stream	Urban	Water	
Gully	7.6%	17.6%	10.9%	2.1%	0.1%	2.2%	0.0%	59.0%	0.3%		0.0%	0.1%	100%
Hillslope surface soil	14.7%		18.7%	2.8%				63.8%					100%
Streambank										100%			100%
Channel Remobilisation										100%			100%
Other													
All Sources	**2.8%**	**5.1%**	**3.9%**	**0.7%**	**0.0%**	**0.6%**	**0.0%**	**19.5%**	**0.1%**	**67.3%**	**0.0%**	**0.0%**	**100%**

Note: Moonie/Border Rivers models Functional Units were adjusted to the majority of land use within the area

Source: Unpublished DEHP analysis, 2017

Table 30: Modelled Annual Loads as a Percent of Sediment Generation Process – South West region

Sediment Generation Process	Functional Unit used in Model										Grand Total
	Conservation	Cropping	Forestry	Grazing Alluvial Open	Grazing Hard Country Open	Grazing Sandplains Open	Grazing Woodlands Forests Open	Grazing Other	Stream	Water	
Gully	1.9%	0.0%	0.0%	17.4%	46.3%	7.2%	17.1%	7.7%		2.3%	**100%**
Hillslope surface soil	3.3%		0.1%	11.3%	45.7%	11.6%	18.8%	9.2%			**100%**
Streambank									100%		**100%**
Channel Remobilisation									100%		**100%**
Other											
All Sources %	**1.1%**	**0.0%**	**0.0%**	**7.6%**	**22.6%**	**4.2%**	**8.6%**	**4.0%**	**51.1%**	**0.8%**	**100%**

Note: South West region models functional units were adjust to the majority of land use within the area

Source: Unpublished DEHP analysis, 2017

8.2 Benefits of maintaining environmental values

Both economic sectors and human interactions with the environment are affected when water quality declines. Examples of these are:

- water supply costs may rise when problems increase the treatment requirements to ensure regulated standards are met (e.g. nutrient loads, pathogen, sediment, toxicity, salinity, changed pH).
- recreation opportunities for locals and tourists would be damaged if water quality declined. Commercial and recreational fishing could be damaged by falling fish stocks resulting from disruption to natural systems; and
- cultural values for both Indigenous and non-Indigenous communities will be diminished if the rivers and wetlands are not kept in a healthy condition.

The Draft environmental values and water quality guidelines reports[30] attributes the relevant environmental values to each of the catchments in the area. The full set of environmental values used are set out in Figure 231.

[30] http://www.ehp.qld.gov.au/water/policy/

Figure 21: Environmental Values: icons and definitions

Aquatic ecosystem
- The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways, waterholes and riparian areas, for example, biodiversity, ecological interations, plants, animals, key species (such as turtles, yellowbelly, cod and yabbies) and their habitat, food and drinking water.

Irrigation
- Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.

Farm water supply/use
- Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.

Stock watering
- Suitability of water supply for production of healthy livestock.

Aquaculture
- Health of aquaculture species and humans consuming aquatic foods (such as fish and prawns) from commercial ventures.

Human consumers of aquatic foods
- Health of humans consuming aquatic foods, such as fish and prawns, from natural waterways.

Primary recreation
- Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, diving and water-skiing.

Secondary recreation
- Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating, rowing and fishing.

Visual recreation
- Amenity of waterways for recreation which does not involve contact with water. For example, walking and picnicking adjacent to a waterway.

Drinking water supply
- Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.

Industrial use
- Suitability of water supply for industrial use, for example, food, beverage, paper, petroleum and power industries, mining and minerals refining/processing. Industries usually treat water supplies to meet their needs.

Cultural, spiritual and ceremonial values
- Cultural, spiritual and ceremonial values of water means its aesthetic, historical, scientific, social or other significance, to the past, present or future generations.

Source: DEHP 2017

By maintaining environmental values the costs of declining environmental values are avoided – which can be considered a benefit to the community. To estimate monetised values for the benefit of maintaining environmental values the analytical process followed two steps:

- Firstly, we considered the linkage between the identified risk factors and environmental values;
- Secondly, we identified existing estimates for the relevant environmental values.

It should be noted that the estimates provided here are indicative of what the environmental values are worth.

Estimated benefit of maintaining environmental values uses a Total Economic Value framework (set out in attachment 2) and utilises benefit transfer techniques - which put simply uses previous estimates of environmental values for similar settings. It should be noted that benefit transfer only provides a reasonable estimate of the environmental value where the environment and the population characteristics are quite similar.

In assessing the benefits, we have focussed on the change in environmental values that would arise from the management actions. This can be considered in terms of the four condition levels for waters that are identified in the EPP Water – and are set out in Table 31.

Aligning the outcomes of management actions to condition levels allows analysis of the change in benefits that would arise from a 1 or 2 level change in environmental condition.

Table 31: Levels of aquatic ecosystem condition.

Ecosystem condition	Definition
Level 1 High ecological value (HEV) ecosystems	Waters in which the biological integrity of the water is effectively unmodified or highly valued.
Level 2 Slightly disturbed ecosystems	Waters that have the biological integrity of high ecological value waters with slightly modified physical or chemical indicators but effectively unmodified biological indicators.
Level 3 Moderately disturbed ecosystems	Waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree.
Level 4 Highly disturbed ecosystems	Waters that are significantly degraded by human activity and have lower ecological value than high ecological value waters or slightly or moderately disturbed waters.

Source: Department of Science, Information Technology and Innovation, Queensland, 2017, Draft environmental values and water quality guidelines: Queensland Murray Darling Basin

8.2.1 Mapping of risk factors to environmental values

In considering environmental values, Marsden Jacob applied the Total Economic Value (TEV) framework – which is described in detail in attachment 2. In summary, the Total Economic Value framework disaggregates and identifies the full range of benefits that a community may gain from an environmental resource.

Each of the "risk factors" identified in the risk analysis align to a "risk" which is strongly linked to environmental values.

If not managed all environmental values have the potential to be impacted by risks to water quality, however, the risk assessment highlighted that some of the most at risk values are the following:

- Water quality unsuitable for aquatic ecosystem environmental value
- Water quality unsuitable for irrigation
- Water quality unsuitable for aquaculture and/or human consumers
- Water quality unsuitable for primary, secondary or visual recreation

The benefit estimates below are concentrated on these environmental values.

8.2.2 Benefit estimates

Water quality unsuitable for irrigation

The key risk factor that threatens water for irrigation relates to elevated salinity levels in waters and, potentially, groundwater systems. At lower levels salinity may impact on yields for irrigated agriculture and at higher levels it may make the water unsuitable for irrigation or for cattle.

Table 32 provides indicative electrical conductivity (EC) tolerances for example crops typically grown in the QMDB and South West catchments.

Table 32: Irrigated crops and tolerance of plants to salinity in irrigation

Pastures and crops	Electrical conductivity (dS/m) threshold for yield reduction for crops growing in		
	sand	Loam	clay
Pasture for grazing	1.8-12.8	1.0-7.3	0.6-4.2
Cereal crops for grain or seed	9.4 (wheat)	5.3 (wheat)	3.1 (wheat)
Cotton	12.1	6.9	3.9
Other broadacre crops	4.4 (peanut)	2.5 (peanut)	1.5 (peanut)
Horticulture	2.9 (orange)	1.7 (orange)	1.0 (orange)
Grapevines	3.3 (grape)	1.9 (grape)	1.1 (grape)

Note: 1 dS/m= 1,000 µS/cm.

Source: Queensland Government: DERM (2009) Irrigation water quality—salinity and soil structure stability

Achieving WQOs will provide some benefits to irrigated agriculture through the maintenance of productive yields and by ensuring that remediation costs are not incurred by irrigators in the future. Based on studies elsewhere, because of the time lags between undertaking remediation activities and productivity being restored, remediation is rarely economically viable.

The value of water that is suitable for irrigation can be estimated based on either water trades or Gross margin analysis.[31] In the Condamine region the ABS reports that in 2014-15 a total of 11,897 ML or water was purchases on a temporary basis for a total cost $1,156,541. This equates to a value of $97 per ML which is 9.7 cents per kL.

Water quality unsuitable for aquaculture and/or human consumers

This risk outcome links to two environmental values:

- aquaculture – which is defined as health of aquaculture species and humans consuming aquatic foods (such as fish and prawns) from commercial ventures; and

[31] Gross margins are simply the difference between sales revenue and the production costs, excluding fixed costs such as overheads, interest payments and tax. Changes in gross margins will be the net impact of both any changes in yields (and subsequent revenues) and changes in inputs costs.

- human consumers of aquatic foods – which is defined as Health of humans consuming aquatic foods, such as fish and prawns, from natural waterways.

There is limited data on aquaculture in the region that appears to indicate that this industry is quite small.

Recreational fishing in natural waterways is considered both as a recreation value and as a consumption value. Given this split of the value of the consumption of recreational fishing will be similar to the value commercial fishing and will be based on the market price of the relevant fish products for consumption.

Indicative values for the value of improved water quality can be imputed from previous work on the Benefits of Basin Plan for the MDB fishing industries. These values are set out in Table 33 and this shows current ($2017) values for each of the regions.

Table 33: Marginal impact of the Basin Plan on recreational fishing

MDB region	% Increase in End of system water flows	Annual economic expenditure (2012$)	Change in consumer surplus (2012$)	Change in consumer surplus (2017$)
Border Rivers	5.66%	17,720,812	46,865	51,580
Condamine Balonne	21.48%	79,767,104	799,998	880,475
Warrego	1.63%	5,451,846	4,150	4,567
Paroo	0%	1,188,192	-	
Moonie	3.05%	No LGA info	No LGA info	

Source: Deloitte Access Economics, Benefits of the Basin Plan for the fishing industries in the Murray-Darling Basin, July 2012

Water quality unsuitable for primary, secondary or visual recreation

As set out in section 7.1.23 the total value of recreation in the region is estimated to be $127.9 million per year.

However, this gives an estimate of the total value, rather than the change in value that would arise from the management actions.

Water quality unsuitable for aquatic ecosystem environmental value

As set out in the TEV framework, habitat and ecosystem values are considered to be "non-use" values – which means that people attribute a value to these environmental features, even if they do not plan to visit or use the feature. Estimates of the monetised value of aquatic ecosystems are obtained through willingness to pay studies such as Contingent Valuation and Choice Modelling surveys.

As no willingness to pay assessments have been identified for the Queensland MDB catchments, we have referred to values obtained for South East Queensland.

The value of ecosystems services was examined in a major study of South East Queensland catchments in 2010.[32] The study found that of the various environmental issues examined, the highest economic values attributed by survey respondents related to water quality in creeks and rivers and coastal condition.

The 2010 study used a choice modelling technique to identify that households were willing to pay, on average, $135 (in 2016 values) per annum to avoid expected declines in water quality of creeks and rivers, $62 per annum for the protection of coastal vegetation and seagrass, and a further $17 per annum to maintain the current area of inland wetlands.[33] In total, the results indicate that households are each willing to pay at least $214 per year[34] to prevent any decline in ecosystem services.

8.2.3 Total benefits

We have estimated the unit benefits of the proposed management actions.

The total scale of the benefits will become clearer as the management actions are implemented.

8.3 Costs of improving or maintaining water quality

The costs of improving or maintaining water quality have been separated into urban diffuse, point source and rural diffuse.

8.3.1 Urban diffuse

As set out in section 8.1.1 there are existing planning policies for the management of urban diffuse water pollution. These policies impact most significantly larger urban centres, and in the post construction requirements only apply to Toowoomba.

The regulatory burden of Water Sensitive Urban Design was calculated for the Queensland Competition Authority in 2012.[35] The elements relating to water pollution (per house) are set out in Table 34, below. As can be seen from the table, the construction of Bioretention basins is the largest single item and is over half of the total cost.

32 Marsden Jacob Associates (2010) Managing what matters: The cost of environmental decline in South East Queensland prepared for South East Queensland Catchments

33 Information for non-water related services was also obtained but is not reported here.

34 Inflated to 2016 dollar (RBA Inflation calculator). Original citation $190 per household per year in 2010 values.

35 Mainstream Economics, *Measuring the regulatory burden of Water Sensitive Urban Design in South East Queensland - A report for the Queensland Competition Authority*, December 2012

Table 34: Estimated full cost of WSUD per property — detached houses

Cost element	Medium Estimate ($2012)	Medium Estimate ($2017)
Substantive		
Capital		
Design	$299	$329
Bioretention basins	$2,200	$2,422
Detention basins	$250	$275
Annual operating and maintenance		
Other WSUD	$31	$34
Opportunity cost — cash cost embedded in WSUD capital costs	$0	$0
Training and capacity building	$23	$25
Administrative		
Development assessment processing — local government	$250	$275
Development assessment processing — state	$13	$14
Asset handover	$12	$13
Total	**$3,078**	**$3,389**

Source: Adapted from Mainstream Economics, Measuring the regulatory burden of Water Sensitive Urban Design in South East Queensland - A report for the Queensland Competition Authority, December 2012

The requirements for urban diffuse pollution are not directly impacted by the development of EVs and WQOs and therefore the marginal cost increase is likely to be minimal or zero.

8.3.2 Point source

As set out in section 8.1.2, in the study area point sources for pollutant loads which can impact surface or ground water resources include waste treatment plants, chemical processing, piggeries, and mine sites.

Table 35 illustrates the some of the estimated costs of water treatment (wastewater treatment plants). Importantly the requirements on point source pollution sources will not be directly impacted by the development of EVs and WQOs and therefore the marginal cost increase is likely to be minimal or zero.

Table 35: Water treatment infrastructure costs (wastewater treatment plants)

Cost item/unit	Lower bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
WWTP upgrades - reducing nitrogen to 2 mg/L $/tonne/year	200,000	500,000	800,000	Includes operating costs and capital costs (amortised over 20 years). Significant variation depending on current concentrations and existing treatment infrastructure.
WWTP upgrades – reducing phosphorus to 2 mg/L $/tonne/year	35,000	55,000	75,000	Includes operating costs and capital costs (amortised over 20 years). Significant variation depending on current concentrations and existing treatment infrastructure.
WWTP upgrades - cost of reducing phosphorus to 5 mg/L $/tonne/year	150,000	230,000	380,000	Includes operating costs and capital costs (amortised over 20 years). Significant variation depending on current concentrations and existing treatment infrastructure.
Water quality abatement (cost per kg of nitrogen)	600	800	1,200	Cost based on the average cost of treating nitrogen. Cost varies depending on type of development.

Source: Marsden Jacob Associates, report on the economic and social impacts of protecting environmental values in Great Barrier Reef catchment waterways and the reef lagoon - Report prepared for Queensland DEHP, 2013

8.3.3 Rural diffuse

Primary industries are a relatively important contributor in the study area. The predominant land use is grazing across all the catchments, with some dryland and irrigated agriculture and intensive livestock occurring in some of the catchments.

Across the Upper Condamine, Border Rivers-Maranoa-Balonne, and South West regions, approximately 90% of land holding is classified as agricultural production.[36]

In the Upper Condamine region, the Condamine Alliance has a number of programs which support sustainable agriculture through issues such as managing weeds and pests (flora and fauna), improving water quality and replanting of native vegetation.

In 2015-16, it estimated that 16,538 ha of land was improved through a $3,188,678 investment across the catchment (where 1,141 landholders and 11 Landcare and community groups were involved)[37]. Therefore, improvement was achieved at an average cost of $192.81/hectare.

Previous studies have estimated the cost arising in improved management actions in similar catchments in Queensland. These have identified the conditions as:

- A. Practices likely to maintain land in **good** condition and/or improve land in lesser condition.

36 ABS (2016) *Land Management and Farming in Australia, 2014-15.* Cat 4627.0

37 http://www.condaminealliance.com.au/programs

- B. Practices likely to maintain land in **fair** condition and/or improve land in lesser condition.
- C. Practices likely to degrade some land to **poor** condition.
- D. Practices likely to degrade some land to very **poor** condition.

A previous study from the Burnett Mary region[38], Table 36 shows that there would be some cost to the landowner when implementing improved management practices, and these are dependent on the practices undertaken. A movement from C to B results in a cost of $2.10/ha while B to A sees a slightly higher cost of $5.20/ha.

Table 36. Unit costs of amending agricultural management practices in Burnett Mary

Management practice change		Average cost $/ha		
Existing practice	Future practice	Capital cost	Maintenance cost (annual cost)	Change in farm profit
C	B	10	1	-2.1
B	A	37	3.7	-5.2

Source. Alluvium (2016) Costs of achieving the water quality targets for the Great Barrier Reef. July 2016

Applying fertiliser at a rate that is taken up by grasses, crops and horticulture will reduce the amount of potential run-off of nutrients. While 55% of agricultural businesses in the Condamine region apply fertiliser, figures for the combined Border Rivers-Maranoa-Balonne show that only 7% of businesses are applying fertiliser.[39]

A tender program for changed horticulture practice in the Burnett Mary revealed costs of $0.23 per kg/N, $1.78 per kg/P and $1.62 per tonne of sediment (Rolfe and Windle 2011).

Managing grazing access to riparian areas reduces pressure on riparian vegetation, which reduces the risk of erosion and subsequent deterioration in water quality. It also reduces the nutrients produced from cattle near the water.

Approximately half of agricultural businesses in the region whose properties contained creeks, rivers or wetlands undertook activities to protect these areas (53% - Upper Condamine; 53% - Border Rivers-Maranoa-Balonne; and 51% - South West).[40] The most commonly used activities were:

- Livestock exclusion (total or controlled);
- Managing weeds, pests and feral animals; and
- Retaining native vegetation.

Table 37 provides estimates of the cost (generally per hectare) of some of these potential management practices used to improve the quality of the environment in the catchment regions.

[38] Alluvium (2016) *Costs of achieving the water quality targets for the Great Barrier Reef.* July 2016

[39] ABS (2016) *Land Management and Farming in Australia, 2014-15.* Cat 4627.0

[40] Ibid

Table 37. Estimated costs of potential management actions

Cost item/unit	Lower bound estimate ($/unit)	Medium estimate ($/unit)	Upper bound estimate ($/unit)	Comments
Revegetation (total cost per ha)	905	2,809	8,474	Includes cost of project management, transport costs, site preparation, seed or seedlings, labour, fencing and other commonly encountered costs such as tree guards. Depends heavily on the type of revegetation being carried out, with assisted natural revegetation being the least expensive and rainforest regeneration in moist tropical regions being the most expensive. Offsets policy may determine what type of revegetation required. Factors impacting cost include accessibility of site, availability of seedstock, and extent of site preparation and follow up care.
Weed eradication (per ha)	15	1,528	4,000	Cost includes materials and labour. Variability depends heavily on type of weed eradication method chosen. For example, grazing as a method of weed eradication is far less expensive than manual removal of weeds. Variability in costs also depends on size of site, accessibility, region and terrain. Landowners are legally responsible for controlling some weeds while other weeds may need to be eradicated based on the property management plan developed.
Chemical control of weeds by industry (cost per ha)				Includes fungicides, insecticides, pesticides and herbicides for crop and pasture.
Grain	57	59	61	
Dairy	7	8	8	Non-chemical costs (mainly labour) also included.
Beef	1	1	1	
Cotton	198	215	231	Variability in costs depends on size of site, commodity type, accessibility, region and terrain.
Sugar	104	108	112	
Fruit	93	190	287	
Vegetables	92	179	265	
Pest eradication (cost per ha)[1]	10	148	500	Cost includes material and labour for pest control. Cost variable depending on the pest being targeted, severity of infestation and eradication method used. For example, chemical control of insect pests is less expensive than shooting of vertebrate fauna pests.
Establishing replacement wetlands—small (cost per ha)	800,000	900,000	1,000,000	Should include site preparation, removal of exotic plants, establishment of new plants and property management for the establishment of the site. Cost will vary depending on size, prior condition of site, location of site (especially the choice between urban or rural land) need for water re-routing and availability of necessary plants and expertise. Likely to be significant costs over a fairly long period, as plants are progressively introduced. A well-run wetland mitigation bank would probably decrease transaction costs and lead to a better environmental outcome.

Establishing replacement wetlands—medium to large (cost per ha) + establishment cost of $738,607	275,130	343,913	412,696	Should include site preparation, removal of exotic plants, establishment of new plants and property management for the establishment of the site. Cost will vary depending on size, prior condition of site, location of site (especially the choice between urban or rural land) need for water re-routing and availability of necessary plants and expertise. Likely to be significant costs over a fairly long period, as plants are progressively introduced. A well-run wetland mitigation bank would probably decrease transaction costs and lead to a better environmental outcome.
Fencing to exclude stock and pests (per km of fence)[1]	1,350	2,810	6,175	Includes materials (wire, posts and gates) and labour. Cost of depends on the shape of area to be fenced, the type of stock excluded and the nature of the terrain. Cashflow requirements heavily skewed towards the short term.
Establishing watering points (per watering point)	3,758	4,175	4,593	Includes capital costs of troughs, reservoir, pipes and reticulation per watering point. Number of points required dependent on riparian zone excluded, existing access to riparian zone and number of cattle. Cashflow requirements heavily skewed towards short term.
Gulley treatment to reduce erosion /km treatment	5,000	27,500	50,000	Treatment costs affected by current condition of gully, soil types, slope, vegetation requirements, requirements for engineering options. Significant cost saving potential through targeted site selection. Significant potential cost savings through choice of policy instruments (potential for use of MBIs to select and secure offset sites). Cashflow requirements heavily skewed towards short term.
Salinity mitigation ($/tonne of salt removed) Evaporative Basin (100 ha) Reverse osmosis Tree plantation Cap and pipe bores	1,800 1,580 4,200 1,850	2,158 2,385 7,150 2,565	2,516 3,189 10,100 3,280	These figures represent the net present value of the salt mitigation options. Cost will vary depending on many factors including availability of offset projects, value of other uses for project (e.g. sale of treated water).

Source. Marsden Jacob Associates, report on the economic and social impacts of protecting environmental values in Great Barrier Reef catchment waterways and the reef lagoon - Report prepared for Queensland DEHP, 2013

1. Cost of the fencing will not only be dependent on the type of pests seeking to be eradicated but also whether or not a completely new fence was being erected. For example, a program running on Banff Downs, Morven (in the Nebine catchment) installed 2 different fence types to reduce wild dogs and kangaroos in order to reduce grazing pressure. Fence 1 (an old dog netting fence with new wire running next to it) had a cost of $2,300/km while Fence 2 (a totally new fence) cost $4,000/km[41].

[41] http://www.leadingsheep.com.au/wp-content/uploads/2013/05/Exclusion-Fencing-Case-Study-Banff-Downs-Morven.pdf

8.3.4 Water allocation

The key water allocation management action would be the implementation of a cap on water use – as set out in the Murray-Darling Basin Plan 2012.

The value of water for any reduction in water use will be defined by its opportunity cost and will depend on water usage in the region.

The value of water for irrigation indicated in the previous section ($97 per ML per annum which equates to 9.7 cents per kL per annum) provides a useful indicator. However, the true cost will vary depending on the location, water use in the area and the season.

8.3.5 Total costs

We have estimated the unit costs of the proposed management actions.

The total cost of voluntary based management actions will become clearer as they are implemented through time.

However, there is a strong case for maintaining and enhancing waterway health in the region in conjunction with facilitating sustainable regional development. The challenge for policy makers is recognising the trade-offs between regional development and waterway health and establishing development pathways that genuinely meet both objectives.

Appendix 1: Risk assessment process

In identifying the environmental values that are most at risk the DEHP applied a risk assessment process that followed accepted risk assessment frameworks and is detailed in AS/NZS ISO 31000:2009[42]

Using the process set out in the standard the risk assessment considers both **likelihood** and **consequence** of an event. The risk is then the function of the score applied for each element. In this manner, the function can be written mathematically as

Risk = likelihood x consequence.

For this risk assessment DEHP defined the scope of risk being assessed as:

- Current risk = risk under the current plan (WRP)
- Effects of any water recovery to date shouldn't be considered (this will be included as part of the mitigation scenario)

Defining likelihood

The likelihood is the chance of the risk occurring within the timeframe considered by the assessment (how likely is it to occur?). The likelihood categories and their definitions are listed in Table 1.

Table 1: Likelihood definitions

Likelihood categories	Definition	Score
Rare	Occurs only in exceptional circumstances (occurrence probability < 15%)	1
Unlikely	Uncommon, could occur but not expected (occurrence probability 15–34%)	2
Possible	Could occur in the assessment area (occurrence probability 35–64%)	3
Likely	Will probably occur in most circumstances (occurrence probability 65–84%)	4
Almost certain	Is expected to occur in most circumstances – will be evident throughout the assessment area (occurrence probability > 85%)	5

42 https://infostore.saiglobal.com/store/details.aspx?ProductID=1378670

Defining consequence

Consequence is the expected impact on the relevant environmental, economic and social/cultural values, should a risk occur. This is separate to the consideration of how likely something is to occur (covered by Likelihood above). Consequence definitions are provided below for environmental, economic and social/cultural values in Table 2 below. Select the most appropriate column that applies to the assessment e.g. environmental, or where all three impacts are relevant and need to be considered as part of the risk assessment, select the column with the highest consequence to arrive at one consequence level for a risk.

Table 2: Consequence definitions

Consequence	Environmental impacts	Economic impacts	Social/cultural impacts	Score
Insignificant	Impact on aquatic environmental values is negligible/undetectable	Minimal or no financial losses.	Minimal or no impact on Indigenous or non-Indigenous heritage sites or values, recreational values and amenity.	1
Minor	Minimal detectable impact on environmental value, minor reduction in population size and community structure, change in food resource availability, recovery likely within a short time frame,	Financial loss requiring some reprioritisation and/or restructuring of business.	Minor impact on Indigenous or non- Indigenous heritage sites or values, recreational values and amenity.	2
Moderate	Obvious and significant impacts on environmental value, change in community structure (loss of sensitive species), moderate habitat disturbance and loss, recovery possible within years.	Significant individual financial loss with minimal community level impact.	Moderate impact on Indigenous or non-Indigenous heritage sites or a vital community resource, recreational values and amenity	3
Major	Significant spatial and temporal impact on environmental values, changes to long-term recruitment processes possibly leading to local extinction of one or more populations, loss of sensitive species, major changes in food resources and food webs, major habitat loss.	Major financial loss with severe individual and some community level impact.	Major disturbances to significant Indigenous or non-Indigenous heritage sites &/or values, recreational values and amenity. Access to resource denied, or vital community resource unavailable, in the medium to long-term.	4
Catastrophic	Extreme and widespread impacts – loss of species, dramatic changes to communities and ecosystem functions, replaced with generalists, exotic biota, and extensive loss of habitat.	Disastrous long-term financial loss with severe individual and community level impact.	Major disturbances to significant Indigenous or non-Indigenous heritage sites & or values, recreational values and amenity. Site access or vital community resource permanently removed.	5

For each risk, the total risk score allocated was the function of the Likelihood and the consequence. In this manner, all risks received a score of 1 to 25 inclusive. This is shown in Table 3.

Table 3: Risk assessment matrix

Likelihood		Consequence: Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Rare	**1**	1	2	3	4	5
Unlikely	**2**	2	4	6	8	10
Possible	**3**	3	6	9	12	15
Likely	**4**	4	8	12	16	20
Almost certain	**5**	5	10	15	20	25

Based on the scores in Table 3, the level of risk is categorised into low, medium or high as per the scoring in Table 4.

Table 4: Level of Risk

Risk ranking	Scores
High	12–25
Medium	8–11
Low	1–7

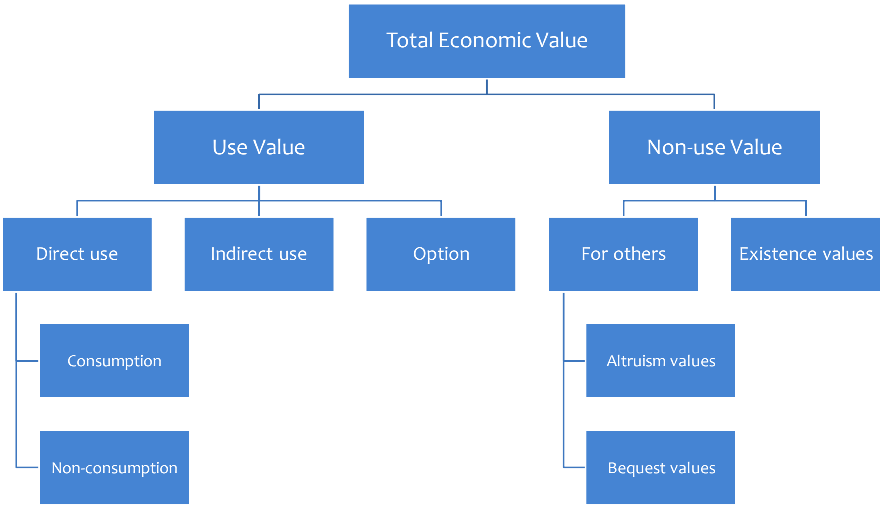
Appendix 2: Environmental valuation using Total Economic Value framework

The Total Economic Value framework is a common approach to environmental economics that considers the full range of values that a community derives from a natural asset.

This includes non-consumptive values which may be environmental or social in nature, as well as financial or commercial outputs. The Total Economic Value framework is shown in Figure 22.

The values on the left of the image (use values and particularly "direct use values" are relatively easy to value, whereas "non-use values" (such as existence values) are relatively difficult to measure.

Figure 22: Total Economic Value framework



Source: Marsden Jacob

Willingness to pay and willingness to accept

For the purposes of this report, economic value is interpreted in its broadest sense, and includes valuations of both use values (including consumption and recreational values) and non-use values (including environmental values). Within an economic framework, both use and non-use values are represented in monetary terms based on community preference. The foundation for monetisation is the concept of willingness to pay, and the related concept of willingness to accept:

- willingness to pay (WTP) is the maximum amount that an individual is prepared to pay to gain the outcomes that they view as being desirable; and
- willingness to accept (WTA) is the minimum amount that an individual is prepared to accept as compensation to forego an outcome that they view as being desirable.

The WTP and WTA values can be applied regardless of whether individuals will actually be required to pay, or will be provided compensation for, the outcomes being evaluated.

Determining the WTP or WTA for water quality management requires an examination of the linkages between the Department's water quality management activities and outcomes for the community and the environment. The DEHP's activities can either protect against water quality degradation (e.g. by ensuring only low risk land uses take place within a catchment) or actively improve water quality (e.g. salinity management initiatives).

Once the environmental and community impacts have been identified, economic evaluation requires those impacts to be described in monetary terms. For consumptive uses, individual's willingness to pay or to accept compensation will depend on the options available to that individual if water quality is altered.

If water quality degrades to a level that renders the water unusable, users may choose to abandon the water source by either reducing their consumption or finding an alternative water supply. In this sense, water scarcity is not only related to the volume of water available, but also whether the quality is appropriate for the particular application (i.e. is 'fit-for-purpose').

TEV framework

The net sum of all relevant willingness-to-pay and willingness-to-accept impacts that result from a reduction in water pollution is defined as the *total economic value* (TEV) of the pollution reduction. The TEV framework provides a basis for classifying the estimation of these various values.

The TEV framework has been widely adopted by environmental economists over the past three decades, however there is no one standard categorisation nor standard terminology. Although the classification is somewhat arbitrary and may differ from one use to another, the TEV framework is useful for ensuring that all components of value are given recognition in empirical analyses and that "double counting" of values does not occur when multiple valuation methods are employed (National Research Council Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems, 2004).

The general TEV framework distinguishes between **use** and **non-use** values (**Error! Reference ource not found.**).

Use values measure the value arising from the actual, planned or possible use of the good in question. Use values can be direct, indirect, or option values. Direct use values measure the willingness to pay for the good as a final consumption good. For example, potable drinking water is an example of a final consumption good, and the willingness to pay for drinking water is a direct use value. Indirect use value measures the value that a good has as an intermediate input in some production process whose end good is of value. For example, if an increase in water quality results in an increase to fish stocks, and these fish stocks have an end value, then the water quality improvement has an indirect value in the creation and maintenance of the fish stock. When discussed in terms of future planned use, the improved quality of the water stock provides an option value as it provides an option to use the resource in the future.

Non-use values refers to the willingness to pay to maintain some good in existence even when the individual does not use the resource or plan to use the resource at some time in the future. Non-use values are generally separated existence, altruism and bequest values. Existence values refers to the WTP to keep a good in existence in the context where the individual expressing the value has no actual or planned use of the resource for herself, *or for anyone else*. Motivations for having an existence value may include being concerned for the good itself in its own right, or a stewardship motivation. An example of existence values for water is the cultural and spiritual values that the local indigenous community attributes to culturally significant water bodies in their area.

Altruism and bequest values stem from the preference of the individual for others to enjoy and benefit from the resource, even if the individual professing the value does not use the resource themselves. In the case of altruism values, the preference is for others in the current generation to enjoy the resource, whereas a bequest value reflects the preference for future generations to be able to enjoy / benefit from the resource. An example of altruism or bequest values could be if community members indicated a desire to protect wild rivers in the Northern Australia– even if they do not intend to use or visit them. If the desire is to protect them for the current generation then this is an altruism value or if the desire is to protect them for future generations then this would be a bequest value.

Valuation methods are typically either based on the observed market behaviour of individuals, or through responses to survey questions that reveal the stated preferences of individuals. The former approach is generally termed the revealed preference approach and the latter the stated preference approach to valuation. While revealed preference approaches are in general preferable to stated preference approaches, in some cases it is impossible to value goods and services using revealed preference approaches. In particular, the non-use value of goods and services cannot be estimated using the revealed preference method.

Alignment of the TEV framework to the environmental values identified in the Draft environmental values and water quality guidelines reports

The Draft environmental values and water quality guidelines reports[43] attributes the relevant environmental values to each of the catchments in the area. The full set of environmental values used are set out in Figure 23.

43 http://www.ehp.qld.gov.au/water/policy/

Figure 23: Environmental Values: icons and definitions

Aquatic ecosystem

- The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways, waterholes and riparian areas, for example, biodiversity, ecological interations, plants, animals, key species (such as turtles, yellowbelly, cod and yabbies) and their habitat, food and drinking water.

Irrigation

- Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.

Farm water supply/use

- Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.

Stock watering

- Suitability of water supply for production of healthy livestock.

Aquaculture

- Health of aquaculture species and humans consuming aquatic foods (such as fish and prawns) from commercial ventures.

Human consumers of aquatic foods

- Health of humans consuming aquatic foods, such as fish and prawns, from natural waterways.

Primary recreation

- Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, diving and water-skiing.

Secondary recreation

- Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating, rowing and fishing.

Visual recreation

- Amenity of waterways for recreation which does not involve contact with water. For example, walking and picnicking adjacent to a waterway.

Drinking water supply

- Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.

Industrial use

- Suitability of water supply for industrial use, for example, food, beverage, paper, petroleum and power industries, mining and minerals refining/processing. Industries usually treat water supplies to meet their needs.

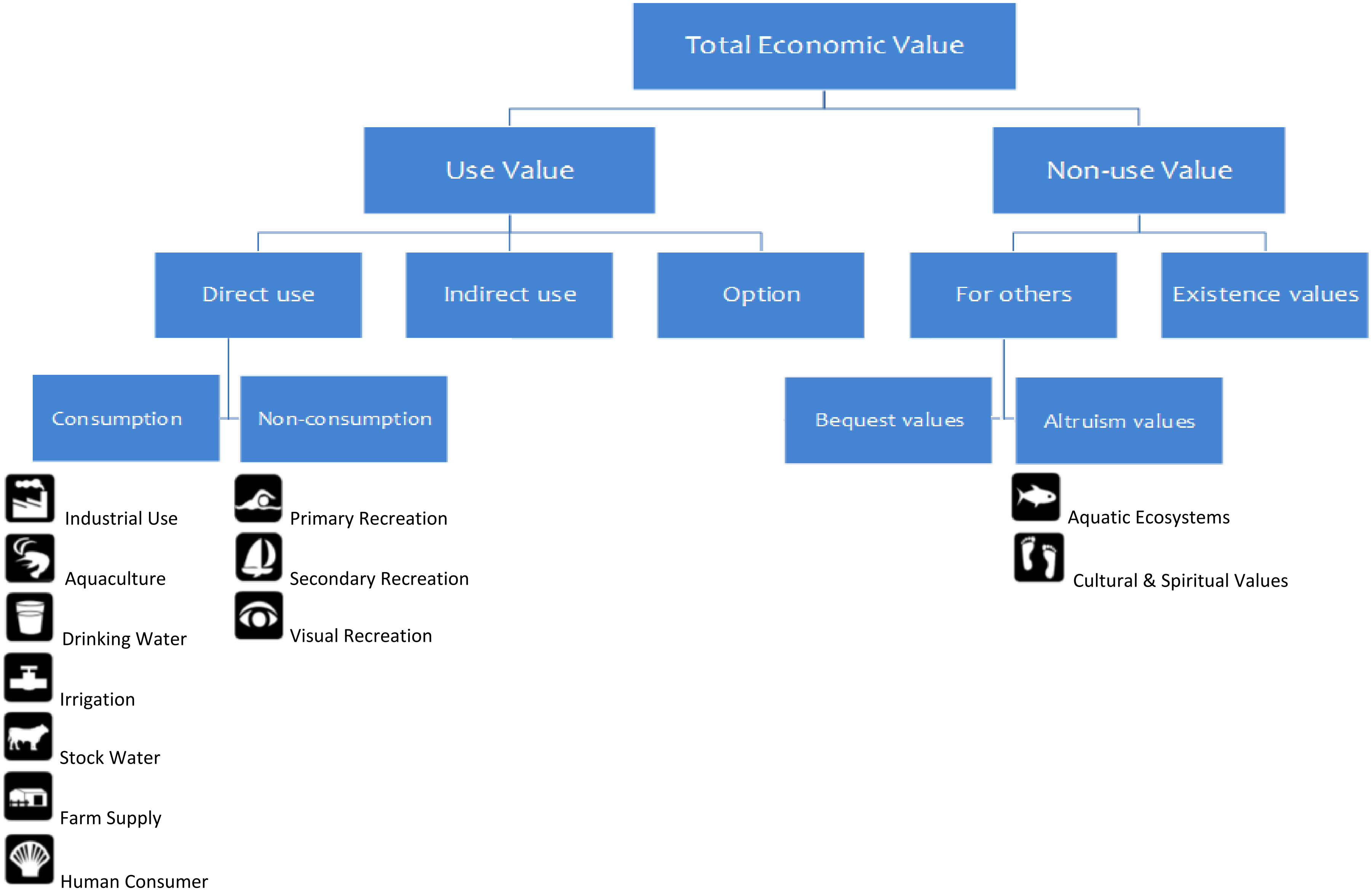
Cultural, spiritual and ceremonial values

- Cultural, spiritual and ceremonial values of water means its aesthetic, historical, scientific, social or other significance, to the past, present or future generations.

Source: DEHP, 2017

These environmental values can be linked to the benefit types under the Total Economic Value Framework as shown in the following Figure 24 on the following page.

Figure 24: Alignment of environmental values to the benefit types under the Total Economic Value Framework



Glossary

ABS	Australian Bureau of Statistics
CA	Condamine Alliance
CSG	Coal seam gas
DEHP	Department of the Environment and Heritage Protection, Queensland
DILGP	Department of Infrastructure, Local Government and Planning (Qld)
DIP	Department of Infrastructure and Planning (Qld)
DO	Dissolved Oxygen
DoEE	Department of the Environment and Energy (Cmth)
DPI NSW	Department of Primary Industries (NSW)
EPP Water	Environment Protection (Water) Policy 2009 developed under the *Environmental Protection Act 1994 (Qld)*
EV	Environmental values
GAB	Great Artesian Basin
ha	Hectares
HLW	Health Land and Water
kg	Kilograms
km	Kilometres
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MJA	Marsden Jacob Associates
OESR	Office of Economic and Statistical Research
OESR	Office of Economic and Statistical Research (Qld)
QCA	Queensland Competition Authority
QMDB	Refers to the sections of the Murray-Darling Basin within Queensland
SDL	Sustainable Diversion Limit
SPP	State Planning Policy
STP	Sewerage treatment plant
SWNR	South West Natural Resources
TEV	Total Economic Value
TN	Total nitrogen
TP	Total phosphorous
WQO	Water quality objectives
WSUD	Water Sensitive Urban Design

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