Healthy Waters Management Plan

Queensland Border Rivers and Moonie River Basins

This Healthy Waters Management Plan meets accreditation requirements for relevant water quality sections under the Water Act 2007- Basin Plan 2012

Queensland Government

Acknowledgement of the Traditional Owners of the Queensland Border Rivers and Moonie region

The Department of Environment and Science (the department) would like to acknowledge and pay respect to the past and present Traditional Owners of the region and their Nations, and thank the representatives of the Aboriginal communities, including the Elders, who provided their knowledge of natural resource management throughout the consultation process. The department acknowledges that the Traditional Owners of the Queensland Border Rivers and Moonie basins have a deep cultural connection to their lands and waters. The department understands the need for recognition of Traditional Owner knowledge and cultural values in water quality planning.

Prepared by: Department of Environment and Science.

Citation

DES 2019. Healthy Waters Management Plan: Queensland Border Rivers and Moonie River Basins. Brisbane: Department of Environment and Science, Queensland Government.

Acknowledgements

The department would like to thank all stakeholders for their input throughout the development of this document, including members of the local community, industry, environmental groups, Traditional Owner groups, government representatives and natural resource management organisations.

The development of this report was supported by the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended National Partnership Agreement.

Front cover photo: Nundubbermere Falls, west of Stanthorpe.

February, 2019

Foreword

This document has been prepared in accordance with the Healthy Waters Management Plan requirements under the Queensland *Environmental Protection Act 1994* and Environmental Protection (Water) Policy 2009. This document also contributes to meeting particular requirements of a Water Quality Management Plan under the Commonwealth *Water Act 2007—Basin Plan 2012* (Basin Plan). The requirement for a Water Quality Management Plan is listed under Chapter 10, Part 7 of the Basin Plan. Text boxes such as this include explanations as to how this Healthy Waters Management Plan for the Queensland Border Rivers and Moonie River basins (Refer to Figure 1) contributes to meeting the requirements of a Water Quality Management Plan under the Basin Plan.

What is a Healthy Waters Management Plan?

The Environmental Protection (Water) Policy 2009 (EPP Water), subordinate legislation under the *Environmental Protection Act 1994* (Qld.), establishes Healthy Waters Management Plans (HWMPs) as a key planning mechanism to improve the quality of Queensland waters.

HWMPs advance achievement of the purpose of the EPP Water to protect Queensland's water environment whilst allowing for development that is ecologically sustainable.

HWMPs include:

- identification and mapping of environmental values, desired levels of aquatic ecosystem protection and management goals for Queensland waters;
- water quality objectives (under the National Water Quality Management Strategy (NWQMS)[1]) to protect the environmental values; and
- management responses, which address point and diffuse emission sources, and may include market-based instruments, best management practice and adaptive management.

HWMPs provide an ecosystem-based approach to integrated water management, supported by best available science. The preparation of HWMPs includes:

- engaging with the local government, natural resource management groups, industry groups, local Aboriginal Nations and the community;
- addressing identified priority threats to water quality; and
- incorporating local catchment-based approaches to develop management responses.

What is a Water Quality Management Plan?

The Commonwealth *Water Act 2007—Basin Plan 2012* (Basin Plan) requires a water resource plan to include a Water Quality Management Plan (WQM Plan), prepared in accordance with Chapter 10, Part 7 of the Basin Plan. WQM Plans advance the achievement of the Basin Plan objectives and outcomes through:

- identifying the key causes, or likely causes, of water quality degradation;
- including measures to address risks arising from water quality degradation;
- identifying water quality target values;
- specifying measures to be undertaken in, or in relation to, the water resources of the water resource plan area;
- identifying locations of water quality targets for irrigation water; and
- assessing and having regard to the impact of the WQM Plan on the water resources of another Basin State.

Queensland's approach to the WQM Plan is an index which refers to relevant State and Commonwealth instruments to fulfil the requirements of the Basin Plan Chapter 10, Part 7. The HWMP prepared under the EPP Water fulfils most requirements of a WQM Plan. As a result, the HWMP is the primary document referred to under the WQM Plan (Refer to Figure 2).

The sections of this report that fulfil requirements of a WQM Plan under the Basin Plan include parts of Section 7 to Section 10.

[1] The NWQMS is a joint strategy developed by two Ministerial Councils – the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ).

Figure 1: The Queensland Healthy Waters Management Plan areas that intersect the Murray-Darling Basin. This HWMP applies to the Queensland Border Rivers and Moonie River basins only.

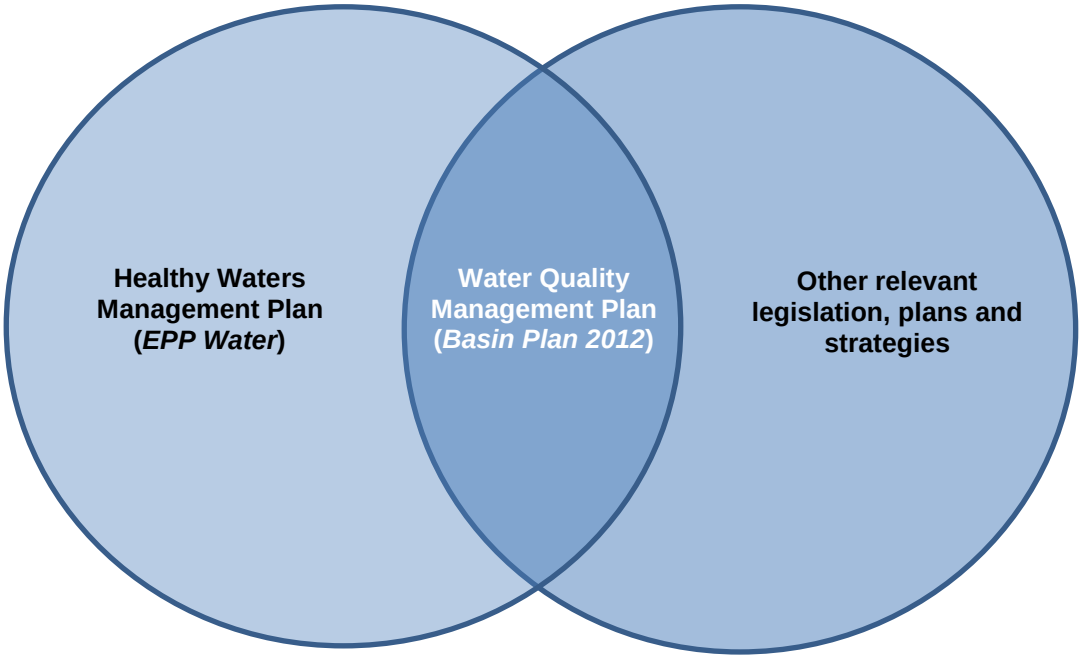


Figure 2: Queensland's approach to meeting Water Quality Management Plan requirements under Basin Plan.

The WQM Plan, prepared under Chapter 10, Part 7 of the Basin Plan, is an index that refers to relevant legislation, plans and strategies that address water quality. HWMPs, prepared under the EPP Water, are the primary documents referred to under the WQM Plan. Other relevant instruments that are referenced by the WQM Plan include Queensland Water Plans prepared under the *Water Act 2000* and the Basin Salinity Management Strategy (Schedule B to the Murray-Darling Basin Agreement).

Contents

Figures

Tables

Executive summary

The Healthy Waters Management Plan (HWMP) for the Queensland Border Rivers and Moonie River basins has been prepared under the Environmental Protection (Water) Policy 2009 (EPP Water), which is subordinate legislation under the *Environmental Protection Act 1994* (Qld.). HWMPs present ways to improve the quality of water for a specified region in Queensland. As the Queensland Border Rivers and Moonie River basins are located within the Murray-Darling Basin, this HWMP also contributes to the requirements of a Water Quality Management Plan (WQM Plan) under the Commonwealth *Water Act 2007— Basin Plan 2012.*

The HWMP for the Queensland Border Rivers and Moonie River basins identifies the environmental, economic, social, cultural, spiritual and ceremonial values associated with the rivers, creeks, waterholes, floodplains, overflow channels, lakes, wetlands and groundwaters of the Queensland Border Rivers and Moonie region. These are referred to under the EPP Water as 'environmental values' and are the qualities that make water suitable for supporting aquatic ecosystems and human use. The HWMP also identifies and maps the levels of aquatic ecosystem protection to inform the management of different types of aquatic ecosystems. The HWMP for the Queensland Border Rivers and Moonie River basins was developed in consultation with a range of stakeholders, including Queensland and New South Wales government representatives, natural resource management groups, industry groups, environmental groups, local Aboriginal Nations, and the community.

Management goals are established in the HWMP for the Queensland Border Rivers and Moonie River basins as the objectives and outcomes for water resources. They focus on achieving locally appropriate water quality target values (water quality objectives) that have been established at a sub-catchment level to protect identified aquatic ecosystem and human use environmental values for the waters. Long-term salinity planning and management is also addressed, with reference to the End-of-Valley Targets in Appendix 1 of Schedule B to the Murray-Darling Basin Agreement.

The extent and distribution of freshwater wetlands is the most important indicator of the state of wetland resources in Queensland, as any loss will mean that the services provided by that wetland will be diminished. Targets to maintain the extent of wetlands and riparian forest in the plan area are included in this report to help protect these important ecosystems.

A water quality risk assessment was conducted to identify the potential key types of water quality degradation that could occur in the Queensland Border Rivers and Moonie River Basins. It is important to note that just because a risk was highlighted through the assessment, does not mean the set of circumstances is currently present for the risk to materialise. The factors contributing to a potential risk are summarised in the healthy waters management plan. The risks that were identified are presented below and are addressed through management responses included in the HWMP:

- elevated levels of salinity as a potential high risk in surface waters of the Granite Belt (Stanthorpe region) and as a potential medium risk in groundwaters of the Queensland Border Rivers Fractured Rock (GS55) SDL resource unit;
- elevated levels of suspended matter as a potential medium risk in surface waters of the Lower Border Rivers, Upper Moonie and Lower Moonie;
- elevated levels of nutrients as a potential high risk in surface waters of the Granite Belt (Stanthorpe region), Upper Border Rivers and Lower Border Rivers and as a potential medium risk in the Upper Moonie and Lower Moonie. A potential medium risk was also identified for groundwaters of the Queensland Border Rivers Fractured Rock (GS55) and Queensland Border Rivers Alluvium (GS54) SDL resource units;
- elevated levels of cyanobacteria cell counts or biovolume and toxins and odour compounds as a potential medium risk in surface waters of the Upper Moonie – Moonie River at Flinton;
- water temperature outside of natural ranges as a potential high risk in surface waters of the Upper Border Rivers downstream of Glenlyon Dam and Coolmunda Dam;
- Dissolved oxygen outside natural (ambient) ranges as a potential high risk in surface waters of the Upper Border Rivers downstream of Glenlyon Dam and Coolmunda Dam and as a potential medium risk in Lower Moonie;
- elevated levels of pesticides and other contaminants as a potential medium risk in surface waters of the Granite Belt (Stanthorpe region) and in groundwaters of Queensland Border Rivers Fractured Rock (GS55) and Queensland Border Rivers Alluvium (GS54) SDL resource units;
- climate change as medium risk in the Queensland Border Rivers and Moonie basins; and
- pest fauna (aquatic) as high risk in the Queensland Border Rivers and Moonie basins.

The management responses included in this document seek to maintain, and where practical improve, water quality towards achieving water quality target values (water quality objectives) that protect the environmental

values across the plan area. These management responses recognise the existing projects being conducted across Queensland Murray-Darling Basin drainage basins, which may inform future updates to this document. The HWMP for the Queensland Border Rivers and Moonie River basins also presents opportunities to strengthen the protection of Aboriginal peoples' values and uses of water, based on consultation with people from Aboriginal Nations in the plan area. The HWMP also encourages the implementation of Aboriginal Waterways Assessments (AWAs), where funded opportunities are available. AWAs are an in-field assessment of stream health from the perspective of Traditional Owners, and are a key initiative to increase the participation of Traditional Owners in natural resource and waterway management.

This HWMP advances the protection of the aquatic environment of the Queensland Border Rivers and Moonie River basins in order to achieve objectives and outcomes in relation to water quality and salinity. The plan seeks to maintain appropriate water quality for environmental, social, cultural and economic uses; protect and restore water-dependent ecosystems; and ensure water resources remain fit-for-purpose.

SECTION 1: INTRODUCTION

1 Introduction

A Healthy Waters Management Plan (HWMP) presents ways to improve the quality of water for a specified region. HWMPs are a component of the framework for managing water quality in Queensland under the Environmental Protection (Water) Policy 2009 (EPP Water), which is subordinate legislation to the *Environmental Protection Act 1994* (Qld.).

1.1 Water to which this plan applies

HWMPs address water quality improvement within spatially defined geographic planning areas referred to as 'management units', which may range in scale from sub-region, to whole of catchment, to whole of basin (comprised of multiple catchments). A HWMP applies to all Queensland State waters within the defined management units (that is rivers, creeks, wetlands, lakes and groundwaters), except the types of water listed in Part 4, section 10(3) of the EPP Water.

This HWMP applies to the surface waters and groundwaters in the Queensland Border Rivers and Moonie River basins (Refer to Figure 3), which fall within the Southern Queensland NRM regional organisation area. This HWMP also contributes to the Water Quality Management Plan for the Border Rivers-Moonie water resource plan area under Chapter 10, Part 7 of the *Basin Plan 2012* (Basin Plan).

1.2 Healthy Waters Management Plans under the Environmental Protection (Water) Policy 2009

In the following section, terminology under the Basin Plan is indicated in brackets.

HWMPs, as defined by the EPP Water, support achievement of the purpose of the EPP Water by identifying the environmental values (values and uses), water quality objectives (water quality target values) and management goals (objectives and outcomes) of the waters in a specified region, and identifying and prioritising ways to improve water quality.

The issues identified through a HWMP are broader than 'just water quality'. They include land management issues that can impact water quality, such as the health of the riparian zone or the management of grazing lands.

The economic and social impacts of protecting environmental values through water quality objectives are considered through consultation and via a socio-economic assessment. At the completion of consultation and consideration of all submissions, the environmental values and water quality objectives are subsequently recommended for inclusion under Schedule 1 of the EPP Water.

Water quality objectives under the EPP Water are long-term goals for water quality management. They are measurements, levels or narrative statements of particular indicators of water quality that protect identified environmental values. Once scheduled within the EPP Water, environmental values and water quality objectives inform statutory and non-statutory water quality management planning and decision-making.

1.3 Water Quality Management Plan under the Basin Plan

The Basin Plan, prepared by the Murray-Darling Basin Authority under the Commonwealth *Water Act 2007*, was approved in November 2012. The Basin Plan provides a coordinated approach to water use across the State and Territory government areas that intersect the Murray-Darling Basin (specifically Queensland, New South Wales, Victoria, South Australia and the Australian Capital Territory). The Basin Plan aims to achieve a balance between environmental, economic and social considerations.

The Basin Plan specifies that a WQM Plan is a component of a Water Resource Plan (Commonwealth Water Resource Plan). Commonwealth Water Resource Plans under the Basin Plan are to be submitted to the Murray-Darling Basin Authority for accreditation by the Commonwealth Minister responsible for water. In Queensland, Commonwealth Water Resource Plans are comprised of a package of existing State instruments, primarily Queensland water plans and associated documents under the *Water Act 2000* (Qld.) (Refer to Section 1.5 of this report for more information) and HWMPs under the EPP Water.

A HWMP prepared under the EPP Water contributes to meeting the requirements of a WQM Plan under Chapter 10, Part 7 of the Basin Plan. HWMPs that fulfil select requirements of a WQM Plan have been developed for all Queensland Murray-Darling Basin (QMDB) drainage basins in collaboration with the natural resource management organisations for the region – currently Southern Queensland NRM.

For each Commonwealth Water Resource Plan package submitted to the Murray-Darling Basin Authority for accreditation under the Basin Plan, the Queensland Government will include a HWMP for the relevant water resource plan area.

Three Commonwealth Water Resource Plan packages will be prepared for QMDB catchments, to be compliant with the Basin Plan by 2019:

1. Warrego-Paroo-Nebine water resource plan area
2. Condamine-Balonne water resource plan area
3. Queensland Border Rivers-Moonie water resource plan area.

Note: The Bulloo drainage basin is external to the Murray–Darling Basin and is therefore not subject to the Basin Plan.

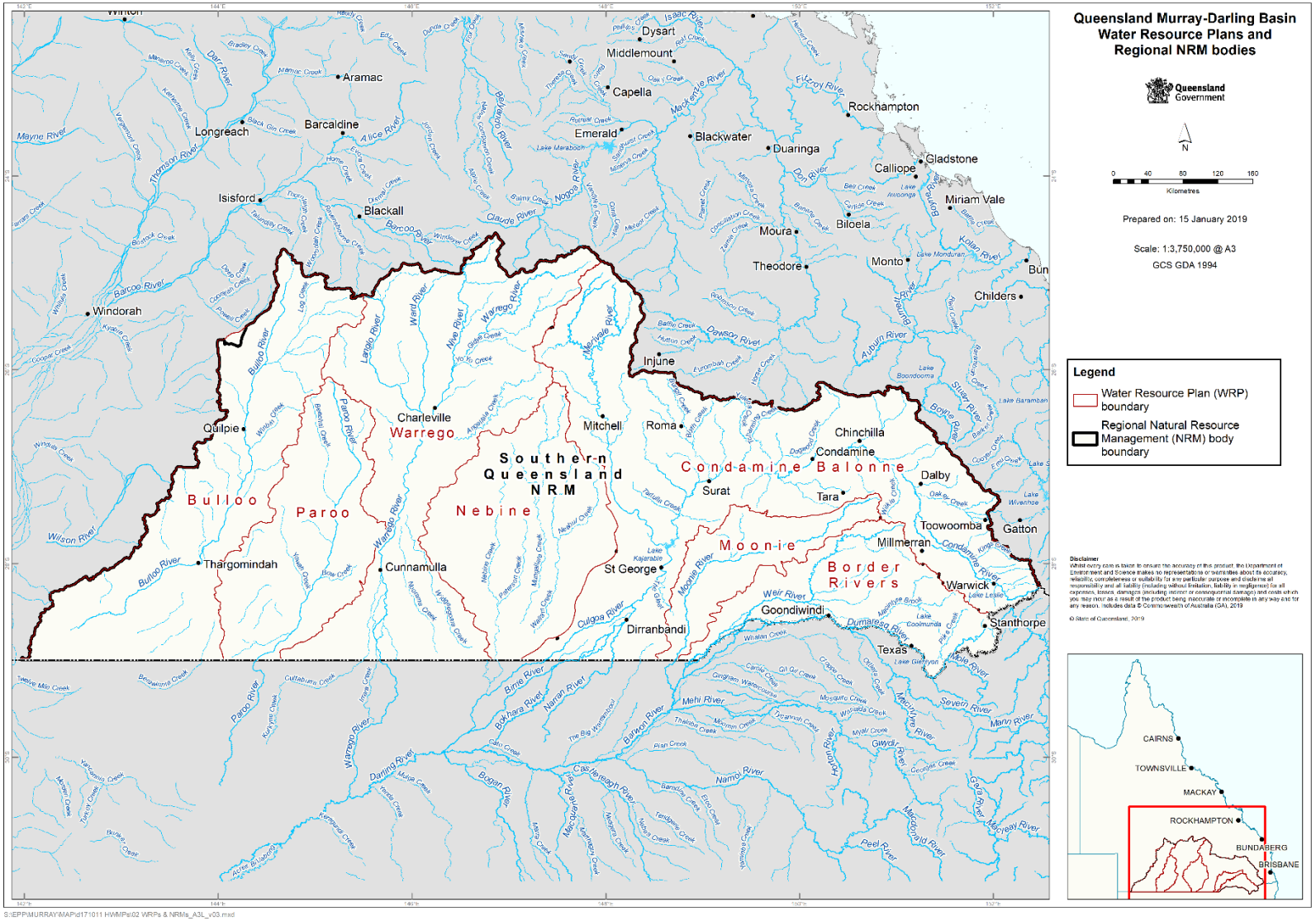


Figure 3: Queensland Murray-Darling Basin Water Resource Plan areas. This HWMP applies to the surface and groundwater of the Queensland Border Rivers and Moonie River basins, in the Southern Queensland NRM regional organisation area.

1.4 Border Rivers and Moonie Region

The Queensland Border Rivers region covers approximately 23,800 square kilometres. The major towns in the region are Goondiwindi and Stanthorpe. Smaller towns in the region include Inglewood, Texas and Mungindi. The local government areas that intersect the plan area are Balonne Shire Council, Goondiwindi Regional Council, Southern Downs Regional Council, Toowoomba Regional Council and Western Downs Regional Council (WetlandInfo, 2018a). National parks in the basin include Bendidee National Park, Girraween National Park, Sundown National Park and Wondul Range National Park.

The Moonie River region covers approximately 14,600 square kilometres. A number of rural towns are located in the region including Thallon, Weengallon, Teelba, Inglestone and Moonie. The local government areas that intersect the plan area are Balonne Shire Council, Goondiwindi Regional Council, Maranoa Regional Council, Toowoomba Regional Council and Western Downs Regional Council (WetlandInfo, 2018a). National parks in the basin include Alton National Park and Southwood National Park.

The dominant land use in the region is farming – grazing, irrigated agriculture and dryland agriculture. Southern Queensland NRM is the regional body for natural resource management in the plan area.

1.4.1 Climate

The Border Rivers and Moonie River basins experience a summer dominant rainfall pattern. The south eastern portion of Border Rivers experiences the most rainfall, with average rainfall reaching approximately 1000mm per annum. Conversely, west Moonie receives less than 500mm per annum. Summer rainfall is dominated by high intensity storms, which are often localised, from October to December. Due to the contrast in rainfall from east to west, majority of the eastern section of the region experiences perennial flow, while tributaries in the western section of the region are mostly ephemeral.

1.4.2 Surface water

The Queensland Border Rivers and Moonie region comprises approximately 12% of the Queensland portion of the Murray-Darling Basin. The Queensland Border Rivers and Moonie basins form part of the headwaters of the Murray-Darling Basin river system that flows through the southern states.

The Border Rivers are a network of perennial streams that rise in the western slopes of the Great Dividing Range on the Granite Belt and New England Tablelands and together form the headwaters of the Darling River. This basin resides predominantly in Queensland with a portion extending into New South Wales. The Macintyre Brook, Severn River (Queensland), Mole River and Beardy River drains from the Inglewood, Granite Belt, Tenterfield and Deep Water districts in the north. The New South Wales section of the Border Rivers from north of Glenn Innes to Guyra is drained by the Severn River (New South Wales) and Macintyre River. The confluence of the Severn River (Queensland) and the Mole River becomes the Dumaresq River which forms part of the border between Queensland and New South Wales. The Dumaresq River enters the Macintyre River above Goondiwindi and continues to form the border between the two states. The Macintyre River flows generally west before reaching its confluence with the Weir River, west of Goondiwindi. The Weir River headwaters are located in the Dunmore State Forest south west of Cecil Plains. It is fed by a number of tributaries that drain to an area west of Millmerran and Inglewood and north of Goondiwindi. The Weir River generally flows in a south west direction and combines with the Macintyre River, north of Mungindi, where it becomes the Barwon River. During high flow events water can flow from the Weir to the Macintyre River. The major water storages in the area are Glenlyon Dam (capacity 254 gigalitres) and Coolmunda Dam (capacity 69 gigalitres).

The Moonie River basin is bound to the east by the Border Rivers and to the north and west by the Condamine-Balonne. The Moonie River rises south west of Dalby and south of Tara and flows in a south westerly direction. A number of tributaries contribute to its flow, with the largest being Teelba Creek, which joins with Bidgel Creek before joining into the Moonie River upstream of Nindigully. Due to the ephemeral nature of this basin, the Moonie River is often a series of disconnected waterholes. The Moonie River flows into the Barwon River near Mogi Mogi in New South Wales.

1.4.2.1 Wetlands

Queensland's wetlands are important habitats and include rivers (riverine), lakes (lacustrine) and swamps (palustrine). Queensland's wetlands support the state's native biodiversity, including migratory birds, frogs, fish and threatened species. They are important for our economy because they provide nurseries for fish, water for farming and other uses. Wetlands remove sediments and transform nutrients and pesticides—protecting other downstream habitats. Wetlands are also great places to enjoy Queensland's natural wonders. Many of Queensland's wetlands are internationally important habitat for migratory birds and other values (WetlandInfo, 2018b). Wetlands are a focus of ecological diversity and abundance, and are subject to booms and busts determined by seasonal and

sometimes decadal conditions.

For an extensive range of information, tools and maps on wetlands in Queensland refer to the Wetland*Info* website.

1.4.2.2 AquaBAMM

AquaBAMM is the state endorsed method for the identifying and assessing wetlands in Queensland. AquaBAMM is a decision support tool that utilises existing information and expert input to assess conservation value in aquatic ecosystems. The output of the AquaBAMM method is an Aquatic Conservation Assessment (ACA) for a specified study area (WetlandInfo, 2013a).

The ACA for the wetlands of the Queensland Murray-Darling Basin was published in July 2011 (Fielder, Davidson, & Barratt, 2011). ACAs provide a source of baseline, wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered. The ACA for the wetlands of the Queensland Murray-Darling Basin was a source of information for the development of this report.

The ACAs assess riverine and non-riverine (palustrine and lacustrine) wetlands separately. A project area, such as the Queensland Murray-Darling Basin, is divided into smaller sub-catchment units for the assessment. The riverine or non-riverine wetlands within the sub-catchment units are then assigned an AquaScore based on an assessment of eight criteria. The criteria are naturalness aquatic, naturalness catchment, diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. The AquaScore represents the overall conservation value of a sub-catchment unit and varies from very low to very high.

Figure 4 and Figure 6 display the riverine and non-riverine AquaScores for the Queensland Border Rivers and Moonie River basins. To highlight the significant wetland areas in the plan area, Figure 5 and Figure 7 present the riverine and non-riverine special features that were used in the development of the AquaScores. Special features are areas identified by flora, fauna and ecology expert panels. These features display characteristics which expert panels consider to be of the highest ecological importance. Special features include geomorphic features, unique ecological processes, presence of unique or distinct habitat and presence of unique or special hydrological regimes e.g. spring-fed streams (WetlandInfo, 2013b).

1.4.2.3 Persistent waterholes

Persistent waterholes along the river systems in the plan area provide aquatic habitat during extended periods of low or no flow and, as a result, are referred to as ‘refugial waterholes’. They are critical components of a functioning ‘source and sink’ system for aquatic organisms in the semi-arid landscapes of the QMDB (Silcock, 2009). Refugial waterholes experience variable patterns of connection and disconnection which is a fundamental driver of ecological processes in these riverine environments and is vital for dispersal and survival of diverse populations of biota. Persistent refugial waterholes require careful management, not as individual waterholes, but as an integrated system of waterholes along the length of rivers and channels. The Moonie River basin for example is a rainfall dominated system which experiences very little low flow contribution. During dry spells, the aquatic biota and terrestrial plants and animals are dependent upon refugial waterholes along the river channel (Lobegeiger, 2010). Other water users are also dependent upon these waterholes, including for social, cultural and economic purposes. It is therefore important to ensure the water resources are managed with the aim of preserving these refugial waterholes. The persistent waterholes for the Queensland Border Rivers and Moonie River basins are listed in Appendix 4— Persistent Waterholes in the Border Rivers and Moonie River basins.

1.4.2.4 Barriers to fish passage

Instream infrastructure, such as weirs, dams and road crossings, can limit the passage of aquatic fauna and affect their ability to migrate to new habitats for the purposes of food and spawning, and access to persistent waterholes. Some opportunities for fish passage are provided through barrier drown-out, where water depth downstream of the barrier increases during flooding to equal or exceed the height of the barrier. However, not all fish will be able to utilise these opportunities due to their size and speed. Note that barriers in the centre of a drainage basin impact inland fish more than barriers in lowland reaches, because barriers higher in the catchment typically drown-out less frequently (Kerr, Kimball, Prior, Ellaway, & Luke, 2015). Figure 8 displays the barriers to fish passage in the plan area based on best available information. Further work may identify additional barriers in the plan area. It is important to consider barriers to fish passage for the purposes of managing aquatic fauna in the plan area, particularly with respect to environmental flows/low flow levels and access to persistent waterholes during dry periods.

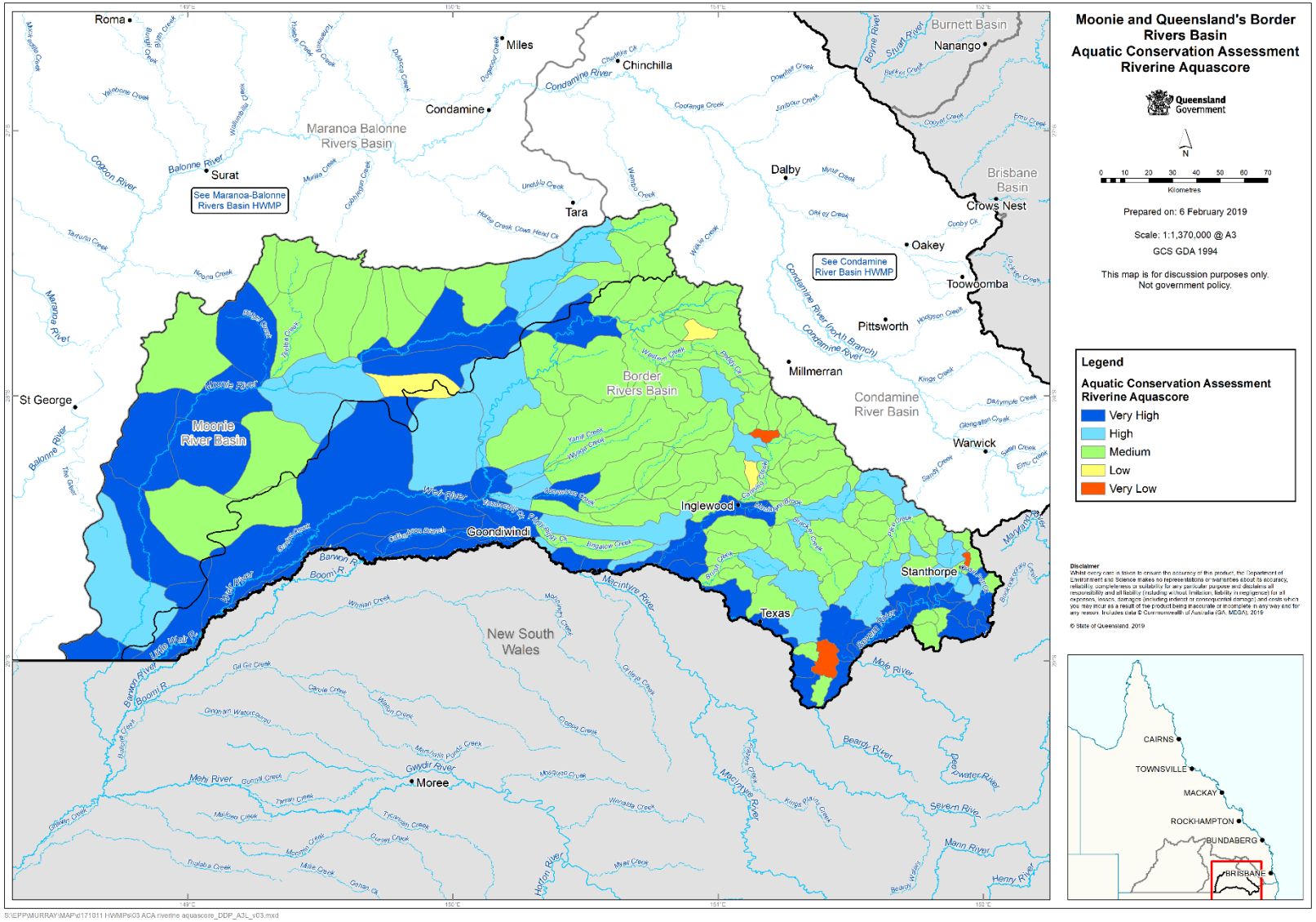


Figure 4: Riverine Aquatic Conservation Assessment AquaScores for the Border Rivers and Moonie River basins

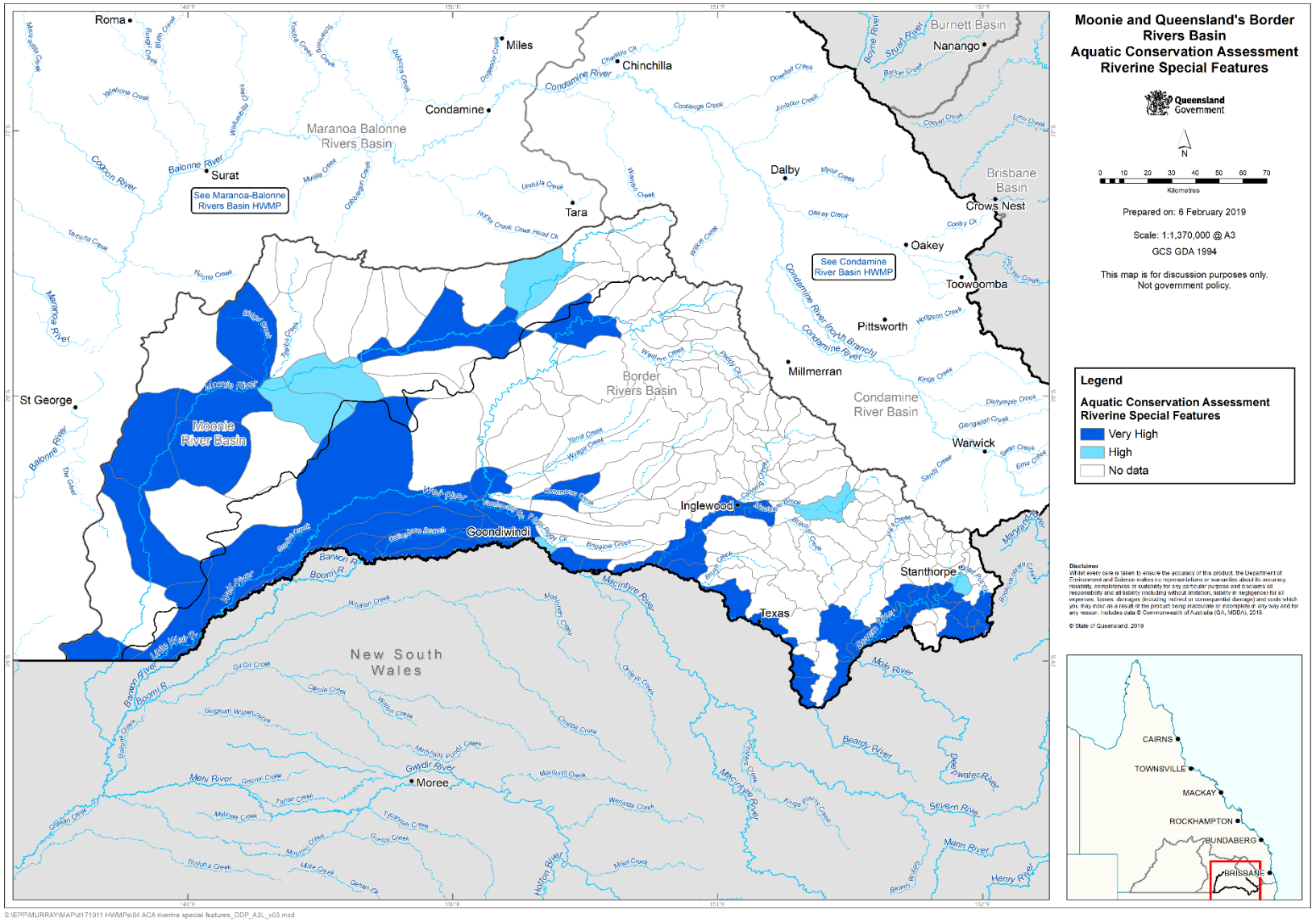


Figure 5: Riverine Special Features contributing to the Aquatic Conservation Assessment for the Border Rivers and Moonie River basins

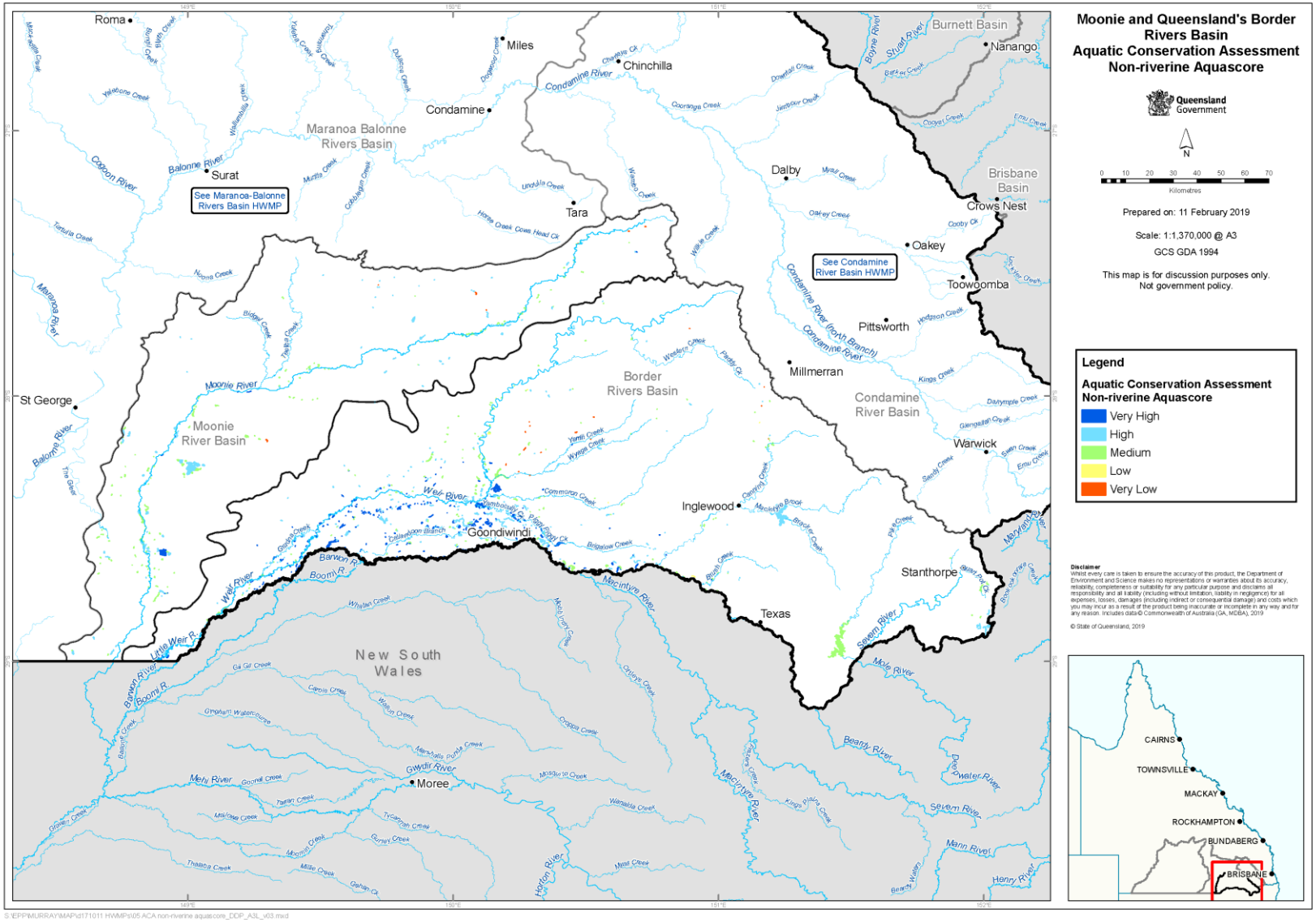


Figure 6: Non-Riverine Aquatic Conservation Assessment AquaScores for the Border Rivers and Moonie River basins

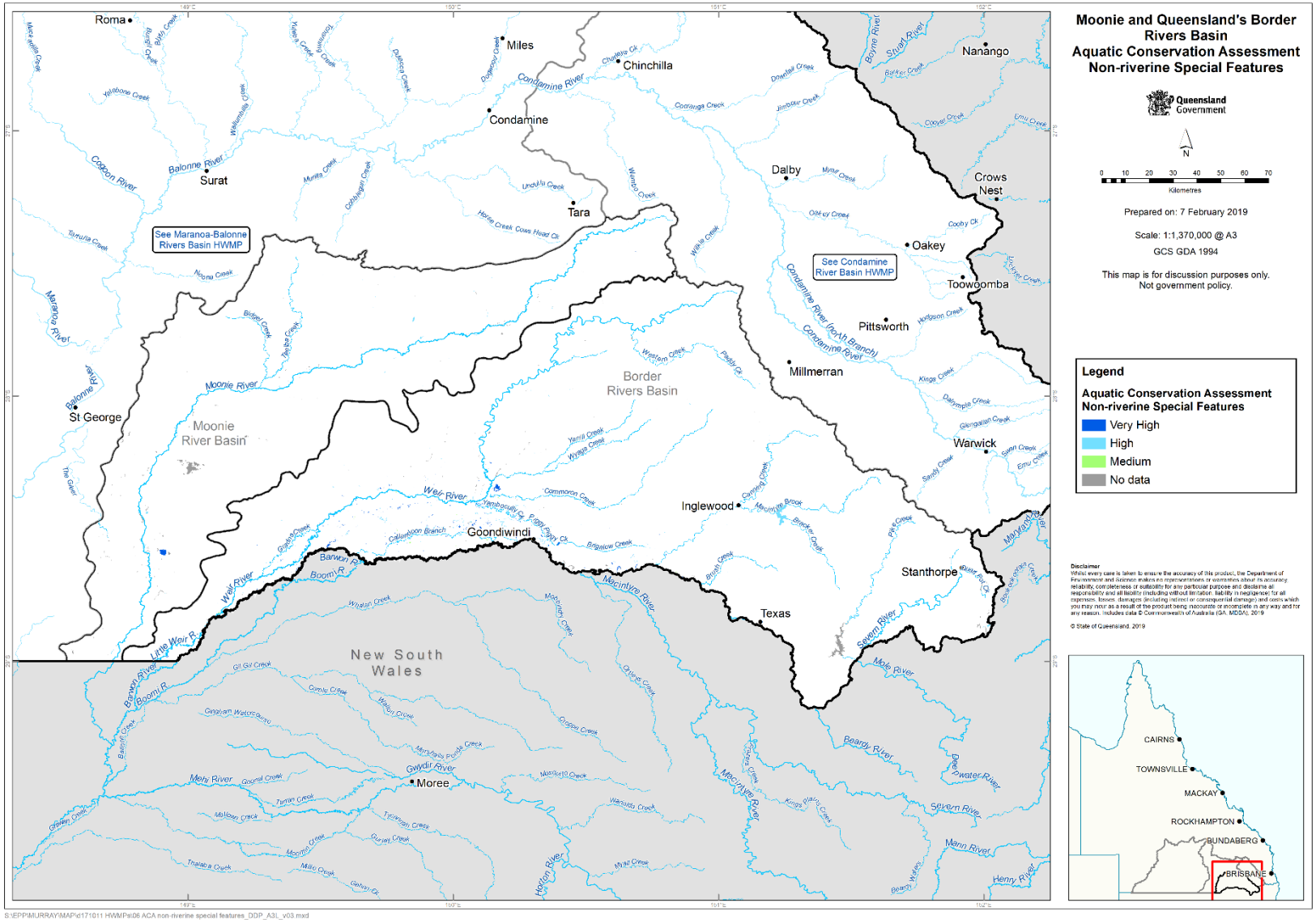


Figure 7: Non-Riverine Special Features contributing to the Aquatic Conservation Assessment for the Border Rivers and Moonie River basins

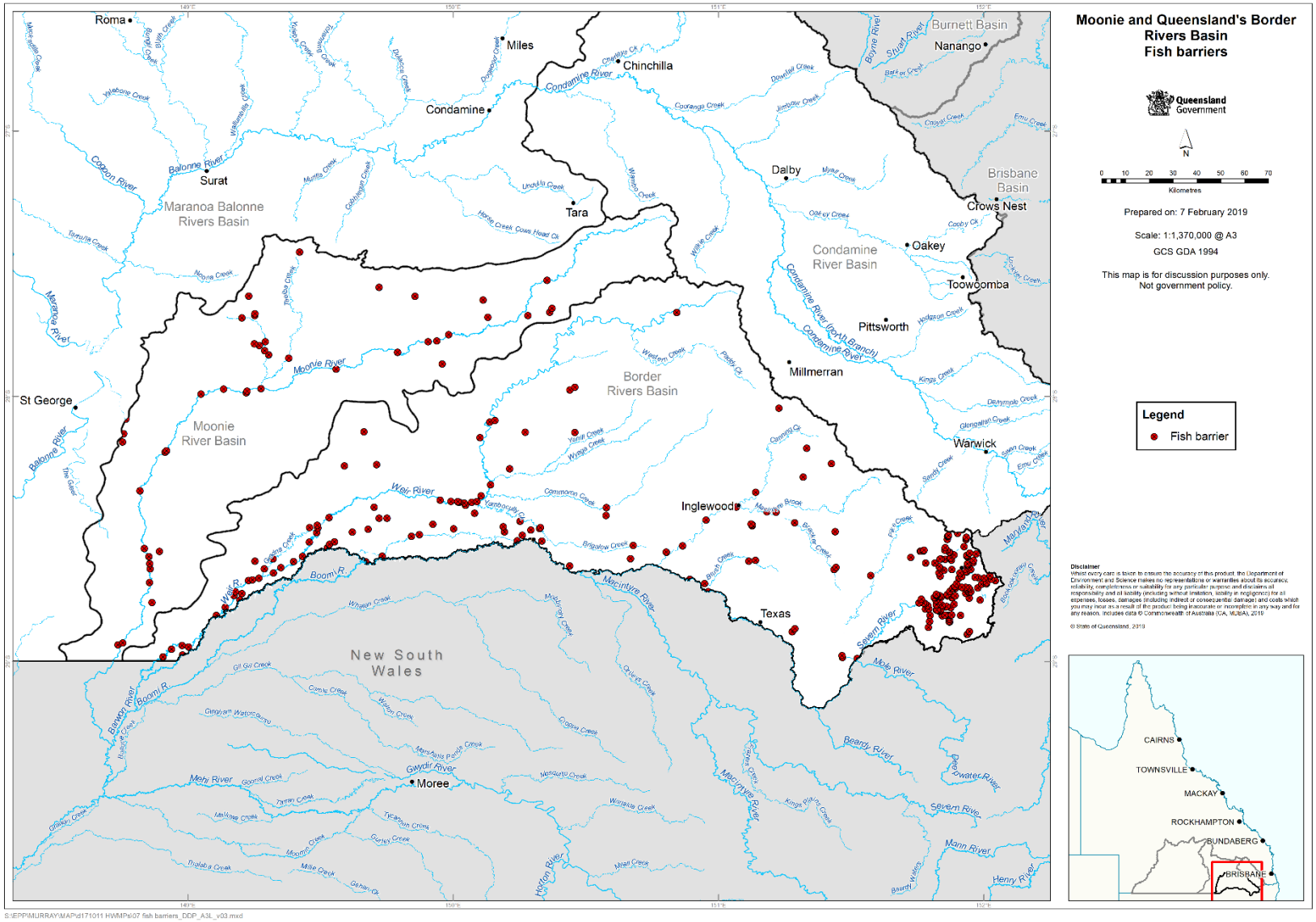


Figure 8: Barriers to fish passage, including weirs and road crossings, in the Border Rivers and Moonie River basins (Kerr et al., 2018).

1.4.3 Groundwater

Groundwater is present in the region in shallow alluvial and sandstone aquifers, and within the deeper confined strata of the Great Artesian Basin. Due to the climate variability, recharge of the groundwater aquifers is strongly episodic and relies on periods of unusually high rainfall or wetter than average winter to increase deep drainage rates (McNeil, Raymond, Bennett, & McGregor, 2017). The Great Artesian Basin (GAB) is recharged from infiltration occurring on the north-west slopes of the Great Dividing Range.

The Basin Plan identified five groundwater Sustainable Diversion Limit (SDL) resource units for the plan area:

- Queensland Border Rivers Alluvium (GS54);
- Queensland Border Rivers Fractured Rock (GS55);
- Sediments above the Great Artesian Basin: Border Rivers (GS57);
- Sediments above the Great Artesian Basin: Moonie (GS59); and
- St George Alluvium: Moonie (GS62).

The Basin Plan does not apply to groundwater of the GAB and as such, SDL resource units do not include GAB waters. However, for Queensland legislative and planning purposes, this HWMP includes waters of the GAB.

Refer to Figure 9 for a map of the groundwater SDL resource units that intersect the plan area.

1.4.3.1 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson, et al., 2011). Ecosystem dependency on groundwater may vary temporally (over time) and spatially (depending on its location in the landscape). GDEs can include aquifers, caves, lakes, palustrine wetlands, lacustrine wetlands, rivers and vegetation (WetlandInfo, 2017a). It is important to note that not all groundwater dependent ecosystems are associated with a spring. Some groundwater dependent ecosystems will access groundwater that does not express at the surface, such as the roots of vegetation (WetlandInfo, 2015).

Refer to Figure 10 for a map of the groundwater dependent ecosystems in the plan area. A basic requirement for managing groundwater and GDEs is to understand where and how groundwater moves through the landscape. Potential GDE aquifer mapping seeks to achieve this through identifying the extent and key characteristics of GDE aquifers in a landscape. Potential GDE aquifer mapping incorporates a range of criteria including, but not limited to, confinement, geology, porosity, groundwater flow system, salinity, pH and recharge processes (WetlandInfo, 2017b). Figure 11 displays the potential GDE aquifers across the plan area.

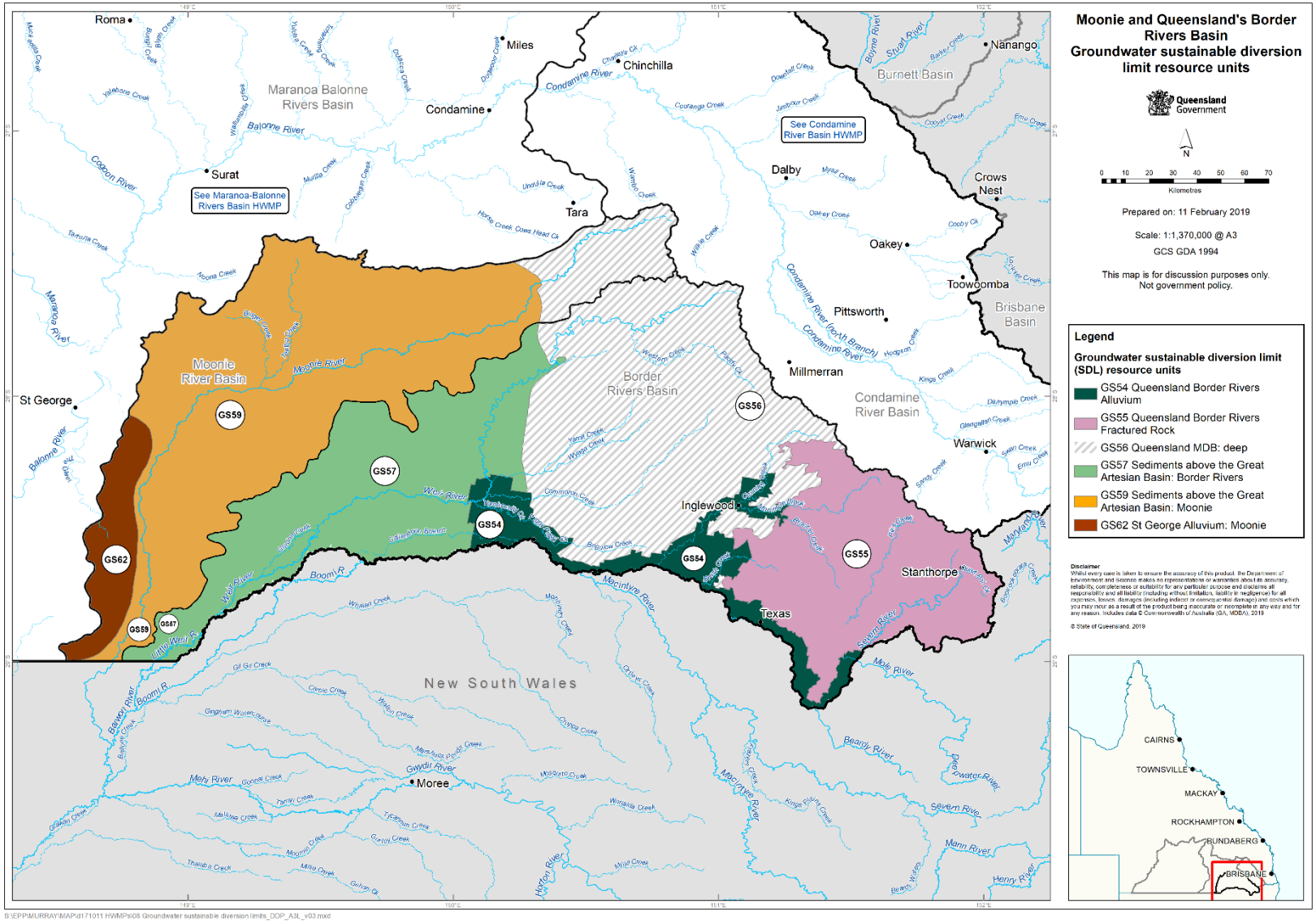


Figure 9: Groundwater Sustainable Diversion Limit resource units identified under the Basin Plan for the Border Rivers and Moonie River basin (MDBA, 2018).

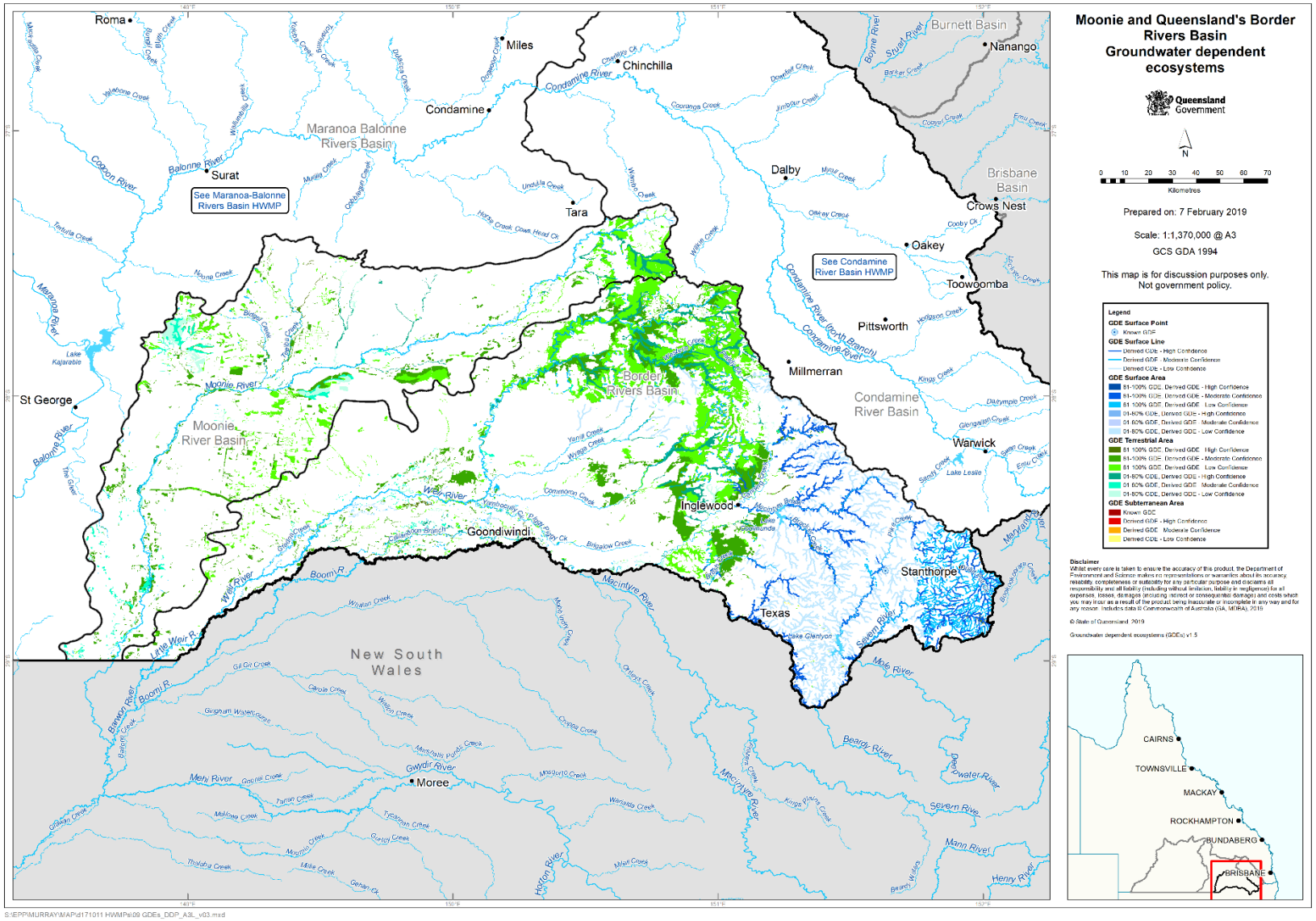


Figure 10: Groundwater dependent ecosystems in the Border Rivers and Moonie River basins.

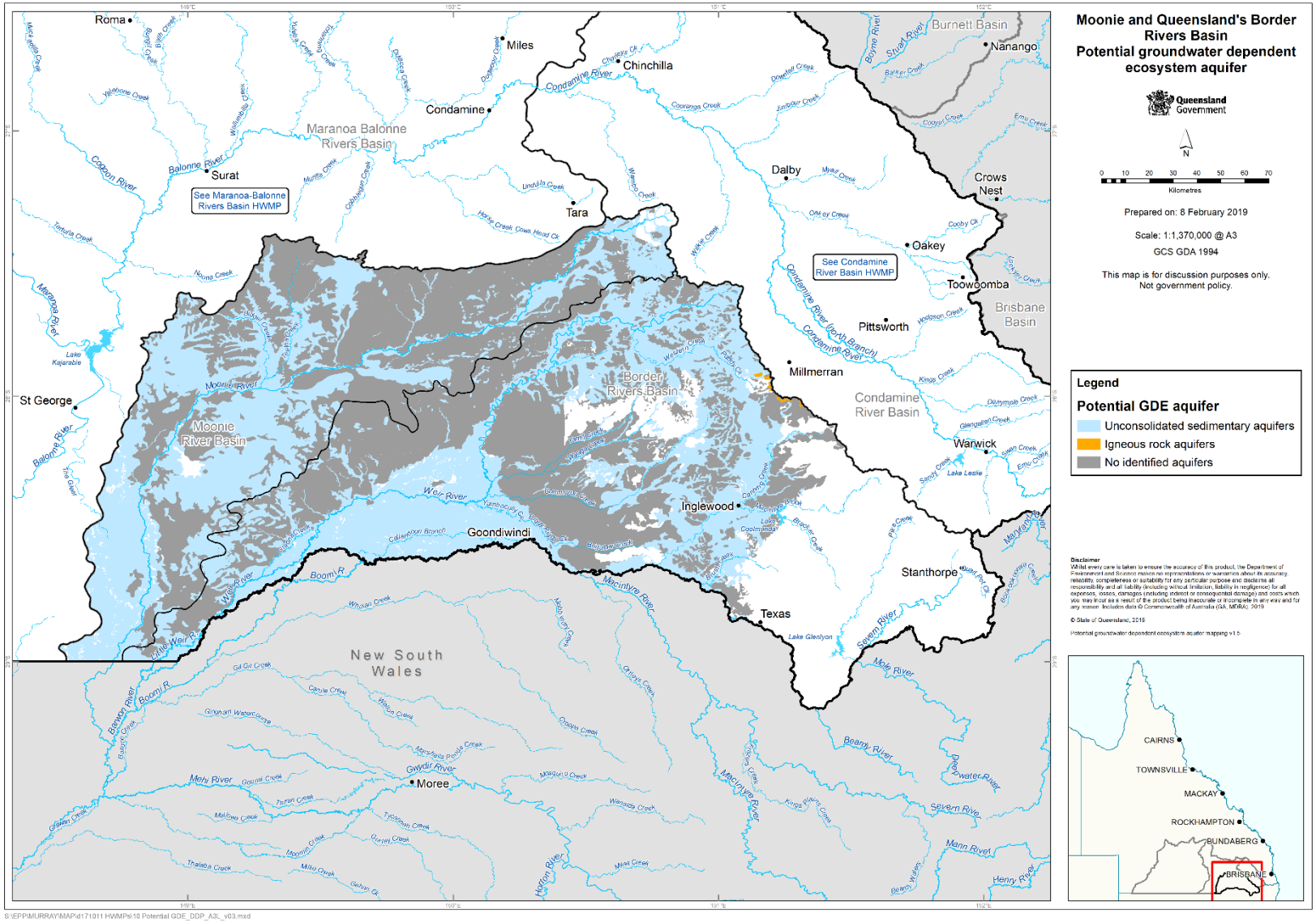


Figure 11: Potential GDE aquifer mapping within the Border Rivers and Moonie River basins.

1.5 Queensland water resource planning

The allocation and sustainable management of water in Queensland is accomplished through the water planning process. This process involves the preparation of statutory water plans under the *Water Act 2000* (Qld.) and accompanying water entitlement notices, water management protocols, resource operations licences, distribution operations licences and operation manuals. The statutory water plan for the area covered by this HWMP is the *Water Plan (Border Rivers and Moonie) 2019.* The water plans state the strategic outcomes, objectives and strategies for achieving a sustainable balance between water for industry, irrigators, town water supply, the community and environment. This includes the economic, social, cultural and ecological outcomes that apply to the plan area, as well as water allocation security objectives and environmental flow objectives.

The Basin Plan requires Commonwealth Water Resource Plans to be submitted to the Murray–Darling Basin Authority for accreditation by the Commonwealth Minister responsible for water. The Commonwealth Water Resource Plans are different from Queensland's existing statutory water plans. They will comprise a package of existing State instruments and other relevant documents that together meet the requirements of the Basin Plan. Key components of this package include the Queensland water planning instruments, as well as the healthy waters management plan and other relevant documents. Currently there are three Queensland water plans that intersect the Murray-Darling Basin—Warrego, Paroo, Bulloo[2] and Nebine; Condamine and Balonne; Border Rivers and Moonie.

1.5.1 Environmental flow objectives and ecological outcomes

The Water Plan (Border Rivers-Moonie) 2019 states the environmental flow objectives and ecological outcomes that apply to the plan area. Refer to the Department of Natural Resources, Mines and Energy water plan areas website to access a copy of the plan.

1.5.2 Great Artesian Basin

The Great Artesian Basin (GAB) underlies majority of the QMDB. The allocation and sustainable management of water from the GAB is managed separately under the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017 and the Water Management Protocol for the Great Artesian Basin and Other Regional Aquifers 2017. The Great Artesian Basin management areas within the Border Rivers and Moonie plan area includes groundwater sub-basin Surat Basin.

1.5.3 Intergovernmental agreements

The New South Wales-Queensland Border Rivers Intergovernmental Agreement 2008*,* recognises the need to maintain a balance between social and economic outcomes and environmental values and sustainability in the allocation and use of waters of the Border Rivers Catchment. The agreement provides for the development and implementation of policies and strategies concerning water resources, which affect the management of the quantity or quality of water in the river system (and associated catchment, floodplains, overflow channels, lakes, wetlands and sub-artesian waters dependent on surface flows) or the aquatic ecosystems, to avoid or eliminate adverse cross-border impacts.

The Dumaresq-Barwon Border Rivers Commission also applies to this plan area. The governments of Queensland and New South Wales agreed to share the waters of the rivers and streams which either form or intersect the boundary between the two states and the associated groundwater resources; and to investigate, construct and operate works to conserve and regulate those waters where considered desirable. The waters included under this interstate agreement include Glenlyon Dam, the Border Rivers (Dumaresq, Macintyre and Barwon Rivers) and the intersecting streams (Moonie, Bokhara, Narran, Culgoa, Ballandool, Warrego and Paroo Rivers).

Water quality monitoring data is collected under both of the above agreements, from sites downstream of the State border and throughout the Border Rivers and intersecting streams. This monitoring data was considered in developing the local water quality targets for fresh water-dependent ecosystems presented in Section 10.2 of this report.

[2] Although the Bulloo drainage basin is not connected to the Murray-Darling Basin, it is included in the Queensland water plan area with the Warrego, Paroo and Nebine drainage basins for State planning purposes.

1.6 State Planning Policy

The State Planning Policy (SPP) defines the Queensland Government's policies about matters of state interest in land use planning and development (a state interest is defined under the *Planning Act 2016*).

1.6.1.1 Regional plans

The Queensland Government prepares regional plans which are long term strategic plans in partnership with local authorities that support local growth and development while also protecting a region's natural resources. At a regional and state level, regional plans guide overall growth patterns. At a local level, they are given effect by local government planning schemes, which are required to demonstrate they have appropriately integrated the relevant regional plan.

The Darling Downs Regional Plan was completed in October 2013. This plan covers a large proportion of the Queensland Murray-Darling Basin and describes environment and heritage matters but does not state strategic directions requiring statutory compliance by councils when preparing their planning schemes.

Current regional plans are available at the Queensland Planning System website at https://planning.dsdmip.qld.gov.au/planning/better-planning/state-planning/regional-plans

1.6.1.2 Local planning schemes

Every local government has a planning scheme. These describe a council's plan for the future direction of a local government area and can span for 20 years or more. Depending on when planning scheme was drafted, planning schemes may or may not align with the current SPP. More recent schemes (prepared after 2014) are likely to include mapping and codes which align with the current SPP and its water quality, biodiversity and heritage guidelines. The more recent planning schemes are likely to contain a biodiversity overlay (or equivalent) which maps the extent of land subject to matters of local environmental significance and codes which regulate development where matters of environmental significance are mapped.

For more information on planning schemes, refer to Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) planning system webpage at https://planning.dsdmip.qld.gov.au/?jumpTo=map

1.6.2 State Planning Policy: state interest—biodiversity

The State Planning Policy (SPP) lists biodiversity as a state interest and seeks to ensure that matters of national, state and local environmental significance are valued and protected and the health and resilience of biodiversity is maintained or enhanced to support ecological integrity. The SPP (and the accompanying SPP Guideline: Biodiversity) guides plan makers preparing or reviewing town planning schemes, regional plans or community infrastructure designations.

The SPP and supporting guideline are available from the DSDMIP website.

1.6.3 State Planning Policy: state interest—cultural heritage

The State Planning Policy (SPP) lists cultural heritage as a state interest and seeks to ensure that 'the cultural heritage significance of heritage places and heritage areas, including places of Indigenous cultural heritage, is conserved for the benefit of the community and future generations'. It includes provisions to integrate the state interest—cultural heritage when making or amending a planning scheme and designating land for community infrastructure. This includes considering and integrating matters of Aboriginal cultural heritage and Torres Strait Islander cultural heritage to support the requirements of the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003*[3]. World heritage properties, national heritage places and non-Indigenous cultural heritage places are additional considerations under the state interest—cultural heritage.

The SPP (state interest—cultural heritage) is supported by the State Planning Policy: state interest guideline—cultural heritage (April 2016 and as updated).

[3] The *Aboriginal Cultural Heritage Act 2003* (ACHA) and *Torres Strait Islander Cultural Heritage Act 2003* (TSICHA) provide for the recognition, protection and conservation of Aboriginal and Torres Strait Islander cultural heritage and impose a duty of care in relation to the carrying out of activities. The requirements of the ACHA and TSICHA apply separately and in addition to the SPP.

The SPP and supporting guideline are available from the DSDMIP's webpage.

1.6.4 State Planning Policy: state interest —water quality

The State Planning Policy (SPP, July 2017) guides local governments in preparing and amending planning schemes to ensure 17 State Interests are considered. The State Interest for Water Quality specifies that the environmental values and quality of Queensland waters are protected and enhanced.

Policy elements and development benchmarks are specified in the SPP for the State Interest for Water Quality to ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in a way that supports the protection of environmental values identified in the Environmental Protection (Water) Policy 2009. The policy elements and benchmarks include the consideration of receiving waters and development in water resource catchments and water supply buffer areas.

The development benchmarks refer to applicable stormwater management design objectives outlined in Tables A and B in Appendix 2 of the SPP. Table A specifies construction phase stormwater management design objectives which apply to all climatic regions in Queensland and aim to minimise the risk of sediment washing off sites and polluting waterways during construction. Table B specifies post-construction phase stormwater management design objectives to address pollutants known to be generated from urban land uses. For the Western Queensland region, post construction phase stormwater management design objectives for total suspended solids, nutrients, gross pollutants and waterway stability management apply to population centres greater than 25,000 persons. Therefore, these objectives currently apply to the city of Toowoomba in the QMDB region, as it classifies as a population centre greater than 25,000 persons.

The SPP State Interest for Water Quality is supported by the State Planning Policy: state interest guideline—water quality (July, 2016). The guideline includes a model code to guide Local Governments in specifying performance outcomes and acceptable solutions that can be incorporated into planning schemes. Environmental values and water quality objectives under the Environmental Protection (Water) Policy 2009 are core concepts under this guideline. The SPP and supporting guideline are available from the DSDMIP website.

SECTION 2: EXISTING CONDITION AND EXTENT

2 Existing condition and extent

2.1 Condition

The Queensland Government Q-catchments Program assessed the threats to the condition of the aquatic ecosystems in the eastern portion of Queensland's Murray-Darling basin (Negus, et al., 2015). The basins assessed in this program were the Condamine, Balonne, Maranoa, Lower Balonne, Moonie and Border Rivers. Threats to the aquatic ecosystem were identified and prioritised for each basin, and are discussed below. The following priority threats were identified for the Border Rivers and Moonie River basins:

1. Instream pest fauna– High priority threat
2. Deposited sediment – High priority threat
3. Climate change – Moderate priority threat
4. Hydrology: sub-threat: in-channel flow variability – Moderate priority threat (Border Rivers only)
5. Hydrology: flow regime general – Moderate priority threat (Border Rivers only)
6. Riparian disturbance – Moderate priority threat (Border Rivers only)
7. Instream connectivity: barriers – Moderate priority threat (Border Rivers only)

The Q-catchments report notes that the identified list of priority threats will be used to support the selection and prioritisation of riverine condition indicators for application in future monitoring activities. This further assessment of the catchment condition informs the management of additional threats to water quality, as it is unlikely that ecological outcomes can be achieved through the management of flow regime alone. Due to the focus of the Q-catchment report on ecosystem condition related to flow regime, this HWMP includes additional sources of information to inform the existing condition of the Queensland Border Rivers and Moonie River basins.

2.1.1 Instream pest fauna

The presence of instream pest fauna is often associated with a decline in the populations and communities of native flora and fauna (Negus, et al., 2015), particularly where native populations are already under stress from poor water quality or habitat degradation. This is due to the increased predation and competition with native species. Pest fish are introduced into the ecosystem in a number of ways including, dumping of unwanted fish to waterways, the use of pest fish as bait, and stocking of fish in dams and impoundments. Of the 12 species of instream pest fauna present in the Murray-Darling basin (Lintermans, 2007), three fish species and one amphibian are known to occur, and two fish species have a real potential to occur in the Queensland Border Rivers and Moonie River basins (Table 1).

Table 1: Presence of instream pest fauna in the Border Rivers and Moonie basins (Negus, et al., 2015).

Species	Border Rivers	Moonie
European carp (*Cyprinus carpio)*	✓	✓
Eastern mosquitofish *(Gambusia holbrooki)*	✓	✓
Goldfish (*Carassius auratus)*	✓	✓
Mozambique tilapia *(Oreochromis mossambicus)*	× (at risk)	× (at risk)
Pearl cichlid *(Geophagus brasiliensis)*	× (at risk)	× (at risk)
Cane Toad *(Bufo marinus)*	✓	✓

2.1.2 In-channel flow variability

Many rivers in QMDB naturally cease to flow and resultantly, become disconnected during dry periods. Water storages and downstream releases in the eastern catchments of QMDB has resulted in an alteration to in-channel

flow variability, by stabilising flows and reducing the magnitudes of flood flows.

Reduced flow variability and increased seasonal stability can adversely impact native fish reproduction or migration, favour populations of exotic fish and has been shown to influence aquatic macroinvertebrates, favouring taxa adapted to such conditions (Negus, et al., 2015).

2.1.3 Deposited sediment

Intermittently flowing river systems of the eastern catchments of QMDB are often characterised by a series of waterholes which vary in persistence. Waterholes offer critical refuges for aquatic biota, terrestrial plants and animals and other water users, including for social, cultural and economic purposes during periods of low or no-flow periods (Lobegeiger, 2010). Alterations to hydrology can threaten waterhole persistence due to changes to the frequency with which waterholes are filled and sediment is flushed through the system (DSITI, 2015).

Research into the persistence of waterholes in the Moonie River basin has shown that up to 2.8 metres of sediment has accumulated since the 1950s (Lobegeiger, 2010). As waterhole depth is considered a key measure of the persistence of waterholes over time, increased sedimentation and changes to hydrology are likely to threaten their persistence, and resultantly, likely to threaten the biota that are dependent upon the availability of waterholes.

The eWater Source Water Quality Model for the Queensland Murray-Darling Basin (Davidson, 2018), provides information about the sources in the landscape contributing sediment to stream in Border Rivers and Moonie River basins (Table 2). The model also indicates the proportion of sediment being contributed to stream from each land use in the Queensland Border Rivers and Moonie River basins (Table 3). This information is useful for determining where investment in land management will be most effective for reducing instream sedimentation rate.

Table 2: Proportion of total suspended solids contributed to stream by each source for the Queensland Border Rivers and Moonie River basins (Davidson, 2018).

Source of sediment	Border Rivers (%)	Moonie (%)
Channel Remobilisation	1	2
Gully	20	73
Hillslope	39	23
Streambank	37	2
Undefined	3	0

Table 3: Contribution of total suspended solids to stream from exported tonnes per hectare, by land use in the Queensland Border Rivers and Moonie River basin (Davidson, 2018).

Land use	Border Rivers (%)	Moonie (%)
Conservation	19	8
Cropping	18	20
Grazing	36	33
Forestry	5	5
Horticulture	7	7
Mining	2	0
Other	3	8

Land use	Border Rivers (%)	Moonie (%)
Stream	0	0
System Supply	0	0
Urban	5	0
Water	5	18

2.1.4 Flow regime and instream connectivity: barriers

The flow regime of the Border Rivers has been altered from natural flows over time due to the presence of numerous dams and weirs, and the extraction of water by industry, irrigation and other land uses. The Moonie River however, remains mostly unregulated with no major weirs along the channel. Aquatic species have evolved or adapted in line with natural flow regimes, often relying on hydrologic cues for spawning, migration or recruitment. Alterations to natural flows can negatively impact or exclude aquatic species, particularly fish.

Barriers to fish passage, either due to infrastructure or periods of low flow, can prevent fish from migrating to access foraging or breeding areas, and vital drought refugia. For many species the timing of this is key to reproductive success. Refer to Figure 8 for the barriers to fish passage in the Border Rivers and Moonie River basins.

2.1.5 Riparian disturbance and riparian weeds

Riparian disturbance including clearing, reduction and fragmentation of riparian vegetation, impacts the aquatic and terrestrial ecosystem. Habitat removal, along with decreased bank stability, reduced interception of sediments and other pollutants, increased light penetration and increased abundance and prevalence of weed species, are associated impacts of riparian vegetation disturbance.

The loss of riparian vegetation from pre-European settlement to 2013 due to anthropogenic impacts was determined in the Riparian Forest and Ground Cover Levels report (Clark, Healy, & Tindall, 2015). Clark et al., found that 36% of pre-European riparian vegetation has been cleared in the Border Rivers[4] (123,688 ha) and 38% in the Moonie River (24,725 ha). Refer to section 10.2.8 for further information on riparian levels and recommended targets to contribute to maintaining and improving ecosystem health.

Although introduced riparian flora was not identified as a priority threat by the Q-catchments program in the Queensland Border Rivers or Moonie River basins, riparian weeds, including Weeds of National Significance (WONS), have been identified in these basins. Table 4 displays the riparian floral weed species identified in the Queensland Border Rivers and Moonie River basins.

Table 4: Riparian weeds identified in the Queensland Border Rivers and Moonie River basins (Negus, et al., 2015) (derived from Goondiwindi Regional Council and Southern Downs Regional Council).

Species	Border Rivers	Moonie River
African boxthorn (*Lycium ferocissimum*)*	✓	✓
Annual Ragweed (*Ambrosia artemisiifolia*)	✓	×
Athel Pine (*Tamarix aphylla*)*	✓	×
Balloon Vine (*Cardiospermum grandiflorum*)	✓	×

[4] 35% for the Macintyre and Weir Rivers; 39% for the Macintyre Brook; and 34% for the Dumaresq River.

Species	Border Rivers	Moonie River
Bathurst Burr (*Xanthium spinosum*)	✓	×
Blackberry (*Rubus fruticosus* sp. aggregate)*	✓	×
Bridal creeper (*Asparagus asparagoides*)*	✓	×
Broad-leaved Pepper Tree (*Schinus terebinthifolius*)	✓	×
Camphor Laurel (*Cinnamomum camphora*)	✓	×
Cat's Claw Creeper (*Macfadyena unguis-cati*)*	✓	✓
Chinese Celtis (*Celtis sinensis*)	✓	✓
Firethorn (*Pyracantha* spp.)	✓	×
Groundsel (*Baccharis halimifolia*)	✓	✓
Harrisia Cactus (*Eriocereus* spp. Inc. *E. martini*)	✓	✓
Honey Locust Tree (*Gleditsia triacanthos*)	✓	✓
Lantana (*Lantana camara*)*	✓	✓
Lantana (*Lantana montevidensis*)	✓	×
Lippia (*Phyla canescens*)	×	✓
Mimosa Bush (*Acacia farnesiana*)	✓	✓
Mother-of-Millions (*Bryophyllum delagoense* syn. *B tubiflorum*)	✓	✓
Noogoora Burr (*Xanthium pungens*)	✓	✓
Parkinsonia (*Parkinsonia aculeate*)*	✓	×
Parthenium (*Parthenium hysterophorus*)*	✓	✓
Prickly pear/Opuntioid cacti (*Opuntia* spp.)*.	×	✓
Privets (*Ligustrum lucidum* & *L. sinense*)	✓	×
Serrated tussock (*N. trichotoma*)*, Mexican Feather Grass (*N. tenuissima*), Weedy Sporobolus or Rat's Tail Grasses, Parramatta Grass, (*S. africanus*) Giant Parramatta Grass, (*S. fertilis*) Giant Rat's Tail Grass (*S.pyramidalis* and *S. natalensis*)	✓	✓
St John's Wort (*Hypericum perforatum*)	✓	×
Tiger Pear (*O. aurantiaca*)	✓	✓
Velvet Tree Pear (*O. tomentose*)	✓	✓
Willows (*Salix* spp.)*	✓	×

*Weeds of National Significance (WONS).

2.1.6 Water Quality

2.1.6.1 Surface water

The water quality of the Queensland Border Rivers and Moonie River basins was assessed during the development of water quality targets for these basins (Refer to Appendix 1—Refining water quality targets for fresh water-dependent ecosystems to reflect local conditions). A comparison of surface water quality across Upper and Lower Border Rivers and Upper and Lower Moonie River[5] basins is displayed in the below figures.

Figure 12 shows the average concentration of total nitrogen and total phosphorus across the catchments. Upper Moonie has the greatest average concentration of total nitrogen (2297µg/L) and total phosphorus (555µg/L), followed by Lower Moonie (1881µg/L) (510µg/L), Lower Border Rivers (900µg/L) (128µg/L) and Upper Border Rivers (688µg/L) (53µg/L). The rivers with the most elevated concentrations occur in the Moonie River (elevated throughout the upper, middle and lower Moonie) and the Weir River (elevated throughout the upper and lower). The nutrient concentrations in Canning Creek, Dumaresq Floodplain, Traprock, Granite Belt and Macintyre Barwon Floodplain are considerably lower than the Moonie and Weir.

Figure 13 shows the average turbidity (NTU) across the catchments. Lower Moonie has the highest turbidity levels out of the four river catchments (656NTU), followed by Upper Moonie (464NTU), Lower Border Rivers (171NTU) and Upper Border Rivers (55NTU). Turbidity and suspended solids in the waters of Moonie and Weir River are also much higher than Canning Creek, Dumaresq Floodplain, Traprock, Granite Belt and Macintyre Barwon Floodplain.

Figure 14 displays the average electrical conductivity (µS/cm) across the catchments. Lower Border Rivers has the highest electrical conductivity out of the four river catchments (312µS/cm), followed by Upper Border Rivers (290µS/cm), Upper Moonie (187µS/cm) and Lower Moonie (160µS/cm). At present, in-stream salinity is not high compared to other areas of the Murray-Darling Basin. However, it has the potential to become a water quality issue if land uses and management practices that result in elevated salinity levels are not managed appropriately into the future.

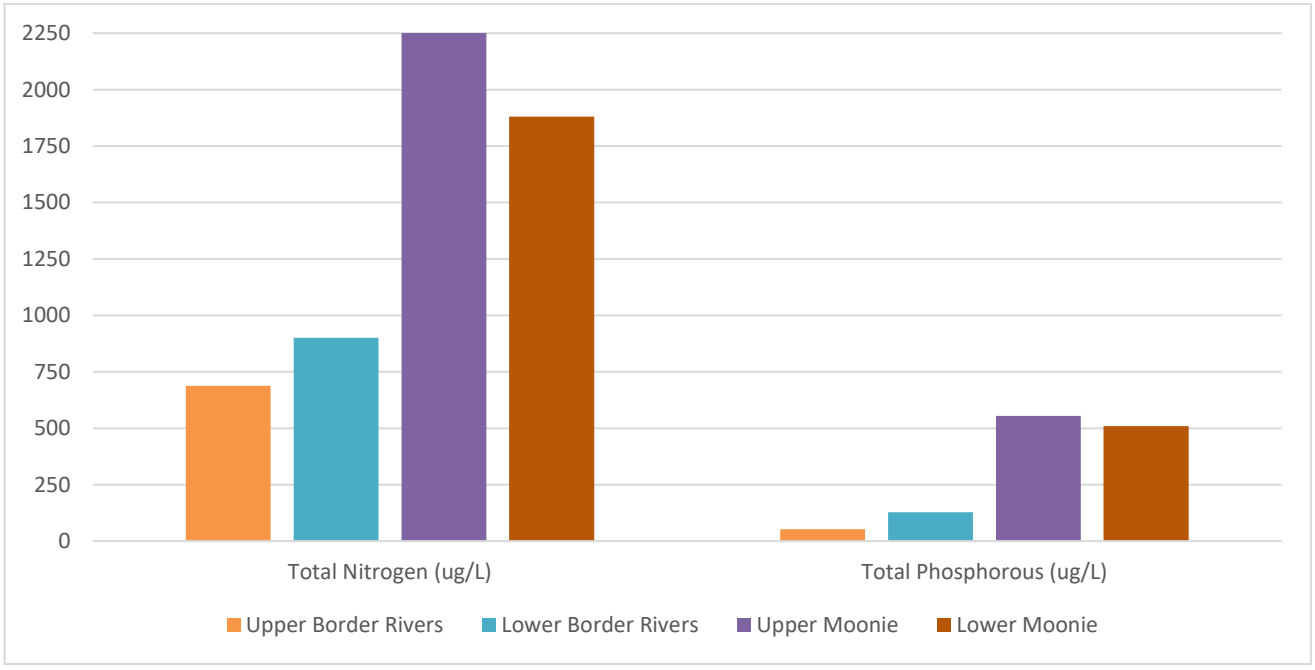


Figure 12: Comparison of average total nitrogen and total phosphorus concentrations (µg/L) in the Border Rivers and Moonie River basins.

[5] The four water quality zones are an amalgamation of several water types (refer to Figure 30) as such: Upper Border Rivers (Canning Creek, Dumaresq Floodplain, Granite Belt, Kumbarilla Ridge, Traprock and Upper Weir River); Lower Border Rivers (Lower Mac Brook, Lower Weir River and Macintyre Barwon Floodplain); Upper Moonie (Upper Moonie River, Kumbarilla Ridge and Middle Moonie River); Lower Moonie (Lower Moonie River).

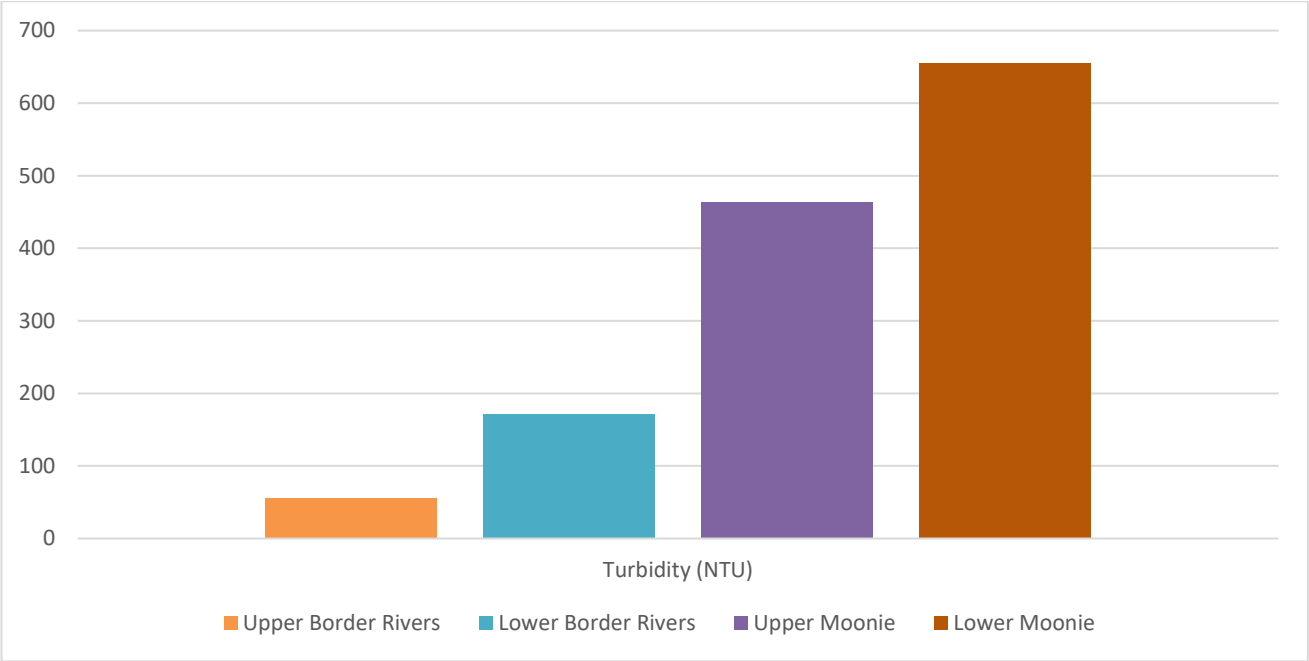


Figure 13: Comparison of average turbidity (NTU) in the Border Rivers and Moonie River basins.

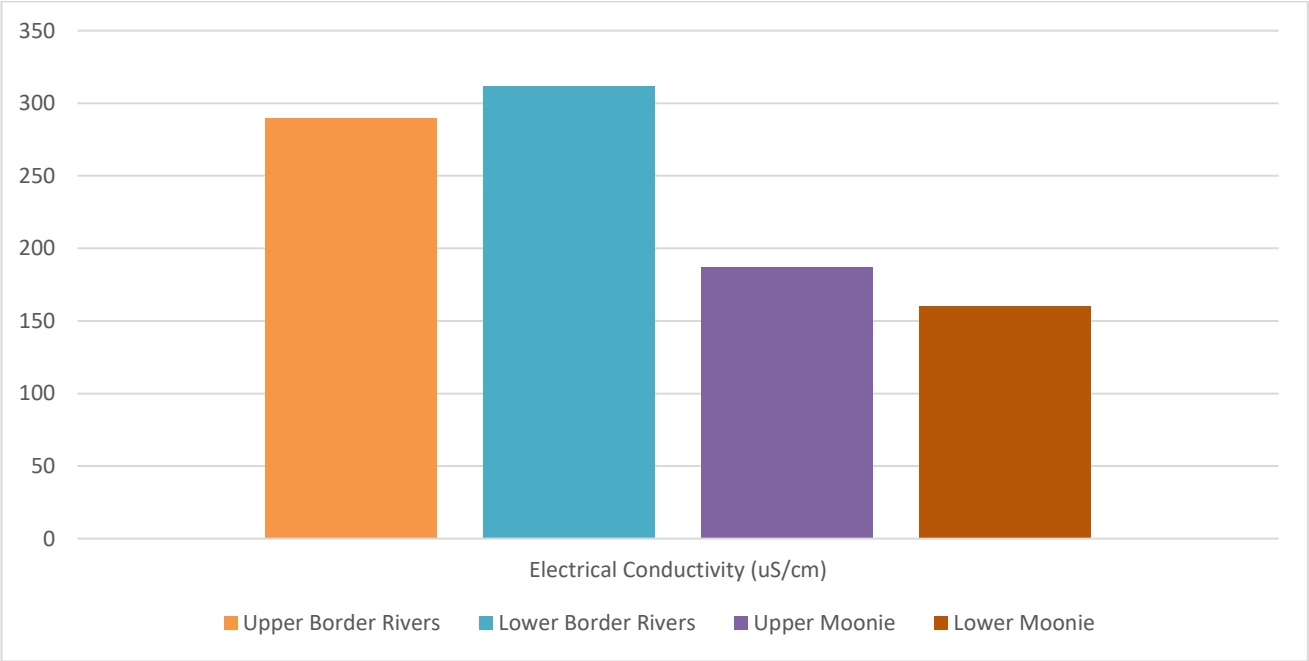


Figure 14: Comparison of average electrical conductivity concentration (µS/cm) in the Border Rivers and Moonie River basins.

The eWater Source Water Quality Model for the Queensland Murray-Darling Basin (Davidson, 2018) shows the proportion of total nitrogen and total phosphorus being contributed to stream from each land use in the Border Rivers and Moonie River basins (Table 5). This information is useful for determining where investment in land management will be most effective in reducing nutrient export to stream.

Table 5: Proportion of total nitrogen and total phosphorus from exported tonnes per hectare, contributed to stream by land use in the Border Rivers and Moonie River basins (Davidson, 2018).

Land use	Border Rivers		Moonie	
	TN (%)	TP (%)	TN (%)	TP (%)
Conservation	7	9	6	5
Cropping	35	41	30	39
Grazing	20	19	26	21
Forestry	3	3	16	8
Horticulture	4	5	6	8
Mining	7	8	0	0
Other	8	7	16	17
Urban	15	8	0	0
Water	0	1	1	3

2.1.6.2 Groundwater

Groundwater quality was analysed during the development of water quality targets for the groundwaters of QMDB. For further information on methods, refer to Regional groundwater chemistry zones: Queensland Murray-Darling Basin (McNeil et. al., (2017).

McNeil et al., (2017) found that some interaction between surface and groundwaters occurs in the Queensland Border Rivers as indicated by similarities in water chemistry. The connectivity between surface and groundwaters for the Moonie basin cannot be determined due to a lack of water quality data from the shallower aquifers. The shallow groundwaters in the Queensland Border Rivers are dominated by low salinity sodium bicarbonate waters to moderately saline bicarbonate waters. Most artesian bores are moderately saline sodium bicarbonate, except those along the Kumbarilla Ridge which have highly saline sodium chloride waters. The sub artesian groundwaters in the Moonie basin are moderately saline sodium bicarbonate chemistry which is typical of the artesian systems of the region. However, as in the Queensland Border Rivers, saline to highly saline sodium chloride waters can be occasionally found in the Kumbarilla Ridge region of the Moonie.

Refer to section 7 for further information about potential risks to water quality over the life of the plan in the Queensland Border Rivers and Moonie River basins. Refer to section 8 for information on management responses to address risks to water quality in the Queensland Border Rivers and Moonie River basins.

2.1.7 Climate change

A changing climate is likely to impact the water resources and freshwater ecosystems of the QMDB (Negus, et al., 2015). Rainfall variability is likely to increase with current climate modelling predicting that rainfall during winter and spring will decrease and the frequency of intense downpours will increase (State of Queensland, 2017). It is likely that this will be associated with changes to river flows and to the frequency and extremity of droughts and floods.

Climate change is predicted to impact fish species, particularly the cold-water tolerant species (Balcombe, et al., 2011). Reductions to flood frequency and duration may impact vegetation (river red gums - *Eucalyptus camaldulensis* for example), reducing river shading and reducing the contribution of organic matter to stream. This will impact fish species as stream water temperature will increase and food and habitat availability will decrease. Drought refugia may dry out faster under current climate predictions due to increased evapotranspiration and changes to flood frequency and duration (Balcombe, et al., 2011).

Refer to the Queensland Government webpage for more information about climate change predictions, and adaptation and mitigation strategies https://www.qld.gov.au/environment/climate/climate-change. Refer to section 8 for information on management responses to address risks of climate change in the Queensland Border Rivers and Moonie River basins.

2.1.8 State of the Environment

The Queensland Government is responsible for reporting on the environmental performance of the State of Queensland. This reporting occurs on a biennial frequency with the report structured around four themes – biodiversity, heritage, pollution and climate.

Refer to the Queensland Government webpage for more information about the State of the Environment reporting: https://www.stateoftheenvironment.des.qld.gov.au/.

2.2 Extent

The extent and distribution of freshwater wetlands is the most important indicator of the state of wetland resources in Queensland, as any loss will mean that the services provided by that wetland will be diminished. Different wetland systems provide different values to society. These values can vary throughout the State and can be affected by changes in extent.

Freshwater wetlands include:

Riverine wetlands: Systems that are contained within a channel (e.g. river, creek or waterway) and their associated streamside vegetation (WetlandInfo, 2013c).

Lacustrine wetlands (lakes): Systems that are dominated by open water. Although lakes may have fringing vegetation, the majority of the wetland area is open water. Lacustrine systems in Queensland, particularly in arid and semi-arid areas, are highly variable. Some are known to dry out and to support species adapted to these conditions, while others stay wet for long periods and provide a refuge for many species during dry times (WetlandInfo, 2013d).

Palustrine wetlands: Systems traditionally considered as a wetland. They are vegetated, non-riverine or non-channel systems and include billabongs, swamps, bogs, springs, soaks etc. They have more than 30% emergent vegetation and are an important part of the landscape, providing habitat and breeding areas for a wide variety of species (WetlandInfo, 2013e).

The tables below specify the area of freshwater wetlands (by system) in the plan area as a whole, as well as within each individual basin.

Table 6: Wetland area by system (2013): Whole of plan area

System	Area (km^2)	Wetlands area (%)	Total area (%)
Artificial and highly modified	244.8	37.7	0.6
Lacustrine	7.2	1.1	0.0
Palustrine	59.8	9.2	0.2
Riverine	336.9	56.4	0.9
Total	**648.7**	**100.0**	**1.7**

Note: Areas are approximate and calculated using the GDA94/Australian Albers projection. Areas may change over time as mapping approaches improve. Totals may not match the sum of individually displayed figures due to the rounding of displayed figures.

Source: Based on figures sourced from: Water resource planning area 2013 wetland system extents, WetlandInfo, Department of Environment and Heritage Protection, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/statistics/wetland-extent/water-resource-planning-area.html>.

Table 7: Wetland area by system (2013): Water resource plan basins

System	Area (km^2)	Wetlands area (%)	Total area (%)
Moonie			
Artificial and highly modified	53.7	45.4	0.4
Lacustrine	1.7	1.4	0.0
Palustrine	15.0	12.7	0.1
Riverine	47.8	40.5	0.3
Total	**118.2**	**100.0**	**0.8**
Queensland Border Rivers			
Artificial and highly modified	191.1	36.0	0.8
Lacustrine	5.5	1.0	0.0
Palustrine	44.8	8.4	0.2
Riverine	289.1	54.5	1.2
Total	**530.5**	**100.0**	**2.2**

Note: Areas are approximate and calculated using the GDA94/Australian Albers projection. Areas may change over time as mapping approaches improve. Totals may not match the sum of individually displayed figures due to the rounding of displayed figures.

Source: Moonie drainage basin — facts and maps, WetlandInfo, Department of Environment and Science, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-moonie/>.

Border Rivers water resource planning area — facts and maps, WetlandInfo, Department of Environment and Science, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/water-resource-planning-area-border-rivers/>.

Wetlands can also be described by type of habitat that occurs within the system. The tables below specify the wetland area by habitat for the plan area. Refer to the Queensland Wetland*Info* website for conceptual models that describe each habitat type in terms of its hydrology, geomorphology, fauna and flora.

Table 8: Wetland area by habitat (2013): Moonie

Habitat	Area (km^2)	Wetlands area %	Total area (%)
Coastal and sub-coastal saline swamp	0.0	0.0	0.0
Coastal and sub-coastal non-floodplain tree swamp—Melaleuca spp. and Eucalyptus spp.	1.8	1.5	0.0
Coastal and sub-coastal non-floodplain grass sedge and herb swamp	1.3	1.1	0.0
Coastal and sub-coastal floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	8.0	6.8	0.1
Coastal and sub-coastal floodplain grass, sedge, herb swamp	3.9	3.3	0.0
Coastal and sub-coastal floodplain lake	1.7	1.4	0.0

Habitat	Area (km^2)	Wetlands area %	Total area (%)
Artificial and highly modified wetlands (dams, ring tanks, irrigation channels)	42.6	36.1	0.3
(modified natural) Coastal and sub-coastal non-floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	10.9	9.2	0.1
(modified natural) Coastal and sub-coastal non-floodplain grass sedge and herb swamp	0.1	0.1	0.0
Riverine	47.8	40.5	0.3
Total	**118.2**	**100.0**	**0.8**

Note: Areas are approximate and calculated using the GDA94/Australian Albers projection. Areas may change over time as mapping approaches improve. Totals may not match the sum of individually displayed figures due to the rounding of displayed figures.

Source: Moonie drainage basin — facts and maps, WetlandInfo, Department of Environment and Science, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-moonie/>.

Table 9: Wetland area by habitat (2013): Queensland Border Rivers

Habitat	Area (km^2)	Wetlands area %	Total area (%)
Coastal and sub-coastal saline swamp	0.0	0.0	0.0
Coastal and sub-coastal non-floodplain grass sedge and herb swamp	1.5	0.3	0.0
Coastal and sub-coastal floodplain tree swamp—Melaleuca spp. and Eucalyptus spp.	30.9	5.8	0.1
Coastal and sub-coastal floodplain grass, sedge, herb swamp	12.2	2.3	0.1
Coastal and sub-coastal floodplain lake	5.2	1.0	0.0
Coastal and sub-coastal non-floodplain soil lake	0.3	0.1	0.0
Arid and semi-arid lignum swamp (floodplain)	0.1	0.0	0.0
Artificial and highly modified wetlands (dams, ring tanks, irrigation channels)	185.6	35.0	0.8
(modified natural) Coastal and sub-coastal non-floodplain grass sedge and herb swamp	1.0	0.2	0.0
(modified natural) Coastal and sub-coastal floodplain tree swamp—Melaleuca spp. and Eucalyptus spp.	4.2	0.8	0.0
(modified natural) Coastal and sub-coastal floodplain grass, sedge, herb swamp	0.2	0.0	0.0

Habitat	Area (km^2)	Wetlands area %	Total area (%)
(modified natural) Coastal and sub-coastal floodplain lake	0.1	0.0	0.0
(modified natural) Coastal and sub-coastal non-floodplain soil lake	0.1	0.0	0.0
Riverine	289.2	54.5	1.2
Total	**530.7**	**100.0**	**2.2**

Note: Areas are approximate and calculated using the GDA94/Australian Albers projection. Areas may change over time as mapping approaches improve. Totals may not match the sum of individually displayed figures due to the rounding of displayed figures.

Source Border Rivers water resource planning area — facts and maps, WetlandInfo, Department of Environment and Science, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/water-resource-planning-area-border-rivers/>.

The loss of wetland extent in Queensland is affected primarily by drainage, clearing or levelling in lowland parts of catchments due to intensive agriculture and urbanisation. However, wetland extent can also be impacted by upland activities, such as dam construction, altering the hydrology of downstream wetlands. The greatest losses have occurred in the palustrine and riverine systems. At a state-wide scale, an estimated 94% of pre-clear extent of freshwater wetland remains (DEHP, 2017). Estimated historical loss of wetlands is unevenly distributed across drainage divisions and catchments with:

- 84% remaining in the Queensland Murray-Darling division
- 50% remaining in the North East Coast (non-Great Barrier Reef (GBR)) division
- 80% remaining in the North East Coast—GBR division
- close to 100% remaining in the other divisions.

Of the three freshwater wetland systems (lacustrine, palustrine, riverine) in Queensland, one of the greatest ongoing losses has occurred in palustrine and riverine systems in the Queensland Murray-Darling drainage division. Within this division, historical loss of freshwater wetland extent is unevenly distributed. The Macintyre, Weir and the Dumaresq have less than, or equal to, 50% remaining. Historical loss of palustrine wetlands in the Moonie, Macintyre and Weir catchments has resulted in less than 25% remaining (DEHP, 2017).

Net rate of loss of wetlands in the Queensland Murray-Darling drainage division over the 2001-05, 2005-09 and 2009-13 periods has decreased from a rate of over 1500 hectares (ha) to 291ha (2009-13)—a rate of 72ha per year. Most of this loss is due to broad acre land clearing of riverine and palustrine wetlands, primarily in the Warrego drainage basin (DEHP, 2017).

There are 40,901ha of freshwater wetlands within protected areas in the Queensland Murray-Darling drainage division. This amounts to 9% of the total 432,603ha of freshwater wetlands in the division and 0.7% across the state. The majority (78%) of freshwater wetlands that are in protected areas are contained within national parks. The rest are mostly within nature refuges (19%). Both lacustrine and palustrine wetlands are reasonably well represented in protected areas, at 14% and 11% respectively, however only 1% of riverine wetlands are contained within protected areas (DEHP, 2017).

The tables below specify the change in wetland extent by system and habitat within the Queensland Border Rivers and Moonie River basins.

Table 10: Wetland extent change by system: Queensland Border Rivers and Moonie River basins

System	2013 area (km^2)	2009 area (km^2)	2005 area (km^2)	2001 area (km^2)	2013/pre-clear (%)
Queensland Border Rivers					
Artificial and highly modified	191.2	189.9	189.7	173.1	n/a
Lacustrine	5.5	5.5	5.5	5.5	n/a
Palustrine	44.8	44.8	44.8	44.9	65.9
System	2013 area (km^2)	2009 area (km^2)	2005 area (km^2)	2001 area (km^2)	2013/pre-clear (%)
Queensland Border Rivers cont.					
Riverine	289.2	289.4	290.1	292.5	65.3
Total	530.7	529.6	530.1	516.0	69.0
Moonie					
Artificial and highly modified	53.7	52.4	50.3	47.8	n/a
Lacustrine	1.7	1.7	1.7	1.7	n/a
Palustrine	15.0	15.0	15.0	15.0	21.8
Riverine	47.8	47.8	47.9	48.2	93.4
Total	**118.2**	**116.9**	**114.8**	**112.7**	**79.8**

Note: Areas are approximate and calculated using the GDA94/Australian Albers projection. Areas may change over time as mapping approaches improve. Totals may not match the sum of individually displayed figures due to the rounding of displayed figures.

Source: Border Rivers water resource planning area — facts and maps, WetlandInfo, Department of Environment and Science, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/water-resource-planning-area-border-rivers/>.

Moonie drainage basin — facts and maps, WetlandInfo, Department of Environment and Science, Queensland, viewed 11 October 2017, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-moonie/>.

Table 11: Wetland extent change by habitat: Queensland Border Rivers and Moonie River basins

Habitat	2013 area (km^2)	2009 area (km^2)	2005 area (km^2)	2001 area (km^2)
Queensland Border Rivers				
Coastal and sub-coastal saline swamp	0.0	0.0	0.0	0.0
Coastal and sub-coastal non-floodplain grass sedge and herb swamp	1.5	1.5	1.5	1.5
Coastal and sub-coastal floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	30.9	30.9	30.9	31.0
Coastal and sub-coastal floodplain grass, sedge, herb swamp	12.2	12.2	12.2	12.3
Coastal and sub-coastal floodplain lake	5.2	5.2	5.2	5.2
Coastal and sub-coastal non-floodplain soil lake	0.3	0.3	0.3	0.3
Arid and semi-arid lignum swamp (floodplain)	0.1	0.1	0.1	0.1
Artificial and highly modified wetlands (dams, ring tanks, irrigation channels)	185.6	184.3	184.1	167.5
(modified natural) Coastal and sub-coastal non-floodplain grass sedge and herb swamp	1.0	1.0	1.0	1.0
(modified natural) Coastal and sub-coastal floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	4.2	4.2	4.2	4.2
(modified natural) Coastal and sub-coastal floodplain grass, sedge, herb swamp	0.2	0.2	0.2	0.2
(modified natural) Coastal and sub-coastal floodplain lake	0.1	0.1	0.1	0.1
(modified natural) Coastal and sub-coastal non-floodplain soil lake	0.1	0.1	0.1	0.1
Riverine	289.2	289.4	290.1	292.5
Total	**530.7**	**529.6**	**530.1**	**516.0**

Habitat	2013 area (km^2)	2009 area (km^2)	2005 area (km^2)	2001 area (km^2)
Moonie				
Coastal and sub-coastal saline swamp	0.0	0.0	0.0	0.0
Coastal and sub-coastal non-floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	1.8	1.8	1.8	1.8
Coastal and sub-coastal non-floodplain grass sedge and herb swamp	1.3	1.3	1.3	1.3
Coastal and sub-coastal floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	8.0	8.0	8.0	8.0
Coastal and sub-coastal floodplain grass, sedge, herb swamp	3.9	3.9	3.9	3.9
Coastal and sub-coastal floodplain lake	1.7	1.7	1.7	1.7
Artificial and highly modified wetlands (dams, ring tanks, irrigation channels)	42.6	41.4	39.3	36.8
(modified natural) Coastal and sub-coastal non-floodplain tree swamp—*Melaleuca* spp. and *Eucalyptus* spp.	10.9	10.9	10.9	10.9
(modified natural) Coastal and sub-coastal non-floodplain grass sedge and herb swamp	0.1	0.1	0.1	0.1
Riverine	47.8	47.8	47.9	48.2
Total	**118.2**	**116.9**	**114.8**	**112.7**

Note: Areas are approximate and calculated using the GDA94/Australian Albers projection. Areas may change over time as mapping approaches improve. Totals may not match the sum of individually displayed figures due to the rounding of displayed figures.

Source: Border Rivers drainage basin — facts and maps, Wetland*Info*, Department of Environment and Science, Queensland, viewed 1 February 2018, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-border-rivers/>.

Moonie drainage basin — facts and maps, Wetland*Info*, Department of Environment and Science, Queensland, viewed 1 February 2018, <https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-moonie/>.

SECTION 3: OBJECTIVES AND OUTCOMES FOR WATER RESOURCES

3 Objectives and outcomes for water resources

The objectives and outcomes for water resources[6] are stated below. Specific objectives and outcomes apply to the waters of the Murray-Darling Basin as a whole and the waters of the Queensland Border Rivers and Moonie River basins. The relevant section numbers are listed for objectives and outcomes derived from the Basin Plan.

3.1 Objectives and outcomes for Murray-Darling Basin water resources (whole system)

The following objectives and outcomes apply to the Queensland Border Rivers and Moonie River drainage basins due to their connectivity with the Murray-Darling Basin system.

3.1.1 Objectives and outcome to contribute to the achievement of the Murray-Darling Basin Plan

The relevant objectives for **water quality** are:

a. to give effect to relevant international agreements through the integrated management of Basin water resources
b. to establish a sustainable and long-term adaptive management framework for Basin water resources, that takes into account the broader management of natural resources in the Murray-Darling Basin
c. to optimise social, economic and environmental outcomes arising from the use of water resources.

(Reflects Basin Plan Section 5.02, 1a-c)

The outcome for the Basin Plan as a whole is a healthy and working Murray-Darling Basin that includes:

a. communities with sufficient and reliable water supplies that are fit for a range of intended purposes, including domestic, recreational and cultural use; and
b. productive and resilient water-dependent industries, and communities with confidence in their long-term future; and
c. healthy and resilient ecosystems with rivers and creeks regularly connected to their floodplains and ultimately, the ocean.

(Reflects Basin Plan Section 5.02, 2a-c)

3.1.2 Objectives and outcome in relation to environmental outcomes

The objectives in relation to environmental outcomes are, within the context of a working Murray-Darling Basin:

a. to protect and restore water-dependent ecosystems of the Murray-Darling Basin; and
b. to protect and restore the ecosystem functions of water-dependent ecosystems; and
c. to ensure that water-dependent ecosystems are resilient to climate change and other risks and threats.

(Reflects Basin Plan Section 5.03, 1a-c)

The outcome in relation to objectives (a) to (c) is the restoration and protection of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin with strengthened resilience to a changing climate.

(Reflects Basin Plan Section 5.03, 2)

[6] Reflects the terminology used in the Basin Plan. 'Objectives and outcomes for water resources' are equivalent to 'Management Goals' under the National Water Quality Management Strategy. The EPP Water provides for the development of Management Goals that are long-term management objectives used to assess whether corresponding Environmental Values are being maintained. Management Goals for aquatic ecosystems reflect the management intent described in Section 14 of the EPP Water.

3.1.3 Objective and outcome in relation to water quality and salinity

The objective in relation to water quality and salinity is to maintain appropriate water quality, including salinity levels, for environmental, social, cultural and economic activity in the Queensland Border Rivers and Moonie River basins.

The outcome in relation to water quality and salinity is that water resources in the Queensland Border Rivers and Moonie River basins remain fit for purpose.

(Reflects Basin Plan Section 5.04, 1-2)

3.2 Objectives and outcomes for the Queensland Border Rivers and Moonie River basins

The following objectives and outcomes apply to the Queensland Border Rivers and Moonie River basins.

3.2.1 Objective to maintain good levels of water quality

If the value of a water quality indicator (for example, salinity, nutrients, pH, turbidity etc.) is at a level that is better than the target value for water quality (set out in section 10 of this report), the objective is to maintain that level.

(Reflects Basin Plan Section 9.08)

3.2.2 Objective to maintain the extent of natural wetlands and riparian forested areas

The objective is to maintain and, where possible, enhance the extent of natural wetlands (palustrine, lacustrine and riverine) and riparian forested areas across the Queensland Border Rivers and Moonie River basins.

3.2.3 Objective for declared Ramsar wetlands aquatic ecosystems

The Queensland Border Rivers and Moonie River basins do not contain any Ramsar wetlands at time of print.

If wetlands of international significance are declared in the future, the objective is that the quality of water is sufficient to maintain the ecological character of the wetlands.

(Reflects Basin Plan Section 9.04, 1)

3.2.4 Objective for aquatic ecosystems other than declared Ramsar wetlands

The objective is that the quality of water is sufficient:

a. to protect and restore the ecosystems; and
b. to protect and restore the ecosystem functions of the ecosystems; and
c. to ensure that the ecosystems are resilient to climate change and other risks and threats.

(Reflects Basin Plan Section 9.04, 2a-c)

3.2.5 Objective and outcome for Aboriginal cultural, spiritual and ceremonial values and uses of water

The objective is to ensure the suitability of water to support the identified cultural, ceremonial and spiritual values and uses of waters across the Queensland Murray-Darling Basin.

The outcome is that Queensland Murray-Darling Basin water resources remain fit for purpose in relation to cultural, spiritual and ceremonial values and uses of water.

(Reflects Basin Plan Section 10.52, 1a-b)

3.2.6 Objectives for raw water for treatment for human consumption

The objectives for raw water treatment for human consumption are:

a. to minimise the risk that the quality of raw water taken for treatment for human consumption results in adverse human health effects; and
b. to maintain the palatability rating of water taken for treatment for human consumption at the level of good as set out in the Australian Drinking Water Guidelines; and
c. to minimise the risk that the quality of raw water taken for treatment for human consumption results in the odour of drinking water being offensive to consumers.

(Reflects Basin Plan Section 9.05, a-c)

3.2.7 Objective for irrigation water

The objective for irrigation water is that the quality of surface water, when used in accordance with the best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation.

Soil degradation means reduced permeability and soil structure breakdown caused by the level of sodium in the irrigation water, and is assessed using the sodium adsorption ratio[7].

(Reflects Basin Plan Section 9.06)

3.2.8 Objective for recreational water quality

The objective for recreational water quality is to achieve a low risk to human health from water quality threats posed by exposure through ingestion, inhalation or contact during recreational use of Queensland Border Rivers and Moonie River basin water resources.

(Reflects Basin Plan Section 9.07)

3.2.9 Objective for waters under the Environmental Protection (Water) Policy 2009

It is the management intent for waters[8] that the decision to release waste water or contaminants to the waters must ensure the following for:

- high ecological value (HEV) waters—the measures for the indicators for all EVs are maintained
- slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives (targets) for HEV waters
- moderately disturbed (MD) waters, if the measures for indicators of the EVs:
  - achieve the water quality objectives for the water— the measures for the indicators are maintained at levels that achieve the water quality objectives (targets) for the water
  - do not achieve the water quality objectives (targets) for the water—the measures for indicators of the EVs are improved to achieve the water quality objectives (targets) for the water.

Refer to Section 6 of this plan for further details.

[7] See Chapter 11 – Salinity Management Handbook (DNR, 1997); or Figure 4.2.1 of Chapter 4 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

[8] Refer to Section 14 of the EPP Water.

SECTION 4: CONSULTATION AND ENGAGEMENT

4 Consultation and engagement

Consultation requirements for the WQM Plan are specified under section 10.32(4)(d) and 10.35 of the Basin Plan and relate to the connectivity of water resources with New South Wales. Section 4 provides information in support of these consultation requirements.

The development of the HWMP for the Queensland Border Rivers and Moonie River basins involved ongoing consultation in accordance with the requirements of the EPP Water and the Basin Plan. Consultation on the technical components of the draft HWMP occurred throughout 2016 and 2017. Following this, a draft version of the HWMP was released online for community and stakeholder consultation from April 2018 to June 2018.

Engagement with stakeholders and the community was encouraged through a range of mediums, including local print media, mail-outs, emails, natural resource management websites, meetings and workshops. The consultation was open to all interested stakeholders, including community members, participants from local, state and federal governments, natural resource management groups, local Aboriginal Nations, industry groups and environmental groups.

The stakeholder and community-based discussions indicated that water is a key regional asset, whether above or below ground. The major variances in discussion amongst the groups were the different uses and outcomes, the allocations to various sectors and the potential threats to the quantity and quality of both above ground or underground water supplies.

4.1 Water Quality Technical Panel

Throughout the development of the HWMP for the Queensland Border Rivers and Moonie River basins, the Water Quality Technical Panel was consulted on matters where skilled expertise or technical input was required. The panel was comprised of technical staff from Queensland Government departments, the former-Queensland Murray-Darling Basin Committee and external water quality experts, and utilised a range of State and Commonwealth information resources.

The Water Quality Technical Panel initially met to divide the Queensland Border Rivers and Moonie River basins into sub-regions through GIS mapping, to enable more targeted discussions and establishment of environmental values at stakeholder and community workshops. The Water Quality Technical Panel further met to discuss the development of water quality targets based on local data to protect environmental values.

The panel was also consulted during the initial risk assessment conducted in 2013 and again in 2016-17 when the risk assessment for the Queensland Border Rivers and Moonie was refined.

4.2 Consultation – Environmental values

Environmental values (EVs) for the Border Rivers and Moonie River basins were established through a consultative process conducted by various agencies between early 2000 and 2017.

In 2002, the Condamine Balonne Water Committee began the process of identifying EVs for the waters of the Queensland Border Rivers and Moonie River basins, and found that *"most respondents want water quality that supports all environmental values in all catchments"* (CBWC, 2002).

In 2012, the former-Queensland Murray Darling Committee (QMDC) re-established this work to support the development of the Healthy Waters Management Plans for the Queensland Border Rivers and Moonie River basins, as well as for the Maranoa and Balonne River basin. QMDC collected the values and uses of surface and groundwater as informed by stakeholders in the Maranoa, Balonne, Border Rivers and Moonie basins (Queensland Murray-Darling Committee , 2017). Feedback was received from 50 stakeholders or stakeholder groups, including local governments, catchment management groups, Traditional Owner groups, the irrigation industry, Queensland Government and the mining industry. During this process, the Water Quality Technical Panel divided the Maranoa, Balonne, Queensland Border Rivers and Moonie basins into sub-regions, to enable more targeted discussions around how stakeholders value and use water. The EVs identified during the process employed by QMDC have been considered, and were included in this HWMP.

In 2016, the Queensland Government further refined the EVs that were identified for groundwater. Groundwater aquifer zones were established to allow for the development of locally relevant water quality objectives. This process included identifying EVs for each groundwater aquifer using bore records. The Water Quality Technical Panel were consulted to ensure the approach taken to identify groundwater EVs was accurate and representative.

Feedback from Aboriginal Nations during the refinement of the groundwater EV method confirmed that the Cultural,

Spiritual and Ceremonial EV should be identified for all groundwater aquifers.

In March 2017, the draft EVs were released for a three month public consultation period via print media, email, and website. The material was made available, and in many cases presented, to 51 stakeholder groups, including Local State and Federal governments, Northern Basin Aboriginal Nations, SunWater, Arrow Energy, QMDC and Condamine Balonne Water Committee. Submissions received during the consultation period included the following common suggestions:

- *Include an appendix in the guidelines with location details of identified High Ecological Value and Slightly Disturbed Aquatic Ecosystems*
    - An appendix is included in this HWMP with locations of the persistent waterholes which are High Ecological Value. Spatial information on High Ecological Value and Slightly Disturbed Aquatic Ecosystems will be available via QSpatial, as per below.
- *Spatial information layer on identified High Ecological Value and Slightly Disturbed Aquatic Ecosystems (and extent of Water Type Zone boundaries) be made available on Qld Globe and to NRM bodies*
    - This layer will be published on QSpatial once the EVs and WQOs have been recommended for inclusion under Schedule 1 of EPP Water.

In the April 2018 submissions period, additional feedback was received regarding the Environmental Values mapping included in the draft HWMPs. The feedback received during each consultation process resulted in the final set of EVs presented in Table 12 and shown in Figure 16 to Figure 25 of this HWMP.

The economic and social impacts of protecting environmental values are considered through consultation, as well as through a socioeconomic report commissioned by the Queensland Government (Marsden Jacob Associates, 2017). At the completion of consultation and consideration of all submissions, finalised environmental values and water quality objectives (water quality target values) will be subsequently recommended for inclusion under Schedule 1 of the EPP Water[9]. Under the EPP Water, environmental values and associated water quality objectives (water quality target values) inform statutory and non-statutory water quality management planning and decision-making.

4.3 Consultation – Water Quality Objectives

Consultation with relevant local stakeholders occurred throughout the development of the water quality objectives[10] (WQOs) for the Queensland Border Rivers and Moonie River basins. In March 2017, the draft WQOs were released for a three month public consultation period via print media, email, and publishing on the Queensland Government website. The material was made available, and in many cases presented, to 51 stakeholder groups, including Local State and Federal governments, Northern Basin Aboriginal Nations, SunWater, Arrow Energy, QMDC and Condamine Balonne Water Committee. This consultation period allowed stakeholders to provide comment on the draft local water quality objectives which are developed to protect the draft environmental values for each sub-catchment.

Following the consultation period, communication was maintained with several stakeholder groups who indicated they possessed additional water quality data that would assist the department to further refine the WQOs and increase the relevance of the values to their local area. Submissions were received on the draft WQO material during and after the consultation period, and included the following common suggestions:

- *Implement event monitoring programs including end of system monitoring and a number of nested monitoring sequences to improve understanding of pollutant sources and sinks through the catchment systems*
- *Maintain existing ambient monitoring programs*
- *Consideration should be given to coupling water quality guidelines and associated monitoring and modelling with broader environmental accounts and socioeconomic indicators.*

This consultation also provided the community with an update of progress towards the Queensland Border Rivers and Moonie River basin HWMP and an opportunity to provide feedback on the draft environmental values, levels of

[9] If the environmental values and associated water quality objectives are not listed in schedule 1 of the EPP Water, the environmental values are stated under section 6 (2) of the EPP Water and the water quality objectives are the set of water quality guidelines for all indicators that protect all the environmental values for the water.

[10] This terminology is sourced from EPP Water. Under Basin Plan, water quality objectives are termed ‘water quality targets’.

aquatic ecosystem protection and sub-regional mapping.

In April 2018, the department invited submissions on the draft HWMP for the plan area, which contained the environmental values and water quality objectives. The department encouraged any additional data to be submitted by stakeholders in a format that would enable the refinement of the WQOs.

4.4 Consultation – Risk Assessment

An initial risk assessment workshop to assess the risk of water quality degradation in the Border Rivers and Moonie River basins was conducted in March 2013. The workshop was comprised of the Water Quality Technical Panel and included local on-ground expertise from the former-Department of Natural Resources and Mines (DNRM) and staff from former-Queensland Murray-Darling Committee (QMDC).

The scores from the initial risk assessment were revisited in October 2016 and an additional workshop was held with the Water Quality Technical Panel to update the risk scores. Following update to the risk scores, further consultation occurred between staff from the Queensland Government and former-QMDC. The following feedback is an example of what was received from this consultation:

- *Risks identified and risk scores look to be accurate, noting that localised risks could occur but due to the spatial scale of the assessment units, these risks could be overlooked.*
    - This was addressed by identifying hotspots within each assessment area.

Following the internal workshops, joint external workshops were held with representatives from former-DNRM to present the draft risk assessment material to key stakeholders. The joint external workshop for the Border Rivers and Moonie risk assessment was held in Goondiwindi on the 29th November 2016. Fifteen participants attended the workshop, which included representatives from Border Rivers Food and Fibre, Border Rivers Water Network, SunWater and Growcom, as well as community members, irrigators, ecologists and farmers.

The risk assessment contributes to the requirements of a Water Quality Management Plan under Chapter 10, Part 7 of the Basin Plan and will be included in the Commonwealth Water Resource Plan package to be submitted to the Murray-Darling Basin Authority for accreditation under the Basin Plan.

4.5 Consultation – Aboriginal Nations

The Department of Environment and Science would like to acknowledge and pay respect to the past and present Traditional Owners of the region and their Nations, and thank the representatives of the Aboriginal communities, including the Elders, who provided their knowledge of natural resource management throughout the consultation process. It is recognised that there are values and protocols of men's and women's business that relate to water which are culturally sensitive and were not discussed openly through consultation. It is acknowledged that only the commonly known places and stories can be discussed openly. It is also understood that places and stories can hold different cultural values and significance between each Aboriginal Nation.

Consideration of Aboriginal social, cultural and economic values and uses has been a key part of the consultation process for the development of the HWMP. The term 'Aboriginal water values' is used to describe the relationship between Aboriginal and Torres Strait Islander peoples and water and the importance of water and water dependent resources. Their relationship with water is intrinsic in nature, with water not only being fundamental for survival, but an indivisible, interwoven and central element of cultural and spiritual life (Constable & Love, 2015).

The consultation process, and how the consultation process fits into water planning, is described in detail in the Water Connections Report (DNRME, 2019) – but has been summarised below for the purposes of the HWMP. The Queensland Government aimed to consult with as many Traditional Owners as possible from Aboriginal Nations in the Border Rivers, Moonie, Condamine and Maranoa-Balonne river basins. The Department of Environment and Science worked closely with the Department of Natural Resources, Mines and Energy to align the consultation process for the development of the water plans and HWMPs for Queensland Murray-Darling Basin catchments.

It is important to note that Aboriginal Nation areas do not align with water plan areas or state borders and there are multiple Aboriginal Nations within the Border Rivers and Moonie River basins. Aboriginal Nations of the Murray–Darling Basin (for both surface water and groundwater) are listed on maps produced by the Murray–Darling Basin Authority and representatives of the Aboriginal Nations (MDBA, 2018a & MDBA, 2018b).

The Aboriginal Nations involved in the consultation process included:

- Barunggam
- Bidjara
- Bigambul
- Euahlayi
- Giabel
- Githabul
- Gomeroi (Kamilaroi)
- Gunggari
- Guwamu (Kooma)
- Jarowair
- Kambuwal
- Mandandanji
- Wakka Wakka.

Note: Murrawarri Nation representatives have indicated to the Queensland Government that their traditional lands do not extend far into Queensland, and therefore they do not need to be part of the engagement.

The consultation process started in August 2016 with a joint workshop held in Boggabilla between the Northern Basin Aboriginal Nations Delegates from the Nations in the catchment areas. The workshop outlined options for the Aboriginal Nation Delegates to consider how they wished to be engaged. From August 2016 to August 2017, people from the Aboriginal Nations across the plan area were engaged through a series of workshops on a Nation by Nation basis. In addition to the Nation workshops, individual Traditional Owners from each basin area were also consulted and input sought.

The consultation process aimed to identify values and uses of water, risks to the values and uses of water, objectives and outcomes desired for the water, and opportunities to strengthen the protection of Aboriginal values and uses, for consideration in both the HWMP and Queensland Water Plan for Border Rivers-Moonie plan area. During consultation, careful consideration was given towards ensuring this information was documented in participant's own words.

Discussions with participants in the consultation workshops and meetings raised a number of risks related to:

- Aboriginal values and uses arising from the use and management of water resources; and
- that insufficient water is available, or water is not suitable, to maintain social, cultural, Aboriginal and other public benefit values.

The risks raised at the workshops and during discussions were largely consequential risks that have occurred as a result of insufficient water available for the environment, water being of a quality unsuitable for use or the poor health of water-dependent ecosystems. In the discussions, Aboriginal people often relayed the risks in the form of stories about impacts to important social, spiritual and cultural aspects related to land and water. Participants also drew comparisons between the current state of the river systems and how they remembered using and valuing the river systems when they were children or from stories passed on from earlier generations.

Following on from the consultation process described above, in April 2018 the draft version of the Healthy Waters Management Plan for Queensland Border Rivers and Moonie River basins was made available to Traditional Owners through the Department of Environment and Science website as well as through the former-QMDC website. People from Aboriginal Nations across the plan area were then met with again during May and June of 2018 to discuss the draft plans and review the way in which their values and uses of water were included. Overall, 180 submissions on the water plans and HWMPs were received from the Aboriginal community. The Department of Environment and Science reviewed submissions related to water quality that were received, to address through the HWMP where possible.

Section 9 of the HWMP presents Aboriginal people's values and uses addressed under a healthy waters management plan, which relates to water quality matters.

4.6 Consultation – Climate variability

The impacts of a changing climate are already being experienced in Queensland. These changes pose a threat to the state's economy, communities and environment. Due to this, climate change and the impacts of climate change on water quality have been considered in this HWMP.

In 2017, the former-Department of Environment and Heritage Protection (DEHP) prepared a response to ensure Queensland is equipped to understand, adapt and transition under a changing climate.

The Queensland Climate Change Response outlines the commitments and the actions Queensland Government will take to transition to a low carbon, clean growth economy and adapt to the impacts of a changing climate. The Queensland Climate Change Response includes two key strategies: Queensland Climate Transition Strategy; and Queensland Climate Adaptation Strategy. The commitments and actions listed in these strategies inform the measures to address risks resultant of climate change. Further information about Queensland's approach to understand, adapt and transition under a changing climate can be found here: https://www.qld.gov.au/environment/climate/response.

4.7 Consultation – New South Wales Government

Under the Basin Plan, consultation with the New South Wales Government on the WQM Plan (and accompanying HWMP) must be undertaken by the Queensland Department of Environment and Science to consider any cross-border impacts that may result from the management of water quality in these basins. In particular, the following must be considered:

- the impact of Queensland proposed alternative water quality target values on the ability of New South Wales to meet water quality targets;
- the impact of Queensland measures on the ability of New South Wales to meet water quality targets; and
- any adverse impacts measures may have on New South Wales water resources.

Components of the draft HWMPs for the Queensland Border Rivers-Moonie and Maranoa and Balonne River basins were presented to water quality representatives from the New South Wales Department of Primary Industries (DPI) on 30 June 2017 and 23 January 2018. The department briefed DPI on the following components of the HWMP:

- 30 June 2017
    - A summary of risks to water quality identified by the department in the Border Rivers, Moonie River and Lower Balonne River basins. These risks were compared to the risks to water quality identified in the risk assessment conducted by DPI. Inconsistencies between the two risk assessments were highlighted and investigated.
- 23 January 2018
    - An updated summary of risks to water quality by the department in the Border Rivers, Moonie River and Lower Balonne River basins was provided to DPI for comparison to the risks to water quality identified by DPI.
    - The methods used to develop the proposed alternative water quality target values for surface and groundwater were discussed.

During the development of this HWMP, feedback provided to the department from DPI during the development of the Warrego, Paroo, Bulloo and Nebine Healthy Waters Management Plan (Department of Environment and Heritage Protection, 2016) has been considered to better meet cross-border outcomes, as the feedback is also applicable to the Queensland Border Rivers and Moonie River basins. The following suggestions have been incorporated into this HWMP:

- Include water quality data from NSW catchments in the development of proposed alternative water quality target values
- Include text boxes throughout the document to assist the reader to understand how the HWMP for the Queensland Border Rivers and Moonie River basins contributes to meeting the requirements of a Water Quality Management Plan under the Basin Plan.

A final version of the HWMPs was provided to the New South Wales Government for their response following consideration of the Basin Plan requirements. On 12th February 2019, the New South Wales Department of Industry (Water) indicated their support for the Queensland Border Rivers-Moonie Water Quality Management Plan.

SECTION 5: SOCIAL, ECONOMIC, CULTURAL AND ENVIRONMENTAL VALUES AND USES

5 Social, economic, cultural and environmental values and uses

The social, economic, cultural and environmental values and uses of water for the Queensland Border Rivers and Moonie River basins were established through the environmental values framework under the EPP Water. Environmental values (EVs) reflect the ways in which water is valued and used in a catchment area. Setting environmental values through community and stakeholder consultation reflects how a local region values and uses water. Under the EPP Water, and as depicted by Figure 15, EVs include:

- aquatic ecosystem[11]
- cultural and spiritual values (modified to 'cultural, spiritual and ceremonial values' for the purposes of this HWMP at the request of Traditional Owners)
- agriculture (including irrigation, stock and domestic)
- aquaculture
- human consumption of aquatic foods
- drinking water (suitable for treatment before supply as drinking water[12])
- industrial use; and
- recreation (primary, secondary and visual/aesthetic).

Initially, for the purpose of establishing environmental values for the surface waters of the Queensland Border Rivers and Moonie River basins, sub-catchments were defined within each basin. The creation of sub-catchments enables locally relevant discussion around how water is valued and used by stakeholders and the community. The surface water sub-catchments were generated from Queensland Government, public domain information and community consultation and were developed on the basis of:

a. likely geological influences on soil type and water quality
b. recognition of existing defined sub-regional natural resource management planning areas.

The environmental values that apply to each surface water sub-catchment were determined through stakeholder and community consultation, and were further refined by technical input from Queensland Government staff (Refer to Section 4). To simplify the final EVs mapping, the sub-catchments were aligned, where possible, with the water types which were developed through the water quality objective development. A description of water types in the Border Rivers and Moonie River basins is provided in Appendix 2—Description of water types in the Queensland Border Rivers and Moonie River basins.

To enable the accurate and comprehensive depiction of environmental values that apply to groundwater, groundwater aquifer units and sub-aquifer chemistry zones were defined for QMDB (McNeil, Raymond, Bennett, & McGregor, 2017). Groundwater chemistry data was analysed to identify zones of similar water chemistry. The EVs for each zone of similar water chemistry (sub-aquifer chemistry zones) were initially determined by reviewing the bore installation records, which are held within the Queensland Government Water Entitlements Registration Database. The bore installation records detail how the groundwater for each bore will be used, thus informing how the water is valued. Consultation with the Water Quality Technical Panel was conducted to ensure the approach taken to identify groundwater EVs is accurate and representative (Refer to Section 4).

At the completion of consultation and consideration of all submissions, finalised environmental values and water quality objectives (water quality target values) will be subsequently recommended for inclusion under Schedule 1 of the EPP Water[13].

[11] The Australian and New Zealand Water Quality Guidelines (ANZECC/ARMCANZ) and the EPP Water outline how aquatic ecosystems can be subdivided into different levels of protection, depending on condition. The EPP Water recognises four possible levels of ecosystem condition and corresponding management intent; namely high ecological value (effectively unmodified) systems; slightly disturbed, moderately disturbed and highly disturbed systems. Section 14 of the EPP Water states the management intent for waters subject to an activity that involves the release of wastewater or contaminants to waters.

[12] For drinking water guidelines that apply to water after it has been treated or is to be used for drinking—see the Australian Drinking Water Guidelines developed by the National Health and Medical Research Council.

[13] If the environmental values and associated water quality objectives are not listed in schedule 1 of the EPP Water, the environmental values are stated under section 6 (2) of the EPP Water and the water quality objectives are the set of water quality guidelines for all indicators that protect all the environmental values for the water.

Under the EPP Water, environmental values and associated water quality objectives (water quality target values) inform statutory and non-statutory water quality management planning and decision-making.

The environmental values that apply to the surface and groundwater of the Queensland Border Rivers and Moonie River basins are presented in Table 12 and mapped for each surface water sub-catchment and groundwater sub-aquifer chemistry zone in Figure 16 to Figure 25.

Figure 15: Environmental values icons and definitions under EPP Water (used in Figures 16-25).

5.1 Socioeconomic assessment for the protection of environmental values

EPP Water s12(b), states that the economic and social impacts of protecting environmental values must be considered prior to recommending the environmental values for inclusion in schedule 1 of EPP Water. The former Department of Environment and Heritage Protection commissioned Marsden Jacob Associates to assess the value of protecting and enhancing environmental values and water quality in QMDB. This work forms the socioeconomic report for the protection of environmental values in the Queensland Murray-Darling and Bulloo Basins (Marsden Jacob Associates, 2017).

> **"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."** (Marsden Jacob Associates, 2017)

Benefits to the community, region and State from maintaining environmental values and water quality in QMDB as a whole, and in the Queensland Border Rivers and Moonie River basins more specifically, were identified in the socioeconomic assessment. Key findings were that the aquatic ecosystem, ecosystem functions and services in QMDB directly contribute to the social and economic wellbeing of the community, region and State. Benefits from maintaining environmental values and water quality include:

- maintaining a regionally significant and developing tourism sector in QMDB which generates $952 million per annum
    - The joint wine and tourism region in the Southern Downs (Border Rivers), contributes $165 million per annum to this total.
    - 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
    - Water based recreational activities in QMDB is valued at approximately $128 million per annum.
- ensuring a sustainable recreational fishing sector
    - Valued at $104 million per annum and further enhances recreational and eco-tourism opportunities.
- providing biological support and physical protection for biodiversity, fisheries and ecosystems
    - Community willingness to pay to protect the 1.3 million hectares of wetlands in QMDB is estimated to be $1.9 billion.
- ensuring the agricultural sector is sustainable
    - Land and water resources of suitable quality are critical to a sustainable agriculture sector
    - Agriculture production in the Queensland Border Rivers and Moonie regions was worth approximately $786[14] million in 2011.
    - In QMDB as a whole, agricultural production is worth $3,162 million.

The full socioeconomic report can be viewed on the Queensland Government website: https://environment.des.qld.gov.au/water/policy/pdf/qmdb-socioeconomic-report.pdf.

[14] This figure includes data from the NSW portion of the Border Rivers.

5.2 Environmental values for the Queensland Border Rivers and Moonie River Basins

Table 12: Environmental values for the Border Rivers and Moonie River basin surface waters and groundwaters

Notes:

1. Refer to the accompanying maps (Figures 16-25), as indicated in the table, for the sub-catchments and sub-aquifers where environmental values apply.
2. ✓ means the environmental value is selected for protection. Blank indicates that the environmental value is not selected for protection.
3. Refer to Section 10 for the water quality target values that apply to protect the environmental values in Table 12.

Queensland Border Rivers and Moonie River Basins	Environmental values[1–3]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Water												
SURFACE FRESH WATERS (rivers, creeks, streams) (Figure 16)												
Canning Creek	✓	✓		✓					✓			✓
Dumaresq Floodplain	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Granite Belt	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lower Macintyre Brook	✓	✓	✓	✓		✓	✓		✓	✓		✓
Lower Weir River	✓	✓	✓	✓		✓	✓		✓	✓		✓
Macintyre Barwon Floodplain	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓

Queensland Border Rivers and Moonie River Basins	Environmental values[1–3]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Water												
Traprock	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Upper Weir River	✓	✓	✓	✓		✓	✓		✓	✓		✓
Lower Moonie River	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Middle Moonie River	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Upper Moonie River	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
GROUNDWATERS												
Alluvial Zones (Figure 17)												
Border Rivers	✓	✓	✓	✓	✓					✓	✓	✓
Upper Dumaresq	✓	✓	✓	✓	✓					✓	✓	✓
Macintyre Brook	✓	✓	✓	✓	✓					✓	✓	✓

Queensland Border Rivers and Moonie River Basins	Environmental values[1–3]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Water												
Lower Balonne	✓	✓	✓	✓						✓	✓	✓
Moonie	✓		✓	✓								✓
Fractured Rock Zones (Figure 18)												
Border Rivers Headwaters	✓	✓	✓	✓						✓		✓
Glenlyon	✓	✓	✓	✓						✓		✓
New England Granite	✓	✓	✓	✓						✓	✓	✓
Sediments Overlying the GAB Zones (Figure 19)												
Tertiary Sediments	✓		✓	✓								✓
Weathered Alluvium	✓	✓	✓	✓	✓					✓	✓	✓
Upper GAB Zones (Figure 20)												

Queensland Border Rivers and Moonie River Basins	Environmental values[1–3]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Water												
Winton Mackunda Eastern	✓	✓	✓	✓						✓	✓	✓
Main GAB Aquitard Zones (Figure 21)												
Central Surat Mid Cretaceous	✓		✓	✓								✓
Eastern Wallumbilla Outcrop	✓		✓	✓						✓		✓
Mid GAB Aquifer Zones (Figure 22)												
Eastern Cretaceous Outcrop	✓		✓	✓						✓	✓	✓
Lower Balonne Gubberamunda	✓	✓	✓	✓						✓	✓	✓
Northern Surat Thickest Bungil and Mooga	✓	✓	✓	✓						✓		✓
Southeast Kumbarilla	✓	✓	✓	✓	✓					✓		✓
Lower GAB Zones (Figure 23)												

Queensland Border Rivers and Moonie River Basins	Environmental values[1–3]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Water												
Central Surat Springbok Area	✓	✓	✓	✓	✓					✓		✓
Eastern Springbok Outcrop	✓		✓	✓						✓		✓
Saline Southeastern Hutton Outcrop	✓	✓	✓	✓						✓		✓
Basal GAB Zones (Figure 24)												
Eastern Central Area	✓	✓	✓	✓						✓	✓	✓
Southeastern Evergreen	✓	✓	✓	✓						✓	✓	✓
Earlier sedimentary Earlier sedimentary Earlier Basins Partially Underlying the GAB Zones (Figure 25)												
Bowen Basin	✓			✓								✓

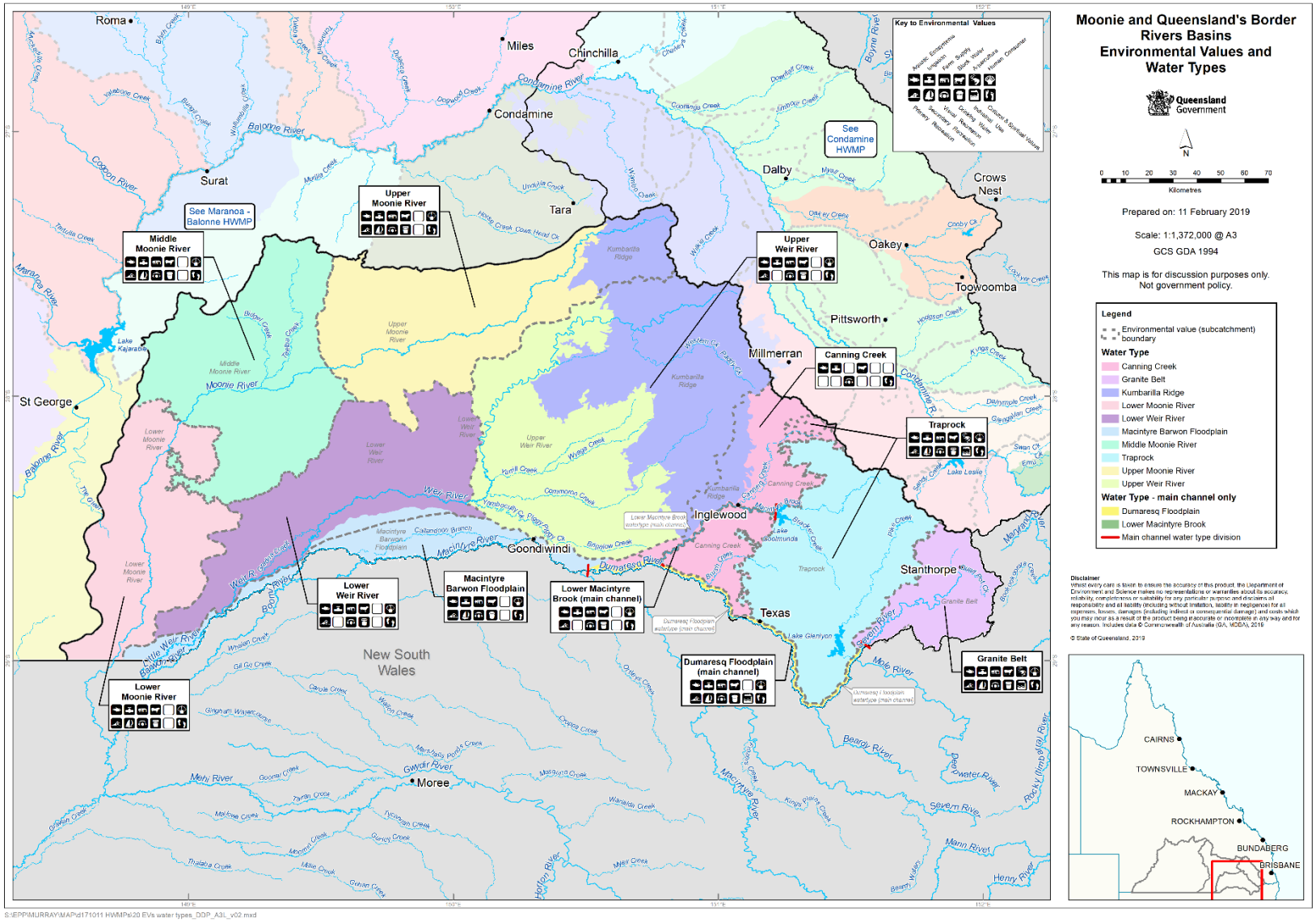


Figure 16: Environmental values and water types that apply to the surface waters in each sub-region within the Queensland Border Rivers and Moonie River basins.

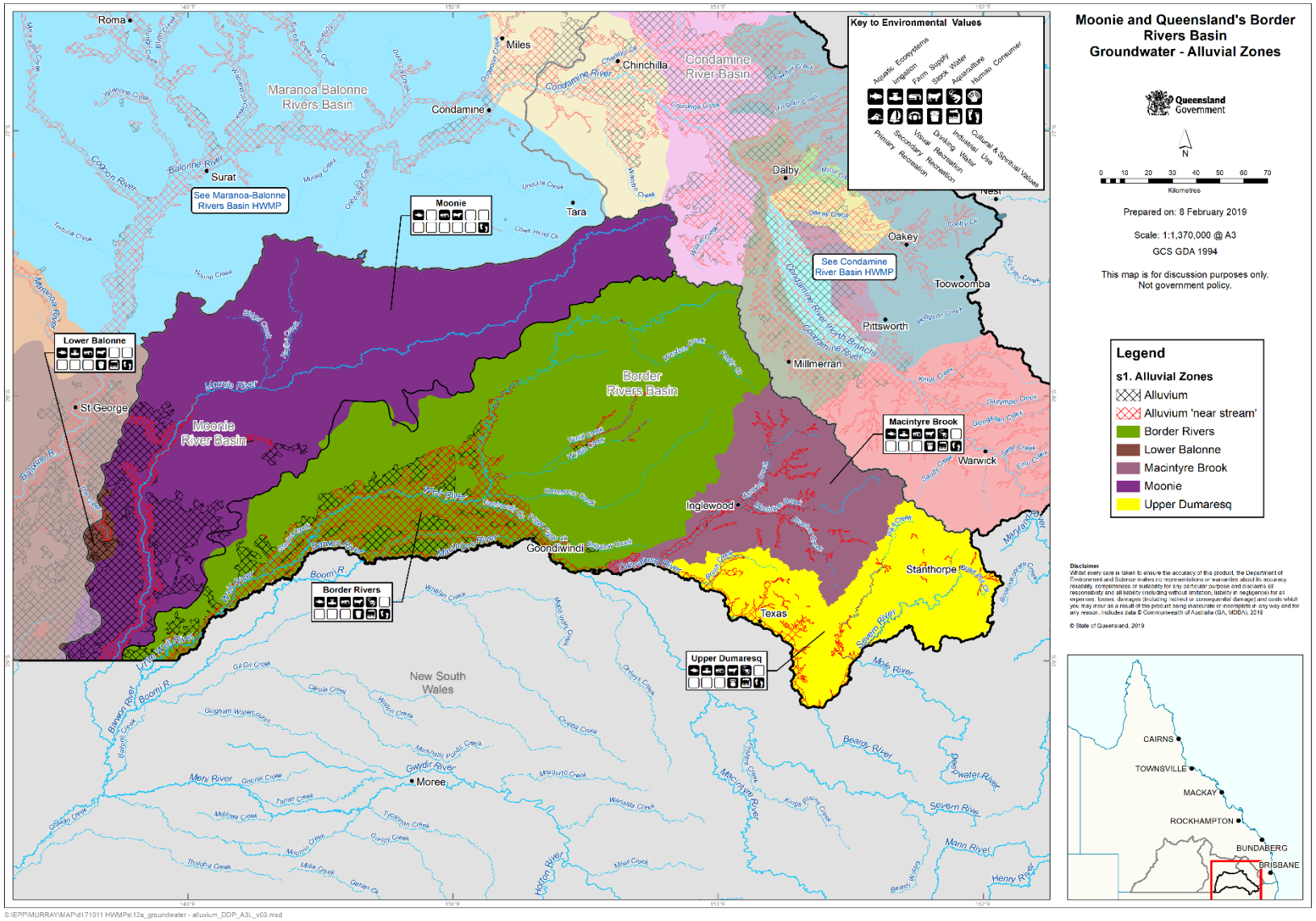


Figure 17: Environmental Values that apply to the Alluvial aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins

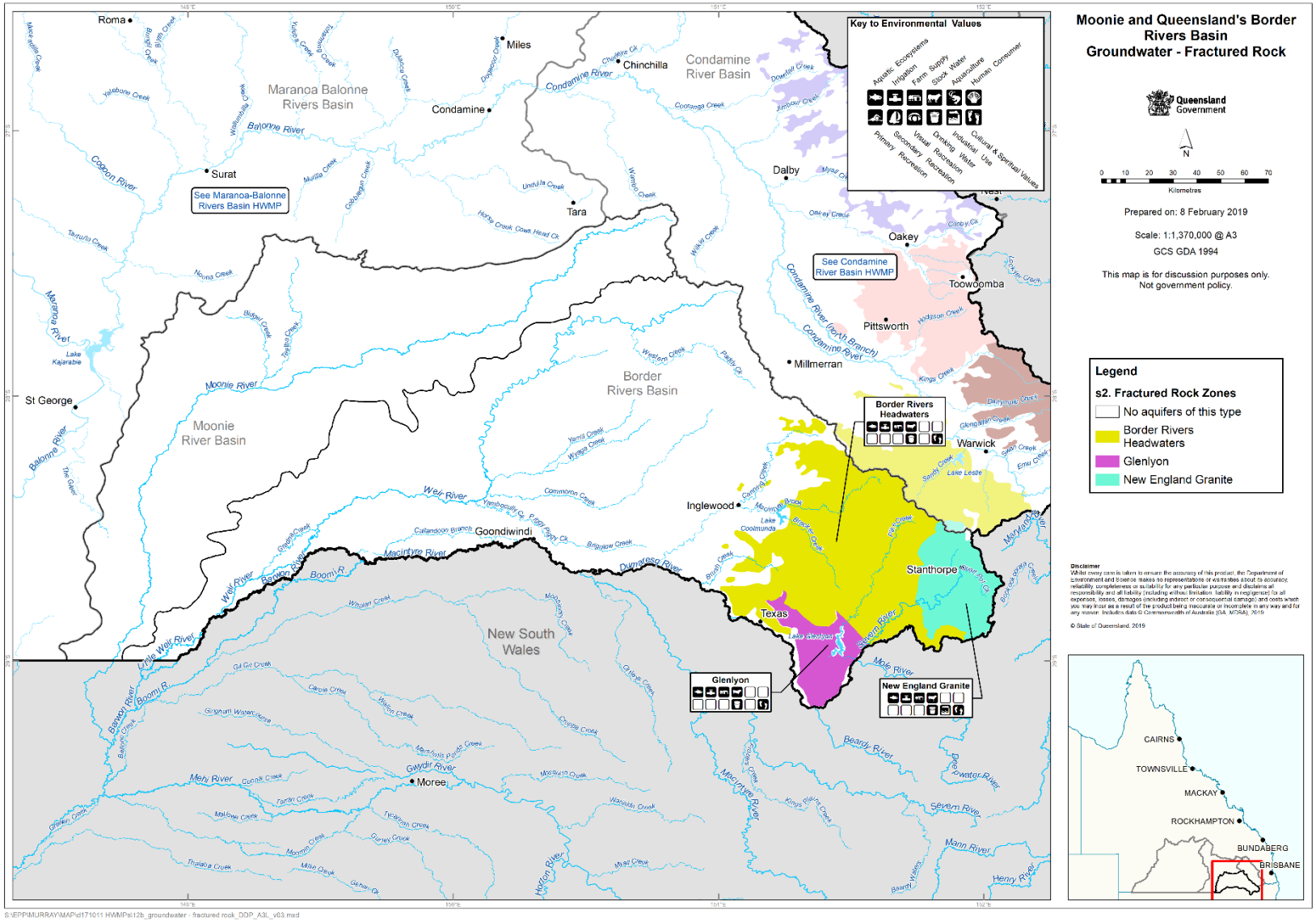


Figure 18: Environmental Values that apply to the Fractured Rock aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

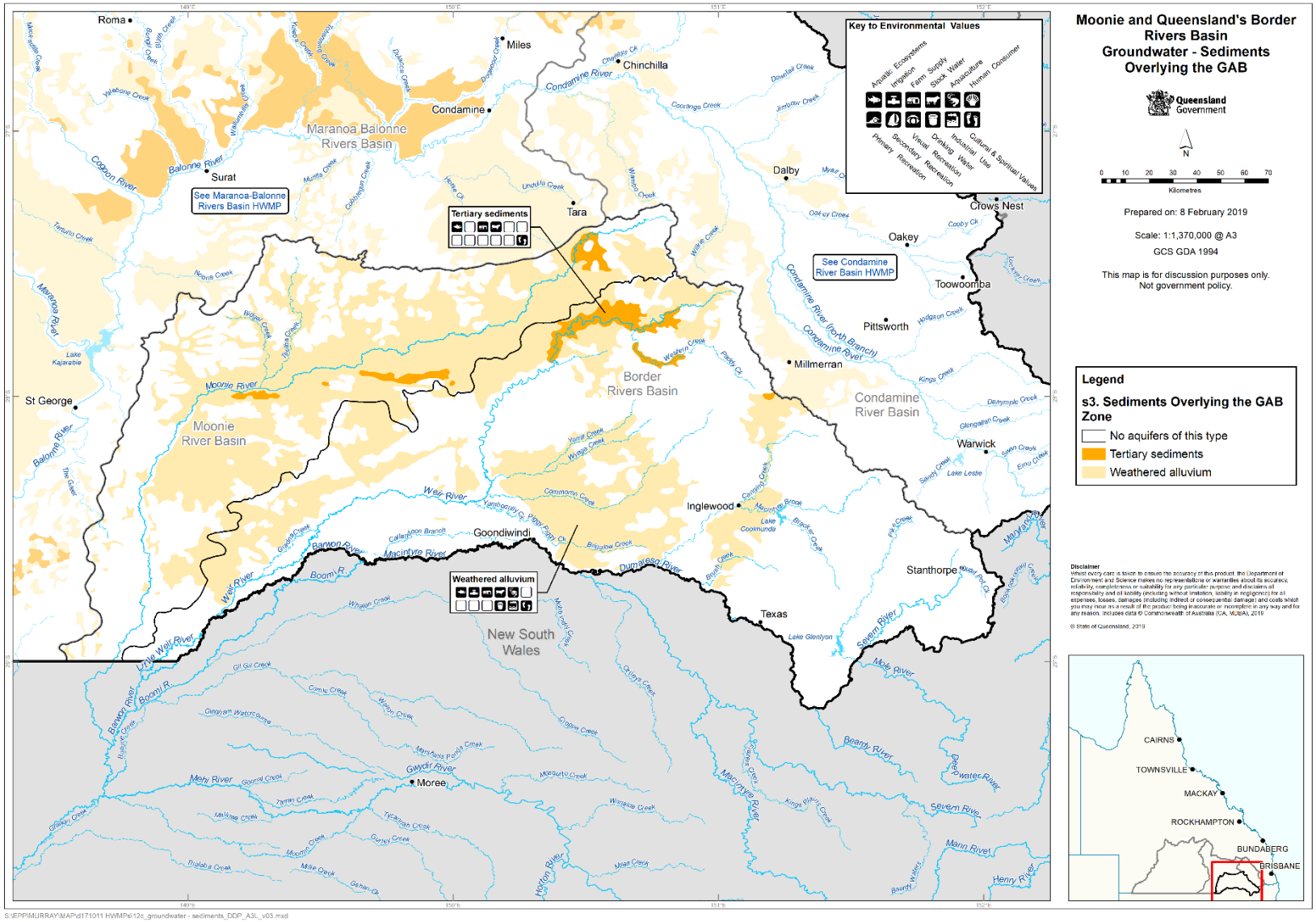
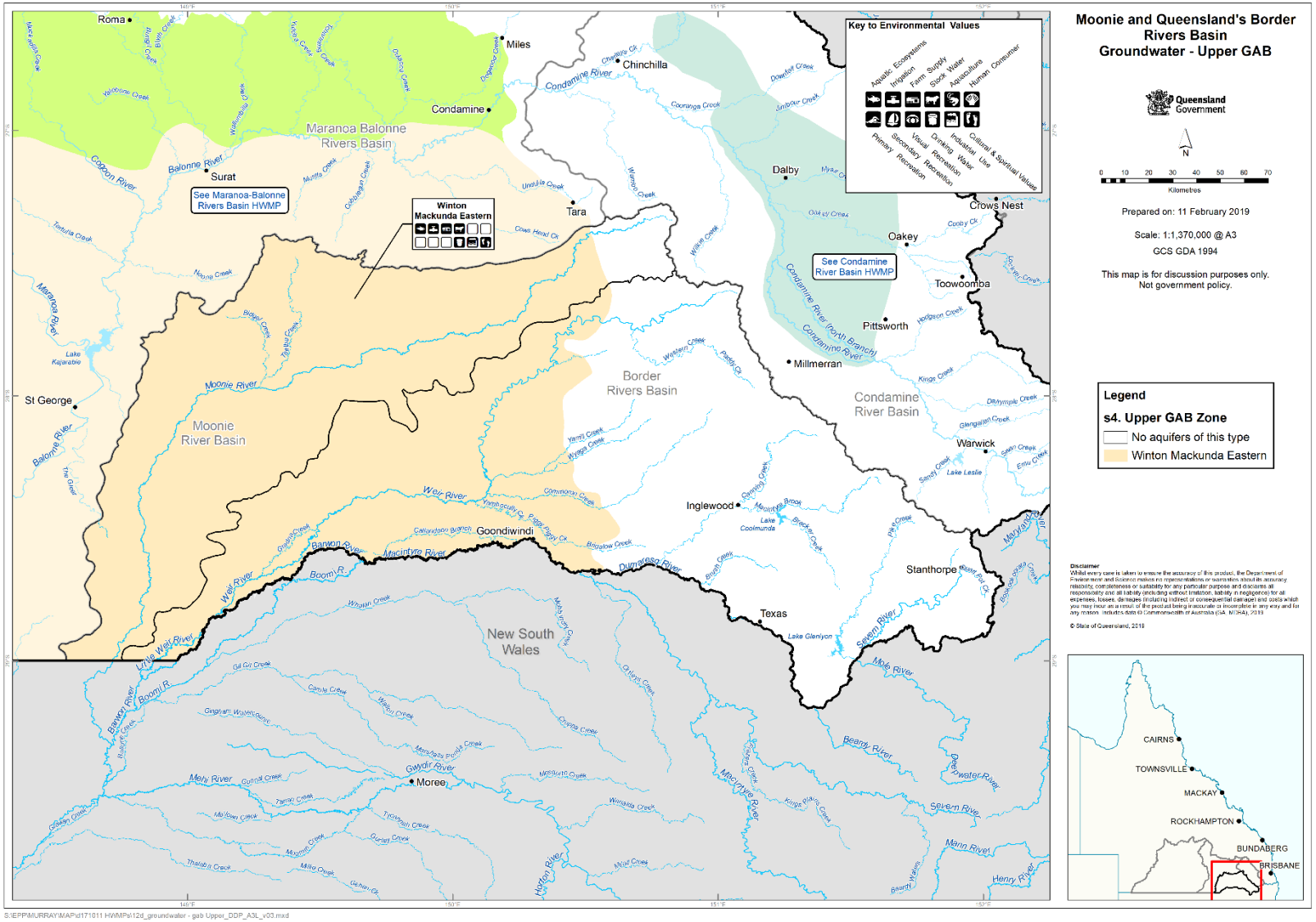


Figure 19: Environmental Values that apply to the Sediments Overlying the GAB aquifer zones within the groundwaters of the Qld. Border Rivers and Moonie River basins.



S:\EPP\MURRAY\MAP\id171011 HWMPs\12d_groundwater - gab Upper_DDP_A3L_v03.mxd

Figure 20: Environmental values that apply to the Upper GAB aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

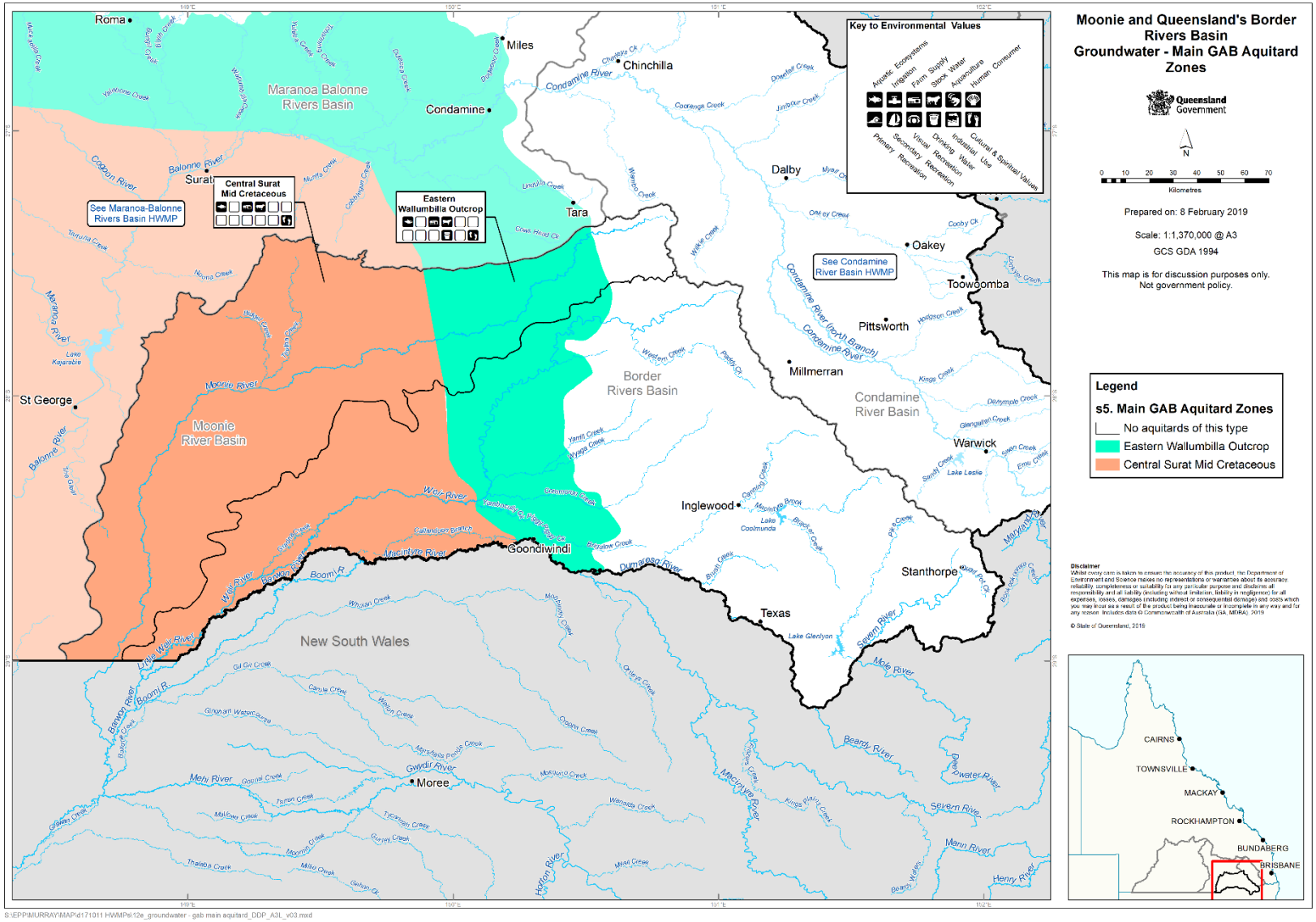


Figure 21: Environmental values that apply to the Main GAB aquitard zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

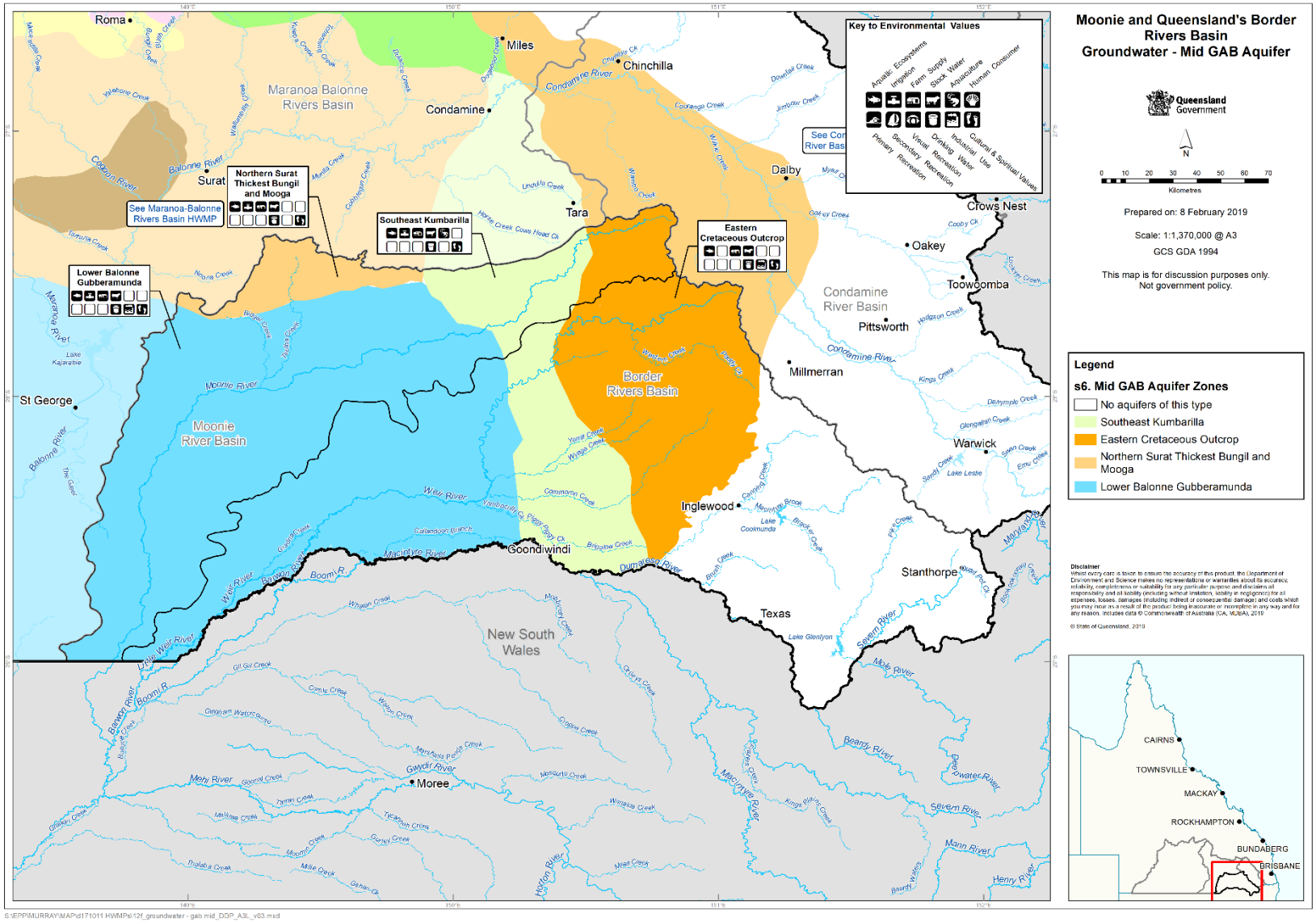


Figure 22: Environmental values that apply to the Mid GAB aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

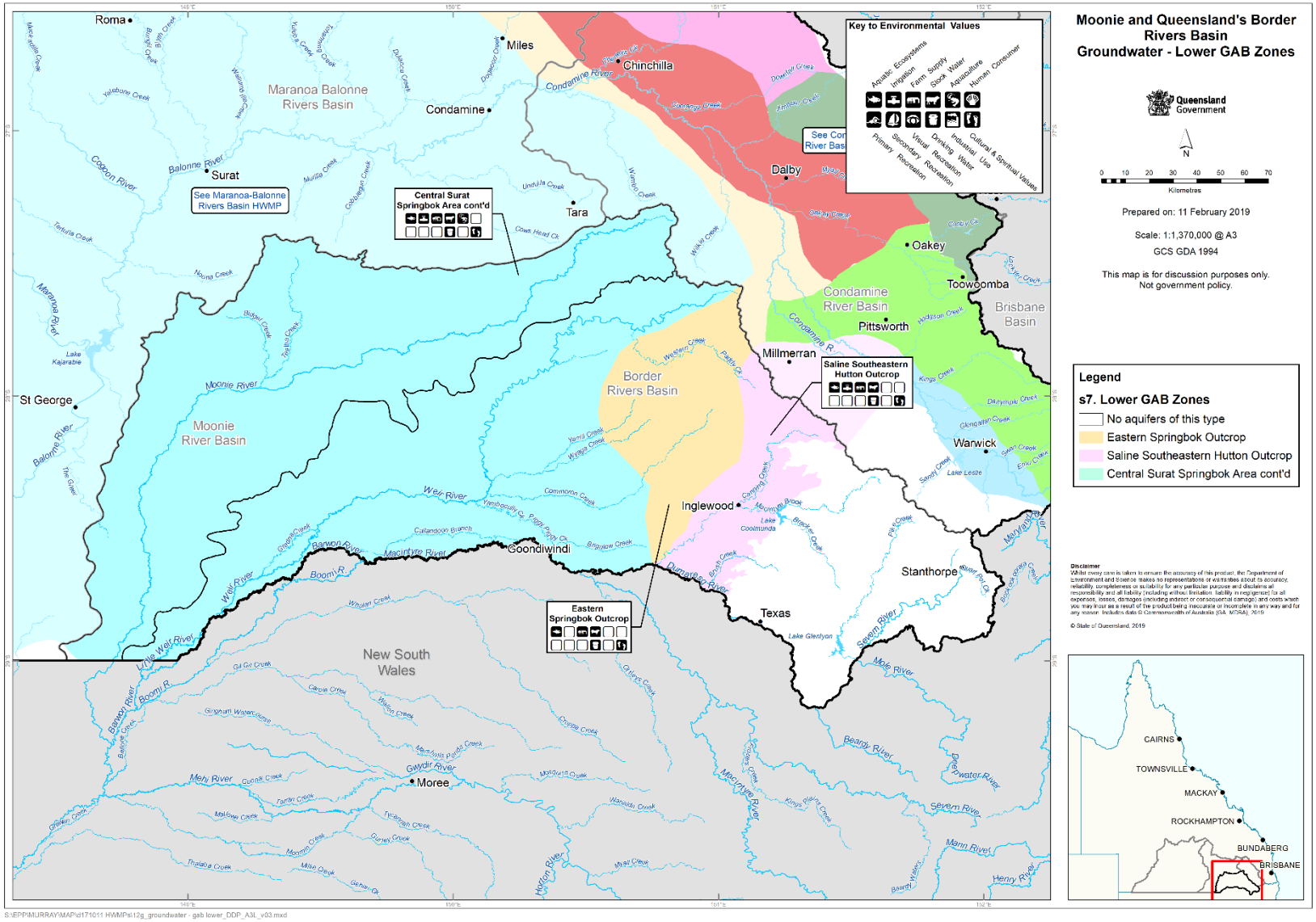


Figure 23: Environmental values that apply to the Lower GAB aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

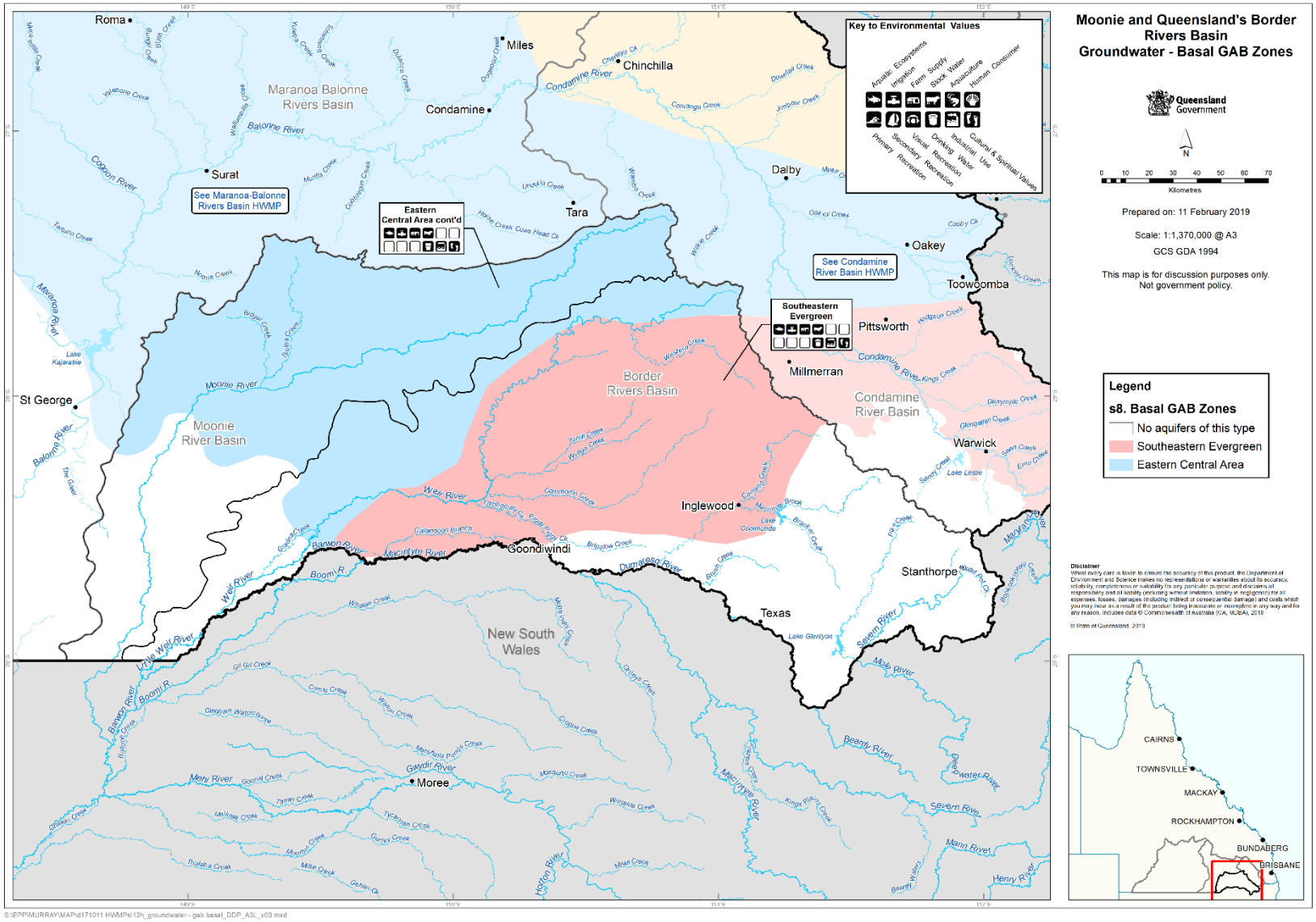


Figure 24: Environmental values that apply to the Basal GAB aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

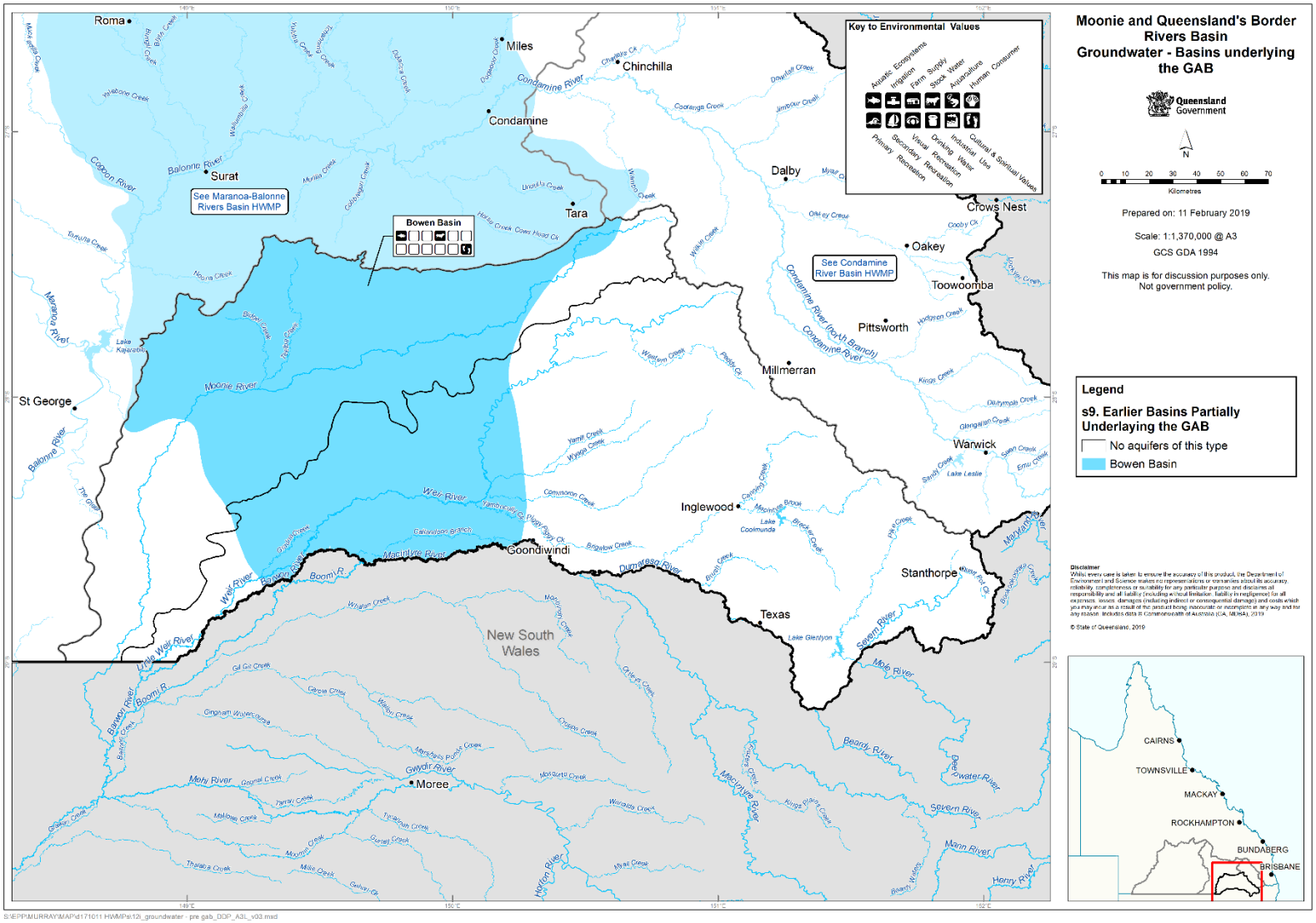


Figure 25: Environmental values that apply to the Earlier sedimentary basins underlying the GAB aquifer zones within the groundwaters of the Queensland Border Rivers and Moonie River basins.

SECTION 6: LEVELS OF AQUATIC ECOSYSTEM PROTECTION

6 Levels of aquatic ecosystem protection

For the aquatic ecosystem environmental value, the EPP Water identifies four levels of protection according to the current condition of waters. The four levels of protection are high ecological value, slightly disturbed, moderately disturbed and highly disturbed (Table 13). Each level of protection is assigned a specific management intent under the EPP Water, as described in Section 6.4 of this report.

Table 13: Levels of aquatic ecosystem protection

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: EPP Water, Schedule 2.

The designation of levels of aquatic ecosystem condition and the subsequent management intent for waters across Queensland is initially determined by a rules-based approach. This is described in Environmental Protection Policy (Water) Mapping procedural guide (Department of Environment and Science, 2018). This approach is used to develop draft for consultation mapping, which is then refined to consider local water quality data, regional studies and local consultation information. Priority aquatic ecosystems are assigned as either High Ecological Value aquatic ecosystems or Slightly Disturbed aquatic ecosystems based on their condition.

6.1 High Ecological Value and Slightly Disturbed Aquatic Ecosystems

High Ecological Value and Slightly Disturbed Aquatic Ecosystems are presented in Figure 26. The High Ecological Value and Slightly Disturbed waters designations apply only to the waters within the identified boundaries.

The information and datasets considered in the identification and mapping of High Ecological Value waters included:

- protected estates (primarily national parks);
- Wetlands of High Ecological Significance;
- the list of persistent waterholes considered as critical refugia, tabulated at Appendix 4— Persistent Waterholes in the Border Rivers and Moonie River basins (Department of Science, Information Technology and Innovation, 2017);
- Great artesian basin (GAB) springs in the ground dependent ecosystems (GDE) register of the QLD GAB and Other Regional Aquifers water management protocol;
- Matters of National Environmental Significance;
- Matters of State Environmental Significance;
- NRM supporting documents (former-QMDC); and
- stakeholder consultation and expert opinion through the Water Quality Technical Panel.

The information and datasets for the Slightly Disturbed waters mapping included:

- nature refuges and state forests;
- conservation parks;
- Coordinated Conservation Areas; and
- stakeholder consultation and expert opinion through the Water Quality Technical Panel.

6.2 Moderately Disturbed Aquatic Ecosystems

All other areas of the Queensland Border Rivers and Moonie River basins that are not identified as High Ecological Value, Slightly Disturbed or Highly Disturbed Aquatic Ecosystems are classed as Moderately Disturbed waters. This is the most common level of protection.

6.3 Highly Disturbed Aquatic Ecosystems

Areas classed as Highly Disturbed are assigned until after local water quality data, regional studies and local information has been considered and clearly identify a more heavily degraded condition for particular waters.

Highly Disturbed waters have not been identified in the Queensland Border Rivers and Moonie River basin.

6.4 Management intent under the EPP Water

Section 14 of the EPP Water states how waters in the different levels of protection described above should be managed. These matters must be considered when decisions are being made about the release of waste water into receiving waters.

For the matters to be complied with for environmental management decisions, including consideration of the management intent, refer to the Environmental Protection Regulation 2008 (as updated), section 51.

Table 14: Management intent under the EPP Water for levels of aquatic ecosystem protection

Level of protection	Management intent
High ecological value (HEV) waters	The measures for the indicators for all Environmental Values are maintained i.e. maintain water quality objectives (target values) for HEV waters.
Slightly disturbed waters	The measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives (target values) for HEV waters.
Moderately disturbed waters	If the measures for indicators of the Environmental Values achieve the water quality objectives (target values) for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives (target values) for the water, or If the measures for indicators of the Environmental Values do not achieve the water quality objectives (target values) for the water—the measures for indicators of the Environmental Values are improved to achieve the water quality objectives (target values) for the water.
Highly disturbed waters	The measures for the indicators of all Environmental Values are progressively improved to achieve the water quality objectives (target values) for the water.

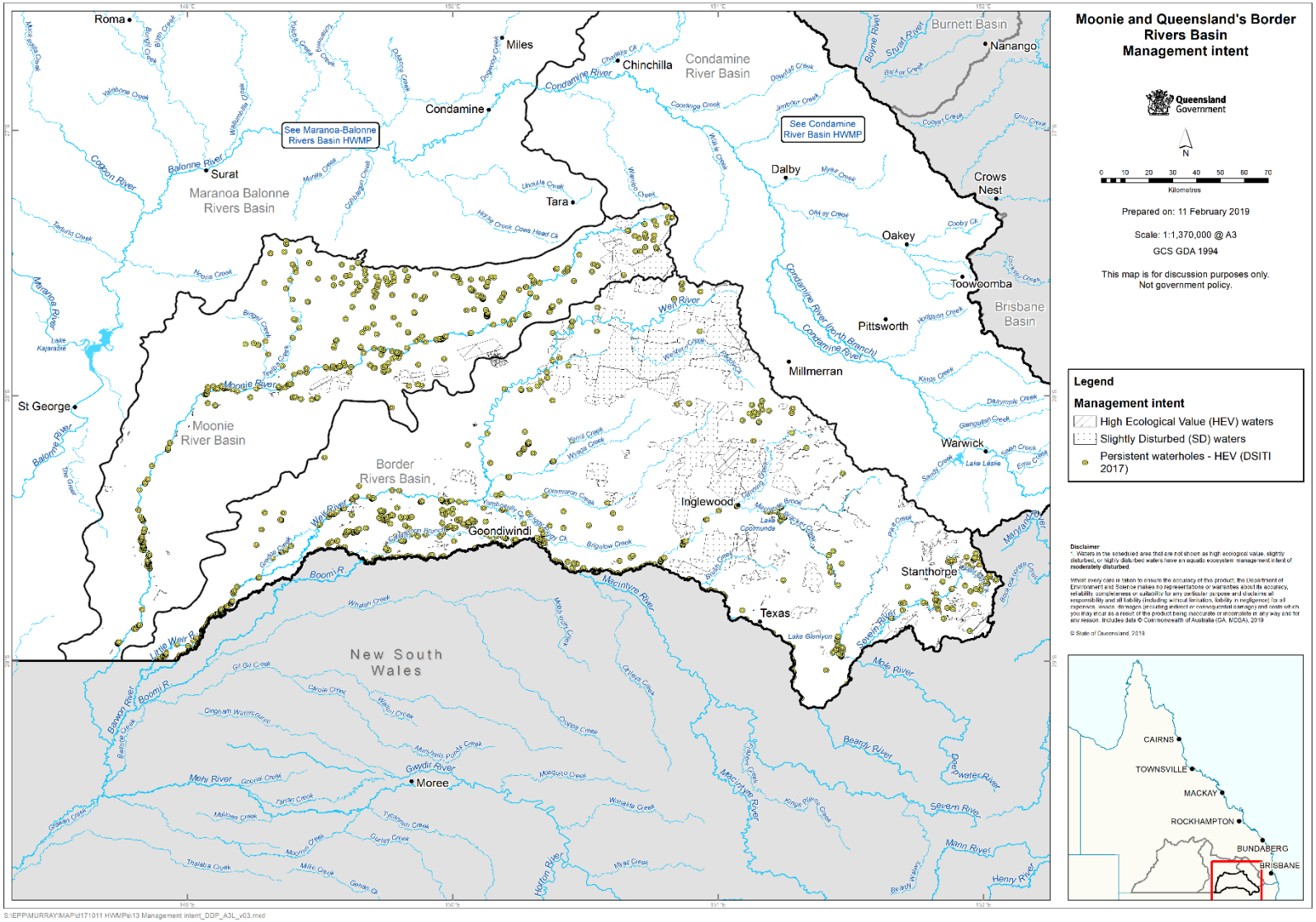


Figure 26: High Ecological Value and Slightly Disturbed waters. The persistent waterholes shown are High Ecological Value waters. A list of the waterholes in the basin area is provided in Appendix 4.

SECTION 7: KEY CAUSES OF WATER QUALITY DEGRADATION AND RISK ASSESSMENT OF WATER BEING OF A QUALITY UNSUITABLE FOR USE

7 Key causes, or likely causes, of water quality degradation and risk assessment of water being of a quality unsuitable for use

The Basin Plan specifies that a WQM Plan must identify the causes, or likely causes, of water quality degradation in the water resource plan area having regard to the key causes of water quality degradation identified in the Basin Plan (Part 2 of Chapter 9 and Schedule 10) under Section 10.30 for surface waters and Section 10.35A for groundwater.

Section 10.41 of the Basin Plan specifies that a water resource plan must be prepared having regard to current and future risks to the condition and continued availability of the water resources of the water resource plan area. Risks include those arising from elevated levels of salinity or other types of water quality degradation.

The key causes, or likely causes, of water quality degradation specific to the Queensland Border Rivers and Moonie River basin surface waters and groundwater, have been identified through assessment of the current and future risks to the water quality of Basin water resources.

Table 15 presents the key causes, or likely causes, of water quality degradation and the risk of each cause occurring in the Queensland Border Rivers and Moonie River basins.

For details of the likelihood and consequence of the key causes, or likely causes, of water quality degradation impacting on water resources in the plan area, refer to the Water Quality Risk Assessment spreadsheet on the following website: https://environment.des.qld.gov.au/water/policy/murray-darling-bulloo-evs.html.

A water quality risk assessment was completed in accordance with the requirements of section 10.41 of the Basin Plan. The risk assessment assessed the current and future risks to the condition, or continued availability, of Basin water resources as a result of water being of a quality unsuitable for use. For the purposes of the risk assessment, 'use' included:

- cultural, spiritual and ceremonial
- aquatic ecosystem
- agriculture (including irrigation, stock and domestic)
- consumption of aquatic food (aquaculture and human consumption of aquatic foods)
- drinking water
- industrial use
- recreation (primary, secondary and visual/aesthetic).

The risk assessment was based on the 'Key causes of water quality degradation' derived from Part 2 of Chapter 9 and Schedule 10 of the Basin Plan and identified for the Queensland Border Rivers and Moonie River basin surface waters and groundwater (see Table 15). During consultation, it was considered necessary to include in the risk assessment issues of local significance that indirectly impact water quality, including pest flora and fauna and climate change. These risks were informed by the Queensland Government Q-catchments Program (Negus, et al., 2015) and other sources as listed in Table 15. Risks to Aboriginal values and uses are displayed and discussed in Section 9 of the HWMP.

7.1 Risk assessment process

The environmental values and water quality targets at Section 5 and Section 10 of this HWMP take precedent to ANZG 2018 (previously ANZECC) guidelines, with exception of pesticides, heavy metals and other toxicant contaminants where ANZG 2018 guidelines continue to apply.

The risk assessment methodology is detailed in Appendix 3—Condamine-Balonne, Moonie and Queensland Border Rivers Water Quality Risk Assessment Methodology of this report and is consistent with the AS/NZS ISO 31000:2009 Risk Management—Principles and Guidelines. It is also consistent with the National Water Initiative Policy Guidelines for Water Planning and Management—Risk Assessment Module developed by the former-Department of Sustainability, Environment, Water, Population and Communities.

The spatial scale of the surface water assessment was based on grouping several water type zones. The surface water risk assessment units for the Moonie region included the Upper Moonie and Lower Moonie. The surface water risk assessment units for the Border Rivers region included Granite Belt, Upper Border Rivers and Lower

Border Rivers (Figure 27).

The spatial scale of the groundwater assessment was based on the groundwater Sustainable Diversion Limit (SDL) resource units identified by the Murray-Darling Basin Authority.

Refer to the Murray-Darling Basin Authority website for further information on Sustainable Diversion Limit resource units in the Murray-Darling Basin.

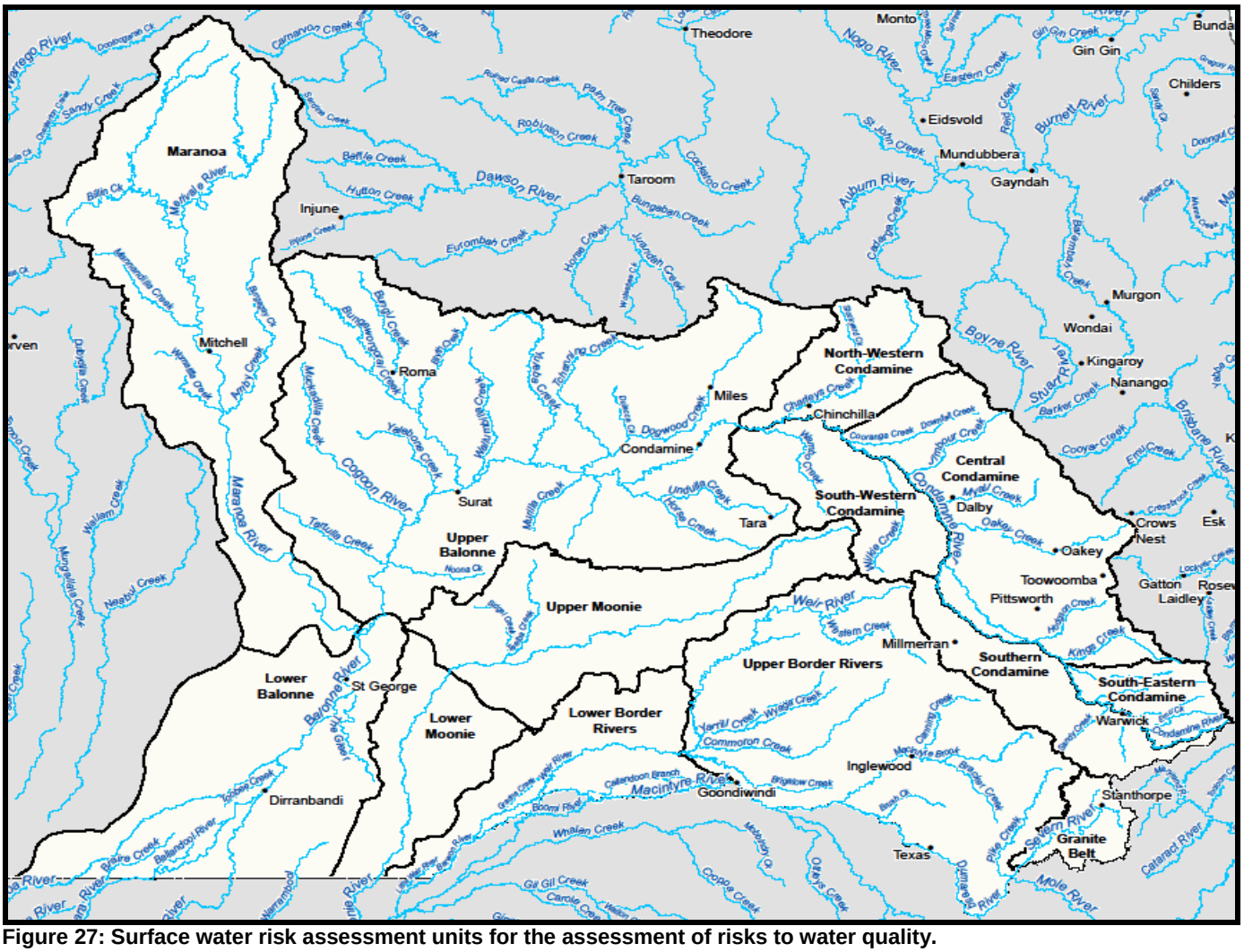


Figure 27: Surface water risk assessment units for the assessment of risks to water quality.

7.2 Risk assessment workshops

The initial risk assessment workshop for the Condamine, Maranoa, Balonne, Queensland Border Rivers and Moonie regions was conducted in March 2013. The workshop was comprised of the Water Quality Technical Panel (Refer to section 4.1) and included local on-ground expertise from the former-Department of Natural Resources and Mines (DNRM) and staff from the former-Queensland Murray-Darling Committee (QMDC). The scores from the initial risk assessment were revisited in October 2016 and an additional workshop was held with the Water Quality Technical Panel to update the risk scores. Following the internal workshops, joint external workshops were held with former-DNRM to present the draft risk assessment material to key stakeholders. For more information refer to section 4.4 which details the risk assessment consultation.

7.3 Risk assessment results

A water quality risk assessment was conducted to identify the potential key types of water quality degradation that could occur in the Queensland Border Rivers and Moonie River Basins. It is important to note that just because a risk was highlighted through the assessment, does not mean the set of circumstances is currently present for the risk to materialise. The factors contributing to a potential risk are summarised in the Table 15. The risks that were identified included:

- elevated levels of salinity as a potential high risk in surface waters of the Granite Belt (Stanthorpe region) and as a potential medium risk in groundwaters of the Queensland Border Rivers Fractured Rock (GS55) SDL resource unit;
- elevated levels of suspended matter as a potential medium risk in surface waters of the Lower Border Rivers, Upper Moonie and Lower Moonie;
- elevated levels of nutrients as a potential high risk in surface waters of the Granite Belt (Stanthorpe region), Upper Border Rivers and Lower Border Rivers and as a potential medium risk in the Upper Moonie and Lower Moonie. A potential medium risk was also identified for groundwaters of the Queensland Border Rivers Fractured Rock (GS55) and Queensland Border Rivers Alluvium (GS54) SDL resource units;
- elevated levels of cyanobacteria cell counts or biovolume and toxins and odour compounds as a potential medium risk in surface waters of the Upper Moonie – Moonie River at Flinton;
- water temperature outside of natural ranges as a potential high risk in surface waters of the Upper Border Rivers downstream of Glenlyon Dam and Coolmunda Dam;
- Dissolved oxygen outside natural (ambient) ranges as a potential high risk in surface waters of the Upper Border Rivers downstream of Glenlyon Dam and Coolmunda Dam and as a potential medium risk in Lower Moonie;
- elevated levels of pesticides and other contaminants as a potential medium risk in surface waters of the Granite Belt (Stanthorpe region) and in groundwaters of Queensland Border Rivers Fractured Rock (GS55) and Queensland Border Rivers Alluvium (GS54) SDL resource units;
- climate change as medium risk in the Queensland Border Rivers and Moonie basins; and
- pest fauna (aquatic) as high risk in the Queensland Border Rivers and Moonie basins.

The results of the water quality risk assessment for the Queensland Border Rivers and Moonie River basins are displayed in Table 15.

Table 15: Key causes, or likely causes, of water quality degradation and the risk of each cause occurring in the Queensland Border Rivers and Moonie River basin.

The causes of water quality degradation are reflective of the risk assessment results. A Risk Register Code is listed for all medium or higher risks and relates to the full water quality risk assessment, available online as supporting information to the HWMP for the Queensland Border Rivers and Moonie River basins.

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
Key causes, or likely causes, of water quality degradation identified from Schedule 10 of the Basin Plan					
	Elevated levels of salinity	The process of mobilisation of salt stores in the landscape and geological redisposition to salinity development, including by: (a) the following processes and activities relating to water flow or water management: (i) saline groundwater and surface water discharges into surface water systems	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, the technical panel determined that this cause of water quality degradation was either rare or unlikely to occur. This risk could become present with an increase in irrigation, particularly if Emu Swamp Dam is constructed for Stanthorpe urban water supply. The Lower Border Rivers assessment area could present a risk in future if saline groundwater discharges to surface. The uncertainty is low for this risk as the water quality technical panel informed the likelihood of occurrence.
		(ii) increased deep drainage below irrigated agricultural land displacing saline groundwater to surface water systems	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, the technical panel determined that this cause of water quality degradation was either rare or unlikely to occur. This risk could become present with an increase in irrigation throughout the Border Rivers. Expanded irrigation in the Moonie is considered unlikely due to limited water available in this basin. The uncertainty is low for this risk as the water quality technical panel informed the likelihood of occurrence.
Surface water LM3		(iii) saline surface and shallow groundwater drainage from irrigated agricultural land into surface water systems	Granite Belt (Stanthorpe) – Broadwater Creek	High	Analysis of water quality data for the Granite Belt has shown that Broadwater creek has elevated electrical conductivity relative to the rest of the Granite Belt. The expert panel has identified that irrigation induced salinity is present in the Granite Belt (Biggs & Powers, 2002; Biggs, 2010). However, with continuous improvement in irrigation efficiency and active management the risk will decline. It should be noted that irrigated cropping could increase in this region with increased water supply, if Emu Swamp Dam is constructed.

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
					The uncertainty is low for this risk as the water quality data for electrical conductivity is a reliable sample size (N= 823) and the water quality technical panel informed the cause of this risk.
Groundwater LM3		(iv) irrigation at high salinity risk locations without adequate drainage management; Example: Locations where there is a high risk of recharge to groundwater resulting in saline discharges to surface waters	Queensland Border Rivers Fractured Rock (GS55)	Medium	The expert panel has identified that this resource unit is highly connected between groundwater (weathered zone) and surface water. The salinity of the resource unit is low, however, irrigation induced salinity is present in the Granite Belt (Biggs & Powers, 2002; Biggs, 2010). The high connectivity between zones increases the risk that saline surface water will intrude into the resource unit. This issue is of particular concern in Broadwater (west of Stanthorpe). The uncertainty is low for this risk as the water quality technical panels indicated that the high connectivity and presence of salinity issues is supported by the literature.
Surface water LM3			Granite Belt (Stanthorpe) – Broadwater Creek	High	Analysis of water quality data for the Granite Belt has shown that Broadwater creek has elevated electrical conductivity relative to the rest of the Granite Belt. The expert panel has identified that irrigation induced salinity is present in the Granite Belt (Biggs & Powers 2002, Biggs 2010). The uncertainty is low for this risk as the water quality data for electrical conductivity is a reliable sample size (N= 823) and the water quality technical panel informed the cause of this risk.
		(v) de-watering of saline groundwater which mobilises salt into surface water systems	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. This risk could become present if de-watering were to occur and measures should be taken to prevent any associated risks to surface water systems. The uncertainty is low for this risk as the water quality data for electrical conductivity did not indicate a risk is present and the sample size is reliable (N= 823); and the water quality technical panel informed the likelihood of occurrence.
		(vi) reduction in stream flows, limiting the	All surface water	Low	Across the assessment units for the Queensland Border Rivers

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
		dilution of salinity.	and groundwater units		and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. DNRME have assessed the risk of reduced flow and have found the risk is low. It should be noted that reduced flows could result under a changing climate. DNRME have assessed the risk of climate change resulting in reduced flows and have found the risk is low. This is based on modelling wet/median/dry scenarios. It should also be noted that the modelling has a low level of precision (high uncertainty). The uncertainty is medium for this risk due to the uncertainty surrounding the flow conditions under climate change.
		(b) land management practices involving the replacement of deep-rooted vegetation with shallow-rooted crops and pastures, resulting in increased rainfall recharge displacing saline groundwater to surface water systems	All surface water and groundwater units	Low	Across the assessment units for Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. The conversion of forested land to cropping or grazing land has occurred throughout the assessment area, however salinity issues haven't been attributed to this factor. The uncertainty is low for this risk as the water quality data for electrical conductivity did not indicate a risk is present and the sample size is reliable (N= 823); and the water quality technical panel informed the likelihood of occurrence.
		(2) The use of groundwater for irrigation purposes at locations where highly saline upper aquifer water drains to the lower aquifer.	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. The uncertainty is low for this risk as the water quality data for electrical conductivity did not indicate a risk is present and the sample size is reliable (N= 823); and the water quality technical panel informed the likelihood of occurrence.
		(3) With respect to soil degradation, the use of water with a high ratio of sodium to calcium and magnesium for irrigation.	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. The uncertainty is low for this risk as the water quality data for

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
					electrical conductivity did not indicate a risk is present and the sample size is reliable (N= 823); and the water quality technical panel informed the likelihood of occurrence.
	Elevated levels of suspended matter	Sediments entering Basin water resources, which is contributed to by: (a) the following land management practices: (i) inappropriate frequency, timing and location of cultivation; Example: Cultivation taking place at times of the year when the risk of erosion is high (e.g. during the high rainfall season), excessive frequency of cultivation, and cultivation of steep slopes	All surface water units. Not applicable to groundwater units.	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. The use of cover crops during fallow periods is recommended to prevent this risk from increasing, especially during periods of high rainfall. The uncertainty is low for this risk as the water quality technical panel informed the likelihood of occurrence.
Surface water LM41		(ii) overgrazing of catchments and grazing of riverbanks and floodplains; Example: The riparian zone along watercourses kept in permanent vegetation can effectively mitigate the movement of sediment within farmlands and from farmlands	Lower Border Rivers	Medium	Analysis of data from the Lower Border Rivers shows that the Basin Plan Target application zone (A2) aquatic ecosystem guideline for turbidity will possibly be exceeded. High concentration of dryland cropping and grazing throughout catchment. Continuation of best practice in agriculture is required to keep risk low. The QMDB Source Water Quality model (Davidson, 2018) shows that 36% of TSS is contributed to stream from grazing land use in the Border Rivers basin. The uncertainty is low for this risk as local expert knowledge and land use mapping supports the water quality data analysis.
Surface water LM57 LM58		(iii) poor soil conservation practices; Example: Practices that fail to use management strategies that prevent soil erosion, acidification, salinisation or other chemical soil contamination, or fail to adopt proven soil conservation technologies such as the construction of contour banks	Upper Moonie	Medium	Analysis of data from the Upper and Lower Moonie shows that Basin Plan Target application zones (B2) and (A2) aquatic ecosystem guideline for turbidity is almost certain to be exceeded. The expert panel has identified the following land management practices likely to result in elevated suspended matter: grazing is the predominant land use in the region and dryland production is present throughout region, often adjacent to waterways; irrigated

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
Surface water LM45 LM46			Lower Moonie	Medium	cropping and production forestry is located in the eastern part of the Upper and Lower Moonie. Vegetated headwaters in the eastern part of Moonie should minimise sediment transport in upper parts of the catchment, however riparian vegetation is lacking throughout the rest of the region. Although extractive industries and CSG are present in the Upper Moonie, this land use is regulated under the Environmental Protection Act 1994. The QMDB Source Water Quality model (Davidson, 2018) shows that 33% and 20% of TSS is contributed to stream from grazing and cropping land uses respectively in the Moonie basin. The uncertainty is low for this risk as the water quality technical panel and the QMDB Source Water Quality model supported the water quality data analysis. The water quality data sample size was reliable (Upper Moonie N=76, Lower Moonie N=247).
		(iv) practices that over the long-term cause decline of stream morphology, leading to near stream processes of gully erosion, side wall cut and head migration.	Upper Moonie Lower Moonie	Medium	Analysis of water quality data from the Upper and Lower Moonie shows that Basin Plan Target application zones (B2) and (A2) aquatic ecosystem guideline for turbidity is almost certain to be exceeded. The QMDB Source Water Quality model (Davidson, 2018) shows that 70% of TSS is contributed to stream from gully erosion in the Moonie basin. Across the assessment units for Border Rivers, this cause of water quality degradation was determined as either rare or unlikely to occur. The uncertainty is low for this risk as the water quality technical panel and the QMDB Source Water Quality model informed the likelihood of occurrence.

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
		(b) the following water management practices: (i) rapid drawdown of water within a surface water resource; Example: Rapid drawdown of water in a dam (ii) the volume or manner of release of water, resulting in bank or bed erosion.	All surface water units. Not applicable to groundwater units.	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. Coolmunda, Glenlyon and Storm King reservoir release water periodically. However, impacts from this activity resulting in increased turbidity and/or suspended solids have not been identified. Water storages are managed through the water planning process. The uncertainty is low for this risk as the water quality technical panel informed the likelihood of occurrence.
		(c) wave wash (for example, that caused by speedboats).	All surface water units. Not applicable to groundwater units.	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. The uncertainty is low for this risk as the water quality technical panel informed the likelihood of occurrence.
Surface water LM26 LM56	Elevated levels of nutrients	Nutrients entering Basin water resources through both point and diffuse sources. The key sources of nutrients are: (a) soil and organic matter (b) animal waste (c) fertilisers (d) sewage and industrial discharges (e) nutrients from water storages released as a result of storage management practices.	Upper Moonie	Medium	The analysis of water quality data from the Upper and Lower Moonie region shows that the Basin Plan Target Application Zone (B2) and (A2) aquatic ecosystem guidelines for total nitrogen and total phosphorus will be addressed by the water quality targets developed for these waters. The uncertainty for this risk is low as the water quality technical panel confirmed the presence of the key causes. The water quality data analysis supported the advice from the technical panel and the data sample size is reasonable, although confidence in risk score would increase with a greater sample size (Upper Moonie TN: N=57 & TP: N=52. Lower Moonie TN: N=99 & TP: N=104). Further, the data analysis shows that the NHMRC Recreation guideline for total phosphorus is likely to be exceeded in the Upper Moonie and almost certain to be exceeded in the Lower Moonie. The uncertainty for the exceedance of the Recreation guideline is high, as the total phosphorus guideline value used as the sole indicator in determining the likelihood of a cyanobacteria bloom is
Surface water LM43 LM44			Lower Moonie	Medium	

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
					inappropriate (water temperature and potential for the river system to stratify must also be considered), The QMDB Source Water Quality model (Davidson, 2018) shows that 30% and 26% of TN and 39% and 21% of TP is contributed to stream from cropping and grazing land uses respectively in the Moonie basin.
Surface water LM2			Granite Belt (Stanthorpe)	High	The analysis of water quality data from the Granite Belt region shows that the Basin Plan Target Application Zone (C2) aquatic ecosystem guideline for total nitrogen and total phosphorus is almost certain to be exceeded. In addition, localised elevated concentrations of TN and TP have been detected in both the Upper Weir River and the Lower Weir River. The QMDB Source Water Quality model (Davidson, 2018) shows that for the Queensland Border Rivers basin, 35% and 20% of TN is contributed to stream from cropping and grazing land uses respectively. Further, 41% and 19% of TP is contributed to stream from cropping and grazing land use respectively and 15% of TN is contributed to stream from urban waste treatment. Southern Downs Regional Council (2016), calculated that approximately 100% of treated effluent from Stanthorpe STP is used for beneficial use. This is a regulated activity under the Environmental Protection Regulation 2008. Potential impacts from regulated activities are addressed through the Development Application and Environmental Approval– thus mitigating point source risk. The uncertainty is low as the risk was identified by local experts and land use mapping supports available data.
Surface water LM22			Upper Border Rivers	High	
Surface water LM8			Lower Border Rivers	High	
Groundwater LM4			Queensland Border Rivers Fractured Rock (GS55)	Medium	Due to the sandy landscape of this resource unit, nutrients do not readily bind to soils. Combined with the higher rainfall than other areas of QMDB, this leads to an increased likelihood of highly mobile contaminants. If the groundwater underlies intensive agriculture, on first principles nutrient problems may arise. However, the expert panel identified that efficient application of fertiliser (drip fertigation) is preventing an increase in the risk.

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
					The QLD Border Rivers Fractured Rock – Granite Belt is a highly connected landscape (GW and SW) that requires active management to mitigate risk. Effluent is applied to land through an irrigation scheme run by the local council - which increases the potential of the nutrient risk to groundwater. There is a medium level of uncertainty for this risk as land use indicates the potential for elevated levels of nutrients but current groundwater data does not show high levels.
Groundwater LM9			Queensland Border Rivers Alluvium (GS54)	Medium	The expert panel assessment indicates that based on first principles a risk could potentially occur in this resource unit due to an increase in agriculture, intensive livestock, horticulture and urban development. A Groundwater Quality Assessment of the Alluvial Aquifers of the Border Rivers Region (Please, 2000) stated that groundwater nitrate-N concentrations are considered generally low in this region, however concentrations of ammonium-N and TDP are notably higher than those found in other field areas in the Murray-Darling Basin. The expert panel indicated that there is a localised risk from Goondiwindi and Dumaresq region due to beneficial use of effluent to land, urban inputs and fertiliser application - particularly relating to an increase in nitrogen. The Dumaresq is at risk due to the high permeability of the Macintyre River Alluvium. Increasing land use intensity may have impacts on groundwater in the eastern sector of the resource unit (Dumaresq) if river water becomes contaminated due to high connectivity between surface water and groundwater (Please, 2000). The uncertainty for this risk is low as monitoring data indicates elevated concentrations of nutrients. Land use supports the presence of elevated levels of nutrients.

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
Surface water LM25	Elevated levels of cyanobacteria cell counts or biovolume and toxins and odour compounds	The interaction of the following factors: (a) a water body with little or no flow (b) stratification in the water body (c) sunlight (d) the availability of phosphorus and nitrogen in the water (e) seeding from up-stream (although cyanobacteria blooms may occur without this factor).	Upper Moonie – Hotspot: Moonie River at Flinton Not applicable to groundwater units.	Medium	Nutrient concentrations in the Upper Moonie indicates the potential for elevated levels of cyanobacteria. This potential is increased by the extensive clearing of riparian vegetation in the Moonie, exposing the system to direct sunlight. However, the elevated levels of suspended matter in the Upper Moonie would inhibit cyanobacterial growth by limiting available light in the water column. The Queensland Harmful Algal Bloom Response Plan identifies roles and responsibilities of government agencies in the event of a harmful algal bloom. There is high uncertainty for this risk due to a low sample size (N=7), with the analysis based on using chlorophyll-a as a surrogate for cyanobacteria (Microcystins). Data was only available for the Moonie River at Flinton.
Surface water WM23 WM24	Water temperature outside natural ranges	(1) The key cause of water temperature of Basin water resources below natural ranges is the release of stored water from below the thermocline from large water storages in spring, summer and autumn. (2) The key causes of water temperature of Basin water resources above natural ranges are the following: (a) the release of stored water from large water storages in winter	Upper Border Rivers downstream of Glenlyon Dam and Coolmunda Dam. Not applicable to groundwater units.	High	Glenlyon Dam has been identified as a high risk for thermal alteration (Department of Natural Resources and Mines, 2017). As the reservoir currently has a single level offtake for water releases, there is potential that water being released is below natural ranges. The former NRM body for the region, Queensland Murray-Darling Committee, identified waters downstream of both Glenlyon and Coolmunda Dams as having experienced cold water pollution events following water releases. Coolmunda Dam is equipped with a multi-level offtake. As such, the potential for releases of water outside of the natural range is less than that of Glenlyon Dam. Water storages are managed through the water planning process. The uncertainty of this risk is low as the literature review component of this risk assessment indicated the high and medium risk of thermal alteration occurring in Glenlyon and Coolmunda Dams respectively.
		(b) the removal of shading riparian vegetation	All surface water units. Not applicable to	Low	Although riparian vegetation has decreased across the assessment units, this cause of water quality degradation was determined as either rare or unlikely to occur. This risk level can be maintained into the future by ensuring riparian vegetation

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
			groundwater units.		cover is maintained or increased. The uncertainty of this risk is low as the Water Quality Technical Panel did not identify this key cause as resulting in a risk despite the cause being present throughout the majority of the Queensland Border Rivers and Moonie basins.
		(c) reduced flow.	All surface water units. Not applicable to groundwater units.	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. DNRME have assessed the risk of reduced flow and have found the risk is low. It should be noted that reduced flows could result under a changing climate. DNRME have assessed the risk of climate change resulting in reduced flows and have found the risk is low. This is based on modelling wet/median/dry scenarios. It should also be noted that the modelling has a low level of precision (high uncertainty). The uncertainty is medium for this risk due to the uncertainty surrounding the flow conditions under climate change.
	Dissolved oxygen outside natural ranges	(1) Micro-organisms consuming organic matter and depleting oxygen at a rate faster than it can be replenished. Example: This can arise when there is a discharge from sewage treatment plants or the flushing of natural organic material from the floodplain.	All surface water units. Not applicable to groundwater units.	Low	Despite Southern Downs Regional Council (2016) calculating that approximately 100% of treated effluent from Stanthorpe STP is used for beneficial use, this cause of water quality degradation was determined as either rare or unlikely to occur across the assessment units for the Queensland Border Rivers and Moonie, Beneficial use of treated effluent is a regulated activity under the Environmental Protection Regulation 2008. The uncertainty ranges between low to high depending on available data and expert knowledge for the assessment unit.
Surface water WM21		(2) Bottom release from, or overturn within, a stratified water storage.	Upper Border Rivers downstream of Glenlyon Dam and Coolmunda Dam.	High	The potential for thermal stratification in Glenlyon and Coolmunda Dams provides the conditions needed for depleted dissolved oxygen, both within the reservoir and upon a release event. The multi-level offtake at Coolmunda Dam reduces the potential for oxygen depleted water to be released. However, the potential is still present as the mixing of water may be insufficient to replenish oxygen concentrations to natural ranges. Water

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
			Not applicable to groundwater units.		storages are managed through the water planning process. The uncertainty of this risk is low as the literature review component of this risk assessment indicated the high and medium risk of thermal alteration occurring in Glenlyon and Coolmunda Dams respectively.
Surface water LM42		(3) Eutrophication leading to excessive plant growth causing high diurnal variations in dissolved oxygen levels, both above and below natural ranges.	Lower Moonie Not applicable to groundwater units.	Medium	The analysis of water quality data from the Lower Moonie region shows that the exceedance of the Basin Plan Target Application Zone (A2) aquatic ecosystem guidelines for dissolved oxygen is possible. Elevated nutrient concentrations provide ideal conditions for eutrophication and associated DO fluctuations. The Queensland Harmful Algal Bloom Response Plan identifies roles and responsibilities of government agencies in the event of a harmful algal bloom. In the event of a fish kill, the type of response implemented will be dependent on the likely cause for concern, e.g. low dissolved oxygen, disease, etc. The Queensland Government will coordinate involvement across agencies depending on the nature of the event. The uncertainty for this risk is low as the high nutrient concentrations in the Lower Moonie provide ideal conditions for eutrophication and associated DO fluctuations. Data sample size for DO is temporally limited (N=37), however nutrient data is sufficient to provide confidence. It should be noted that elevated levels of suspended matter in the Lower Moonie would inhibit plant growth by limiting available light in the water column.
Surface water LM35	Elevated levels of pesticides and other contaminants	Poor management practices including the following: (a) pesticide spray drift (b) allowing pesticides or other contaminants into surface water runoff (c) allowing pesticides or other contaminants to leach into groundwater	Granite Belt (Stanthorpe)	Medium	The Water Quality Technical Panel identified a potential for elevated levels of pesticides and other contaminants in the Granite Belt region. There are many abandoned mines throughout this region and although abandoned mines are managed by the Department of Environment and Science, the potential risk of elevated metal concentrations is noted. The Granite Belt has a large proportion of horticulture land use which presents the potential for pesticide spray drift and contamination of surface and groundwaters. The uncertainty for this risk is medium as although data provides quantitative evidence for the presence of elevated

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
		(d) allowing erosion of contaminated soil (e) inappropriate disposal of pesticides (f) inappropriate disposal and management of industrial and other waste (including from mining and coal-seam gas extraction).			pesticide concentrations adjacent to farmland, the sample size and the temporal range of data is lacking. Land use maps display abandoned mines and prevalence of horticulture in the region, providing some confidence surrounding causes being present (Qld Globe).
Groundwater LM5			Queensland Border Rivers Fractured Rock (GS55)	Medium	This resource unit is a highly connected landscape between groundwater (weathered zone) and surface water. Due to the sandy landscape, pesticides and other contaminants do not readily bind to soils. Combined with the higher rainfall than other areas of QMDB, this leads to an increased likelihood of highly mobile contaminants. This resource unit is also located in a metalliferous zone (tin mining previously occurred) so there is a higher likelihood of elevated metals naturally occurring. The uncertainty for this risk is medium as pesticide and other contaminant monitoring data is lacking. However, land use and rainfall data indicates that these contaminants may be present in groundwater. Previous studies show the high connectivity between land and basalts.
Groundwater LM10			Queensland Border Rivers Alluvium (GS54)	Medium	The expert panel assessment indicated that there is a localised risk from Goondiwindi and Dumaresq regions due to urban and rural development. The Dumaresq is at risk due to the high permeability of the Macintyre River Alluvium. On first principles, there is a thin unconsolidated zone associated with this resource unit which could lead to increased levels of pesticides, heavy metals and other toxic contaminants. It should be noted that Western Sector aquifers are very clayey with low permeability and poor yields which may impede infiltration of soluble and particulate contaminants and recharge waters. However, the Western Sector also has 'cracking clays' which may still enable recharge waters to enter the aquifer (Please, 2000). A Groundwater Quality Assessment of the Alluvial Aquifers of the Border Rivers Region (Please, 2000) stated that the frequency of groundwater pesticide contamination is low - noting that the most frequently detected pesticide was atrazine. Fluormetron was also detected in one sample. This report also found that several metals and trace elements exceeded ANZECC irrigation water quality guideline concentrations (ANZECC/ARMCANZ, 2000) in the Macintyre and western sectors of the resource unit (Serpentine

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
					region). In the central and eastern areas of the resource unit, four trace elements/metals (Al, As, Mo and Pb) exceeded health, aesthetic or irrigation guidelines (Please, 2000). It was noted that localised contamination incidents may arise from airports, cattle dips, service stations and industrial areas associated with rural towns, however these are managed in a way that protects public health and the environment by the Department of Environment and Science. The uncertainty for this risk is low as pesticide and other contaminant monitoring data indicates presence of contaminants. Land use mapping supports the presence of causes that result in these contaminants in the groundwater.
	pH outside natural ranges	(1) The exposure to the air of soils containing iron sulphide minerals. Note: When iron sulphide minerals are exposed to air natural oxidation processes can result in the release of acid, which can be flushed into Basin water resources. (2) Agricultural practices that lead to the acidification of soils.	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. Despite acid sulphate soils not being detected in the region, if present, poor agricultural land use practices in this region may convert potential acid sulphate soils to actual acid sulphate soils. There is predominately a low level of uncertainty for this risk across the assessment units due to local expert knowledge and availability of land use mapping.
		(3) Eutrophication leading to excessive plant growth causing high diurnal variation in pH.	All surface water and groundwater units	Low	Although the potential for eutrophication and plant growth has been identified in Lower Moonie, it is not considered likely that pH will be impacted. In addition, elevated levels of suspended matter would inhibit plant growth by limiting available light in the water column. There is predominately a low level of uncertainty for this risk across the assessment units due to local expert knowledge and availability of land use mapping.

Risk Register code	Type of water quality degradation	Key causes, or likely causes, of water quality degradation for that type (Schedule 10 of the Basin Plan)	Applicable assessment unit	Level of risk	Justification
	Elevated pathogen counts	Pathogens entering Basin water resources through both point and diffuse sources. The key sources of pathogens are: (a) human and animal waste (b) sewage discharges.	All surface water and groundwater units	Low	Across the assessment units for the Queensland Border Rivers and Moonie, this cause of water quality degradation was determined as either rare or unlikely to occur. A risk may arise if an expansion in tourism increases unsewered effluent emissions in the Stanthorpe region. The uncertainty for this risk is high due to a lack of available data.

Additional key causes, or likely causes, of water quality degradation identified through consultation					
	Degradation of aquatic habitat, riparian extent/connectivity, riparian condition	Removal of riparian vegetation. Overgrazing of catchments and grazing of riverbanks and floodplains. Practices that over the long-term cause decline of stream morphology, leading to near stream processes of gully erosion, side wall cut and head migration. The implementation of poor management practices leading to elevated levels of pesticides and other contaminants. Unmanaged fire risk leading to wildfires, destruction of riparian vegetation.	Border Rivers – Macintyre, Weir and Dumaresq Rivers and Macintyre Brook Not applicable to groundwater units.	Low	The Border Rivers has lost approximately 35% of pre-European riparian vegetation (Clark, Healy, & Tindall, 2015). Despite this, riparian connectivity remains relatively high in the Border Rivers. Although the risk is low, it should be noted that the proportion of the catchment's riparian area that is endangered is approximately 2% and the proportion that is of concern is approximately 20%. The removal or fragmentation of riparian vegetation increases the risk of pollutant transport to stream, reduces bank stability and can increase the amount of direct sunlight the stream receives. This risk will remain low if best management practices are implemented and continued in the basin.
			Moonie River Basin Not applicable to groundwater units.	Low	The Moonie River has lost approximately 37% of pre-European riparian vegetation (Clark, Healy, & Tindall, 2015). Despite this, riparian connectivity remains higher in Moonie River catchment than other river catchments in Queensland's Murray-Darling Basin. Although the risk is low, it should be noted that this catchment has among the highest proportion of ecosystems in QMDB that have been classified as endangered (4%) and of concern (27%). This risk will remain low if best management practices are implemented and continued in the basin.
	Climate change	The appropriate actions are not taken to reduce Greenhouse Gas emissions, increase carbon capture and promote adaptation. Rainfall variability and associated changes to river flows and to the frequency and extremity of droughts and floods. Changes to flood frequency and duration may impact vegetation, reducing river shading and the contribution of organic matter to stream. This will impact fish species, particularly the cold-water tolerant species (Balcombe, et al., 2011), as stream water temperature will increase and food and habitat availability will decrease. Drought refugia may dry out faster due to	Border Rivers Basin Moonie River Basin	Medium	The Q-catchments report for QMDB (Negus, et al., 2015) assessed the risk of climate change on aquatic ecosystems in the Queensland Border Rivers and Moonie River basins, as medium. A changing climate is likely to impact the water resources and freshwater ecosystems of the QMDB. Rainfall variability is likely to increase with current climate modelling predicting that rainfall during winter and spring will decrease and the frequency of intense downpours will increase (State of Queensland, 2017). It is likely that this will be associated with changes to river flows and to the frequency and extremity of droughts and floods. Climate change is predicted to impact fish species, particularly the cold-water tolerant species (Balcombe, et al., 2011). Changes to flood frequency and duration may impact vegetation (river red gums - *Eucalyptus camaldulensis* for example), reducing river shading and reducing the contribution of organic matter to stream. This will impact fish species as stream water temperature will

		increased evapotranspiration and changes to flood frequency and duration (Balcombe, et al., 2011).			increase and food and habitat availability will decrease. Drought refugia may dry out faster under current climate predictions due to increased evapotranspiration and changes to flood frequency and duration (Balcombe, et al., 2011).
	Pest fauna—Aquatic	Predation of native species. Competition with native fish populations for food, habitat and spawning locations. Increase in suspended sediment and nutrients. (Negus et al., 2012a-d).	Border Rivers Basin Moonie River Basin Not applicable to groundwater units.	High	Of the 12 species of instream pest fauna present in the Murray-Darling basin (Lintermans, 2007), three fish species and one amphibian are known to occur, and two fish species have a real potential to occur in the Queensland Border Rivers and Moonie River basins. The presence of instream pest fauna generally results in a decline in the populations and communities of native flora and fauna (Negus, et al., 2015). This is due to the increased predation and competition with native species. Pest fish are introduced into the ecosystem in a number of ways including, dumping of unwanted fish to waterways, the use of pest fish as bait, and stocking of fish in dams and impoundments.

SECTION 8: MANAGEMENT RESPONSES

8 Management responses

Section 10.33 of the Basin Plan that a WQM Plan must specify measures to be undertaken in, or in relation to, the surface water resources of the water resource plan area that contribute to the achievement of objectives. Similarly, Section 10.35C of the Basin Plan specifies that regard must be had to whether it is desirable for the WQM Plan to include rules or measures that support the maintenance of water quality within groundwater SDL resource units, based on consideration of a number of matters specified in the Basin Plan.

A measure is recommended for accreditation in a WQM Plan for Queensland Murray-Darling Basin catchments if the:

- **level of risk is medium, high or very high;**
- **relevant water quality and salinity target values are identified in the HWMP;**
- **measure is an action within the scope of the *Water Act 2007* and Queensland *Water Act 2000*;**
- **measures are fit-for-purpose and cost effective.**

As a result of these criteria, the management responses listed in a HWMP are not flow-related accredited measures for the purposes of the Basin Plan. However, in order to encapsulate the overall framework for the management of water quality in the Queensland Murray-Darling Basin, the WQM Plan under the Basin Plan *recognises* that the following land management responses, listed in Section 8, contribute to improving water quality in the Queensland Border Rivers and Moonie River basins.

The management responses presented in this section assist in addressing the risks identified in Section 7 of this report and contribute to the achievement of the objectives and outcomes for water resources specified in Section 3. Management responses listed in the tables below address risks to water quality in the Queensland Border Rivers and Moonie River basins identified as being at a medium or higher level of risk. Risks identified as at a low level, and the accompanying management responses to maintain low risk scores, are also included in these tables.

Existing projects being conducted across Queensland Murray-Darling Basin may inform future management responses and updates to this document. The implementation of future projects will be dependent on the allocation of funding and resources for natural resource management actions.

The extent and cost of the management responses is guided by the level of risk assigned to the type of water quality degradation the management response seeks to address. Management responses should also be fit-for-purpose and collaborative to increase cost efficiency.

The overarching NRM program “Regional Coordination and Evaluation” is relevant to the management of all risks. This project supports essential functions that assist to effectively deliver NRM outcomes including: design and on-going improvement of monitoring, evaluation, reporting and improvement (MERI) processes; development of shared evaluation and monitoring frameworks; analysis and interpretation of critical resource condition and spatial data; improving knowledge management systems; upskilling staff; engaging key stakeholders & developing partnerships; and, developing key strategies to ensure efficiencies and continuous improvement of project delivery. The Southern Queensland NRM project is delivered under the Queensland Government Natural Resources Investment Program 2018-2022.

The success of the management responses provided in this section will be assessed against the water quality target values specified in section 10 of this report, where funded monitoring programs are available. The management responses have been designed to maintain and/or improve water quality to achieve these water quality targets.

8.1 Management responses to address risks and contribute to the achievement of objectives

8.1.1 Risk factor: Elevated levels of salinity

Risk level	
Granite Belt (Stanthorpe) – Broadwater Creek	High
Queensland Border Rivers Fractured Rock (GS55)	Medium
All other surface waters and groundwaters	Low

Table 16: Management responses to address risks from elevated levels of salinity

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Saline groundwater and surface water discharges into surface water systems. De-watering of saline groundwater which mobilises salt into surface water systems Land management practices involving the replacement of deep-rooted vegetation with shallow-rooted crops and pastures. The use of groundwater for irrigation purposes at locations where highly saline upper aquifer water drains to the lower aquifer.	**Basin Salinity Management 2030** The Queensland Government will implement Basin Salinity Management 2030, in accordance with Schedule B of Schedule 1 of the Commonwealth *Water Act 2007* (and as revised) – for the purposes of long-term salinity planning and management. **Environmental Authorities under the *Environmental Protection Act 1994*** Environmentally relevant activities (ERAs) require an environmental authority under the *Environmental Protection Act 1994* to be issued before any activity can begin. ERAs are industrial or intensive agricultural activities with the potential to release contaminants into the environment. They include a wide range of activities such as aquaculture, sewage treatment, cattle feedlotting, mining and coal seam gas extraction. Environmental authorities include conditions requiring developments to conduct activities in an environmentally responsible manner and reduce or avoid potential environmental impacts. Where the proposed environmentally relevant activity involves salinity being generated, applicants are encouraged to develop a detailed management strategy. The strategy should demonstrate that the environmentally relevant activity will be managed to minimise the impacts on the environment. **Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** The risk of salinity is reduced by maintaining ground cover in sodic soil areas and through native vegetation management, such as maintaining/improving deep rooted vegetation. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%.

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	• Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. Water quality objectives for electrical conductivity have also been established for the various water types in the plan area, which complement the end-of-valley salinity targets under Schedule B of Schedule 1 of the Commonwealth *Water Act 2007* (and as revised). Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and,

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/

8.1.2 Risk factor: Elevated levels of suspended matter—including deposited sediment

Risk level	
Lower Border Rivers	Medium
Upper Moonie	Medium
Lower Moonie	Medium
All other surface waters	Low
Not applicable to groundwater.	

Table 17: Management responses to address risks from elevated levels of suspended matter—including deposited sediment

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Inappropriate frequency, timing and location of cultivation; Example: Cultivation taking place at times of the year when the risk of erosion is high (e.g. during the high rainfall season), excessive frequency of cultivation, and cultivation of steep slopes. Overgrazing of catchments and grazing of riverbanks and floodplains; Example: The riparian zone along watercourses kept in permanent vegetation can effectively mitigate the movement of sediment within farmlands and from farmlands. Poor soil conservation practices; Example: Practices that fail to use management strategies that prevent soil erosion, acidification, salinisation or other chemical soil contamination, or fail to adopt proven soil conservation technologies such as the construction of contour banks. Practices that over the long-term cause decline of stream morphology, leading to near stream processes of gully erosion, side wall cut and head migration.	**Land Restoration Fund** A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. The carbon farming projects will have a number of co-benefits, such as restoring ecosystems and degraded land which will contribute to the reduction of sediment inputs to stream. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/ **Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** The risk of suspended matter is reduced through maintaining ground cover and vegetation in riparian zones and the wider landscape. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. Water quality objectives for turbidity have also been established for the various water types in the plan area. Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. **Store and release code of practice** 'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **eWater Source Modelling** Under the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended National Partnership Agreement, the Queensland Government received funding to support the development of a water quality model (eWater Source Modelling) for Queensland Murray-Darling Basin catchments. The Source Catchment model enables a greater understanding of the temporal and spatial variability in water quality loads and concentrations across the Border Rivers-Moonie basins, enabling better prioritisation of management responses. The water quality model assesses total suspended solids, as well as key nutrients. Water quality monitoring has also been conducted to validate and calibrate the model. **Natural Disaster Relief and Recovery Arrangements (NDRRA):** In response to the damage caused by Severe Tropical Cyclone Debbie in 2017, the Australian and Queensland Governments made funding available for impacted individuals, primary producers, small businesses, non-profit organisations and local governments under the Natural Disaster Relief and Recovery Arrangements. The funding package included $35 million for the Environmental Recovery Package. The on-ground works produced through the Environmental Recovery Package will enhance catchment resilience and improve catchment condition through riparian recovery, weed control, soil conservation and gully and streambank stabilisation. **Point Source Water Quality Offsets Policy** The voluntary Point Source Water Quality Offsets Policy offers an alternative investment option for regulated point source operators, including sewage treatment plants, quarries, abattoirs and mine sites, to manage their water emissions under the *Environmental Protection Act 1994*, while improving water quality. Water quality offsets may come from another point source (such as a bubble licence) or the offsets may be achieved through diffuse actions such as bank stabilisation, on farm nutrient runoff reduction and constructed wetlands. Where implemented, these onground actions will contribute to the reduction of sediments to waterways. **State Planning Policy – Water Quality State Interest** The State Planning Policy (SPP) guides local governments in preparing and amending planning schemes to ensure 17 State Interests are considered. The State Interest for Water Quality specifies that the environmental values and quality of Queensland waters are protected and enhanced. Performance outcomes are specified in the SPP for the State Interest: Water Quality to ensure development is planning, designed, constructed and operated to manage stormwater and wastewater in a way that supports the protection of environmental values identified in the Environmental Protection (Water) Policy 2009. The performance outcomes refer to applicable stormwater management design objectives outlined in Tables A and B in Appendix 2 of the SPP. Table A specifies construction phase stormwater management design objectives which apply to all climatic regions in Queensland and aim to minimise the risk of sediment washing off sites and polluting waterways during construction. Table B

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	specifies post-construction phase stormwater management design objectives to address pollutants known to be generated from urban land uses. For the Western Queensland region, post construction phase stormwater management design objectives for total suspended solids, nutrients, gross pollutants and waterway stability management apply to population centres greater than 25,000 persons. **Toolkit measures** In July 2018, the Basin Plan 2012 was amended following the outcomes of the Northern Basin review. In the Northern Basin, a range of 'toolkit measures' will be adopted by the New South Wales and Queensland Governments, with assistance from the Australian Government. The toolkit measures recognise that environmental outcomes can be achieved not only through water recovery, but also through complementary actions to enhance water recovery efforts. The toolkit measures include environmental works and measures to promote fish movement and habitat, as well as cold water pollution control, which aligns with the objectives of the HWMPs.

8.1.3 Risk factor: Elevated levels of nutrients, including phosphorus and nitrogen

Risk level	
Granite Belt (Stanthorpe)	High
Upper Border Rivers	High
Lower Border Rivers	High
Upper Moonie	High
Lower Moonie	Medium
Queensland Border Rivers Fractured Rock (GS55)	Medium
Queensland Border Rivers Alluvium (GS54)	Medium
All other surface waters and groundwaters	Low

Table 18: Management responses to address risks from elevated levels of nutrients, including phosphorus and nitrogen

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Nutrients entering Basin water resources through both point and diffuse sources. The key sources of nutrients are: (a) soil and organic matter (b) animal waste (c) fertilisers (d) sewage and industrial discharges (e) nutrients from water storages released as a result of storage management practices.	**Environmental Authorities under the *Environmental Protection Act 1994*** Environmentally relevant activities (ERAs) require an environmental authority under the *Environmental Protection Act 1994* to be issued before any activity can begin. ERAs are industrial or intensive agricultural activities with the potential to release contaminants, including nutrients, into the environment. They include a wide range of activities such as aquaculture, sewage treatment, cattle feedlotting, mining and coal seam gas extraction. Environmental authorities include conditions requiring developments to conduct activities in an environmentally responsible manner and reduce or avoid potential environmental impacts. **Land Restoration Fund** A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. The carbon farming projects will have a number of co-benefits, such as restoring ecosystems and degraded land which will contribute to the reduction of sediment inputs to stream. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes.

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	Regional Agricultural Landcare Facilitator (RALF) A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/ **Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** Maintaining ground cover and vegetation in riparian zones and the wider landscape can assist in preventing nutrients from flowing to waterways. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	at a level that minimises soil erosion by water. Water quality objectives for nutrients, including total nitrogen and total phosphorus, have also been established for the various water types in the plan area. Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. It is important to notice that while wetlands and riparian areas can be effective in water quality improvement, caution should be taken when relying solely on natural and near natural wetlands for this purpose as it may come at the expense of the other ecosystem services that they provide. Other water quality treatments are available and must be considered when aiming to prevent toxicants from reaching natural waterways. **Store and release code of practice** 'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **eWater Source Modelling** Under the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended National Partnership Agreement, the Queensland Government received funding to support the development of a water quality model (eWater Source Modelling) for Queensland Murray-Darling Basin catchments. The Source Catchment model enables a greater understanding of the temporal and spatial variability in water quality loads and concentrations across the Border Rivers-Moonie basins, enabling better prioritisation of management responses. The water quality model assesses total suspended solids, as well as key nutrients. Water quality monitoring has also been conducted to validate and calibrate the model. **Natural Disaster Relief and Recovery Arrangements (NDRRA):** In response to the damage caused by Severe Tropical Cyclone Debbie in 2017, the Australian and Queensland Governments made funding available for impacted individuals, primary producers, small businesses, non-profit organisations and local governments under the Natural Disaster Relief and Recovery Arrangements. The funding package included $35 million for the Environmental Recovery Package. The on-ground works produced through the Environmental Recovery Package will enhance catchment resilience and improve catchment condition through riparian recovery, weed control, soil conservation and gully and streambank stabilisation. **Point Source Water Quality Offsets Policy** The voluntary Point Source Water Quality Offsets Policy offers an alternative investment option for regulated point source operators, including sewage treatment plants, quarries, abattoirs and mine sites, to manage their water emissions under the

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	Environmental Protection Act 1994, while improving water quality. Water quality offsets may come from another point source (such as a bubble licence) or the offsets may be achieved through diffuse actions such as bank stabilisation, on farm nutrient runoff reduction and constructed wetlands. Where implemented, these onground actions will contribute to the reduction of sediments to waterways. **State Planning Policy – Water Quality State Interest** The State Planning Policy (SPP) guides local governments in preparing and amending planning schemes to ensure 17 State Interests are considered. The State Interest for Water Quality specifies that the environmental values and quality of Queensland waters are protected and enhanced. Performance outcomes are specified in the SPP for the State Interest: Water Quality to ensure development is planning, designed, constructed and operated to manage stormwater and wastewater in a way that supports the protection of environmental values identified in the Environmental Protection (Water) Policy 2009. The performance outcomes refer to applicable stormwater management design objectives outlined in Tables A and B in Appendix 2 of the SPP. Table A specifies construction phase stormwater management design objectives which apply to all climatic regions in Queensland and aim to minimise the risk of sediment washing off sites and polluting waterways during construction. Table B specifies post-construction phase stormwater management design objectives to address pollutants known to be generated from urban land uses. For the Western Queensland region, post construction phase stormwater management design objectives for total suspended solids, nutrients, gross pollutants and waterway stability management apply to population centres greater than 25,000 persons.

8.1.4 Elevated cyanobacteria cell counts or biovolume, toxins and odour compounds

Risk level	
Upper Moonie – Moonie River at Flinton	High
All other surface waters.	Low
Not applicable to groundwater.	

Table 19: Management responses to address risks from elevated cyanobacteria cell counts or biovolume, toxins and odour compounds

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
The interaction of the following factors: (a) a water body with little or no flow (b) stratification in the water body (c) sunlight (d) the availability of phosphorus and nitrogen in the water (e) seeding from up-stream (although cyanobacteria blooms may occur without this factor).	**Queensland Harmful Algal Bloom Response Plan** Seasonal incidents of harmful algal blooms can occur throughout Queensland. This response plan, developed in 2014 (and updated), identifies the appropriate response agency to deal with a harmful algal bloom incident or enquiry. The response plan ensures a coordinated response to address the issue and minimise the risk of harmful algal blooms to humans, livestock and wildlife. The Queensland Harmful Algal Bloom Response Plan is supported by the Queensland Harmful Algal Bloom operational procedures. To address phosphorus and nitrogen in the water, the following management responses apply: **Environmental Authorities under the *Environmental Protection Act 1994*** Environmentally relevant activities (ERAs) require an environmental authority under the *Environmental Protection Act 1994* to be issued before any activity can begin. ERAs are industrial or intensive agricultural activities with the potential to release contaminants, including nutrients, into the environment. They include a wide range of activities such as aquaculture, sewage treatment, cattle feedlotting, mining and coal seam gas extraction. Environmental authorities include conditions requiring developments to conduct activities in an environmentally responsible manner and reduce or avoid potential environmental impacts. **Land Restoration Fund** A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. The carbon farming projects will have a number of co-benefits, such as restoring ecosystems and degraded land which will contribute to the reduction of sediment inputs to stream. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change.

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	Raising the profile of remnant brigalow in the Queensland Murray Darling A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	Store and release code of practice Re-direction of stored water to environmental water is a voluntary action farmers may choose to pursue as a request by the State, to move water from one location to a nearby location or to lower the water level in a private storage. 'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the *Environmental Protection Act 1994*. The code includes measures to minimise the potential risks of harm to the environment due to sediments, contaminants, such as elevated nutrients and pesticides, and stratification. **Environmental values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** Maintaining ground cover and vegetation in riparian zones and the wider landscape can assist in preventing nutrients from flowing to waterways. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. Water quality objectives for nutrients, including total nitrogen and total phosphorus, have also been established for the various water types in the plan area. Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. It is important to notice that while wetlands and riparian areas can be effective in water quality improvement, caution should be taken when relying solely on natural and near natural wetlands for this purpose as it may come at the expense of the other ecosystem services that they provide. Other water quality treatments are available and must be considered when aiming to prevent toxicants from reaching natural waterways. **Store and release code of practice** 'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **eWater Source Modelling** Under the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	National Partnership Agreement, the Queensland Government received funding to support the development of a water quality model (eWater Source Modelling) for Queensland Murray-Darling Basin catchments. The Source Catchment model enables a greater understanding of the temporal and spatial variability in water quality loads and concentrations across the Border Rivers-Moonie basins, enabling better prioritisation of management responses. The water quality model assesses total suspended solids, as well as key nutrients. Water quality monitoring has also been conducted to validate and calibrate the model. **Natural Disaster Relief and Recovery Arrangements (NDRRA):** In response to the damage caused by Severe Tropical Cyclone Debbie in 2017, the Australian and Queensland Governments made funding available for impacted individuals, primary producers, small businesses, non-profit organisations and local governments under the Natural Disaster Relief and Recovery Arrangements. The funding package included $35 million for the Environmental Recovery Package. The on-ground works produced through the Environmental Recovery Package will enhance catchment resilience and improve catchment condition through riparian recovery, weed control, soil conservation and gully and streambank stabilisation. **Point Source Water Quality Offsets Policy** The voluntary Point Source Water Quality Offsets Policy offers an alternative investment option for regulated point source operators, including sewage treatment plants, quarries, abattoirs and mine sites, to manage their water emissions under the *Environmental Protection Act 1994*, while improving water quality. Water quality offsets may come from another point source (such as a bubble licence) or the offsets may be achieved through diffuse actions such as bank stabilisation, on farm nutrient runoff reduction and constructed wetlands. Where implemented, these onground actions will contribute to the reduction of sediments to waterways. **State Planning Policy – Water Quality State Interest** The State Planning Policy (SPP) guides local governments in preparing and amending planning schemes to ensure 17 State Interests are considered. The State Interest for Water Quality specifies that the environmental values and quality of Queensland waters are protected and enhanced. Performance outcomes are specified in the SPP for the State Interest: Water Quality to ensure development is planning, designed, constructed and operated to manage stormwater and wastewater in a way that supports the protection of environmental values identified in the Environmental Protection (Water) Policy 2009. The performance outcomes refer to applicable stormwater management design objectives outlined in Tables A and B in Appendix 2 of the SPP. Table A specifies construction phase stormwater management design objectives which apply to all climatic regions in Queensland and aim to minimise the risk of sediment washing off sites and polluting waterways during construction. Table B specifies post-construction phase stormwater management design objectives to address pollutants known to be generated from urban land uses. For the Western Queensland region, post construction phase stormwater management design objectives for total suspended solids, nutrients, gross pollutants and waterway stability management apply to population centres greater than 25,000 persons.

8.1.5 Risk factor: Water temperature outside natural ranges

Risk level	
Upper Border Rivers – Downstream of Glenlyon and Coolmunda Dams	High
All other surface and groundwaters	Low

Table 20: Management responses to address risks from water temperature outside natural ranges

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
The release of stored water from below the thermocline from large water storages in spring, summer and autumn. The release of stored water from large water storages in winter The removal of shading riparian vegetation Reduced flow.	**Water planning framework under the Water Act 2000** The Water Act 2000 enables provisions to be included on Resource Operation Licences regarding operating rules to minimise impacts to ecosystems. The Water Act 2000 also provides for outcomes, measures, objectives and indicators to be developed for the respective plan area under a Water Plan. The release of water from storages is managed by conditions on each Resource Operations Licence (ROL) under the Water Act 2000. These ROL conditions are implemented by the Resource Operations Licence Holder e.g. SunWater. To address the risk of water temperature outside natural ranges due to the removal of shading riparian vegetation, the following management responses apply: **Land Restoration Fund** A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. The carbon farming projects will have a number of co-benefits, such as restoring ecosystems and degraded land which will contribute to the reduction of sediment inputs to stream. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes. **Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** Maintaining ground cover and vegetation in riparian zones and the wider landscape can assist in preventing nutrients from flowing to waterways. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. **Store and release code of practice** 'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **Toolkit measures** In July 2018, the Basin Plan 2012 was amended following the outcomes of the Northern Basin review. In the Northern Basin, a range of 'toolkit measures' will be adopted by the New South Wales and Queensland Governments, with assistance from the Australian Government. The toolkit measures recognise that environmental outcomes can be achieved not only through water recovery, but also through

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	complementary actions to enhance water recovery efforts. The toolkit measures include environmental works and measures to promote fish movement and habitat, as well as cold water pollution control, which aligns with the objectives of the HWMPs.

8.1.6 Risk factor: Dissolved oxygen outside natural ranges

Risk level	
Upper Border Rivers – Downstream of Glenlyon and Coolmunda Dams	High
Lower Moonie	Medium
All other surface waters	Low
Not applicable to groundwater.	

Table 21: Management responses to address risks from dissolved oxygen outside natural ranges

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Micro-organisms consuming organic matter and depleting oxygen at a rate faster than it can be replenished. Example: This can arise when there is a discharge from sewage treatment plants or the flushing of natural organic material from the floodplain. Bottom release from, or overturn within, a stratified water storage. Eutrophication leading to excessive plant growth causing high diurnal variations in dissolved oxygen levels, both above and below natural ranges.	**Water planning framework under the Water Act 2000** The Water Act 2000 enables provisions to be included on Resource Operation Licences regarding operating rules to minimise impacts to ecosystems. The Water Act 2000 also provides for outcomes, measures, objectives and indicators to be developed for the respective plan area under a Water Plan. The release of water from storages is managed by conditions on each Resource Operations Licence (ROL) under the Water Act 2000. These ROL conditions are implemented by the Resource Operations Licence Holder e.g. SunWater. To address the risk of dissolved oxygen outside natural ranges due to eutrophication, the following management responses apply: **Environmental Authorities under the *Environmental Protection Act 1994*** Environmentally relevant activities (ERAs) require an environmental authority under the *Environmental Protection Act 1994* to be issued before any activity can begin. ERAs are industrial or intensive agricultural activities with the potential to release

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	contaminants, including nutrients, into the environment. They include a wide range of activities such as aquaculture, sewage treatment, cattle feedlotting, mining and coal seam gas extraction. Environmental authorities include conditions requiring developments to conduct activities in an environmentally responsible manner and reduce or avoid potential environmental impacts. **Land Restoration Fund** A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. The carbon farming projects will have a number of co-benefits, such as restoring ecosystems and degraded land which will contribute to the reduction of sediment inputs to stream. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange;

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/ **Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** Maintaining ground cover and vegetation in riparian zones and the wider landscape can assist in preventing nutrients from flowing to waterways. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. Water quality objectives for nutrients, including total nitrogen and total phosphorus, have also been established for the various water types in the plan area. Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. **Store and release code of practice**

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **Natural Disaster Relief and Recovery Arrangements (NDRRA):** In response to the damage caused by Severe Tropical Cyclone Debbie in 2017, the Australian and Queensland Governments made funding available for impacted individuals, primary producers, small businesses, non-profit organisations and local governments under the Natural Disaster Relief and Recovery Arrangements. The funding package included $35 million for the Environmental Recovery Package. The on-ground works produced through the Environmental Recovery Package will enhance catchment resilience and improve catchment condition through riparian recovery, weed control, soil conservation and gully and streambank stabilisation. **Point Source Water Quality Offsets Policy** The voluntary Point Source Water Quality Offsets Policy offers an alternative investment option for regulated point source operators, including sewage treatment plants, quarries, abattoirs and mine sites, to manage their water emissions under the *Environmental Protection Act 1994*, while improving water quality. Water quality offsets may come from another point source (such as a bubble licence) or the offsets may be achieved through diffuse actions such as bank stabilisation, on farm nutrient runoff reduction and constructed wetlands. Where implemented, these onground actions will contribute to the reduction of sediments to waterways. **State Planning Policy – Water Quality State Interest** The State Planning Policy (SPP) guides local governments in preparing and amending planning schemes to ensure 17 State Interests are considered. The State Interest for Water Quality specifies that the environmental values and quality of Queensland waters are protected and enhanced. Performance outcomes are specified in the SPP for the State Interest: Water Quality to ensure development is planning, designed, constructed and operated to manage stormwater and wastewater in a way that supports the protection of environmental values identified in the Environmental Protection (Water) Policy 2009. The performance outcomes refer to applicable stormwater management design objectives outlined in Tables A and B in Appendix 2 of the SPP. Table A specifies construction phase stormwater management design objectives which apply to all climatic regions in Queensland and aim to minimise the risk of sediment washing off sites and polluting waterways during construction. Table B specifies post-construction phase stormwater management design objectives to address pollutants known to be generated from urban land uses. For the Western Queensland region, post construction phase stormwater management design objectives for total suspended solids, nutrients, gross pollutants and waterway stability management apply to population centres greater than 25,000 persons.

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	Toolkit measures In July 2018, the Basin Plan 2012 was amended following the outcomes of the Northern Basin review. In the Northern Basin, a range of 'toolkit measures' will be adopted by the New South Wales and Queensland Governments, with assistance from the Australian Government. The toolkit measures recognise that environmental outcomes can be achieved not only through water recovery, but also through complementary actions to enhance water recovery efforts. The toolkit measures include environmental works and measures to promote fish movement and habitat, as well as cold water pollution control, which aligns with the objectives of the HWMPs.

8.1.7 Elevated levels of pesticides, heavy metals and other toxic contaminants

Risk level	
Granite Belt (Stanthorpe)	Medium
Queensland Border Rivers Fractured Rock (GS55)	Medium
Queensland Border Rivers Alluvium (GS54)	Medium
All other surface waters and groundwaters	Low

Table 22: Management responses to address risks from elevated levels of pesticides, heavy metals and other toxic contaminants

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Poor management practices including the following: Pesticide spray drift Allowing pesticides or other contaminants into surface water runoff Allowing pesticides or other contaminants to	**Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** Maintaining ground cover and vegetation in riparian zones and the wider landscape can assist in preventing nutrients from flowing to waterways. Water quality objectives to protect environmental values in the plan area include the following targets for wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
leach into groundwater Allowing erosion of contaminated soil Inappropriate disposal of pesticides Inappropriate disposal and management of industrial and other waste (including from mining and coal-seam gas extraction).	connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. Water quality objectives for toxicants, including pesticides and heavy metals, have also been established for the various water types in the plan area. Water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. It is important to notice that while wetlands and riparian areas can be effective in water quality improvement, caution should be taken when relying solely on natural and near natural wetlands for this purpose as it may come at the expense of the other ecosystem services that they provide. Other water quality treatments are available and must be considered when aiming to prevent toxicants from reaching natural waterways. **Store and release code of practice** 'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	Hort360 Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/

8.1.8 Risk factor: pH outside natural ranges

Risk level	
All surface waters and groundwaters	Low

Table 23: Management responses to address risks from pH outside natural ranges

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
The exposure to the air of soils containing iron sulphide minerals. Note: When iron sulphide minerals are exposed to air natural oxidation processes can result in the release of acid, which can be flushed into Basin water resources. Agricultural practices that lead to the acidification of soils.	**State Planning Policy – Emissions and Hazardous Activities State Interest** The State Planning Policy (SPP) guides local governments in preparing and amending planning schemes to ensure 17 State Interests are considered. The State Interest for Emissions and Hazardous Activities seeks to minimise the disturbance to acid sulfate soils to reduce risks posed to the natural and built environments from the release of acid and metal contaminants. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/

8.1.9 Risk factor: Elevated pathogen counts

Risk level	
All surface waters and groundwaters	Low

Table 24: Management responses to address risks from elevated pathogen counts

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Pathogens entering water through both point and diffuse sources. The key sources of pathogens include animal and human waste and sewage discharges.	**Environmental Authorities under the *Environmental Protection Act 1994*** Environmentally relevant activities (ERAs) require an environmental authority under the *Environmental Protection Act 1994* to be issued before any activity can begin. ERAs are industrial or intensive agricultural activities with the potential to release contaminants, including pathogens, into the environment. They include a wide range of activities such as aquaculture, sewage treatment, cattle feedlotting, mining and coal seam gas extraction. Environmental authorities include conditions requiring developments to conduct activities in an environmentally responsible manner and reduce or avoid potential environmental impacts. **Store and release code of practice**

	'The Code of practice for the release of stored water from privately owned farm storages to receiving waters in the Queensland Murray-Darling Basin' was developed in 2016 to provide guidance to landholders that wish to release water from privately owned farm storages to receiving waters, helping them comply with their general environmental duty under the Environmental Protection Act 1994. The code includes measures to minimise the potential water quality impacts of the release of stored water on the environment. The release of stored water from privately owned farm storages to receiving waters has been an action identified by the Commonwealth Environmental Water Holder to complement water recovery in the northern Murray-Darling Basin. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the Grazing BMP program by graziers in the plan area. The voluntary and industry-led Grazing BMP program provides graziers across Queensland with the opportunity to improve productivity and reduce soil run-off to waterways through the identification of improved practices. The Grazing BMP program is available to graziers online via the following website: https://www.bmpgrazing.com.au.

8.1.10 Risk factor: Degradation of aquatic habitat, riparian extent/connectivity, riparian condition

Risk level	
All surface waters	Low
Not applicable to groundwater.	

Table 25: Management responses to address the risk of degradation of aquatic habitat, riparian extent/connectivity, riparian condition

Key causes, or likely causes, of water quality degradation to be addressed	**Management responses to address risks and contribute to the achievement of objectives**
Removal of riparian vegetation.	**Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009** Maintaining ground cover and vegetation in riparian zones and the wider landscape can assist in preventing nutrients from flowing to waterways. Water quality objectives to protect environmental values in the plan area include the following targets for

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Overgrazing of catchments and grazing of riverbanks and floodplains. Practices that over the long-term cause decline of stream morphology, leading to near stream processes of gully erosion, side wall cut and head migration. The implementation of poor management practices leading to elevated levels of pesticides and other contaminants. Unmanaged fire risk leading to wildfires, destruction of riparian vegetation.	wetland extent, ground cover in grazing lands and riparian vegetation: • Target for wetland extent: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels. • Target for ground cover in grazing lands: Maintain a ground cover level of >70%. • Targets for riparian areas: (1) No reduction in forested riparian areas from 2013 baseline levels; (2) No reduction in riparian forest connectivity from 2013 baseline levels; (3) In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water. In addition, persistent waterholes have been identified and assigned high ecological value management intent due to their importance as refugial habitats in 'boom and bust' landscapes. Water quality objectives, and accompanying mapping displaying management intent, will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 to inform statutory and non-statutory planning and decision-making. **Land Restoration Fund** A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. The carbon farming projects will have a number of co-benefits, such as restoring ecosystems and degraded land which will contribute to the reduction of sediment inputs to stream. **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	appropriate grazing regimes. **Regional Agricultural Landcare Facilitator (RALF)** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project builds on the strong, established partnerships across the South West Queensland, Condamine, and Maranoa Balonne and Border rivers management units. The Regional Agriculture Landcare Facilitators will support the development and delivery of agriculture projects and initiatives by proactively engaging with agricultural industries, landholder groups, Landcare Groups and other key stakeholders to: facilitate information exchange; provide linkages to technical experts; support local and regional agricultural events; facilitate innovative agricultural practice demonstrations; assist with accessing grants for sustainable agriculture activities; and, facilitate connections with a range of programs that align to the NLP2 Regional Land Partnership objectives. **Grazing BMP** Promote uptake of the industry-led, voluntary Grazing BMP program by graziers in the plan area. The Grazing BMP initiative is supported by Queensland Government, Fitzroy Basin Association, AgForce and a range of other delivery partners. The Grazing BMP modules include Soil Health, Grazing Land Management, People and Business, Animal Production and Animal Health and Welfare. Website: https://www.bmpgrazing.com.au/ **myBMP – Cotton** Promote uptake of myBMP, the voluntary farm and environmental management program that ensures cotton is produced to industry best practice. myBMP is supported by Cotton Australia through funding from the Australian Government's National Landcare Programme and the Cotton Research Development Corporation. myBMP comprises 10 modules including Sustainable Natural Landscape (for managing vegetation and riparian assets on farm), Soil Health (for maintaining and/or improving soil quality and fertility), Pesticide Management (including storage and use) and Water Management (addresses water quality, efficiency of storage and distribution for both dryland and irrigated farming practices). Website: https://www.mybmp.com.au/home.aspx **Hort360** Promote uptake of Hort360, a voluntary BMP program for horticultural enterprises. The program is supported by Growcom and the Queensland Government. The Hort360 program comprises 14 modules, including irrigation, runoff, soil, biodiversity, climate and pesticide management. Website: https://www.hort360.com.au/ **Aerial Survey of wetlands and waterbirds in Queensland** Under the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended National Partnership Agreement, the Queensland Government received funding to support the 'Aerial Survey of wetlands and waterbirds in Queensland' from 2014-2017. This project surveys 2,697,000 km^2 of eastern Australia and can monitor changes in the distribution and abundance of 50 waterbird species, including threatened species, and the health of rivers and wetlands. The survey is a powerful tool to observe changes in Ramsar wetland condition as well as other global and international conservation agreements. The survey can also detect potential long term changes through implementation of the Basin Plan. The aerial surveys are conducted by the University of New South Wales. Refer to https://www.ecosystem.unsw.edu.au/content/rivers-and-

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
	wetlands/waterbirds/eastern-australian-waterbird-survey for more information. **Fire management** Actively manage fire risk to mitigate risk of wildfires, which can lead to destruction of riparian vegetation, high levels of erosion, and declines in water quality. This could be delivered through NRM bodies, local governments, landholder education, and ranger programs. **Toolkit measures** In July 2018, the Basin Plan 2012 was amended following the outcomes of the Northern Basin review. In the Northern Basin, a range of 'toolkit measures' will be adopted by the New South Wales and Queensland Governments, with assistance from the Australian Government. The toolkit measures recognise that environmental outcomes can be achieved not only through water recovery, but also through complementary actions to enhance water recovery efforts. The toolkit measures include environmental works and measures to promote fish movement and habitat, as well as cold water pollution control, which aligns with the objectives of the HWMPs.

8.1.11 Risk factor: Climate change

Risk level	
Border Rivers Basin	Medium
Moonie River Basin	Medium

Table 26: Management responses to address risks from climate change

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives[15]
The appropriate actions are not taken to reduce Greenhouse Gas emissions, increase carbon capture and promote adaptation. Rainfall variability and associated changes to river flows and to the frequency and extremity of droughts and floods. Changes to flood frequency and duration may impact vegetation, reducing river shading and the contribution of organic matter to stream. This will impact fish species, particularly the cold-water tolerant species (Balcombe, et al., 2011), as stream water temperature will increase and food and habitat availability will decrease. Drought refugia may dry out faster due to increased evapotranspiration and changes to flood frequency and duration (Balcombe, et al., 2011).	The Queensland Government is working closely with business and industry, local councils and regional communities to understand the impacts of climate change, and to guide the state to adapt and transition under a changing climate. The following initiatives have been funded by Queensland Government and directly relate to water and land management: • **Land Restoration Fund**: A $500 million fund that will directly support land based carbon reduction projects. This fund will support rehabilitation and revegetation of public and private land (including grazing land), protection of native forests and removal of pest and weed species. • **CarbonPlus fund**: An $8.4 million project that will support and expand the carbon farming industry. The project has two parts: (1) equip Queensland Indigenous communities to participate in the carbon market and ensure the cultural, social and environmental co-benefits of Aboriginal carbon farming projects are recognised and appropriately valued. The Aboriginal Carbon Fund was engaged to undertake this component of the project. (2) the purchase of carbon credits to offset the Queensland Government's vehicle emissions from 2017-18 to 2018-19, with credits from Indigenous carbon projects being prioritised. In addition to the above, the current initiatives employed by the Queensland Government to understand, adapt and transition under a changing climate are not limited to water and land management initiatives, but instead include projects that encourage a whole-of-sector response (Refer to https://www.qld.gov.au/environment/climate/response for more information). These include: • **Transition to a zero carbon economy**: A strategy to ensure Queensland is positioned to take advantage of the opportunities as the world economy transitions to reduce pollution and adopt low carbon alternatives. • **1 million solar rooftops**: Supporting the deployment of solar PV on the rooftops of businesses, community buildings and commercial or industrial sites including on public housing and schools under the Advancing Clean Energy Schools program: http://education.qld.gov.au/facilities/solar/energy.html. • **Solar150**: The initiative, in conjunction with the large-scale solar PV competitive funding round conducted by the Australian Renewable Energy Agency (ARENA), will help support the development of large-scale solar energy projects in Queensland. • **Green Bonds**: Proceeds from QTC Green Bonds are to be used to fund qualifying green projects and assets for the State of Queensland. The proceeds are allocated to specific projects that support Queensland's transition to a low-carbon and climate resilient economy. So far, the qualifying green projects include rail links, cycleways and solar farms. • **Queensland Climate Resilient Councils**: a five year program working with Queensland local governments to strengthen internal council decision-making processes to respond to climate change (http://qcrc.lgaq.asn.au/). • **Biofutures**: The Advance Queensland's Biofutures 10-Year Roadmap and Action Plan has a vision for a $1 billion

[15] As the strategies to mitigate climate change are not restricted to a basin level, but require local, national and international initiatives, the management responses presented here are not restricted to those within the Border Rivers and Moonie River basins.

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives[15]
	sustainable (including low carbon) and export-oriented industrial biotechnology and bioproducts sector: https://advance.qld.gov.au/our-vision/roadmaps/biofutures.aspx. Future activities: • Transitioning to a low carbon energy sector: Working with industry and the community to transition to an efficient, affordable and fair clean energy system, including: setting a 50% Renewable Energy Target by 2030 to drive jobs, investment, and cut carbon pollution; unlocking North Queensland's renewable energy potential; and supporting an additional 400 megawatts of new large-scale renewable capacity. Continue to work collaboratively with land holders to consider, mitigate and adapt to climate change **Protecting and enhancing key soil, water and vegetation assets of southern inland Queensland** A Southern Queensland NRM project delivered under the Queensland Government Natural Resources Investment Program 2018-2022. This project seeks to improve 12,500ha for soil health and stability, 12,000ha of native vegetation, and 2,400ha of riparian and wetland areas through land managers adopting improved management practices Southern Queensland NRM will partner with community and Landcare groups, regional councils, Government agencies, Traditional Owner groups, and research and development organisations to enhance the delivery of the project. **Future proofing agricultural lands** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will address declining native vegetation and soil carbon in the South West Queensland, Condamine, and Maranoa Balonne and Border Rivers through building the adaptive capacity of producers to adopt best practice natural resource management to improve the condition of native vegetation, biodiversity and soils. This will enhance the resilience of the region to climate change. **Raising the profile of remnant brigalow in the Queensland Murray Darling** A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23.This project will implement recommended management actions to address the key threatening processes of clearing, fire, weeds, pest animals, overgrazing and climate change on brigalow, which is an Endangered Threatened Ecological Community under the Environment Protection and Biodiversity Conservation Act 1999. The management actions will include re-establishing brigalow in cleared areas; protecting remnant brigalow from further loss; reinstating habitat integrity, complexity and connectivity; reducing fire hazards; controlling weeds and pigs; and adopting appropriate grazing regimes.

8.1.12 Risk factor: Pest fauna—Aquatic

Risk level	
Border Rivers Basin	High
Moonie River Basin	High
Not applicable to groundwater.	

Table 27: Measures to address risks from aquatic pest fauna

Key causes, or likely causes, of water quality degradation to be addressed	Management responses to address risks and contribute to the achievement of objectives
Predation of native species. Competition with native fish populations for food, habitat and spawning locations. Increase in suspended sediment and nutrients. (Negus et al., 2012a-d).	**National Carp Control Plan** A $15-million planning process, on behalf of the Australian Government, to lead a large program of research and consultation to identify a smart, safe, effective and integrated suite of measures to control carp impacts. Consultation has occurred with Queensland stakeholders including, Northern Basin Aboriginal Nations, fishing groups, NRM bodies and community members. Further information can be found at http://www.carp.gov.au/. **Carp busting events** Fishing competitions that target carp are held throughout the catchment. Although it is recognised that these events are unlikely to have a significant impact on carp population numbers (except in closed systems), the educational opportunity that these events provide to the wider community about the detrimental impacts of pest fish are valuable. **Pest management plans**[16]: Goondiwindi Regional Council, Balonne Regional Council, Western Downs Regional Council, Toowoomba Regional Council, and Southern Downs Regional Council. Pest management plans recognise the need to control pest species in the catchment through partnership with all levels of government, natural resource management bodies and community. **Barriers to fish passage**: Mitigate existing barriers to fish passage, where possible. Options for the installation of fishways include the relevant Natural Resource Management body for the region or through the toolkit measures to complement environmental water recovery in the Northern Murray-Darling Basin under the Basin Plan – in consultation with Traditional Owners.

[16] Pest management plans include plans from adjacent Local Government areas as it is recognised that addressing pest species in the Border Rivers and Moonie is not limited to local government boundaries.

SECTION 9: ABORIGINAL PEOPLE'S VALUES AND USES OF WATER ADDRESSED UNDER A HEALTHY WATERS MANAGEMENT PLAN

9 Aboriginal people's values and uses of water addressed under a healthy waters management plan

Section 10.52 of the Basin Plan outlines the process to identify objectives and outcomes based on Indigenous values and uses.

Section 9.5 of the Healthy Waters Management Plan for the Border Rivers and Moonie River Basins outlines opportunities to strengthen the protection of Aboriginal values and uses of water that are relevant to the content of a HWMP. The values and uses of water resources and the risks to these values and uses (Refer to Section 9.2 and Section 9.4) were identified through a consultation process led by the Department of Natural Resources, Mines and Energy and DES, with Nations within the eastern catchments of QMDB and the Northern Basin Aboriginal Nations (NBAN) (Refer to section 4.5). This consultation process also identified the objectives and outcomes that Aboriginal people within the eastern catchments of QMDB want to achieve for the water resources of the plan area (See Section 9.3). The content below has been informed by the Water Connections Report (DNRME, 2019). The identification of objectives and outcomes for water resources enables the values and uses to be protected and enhanced by water resource planning, particularly those relating to water quality and land management, which can be addressed under the *Environmental Protection (Water) Policy 2009* through the Border Rivers and Moonie River HWMP.

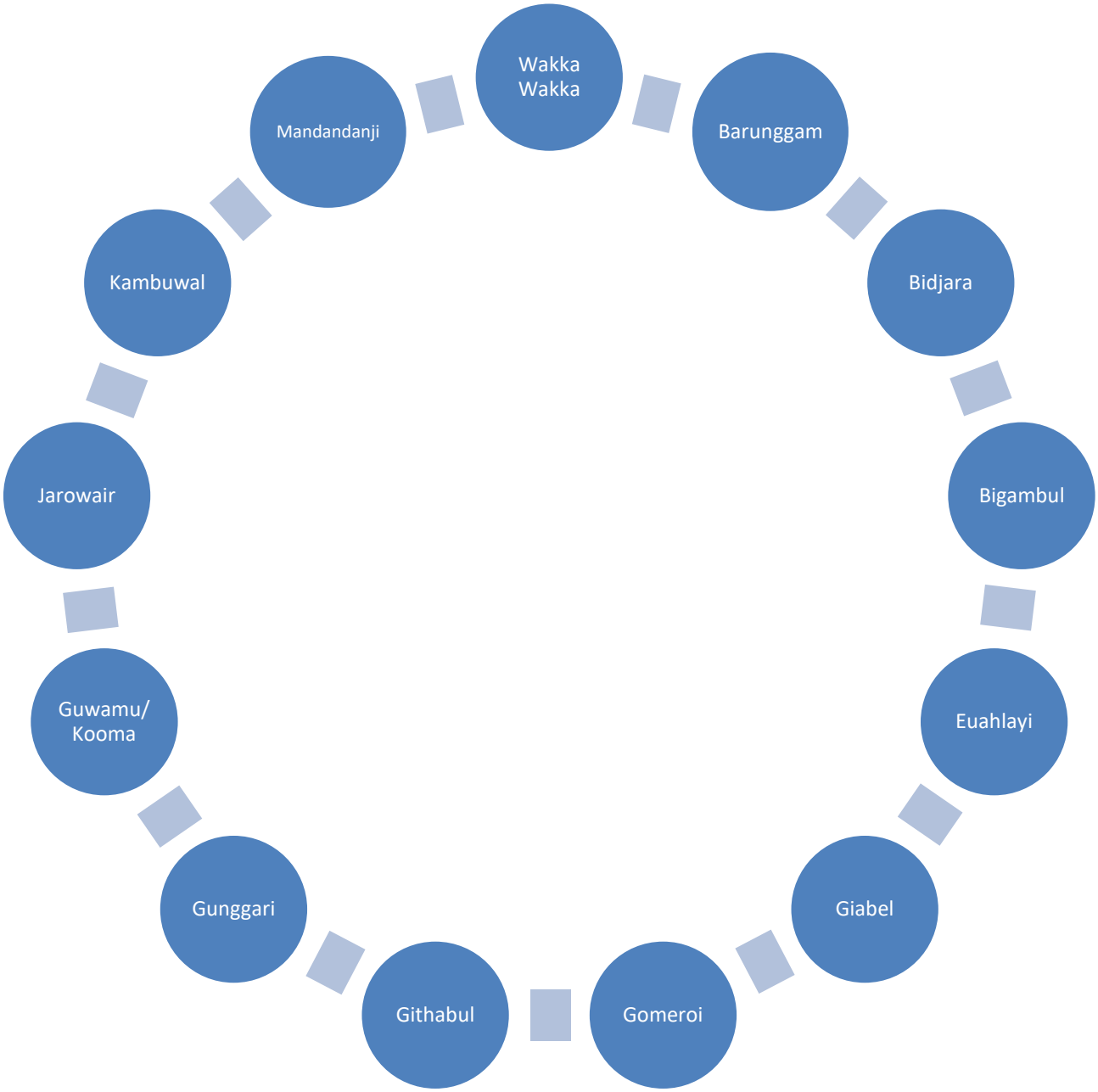


Figure 28 Aboriginal Nations consulted in the Border Rivers, Moonie, Condamine, and Maranoa-Balonne.

9.1 Background

Aboriginal peoples[17] in Australia have frequently expressed the desire for better inclusion in the management of land and water resources. Aboriginal relationships with water are holistic, combining land, water, culture, society and economy. Water underpins social, spiritual and economic well-being, is inseparable from the land, and the relationship of Aboriginal peoples with waters, lands and their resources is crucial to cultural well-being and resilience (Human Rights Commission, 2008). It is worth emphasising the sense of responsibility that Aboriginal peoples feel for their land and water, to look after it as their ancestors have done for tens of thousands of years. This interest entails an inherent cultural responsibility to look after water, and presents an incredible source of knowledge and opportunity for involvement for water resource planning.

The Queensland Government is now working to improve Aboriginal involvement in water resource planning in the Queensland Murray-Darling Basin through the Basin Plan, which details the ways in which water planning authorities must consult with relevant Aboriginal organisations in relation to the requirements of section 10.52: Objectives and outcomes based on Indigenous values and uses. This work has been summarised in the Water Connections Report (DNRME, 2019).

The Aboriginal values and uses of water that can be protected and enhanced by a HWMP are those that are related to water quality. Good water quality supports all human uses and is fundamental to plants, animals and healthy aquatic ecosystems. Fishing, for example, relies on healthy ecosystems to support healthy fish in good numbers. For some Nations, specific species of fish, such as Yellowbelly (Golden perch), hold deep spiritual importance as a totem animal and is seen as a family member[18].

The HWMP can support cultural and spiritual values by protecting water quality through the water quality objectives (refer to section 10). The water quality objectives are designed to protect aquatic ecosystems of a certain condition (Highly Disturbed, Moderately Disturbed, Slightly Disturbed, and High Ecological Value). As other project outcomes come to light and are more clearly defined, for example the bioregional assessments (Constable & Love, 2015) and the Cultural Flows project (Section 9.4.1), it may be possible to develop water quality objectives that are specific to protecting cultural, spiritual and ceremonial values and uses.

Limitations

It is important to point out that while every effort has been made to speak to as many Traditional Owners as possible, the information obtained from the consultation process is not exhaustive, and there will be further values and uses and risks associated with these that have not been identified here. This provides a representation of the values and uses and associated risks identified by the Aboriginal Nations who engaged in the consultation process, consistent with those included in the Water Connections Report (DNRME, 2019). In addition, it is important to note the complexity of the holistic nature of Aboriginal perspectives of the landscape, for example, stories of Aboriginal people often focus on the creation of the whole landscape, not just individual rivers or elements of the landscape. Interconnected water sources are believed to have the same spiritual energy, forming part of the same ‘site’, in some cases in a similar way to groundwater connectivity, but also through waterways forming dreaming tracks and songlines (Australian Government, 2017). It is important to acknowledge that these values and uses remain the Intellectual Property of Traditional Owners, and this as well as the complexity of Aboriginal perspectives and culture is another reason it is imperative to involve Aboriginal people directly in water resource management, as they are the best people to speak for their land and water and it is their right.

9.2 Aboriginal people’s values and uses of water from consultation

As Aboriginal Nation boundaries are independent of water planning boundaries, the information contained in this section of the Queensland Border Rivers and Moonie River basins HWMP may have some overlap with information from Nations that are also represented in the Maranoa and Balonne HWMP, and/or the Condamine HWMP.

[17] In this chapter, the term *Indigenous* is used where quoting the Basin Plan and where used in other existing legislation or literature. *Aboriginal* or *Aboriginal peoples* will be used in this report in the context of Aboriginal people consulted with in the Murray-Darling basin, noting the great diversity of Aboriginal Nations and cultures.

[18] Not only because they are, but because knowing them and their distribution and behaviour in great detail give subtle information on changes in the landscape which can be very significant, even life-saving when living in the bush.

The Traditional Owners of the Queensland Border Rivers and Moonie River basins described the way in which water is valued and used across the plan area, as described in Figure 29.

Figure 29 Aboriginal values and uses of water, and interrelated aspects of culture.

Water is a foundational element that runs through almost all aspects of Aboriginal culture, as described in the figure above. Clean water is essential for survival, ensures the survival of plants and animals needed for traditional diet and medicine. Scarred and carved trees that are large and old are likely to have very deep roots that tap into groundwater. Middens, for example those that are comprised of mollusc shells, often are situated near waterways due to the source of the materials, and are therefore susceptible to erosion from nearby creeks or rivers.

9.3 Aboriginal objectives and outcomes from consultation

The objectives and outcomes in this section were informed by the consultation process conducted by Queensland Government with the Traditional Owners of the Condamine, Maranoa, Balonne, Moonie and Border Rivers basins, as described in section 4.5. The objectives and outcomes aim to protect Aboriginal cultural, spiritual and ceremonial values and uses of water.

Table 28 Aboriginal objectives and outcomes from consultation

Objectives of water resource management as identified by Nations	Desired outcomes of water resource management as identified by Nations
Bigger populations and better health of animals and plants Better balance in how water is shared between users and environment Better sharing of water between users and Aboriginal peoples More economic opportunities for the ownership, use and trade of water entitlements More natural flows and connectivity down the system Improved water quality Protected riparian zones, floodplains, waterways, springs, animals, plants, waterholes and cultural sites for future generations Improved access to waterways More involvement of Aboriginal peoples in decision making and management of waterways Improved and continuous consultation and participation in water planning process Improved capacity building and education of Aboriginal peoples and government Better integration of traditional knowledge and western science	A healthy system that supports populations of animals and plants Clean, connected and flowing rivers, creeks, lakes, floodplains, wetlands and springs Aboriginal peoples can use waterways for cultural, social, environmental, spiritual and economic purposes Stronger connection to Country Waterways are being accessed for swimming, fishing, storytelling, family gatherings, education A seat at the table for decisions on how water is managed and shared Aboriginal peoples have the capacity and are fully informed about water planning Traditional ecological knowledge is used as part of water planning process

9.4 Risks to Aboriginal people's values and uses identified through consultation

Following the documentation of how Traditional Owners of the Border Rivers and Moonie River basins value and use water resources, the risks that threaten the continued availability of these values and uses were discussed. The risks raised at the workshops and during discussions were often relayed in the form of stories about impacts to important social, spiritual and cultural aspects of land and water. Participants also drew comparisons between the current state of the system and how they remembered using and valuing the system when they were children or from stories passed on from earlier generations. The common risks raised during the workshops were risks that are linked to insufficient water available for the environment, water being of a quality unsuitable for use, and the poor health of water-dependent ecosystems.

Many of the risks raised by Aboriginal peoples and Traditional Owners are related to the use and management of water resources, as well as from land use and other non-water related activities. Although some of the risks to values and uses identified by local Aboriginal peoples cannot be addressed specifically by the HWMP, they are included in this HWMP in order to understand the full range of issues affecting water related values and uses in the basin. The full list of risks and the factors contributing to the risks are displayed in Table 29.

Table 29 Risks and causes of risks to Aboriginal values and uses as identified during consultation with individual Aboriginal Nations

Risk to Aboriginal peoples values and uses	Factors contributing to risk
Risk to all Aboriginal peoples values and uses (Climate change and associated extreme weather events)	Climate change: increasing rainfall variability and associated changes to river flows and to the frequency and extremity of droughts and floods and associated water quality.
	Changes to flood frequency/duration may impact vegetation, reducing river shading and organic matter inputs. Increased temperatures and reduced food and habitat will impact native fish and other aquatic species.
	Drought refugia may dry out faster, impacting aquatic ecosystems and water availability.
Risk to continued availability of water resources for Aboriginal people (Reduced and altered flow from increases in take from watercourse and changing climate and rainfall patterns)	Flood and overland flow harvesting, dam operations, stock and domestic take, pumping from refugial waterholes, extraction of groundwater.
	Land clearing around the ranges that affects the rainfall on floodplains to the west and reducing inflows.
Risk to use of water resources for cultural, spiritual and ceremonial activities of Aboriginal peoples (Lack of access to waterways)	Lack of access to waterways
Risk to sense of obligation to care for Country (Lack of a role or responsibilities in managing and decision-making around water resources)	Lack of representation on committees, lack of recognition, lack of employment opportunities in government and other decision making bodies, lack of capacity, and lack of influence over decision making on land and water management.
Risk to water being of a quality unsuitable for use by Aboriginal people (Turbidity, nutrients and pesticides and other contaminants)	Erosion from stock, clearing of riparian vegetation, siltation behind infrastructure, land management activities, feral pigs, vehicle use, mining and motorboats causing wave wash.
	Erosion from stock, clearing of riparian vegetation, nutrient inputs promoting algal blooms, land management activities, mining, blueberry farms, sewage leaks
	Mining and farming activities and practices
Risk to health and wellbeing of Aboriginal people (Declining aquatic ecosystems)	Removal or decline of one animal or plant species affects the whole system and other species. Impact of weeds and pest species, such as carp and azolla. Algal blooms. Water pumps installed without screens.

Risk to Aboriginal peoples values and uses	Factors contributing to risk
Risk to degradation of important cultural sites (destruction and degradation of important cultural sites, such as burial grounds and scar trees)	Mismanagement of land and waterways, Council activities, farming and mining practices and motorboats.

9.5 Opportunities to strengthen the protection of Aboriginal values and uses of water under the HWMP

The opportunities to strengthen the protection of Aboriginal peoples' values and uses of water are linked to Basin Plan section 10.52(3). These opportunities are identified to be consistent with the objectives and outcomes (Section 9.4) identified during consultation with the Aboriginal Nations.

Aboriginal Waterways Assessments

Aboriginal Waterways Assessments (AWAs) are an in-field assessment of stream health from the perspective of Traditional Owners, and are a key initiative to increase the participation of Traditional Owners in natural resource and waterway management. They provide a tool for Aboriginal communities to consistently measure and prioritise river and wetland health so that they are better placed to negotiate for their Country's water needs.

AWAs were adapted from a Māori-originated water assessment tool by the Northern Basin Aboriginal Nations, Murray Lower Darling Rivers Indigenous Nations and the Murray-Darling Basin Authority Aboriginal Partnerships team.

The Queensland Government, with contribution from the MDBA, is funding six AWAs in the Condamine, Border Rivers, Moonie, Balonne and Warrego River basins. The AWAs are being conducted throughout 2018/19 and are being jointly delivered by the Northern Basin Aboriginal Nations and the former-NRM bodies, QMDC and Condamine Alliance (which are currently transitioning to Southern Queensland NRM). Additionally, DES, DNRME and MDBA are providing in-kind support to assist the Queensland AWA projects.

AWAs also align with the principles for engaging Indigenous peoples in water planning and management as stated in Section 1.3 of the *Module to the National Water Initiative (NWI) Policy Guidelines for Water Planning and Management: Engaging Indigenous Peoples in Water Planning and Management* (Australian Government, 2017):

"Investing in capacity building exercises for Indigenous peoples to develop their skills in water planning and management practices, and reciprocal knowledge transfer from Indigenous peoples to water planners." In addition the AWAs can facilitate intended active and informed participation of Indigenous people as stated in Section 10.53 (1) (e) of Basin Plan.

Under the HWMP, the Queensland Government will continue to seek to identify opportunities for further AWAs in the QMDB. With the approval of the Aboriginal Nation that conducted an AWA, the HWMPS can be amended to include main findings of the AWAs.

Queensland Indigenous Land and Sea Rangers

The Queensland Indigenous Land and Sea Ranger program currently provides funding for over 100 Indigenous land and sea rangers across Queensland, most of whom are Traditional Owners of the land on which they work. The Queensland Government, through the Department of Environment and Science, funds local Indigenous host organisations to employ the land and sea rangers. Traditional Owners and local communities have ownership of the work programs for their rangers, including fire and feral animal management, fencing of wetlands, land restoration, and conservation of rock art sites. Many of these practices assist in improving water quality, as well as preventing wildfires, reducing carbon emissions and improving biodiversity.

There are currently no Queensland Indigenous Land and Sea ranger positions in the Border Rivers and Moonie basins of the Queensland Murray Darling basin. This represents a significant opportunity to support current efforts to deal with pest management and a range of other risks to Aboriginal values and uses, while providing additional employment to Traditional Owners to support them looking after their Country, as discussed in Sections 9 and 9.4.

Rangers are critical to future land and water management throughout the Murray-Darling Basin.

Identified Aboriginal ranger positions on Country, managed through native title bodies, Aboriginal corporations or through NBAN, was a pressing need highlighted by many participants during the consultation with Aboriginal Nations. This consultation indicated that the rangers must be trained by Traditional Elders. Rangers could fulfil

functions such as, but not limited to, the following:

- land and water care and management;
- pest management;
- fire management;
- locally appropriate revegetation;
- monitoring and reporting potential issues of non-compliance;
- monitoring of water quality and ecosystem health; and
- Cultural heritage protection.

Identified Aboriginal ranger positions could also take responsibility for identifying issues regarding cultural heritage and the care of managing and maintaining these locations.

Under the HWMP, the Queensland Government will continue to seek to identify opportunities to expand the Queensland Indigenous Land and Sea Ranger program to the Border Rivers and Moonie basins.

Looking after Country Grant Program

The Looking after Country Grant program is a Queensland-based initiative that was formerly known as the Queensland Indigenous Land and Sea Grant Program. If successful following an application process, Aboriginal and Torres Strait Islander groups are provided with grants of up to $75,000 for projects on-Country, aimed at conserving environmental and cultural resources and values.

The program encourages collaborative projects that may address (but are not limited to) the following:

- cultural heritage site management
- protected species monitoring and conservation
- habitat restoration
- feral animal and weed management
- fire management
- erosion control
- the development and implementation of country management plans.

The application process for the Looking after Country Grant program is outlined on the following website: https://www.qld.gov.au/environment/plants-animals/conservation/community/land-sea-rangers/grants-program.

The Looking after Country Grant program aligns with many of the responses received during the Aboriginal community consultation seeking opportunities for better involvement in natural resource management activities.

Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009

The Queensland Government schedules environmental values and water quality objectives under the Environmental Protection (Water) Policy 2009 (EPP Water) to inform statutory and non-statutory planning and decision-making. This framework seeks to protect and maintain water quality within Queensland's waterways and groundwater aquifers. The environmental values and water quality objectives are informed by community consultation. Through the process of engaging with Aboriginal Nations, the following was determined for consideration for inclusion under Schedule 1 of the EPP Water:

- Cultural, spiritual and ceremonial environmental values apply to all surface water and groundwater in the Queensland Murray–Darling Basin, and this has been included on the relevant mapping.
- Default water quality objectives apply for the protection of the cultural, spiritual and ceremonial environmental values. In future, water quality objectives that are specific to cultural flows or developed by an Aboriginal nation may be available to update relevant documents accordingly.
- Persistent waterholes in the Queensland Murray–Darling Basin have been mapped and assigned the highest level of protection (high ecological value) under the Environmental Protection (Water) Policy 2009.
- Maintaining healthy riparian vegetation zones which reduce run-off and erosion was identified as important through consultation. Water quality objectives to protect environmental values in the plan area include targets for wetland extent, ground cover in grazing lands and riparian vegetation.

Environmental values support Aboriginal values and uses of water, and these values and uses of water will continue to be reflected in healthy waters management plans moving forward.

Queensland Carbon Plus Fund

In December 2016, the Queensland Government announced an $8.4 million project that will support and expand

the carbon farming industry and create jobs for Traditional Owners. The project has two parts:

1. equip Queensland Aboriginal nations to participate in the carbon market and ensure the cultural, social and environmental co-benefits of Aboriginal carbon farming projects are recognised and appropriately valued. The Aboriginal Carbon Fund was engaged to undertake this component of the project
2. the purchase of carbon credits to offset the Queensland Government's fleet vehicle emissions from 2017–18 to 2018–19, with credits from Aboriginal carbon projects being prioritised.

Refer to this link for more information: https://www.qld.gov.au/environment/climate/climate-change/carbon-farming

Supporting Indigenous Participation

A Southern Queensland NRM project delivered under the Australian Government National Landcare Program (Phase 2) – Regional Land Partnerships Program 2018-23. This project will support engagement and involvement of Aboriginal Australians in the planning and implementation natural resource management initiatives. Aboriginal Australians have been the custodians of Southern Queensland for at least 40,000 years and have looked after the natural assets and landscapes of the region successfully for thousands of generations. Southern Queensland NRM will engender a strong culture of learning, respect and inclusion of Traditional Owner groups. Involvement will be underpinned by a Reconciliation Action Plan and an Indigenous Participation Plan.

Healthy Waters Management Plan: Management Responses

Section 8 of the Healthy Waters Management Plans identifies management responses to address risks and contribute to the achievement of objectives. These actions will help to address water quality and aquatic ecosystem concerns captured in the consultation with Aboriginal nations, such as reducing sediment and nutrients entering water through streambank stabilisation and improving the health of riparian zones.

Great Artesian Basin – Environmental values and water quality objectives

Participants at the Aboriginal Nations' consultation identified that the Great Artesian Basin is of great cultural and spiritual significance to Aboriginal people, and is important for maintaining the health of aquatic ecosystems. There were concerns expressed over mining and coal seam gas operations in terms of the potential threat to the Great Artesian Basin, including over-extraction, pollution/contamination, and reduced aquifer recharge.

The environmental values and water quality objectives for groundwater established for the Queensland Murray–Darling Basin region include the Great Artesian Basin aquifers. The cultural, spiritual and ceremonial environmental value applies to all groundwater, based on the results of consultation with Aboriginal Nations. Environmental values and water quality objectives will be recommended for inclusion under Schedule 1 of the Environmental Protection (Water) Policy 2009 and will subsequently inform mining and coal seam gas development.

9.6 Recommendations broader than the HWMP

A range of comments and submissions received through consultation related to important issues that were broader than the HWMP. The Water Connections Report (DNRME, 2019) has summarised these issues and provides a response to each. The Queensland Government recognises the importance of following up these issues with the relevant agencies.

SECTION 10: WATER QUALITY TARGET VALUES

10 Water quality target values

Water quality target values[19] are quantitative measures of water quality indicators that protect a stated environmental value (Refer to section 5 of this report). The targets can be concentrations, loads or a biological measure, e.g. macroinvertebrate diversity. Where there are multiple water quality target values for a particular indicator to protect different environmental values at a location, the most stringent water quality target value applies.

Section 10.32 of the Basin Plan specifies that a WQM Plan is to identify surface water quality target values for fresh water-dependent ecosystems, irrigation water and water used for recreational purposes. Section 10.35B specifies that a WQM Plan must also identify the groundwater quality target values for the plan area for these purposes. Default water quality target values are provided in the Basin Plan (Chapter 9 and Schedule 11) for these matters. Subsections 10.32 (3) and (4) enables the WQM Plan to specify alternative surface water quality target values if they are developed in accordance with stated requirements. Similarly, subsection 10.35B (3) enables the WQM Plan to specify alternative groundwater quality target values if they are consistent with stated water quality objectives.

Where available, alternative local water quality targets to those specified in Chapter 9 and Schedule 11 of the Basin Plan have been included in Section 10 of the HWMP for the Border Rivers and Moonie River basins for both surface water and groundwater. The application of the default Basin Plan water quality targets is considered inappropriate where local water quality target values have been developed. The default Basin Plan targets under Chapter 9 and Schedule 11 were developed for a broad spatial scale that does not reflect the variation in water types across the Border Rivers and Moonie River basins (Refer to the waters types in Figure 30 and described in Appendix 2—Description of water types in the Queensland Border Rivers and Moonie River basins). Where local water quality data was available, local water quality target values were developed for surface water types, under high and base flow conditions, and for groundwater aquifer zones. Further information on the development of alternative water quality target values is provided in Appendix 1—Refining water quality targets for fresh water-dependent ecosystems to reflect local conditions.

Refer to the following sections of the Healthy Waters Management Plan for the water quality target values for accreditation under section 10.32 of the Basin Plan for surface water. Note: There are no Ramsar Wetlands currently identified in the plan area.

<u>Fresh water-dependent ecosystems (other than Declared Ramsar wetlands)</u>

- **Section 10.2.1: Water quality targets for fresh water-dependent ecosystems (moderately disturbed aquatic ecosystems) Table 30 for the Border Rivers basin surface waters and Table 32 for the Moonie River basin surface waters.**

<u>Irrigation water</u>

- **As there are no irrigation infrastructure operators in the plan area (as defined under the Water Act 2007), irrigation water quality target values for accreditation do not apply. While not accredited under the Basin Plan, Section 10.3.1,**
- **Table 50 provision (1) for the Border Rivers and Moonie River basins is recognised to provide targets for irrigation water in the plan area for the purposes of Queensland water quality planning and management.**

<u>Water used for recreation</u>

- **Section 10.3.5: Water quality targets for the protection of the Primary, Secondary and Visual Recreation Environmental Values Table 64, provision (1) - Suitability for primary, secondary and visual recreation.**

Refer to the following sections of the Healthy Waters Management Plan for the water quality target values for accreditation under section 10.35B of the Basin Plan for groundwater:

<u>Fresh water-dependent ecosystems (other than Declared Ramsar wetlands)</u>

- **Section 10.2.6: Water quality targets to protect aquatic ecosystem environmental values for groundwater aquifer zones in the Queensland Border Rivers and Moonie River Basins specified in Table 35, Table 36, Table 37 and Table 43.**

<u>Irrigation water</u>

- **As there are no irrigation infrastructure operators in the plan area (as defined under the Water Act 2007), irrigation water quality target values for accreditation do not apply.**
- **While not accredited under the Basin Plan, Section 10.3.1,**

[19] 'Water quality target values' under the Basin Plan are equivalent to 'Water Quality Objectives' under the EPP Water.

- **Table 50 provision (1) for the Border Rivers and Moonie River basins is recognised to provide targets for irrigation water in the plan area for the purposes of Queensland water quality planning and management.**

Water used for recreation

- **Section 10.3.5: Water quality targets for the protection of the Primary, Secondary and Visual Recreation Environmental Values Table 64, provision (1) - Suitability for primary, secondary and visual recreation.**

10.1 Targets for managing water flows

Water quality in relation to the management of water flows in the Border Rivers and Moonie River basins is addressed through the Department of Natural Resources, Mines and Energy water planning framework. Refer to the Department of Natural Resources, Mines and Energy — Water Management website for further information.

10.2 Water quality targets for the protection of the Aquatic Ecosystem Environmental Value

The water quality targets in this section apply where the Aquatic Ecosystem Environmental Value has been identified in the Border Rivers and Moonie River basins (Refer to section 5 of this report).

10.2.1 Water quality targets for fresh water-dependent ecosystems (moderately disturbed aquatic ecosystems)

Section 10.32 (2)(a) of the Basin Plan requires a WQM Plan to identify water quality targets for fresh water-dependent ecosystems other than declared Ramsar wetlands. Section 10.35B (2)(a) specifies that a WQM Plan must also identify the groundwater quality target values for the plan area for these purposes.

Under the Healthy Waters Management Plan, water quality targets for the protection of the Aquatic Ecosystem Environmental Value were developed for each water type[20] in the Border Rivers and Moonie River basins, for low and high flow conditions, based on local data. A sub-set of these water quality targets are relevant to meeting the requirements of section 10.32 (2)(a) of the Basin Plan for fresh water-dependent ecosystems other than declared Ramsar wetlands. The water quality target values for accreditation under section 10.32 (2)(a) of the Basin Plan are the water quality target values in:

Fresh water-dependent ecosystems (other than Declared Ramsar wetlands)

- **Section 10.2.1: Water quality targets for fresh water-dependent ecosystems (moderately disturbed aquatic ecosystems) Table 30 for the Border Rivers basin surface waters and Table 32 for the Moonie River basin surface waters.**

While not accredited under the Basin Plan, the water quality target values for additional indicators in Table 31 and Table 33, which were developed under the Queensland legislative water quality framework (see Appendix 1— Refining water quality targets for fresh water-dependent ecosystems to reflect local conditions), are recognised to support the accredited water quality target values to protect and restore water-dependent ecosystems.

Water quality targets were also developed for aquifers in the plan area based on local groundwater data. The water quality target values for accreditation under section 10.35B (2)(a) of the Basin Plan for groundwater are:

Fresh water-dependent ecosystems (other than Declared Ramsar wetlands)

- **Section 10.2.6: Water quality targets to protect aquatic ecosystem environmental values for groundwater aquifer zones in the Queensland Border Rivers and Moonie River Basins specified in Table 35, Table 36, Table 37 and Table 43.**

While not accredited under the Basin Plan, the water quality target values in Table 38 to Table 42, which were developed under the Queensland legislative water quality framework (see Appendix 1—Refining water quality targets for fresh water-dependent ecosystems to reflect local conditions), are recognised to support the accredited water quality target values to protect and restore water-dependent ecosystems.

Note: The Border Rivers and Moonie River basins do not contain declared Ramsar wetlands.

Local water quality targets for fresh water-dependent ecosystems were developed for each water type identified in Figure 30. A description of water types in the Border Rivers and Moonie River basins is provided in Appendix 2— Description of water types in the Queensland Border Rivers and Moonie River basins. Where local data was unavailable, the regional water quality targets for fresh water-dependent ecosystems listed in Schedule 11 of the Basin Plan apply. The relevant target application zones for the Border Rivers and Moonie River basin are B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone) – Other water dependent ecosystems; A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone) – Other water dependent ecosystems; and C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone) – Other water dependent ecosystems[21] (also displayed on Figure 30).

[20] Water types for the Border Rivers and Moonie River basins are mapped in Figure 30 and are described in Appendix 3.

[21] Refer to the Murray-Darling Basin Authority website for spatial information on Water Quality Zones.

NOTE: The purpose of the targets provided in this section is to assist those involved in managing water resources to ensure that moderately disturbed aquatic ecosystems are adequately protected (Refer to Section 6: Levels of aquatic ecosystem protection). The local water quality targets presented below are applicable to low flow conditions and high flow conditions when sufficient data was available. Additional water quality monitoring and modelling is required to derive additional local water quality target values for other flow scenarios.

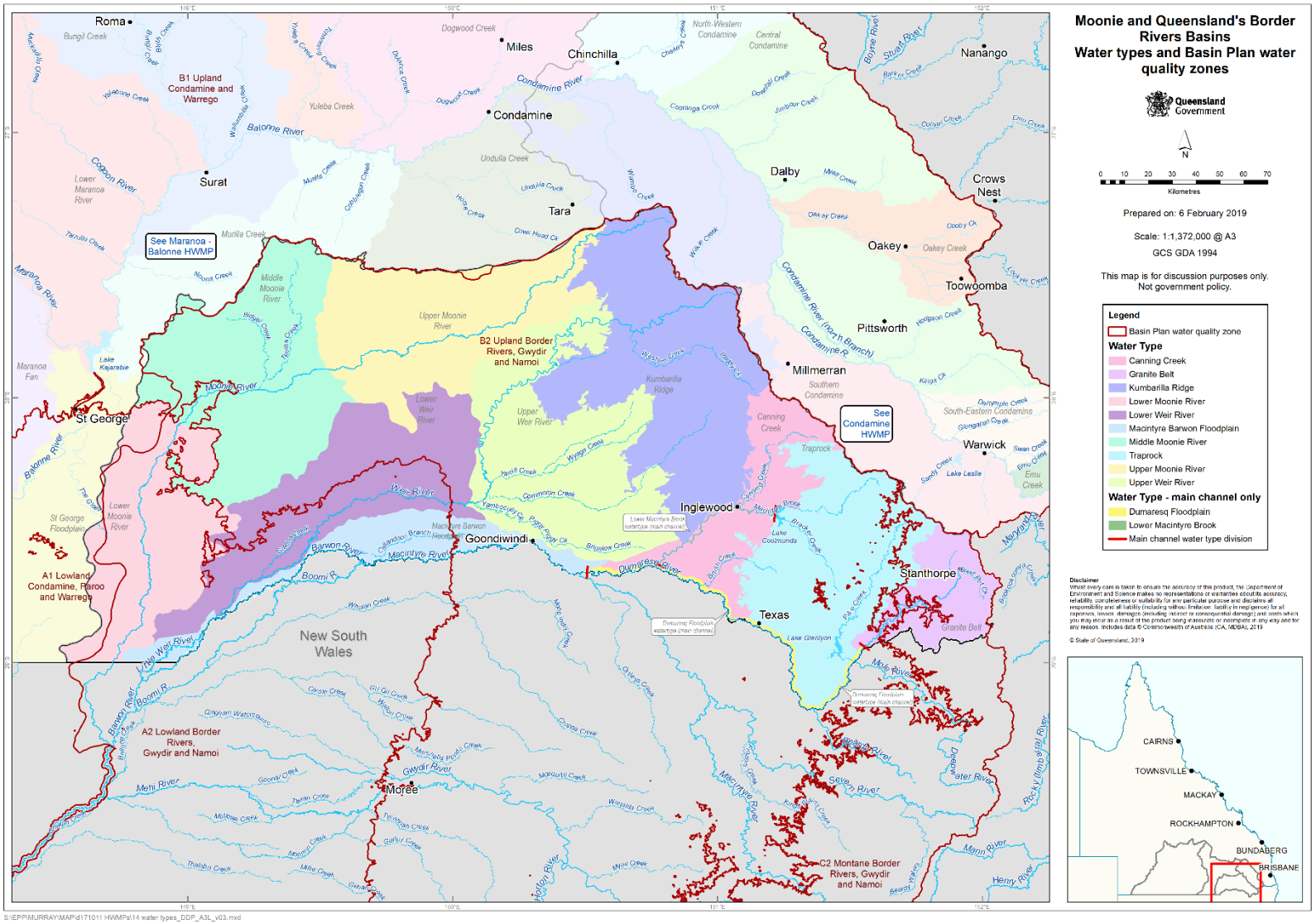


Figure 30: Water types developed for the Moonie and Queensland Border Rivers basins. Local surface water quality target values for fresh water-dependent ecosystems apply to these water types (Refer to Table 30 to Table 33). See Appendix 2 for a description of each water type.

Table 30: Water quality target values for Moderately Disturbed surface waters of the Border Rivers basin under low and high flow conditions[22]. Refer to Figure 30 for the map of water types.

Water type	Management intent/Level of protection	**Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values** **Notes**: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.								
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range) (mg/L)	**Dissolved Oxygen** (Annual median within the range) (% sat.)	**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
CANNING CREEK catchment waters	**Low Flow**									
	Moderately Disturbed	35 (s1)	30 (s1)	520 (s1)	ID	60-110 (s2)	7.2-7.8 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	50 (s1)	40 (s1)	600 (s1)	ID	60-110 (s2)	6.9-7.9 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
DUMARESQ	**Low Flow**									

[22] Water quality target values in Table 30 are accreditable water quality target values for fresh water-dependent ecosystems (other than declared Ramsar wetlands) under section 10.32 of the Basin Plan.

Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values

Notes:

1. Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated.

2. ID: Insufficient data to develop a target value.

3. Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.

Water type	Management intent/Level of protection	**Turbidity** (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range)		**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
					(mg/L)	(% sat.)				
FLOODPLAIN catchment waters	Moderately Disturbed	8 (s1)	40 (s1)	490 (s1)	ID	60-110 (s2)	7.4-8.1 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	35 (s1)	60 (s1)	800 (s1)	ID	60-110 (s2)	7.1-7.8 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
GRANITE	**Low Flow**									

Water type	Management intent/Level of protection	**Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values** **Notes**: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.								
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range) (mg/L)	**Dissolved Oxygen** (Annual median within the range) (% sat.)	**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
BELT catchment waters	Moderately Disturbed	5 (s1)	35 (s1)	650 (s1)	ID	60-100 (s2) 90-110 (s4)	6.6-7.5 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s4)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	12 (s1)	50 (s1)	1000 (s1)	ID	60-100 (s2) 90-110 (s4)	6.6-7.3 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s4)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
LOWER	**Low Flow**									

Water type	Management intent/Level of protection	**Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values** **Notes**: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.								
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range) (mg/L)	**Dissolved Oxygen** (Annual median within the range) (% sat.)	**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
MACINTYRE BROOK catchment waters	Moderately Disturbed	11 (s1)	55 (s1)	710 (s1)	ID	60-110 (s2)	7.4-8.0 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	25 (s1)	70 (s1)	910 (s1)	ID	60-110 (s2)	7.2-8.0 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
LOWER WEIR	**Low Flow**									

Water type	Management intent/Level of protection	**Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values** **Notes**: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.									
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range)		**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
					(mg/L)	(% sat.)				
RIVER catchment waters	Moderately Disturbed	400 (s1)	190 (s1)	1300 (s1)	ID (s2) >5 (s3)	60-110 (s2) 65-100 (s3)	6.9-7.6 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s3)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	285 (s1)	210 (s1)	1200 (s1)	ID (s2) >5 (s3)	60-110 (s2) 65-100 (s3)	6.8-7.3 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s3)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
MACINTYRE	**Low Flow**									

Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values

Notes:

1. Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated.

2. ID: Insufficient data to develop a target value.

3. Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.

Water type	Management intent/Level of protection	**Turbidity** (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range)		**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
					(mg/L)	(% sat.)				
BARWON FLOODPLAIN catchment waters	Moderately Disturbed	30 (s1)	70 (s1)	575 (s1)	ID (s2) >5 (s3)	60-110 (s2) 65-100 (s3)	7.4-8.0 (s1)	Barwon River 250	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	110 (s1)	150 (s1)	900 (s1)	ID (s2) >5 (s3)	60-110 (s2) 65-100 (s3)	7.0-7.5 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
TRAPROCK	**Low Flow**									

Water type	Management intent/Level of protection	**Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values** **Notes**: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.								
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range) (mg/L)	**Dissolved Oxygen** (Annual median within the range) (% sat.)	**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
catchment waters	Moderately Disturbed	4 (s1)	30 (s1)	520 (s1)	ID	60-100 (s2) 90-110 (s4)	7.1-8.0 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	9 (s1)	40 (s1)	600 (s1)	ID	60-100 (s2) 90-110 (s4)	6.9-7.7 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
UPPER WEIR	**Low Flow**									

Water type	Management intent/Level of protection	**Table 30: BORDER RIVERS BASIN SURFACE WATERS– accreditable water quality target values** **Notes**: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for C2 (Border Rivers, Gwydir and Naomi valleys; Montane zone)—Other water-dependent ecosystem.								
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range) (mg/L)	**Dissolved Oxygen** (Annual median within the range) (% sat.)	**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
RIVER catchment waters	Moderately Disturbed	200 (s1)	290 (s1)	1750 (s1)	ID	60-110 (s2)	7.0-7.7 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	350 (s1)	ID	ID	ID	60-110 (s2)	6.8-7.4 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.

Table 31: Additional water quality target values for Moderately Disturbed surface waters of the Border Rivers basin under low and high flow conditions[23]. Refer to Figure 30 for the map of water types.

Water type	Management intent/ level of protection	**Table 31: BORDER RIVERS BASIN SURFACE WATERS– additional water quality target values** **Notes:** **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data.							
		Electrical Conductivity (µS/cm)	**Total Suspended Solids (mg/L)**	**Alkalinity (mg/L as $CaCO_3$)**	**Oxidised Nitrogen (µg-N/L)**	**Ammonium N (µg-N/L)**	**Filterable Reactive Phosphorus (µg-P/L)**	**Sulphate as SO_4 (mg/L)**	**Chlorophyll-a (µg/L)**
CANNING CREEK catchment waters	Moderately Disturbed	**Low Flow**							
		200 (s1)	25 (s1)	80 (s1)	6 (s1)	10 (s1)	8 (s1)	2 (s1)	ID
		High Flow							
		165 (s1)	60 (s1)	ID	ID	ID	ID	3 (s1)	ID
DUMARESQ FLOODPLAIN catchment waters	Moderately Disturbed	**Low Flow**							
		220 (s1)	7 (s1)	55 (s1)	10 (s1)	ID	ID	10 (s1)	ID

[23]While not accreditable under the Basin Plan, water quality target values in Table 30 are recognised to support the accreditable water quality target values in Table 29 to protect and restore fresh water-dependent ecosystems.

Table 31: BORDER RIVERS BASIN SURFACE WATERS– additional water quality target values

Notes:

1. Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated.

2. ID: Insufficient data to develop a target value.

3. Sources: s1: Local Data.

Water type	Management intent/ level of protection	Electrical Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Oxidised Nitrogen (µg-N/L)	Ammonium N (µg-N/L)	Filterable Reactive Phosphorus (µg-P/L)	Sulphate as SO_4 (mg/L)	Chlorophyll-a (µg/L)
		High Flow							
		140 (s1)	25 (s1)	60 (s1)	ID	ID	ID	11 (s1)	ID
GRANITE BELT catchment waters	Moderately Disturbed	**Low Flow**							
		185 (s1)	5 (s1)	45 (s1)	4 (s1)	9 (s1)	4 (s1)	5 (s1)	ID
		High Flow							
		150 (s1)	12 (s1)	40 (s1)	45 (s1)	30 (s1)	10 (s1)	6 (s1)	ID
LOWER MACINTYRE BROOK catchment waters	Moderately Disturbed	**Low Flow**							
		370 (s1)	10 (s1)	90 (s1)	18 (s1)	8 (s1)	11 (s1)	10 (s1)	ID
		High Flow							

Water type	Management intent/ level of protection	**Table 31: BORDER RIVERS BASIN SURFACE WATERS– additional water quality target values** **Notes:** **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data.							
		Electrical Conductivity (µS/cm)	**Total Suspended Solids (mg/L)**	**Alkalinity (mg/L as $CaCO_3$)**	**Oxidised Nitrogen (µg-N/L)**	**Ammonium N (µg-N/L)**	**Filterable Reactive Phosphorus (µg-P/L)**	**Sulphate as SO_4 (mg/L)**	**Chlorophyll-a (µg/L)**
		250 (s1)	25 (s1)	95 (s1)	ID	ID	ID	10 (s1)	ID
LOWER WEIR RIVER catchment waters	Moderately Disturbed	**Low Flow**							
		165 (s1)	75 (s1)	80 (s1)	70 (s1)	10 (s1)	25 (s1)	3 (s1)	ID
		High Flow							
		120 (s1)	150 (s1)	80 (s1)	ID	ID	ID	2 (s1)	ID
MACINTYRE BARWON FLOODPLAIN catchment waters	Moderately Disturbed	**Low Flow**							
		240 (s1)	25 (s1)	55 (s1)	10 (s1)	20 (s1)	20 (s1)	7 (s1)	3 (s1)
		High Flow							
		180 (s1)	70 (s1)	55 (s1)	195 (s1)	ID	ID	6 (s1)	ID

Water type	Management intent/ level of protection	**Table 31: BORDER RIVERS BASIN SURFACE WATERS– additional water quality target values** **Notes:** **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data.							
		Electrical Conductivity (µS/cm)	**Total Suspended Solids (mg/L)**	**Alkalinity (mg/L as $CaCO_3$)**	**Oxidised Nitrogen (µg-N/L)**	**Ammonium N (µg-N/L)**	**Filterable Reactive Phosphorus (µg-P/L)**	**Sulphate as SO_4 (mg/L)**	**Chlorophyll-a (µg/L)**
TRAPROCK catchment waters	Moderately Disturbed	**Low Flow**							
		290 (s1)	5 (s1)	40 (s1)	6 (s1)	10 (s1)	8 (s1)	25 (s1)	ID
		High Flow							
		215 (s1)	10 (s1)	55 (s1)	ID	ID	ID	18 (s1)	ID
UPPER WEIR RIVER catchment waters	Moderately Disturbed	**Low Flow**							
		200 (s1)	100 (s1)	50 (s1)	65 (s1)	19 (s1)	30 (s1)	3 (s1)	ID
		High Flow							
		100 (s1)	ID	ID	ID	ID	ID	ID	ID

Table 32: Water quality target values for Moderately Disturbed surface waters of the Moonie River basin under low and high flow conditions[24]. Refer to Figure 30 for the map of water types.

Water type	Management intent/Level of protection	**Table 32: MOONIE RIVER BASIN SURFACE WATERS– accreditable water quality target values** Notes: **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for A1 (Condamine, Paroo and Warrego valley; Lowland zone)—Other water-dependent ecosystems; s5: Basin Plan Schedule 11 target value for B1 (Condamine and Warrego valleys; Upland zone)—Other water-dependent ecosystems								
		Turbidity (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range) (mg/L)	**Dissolved Oxygen** (Annual median within the range) (% sat.)	**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
LOWER MOONIE catchment waters	**Low Flow**									
	Moderately Disturbed	400 (s1)	430 (s1)	1700 (s1)	ID (s2) >5.0 (s3, s4)	60-110 (s2, s4) 65-100 (s3)	7.1-7.7 (s1)	140	Between the 20th and 80th percentiles of natural monthly water temperature. (s3)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	320 (s1)	320 (s1)	1660 (s1)	ID (s2) >5.0 (s3, s4)	60-110 (s2, s4) 65-100 (s3)	6.8-7.5 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s3)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.

[24] Water quality target values in Table 31 are accreditable water quality target values for fresh water-dependent ecosystems (other than declared Ramsar wetlands) under section 10.32 of the Basin Plan.

Table 32: MOONIE RIVER BASIN SURFACE WATERS– accreditable water quality target values

Notes:

1. Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated.

2. ID: Insufficient data to develop a target value.

3. Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for A1 (Condamine, Paroo and Warrego valley; Lowland zone)—Other water-dependent ecosystems; s5: Basin Plan Schedule 11 target value for B1 (Condamine and Warrego valleys; Upland zone)—Other water-dependent ecosystems

Water type	Management intent/Level of protection	**Turbidity** (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range)		**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
					(mg/L)	(% sat.)				
MIDDLE MOONIE catchment waters	**Low Flow**									
	Moderately Disturbed	380 (s1)	470 (s1)	1910 (s1)	ID (s2, s5) >5.0 (s3)	60-110 (s2, s5) 65-100 (s3)	7.1-7.6 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately Disturbed	ID	ID	ID	ID (s2, s5) >5.0 (s3)	60-110 (s2, s5) 65-100 (s3)	ID	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
UPPER MOONIE catchment waters	**Low Flow**									
	Moderately Disturbed	205 (s1)	375 (s1)	1740 (s1)	ID	60-110 (s2)	7.0-7.6 (s1)	Not applicable	Between the 20th and 80th percentiles of natural monthly water temperature. (s2)	ANZECC default trigger values that apply to slightly-moderately disturbed systems must not be exceeded.
	High Flow									
	Moderately	275	ID	ID	ID	60-110	6.0-7.2	Not	Between the 20th and	ANZECC default trigger

Table 32: MOONIE RIVER BASIN SURFACE WATERS– accreditable water quality target values

Notes:

1. Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated.

2. ID: Insufficient data to develop a target value.

3. Sources: s1: Local Data; s2: Basin Plan Schedule 11 target value for B2 (Border Rivers, Gwydir and Naomi valleys; Upland zone)—Other water-dependent ecosystems; s3: Basin Plan Schedule 11 target value for A2 (Border Rivers, Gwydir and Naomi valleys; Lowland zone)—Other water-dependent ecosystems; s4: Basin Plan Schedule 11 target value for A1 (Condamine, Paroo and Warrego valley; Lowland zone)—Other water-dependent ecosystems; s5: Basin Plan Schedule 11 target value for B1 (Condamine and Warrego valleys; Upland zone)—Other water-dependent ecosystems

Water type	Management intent/Level of protection	**Turbidity** (NTU) (Annual median)	**Total Phosphorus** (µg/L) (Annual median)	**Total Nitrogen** (µg/L) (Annual median)	**Dissolved Oxygen** (Annual median within the range)		**pH** (Annual median within the range)	**Salinity** (End-of-valley targets) (Median)	**Temperature** (Monthly median within the range)	**Pesticides, heavy metals and other toxic contaminants**
					(mg/L)	(% sat.)				
	Disturbed	(s1)				(s2)	(s1)	applicable	80th percentiles of natural monthly water temperature. (s2)	values that apply to slightly-moderately disturbed systems must not be exceeded.

Table 33: Additional water quality target values for Moderately Disturbed surface waters of the Moonie River basin under low and high flow conditions[25]. Refer to Figure 30 for the map of water types.

Water type	Management intent/ level of protection	**Table 33: MOONIE RIVER BASIN SURFACE WATERS– additional water quality target values** **Notes:** **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data.							
		Electrical Conductivity (µS/cm)	**Total Suspended Solids (mg/L)**	**Alkalinity (mg/L as $CaCO_3$)**	**Oxidised Nitrogen (µg-N/L)**	**Ammonium N (µg-N/L)**	**Filterable Reactive Phosphorus (µg-P/L)**	**Sulphate as SO_4 (mg/L)**	**Chlorophyll-a (µg/L)**
LOWER MOONIE catchment waters	Moderately Disturbed	**Low Flow**							
		145 (s1)	200 (s1)	55 (s1)	25 (s1)	25 (s1)	25 (s1)	3 (s1)	ID
		High Flow							
		95 (s1)	460 (s1)	35 (s1)	420 (s1)	ID	35 (s1)	3 (s1)	ID
MIDDLE MOONIE catchment waters	Moderately Disturbed	**Low Flow**							
		150 (s1)	120 (s1)	55 (s1)	25 (s1)	25 (s1)	25 (s1)	4 (s1)	ID

[25] While not accreditable under the Basin Plan, water quality target values in Table 32 are recognised to support the accreditable water quality target values in Table 31 to protect and restore fresh water-dependent ecosystems.

Water type	Management intent/ level of protection	**Table 33: MOONIE RIVER BASIN SURFACE WATERS– additional water quality target values** **Notes:** **1.** Water quality targets for indicators are shown as single values to be achieved by annual median of test data, unless otherwise indicated. **2.** ID: Insufficient data to develop a target value. **3.** Sources: s1: Local Data.							
		Electrical Conductivity (µS/cm)	**Total Suspended Solids (mg/L)**	**Alkalinity (mg/L as $CaCO_3$)**	**Oxidised Nitrogen (µg-N/L)**	**Ammonium N (µg-N/L)**	**Filterable Reactive Phosphorus (µg-P/L)**	**Sulphate as SO_4 (mg/L)**	**Chlorophyll-a (µg/L)**
		High Flow							
		ID	ID	ID	ID	ID	ID	ID	ID
UPPER MOONIE RIVER catchment waters	Moderately Disturbed	**Low Flow**							
		160 (s1)	85 (s1)	50 (s1)	25 (s1)	25 (s1)	25 (s1)	2 (s1)	ID
		High Flow							
		130 (s1)	ID	ID	ID	ID	ID	ID	ID

10.2.2 Water quality targets for declared Ramsar wetlands

As a Ramsar Convention signatory, Australia is expected to describe and maintain the ecological character of each of its current 65 Ramsar sites. An ecological character description (ECD) is a rigorously prepared assessment of the ecosystem components, processes and benefits/services of a site. The trigger levels contained in the ECD provide the benchmark against which ecological changes at the site are assessed for significance.

Section 10.32 (2)(a) of the Basin Plan requires a WQM Plan to identify water quality targets for fresh water-dependent ecosystems that are declared Ramsar wetlands.

The Border Rivers and Moonie River basins do not currently contain any declared Ramsar wetlands. If, following publication of this document, sites within the Border Rivers and Moonie River basin are declared as Ramsar wetlands, locally relevant water quality target values for low and high flow conditions should be developed for these sites to ensure no deterioration of the water quality range occurs over time.

10.2.3 Water quality targets for lakes other than declared Ramsar wetlands

Lakes in dryland regions are diverse in their natural water conditions and biology. Local investigations of the natural range of water quality in all stages of inundation and drying are necessary to develop local water quality target values.

To protect the aquatic ecosystem values of lakes, they should be protected against threats of secondary salinity, sedimentation and disrupted hydrologic regime. Thus, there should be no change from historic hydrologic regime (i.e. no change in flow frequency, intensity required to inundate the lake), and loads of salt and sediments from upstream catchments should be managed in accordance with the management intent for the waters (Refer to section 6.4) and consistent with the Basin Salinity Management Strategy 2030.

As additional data becomes available, it is recommended that water quality targets are developed for lakes throughout the Border Rivers and Moonie River basins.

10.2.4 Water quality targets for Slightly Disturbed waters

The water quality target values for pesticides, heavy metals and other toxic contaminants for Slightly Disturbed waters in the Border Rivers and Moonie River basins are that the values in ANZECC Guidelines (as updated), for the protection of 99% of species must not be exceeded.

The water quality target values for Slightly Disturbed waters in the Border Rivers and Moonie River basins for all other indicators are as follows:

1. if the measures for indicators achieve the water quality target values for High Ecological Value waters in the Border Rivers and Moonie River basins, maintain the water quality to this standard

2. if the measures for indicators do not achieve the water quality target values for High Ecological Value waters in the Border Rivers and Moonie River basins, progressively improve the water quality at the site towards achieving the High Ecological Value water quality target values for each indicator.

Refer to section 6.4 for a description of the management intent under the EPP Water for Slightly Disturbed waters in the Border Rivers and Moonie River basins.

The Slightly Disturbed waters are mapped at Figure 26.

10.2.5 Water quality targets for High Ecological Value waters

The water quality targets for pesticides, heavy metals and other toxic contaminants for High Ecological Value waters is that the values in ANZECC Guidelines (as updated), for the protection of 99% of species must not be exceeded.

The water quality target for High Ecological Value waters in the Border Rivers and Moonie River basin for all other indicators is to maintain the existing water quality distribution (i.e. maintain the 20th, 50th and 80th percentile values for each indicator). Refer to the Queensland Water Quality Guidelines 2009 (section 4) for appropriate procedures to derive sub-regional water quality guidelines.

Refer to section 6.4 for a description of the management intent under the EPP Water for High Ecological Value waters in the Border Rivers and Moonie River basins.

The High Ecological Value waters are mapped at Figure 26.

10.2.5.1 Persistent waterholes

Persistent waterholes, as mapped at Figure 26 and listed at Appendix 4— Persistent Waterholes in the Border Rivers and Moonie River basins, are important for their outstanding natural values in dryland river systems. In dryland regions, many rivers stop flowing for extended periods of time and become disconnected waterholes and wetlands. The waterholes are critical refugia for aquatic organisms, such as fish, turtles and invertebrates. Persistent waterholes also support birds, plants, other reptiles and amphibians.

Due to the variable nature of rainfall in the Queensland Murray-Darling Basin, the refugial waterholes along the river systems in the region represent the only permanent aquatic habitat during extended periods of low or no flow and are critical components of a functioning 'source and sink' system for aquatic organisms in semi-arid landscapes.

Waterholes experience variable patterns of connection and disconnection. This is a fundamental driver of ecological processes in dryland riverine environments, vital for dispersal and survival of diverse populations of biota. Waterholes require careful management, both individually and as an integrated system of waterholes along the length of rivers and channels.

Waterhole persistence is associated with active channel-forming processes (to provide deep waterhole habitat for biota) and bankfull discharge[26]. In-channel flows, or flow pulses, are important for connecting waterholes and improving water quality (Sheldon, 2010). As a result, the water quality of waterholes in the Queensland Murray-Darling Basin basins will be largely influenced by the strategies for water resource development implemented through water planning instruments. It is recommended water resource development maintains the hydrological variability of waterholes and prevents extreme levels of water abstraction (Sheldon, 2010).

As the persistent waterholes mapped in Figure 26 are classified as High Ecological Value waters, refer to section 10.2.5 for the water quality target values that apply. Additionally:

1. riparian vegetation surrounding persistent waterholes should be maintained or, as necessary over time, restored;
2. disturbance to beds and banks of waterholes should be minimised where possible to reduce sedimentation through offstream watering of stock.

[26] Bankfull discharge is the point at which water overflows onto a floodplain.

10.2.6 Water quality targets to protect groundwater aquatic ecosystem environmental values

Section 10.35B (2)(a) specifies that a WQM Plan must identify water quality target values for groundwater fresh-water dependent ecosystems in the plan area.

The water quality parameters shown in Schedule 11 of Basin Plan are not applicable to groundwater as the majority of the parameters listed are not appropriate in gauging groundwater quality. Further, the target application zones shown in Schedule 11 do not allow for the complexities of groundwater aquifer systems and accompanying water quality variability to be represented. Thus, alternative water quality target values for accreditation under section 10.35B (3) of the Basin Plan have been developed for groundwater of the Border Rivers and Moonie River basins.

Fresh water-dependent ecosystems (other than Declared Ramsar wetlands)

- **Section 10.2.6: Water quality targets to protect aquatic ecosystem environmental values for groundwater aquifer zones in the Queensland Border Rivers and Moonie River Basins specified in Table 35, Table 36, Table 37 and Table 43.**

The groundwater aquifer zones are displayed in Figure 17 to Figure 25.

While not accredited under the Basin Plan, the water quality target values in Table 38 to Table 42, which were developed under the Queensland legislative water quality framework (see Appendix 1—Refining water quality targets for fresh water-dependent ecosystems to reflect local conditions), are recognised to support the accredited water quality target values to protect and restore water-dependent ecosystems.

This section lists the water quality targets for various groundwater types to protect the aquatic ecosystem environmental values stated for the groundwaters of the Border Rivers and Moonie River basins (Refer to Section 5).

Water quality targets for groundwaters of QMDB have been determined following the identification of aquifer types, which are based on the clustering of zones of similar water chemistry (McNeil, Raymond, Bennett, & McGregor, 2017). Sub-aquifer chemistry zones were further defined within each aquifer to allow development of water quality targets that are representative of local groundwater conditions. Following the derivation of sub-aquifer chemistry zones, the groundwater quality data was used to calculate a range of percentiles for several water quality parameters including, major ions, pH and electrical conductivity. The percentiles are used to form the water quality targets which are based on over 7700 sub-artesian and 4200 artesian water quality samples collected from 6600 bores within QMDB since the mid-1960s. For a full description of the methods used to develop the groundwater water quality targets for QMDB, refer to Regional groundwater chemistry zones: Queensland Murray-Darling Basin, 2017.

The water quality targets for the groundwaters of Border Rivers and Moonie River basins are displayed in

Table 35 to Table 43. It is important to note that the spatial extent of groundwater aquifer zones are not restricted to the spatial extent of surface water basins. Where groundwaters interact with surface waters, groundwater quality should not compromise identified environmental values and water quality targets for those waters. The ANZECC Guidelines (as updated) recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Thus, the management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles). ANZECC Guidelines (as updated) trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded. The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

10.2.6.1 Groundwater aquifer zones in the Border Rivers and Moonie River basins

The groundwater aquifer zones in the Border Rivers and Moonie River basins are shown in Figure 17 to Figure 25. The table below shows the sub-aquifer groundwater chemistry zones arranged under nine aquifer types (McNeil, Raymond, Bennett, & McGregor, 2017):

Aquifer Zone	Sub-aquifer chemistry zone
s1. Alluvial Zones	Border Rivers Upper Dumaresq Macintyre Brook Lower Balonne Moonie
s2. Fractured Rock	Border Rivers Headwaters Glenlyon New England Granite
s3. Sediments above the GAB	Tertiary sediments Weathered alluvium
s4. Upper GAB	Winton Mackunda Eastern
s5. Main GAB aquitard	Eastern Wallumbilla Outcrop Central Surat Mid Cretaceous
s6. Mid GAB aquifers	Southeast Kumbarilla Eastern Cretaceous Outcrop Northern Surat Thickest Bungil and Mooga Lower Balonne Gubberamunda
s7. Lower GAB	Eastern Springbok Outcrop Saline Southeastern Hutton Outcrop Central Surat Springbok Area
s8. Basal GAB	Southeastern Evergreen Eastern Central Area
s9. Earlier sedimentary basins underlying the GAB	Bowen Basin

The Groundwater Chemistry Zones that intersect the Groundwater Sustainable Diversion Limit resource units identified under the Basin Plan are identified in Table 34.

Table 34: The groundwater aquifer zones in the Border Rivers and Moonie River basin that intersect the Groundwater Sustainable Diversion Limit resource units under the Basin Plan (refer to Figure 9).

	Groundwater Aquifer zones								
Groundwater SDL resource unit	**s1—Alluvial zones**	**s2—Fractured Rock zones**	**s3—Sediments Overlying the GAB zones**	**s4—Upper GAB zones**	**s5—Main GAB Aquitard zones**	**s6—Mid GAB Aquifer zones**	**s7—Lower GAB zones**	**s8—Basal GAB zones**	**s9— Earlier sedimentary basins underlying the GAB**
Queensland Border Rivers Alluvium (GS54)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Queensland Border Rivers Fractured Rock (GS55)		✓	✓				✓	✓	
Queensland Murray-Darling Basin: deep (GS56)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sediments above the GAB: Border Rivers (GS57)	✓		✓		✓	✓	✓	✓	✓
Sediments above the GAB: Moonie (GS59)	✓		✓	✓	✓	✓	✓	✓	✓
St George Alluvium: Moonie (GS62)[27]	✓		✓	✓	✓	✓	✓	✓	✓

[27] Note: The Basin Plan recognises the St George Alluvium groundwater aquifers in the plan area as a single SDL resource unit termed the St George Alluvium Moonie (GS62). However, under Queensland water planning, this resource unit is managed as the St George Alluvium (shallow) and the St George Alluvium (Deep).

Table 35: Water quality targets to protect the aquatic ecosystem environmental value for Alluvial groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 17).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S1.Alluvial																												
11 - Border Rivers	20th	150	57	13	4	10	6	110	2	117	36	15.1	3	0.27	0	531	78	6.5	104.4	31.0	0.16	0.000	0.005	0.005	0.013	4.95	0.085	0.000
	50th	329	75	34	11	23	14	253	28	381	64	64.5	7	1.90	0	1800	169	7.3	214.0	60.0	0.30	0.010	0.040	0.020	0.015	17.00	0.543	0.049
	80th	4589	89	710	19	569	22	489	57	8723	90	1100.0	10	12.50	0	23910	4399	8.0	413.8	81.0	0.90	0.056	9.740	0.160	0.070	35.70	2.717	1.235
11 - Border Rivers near stream	20th	71	46	13	5	9	6	126	9	69	30	16.2	5	0.00	0	331	70	7.0	123.8	35.9	0.18	0.000	0.009	0.020	0.005	2.83	0.060	ID
	50th	235	65	24	13	17	18	257	34	180	42	53.5	8	1.30	0	820	125	7.5	220.0	55.0	0.25	0.008	0.105	0.070	0.015	9.20	0.913	ID
	80th	1893	89	430	28	334	27	514	64	3871	81	808.1	14	12.50	1	14150	2423	8.0	422.9	71.7	0.69	0.041	5.240	0.160	0.073	21.52	2.717	ID
13 - Upper Dumaresq	20th	58	49	18	18	9	15	140	38	42	22	4.9	2	0.00	0	504	83	7.1	115.0	20.3	0.30	0.000	0.000	0.000	0.012	2.29	0.000	0.000
	50th	112	59	33	23	16	18	248	63	86	33	15.5	4	0.50	0	843	153	7.7	207.0	34.0	0.50	0.010	0.020	0.010	0.015	3.91	0.109	0.000
	80th	147	66	58	29	27	22	412	73	152	53	34.0	8	2.26	1	1104	250	8.1	343.4	46.7	0.60	0.050	0.130	0.020	0.080	4.50	0.491	0.000
13 - Upper Dumaresq near stream	20th	58	49	18	18	9	15	140	38	41	22	4.9	2	0.00	0	498	83	7.1	115.0	20.1	0.30	0.000	0.000	0.000	0.012	2.29	0.000	0.000
	50th	112	59	32	23	16	18	249	63	86	33	15.5	4	0.50	0	833	151	7.7	207.0	34.0	0.50	0.010	0.020	0.010	0.015	3.91	0.109	0.000
	80th	147	66	58	29	27	22	416	73	151	52	32.5	7	2.17	1	1103	250	8.1	349.2	46.0	0.60	0.050	0.130	0.020	0.080	4.47	0.472	0.000
14 - Macintyre Brook	20th	44	47	3	2	1	2	145	32	46	27	1.1	1	0.03	0	410	16	7.5	132.3	10.3	0.20	0.005	0.005	ID	ID	1.80	ID	ID
	50th	124	91	19	14	11	20	295	54	115	34	7.9	3	0.80	0	1178	76	7.9	243.3	39.5	0.41	0.005	0.005	ID	ID	8.92	ID	ID
	80th	412	97	32	26	28	27	610	68	270	56	30.2	6	6.40	1	1700	203	8.6	558.8	43.7	0.89	0.121	0.834	ID	ID	31.59	ID	ID
14 - Macintyre Brook near stream	20th	44	47	4	3	1	3	162	32	45	29	1.3	1	0.07	0	412	17	7.4	132.9	10.9	0.20	0.005	0.005	ID	ID	1.80	ID	ID
	50th	113	91	20	18	14	20	295	53	102	34	6.5	3	0.53	0	1178	111	7.8	243.3	39.5	0.41	0.005	0.013	ID	ID	8.92	ID	ID
	80th	333	94	35	26	39	27	610	67	270	53	30.8	6	6.40	1	1700	266	8.5	503.0	44.6	0.87	0.154	0.838	ID	ID	28.88	ID	ID
17 - Moonie	20th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	26460	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
	50th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	46150	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
	80th	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	56280	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID

Table 36: Water quality targets to protect the aquatic ecosystem environmental value for Fractured Rock groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 18)

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
s2. Fractured Rock																												
6 - Border Rivers Headwaters	20th	75	42	17	9	13	16	164	19	92	42	9.1	2	0.00	0	648	104	7.0	138.8	20.1	0.20	0.000	0.000	0.007	0.003	2.60	0.000	ID
	50th	189	57	67	20	45	22	351	37	305	56	36.0	6	1.00	0	1550	366	7.7	294.5	30.0	0.33	0.010	0.020	0.039	0.015	4.40	0.109	ID
	80th	437	70	127	27	115	30	602	51	1033	72	145.2	11	9.10	1	4212	772	8.2	497.1	39.9	0.59	0.093	0.086	0.097	0.019	7.84	0.652	ID
7 - Glenlyon	20th	26	32	11	22	6	20	65	30	15	16	4.2	3	0.45	0	230	50	7.0	50.5	33.6	0.20	0.005	0.000	0.005	0.000	1.27	0.000	ID
	50th	117	43	113	35	57	25	345	46	109	25	220.0	32	2.40	0	2014	498	7.4	119.5	37	0.23	0.041	0.01	0.01	0.015	2.39	0.272	ID
	80th	191	60	159	37	69	29	568	67	174	43	330.5	50	9.35	6	2125	723	8.0	445.5	42.2	0.52	0.130	0.085	0.058	0.015	2.86	0.950	ID
8 - New England Granite	20th	32	44	6	10	3	9	20	5	30	34	3.2	1	0.21	0	273	45	6.6	16.0	33.9	0.20	0.003	0.010	0.030	0.010	1.80	0.034	ID
	50th	65	64	23	18	9	14	74	37	78	51	12.0	4	1.00	0	600	106	7.1	60.5	52.0	1.36	0.010	0.110	0.925	0.015	3.10	0.217	ID
	80th	173	78	48	39	25	21	175	53	321	85	25.4	11	13.30	4	1225	244	7.7	146.0	65.7	3.00	0.125	0.663	2.583	0.043	6.12	4.489	ID

Table 37: Water quality targets to protect the aquatic ecosystem environmental value for Sediments overlying the GAB groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 19).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S3. Sediments overlying GAB																												
1 - Weathered Alluvium	20th	168	67	13	5	8	7	73	1	144	47	36.3	6	0.00	0	624	71	7.0	78.6	45.0	0.13	0.000	0.000	0.008	0.000	8.10	0.000	0.000
	50th	666	76	82	10	73	13	197	10	982	77	281.7	12	2.40	0	2690	569	7.6	199.7	57.0	0.40	0.000	0.010	0.050	0.015	19.45	0.011	0.000
	80th	4418	87	592	15	550	19	384	40	8590	86	1600.0	16	12.50	0	22710	3706	7.9	333.3	80.0	0.80	0.120	0.184	0.190	0.035	30.10	2.717	0.000
1 - Weathered Alluvium near stream	20th	104	63	7	4	4	2	156	5	75	33	15.1	5	0.00	0	525	27	7.2	134.6	18.3	0.15	0.000	0.000	0.017	0.000	4.65	0.130	ID
	50th	289	74	24	10	10	13	256	49	180	40	76.0	11	2.40	0	1269	102	7.7	210.0	70.0	0.30	0.000	0.010	0.040	0.015	11.50	1.930	ID
	80th	1368	92	170	22	149	20	388	58	2398	83	504.5	15	7.20	1	6400	1000	8.3	321.0	86.0	0.52	0.044	0.043	0.210	0.017	28.32	0.000	ID
3 - Tertiary Sediments	20th	395	81	3	1	0	0	0	4	195	34	0.0	0	ID	ID	0	9	ID	136.1	ID	ID	ID	ID	ID	ID	ID	ID	ID
	50th	432	97	15	2	4	2	212	26	520	74	1.8	0	ID	ID	1575	58	ID	207.5	ID	ID	ID	ID	ID	ID	ID	ID	ID
	80th	3058	99	50	8	6	11	682	63	4712	96	34.9	5	ID	ID	2180	203	ID	609.0	ID	ID	ID	ID	ID	ID	ID	ID	ID

Table 38: Water quality targets to protect the aquatic ecosystem environmental value for Upper GAB groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 20).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S4. Upper GAB																												
3 - Winton Mackunda Eastern	20th	276	74	21	5	13	5	0	4	168	41	20.5	3	0.00	0	0	99	7.4	124.9	16.1	0.15	0.000	0.000	ID	ID	11.59	0.000	0.000
	50th	1025	83	59	8	40	10	240	15	1260	75	138.0	9	0.50	0	1976	291	7.9	282.5	38.0	0.30	0.000	0.000	ID	ID	22.45	0.109	0.000
	80th	1584	89	142	11	97	14	534	50	2483	86	410.5	12	7.21	0	7920	715	8.2	518.6	53.0	0.65	0.017	0.100	ID	ID	31.55	1.567	0.000

Table 39: Water quality targets to protect the aquatic ecosystem environmental value for Main GAB Aquitard groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 21).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S5. Main GAB aquitard																												
1 - Eastern Wallumbilla Outcrop	20th	440	73	3	1	1	0	53	2	158	23	0.0	0	0.00	0	877	9	7.1	144.9	13.0	0.19	0.000	0.000	0.006	0.000	26.72	0.000	ID
	50th	660	96	14	2	6	2	506	31	650	59	9.0	1	0.00	0	2399	53	8.1	567.0	17.0	0.98	0.020	0.040	0.020	0.015	41.59	0.000	ID
	80th	3365	99	493	12	344	15	859	75	6238	89	766.2	7	2.25	0	10000	2580	8.5	763.1	50.4	1.73	0.434	1.800	0.107	0.156	62.61	0.489	ID
3 - Central Surat Mid Cretaceous	20th	454	66	29	6	14	6	90	1	351	47	44.2	5	0.00	0	3151	146	6.8	100.2	35.5	0.08	0.000	0.000	0.005	0.001	15.85	0.000	0.000
	50th	2010	76	256	10	169	13	253	4	3282	84	464.8	10	1.25	0	24000	1322	7.5	221.5	56.0	0.21	0.005	0.020	0.030	0.015	26.05	0.272	0.000
	80th	6065	88	1108	14	1007	20	453	41	12646	90	1879.0	13	12.50	0	50690	6833	8.0	372.9	78.5	0.44	0.030	1.753	0.129	0.050	36.54	2.717	0.000

Table 40: Water quality targets to protect the aquatic ecosystem environmental value for Mid GAB groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 22).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S6. Mid GAB Aquifers																												
3 - Eastern Cretaceous Outcrop	20th	162	82	4	1	1	0	105	6	85	32	0.5	0	0.05	0	771	14	7.3	100.0	13.7	0.10	0.000	0.000	0.005	0.010	12.49	0.021	0.000
	50th	395	93	10	3	4	2	293	30	337	64	8.0	1	0.50	0	1650	47	8.0	263.0	17.0	0.39	0.070	0.010	0.010	0.015	28.30	0.109	0.000
	80th	1167	98	74	9	22	7	644	66	1780	89	95.1	6	1.89	0	3870	267	8.5	571.0	33.3	0.65	0.809	0.182	0.110	0.015	49.27	0.285	0.065
5 - Lower Balonne Gubberamunda	20th	255	98	2	0	0	0	415	57	88	19	0.0	0	0.00	0	1063	5	8.0	351.8	21.0	0.44	0.000	0.000	0.000	0.014	35.76	0.000	0.000
	50th	341	99	2	1	0	0	561	71	130	28	5.0	1	0.25	0	1360	8	8.4	496.0	26.0	0.80	0.010	0.010	0.005	0.015	51.80	0.054	0.000
	80th	510	99	4	1	1	1	863	80	260	37	28.8	4	1.00	0	2016	15	8.6	761.1	29.0	1.50	0.213	0.010	0.010	0.020	72.97	0.217	0.000
8 - Northern Surat Thickest Bungil and Mooga	20th	355	98	1	0	0	0	520	56	120	17	0.0	0	0.00	0	1400	5	8.1	495.5	14.0	0.47	0.000	0.000	0.000	0.000	42.74	0.000	0.000
	50th	444	99	2	1	1	0	763	74	154	25	1.0	0	0.50	0	1720	11	8.4	680.0	17.0	1.25	0.050	0.005	0.005	0.015	65.35	0.109	0.000
	80th	521	99	4	1	1	1	989	82	252	42	24.3	3	0.50	0	2026	16	8.7	874.5	20.0	2.23	0.190	0.010	0.010	0.021	83.91	0.109	0.049
11 – South-east Kumbarilla	20th	315	98	2	0	0	0	459	60	72	13	0.0	0	0.00	0	1173	6	8.0	506.0	13.0	0.55	0.005	0.000	0.000	0.000	38.10	0.000	0.000
	50th	417	99	3	1	1	0	720	80	120	19	2.0	0	0.50	0	1600	10	8.4	660.0	15.0	1.50	0.020	0.010	0.005	0.015	56.30	0.109	0.000
	80th	530	99	4	1	2	1	969	86	260	39	9.1	1	1.30	0	2050	19	8.6	864.6	19.0	3.20	0.130	0.010	0.017	0.015	71.65	0.283	0.033

Table 41: Water quality targets to protect the aquatic ecosystem environmental value for Lower GAB groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 23).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S7. Lower GAB																												
1 - Central Surat Springbok Area (Continues as Fitzroy River basin Zone 1)	20th	235	96	2	1	0	0	346	48	80	19	0.5	0	0.00	0	1042	6	7.9	316.7	14.0	0.40	0.000	0.000	0.000	0.003	27.76	0.000	0.000
	50th	319	99	3	1	1	0	540	71	125	26	10.0	2	0.50	0	1300	12	8.3	472.5	18.0	0.70	0.010	0.005	0.005	0.015	45.00	0.109	0.000
	80th	546	99	10	2	4	2	749	79	307	50	33.6	5	1.20	0	2100	40	8.6	661.0	28.1	1.80	0.165	0.015	0.010	0.020	64.00	0.261	0.000
2 - Eastern Springbok Outcrop	20th	243	79	5	1	2	1	198	7	183	41	0.7	0	0.00	0	963	19	7.5	194.3	13.0	0.19	0.005	0.000	0.005	0.001	14.75	0.000	0.000
	50th	677	91	20	3	11	4	345	26	737	70	8.0	1	0.70	0	2925	96	8.0	308.5	18.0	0.30	0.050	0.010	0.010	0.015	28.97	0.152	0.000
	80th	1830	98	89	10	83	12	838	58	2970	90	47.6	3	2.50	0	9021	612	8.4	795.2	52.1	1.75	0.891	0.097	0.049	0.030	56.49	0.543	0.016
8 - Saline South-eastern Hutton Outcrop	20th	212	66	19	3	10	3	201	6	262	54	2.7	0	0.00	0	1308	100	7.4	168.3	13.0	0.20	0.000	0.000	0.010	0.000	6.50	0.000	0.000
	50th	564	79	54	9	33	12	379	24	760	73	27.0	2	0.50	0	2865	260	7.9	320.0	19.0	0.40	0.010	0.015	0.030	0.010	15.30	0.109	0.000
	80th	1475	92	138	18	123	19	629	41	2482	89	151.2	6	4.30	0	7068	706	8.2	520.9	39.0	0.90	0.235	0.108	0.170	0.024	28.67	1.413	0.023

Table 42: Water quality targets to protect the aquatic ecosystem environmental value for Basal GAB groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 24).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S8. Basal GAB																												
2 - Eastern Central Area (Merged with Fitzroy River basin zone '5 Eastern Central Area')	20th	87	92	2	1	0	0	150	57	36	17	0.0	0	0.00	0	185	6	7.5	162.2	14.0	0.15	0.000	0.000	ID	ID	8.48	0.000	0.000
	50th	255	97	3	2	1	1	420	72	99	26	5.0	2	0.25	0	1040	11	8.2	347.0	19.0	0.53	0.008	0.010	ID	ID	27.56	0.054	0.000
	80th	342	99	8	5	5	4	674	82	165	37	29.6	5	1.00	0	1463	33	8.6	569.6	26.0	2.20	0.180	0.030	ID	ID	48.45	0.217	0.016
4 - Southeastern Evergreen	20th	157	60	10	3	5	3	200	14	161	36	1.3	0	0.00	0	920	42	7.4	172.2	14.0	0.20	0.000	0.000	0.005	0.000	5.62	0.000	ID
	50th	380	76	40	11	29	13	452	34	480	62	21.0	3	0.50	0	2300	230	7.9	380.0	26.0	0.30	0.010	0.020	0.020	0.008	10.29	0.109	ID
	80th	724	94	123	17	89	23	605	62	964	82	70.2	5	3.00	0	3634	675	8.2	532.5	42.0	0.95	0.072	0.187	0.100	0.020	25.88	0.652	ID

Table 43: Water quality targets to protect the aquatic ecosystem environmental value for Earlier sedimentary basins underlying the GAB groundwater aquifer zones in the Border Rivers and Moonie River basins (refer to Figure 25).

The ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **recommend that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value.**

The management intent is to maintain the existing water quality distribution (20th, 50th and 80th percentiles).

ANZECC Guidelines (ANZECC/ARMCANZ, 2000) **trigger values for freshwater for pesticides, heavy metals and other toxic contaminants that protect 99% of species must not be exceeded.**

The target for temperature specified in Schedule 11 of the Basin Plan applies to all aquifer zones. The specified target is: monthly median temperature within the range between the 20%ile and 80%ile of natural monthly water temperature.

ID: Insufficient data

Zone	%ile	Na		Ca		Mg		HCO_3		Cl		SO_4		NO_3		EC	Hard	pH	Alk	SiO_2	F	Fe	Mn	Zn	Cu	SAR	TN	TP
		mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L
S9. Earlier Basins Partially Underlying the GAB																												
1 - Bowen Basin	20th	51	96	2	0	0	0	113	56	14	9	0.0	0	0.00	0	218	5	7.4	105.0	13.0	0.20	0.000	0.000	0.005	0.001	89.57	0.000	0.000
(Merged with Fitzroy River basin zone '8 Lower Bowen')	50th	440	99	2	1	1	0	685	78	109	19	0.0	0	0.00	0	1700	7	8.3	611.0	17.0	1.65	0.040	0.005	0.005	0.001	50.82	0.000	0.000
	80th	853	99	5	3	1	1	1217	90	316	42	2.9	1	0.50	0	3001	19	8.6	1080.9	22.0	5.46	0.150	0.010	0.010	0.015	109.14	0.109	0.000

Notes

1. Abbreviations: Na: Sodium, Ca: Calcium, Mg: Magnesium, HCO_3: Bicarbonate, Cl: Chloride, SO_4: Sulfate, NO_3: Nitrate, EC: Electrical conductivity, Hard: hardness, Alk: alkalinity, SiO_2: Silica, F: Fluoride, Fe: Iron, Mn: Manganese, Zn: Zinc, Cu: Copper, SAR: Sodium adsorption ratio, TN: total nitrogen, TP: total phosphorus, mg/L: milligrams per Litre, µS/cm: microsiemens/centimetre

2. Percentiles are provided in most cells where samples are available for a particular indicator. The Queensland Water Quality Guidelines (section 4) contains information on recommended minimum sample size when deriving percentiles for use in deriving water quality guidelines. For this table, where less than 8 samples were available, cell shows insufficient data ('id'); where 8–20 samples were available, 50_{th} percentile values are provided (in bold). Where greater than 20 samples were available, the full percentile ranges are provided. The intent is to maintain current water quality (20_{th}, 50_{th} and 80_{th} percentile ranges) where water quality is in natural condition. Where there is evidence of anthropogenic disturbance in groundwater quality, a long term goal to improve water quality may be established and reflected by adoption of an alternative (e.g. 40_{th} percentile) value.

3. Na, Ca and other ion % columns: The percentages of major cations (Na, Ca and Mg) were evaluated for each sample, as were the major anions (Cl, HCO3, SO4 and NO3). Then the ion % columns were compiled by calculating the percentiles of these percentages independently of each other. For instance, in Alluvium zone 11 - Border Rivers, the 50th percentile of Na is 75, while the 20th–80th percentile range is 58–90. This means that half of the samples contain at least 75% of dissolved Na, with the balance being made up of Ca and Mg in any proportions. Because of this, the sum of the 50th percentiles in Alluvium zone 11 - Border Rivers is near to 100%, with Ca contributing 11% and Mg contributing 14%. However, the 20th and 80th percentiles of each of the major cations are based on ranges of that cation, and add up to less or more than 100% respectively.

4. Low TP values (e.g. recordings of zero) may be due to concentrations below detection limits. Concentrations of TP are usually low in Queensland groundwaters, because most of the phosphorus binds to particles in the soil and unsaturated zone, restricting its movement to the aquifer (Holman et al. 2008).

5. Refer to accompanying figures (maps) for locations of chemistry zone. In some locations (mainly within the alluvial aquifer class) a chemistry zone is identified by entire zone and the 'near stream' (within 1.5km of stream channel) component of the zone, where near stream water quality characteristics may be different from overall zone. Percentiles are provided in each case. Overall zone includes near stream and other areas. Near stream zone is shown on large scale plans accompanying this report, available on the department's website.

10.2.7 Target for wetland extent

As identified in Section 2.2 of this report, the extent and distribution of freshwater wetlands is the most important indicator of the state of wetland resources in Queensland, as any loss will mean that the services provided by that wetland will be diminished.

Target 1: No reduction in the extent of natural wetlands (palustrine, lacustrine and riverine) from 2013 baseline levels.

The indicators are:

- Wetland area by system (2013): Whole of plan area
- Wetland area by system (2013): Water resource plan basins

Refer to Table 6 and Table 7 of this report for a description of these indicators.

10.2.8 Riparian targets and catchment ground cover

The following recommendations are aimed at NRM bodies, with specific focus on aquatic ecosystem health.

10.2.8.1 Riparian health

Riparian zones are recognised as an important component of riverine ecosystems. Healthy riparian zones contain varying proportions of both forest and ground cover vegetation. This vegetation helps to stabilize banks and reduce erosion, provides a filtering mechanism for catchment run-off, provides habitat for various aquatic related species and provides shading, which reduces temperature extremes in waterbodies. Maintaining healthy riparian zones is therefore important to overall ecosystem health. Due to these factors, riparian targets have been included in the HWMP for the Border Rivers and Moonie River basins.

Details of ground cover mapping in the Queensland Murray Darling Basin can be found in the Riparian vegetation levels in the Queensland Murray-Darling Basin and Bulloo catchments for 2013 (Clark, Healy, & Tindall, 2015) and the Queensland Murray-Darling Basin Ground Cover 2015 reports (van den Berg, Trevithick, & Tindall, 2015). Mapping of riparian areas is done using satellite imagery with a pixel resolution of 30 m. For the purposes of these reports, the riparian area is defined as the area within 100 metres either side of a (mapped) stream or riverine wetland, and two forms of riparian area are considered—forested and non-forested. These are defined as follows:

Forested: Areas where tree crown cover is >~20%

Non-forested: Areas where tree crown cover is <~20%

In wetter coastal areas, riparian areas would naturally be 100% forested. However, in the drier western catchments considered in this document, extensive reaches of the riparian zones may be naturally non-forested.

See Riparian Vegetation Levels in the Queensland Murray-Darling Basin and Bulloo Catchment for 2013 (Clark, Healy, & Tindall, 2015) for further information.

Indicators for forested riparian areas

Indicator 1—Total forested riparian area: This is the total forested riparian area measured in each catchment in 2013. The target is that there should be no further net loss of the existing (2013) forested area.

Indicator 2—Normalised Patch Density (NPD): Establishes the number of riparian forest patches per kilometre of stream network and provides a measure of the linear connectivity of riparian forest along the stream network. This measure is normalised to account for the different proportion of each catchment's riparian area that is forested. A low NPD score is assigned to catchments with a highly connected riparian forest. Conversely, a high NPD score indicates there is lower connectivity between riparian forest patches in a catchment. The target is to have no increase from existing (2013) NPD scores.

Indicator 3—Patch Size and Connectivity Index (PSCI): The PSCI analyses the size of riparian forest patches and the distance between them. As vegetation extent is increased, the PSCI value will also increase. This indicates that riparian forest patches have become larger and more connected at the landscape scale. Alternatively, as patches either become smaller or the distance between them increases, the PSCI value will decrease. This indicates a loss of connectivity at the landscape scale. A value of 100 indicates fully connected riparian forests while a value of 0 indicates no connectivity. The target is to have no decline in existing (2013) PSCI scores.

Indicators for non-forested riparian areas

In the non-forested areas, satellite imagery is able to assess the density of ground cover vegetation (grasses, small shrubs, general plant litter). The standardised method is to assess three categories of ground cover density:

- >70% ground cover
- 30 to 70% ground cover
- <30% ground cover

Non-forested riparian areas are classified in good condition if ground cover is >70%.

Indicator 4—Riparian area with ground cover >70%: This is the total non-forested riparian area with >70% cover as measured in each catchment in 2013. The objective is that there should be no further net loss of the existing area with >70% cover. It is recognised that riparian ground cover varies significantly with rainfall and so the objective will need to be assessed over a range of seasons.

Riparian targets

Due to the natural occurrence of non-forested riparian areas in these catchments, and also the variation in proportions of natural forested/non-forested riparian areas between catchments, the targets are tailored to each catchment. The overall aim is to maintain existing riparian quality as measured by the indicators described above.

Riparian targets, and corresponding indicators, are specified in Table 44 to Table 46.

Table 44: Total forested riparian area target and supporting indicator

Target 1: No reduction in forested riparian areas from 2013 baseline levels.	
	Indicator 1—Total forested riparian area (ha) in 2013.
Border Rivers • Macintyre and Weir Rivers • Macintyre Brook • Dumaresq River	**217,912** 98,029 58,503 61,381
Moonie	40,172

Note: Targets are based on the Queensland drainage sub-basins layer on the SIR spatial database, which differs slightly to the water resource plan boundaries for the plan area.

Source: Riparian vegetation levels in the Queensland Murray-Darling Basin and Bulloo catchment for 2013 (Clark, Healy, & Tindall, 2015)

Table 45: Riparian connectivity target and supporting indicators

Target 2: No reduction in riparian forest connectivity from 2013 baseline levels.		
	Indicator 2—No increase in the Normalised Patch Density (NPD) value for each major catchment.	Indicator 3—No reduction in the Patch Size and Connectivity Index (PSCI) value for each major catchment.
Border Rivers • Macintyre and Weir Rivers • Macintyre Brook • Dumaresq River	 14.8 27.2 26.4	 62.7 57.9 69.1
Moonie	15.7	69.1

Note: Targets are based on the Queensland drainage sub-basins layer on the SIR spatial database, which differs slightly to the water resource plan boundaries for the plan area.

Source: Riparian vegetation levels in the Queensland Murray-Darling Basin and Bulloo catchment for 2013 (Clark, Healy, & Tindall, 2015)

Table 46: Riparian ground cover target and supporting indicator

Target 3: In non-forested areas, maintain riparian ground cover in each catchment at a level that minimises soil erosion by water.	
	Indicator 4—No reduction from 2013 baseline levels in the area of non-forested riparian ground cover that has more than 70% coverage (ha) in each major catchment.
Border Rivers • Macintyre and Weir Rivers • Macintyre Brook • Dumaresq River	 19,862 32,815 28,570
Moonie	10,794

Note: Targets are based on the Queensland drainage sub-basins layer on the SIR spatial database, which differs slightly to the water resource plan boundaries for the plan area.

Source: Riparian vegetation levels in the Queensland Murray-Darling Basin and Bulloo catchment for 2013 (Clark, Healy, & Tindall, 2015)

10.2.8.2 Ground cover in grazing lands

The Queensland Murray-Darling Basin Ground Cover Report—2015 (van den Berg, Trevithick, & Tindall, 2015) established a baseline for ground cover in grazing lands by calculating a 28-year long-term mean and seasonal changes in ground cover during 2015. The study was limited to reporting areas, defined by a grazing land-use with foliage projection cover of less than 60% (which is the method limit for 'fractional ground cover'). Within the reporting area for each of the 11 defined catchments, the mean (average) level of ground cover in each season was calculated for 2015, and compared to the corresponding 28-year mean. The report also calculated the area with less than 70% ground cover, as independent studies have indicated that a ground cover level of at least 70% is required to minimise erosion by water (van den Berg, Trevithick, & Tindall, 2015).

Ground cover is defined as the vegetation (living and dead), biological crusts and stone that are in contact with the soil surface. Ground cover levels are the result of complex interactions between landscape function (soil type, topography and vegetation dynamics), climate and land management. Some areas maintain naturally higher levels of ground cover due to factors such as high soil fertility and consistently high annual rainfall. The impacts of grazing land management practices on ground cover levels in these areas may be minimal due to the resilience of the land to respond to pressures. In areas where rainfall is less reliable and soils are less fertile, ground cover levels can vary greatly and the influence of grazing land management practices on ground cover levels and the species composition of the ground cover can be more pronounced.

Target 1: Maintain 90% of catchment with a ground cover level of >70% in the late dry season.

Queensland Murray-Darling Basin (QMDB) catchments where a strong east to west rainfall gradient exists, the impacts of drought can be prolonged and rainfall can be highly variable in space and time. Some parts of the QMDB (e.g. Paroo and Bulloo catchments) also have soils of lower fertility and low mean annual rainfall. Ground levels in these areas are naturally lower than eastern QMDB catchments and will therefore rarely attain levels of 90% of the catchment with ground cover above 70 percent.

The Queensland Murray-Darling Basin Ground Cover Report—2015 (van den Berg, Trevithick, & Tindall, 2015) set the ground cover results in the context of climatic conditions. Rainfall was below average in 2015 for all catchments within the QMDB, with large parts of western Queensland drought declared during mid-late 2013 and 2014. Generally drier conditions across the QMDB area led to reductions in ground cover levels. The effects of high rainfall in 2010 and 2011 were observed for all catchments, with significant increases in ground cover levels and subsequent reduction in the area with ground cover below 70 percent.

Macintyre-Weir

Mean rainfall for 2015 in the Macintyre-Weir catchment was 500 millimetres, 71 mm below the long term mean of 571 mm. The preceding year was also below the mean with 423 mm.

The ground cover in the Macintyre-Weir catchment significantly fluctuated in 2015 across the seasons. This is often apparent in degraded areas, which green up rapidly in wet periods, but do not retain cover over time. The proportion of grazing land greater than 70 percent was 93 percent in winter, but only 51 percent during spring, the driest season. Similarly, the highest mean ground cover was highest during winter (84 percent) and lowest in spring (69 percent). These levels were similar to the 28-year mean cover, except for spring which was a little lower (6 percent). Despite the Macintyre-Weir having high levels of ground cover in winter, the rapid drop in cover during the dry season resulted in the catchment failing to meet the target by a considerable degree.

Macintyre

Mean rainfall for 2015 in the Macintyre catchment was 579 millimetres, 65 mm below the long term mean of 644 mm. The preceding year was also below the mean with 490 mm.

The proportion of grazing lands greater than 70 percent was relatively high across all seasons, with the lowest level occurring in spring, at 82 percent. The Macintyre catchment also had high mean ground cover across all seasons for 2015. This catchment also has high long-term mean ground cover for all seasons. The 2015 ground cover was lowest for the spring season at 78 percent and highest during autumn at 90 percent. Despite the generally high levels of cover, the Macintyre did not quite meet the ground cover target.

Dumaresq

Mean rainfall for 2015 was 627 millimetres, 83 mm below the long term mean of 710 mm. The preceding year was also below the mean with 551 mm.

The Dumaresq catchment receives the most rainfall in the QMDB. The proportion of grazing lands greater than 70 percent was greater than 90 percent across all seasons. The Dumaresq catchment had high mean ground cover across all seasons for 2015. This catchment also has high long-term mean ground cover for all seasons. The 2015 ground cover was lowest for the spring season at 82 percent and highest during autumn at 93 percent. These are very high levels of ground cover and the Dumaresq met the target.

Table 47 and Mean rainfall for 2015 in the Moonie catchment was 403 millimetres, 140 mm below the long term mean of 543 mm. The preceding year was also well below the long term mean with 422 mm.

The ground cover in the Moonie catchment significantly fluctuated in 2015 across the seasons. This is often apparent in degraded areas, which green up rapidly in wet periods but do not retain cover over time. The proportion of grazing lands above 70 percent cover was lowest during spring, at 55 percent. This was notably less than the long term average of 66 percent. Mean ground cover for 2015 in the Moonie catchment was lowest (70 percent), for both summer and spring, and highest in winter, at 81 percent. These levels were slightly lower than the 28-year mean ground cover for each season. Despite the Moonie having high levels of ground cover in winter, the rapid drop in cover during the dry season resulted in the catchment failing to meet the target by a considerable degree.

Table 48 characterise the level of ground cover in the grazing lands of each drainage basin in 2015. The values in each table can be used as a baseline to track increases or decreases in groundcover through time, while working towards the target of 90% of the catchment area with greater than 70% ground cover in the late dry season. Maintaining and/or improving ground cover levels in grazing lands from 2015, with consideration to soil type, topography, vegetation dynamics, climate and land management, would have multiple benefits to the Border Rivers and Moonie River basins. Ground cover is a key component of many soil processes including infiltration, runoff and surface erosion. It is particularly important to try to maintain ground cover during dry periods or periods of unreliable rainfall to minimise loss of water, soil, and nutrients when rainfall eventually occurs. This will also maximise the pasture response to rainfall. Implementation of appropriate and sustainable land management practices, particularly careful management of grazing pressure, can help to maintain or improve ground cover and improve the stability and resilience of the grazing system.

See Queensland Murray-Darling Basin Ground Cover Report—2015 (van den Berg, Trevithick, & Tindall, 2015) for further information.

Border Rivers

Macintyre-Weir

Mean rainfall for 2015 in the Macintyre-Weir catchment was 500 millimetres, 71 mm below the long term mean of 571 mm. The preceding year was also below the mean with 423 mm.

The ground cover in the Macintyre-Weir catchment significantly fluctuated in 2015 across the seasons. This is often apparent in degraded areas, which green up rapidly in wet periods, but do not retain cover over time. The proportion of grazing land greater than 70 percent was 93 percent in winter, but only 51 percent during spring, the driest season. Similarly, the highest mean ground cover was highest during winter (84 percent) and lowest in spring (69 percent). These levels were similar to the 28-year mean cover, except for spring which was a little lower (6 percent). Despite the Macintyre-Weir having high levels of ground cover in winter, the rapid drop in cover during the dry season resulted in the catchment failing to meet the target by a considerable degree.

Macintyre

Mean rainfall for 2015 in the Macintyre catchment was 579 millimetres, 65 mm below the long term mean of 644 mm. The preceding year was also below the mean with 490 mm.

The proportion of grazing lands greater than 70 percent was relatively high across all seasons, with the lowest level occurring in spring, at 82 percent. The Macintyre catchment also had high mean ground cover across all seasons for 2015. This catchment also has high long-term mean ground cover for all seasons. The 2015 ground cover was lowest for the spring season at 78 percent and highest during autumn at 90 percent. Despite the generally high levels of cover, the Macintyre did not quite meet the ground cover target.

Dumaresq

Mean rainfall for 2015 was 627 millimetres, 83 mm below the long term mean of 710 mm. The preceding year was also below the mean with 551 mm.

The Dumaresq catchment receives the most rainfall in the QMDB. The proportion of grazing lands greater than 70 percent was greater than 90 percent across all seasons. The Dumaresq catchment had high mean ground cover across all seasons for 2015. This catchment also has high long-term mean ground cover for all seasons. The 2015 ground cover was lowest for the spring season at 82 percent and highest during autumn at 93 percent. These are very high levels of ground cover and the Dumaresq met the target.

Table 47: A summary of ground cover in the Border Rivers basin per season

	Area of reporting region with greater than 70% ground cover averaged over previous 28 years (%)	Area of reporting region with greater than 70% ground cover in 2015 (%)	28-year mean ground cover (%)	2015 mean ground cover (%)
Macintyre-Weir				
Summer	70	62	76	73
Autumn	82	80	81	80
Winter	88	93	83	84
Spring	68	51	75	69
Macintyre				
Summer	88	86	83	81
Autumn	94	96	87	90
Winter	94	97	87	89
Spring	86	82	81	78
Dumaresq				
Summer	95	94	87	86
Autumn	98	99	91	93
Winter	97	99	90	91
Spring	93	92	85	82

Note: This assessment is based on the Queensland drainage sub-basins layer on the SIR spatial database, which differs slightly to the water resource plan boundaries for the plan area.

Source: Queensland Murray-Darling Basin Ground Cover Report—2015 (van den Berg, Trevithick, & Tindall, 2015)

Moonie

Mean rainfall for 2015 in the Moonie catchment was 403 millimetres, 140 mm below the long term mean of 543 mm. The preceding year was also well below the long term mean with 422 mm.

The ground cover in the Moonie catchment significantly fluctuated in 2015 across the seasons. This is often apparent in degraded areas, which green up rapidly in wet periods but do not retain cover over time. The proportion of grazing lands above 70 percent cover was lowest during spring, at 55 percent. This was notably less than the

long term average of 66 percent. Mean ground cover for 2015 in the Moonie catchment was lowest (70 percent), for both summer and spring, and highest in winter, at 81 percent. These levels were slightly lower than the 28-year mean ground cover for each season. Despite the Moonie having high levels of ground cover in winter, the rapid drop in cover during the dry season resulted in the catchment failing to meet the target by a considerable degree.

Table 48: A summary of ground cover in the Moonie River basin per season

	Area of reporting region with greater than 70% ground cover averaged over previous 28 years (%)	Area of reporting region with greater than 70% ground cover in 2015 (%)	28-year mean ground cover (%)	Ground cover in 2015 (%)
Summer	69	57	75	70
Autumn	82	79	81	79
Winter	86	90	82	81
Spring	66	55	74	70

Note: This assessment is based on the Queensland drainage sub-basins layer on the SIR spatial database, which differs slightly to the water resource plan boundaries for the plan area.

Source: Queensland Murray-Darling Basin Ground Cover Report—2015 (van den Berg, Trevithick, & Tindall, 2015)

10.2.9 Targets for freshwater macroinvertebrates

Freshwater macroinvertebrates are organisms without a backbone that are able to be seen with the naked eye and are found in freshwater environments (Negus, Steward, & Blessing, 2013). Freshwater macroinvertebrates are diverse, common and widespread throughout many aquatic ecosystems, and are easily sampled. Different taxa groups react differentially to varied stressors in the environment. These varied responses allow for a range of indices, such as salinity index, to be calculated from each sample of macroinvertebrates collected. These indices can then provide an integrated measure of stream condition.

Locally derived targets for freshwater macroinvertebrate indices for the Dumaresq River catchment area, within the Border Rivers basin, are listed in Table 49. These targets have been derived from Negus et al. (2013). Due to the standard methods and protocols used to study macroinvertebrates across Australia, and the training and accreditation requirements used for their application (refer to the AUSRIVAS website), data from a number of monitoring programs were combined to develop the locally derived freshwater macroinvertebrates targets.

The targets presented below are based on aquatic macroinvertebrate samples taken from Queensland State Government programs. Existing reference sites and sample data from the Bulloo, Paroo, Warrego, Nebine, Condamine, Balonne, Moonie and Border Rivers catchments were analysed for the development of macroinvertebrate guideline values as per the QWQG (Department of Environment and Heritage Protection, 2009). Target values were determined for each index by combining all reference site sample data within each catchment and calculating the 20th and 80th percentile values of this data. It was deemed that, at a minimum, 15 samples from 3 reference sites were required to set interim guidelines.

Additionally, in order to develop the macroinvertebrate targets, 10 metre sections of edge habitats were sampled in accordance with standard national protocols. Freshwater macroinvertebrate targets for Dumaresq River catchment area were developed for the following indices:

- Salinity index: The average of the salinity sensitivity grades assigned to macroinvertebrate taxa in a sample:
  - Grade 1—very tolerant to salinity (taxa have been recorded at a mean conductivity ≥ 350 µScm-1)
  - Grade 10—sensitive to salinity (taxa have been recorded at a mean conductivity < 300 µScm-1)
  - Grade 5—generally tolerant to salinity (Taxa neither very tolerant, nor sensitive) (Horrigan, Choy, Marshall, & Recknagel, 2005).
- Taxa richness: The number of different aquatic macroinvertebrate taxa collected in a sample.
- Average SIGNAL grade: The SIGNAL (Stream Invertebrate Grade Number—Average Level) index was developed for the bioassessment of water quality in rivers in Australia. A SIGNAL score is calculated by grading each detected macroinvertebrate family based upon its sensitivity to pollutants, ranging from 1 (tolerant) to 10 (sensitive). The target value is calculated by averaging the sensitivity grades of all the macroinvertebrate families collected. SIGNAL version 2.iv (Chessman, 2003) was used to develop the target values.

- % tolerant taxa: The proportion of taxa with 'tolerant' SIGNAL grades of 1–3, based on SIGNAL version 2.iv (Chessman, 2003).

Samples for the macroinvertebrate targets were identified in the laboratory to family level, except for Chironimidae (non-biting midges) that are identified to sub-family, and lower Phyla (Porifera, Nematoda, Nemertea, etc.), Oligochaeta (freshwater worms), Acarina (mites), and microcrustacea (Ostracoda, Copepoda, Cladocera) that are not identified further. The taxonomy used to calculate the target indices was based on SIGNAL version 2.iv taxa scores, with minor adjustments (Chessman, 2003); (Negus, Steward, & Blessing, 2013). These taxonomic levels require consideration during the application of the freshwater macroinvertebrate targets specified in Table 49 to ensure numbers of taxa are comparable.

Negus et al. (2013) recommends that targeted macroinvertebrate sampling is conducted for the Moonie River basin and the Border Rivers basin more broadly to allow the development of locally relevant macroinvertebrate guidelines. It is recommended that sampling occur in waters of high ecological value (HEV) as well as slightly disturbed (SD) to moderately disturbed (MD) waters to allow development of targets for the different levels of protection under EPP Water.

Table 49: Freshwater macroinvertebrate targets for slightly to moderately disturbed waters of the Dumaresq catchment, within the Border Rivers basin (Negus, Steward, & Blessing, 2013)

Drainage basin	Index	Edge habitat [1]	
		20th percentile	80th percentile
Border Rivers			
Dumaresq	Salinity index	4.57	5.42
	Taxa richness	13	21
	Average SIGNAL grade	3.13	3.75
	% tolerant taxa	37.93	65.00

Notes:

1. Edge habitat is located along the stream bank.

10.2.10 Targets for freshwater fish

Fish are an important component of the fauna of Australian river systems and can be used as indicators of ecosystem health (Kennard, Harch, Arthington, Mackay, & Pusey, 2001). For example, fish have been used as an indicator of ecosystem health in the Murray-Darling Basin (Hutchinson, 2014) (MDBC, 2008) and also in south east Queensland (EHMP, 2006).Ecosystem health is indicated by developing fish metrics, which are a tool to score the composition of fish fauna in a given system. Once developed, scores may be compared against an expected or average condition derived from existing data sets or expert opinion.

It is recommended that targets for freshwater fish are developed for the Border Rivers and Moonie River basins.

10.3 Water quality targets for the protection of Human Use Environmental Values

These water quality targets apply where the following Human Use Environmental Values have been identified in the Border River and Moonie River basins (Refer to Section 5 of this report). Where more than one EV applies to a given water (for example aquatic ecosystem and recreational use), the adoption of the most stringent water quality target for each water quality indicator will then protect all identified EVs. The water quality targets in this section are, unless otherwise specified, based on national water quality guidelines, including ANZECC Guidelines (as updated), the National Health and Medical Research Council Guidelines for managing risks in recreational water, the Food Standards Australia New Zealand (FSANZ, 2007 & updates), and the Australian Drinking Water Guidelines (NHMRC, 2011, as amended). Where national guidelines are the source for the stated water quality targets, it is recommended that users refer directly to the sources to obtain comprehensive listings of all indicators and up-to-date information.

10.3.1 Water quality targets for the protection of Primary Industry Environmental Values

Section 10.32 (2)(b) and 10.35B (2)(b) of the Basin Plan requires a WQM Plan to identify water quality targets for irrigation water. The target values for irrigation water are set out in Section 9.17 of the Basin Plan. Section 10.34 of the Basin Plan requires a WQM Plan to identify the locations of targets for irrigation water. As per Section 9.17 of the Basin Plan, the target values apply at sites in the Murray-Darling Basin where water is extracted by an irrigation infrastructure operator for the purpose of irrigation.

Irrigation infrastructure operators are defined under Section 7 (4) of the Water Act 2007. Based on this definition, there are no sites in the Queensland Border Rivers and Moonie River Basins that qualify as an irrigation infrastructure operator for the purposes of Basin Plan Section 9.17, 10.32 (2)(b), 10.34 and 10.35B (2)(b).

While not accredited under the Basin Plan, Table 50 provision (1) for the Border Rivers and Moonie River basins is recognised to provide targets for irrigation water in the plan area for the purposes of Queensland water quality planning and management.

Table 50: Suitability of water supply for irrigation: Water quality targets

WATER QUALITY TARGET VALUES FOR IRRIGATION		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for irrigation 	All surface waters and groundwaters	**For the Border Rivers and Moonie river basins:** 1. ANZECC (ANZECC/ARMCANZ, 2000) targets for pathogens and metals are provided in Table 51 and Table 52. For all other indicators, such as major ions and herbicides refer to the ANZECC Guidelines (ANZECC/ARMCANZ, 2000).

Table 51: Suitability of water supply for irrigation: Water quality targets for thermotolerant (faecal) coliforms in irrigation waters used for food and non-food crops[1]

Intended use	Median values of thermotolerant coliforms (colony forming units–cfu) [2]
Raw human food crops in direct contact with irrigation water (e.g. via sprays, irrigation of salad vegetables)	<10 cfu/100mL
Raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed	<1000 cfu/100mL
Pasture and fodder for dairy animals (without withholding period)	<100 cfu/100mL
Pasture and fodder for dairy animals (with withholding period of five days)	<1000 cfu/100mL
Pasture and fodder (for grazing animals except pigs and dairy animals, i.e. cattle, sheep and goats)	<1000 cfu/100mL
Silviculture, turf, cotton, etc. (restricted public access)	<10 000 cfu/100mL

Notes:

1. Adapted from ANZECC (ANZECC/ARMCANZ, 2000) and NHMRC (2011, as updated)

2. Refer to ANZECC (ANZECC/ARMCANZ, 2000), Volume 1, Section 4.2.3.3 for advice on testing protocols.

Source: ANZECC (ANZECC/ARMCANZ, 2000), Volume 1, Section 4.2.3.3 and Table 4.2.2.

Table 52: Suitability of water supply for irrigation: Water quality targets for heavy metals and metalloids in agricultural irrigation water[1]—long-term trigger value (LTV), short-term trigger value (STV) and soil cumulative contamination loading limit (CCL)

Element	Soil cumulative contaminant loading limit (CCL) [2] (kg/ha)	Long-term trigger value (LTV) in irrigation water (up to 100 years) (mg/L)	Short-term trigger value (STV) in irrigation water (up to 20 years) (mg/L)
Aluminium	ND[2]	5	20
Arsenic	20	0.1	2.0
Beryllium	ND	0.1	0.5
Boron	ND	0.5	Refer to ANZECC (ANZECC/ARMCANZ, 2000), Vol 3, Table 9.2.18
Cadmium	2	0.01	0.05
Chromium	ND	0.1	1
Cobalt	ND	0.05	0.1
Copper	140	0.2	5
Fluoride	ND	1	2
Iron	ND	0.2	10
Lead	260	2	5
Lithium	ND	2.5 (0.075 for citrus crops)	2.5 (0.075 for citrus crops)
Manganese	ND	0.2	10
Mercury	2	0.002	0.002
Molybdenum	ND	0.01	0.05
Nickel	85	0.2	2
Selenium	10	0.02	0.05
Uranium	ND	0.01	0.1
Vanadium	ND	0.1	0.5
Zinc	300	2	5

Notes:

1. Concentrations in irrigation water should be less than the trigger values. Trigger values should only be used in conjunction with information on each individual element and the potential for off-site transport of contaminants (refer ANZECC (ANZECC/ARMCANZ, 2000), Volume 3, Section 9.2.5).

2. ND = Not determined; insufficient background data to calculate CCL.

Source: ANZECC (ANZECC/ARMCANZ, 2000), Volume 1, Section 4.2.6 and Table 4.2.10.

Table 53: Suitability of water supply for stock watering: Water quality targets

WATER QUALITY TARGET VALUES FOR STOCK WATERING		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for stock watering 	All surface waters and groundwaters	Water quality targets as per ANZECC (ANZECC/ARMCANZ, 2000), including median faecal coliforms <100 organisms per 100 mL. Water quality targets for total dissolved solids and metals are provided in Table 54 and Table 55, based on ANZECC (ANZECC/ARMCANZ, 2000). For other water quality targets, such as cyanobacteria and pathogens, see ANZECC (ANZECC/ARMCANZ, 2000).

Table 54: Suitability of water supply for stock watering: Water quality targets for tolerances of livestock to total dissolved solids (salinity) in drinking water[1]

Livestock	**Total dissolved solids (TDS) (mg/L)**		
	No adverse effects on animals expected.	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production.	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually.
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000[2]
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

Notes:

1. From ANZECC (ANZECC/ARMCANZ, 2000).

2. Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.

Source: ANZECC (ANZECC/ARMCANZ, 2000), Volume 1, Section 4.3.3.5 and Table 4.3.1.

Table 55: Suitability of water supply for stock watering: Water quality targets (low risk trigger values) for heavy metals and metalloids in livestock drinking water

Metal or metalloid	Trigger value (low risk)[1,2] (mg/L)
Aluminium	5
Arsenic	0.5 (up to 5[3])
Beryllium	ND
Boron	5
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry)
Fluoride	2
Iron	Not sufficiently toxic
Lead	0.1
Manganese	Not sufficiently toxic
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02
Uranium	0.2
Vanadium	ND
Zinc	20

Notes:

1. Higher concentrations may be tolerated in some situations (further details provided in ANZECC (ANZECC/ARMCANZ, 2000), Volume 3, Section 9.3.5).

2. ND = not determined, insufficient background data to calculate.

3. May be tolerated if not provided as a food additive and natural levels in the diet are low.

Source: ANZECC (ANZECC/ARMCANZ, 2000), Volume 1, Section 4.3.4 and Table 4.3.2.

Table 56: Suitability of water supply for farm supply/use: Water quality targets

WATER QUALITY TARGET VALUES FOR FARM SUPPLY/USE		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for farm supply/use 	All surface waters and groundwaters	Targets as per: • ANZECC guidelines (ANZECC/ARMCANZ, 2000).

Table 57: Protection of the human consumer: Water quality targets

WATER QUALITY TARGET VALUES FOR HUMAN CONSUMER		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Protection of the human consumer 	All surface waters and groundwaters	Targets as per: • ANZECC guidelines (ANZECC/ARMCANZ, 2000) • Australia New Zealand Food Standards Code, Food Standards Australia New Zealand (FSANZ, 2007 & updates).

Table 58: Suitability of water supply for aquaculture: Water quality targets

WATER QUALITY TARGET VALUES FOR AQUACULTURE		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for aquaculture 	All surface waters and groundwaters	Targets as per: • Table 59 of this report • ANZECC guidelines (ANZECC/ARMCANZ, 2000) • Australia New Zealand Food Standards Code, Food Standards Australia New Zealand (FSANZ, 2007 & updates).

Table 59: Water quality targets for aquaculture (optimal growth of particular species in freshwater)

WATER QUALITY TARGET VALUES FOR AQUACULTURE						
Water parameter	**Barramundi**	**Eel**	**Silver perch**	**Jade perch**	**Sleepy cod**	**Redclaw**
Dissolved oxygen	4–9mg/L	>3mg/L	>4mg/L	>3mg/L	>4.0mg/L	>4.0mg/L
Temperature ˚C	26–32	23–28	23–28	23–28	22–31	23–31
pH	7.5–8.5	7.0–8.5	6.5–9	6.5–9	7.0–8.5	7.0–8.5
Ammonia (TAN, Total ammonia-nitrogen)		<1.0mg/L			<1.0mg/L	<1.0mg/L
Ammonia (NH_3, un-ionised form)*pH dependent	<0.46mg/L	<0.1mg/L	<0.1mg/L	<0.1mg/L	<0.1mg/L	<0.1mg/L
Nitrate (NO_3)			<100mg/L			
Nitrite (NO_2)	<1.5mg/L	<1.0mg/L	<0.1mg/L		<1.0mg/L	<1.0mg/L
Salinity (extended periods)	0–35ppt		<5ppt	<5ppt		<4ppt
Salinity bath	0–35ppt		5–10ppt for 1 hour		max. 20ppt for 1 hour	
Hardness ($CaCO_3$)			>50 mg/L	>50 mg/L	>40mg/L	>40mg/L
Alkalinity	>20mg/L		100–400 ppm	100–400 ppm	>40mg/L	>40mg/L
Chlorine	<0.04mg/L				<0.04mg/L	
Hydrogen sulphide	0–0.3mg/L				0–0.3mg/L	
Iron	<0.1mg/L		<0.5mg/L	<0.5mg/L	<0.1mg/L	<0.1mg/L
Spawning temperature °C	Marine		23–28	23–28	>24 for more than 3 days	

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

10.3.2 Water quality targets for the protection of the Drinking Water Environmental Value

These water quality targets apply where the Drinking Water Environmental Value has been identified in the Border Rivers and Moonie River basin (Refer to Section 5 of this report).

Table 60: Suitability of drinking water supply: Water quality targets

WATER QUALITY TARGET VALUES FOR DRINKING WATER		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for drinking water supply 	All surface waters and groundwaters	Targets as per: • Table 61 - Local water quality targets for drinking water supply. • The Australian Drinking Water Guidelines (NHMRC, 2011, as amended) provides a framework for the quality of raw water for treatment for human consumption. For water quality after treatment or at point of use refer to legislation and guidelines, including: • Australian Drinking Water Guidelines (NHMRC, 2011, as amended) • *Public Health Act 2005* and Regulation • *Water Fluoridation Act 2008* and Regulation • *Water Supply (Safety and Reliability) Act 2008*, including any approved drinking water management plan under the Act.

Table 61: Suitability of raw drinking water supply: Water quality targets for drinking water supply in the vicinity of off-takes, including groundwater, before treatment

This table outlines the water quality targets for water **before treatment**, unless otherwise stated (e.g. Australian Drinking Water Guidelines (ADWG)). For water quality after treatment or at the point of use, refer to relevant legislation and guidelines, including *Public Health Act 2005* and Regulation, *Water Supply (Safety and Reliability) Act 2008* and Regulation, including any approved drinking water management plan under the Act, *Water Fluoridation Act 2008* and Regulation, and the Australian Drinking Water Guidelines (ADWG, 2011, as amended).

Indicator	Water quality target
Giardia	0 cysts (Queensland Water Supply Regulator) If *Giardia* is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (NHMRC, 2011, as amended).
Cryptosporidium	0 cysts (Queensland Water Supply Regulator) If *Cryptosporidium* is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (NHMRC, 2011, as amended).
E. coli	<100 cfu/100mL Treatment plants with effective barriers and disinfection are designed to address faecal contamination. *E. coli* or thermotolerant coliforms should not be present in any 100 mL sample of (treated) drinking water (NHMRC, 2011, as amended).
Blue-green algae (cyanobacteria)	<2000 cells/mL
Algal toxin	ADWG (NHMRC, 2011, as amended) health guideline: <1.3 µg/L Microcystin
pH	6.5-8.0
Sulphate	ADWG (NHMRC, 2011, as amended) health guideline: <500 mg/L
Dissolved oxygen	60-110 % saturation
Pesticides	Raw supplies: With good land and water quality management practices, pesticides should not be detected in source waters used for drinking water supplies (NHMRC 2011, Section 6.3.2, and Pesticide factsheets). Refer to the ADWG (NHMRC, 2011, as amended) for specific human health related guideline values. Treated drinking water: Advanced treatment processes can aid in removal of pesticides from water supplies. Refer to the ADWG (NHMRC, 2011, as amended) for specific human health related guideline values.
Other indicators (including physico-chemical indicators)	Refer to ADWG (NHMRC, 2011, as amended).

10.3.3 Water quality targets for the protection of the Cultural, Spiritual and Ceremonial Environmental Value

These water quality targets apply where the Cultural, Spiritual and Ceremonial Environmental Value has been identified in the Border Rivers and Moonie River basins (Refer to section 5 of this report).

Table 62: Protection of cultural, spiritual and ceremonial values: Water quality targets

WATER QUALITY TARGET VALUES FOR CULTURAL, SPIRITUAL AND CEREMONIAL VALUES		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Protection of cultural, spiritual and ceremonial values 	All surface waters and groundwaters	Protect or restore cultural, spiritual and ceremonial values consistent with approved policies and plans. Aboriginal Waterways Assessments may provide information to support the cultural, spiritual and ceremonial value.

10.3.4 Water quality targets for the protection of the Industry Environmental Value

These water quality targets apply where the Industry Environmental Value has been identified in the Border Rivers and Moonie River basins (Refer to section 5 of this report).

Table 63: Suitability for industrial use: Water quality targets

WATER QUALITY TARGET VALUES FOR INDUSTRY		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for industrial use 	All surface waters and groundwaters	Water quality requirements for industry vary within and between industries. The ANZECC guidelines (ANZECC/ARMCANZ, 2000) do not provide targets to protect industries, and indicate that industrial water quality requirements need to be considered on a case-by-case basis. This environmental value is usually protected by other values, such as the aquatic ecosystem environmental value.

10.3.5 Water quality targets for the protection of the primary, secondary and visual recreation environmental values

The following water quality targets apply where the following recreational Environmental Values have been identified in the Border Rivers and Moonie River basins (Refer to section 5 of this report).

Section 10.32 (2)(c) of the Basin Plan requires a WQM Plan to identify water quality targets for recreational purposes for surface waters and 10.35B (2)(c) for groundwaters.

The Healthy Waters Management Plan fulfils this requirement by specifying that the water quality targets for water used for recreational purposes includes the values for cyanobacteria cell counts or biovolume as set out in Chapter 6 of the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

The water quality target values for accreditation under section 10.32 (2)(c) and 10.35B (2)(c) of the Basin Plan are the water quality target values in Table 64, provision (1) for primary, secondary and visual recreation. The accredited water quality target values apply in the Border Rivers and Moonie River basins.

While not accredited under the Basin Plan, Table 64, provision (2) for primary, secondary and visual recreation is recognised to support the accredited water quality target values for recreational purposes.

Table 64: Suitability for primary, secondary and visual recreation: Water quality targets

WATER QUALITY TARGET VALUES FOR RECREATION		
Environmental Value	Water type/area	Water quality targets to protect Environmental Value
Suitability for primary contact recreation 	All surface waters and groundwaters	1. Cyanobacteria and algae targets as per Chapter 6 of the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008), including: • Recreational water bodies should not contain: ○ Level 1[1]: ≥ 10 µg/L total microcystins; or ≥ 50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; or ○ Level 2[1]: ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present; or ○ cyanobacterial scums consistently present. Further details are contained in (NHMRC, 2008) and Table 65. 2. All other targets for fresh waters as per the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008), including: • water free of physical (floating and submerged) hazards[28] • temperature range: 16–34°C • pH range: 6.5–8.5 • DO: >80% • faecal contamination: designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin. Two principal components are required for assessing faecal contamination: ○ assessment of evidence for the likely influence of faecal material ○ counts of suitable faecal indicator bacteria (usually enterococci) These two components are combined to produce an overall microbial classification of the recreational water body. • avoiding exposure to freshwater free-living microorganisms (e.g. the protozoan *Naegleria fowleri* in warm fresh waters) • waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes.

[28] Where permanent hazards exist appropriate warning signs should be clearly displayed.

WATER QUALITY TARGET VALUES FOR RECREATION		
Suitability for secondary contact recreation 	All surface waters and groundwaters	1. Cyanobacteria and algae targets as per Chapter 6 of the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Refer to the cyanobacteria and algae targets for primary recreation, NHMRC (2008) and Table 65 for further detail. 2. All other targets for fresh waters as per the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).
Suitability for visual recreation 	All surface waters and groundwaters	1. Cyanobacteria and algae targets as per Chapter 6 of the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Refer to the cyanobacteria and algae targets for primary recreation, NHMRC (2008) and Table 65 for further detail. 2. All other targets for fresh waters as per the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008), including: • recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life.

Notes:

1. Level 1 recognises the probability of adverse health effects from ingestion of known toxins, in this case based on the toxicity of microcystins. Level 2 covers circumstances in which there are very high cell densities of cyanobacterial material, irrespective of the presence of toxicity or known toxins. Increased cyanobacterial densities increase the likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms (NHMRC, 2008; 8)

Table 65: Recreational waters: Alert levels and corresponding actions for management of cyanobacteria

When cyanobacteria are present in large numbers they can present a significant hazard, particularly to primary contact users of waters. Monitoring/action requirements relative to cyanobacteria 'alert' levels are summarised below, and are explained more fully in the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Further details on the process to determine suitability of waters for recreation, relative to historical cyanobacterial levels and susceptibility to cyanobacterial contamination, are contained in Section 6 of the NHMRC guidelines (2008).

Green level surveillance mode[1]	Amber level alert mode[1]	Red level action mode[1]
Fresh waters		
≥ 500 to <5000 cells/mL *M. aeruginosa* or biovolume equivalent of >0.04 to <0.4 mm^3/L for the combined total of all cyanobacteria.	≥ 5000 to <50 000 cells/mL *M. aeruginosa* or biovolume equivalent of ≥0.4 to <4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume[2]. or[3] ≥0.4 to <10 mm^3/L for the combined total of all cyanobacteria where known toxin producers are not present.	Level 1 guideline[4]: ≥ 10 µg/L total microcystins. or ≥ 50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume. or[3] Level 2 guideline[4]: ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present. or cyanobacterial scums are consistently present[5].

Notes:

1. Recommended actions at different alert levels are outlined below (based on NHMRC, 2008, Table 6.6—Fresh waters).
   a. **Green:** Regular monitoring. Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis aeruginosa*, *Anabaena circinalis*, *Cylindrospermopsis raciborskii*, *Aphanizomenon ovalisporum*, *Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums.
   b. **Amber:** Notify agencies as appropriate. Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species (above) are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring.
   c. **Red:** Continue monitoring as for (amber) alert mode. Immediately notify health authorities for advice on health risk. ('In action mode the local authority and health authorities warn the public of the existence of potential health risks; for example, through the media and the erection of signs by the local authority.' NHMRC, 2008; 114). Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability).
2. The definition of 'dominant' is where the known toxin producer comprises 75% or more of the total biovolume of cyanobacteria in a representative sample.
3. This applies where high cell densities or scums of 'non-toxic' cyanobacteria are present i.e. where the cyanobacterial population has been tested and shown not to contain known toxins (microcystin, nodularian, cylindrospermopsin or saxitoxins).
4. Health risks and levels: Level 1 is developed to protect against short-term health effects of exposure to cyanobacterial toxins ingested during recreational activity, whereas the Level 2 applies to the circumstance where there is a probability of increased likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms, from exposure to very high cell densities of cyanobacterial material irrespective of the presence of toxicity or known toxins (NHMRC, 2008; 114).
5. This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

Source: Summarised from NHMRC (2008) Guideline for Managing Risks in Recreational Water (Tables 6.2 and 6.6).

10.4 Salinity targets for the purposes of long-term salinity planning and management

Table 66: Queensland Basin Salinity Management Strategy End-of-Valley Salinity Targets

WATER QUALITY TARGET VALUES FOR LONG-TERM SALINITY PLANNING AND MANAGEMENT									
Valley	Baseline as at 1 Jan 2000			End-of-Valley targets (as absolute value)			Valley reporting site	AWRC Site Number	Map EoV Site ID
	Salinity (EC µS/cm)		Salt Load (t/yr)	Salinity (EC µS/cm)		Salt Load (t/yr)			
	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean			
Queensland									
Border Rivers	250	330	50,000	250	330	50,000	Barwon R @ Mungindi	416001[1]	70
Moonie	140	150	8,700	140	150	8,700	Moonie R @ Renton	417204A	71

Notes:

1. These sites are operated by NSW on behalf of Queensland.

Source: Appendix 1 of Schedule B to the Murray-Darling Basin Agreement (Schedule 1 of the Water Act 2007). Version 15 June 2010, and as amended.

SECTION 11: MONITORING, DATA MANAGEMENT, REPORTING AND GOVERNANCE

11 Monitoring, data management, reporting and governance

11.1 Monitoring

Monitoring should be designed in accordance with the EPP Water Monitoring and Sampling Manual 2018. The principles in section 13.04 of the Basin Plan (listed below in The Queensland Government will continue to monitor water quality through both the Surface Water Ambient Network and Groundwater Ambient Network. End-of-Valley monitoring is also conducted as part of Queensland's responsibilities under Basin Salinity Management 2030, with data derived from gauging station sites in both Queensland and New South Wales. Continuous and field-based water quality monitoring to support the calibration of the QMDB water quality model has also been conducted in the QMDB, supported by the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended National Partnership Agreement. Local short-term water quality monitoring programs are also conducted in the QMDB where funded opportunities arise. These are often implemented by natural resource management groups, community groups or other local stakeholders.

Some activities in Queensland have approval under the *Environmental Protection Act 1994* to release water to the environment. These point sources releases are monitored by the approval holder for various water quality parameters and release volumes. The approval holders can also undertake monitoring of the surrounding environment.

It is an aim of the healthy waters management plan over the life of the plan to identify opportunities for a Report Card for the QMDB region, similar to South East Queensland and the Great Barrier Reef.

Table 67) should also be implemented when conducting monitoring and evaluation in the plan area. These principles apply to all basins within QMDB, including the Bulloo drainage basin. This ensures consistency in monitoring practices across QMBD, as well as the Murray-Darling Basin more broadly.

The Queensland Government will continue to monitor water quality through both the Surface Water Ambient Network and Groundwater Ambient Network. End-of-Valley monitoring is also conducted as part of Queensland's responsibilities under Basin Salinity Management 2030, with data derived from gauging station sites in both Queensland and New South Wales. Continuous and field-based water quality monitoring to support the calibration of the QMDB water quality model has also been conducted in the QMDB, supported by the Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin and an amended National Partnership Agreement. Local short-term water quality monitoring programs are also conducted in the QMDB where funded opportunities arise. These are often implemented by natural resource management groups, community groups or other local stakeholders.

Some activities in Queensland have approval under the *Environmental Protection Act 1994* to release water to the environment. These point sources releases are monitored by the approval holder for various water quality parameters and release volumes. The approval holders can also undertake monitoring of the surrounding environment.

It is an aim of the healthy waters management plan over the life of the plan to identify opportunities for a Report Card for the QMDB region, similar to South East Queensland and the Great Barrier Reef.

Table 67: Principles to be applied in monitoring and evaluating the effectiveness of the Basin Plan (section 13.04 Basin Plan).

Principle	Description
Principles 1-2	Not applicable to the Queensland Government or other state agencies.
Principle 3	Commonwealth agencies and Basin States should report against matters in a manner which reflects the degree to which they are responsible for those matters.
Principle 4	Monitoring and evaluation should be undertaken within the conceptual framework of program logic. Note: Program logic is a mechanism that helps to determine when and what to evaluate so that resources can be used effectively and efficiently: see the Australian Government's NRM MERI Framework.
Principle 5	Monitoring and evaluation findings, including in respect of progress towards meeting targets and trends in the condition and availability of the Basin water resources, should enable decision-makers to use adaptive management.

Principle	Description
Principle 6	Monitoring and evaluation should harness the monitoring capabilities of existing Basin State and Commonwealth programs (including jointly funded programs), provided that the programs are consistent with the principles in this Part, with a view to aligning and improving these programs over time. Note: For example, water information provided by Basin States to the Bureau of Meteorology under Part 7 of the Water Act 2007 may be used, where possible, for monitoring and evaluation to avoid duplication in the sourcing of that information.
Principle 7	The best available knowledge (including scientific, local and cultural knowledge), evidence and analysis should be used where practicable to ensure credibility, transparency and usefulness of monitoring and evaluation findings.
Principle 8	Basin States and the Commonwealth should collaborate on the technical and operational elements of monitoring and evaluation in order to build engagement and ownership.
Principle 9	A risk-based approach should be used for investment in monitoring and evaluation.
Principle 10	Monitoring and reporting should be timely, efficient, cost-effective and consistent, and should supply the information needed for evaluation.
Principle 11	To the extent possible, there should be open access to information collected or used in, or generated by, monitoring and evaluation.

11.2 Data management and reporting

Data management and reporting should be consistent with the following:

1. Data should be stored with sufficient identifiers and metadata associated with the data to ensure its integrity.
2. A common, secure and accessible platform for archiving (storing and retrieval) and displaying water quality information is required.
3. Reporting should be specifically linked to management responses and outcomes.
4. Integration of reporting and linking to related reports should be considered, where possible.
5. Reporting should address progress against actions, performance indicators and timelines. Reporting should also address the outcomes of any review processes undertaken and any updates or improvements made to the plan.
6. Reporting should be web based, where possible.
7. Decision support models should be utilised, if available, to assist with the evaluation of progress and possible management intervention scenarios.

11.3 Governance

A collaborative partnership between the Queensland Government and the relevant NRM group for the Queensland Murray-Darling Basin region is the recommended approach for the delivery of the HWMP for the Border Rivers and Moonie River basins. Resources and implementation of the various management responses to address risks and contribute to the achievement of objectives for water resources will involve Commonwealth and State governments, key stakeholders including industry, commerce, landholders, science providers, environment groups and Traditional Owner groups and the broader community.

SECTION 12: DICTIONARY

12 Dictionary

ADWG means the Australian Drinking Water Guidelines (2011 and as updated), prepared by the National Health and Medical Research Council (NHMRC) in collaboration with the Natural Resource Management Ministerial Council (NRMMC).

ANZECC means the Australian and New Zealand Environment and Conservation Council.

ANZECC Guidelines mean the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (recently updated to become ANZG, 2018), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

Aquatic ecosystems (defined in the AWQG) comprise the animals, plants and micro-organisms that live in water, and the physical and chemical environment and climatic regime in which they interact. It is predominantly the physical components (e.g. light, temperature, mixing, flow, habitat) and chemical components (e.g. organic and inorganic carbon, oxygen, nutrients) of an ecosystem that determine what lives and breeds in it, and therefore the structure of the food web. Biological interactions (e.g. grazing and predation) can also play a part in structuring many aquatic ecosystems.

ARMCANZ means the Agriculture and Resource Management Council of Australia and New Zealand.

AWQG means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

Basin Plan means the *Basin Plan 2012*, prepared under the Commonwealth *Water Act 2007*.

Ecological health (defined in the AWQG) means the 'health' or 'condition' of an ecosystem. It is the ability of an ecosystem to support and maintain key ecological processes and organisms so that their species compositions, diversity and functional organisations are as comparable as possible to those occurring in natural habitats within a region (also termed ecological integrity).

Environmental values (EVs) for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These EVs need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use. Particular waters may have different EVs. EVs for a specified region are listed in Schedule 1 of the EPP Water.

EPP Water is the Environmental Protection (Water) Policy 2009.

Level of protection for a water (aquatic ecosystem EV) means the level of aquatic ecosystem condition specified in Table 13 of this document that the corresponding WQOs for that water are intended to achieve (refer to management intent definition below for further information).

Management intent (aquatic ecosystem EV) is defined in s. 14 of the EPP (Water). It is the management intent for the waters that the decision to release waste water or contaminant to the waters must ensure the following:

- for high ecological value (HEV) waters—the measures for the indicators are maintained
- for slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water
- for moderately disturbed (MD) waters:
    - if the measures for indicators of the EVs achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water, or
    - if the measures for indicators of the EVs do not achieve the water quality objectives for the water—the measures for indicators of the EVs are improved to achieve the water quality objectives for the water
- for highly disturbed (HD) waters—the measures for the indicators of all environmental values are progressively improved to achieve the water quality objectives for the water.

QWQG means the Queensland Water Quality Guidelines.

Queensland waters (as defined in *Acts Interpretation Act 1954*): means all waters that are a) within the limits of the state; or b) coastal waters of the state.

Toxicant (defined in the AWQG) means a chemical capable of producing an adverse response (effect) in a biological system at concentrations that might be encountered in the environment, seriously injuring structure or

function or producing death. Examples include pesticides, heavy metals and biotoxins.

Water quality guidelines (defined in the EPP (Water)) are numerical concentration levels or statements for indicators that protect a stated environmental value. Under the EVs setting process contained in the EPP (Water), water quality guidelines are used as an input to the development of WQOs.

Water quality indicator (for an EV) means a property that is able to be measured or decided in a quantitative way. Examples of water quality indicators include physical indicators (e.g. temperature), chemical indicators (e.g. nitrogen, phosphorus, metals), and biological indicators (e.g. macroinvertebrates, seagrass, fish).

Water quality objectives (WQOs) are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. Water quality objectives are not individual point source emission objectives, but the receiving water quality objectives. They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g. social, cultural and economic). Examples of WQOs include:

- total phosphorus concentration less than 20 micrograms per litre (µg/L)
- chlorophyll a concentration less than 1 µg/L
- dissolved oxygen between 95% and 105% saturation
- family richness of macroinvertebrates greater than 12 families
- exotic individuals of fish less than five per cent.

Water type means groupings of waters with similar characteristics. Water types can include fresh waters (lowland, upland, lakes/reservoirs), wetlands and groundwaters.

SECTION 13: REFERENCED SOURCES

13 Referenced sources

ANZECC/ARMCANZ. (recently updated to become ANZG, 2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Canberra: Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

Australian Government. (2017). *Module to the National Water Initiative (NWI) Policy Guidelines for Water Planning and Management: Engaging Indigenous Peoples in Water Planning and Management.* Canberra: Australian Government.

Balcombe, S., Sheldon, F., Capon, S., Bond, N., Hadwen, W., Marsh, N., & Bernays, S. (2011). Climate-change threats to native fish in degraded rivers and floodplais of the Murray-Darling Basin, Australia. *Marine and Freshwater Research*, 1099-1114.

Biggs, A., & Powers, R. (2002). *A review of salinity occurrences in the Queensland Murray-Darling Basin.* Department of Natural Resources and Mines.

Biggs, A., Watling, K., Cupples, N., & Minehan, K. (2010). *Salinity Risk Assessment for the Queensland Murray-Darling Region.* Toowoomba: Queensland Department of Environment and Resource Management.

CBWC. (2002). *Water quality objectives for the Condamine-Balonne Catchment: development of water quality objectives for the Condamine-Balonne catchment project - Technical Report.* Dalby, Queensland: Condamine Balonne Water Committee Inc.

Chessman, B. (2003). *SIGNAL 2-A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers, Monitoring River Health Initiative Technical Report no. 31.* Canberra: Commonwealth of Australia.

Clark, A., Healy, A., & Tindall, D. (2015). *Riparian vegetation levels in the Queensland Murray-Darling Basin and Bulloo catchments for 2013.* Brisbane: Department of Science, Information Technology and Innovation.

Constable, J., & Love, K. (2015). *Aboriginal water values Maranoa-Balonne-Condamine subregion (Qld), a report for the Bioregional Assessment Programme.* Canberra: Commonwealth of Australia.

Davidson, W. (2018). *Development of a Water Quality Model for the Queensland Murray-Darling Basin using eWater Source Framework, Technical Report.* Toowoomba: Queensland Department of Natural Resources and Mines.

DEHP. (2017). *Queensland Government*. Retrieved from State of the Environment: https://www.ehp.qld.gov.au/state-of-the-environment/finding/?id=1.2.0.1

Department of Environment and Heritage Protection. (2009). *Queensland Water Quality Guidelines.* Queensland Government. doi:ISBN 978-0-9806986-0-2

Department of Environment and Heritage Protection. (2016). *Healthy Waters Management Plan for Warrego, Paroo, Nebine and Bulloo basins.* Brisbane: Queensland Government.

Department of Environment and Science. (2017). *Draft Environmental Values and Water Quality Objectives for QMDB.* Brisbane: State of Queensland.

Department of Environment and Science. (2018). *Environmental Protection Policy (Water) Mapping methodology .* Brisbane: State of Queensland.

Department of Environment and Science. (2018). *Mapping procedural guide.* Brisbane: State of Queensland.

Department of Natural Resources and Mines. (2017). *Preliminary Risk Assessment of Thermal Alteration Downstream of Dams in the Queensland Murray-Darling Basin.* Toowoomba: The State of Queensland.

Department of Science, Information Technology and Innovation. (2017). Persistent Waterhole Classification- Ozius Spatial on behalf of Water Planning Ecology.

Department of the Prime Minister and Cabinet. (2018, January 16). *Indigenous Land and Sea Management Projects*. Retrieved from Indigenous Affairs: https://www.pmc.gov.au/indigenous-affairs/environment/indigenous-land-and-sea-management-projects

DNRME. (2018). *Aboriginal people's water needs in the Queensland Murray-Darling Basin.* Brisbane: Department of Natural Resources, Mines and Energy.

DSITI. (2015). *Waterhole refuge mapping and persistence analysis in the Lower Balonne and Barwon-Darling rivers.* Department of Science, Information Technology and Innovation. .

EHMP. (2006). *Ecosystem Health Monitoring Program 2004-2005 Annual Technical Report.* Brisbane: Moreton Bay Waterways and Catchments Partnerships.

Fielder, D., Davidson, W., & Barratt, P. (2011). *Aquatic Conservation Assessments (ACA), using AquaBAMM, for the wetlands of the Queensland Murray-Darling Basin.* Brisbane: Department of Environment and Resource Management.

FSANZ. (2007 & updates, April 04). *Food Standards Code.* Retrieved from Food Standards Australia New Zealand: http://www.foodstandards.gov.au/foodstandards/foodstandardscode.cfm

Griffith University. (2015). *Central Slopes NRM Collection*. Retrieved from Terra nova: https://terranova.org.au/repository/central-slopes-nrm-collection

Holman, IP, Whelan, MJ, Howden, NJK, Bellamy, PH, Willby, NJ, Rivas-Casado, M & McConvey, P. 2008, 'Phosphorus in groundwater – an overlooked contributor to eutrophication?'. Hydrological Processes, vol. 22, no: 5121–5127.

Horrigan, N., Choy, S., Marshall, J., & Recknagel, F. (2005). Response of stream macroinvertebrates to changes in salinity and the development of a salinity index. *Marine and Freshwater Research*, 825-833.

Human Rights Commission. (2008, February 6). *Native Title Report 2008: Chapter 6, Indigenous Peoples and Water.* Retrieved from Human Rights Commission: http://www.humanrights.gov.au/social_justice/nt_report/ntreport08/

Hutchinson, M. (2014). *Fish assemblages as indicators of ecosystem health in the Condamine-Balonne River system. A guide prepared for the Department of Science, Information Technology, Innovation and the Arts.* Department of Agriculture, Fisheries and Forestry.

Kennard, M., Harch, B., Arthington, A., Mackay, S., & Pusey, B. (2001). Freshwater Fish as Indicators of Ecosystem Health. In M. a. Smith, *Design and Implementation of Baseline Monitoring (DIBM3): Developing Ecosystem Health Monitoring Program for Rivers and Stream in Southeast Queensland SEQRWQMS.* Brisbane.

Kerr, J., Kimball, A., Prior, A., Ellaway, C., & Luke, L. (2015). *Draft Barriers to fish passage in the Queensland Murray-Darling Basin - A report for the south-west Queensland Environmental Flows Assessment Program.* Department of Natural Resources and Mines and Department of Science, Technology and Innovation.

Lintermans, M. (2007). *Fishes of the Murray-Darling Basin: An introductory guide.* Canberra: Murray-Darling Basin Commission.

Lobegeiger, J. (2010). *Refugial Waterholes Project - Research Highlights.* Brisbane: Department of Environment and Resource Management.

Marsden Jacob Associates. (2017). *Socioeconomic report for the protection of environmental values in the Queensland Murray-Darling and Bulloo Basins.* Brisbane: Department of Environment and Heritage Protection.

McNeil, V. H., Raymond, M. A., Bennett, L., & McGregor, G. B. (2017). *Regional groundwater chemistry zones: Queensland Murray-Darling Basin: Summary and results.* Water Planning Ecology: Department of Science, Information Technology and Innovation, Queensland Government.

MDBC. (2008). *Sustainable Rivers Audit.* Canberra: Murray-Darling Basin Commission.

National Cultural Flows Research Project. (2018, February 6). *National Cultural Flows Research Project*. Retrieved from http://www.culturalflows.com.au/~culturalflowscom/

Negus, P., Blessing, J., Steward, A., Clifford, S., Hansen, D., & Hammill, B. (2015). *Ecological risk assessment and threat prioritisation in Queensland's eastern Murray Darling Rivers: Condamine, Balonne and Maranoa; Lower Balonne; Moonie; and Border Rivers.* Brisbane: Q–catchments program: Water Planning Ecology, Department of Science Information Technology and Innovation, Queensland Government.

Negus, P., Steward, A., & Blessing, J. (2013). *Queensland draft macroinvertebrate guidelines: Murray-Darling and Bulloo catchments, November 2013 - Draft for Comment.* Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.

NHMRC. (2008). *The Guidelines for Managing Risks in Recreational Water.* Canberra: Australian Government.

NHMRC. (2011, as amended). *ADWG: Australian Drinking Water Guidelines*. Retrieved from National Health and Medical Research Council: http://www.nhmrc.gov.au/guidelines/publications/eh52

Please, P. M. (2000). *A Groundwater quality assessment of the alluvial aquifers in the Border Rivers Catchment .* Canberra: Bureau of Rural Sciences.

QMDC. (2015). *Context of Climate Change*. Retrieved from Our Future Plan: https://ourfutureplan.org/about/context/

Queensland Government. (2018, March 10). *DATSIP.* Retrieved from Queensland Government: https://www.datsip.qld.gov.au/publications-governance-resources/policy-governance/queensland-indigenous-procurement-policy

Queensland Government, S. (2016). *Common soil types*. Retrieved from Queensland Government: https://www.qld.gov.au/environment/land/soil/soil-testing/types

Queensland Murray-Darling Committee . (2017). *Draft Environmental Values and Communtiy Consultation Report.* Brisbane: Department of Environment and Heritage Protection.

Richardson, E., Irvine, E., Froend, R., Book, P., Barber, S., & Bonneville, B. (2011). *Australian groundwater dependent ecosystems toolbox part 1: assessment framework.* Canberra: National Water Commission.

Sheldon, F. B. (2010). Ecological roles and threats to aquatic refugia in arid landscapes: dryland river waterholes. *Marine and Freshwater Research*, 61:885-895.

Silcock, J. (2009). *Permanent Waterholes of the Murray-Darling Basin and the Bulloo River basin.* unpublished reprot prepared for South West NRM Ltd.

South West NRM Ltd. (2012). *Caring for Water on Country in South West Queensland.* South West Queensland: Far South West Aboriginal Natural Resource Management Group.

South West NRM Ltd. (2014). *Planning for Climate Variability in South West Queensland: Yarning with Traditional Owners in south west Queensland.* Charleville: South West NRM Ltd.

State of Queensland. (2017, October 5). *Climate change resources*. Retrieved from Queensland Government: https://www.qld.gov.au/environment/climate/resources

The State of Queensland. (2017). *State of the Environment.*

van den Berg, D., Trevithick, R., & Tindall, D. (2015). Queensland Murray-Darling Basin Ground cover Report.

WetlandInfo. (2013a, March 22). *AquaBAMM.* Retrieved from Department of Environment and Science: <http://wetlandinfo.ehp.qld.gov.au/wetlands/resources/tools/assessment-search-tool/3/>.

WetlandInfo. (2013b, November 6). *Aquatic Conservation Assessment FAQs.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca/faq/

WetlandInfo. (2013c, March 22). *Riverine ecology.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/riverine/

WetlandInfo. (2013d, March 22). *Lacustrine ecology.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/lacustrine/

WetlandInfo. (2013e, March 22). *Palustrine ecology.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/palustrine/

WetlandInfo. (2015, May 12). *Groundwater dependent ecosystem FAQs.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/gde-background/gde-faq/

WetlandInfo. (2017a, October 30). *Groundwater dependent ecosystems.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/groundwater-dependent/

WetlandInfo. (2017b, July 4). *Potential groundwater dependent ecosystem aquifer mapping background.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/potential-aquifer-background/

WetlandInfo. (2018a, January 28). *Regional NRM body, South West NRM, facts and maps.* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/nrm-south-west-nrm/

WetlandInfo. (2018b, January 28). *Regional NRM body, South West NRM, facts and maps*. Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/nrm-south-west-nrm/

WetlandInfo. (2018b, October 9). *What are wetlands?* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/what-are-wetlands/

WetlandInfo. (2018b, October 9). *What are wetlands?* Retrieved from Department of Environment and Science: https://wetlandinfo.des.qld.gov.au/wetlands/what-are-wetlands/

SECTION 14: APPENDICES

14 Appendices

Appendix 1—Refining water quality targets for fresh water-dependent ecosystems to reflect local conditions

The need to refine water quality targets to reflect local conditions

Under s9.16 and Schedule 11 of the Basin Plan, the water quality target values for fresh water-dependent ecosystems are inappropriate and the target application zones are not relevant to developing local measures that address the causes of water quality degradation. The target application zones are not relevant at a spatial scale that recognises the different Queensland Murray-Darling Basin water types, mapped at sub-catchment level (Refer to Figure 30).

The adoption of the same water quality target values for key indicators across approximately 60% of the Queensland Murray-Darling Basin in Schedule 11 of the Basin Plan is inappropriate for the respective water resource plan areas. Most of the water quality target values in Schedule 11 are less stringent than local water quality target values and for key water–dependent ecosystem indicators, such as suspended solids, the water quality target values are unrealistically low. Further, the majority of the water quality indicators and subsequent target values in Schedule 11 are not applicable to groundwater. Consequently, the Schedule 11 water quality target values are neither environmentally nor economically appropriate. The default application of water quality target values would be inconsistent with s5.02 (1) (d) of the Basin Plan—by failing to optimise social, economic or environmental outcomes in the national (or local community or state) interest.

Under the water quality framework of the ANZECC guidelines and the EPP Water, local water quality targets hold higher precedence over regional, state or national targets. Local water quality targets for fresh water-dependent ecosystems are critical for appropriate economic and environmental management, as the direct application of default regional, state or national water quality targets often do not reflect local water types or water quality characteristics. This results in water quality targets, particularly for physico-chemical indicators, that potentially offer insufficient protection for the local aquatic ecosystem or impose excessive constraints on stakeholders to manage water quality to an inappropriate standard for the local area.

The ANZECC guidelines emphasise the need to tailor water quality targets to local conditions:

“It is not possible to develop a universal set of specific guidelines that apply equally to the very wide range of ecosystem types or production systems, in varying degrees of health, in Australia and New Zealand. Environmental factors can reduce or increase the effects of physical and chemical parameters at a site and these factors can vary considerably across the two countries. A framework is provided that allows the user to move beyond single-number, necessarily conservative values, to guidelines that can be refined according to local environmental conditions — that is, to developing site-specific guidelines. This is a key message of the Water Quality Guidelines….”

“This can produce values more appropriate to a particular water resource. Although tailoring guidelines to local conditions requires more work in some cases, it results in much more realistic management goals. It therefore has the potential to reduce costs for industry.” (ANZECC, 2000; Introduction to the guidelines, 8 - 9)

The ANZECC guidelines refer to four large regions of Australia (Figure A), and derive ‘default’ water quality guidelines for water types in each region. The split between the ‘Tropical’ region and the southern regions is the Tropic of Capricorn.

The Queensland Murray-Darling Basin drainage basins (416-Border Rivers, 417-Moonie, 422 Balonne-Condamine, 423-Warrego and 424-Paroo) and the Bulloo (011) fall within the ANZECC ‘South-east Australia’ region, which includes waters in New South Wales, Victoria and Tasmania.

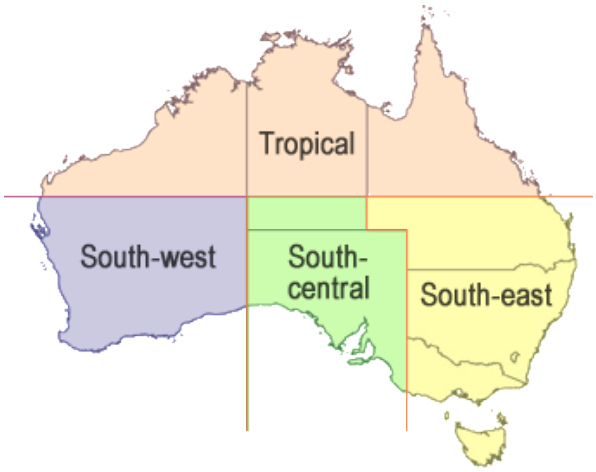


Figure A: ANZECC water type regions

The ANZECC guidelines state:

"The default trigger values in the present guidelines were derived from ecosystem data for unmodified or slightly-modified ecosystems supplied by state agencies. However, the choice of these reference systems was not based on any objective biological criteria. This lack of specificity may have resulted in inclusion of reference systems of varying quality, and further emphasises that the default trigger values should only be used until site- or ecosystem-specific values can be generated."

The water quality targets for fresh-water dependent ecosystems stated in Schedule 11 of the Basin Plan can be considered as 'default' regional trigger values, in the absence of local water quality targets. Refining the regional water quality targets for fresh-water dependent ecosystems stated in Schedule 11 of the Basin Plan based on local water quality data provides the best opportunity to achieve objectives and outcomes for water quality in the QMDB. Thus, where the water quality targets for fresh water-dependent ecosystems differ from those specified in the Basin Plan, they will be as effective in achieving consistency with the objectives.

Procedure

Local water quality targets for fresh water-dependent ecosystems (surface water) were derived based on the procedure outlined for 'Physical and chemical stressors' in section 3.3 of the ANZECC guidelines. The purpose of establishing local water quality targets from this section of the ANZECC guidelines is to ensure that the slightly to moderately disturbed ecosystems of QMDB are adequately protected (Refer to Section 6).

The procedure for determining groundwater quality target values is described briefly in sub-section 10.2.6 of this report, and in full in Regional groundwater chemistry zones: Queensland Murray-Darling Basin (McNeil, Raymond, Bennett, & McGregor, 2017).

Data sources

Best available data was sourced from a variety of databases for the development of water quality target values, as described below.

Surface water

Section 3.3 of the ANZECC Guidelines describes the sources of information for use when deriving water quality targets for physical and chemical stressors:

1. Biological and ecological effects data
2. Reference system data
3. Predictive modelling
4. Professional judgement.

The following local data and information sources were used to refine the water quality targets for fresh water-dependent ecosystems stated in Schedule 11 of the Basin Plan:

- Department of Natural Resources, Mines and Energy water quality and quantity monitoring data (Surface Water and Project Science database)
- Border Rivers Commission Intersecting Streams data
- Queensland Murray-Darling Committee data
- Smart Rivers data
- Stanthorpe Water Assessment and Monitoring Project
- New South Wales Office of Water data
- Published journal articles and data.

The refined water quality targets for surface water were prepared in conjunction with professional advice from the Water Quality Technical Panel. Data from approximately 850 water quality sampling occasions, conducted in the plan area between 1952 and 2017, was used in the analysis.

In the absence of local data for indicators, the regional targets specified in Schedule 11 of the Basin Plan apply.

For further information, refer to the Department of Environment and Science website: https://environment.des.qld.gov.au/water/policy/.

Table 68 displays the metadata summary for surface water quality targets for all water types of the Border Rivers and Moonie River basins.

Groundwater

Data was sourced from the Groundwater Database managed by the Queensland Department of Natural Resources, Mines and Energy. In the Queensland Murray-Darling Basin, there are more than 7,700 sub-artesian and 4,200 artesian water quality samples, supplemented by over 2,500 groundwater level measurements from around 6600 bores, mostly since the mid-1960s.

Site selection

Refer to Figure 31 for the surface water sites with available data that was analysed to derive alternative water quality targets for fresh water-dependent ecosystems in the Border Rivers and Moonie River basins.

Refer to Figure 32 for the groundwater bores with available chemistry data that was analysed to develop groundwater quality targets for the Border Rivers and Moonie River basins.

Data quality

Nutrient samples taken before 1995 were excluded from analyses due to inconsistencies with current sampling and laboratory procedures. Extreme or questionable data was inspected in finer detail, e.g. comparing the sampling dates with meteorological data, comparison with other variables, potential typographical errors, data reported in different units. Obvious errors were excluded, unless the data could be rationalized (e.g. EC recorded in mS/cm instead of µS/cm).

Consultation

Draft water quality target values were developed in consultation with the local government, natural resource management groups, industry groups, the Northern Basin Aboriginal Nations, the New South Wales Government and the community, based on participation at meetings held between March 2017 and January 2018.

Further information

For further information, refer to the Department of Environment and Science website: https://environment.des.qld.gov.au/water/policy/.

Table 68: Metadata summary for surface water quality targets in the Border Rivers and Moonie River basins.

Water type	Flow Condition	Indicators	Sources	Number of samples	Dates (years) of samples
BORDER RIVERS					
1. Granite Belt catchment waters	**Low flow** <0.8 cumecs at gauge 416319A – Stanthorpe	Ammonia N Oxidised N Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Stanthorpe Water Assessment and Monitoring Project, Queensland Murray-Darling Committee, NSW Office of Water, Everyone's Environment Grants (EEG).	15 sample sites, 492 sample dates, N= 103-653 depending on parameter	1962-2016
	High flow > 0.8 cumecs at gauge 416319A – Stanthorpe	Ammonia N Oxidised N Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee, NSW Office of Water	12 sample sites, 81 sample dates, N= 13-97 depending on parameter	1963-2015
2. Dumaresq Floodplain catchment waters	**Low flow** <5.2 cumecs at gauge 416310A – Farnbro	Total N Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Queensland Murray-Darling Committee, NSW Office of Water	20 samples sites, 570 sample dates, N= 180-989 depending on parameter	1960-2016
	High flow >5.2 cumecs at gauge 416310A – Farnbro	Total N Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Queensland Murray-Darling Committee, NSW Office of Water	18 sample sites, 51 sample dates, N= 15-66 depending on parameter	1963-2014
3. Traprock catchment waters	**Low flow** <0.8 cumecs at gauge 416404C – Terraine	Ammonia N Oxidised N Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee, NSW Office of Water, EEG	46 sample sites, 873 sample dates, N= 21-1242 depending on parameter	1960-2016
	High flow	Total N Total P	Surface Water database, Project	35 sample sites, 164 sample dates,	1961-2014

Water type	Flow Condition	Indicators	Sources	Number of samples	Dates (years) of samples
	>0.8 cumecs at gauge 416404C – Terraine	Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Sciences database, Queensland Murray-Darling Committee, NSW Office of Water, EEG	N= 60-201 depending on parameter	
4. Canning Creek catchment waters	**Low flow** <0.6 cumecs at gauge 416410A – Barongarook	Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee, NSW Office of Water	10 sample sites, 86 sample dates, N= 20-102 depending on parameter	1963-2016
	High flow >0.6 cumecs at gauge 416410A – Barongarook	Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Queensland Murray-Darling Committee	9 sample sites, 24 sample dates, N= 10-42 depending on parameter	1962-2013
5. Kumbarilla Ridge catchment waters	**Low flow** <12.8 cumecs at gauge 422336A – Condamine River at Brigalow	Turbidity pH Conductivity Sulphate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray Darling Committee	22 sample sites, 61 sample dates, N= 11-79 depending on parameter	2002-2016
	High flow >12.8 cumecs at gauge 422336A – Condamine River at Brigalow	Insufficient Data			
6. Upper Weir River catchment waters	**Low flow** <1.4 cumecs at gauge 416204A – Gunn Bridge	Ammonium N Oxidised N Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee	21 sample sites, 119 sample dates, N= 8-210 depending on parameter	1997-2016
	High flow >1.4 cumecs at gauge 416204A – Gunn Bridge	Turbidity pH Conductivity	Project Sciences database, Queensland Murray-Darling Committee	8 sample sites, 11 sample dates, N= 20-21 depending on parameter	2005-2015
7. Lower Weir River	**Low flow**	Ammonium N Oxidised N	Surface Water database, Project	19 sample sites, 344 sample dates	1971-2017

Water type	Flow Condition	Indicators	Sources	Number of samples	Dates (years) of samples
catchment waters	<5.0 cumecs at gauge 416202A – Talwood	Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Sciences database, NSW Office of Water, Queensland Murray-Darling Committee	N= 21-416 depending on parameter	
	High flow >5.0 cumecs at gauge 416202A – Talwood	Total N Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, NSW Office of Water	8 sample sites, 44 sample dates, N= 27-48 depending on parameter	1975-2017
8. Macintyre Barwon Floodplain catchment waters	**Low flow** <57.7 cumecs at gauge 416201A – Goondiwindi	Ammonium N Oxidised N Total N FRP Total P Chlorophyll-a Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, NSW Office of Water, Queensland Murray-Darling Committee, Continuous water quality monitoring to validate and calibrate the Source Catchment model and refine local baseline water quality targets (DEHP5)	29 sample sites, 640 sample dates, N= 10-1019 depending on parameter	1962-2017
	High flow >57.7 cumecs at gauge 416201A – Goondiwindi	Oxidised N Total N Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, NSW Office of Water, Queensland Murray-Darling Committee, DEHP5	10 sample sites, 44 sample dates, N= 9-45 depending on parameter	1966-2017
9. Lower Macintyre Brook catchment waters	**Low flow** <2.6 cumecs at gauge 416406A - Ben Dor Weir	Ammonium N Oxidised N Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, NSW Office of Water, Queensland Murray-Darling Committee	20 sample sites, 777 sample dates, N= 10-1424 depending on parameter	1952-2017
	High flow >2.6 cumecs	Total N Total P Turbidity	Surface Water database, Project Sciences database,	16 sample sites, 102 sample dates, N= 37-188	1954-2013

Water type	Flow Condition	Indicators	Sources	Number of samples	Dates (years) of samples
	at gauge 416406A - Ben Dor Weir	Suspended solids pH Conductivity Sulfate Alkalinity	NSW Office of Water, Queensland Murray-Darling Committee	depending on parameter	
MOONIE					
1. Upper Moonie River catchment waters	**Low flow** <2.1 cumecs at gauge 417205A – Flinton	Total N Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee	10 sample sites, 74 sample dates, N= 22-155 depending on parameter	1997-2016
	High flow >2.1 cumecs at gauge 417205A – Flinton	Turbidity pH Conductivity	Project Sciences database, Queensland Murray-Darling Committee	6 sample sites, 6 sample dates N= 11 depending on parameter	2007-2013
2. Middle Moonie River catchment waters	**Low flow** <2.1 cumecs at gauge 417205A – Flinton	Total N Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Queensland Murray-Darling Committee	8 sample sites, 62 sample dates N= 30-78 depending on parameter	2004-2016
	High flow >2.1 cumecs at gauge 417205A – Flinton	Insufficient data.			
3. Lower Moonie River catchment waters	**Low flow** <3.3 cumecs at gauge 417201B - Nindigully	Ammonium N Oxidised N Total N FRP Total P Turbidity Suspended solids pH Conductivity Sulfate Alkalinity	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee	15 sample sites, 159 sample dates, N= 16-271 depending on parameter	1958-2017
	High flow >3.3 cumecs at gauge 417201B - Nindigully	Ammonium N Oxidised N Total N FRP Total P Turbidity Suspended solids pH	Surface Water database, Project Sciences database, Queensland Murray-Darling Committee	8 sample sites, 41 sample dates, N= 8-47 depending on parameter	1972-2017

Water type	Flow Condition	Indicators	Sources	Number of samples	Dates (years) of samples
		Conductivity Sulfate Alkalinity			

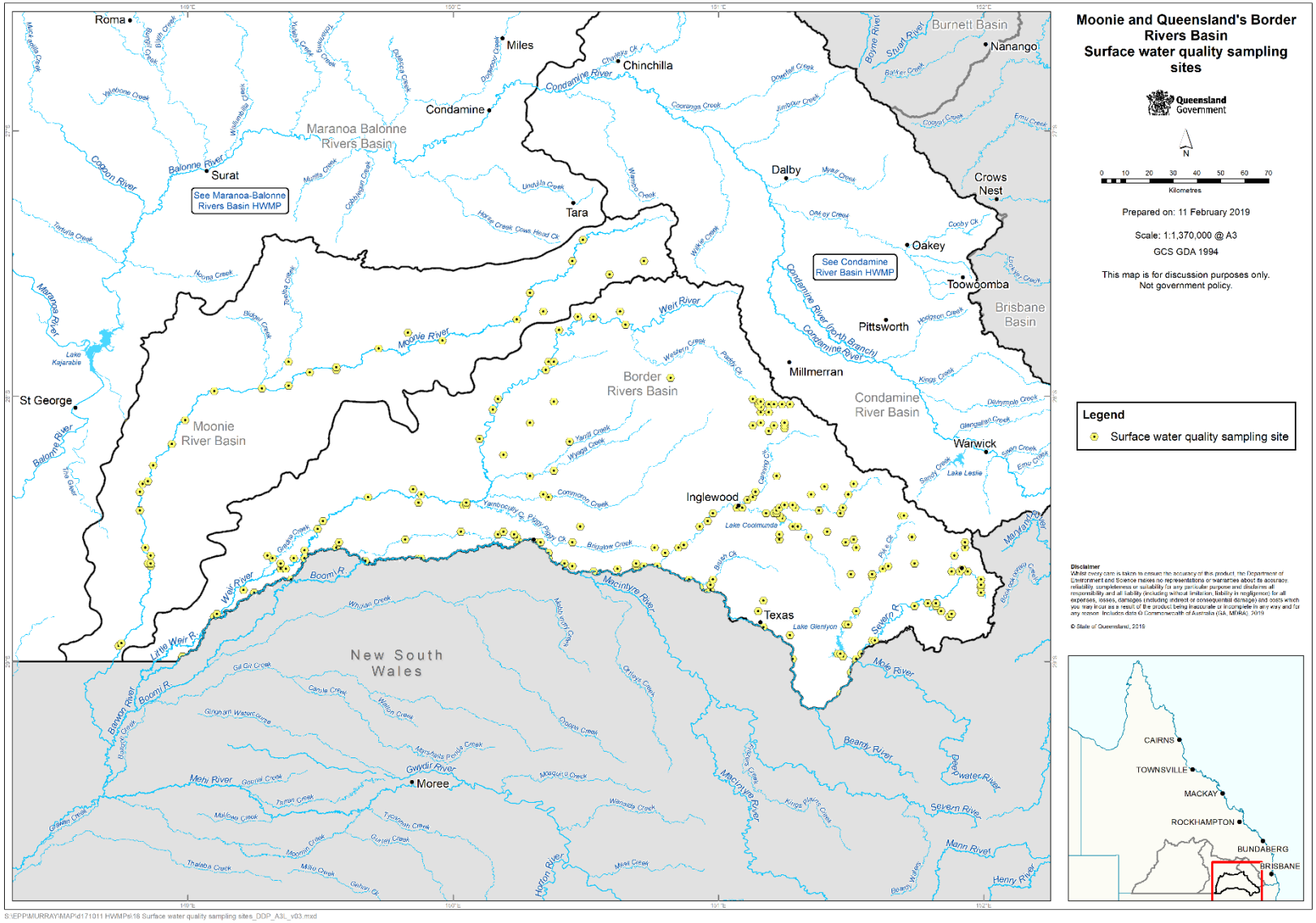


Figure 31: Surface water sample sites in the Moonie River and Queensland Border Rivers basins.

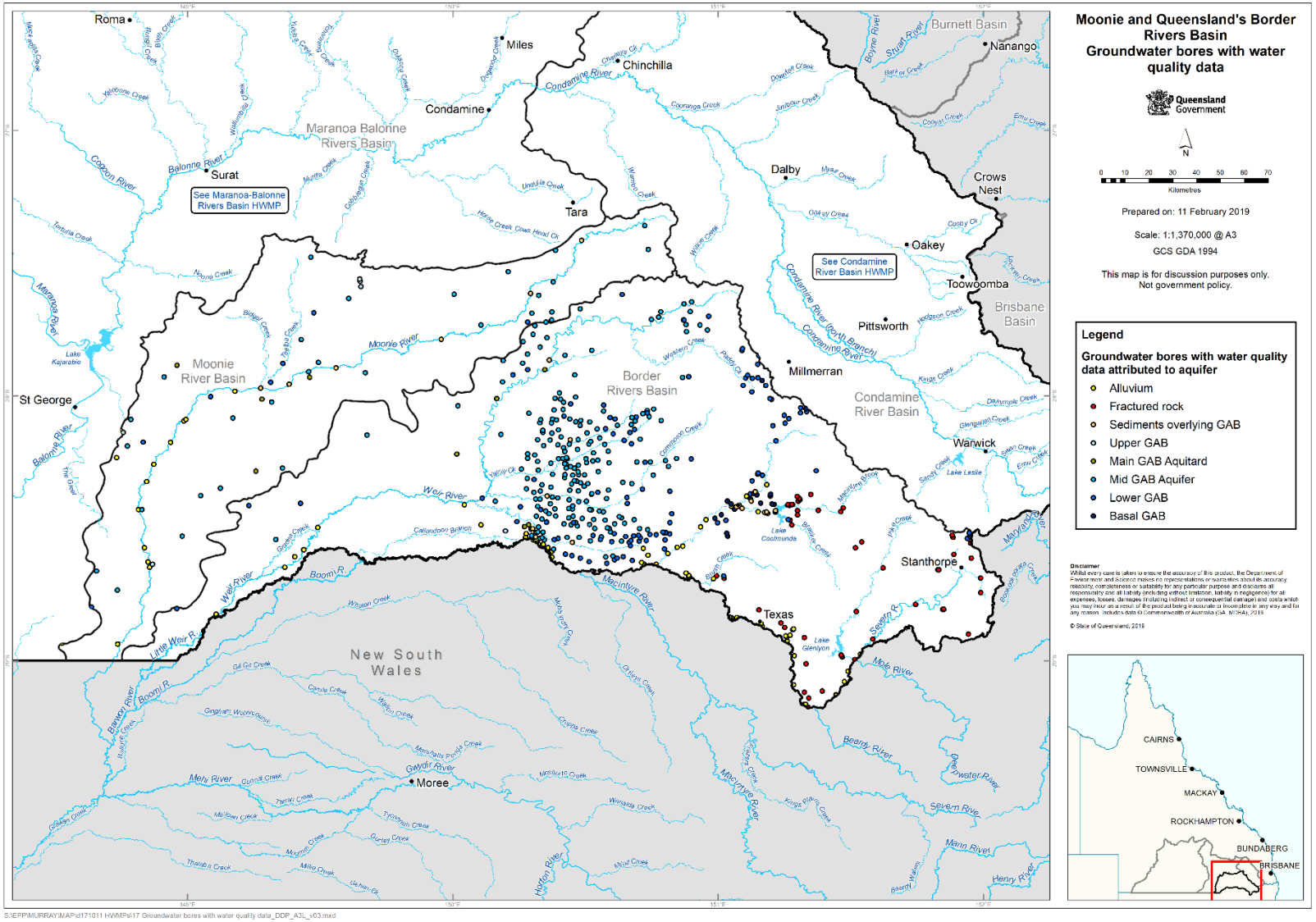


Figure 32: Groundwater bores with available chemistry data in the Moonie River and Queensland Border Rivers basins.

Appendix 2—Description of water types in the Queensland Border Rivers and Moonie River basins

The Queensland Water Quality Guidelines 2009 states that the aim of defining water types is to create groupings within which water quality (or biological condition) is sufficiently consistent that a single guideline value can be applied to all waters within each group or water type. Water types are developed through expert opinion of soil type, geology, topography and rainfall. The water types were considered to best represent ecologically relevant spatial areas for key water quality parameters.

The common soil types in the eastern basins of QMDB are as follows (Queensland Government, 2016):

1. Dermosol: Red, brown, yellow, grey or black soils which have loam to clay textures. The potential for erosion is dependent upon the level of slope and ground cover. This soil type is predominantly found on steep terrain of granites and metamorphics in the Granite Belt and Traprock regions, however the region generally has dermsols throughout.
2. Vertosol: Brown, grey or black soils which crack open when dry. This soil type has very high fertility and a large water-holding capacity, although is prone to sheet erosion if ground cover is not maintained. The region generally has vertosols throughout.
3. Kandosol: Red, yellow and grey soils which have low fertility and poor water-holding capacity. This soil type produces significant runoff under low vegetation cover, is highly erodible. Stoney Kandosols are predominantly found on steep terrain of granites and metamorphics in the Granite Belt and Traprock regions. Deep Kandosols are expressed in the flatter areas of the basins
4. Sodosol: Texture-contrast soils which are low in nutrients and very vulnerable to erosion (gully and tunnel) and dryland salinity when vegetation is removed. This soil type is predominantly found on steep terrain of granites and metamorphics in the Granite Belt and Traprock regions.
5. Chromosol: Texture-contrast soils which are not strongly acidic or sodic. They have moderate chemical fertility and water-holding capacity and can be susceptible to soil acidification and soil structure decline. Deep Chromosols are expressed in the flatter areas of the basins
6. Tenosols: Poorly developed, shallow, stony soils which generally have low fertility and low water-holding capacity (highly erodible). This soil type is predominantly found on steep terrain of granites and metamorphics in the Granite Belt and Traprock regions.

The water types for the Border Rivers and Moonie River basins are displayed in Figure 30.

The following descriptions of water types in the Border Rivers and Moonie River basins were informed by expert opinion from the Water Quality Technical Panel.

Water type	Landscape description
BORDER RIVERS	
Granite Belt catchment waters	Extends to the south west corner to include the Severn/Dumaresq catchment down to where the Dumaresq Valley zone starts. This allows for the inclusion of waters influenced by instream granitic waterholes and the hydrology from upstream.
Dumaresq Floodplain catchment waters	Dumaresq Floodplain catchment waters reflects inflow from Severn River and Glenlyon reservoir and the floodplain extent is defined by elevation.
Traprock catchment waters	Traprock catchment waters includes the ponded area of Coolmunda reservoir.
Canning Creek catchment waters	These catchment waters do not reside over traprock geology or the sandstone formations that define Kumbarilla Ridge. This produces a different water chemistry to the surrounding geologies.
Kumbarilla Ridge catchment waters	The boundaries of this water type are defined by the extent of the sandstone ridge. The differing geology and slope of this land area to adjacent land areas results in a different chemical signature of these waters.
Upper Weir River catchment waters	This water type was classified by variations in land use between Upper and Lower Weir River.

Water type	Landscape description
Lower Weir River catchment waters	This water type was classified by variations in land use between Upper and Lower Weir River.
Macintyre Barwon Floodplain catchment waters	These catchment waters reflect two significant inflows from where the Macintyre River enters Qld from NSW and the Dumaresq River. Although the geology may be similar to the Lower Weir, the inherent characteristics of the inflows warrant the separation of the Macintyre Barwon from the Lower Weir. There is some interflow between these systems from Goondiwindi west, however from a water quality perspective the waters remain different until close to Mungindi.
Lower Mac Brook catchment waters	Low flows in these catchment waters will be dominated by releases from Coolmunda whilst high flows will also include characteristics inherited from Canning Creek.
MOONIE	
Upper Moonie River catchment waters	The boundary between the Upper Moonie and Kumbarilla Ridge is determined due to the differences in land use between the two areas. Upper Moonie has higher salinity and EC than the Middle and Lower Moonie.
Middle Moonie River catchment waters	This water type was classified by variations in land use between Middle and Lower Moonie.
Lower Moonie River catchment waters	This water type was classified by variations in land use between Middle and Lower Moonie.

Appendix 3—Condamine-Balonne, Moonie and Queensland Border Rivers Water Quality Risk Assessment Methodology

Aim

This document aims to ensure that the risk assessment undertaken for the Healthy Waters Management Plans (HWMPs) for the Queensland Murray-Darling Basin Water Resource Plan (WRP) areas meets the requirements of the Murray-Darling Basin Plan (Basin Plan). The Healthy Waters Management Plans intend to fulfil the requirement for a Water Quality Management Plan (WQM Plan) under section 10.29 of the Basin Plan.

This document outlines the methodology to identify, evaluate and treat water quality risks to the current and future condition and continued availability of the water resources of Queensland Murray-Darling Basin WRP areas.

Background

Water quality for Queensland waters is managed under the *Environmental Protection Act 1994* and the Environmental Protection (Water) Policy 2009 (EPP Water). This legislation provides the framework for establishing Environmental Values (EVs), Water Quality Objectives (WQOs) and Healthy Waters Management Plans (HWMPs) for Queensland waters.

Environmental values reflect the ways in which water is valued and used within a catchment and are displayed in Figure 1. The Department of Environment and Science (DES) undertakes a process to identify local environmental values for key regions in Queensland through community and stakeholder consultation. Once the refined set of environmental values has been identified for a region, they are recommended for inclusion under Schedule 1 of the Queensland Environmental Protection (Water) Policy 2009 (EPP Water) (subordinate legislation under the *Environmental Protection Act 1994*) to inform statutory and non-statutory planning and decision-making. This is a key management action for maintaining and improving water quality for Queensland catchments.

The process to identify local environmental values for scheduling under the EPP Water is currently being undertaken across the Queensland Murray-Darling Basin (QMDB) WRP areas. It was conducted by DES, in consultation with the three former-Natural Resource Management groups of the region – Condamine Alliance, Queensland Murray-Darling Committee and South West NRM Ltd – which have now combined to become Southern Queensland NRM. Section 6 of the EPP Water states that in the absence of environmental values included in Schedule 1 of the EPP Water, the full list of environmental values applies to a region. As environmental values are yet to be scheduled under the EPP Water for Queensland Murray-Darling Basin catchments, the full set of environmental values were considered for the water quality risk assessment. This means that the impact of water quality degradation on aquatic ecosystems, irrigation, stock watering, recreation and other key values were included in the assessment.

Following the identification of EVs, local Water Quality Objectives for receiving waters are developed for each catchment area, under low and high flow conditions where possible. WQOs set a numerical value for key water quality indicators, setting the benchmark that is required to achieve the protection of the EVs over time. These WQOs are also scheduled under the EPP Water alongside EVs to inform planning and decision-making. Local WQOs have been developed by DES for QMDB WRP areas, in consultation with Department of Natural Resources, Mines and Energy (DNRME) and key stakeholders.

Under section 10.29 of the Basin Plan, a water resource plan is to include a Water Quality Management Plan. The Queensland Government established that the HWMPs developed under the EPP Water will be aligned with the requirements for a Water Quality Management Plan under the Basin Plan.

Figure 1 Environmental values under the Environmental Protection (Water) Policy 2009

Chapter 10, Part 9 of the Basin Plan describes the approaches to addressing risks to water resources to be included in a water resource plan. In accordance with section 10.41(7) of the Basin Plan, the water resource plan must describe the data and methods used to identify and assess risks.

The focus of the risk assessment methodology detailed in this section is on risks to the condition, or continued availability, of Basin water resources arising from water being of a quality unsuitable for use (water quality risk assessment).

Approach

The water quality risk assessment was conducted in line with the approach used by the Department of Natural Resources, Mines and Energy (DNRME) to review and replace the *Water Plan (Border Rivers) 2003* and *Water Plan (Moonie) 2003.* The approach is outlined in the Risk Assessment report – Border Rivers and Moonie (DNRME 2018) and is consistent with the AS/NZS ISO 31000:2009 Risk Management—Principles and Guidelines. It is also consistent with the National Water Initiative Policy Guidelines for Water Planning and Management—Risk Assessment Module developed by the Department of Sustainability, Environment, Water, Population and Communities. The risk management process follows 6 steps in a cycle, as detailed below and summarised in Figure 2.

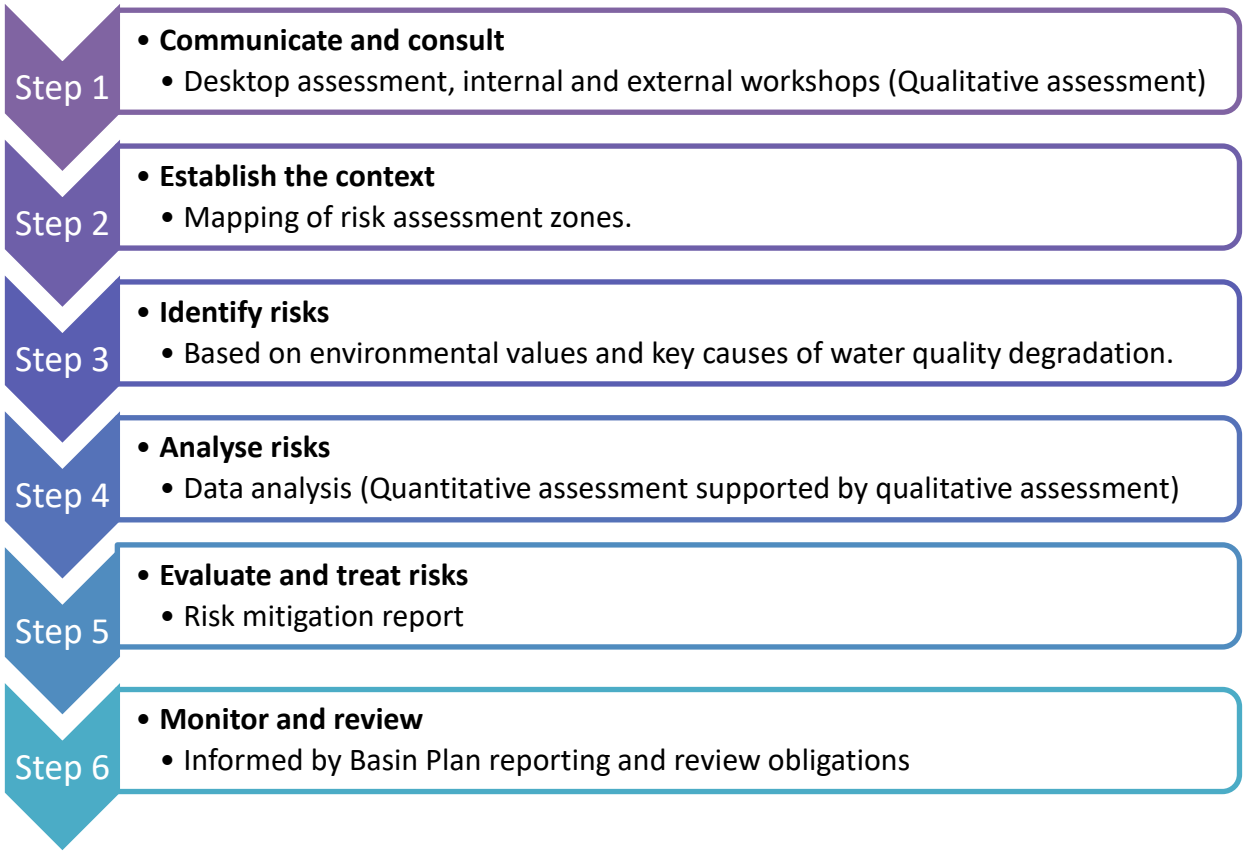


Figure 2: Summary of the approach used for the water quality risk assessment

Step 1: Communicate and consult

The following process was designed to ensure appropriate communication and consultation with internal and external stakeholders—

- Preliminary desktop assessment of known risks and preparation of the risk assessment template.
- Conduct an internal workshop to further identify and analyse risks featuring a panel of experts from across Queensland Government departments, with knowledge of the local area.
- Present outcomes of the risk assessment process to external stakeholders with the Department of Natural Resources, Mines and Energy at a range of workshops across Queensland Murray-Darling Basin catchments.
- Continue to obtain external feedback on the risk assessment through the development of the HWMP.

Step 2: Establish the context

For each Queensland Murray-Darling Basin WRP area, the assessment of surface water quality risks was based on groupings of several water type zones. These zones are displayed in Figure 3**.** This grouping allowed for a more manageable scale of assessment at the risk workshops. The Queensland Water Quality Guidelines 2009 states that the aim of defining water types is to create groupings within which water quality (or biological condition) is sufficiently consistent that a single guideline value can be applied to all waters within each water type. Water types are developed through expert opinion of soil type, geology, topography and rainfall, in addition to water quality data. The assessment of groundwater quality risks was based on the Groundwater and Deep Groundwater SDL resource units published by the Murray-Darling Basin Authority.

Step 3: Identify risks

This step describes risks in terms of what can happen and the impact that can result. Risks were identified based on the 10-year life span of a water resource plan, as defined by the *Water Act 2000* and the Basin Plan.

The water quality risk assessment focussed on risks to the condition, or continued availability, of Basin water resources arising from water being of a quality unsuitable for use. For the purpose of the water quality risk assessment, ‘use’ was taken to mean all the Environmental Values applicable in the plan area (Figure 1). Environmental Values define the uses of water for a region by aquatic ecosystems and for human uses (e.g. drinking water, irrigation, aquaculture, recreation). Thus, the risk assessment assesses the risks to the condition, or continued availability, of Basin water resources arising from water being of a quality unsuitable to protect the Environmental Values in the plan area.

Under section 10.41(2) of the Basin Plan, the risks are to include (where applicable) risks arising from elevated levels of salinity or other types of water quality degradation. The identification of risk factors was informed by the key causes of water quality degradation in Schedule 10 of the Basin Plan. These were included in the water quality risk assessment template.

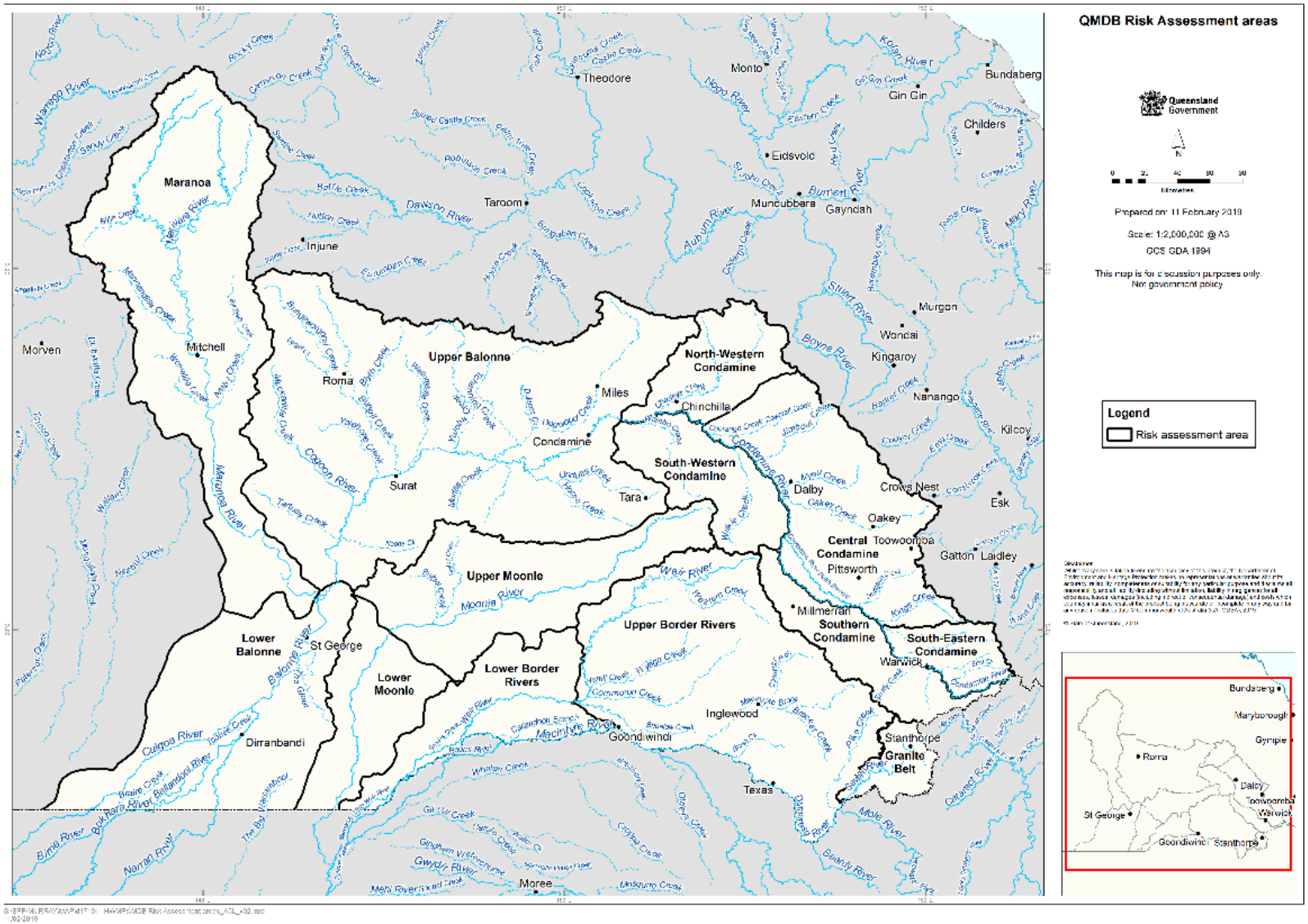


Figure 3: Surface water risk assessment units for the assessment of water quality in QMDB.

Step 4: Analyse risks

Each risk must be must be rated in terms of consequences and likelihood to establish the risk level (AS/NZS ISO 31000:2009 Risk Management - Principles and Guidelines). The Basin Plan does not specify detailed requirements for the risk assessment, such as a preferred risk analysis matrix. However, section 10.41(6) states that the level of risk, must be defined using the following categories—

- low
- medium
- high
- if it is considered appropriate, any additional category.

Section 10.42 of the Basin Plan specifies that a water resource plan must describe each risk identified as having a medium or higher risk and the factors that contribute to the risk.

Section 4.04 of the Basin Plan states that the Authority may publish guidelines setting out specific actions that may be taken in relation to the implementation of the strategies listed in subsection 4.03(3) to deal with the risks identified in section 4.02. These guidelines may include a specific risk assessment tool such as a risk analysis matrix; however, no such guidelines are currently available from the Murray-Darling Basin Authority. In the absence of specified guidelines, the existing risk analysis tools implemented by Queensland Government departments for water and aquatic ecosystems were utilised. This ensures consistency between the risk assessment approaches undertaken by DNRME and DES for the purpose of the Basin Plan accreditation package.

Defining consequence

Each consequence was categorised into ecological, economic and social/cultural impacts. Environmental Values were grouped under each of these headings, as shown below:

Ecological:	Aquatic ecosystems
Economic:	Irrigation, stock watering, aquaculture, farm use/supply, industry, human consumption and drinking water
Social/cultural:	Cultural and spiritual values, primary recreation, secondary recreation and visual amenity.

Note 1: For a risk to be assigned a given consequence it should reflect the situations described for each of the respective categories. However, where more than one impact category is relevant, the category with the highest consequences was selected in order to determine a single consequence level for the particular risk.

Note 2: Cultural and spiritual values, of water, means its aesthetic, historical, scientific, social or other significance, to the present, past or future generations in the general community. Cultural, spiritual and ceremonial values and uses for people from the Aboriginal Nations of the Queensland Murray-Darling Basin are being determined through specific workshops. These workshops will also identify risks to cultural, spiritual and ceremonial values and uses raised by participants of each Nation. This information will be summarised through a separate report.

Refer to **Table 1** for a description of each consequence and its associated impacts.

TABLE 1: **DEFINING CONSEQUENCES**

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 cultural and spiritual 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 cultural and spiritual 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 cultural and spiritual values 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 cultural and spiritual 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 cultural and spiritual values, recreational values and amenity. The site or vital community resource permanently affected.	5

Defining likelihood

The likelihood (chance of something happening) table is consistent with the risk assessments conducted by DNRME. **Table 2** identifies the likelihood categories and their definitions.

The risks to water quality were identified by statistical analysis of water quality data for waters of the Condamine-Balonne, Moonie and Queensland Border Rivers. The statistical analysis assessed the likelihood of water in a defined area exceeding the water quality guideline for that use of water. For example, the likelihood that waters in the Upper Balonne exceed the salinity water quality guideline value for aquaculture was determined to inform the likelihood score. This process was conducted for each Environmental Value in each risk assessment spatial unit. Where relevant, EVs of similar type were combined, allowing the assessment of risks to water quality for each environmental value to be streamlined. The EVs that were combined are:

- Recreation:
  - Primary Recreation
  - Secondary Recreation
  - Visual Recreation
- Consumption of aquatic food:
  - Aquaculture
  - Human Consumers of Aquatic Foods
- Agriculture:
  - Irrigation
  - Stock Watering
  - Farm Water Supply

The water quality data was sourced from the Queensland Government's water quality database, as well as from

local water quality monitoring programs including those conducted by natural resource management and industry groups. The water quality database is a highly comprehensive historical record of water quality for this area. Figure 4 displays the amount of data analysed during the assessment of the likelihood of risks occurring for each of the WRP areas, broken down into sources of data. The large quantity of data used in the analysis, which ranged from 1952-2016, shows the rigour behind this risk assessment process. The statistical analysis supported the qualitative information provided by participants at the risk assessment workshops, as well as highlighting additional risks not previously identified.

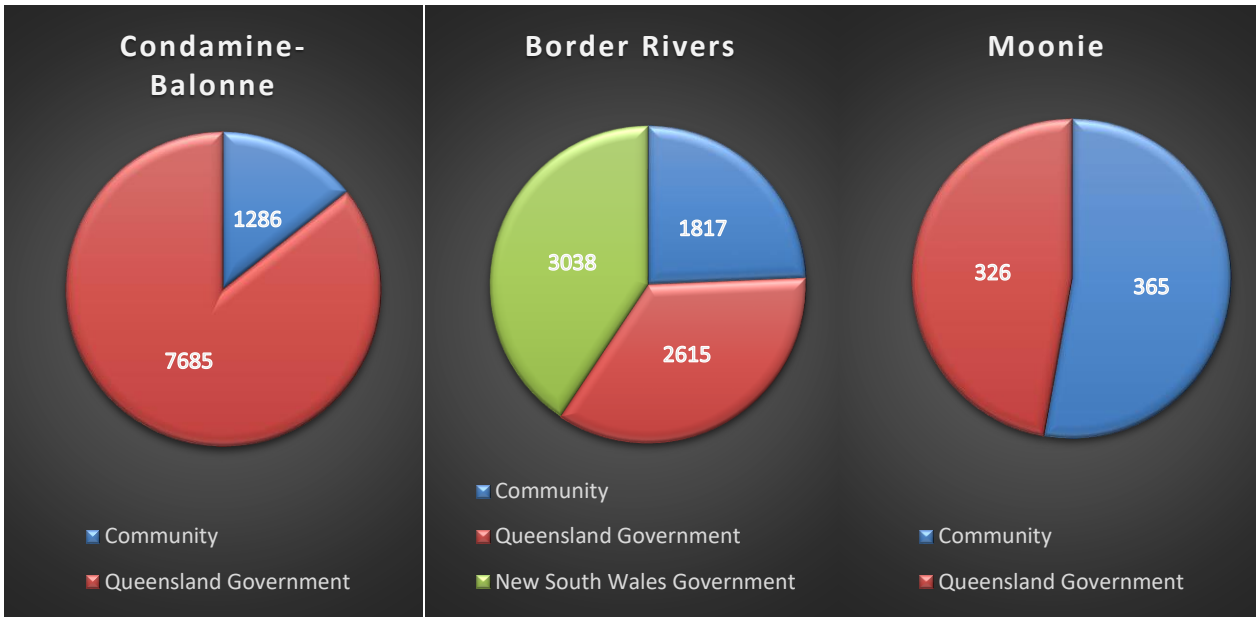


Figure 4: Showing the quantity of data analysed for the assessment of likelihood of risks occurring for the Condamine-Balonne, Border Rivers and Moonie basins, broken down by data source.

TABLE 2: **LIKELIHOOD TABLE**

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

Level of risk

The level of risk is determined using the definitions identified in the consequence and likelihood tables and the matrix shown in **Table 3**. The AS/NZS ISO 31000:2009 Risk Management - Principles and Guidelines states the following:

- consequences may be expressed qualitatively or quantitatively,
- the risk can escalate though knock-on effects
- likelihood can be defined, measured or determined objectively or subjectively, qualitatively or quantitatively and described using general terms or mathematically.

TABLE 3: **CONSEQUENCE AND LIKELIHOOD SCORING**

		Consequence				
Likelihood		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 table 3, the level of risk is categorised into low, medium, high or very 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

As per section 10.43 of the Basin Plan, any risk identified as medium or above must be addressed by management strategies within a water resource plan. The exception to this is if it can be explained why the risk cannot be addressed by the water resource plan in a manner commensurate with the level of risk. It is important therefore to clearly explain why a risk would be considered low and therefore tolerable without need for mitigation measures. The following is an explanation of the reasoning behind the 'low' level of risk identified in Table 4.

- Any risk that has a consequence of insignificant is considered a low risk because the consequences of the event occurring, irrespective of the likelihood of occurrence, would have undetectable impacts (refer to Table 1).
- A risk that has a consequence of minor and a likelihood of possible or less is considered a low risk because even if the event were to occur the consequences of the event are minimal and are recoverable in the short-term. This reasoning also applies to a risk that has a consequence of moderate but a likelihood of unlikely.
- A risk that has a likelihood of rare is ranked as low because it is only likely to occur in exceptional circumstances. The water resource plan accreditation package will include measures to manage extreme events, as required under section 10.51 of the Basin Plan.

Uncertainty rating for level of risk

In accordance with section 10.41(8) of the Basin Plan, the risk assessment must describe any quantified uncertainty in the level of risk attributed to each risk. To do so, an uncertainty score for each risk was assigned as per **Table 5** (based on the approach used by DNRME). Uncertainty scoring was applied to both the likelihood and consequence ranking.

TABLE 5: **UNCERTAINTY SCORES**

Category	Definition	Score
High	Inferred, very little evidence; some information known but not directly relevant to the region	1
Medium	Have some confidence in the score based on local knowledge but this may be limited	2
Low	Adequate high-quality evidence to support scores; process has been documented at a local or regional scale	3

Step 5: Evaluate and treat risks

This step determines which risks require treatment or whether the risk can be tolerated without treatment.

Options are identified to treat intolerable risks and ensure the most appropriate treatment/s for reducing the level of risk is implemented.

Section 10.43 of the Basin Plan states that if the level of risk is medium or higher, the water resource plan must either—

- describe a strategy for the management of the water resources of the water resource plan area that will address the risk, in a manner commensurate with the level of risk; or
- explain why the risk cannot be addressed by the water resource plan in a manner commensurate with the level of risk.

In addition, section 10.31 of the Basin Plan applies to the preparation of a Water Quality Management Plan. If any kind of risk (low, medium or high) has been identified in relation to elevated levels of salinity or other types of water quality degradation, the Water Quality Management Plan must explain why measures addressing the risk have or have not been included in the water resource plan.

For the purposes of the accreditation package, the index will direct the reader to the various instruments that make up the water resource plan as defined under section 10.04 of the Basin Plan. The instruments will include measures and strategies to address risks.

Step 6: Monitor and review

Section 10.46 of the Basin Plan states that a water resource plan must specify the monitoring of the water resources of the water resource plan area that will be done to enable the Basin State to fulfil its reporting obligations under section 13.14. There will also be the opportunity for a formal review of water resource plans, including the Water Quality Management Plans, at five (5) and 10 year intervals under the Basin Plan.

Appendix 4— Persistent Waterholes in the Border Rivers and Moonie River basins

Source: Persistent Waterhole Classification – Ozius Spatial on behalf of Water Planning Ecology, (former) Department of Science, Information Technology and Innovation, 2017.

Table 69: Persistent waterholes of the Border Rivers and Moonie River basins.

Basin	Locality	Longitude	Latitude
Border Rivers	Watsons Crossing	151.3147	-29.14026
Border Rivers	Riverton	151.4879	-29.08588
Border Rivers	Watsons Crossing	151.2785	-29.07375
Border Rivers	Riverton	151.5019	-29.07075
Border Rivers	Riverton	151.5008	-29.06451
Border Rivers	Riverton	151.4999	-29.06422
Border Rivers	Riverton	151.498	-29.06339
Border Rivers	Bonshaw	151.2849	-29.06016
Border Rivers	Bonshaw	151.2854	-29.04271
Border Rivers	Bonshaw	151.2845	-29.04094
Border Rivers	Bonshaw	151.2832	-29.03943
Border Rivers	Glenlyon	151.4082	-29.0342
Border Rivers	Bonshaw	151.2784	-29.02177
Border Rivers	Bonshaw	151.2794	-29.02124
Border Rivers	Bonshaw	151.2835	-29.01074
Border Rivers	Bonshaw	151.2839	-29.00817
Border Rivers	Bonshaw	151.2839	-29.00479
Border Rivers	Bonshaw	151.2831	-29.00234
Border Rivers	Bonshaw	151.282	-29.00097
Border Rivers	Mungindi	148.8786	-28.99828
Border Rivers	Bonshaw	151.2794	-28.99772
Border Rivers	Mungindi	148.9592	-28.99767
Border Rivers	Bonshaw	151.2779	-28.99442
Border Rivers	Mungindi	148.8985	-28.99394
Border Rivers	Mungindi	148.8841	-28.99374
Border Rivers	Bonshaw	151.2774	-28.99279
Border Rivers	Mungindi	148.9633	-28.99166

Basin	Locality	Longitude	Latitude
Border Rivers	Mungindi	148.8911	-28.99134
Border Rivers	Mungindi	148.9661	-28.99107
Border Rivers	Bonshaw	151.2768	-28.98994
Border Rivers	Mungindi	148.8976	-28.98949
Border Rivers	Mungindi	148.8986	-28.98663
Border Rivers	Glenlyon	151.4641	-28.98368
Border Rivers	Glenlyon	151.4644	-28.98328
Border Rivers	Mungindi	148.9071	-28.98191
Border Rivers	Mungindi	148.9117	-28.98167
Border Rivers	Mungindi	148.9163	-28.98124
Border Rivers	Glenlyon	151.4648	-28.98099
Border Rivers	Mungindi	148.9172	-28.98068
Border Rivers	Glenlyon	151.4644	-28.98058
Border Rivers	Glenlyon	151.4622	-28.9796
Border Rivers	Glenlyon	151.4633	-28.97948
Border Rivers	Mungindi	148.9716	-28.97827
Border Rivers	Mungindi	148.9726	-28.97826
Border Rivers	Mungindi	148.9832	-28.97661
Border Rivers	Glenlyon	151.4646	-28.97598
Border Rivers	Mungindi	148.9181	-28.9741
Border Rivers	Mungindi	148.989	-28.97395
Border Rivers	Glenlyon	151.4563	-28.97304
Border Rivers	Mungindi	148.9192	-28.97253
Border Rivers	Mungindi	148.995	-28.97251
Border Rivers	Mungindi	149.0001	-28.96946
Border Rivers	Mungindi	148.9186	-28.96915
Border Rivers	Mungindi	148.9199	-28.96846
Border Rivers	Glenlyon	151.4339	-28.96791
Border Rivers	Mungindi	149.005	-28.96483
Border Rivers	Glenlyon	151.4656	-28.9634

Basin	Locality	Longitude	Latitude
Border Rivers	Mungindi	149.0058	-28.95989
Border Rivers	Mungindi	149.007	-28.95961
Border Rivers	Mungindi	149.0084	-28.95945
Border Rivers	Glenlyon	151.4709	-28.9594
Border Rivers	Mungindi	149.0082	-28.95824
Border Rivers	Mungindi	149.015	-28.9576
Border Rivers	Glenlyon	151.4436	-28.95692
Border Rivers	Mungindi	149.0162	-28.9565
Border Rivers	Mungindi	149.0099	-28.95632
Border Rivers	Mungindi	149.0119	-28.95548
Border Rivers	Mungindi	149.0291	-28.95495
Border Rivers	Mungindi	149.0331	-28.95394
Border Rivers	Mungindi	149.0281	-28.95348
Border Rivers	Mungindi	149.0348	-28.95049
Border Rivers	Mungindi	149.0354	-28.94944
Border Rivers	Glenlyon	151.4698	-28.9491
Border Rivers	Glenlyon	151.4694	-28.94882
Border Rivers	Mungindi	149.0345	-28.94769
Border Rivers	Bonshaw	151.2809	-28.94763
Border Rivers	Bonshaw	151.2806	-28.94708
Border Rivers	Mungindi	149.0347	-28.94539
Border Rivers	Mungindi	149.0357	-28.9451
Border Rivers	Mungindi	149.0364	-28.94374
Border Rivers	Mungindi	149.0031	-28.94333
Border Rivers	Mungindi	149.0383	-28.94317
Border Rivers	Mungindi	149.0399	-28.94233
Border Rivers	Glenlyon	151.4514	-28.94158
Border Rivers	Mungindi	149.039	-28.94073
Border Rivers	Glenlyon	151.4518	-28.94054
Border Rivers	Mungindi	149.0386	-28.93951

Basin	Locality	Longitude	Latitude
Border Rivers	Mungindi	148.9605	-28.93697
Border Rivers	Mungindi	149.043	-28.9366
Border Rivers	Silver Spur	151.266	-28.93607
Border Rivers	Mungindi	149.0434	-28.93475
Border Rivers	Mungindi	149.0456	-28.93277
Border Rivers	Mungindi	149.044	-28.93117
Border Rivers	Mungindi	149.0449	-28.93116
Border Rivers	Mungindi	149.0434	-28.92983
Border Rivers	Mungindi	149.043	-28.92848
Border Rivers	Mungindi	149.0424	-28.92687
Border Rivers	Mungindi	149.0433	-28.92631
Border Rivers	Mungindi	149.0469	-28.92382
Border Rivers	Glenlyon	151.4493	-28.92368
Border Rivers	Mungindi	149.023	-28.92339
Border Rivers	Mungindi	149.0469	-28.92328
Border Rivers	Mungindi	149.0469	-28.92138
Border Rivers	Glenlyon	151.451	-28.91856
Border Rivers	Mungindi	149.0476	-28.91759
Border Rivers	Mungindi	149.0333	-28.91185
Border Rivers	Mungindi	149.055	-28.91179
Border Rivers	Glenlyon	151.4526	-28.90829
Border Rivers	Glenlyon	151.4529	-28.90735
Border Rivers	Glenlyon	151.4532	-28.90654
Border Rivers	Mungindi	149.0557	-28.90217
Border Rivers	Mungindi	149.0563	-28.89959
Border Rivers	Mungindi	149.0569	-28.89904
Border Rivers	Mungindi	149.0578	-28.89848
Border Rivers	Mungindi	149.0587	-28.89684
Border Rivers	Texas	151.207	-28.89333
Border Rivers	Wallangarra	151.9483	-28.88673

Basin	Locality	Longitude	Latitude
Border Rivers	Mungindi	149.0545	-28.88581
Border Rivers	Mungindi	149.0557	-28.88308
Border Rivers	Mungindi	149.0566	-28.88158
Border Rivers	Mungindi	149.0581	-28.88007
Border Rivers	Mungindi	149.0596	-28.87896
Border Rivers	Mungindi	149.0614	-28.8784
Border Rivers	Mungindi	149.0636	-28.87836
Border Rivers	Mungindi	149.0646	-28.87672
Border Rivers	Mungindi	149.0655	-28.87482
Border Rivers	Mungindi	149.0699	-28.87204
Border Rivers	Mungindi	149.0705	-28.86919
Border Rivers	Mungindi	149.0714	-28.86796
Border Rivers	Mungindi	149.0753	-28.85923
Border Rivers	Mungindi	149.0793	-28.85213
Border Rivers	Mungindi	149.0826	-28.84302
Border Rivers	Mungindi	149.0835	-28.8426
Border Rivers	Smithlea	151.1072	-28.84243
Border Rivers	Lyra	151.8506	-28.84053
Border Rivers	Mungindi	149.087	-28.83807
Border Rivers	Sundown	151.6529	-28.83788
Border Rivers	Mungindi	149.0884	-28.83738
Border Rivers	Mungindi	149.0895	-28.83736
Border Rivers	Mungindi	149.0903	-28.83707
Border Rivers	Mungindi	149.106	-28.83602
Border Rivers	Mungindi	149.0916	-28.83516
Border Rivers	Mungindi	149.1111	-28.83431
Border Rivers	Mungindi	149.0959	-28.83428
Border Rivers	Mungindi	149.123	-28.83413
Border Rivers	Mungindi	149.0994	-28.83396
Border Rivers	Mungindi	149.1234	-28.83358

Basin	Locality	Longitude	Latitude
Border Rivers	Mungindi	149.1097	-28.83352
Border Rivers	Mungindi	149.0933	-28.83351
Border Rivers	Mungindi	149.0945	-28.83349
Border Rivers	Mungindi	149.0986	-28.83316
Border Rivers	Mungindi	149.118	-28.83312
Border Rivers	Mungindi	149.1003	-28.83286
Border Rivers	Mungindi	149.0983	-28.83262
Border Rivers	Mungindi	149.0964	-28.83178
Border Rivers	Mungindi	149.108	-28.82516
Border Rivers	Mungindi	149.1083	-28.82421
Border Rivers	Mungindi	149.1094	-28.82297
Border Rivers	Mungindi	149.1129	-28.82292
Border Rivers	Mungindi	149.1184	-28.82283
Border Rivers	Mungindi	149.1104	-28.82269
Border Rivers	Mungindi	149.1207	-28.82253
Border Rivers	Silver Spur	151.2602	-28.82202
Border Rivers	Mungindi	149.1138	-28.82196
Border Rivers	Mungindi	149.1402	-28.82195
Border Rivers	Mungindi	149.1169	-28.8215
Border Rivers	Mungindi	149.1263	-28.81865
Border Rivers	Mungindi	149.1311	-28.81817
Border Rivers	Mungindi	149.1272	-28.81809
Border Rivers	Mungindi	149.1278	-28.81646
Border Rivers	Mungindi	149.1295	-28.81616
Border Rivers	Mungindi	149.1267	-28.81323
Border Rivers	Mungindi	149.1281	-28.81293
Border Rivers	Mungindi	149.1287	-28.81265
Border Rivers	Mungindi	149.1286	-28.81103
Border Rivers	Smithlea	151.0914	-28.80891
Border Rivers	Sundown	151.6957	-28.80825

Basin	Locality	Longitude	Latitude
Border Rivers	Mungindi	149.1255	-28.8077
Border Rivers	Mungindi	149.1261	-28.80728
Border Rivers	Ballandean	151.8297	-28.80569
Border Rivers	Mungindi	149.1301	-28.8056
Border Rivers	Mungindi	149.1282	-28.80508
Border Rivers	Ballandean	151.8851	-28.80291
Border Rivers	Ballandean	151.8641	-28.79916
Border Rivers	Mungindi	149.1461	-28.79506
Border Rivers	Mungindi	149.147	-28.79477
Border Rivers	Mungindi	149.1478	-28.79449
Border Rivers	Mungindi	149.1504	-28.79363
Border Rivers	Somme	151.8281	-28.78916
Border Rivers	Somme	151.8229	-28.78749
Border Rivers	Eukey	151.9664	-28.78677
Border Rivers	Mungindi	149.1634	-28.78476
Border Rivers	Mungindi	149.1643	-28.78218
Border Rivers	Mungindi	149.1646	-28.7815
Border Rivers	Somme	151.7802	-28.78143
Border Rivers	Sundown	151.6914	-28.78114
Border Rivers	Nundubbermere	151.7025	-28.78097
Border Rivers	Somme	151.7738	-28.78001
Border Rivers	Mungindi	149.1667	-28.77849
Border Rivers	Mungindi	149.167	-28.77794
Border Rivers	Mungindi	149.1678	-28.77495
Border Rivers	Mungindi	149.1691	-28.77439
Border Rivers	Mungindi	149.1696	-28.77357
Border Rivers	Fletcher	151.8313	-28.77321
Border Rivers	Fletcher	151.82	-28.77047
Border Rivers	Somme	151.8185	-28.76991
Border Rivers	Somme	151.8185	-28.76796

Basin	Locality	Longitude	Latitude
Border Rivers	Smithlea	151.0269	-28.75736
Border Rivers	Beebo	151.0215	-28.75078
Border Rivers	Nundubbermere	151.8215	-28.74659
Border Rivers	Beebo	151.0157	-28.74637
Border Rivers	South Talwood	149.1749	-28.74587
Border Rivers	South Talwood	149.1723	-28.74104
Border Rivers	South Talwood	149.1727	-28.74049
Border Rivers	Beebo	150.9634	-28.73774
Border Rivers	Mount Tully	151.9517	-28.73724
Border Rivers	Beebo	150.9649	-28.73722
Border Rivers	South Talwood	149.1763	-28.73665
Border Rivers	South Talwood	149.1772	-28.73636
Border Rivers	Beebo	150.9867	-28.73619
Border Rivers	Beebo	150.9612	-28.73608
Border Rivers	Beebo	150.9886	-28.73595
Border Rivers	Storm King	151.9903	-28.73388
Border Rivers	Beebo	150.968	-28.73375
Border Rivers	Beebo	150.9721	-28.73191
Border Rivers	Beebo	150.9392	-28.73115
Border Rivers	Storm King	151.9731	-28.72942
Border Rivers	Glen Aplin	151.8804	-28.72895
Border Rivers	Glen Aplin	151.8819	-28.72856
Border Rivers	South Talwood	149.1873	-28.7205
Border Rivers	Nundubbermere	151.7149	-28.71943
Border Rivers	Severnlea	151.9318	-28.7161
Border Rivers	Storm King	151.9938	-28.71509
Border Rivers	Warroo	151.4533	-28.71397
Border Rivers	Sugarloaf	152.016	-28.70807
Border Rivers	Sugarloaf	152.0151	-28.70807
Border Rivers	Sugarloaf	152.0125	-28.70791

Basin	Locality	Longitude	Latitude
Border Rivers	Thorndale	151.8469	-28.70078
Border Rivers	Sugarloaf	152.0101	-28.70059
Border Rivers	Limevale	151.2469	-28.69542
Border Rivers	Sugarloaf	152.0475	-28.6953
Border Rivers	Beebo	150.8924	-28.69036
Border Rivers	Sugarloaf	152.013	-28.68978
Border Rivers	South Talwood	149.2701	-28.68638
Border Rivers	South Talwood	149.2685	-28.68587
Border Rivers	South Talwood	149.2706	-28.68502
Border Rivers	Sugarloaf	152.0245	-28.68377
Border Rivers	Broadwater	151.868	-28.67795
Border Rivers	Dalcouth	151.9859	-28.67644
Border Rivers	Sugarloaf	152.0232	-28.67636
Border Rivers	Yelarbon	150.6303	-28.67511
Border Rivers	Yelarbon	150.6279	-28.67355
Border Rivers	Yelarbon	150.6074	-28.67131
Border Rivers	Yelarbon	150.623	-28.66895
Border Rivers	Yelarbon	150.6006	-28.66748
Border Rivers	Warroo	151.4252	-28.66567
Border Rivers	Kurumbul	150.4474	-28.6652
Border Rivers	Kurumbul	150.4576	-28.66435
Border Rivers	Kurumbul	150.4559	-28.66345
Border Rivers	Yelarbon	150.6481	-28.66279
Border Rivers	Yelarbon	150.537	-28.66244
Border Rivers	Kurumbul	150.4835	-28.66238
Border Rivers	Yelarbon	150.649	-28.66226
Border Rivers	Yelarbon	150.65	-28.66174
Border Rivers	Yelarbon	150.5421	-28.66095
Border Rivers	Yelarbon	150.5909	-28.66022
Border Rivers	Yelarbon	150.6564	-28.65969

Basin	Locality	Longitude	Latitude
Border Rivers	Yelarbon	150.6572	-28.65943
Border Rivers	Kurumbul	150.4986	-28.65924
Border Rivers	Yelarbon	150.5579	-28.65837
Border Rivers	Kurumbul	150.4879	-28.65776
Border Rivers	Yelarbon	150.6611	-28.6576
Border Rivers	Yelarbon	150.6617	-28.65734
Border Rivers	Yelarbon	150.6623	-28.65708
Border Rivers	Yelarbon	150.6633	-28.65683
Border Rivers	Yelarbon	150.533	-28.65632
Border Rivers	Yelarbon	150.6651	-28.65618
Border Rivers	Yelarbon	150.6995	-28.65528
Border Rivers	Yelarbon	150.6903	-28.65512
Border Rivers	Yelarbon	150.6984	-28.65499
Border Rivers	Yelarbon	150.7045	-28.65401
Border Rivers	Yelarbon	150.7085	-28.65246
Border Rivers	Stanthorpe	151.9533	-28.65196
Border Rivers	Kurumbul	150.4168	-28.65105
Border Rivers	Stanthorpe	151.9543	-28.65089
Border Rivers	Kurumbul	150.4239	-28.65033
Border Rivers	Kurumbul	150.493	-28.64932
Border Rivers	Kurumbul	150.4507	-28.64762
Border Rivers	Yelarbon	150.785	-28.6475
Border Rivers	Warroo	151.421	-28.64599
Border Rivers	Yelarbon	150.7129	-28.64495
Border Rivers	Yelarbon	150.7135	-28.64469
Border Rivers	Yelarbon	150.7155	-28.64418
Border Rivers	Kurumbul	150.4158	-28.64405
Border Rivers	Yelarbon	150.7166	-28.64366
Border Rivers	Yelarbon	150.7173	-28.6434
Border Rivers	Yelarbon	150.718	-28.64314

Basin	Locality	Longitude	Latitude
Border Rivers	Yelarbon	150.7213	-28.64211
Border Rivers	Dalcouth	151.9851	-28.63758
Border Rivers	Stanthorpe	151.9408	-28.63747
Border Rivers	Yelarbon	150.7604	-28.636
Border Rivers	Yelarbon	150.734	-28.63505
Border Rivers	Yelarbon	150.7422	-28.63494
Border Rivers	Yelarbon	150.7399	-28.63488
Border Rivers	Toobeah	149.6786	-28.6348
Border Rivers	Yelarbon	150.7432	-28.63464
Border Rivers	Toobeah	149.6912	-28.63414
Border Rivers	Kurumbul	150.388	-28.63392
Border Rivers	Kurumbul	150.4687	-28.63356
Border Rivers	Toobeah	149.6731	-28.63355
Border Rivers	Warroo	151.4666	-28.63311
Border Rivers	Toobeah	149.6784	-28.63291
Border Rivers	Toobeah	149.692	-28.63269
Border Rivers	Toobeah	149.6751	-28.63243
Border Rivers	Toobeah	149.7056	-28.63178
Border Rivers	Toobeah	149.6989	-28.63142
Border Rivers	Kurumbul	150.4045	-28.63107
Border Rivers	Kurumbul	150.4568	-28.63102
Border Rivers	Kurumbul	150.4043	-28.62905
Border Rivers	Cannon Creek	151.879	-28.62831
Border Rivers	Kurumbul	150.4032	-28.62799
Border Rivers	Toobeah	149.6731	-28.62638
Border Rivers	Yelarbon	150.783	-28.62609
Border Rivers	Kurumbul	150.4332	-28.62599
Border Rivers	Yelarbon	150.7833	-28.62542
Border Rivers	Toobeah	149.7034	-28.62532
Border Rivers	Cannon Creek	151.8677	-28.62514

Basin	Locality	Longitude	Latitude
Border Rivers	Toobeah	149.6727	-28.62436
Border Rivers	Yelarbon	150.7839	-28.62394
Border Rivers	Yelarbon	150.7843	-28.62313
Border Rivers	Yelarbon	150.6288	-28.62267
Border Rivers	Toobeah	149.7079	-28.62203
Border Rivers	Yelarbon	150.7849	-28.62179
Border Rivers	Toobeah	149.7067	-28.62159
Border Rivers	Kurumbul	150.3863	-28.62116
Border Rivers	Applethorpe	151.8898	-28.62072
Border Rivers	Cannon Creek	151.8788	-28.62036
Border Rivers	Applethorpe	151.9624	-28.61913
Border Rivers	Toobeah	149.704	-28.61697
Border Rivers	Yelarbon	150.7868	-28.61695
Border Rivers	Toobeah	149.8921	-28.61674
Border Rivers	Yelarbon	150.7878	-28.61588
Border Rivers	Toobeah	149.82	-28.61542
Border Rivers	Toobeah	149.9032	-28.61529
Border Rivers	Applethorpe	151.965	-28.61509
Border Rivers	Toobeah	149.7609	-28.61474
Border Rivers	Applethorpe	151.9663	-28.61469
Border Rivers	Toobeah	149.7679	-28.61433
Border Rivers	Toobeah	149.7079	-28.61419
Border Rivers	Applethorpe	151.9679	-28.61377
Border Rivers	Applethorpe	151.9813	-28.61359
Border Rivers	Toobeah	149.7175	-28.61268
Border Rivers	Toobeah	149.8202	-28.6123
Border Rivers	Yelarbon	150.7952	-28.61194
Border Rivers	Yelarbon	150.7962	-28.61168
Border Rivers	South Talwood	149.322	-28.61161
Border Rivers	Yelarbon	150.7971	-28.61116

Basin	Locality	Longitude	Latitude
Border Rivers	Toobeah	149.7294	-28.61105
Border Rivers	Toobeah	149.7784	-28.61087
Border Rivers	Toobeah	149.7941	-28.61085
Border Rivers	Applethorpe	151.9666	-28.61077
Border Rivers	Yelarbon	150.798	-28.61063
Border Rivers	Toobeah	149.7165	-28.61063
Border Rivers	Toobeah	149.8773	-28.61046
Border Rivers	Toobeah	149.8472	-28.60998
Border Rivers	Toobeah	149.7747	-28.60991
Border Rivers	Toobeah	149.8821	-28.60978
Border Rivers	Toobeah	149.772	-28.6096
Border Rivers	Toobeah	149.7984	-28.60951
Border Rivers	Yelarbon	150.6704	-28.60925
Border Rivers	Toobeah	149.8221	-28.60901
Border Rivers	Callandoon	149.9679	-28.60896
Border Rivers	Toobeah	149.7894	-28.60874
Border Rivers	Applethorpe	151.9367	-28.60864
Border Rivers	Toobeah	149.9578	-28.60842
Border Rivers	Toobeah	149.8029	-28.60792
Border Rivers	Toobeah	149.8267	-28.60703
Border Rivers	Toobeah	149.8424	-28.60656
Border Rivers	Toobeah	149.8297	-28.60625
Border Rivers	Toobeah	149.8704	-28.60543
Border Rivers	Callandoon	149.9666	-28.60471
Border Rivers	Toobeah	149.8306	-28.60414
Border Rivers	Yelarbon	150.6792	-28.60306
Border Rivers	Toobeah	149.9167	-28.6016
Border Rivers	Warroo	151.4178	-28.60142
Border Rivers	Toobeah	149.9234	-28.60041
Border Rivers	Bungunya	149.6186	-28.59862

Basin	Locality	Longitude	Latitude
Border Rivers	Glen Niven	151.9721	-28.59347
Border Rivers	Kurumbul	150.3567	-28.58952
Border Rivers	South Talwood	149.3542	-28.58913
Border Rivers	South Talwood	149.3555	-28.58816
Border Rivers	South Talwood	149.3586	-28.58797
Border Rivers	Warroo	151.4343	-28.58604
Border Rivers	South Talwood	149.3706	-28.58383
Border Rivers	Toobeah	149.7556	-28.5833
Border Rivers	Toobeah	149.7595	-28.58213
Border Rivers	South Talwood	149.4974	-28.58029
Border Rivers	Toobeah	149.7483	-28.579
Border Rivers	South Talwood	149.3711	-28.57841
Border Rivers	Callandoon	150.084	-28.57503
Border Rivers	Toobeah	149.7496	-28.57411
Border Rivers	Callandoon	150.0859	-28.57368
Border Rivers	South Talwood	149.5713	-28.57165
Border Rivers	Bungunya	149.5929	-28.57002
Border Rivers	Callandoon	150.1894	-28.57002
Border Rivers	Callandoon	150.1869	-28.56866
Border Rivers	Callandoon	150.1899	-28.56739
Border Rivers	Callandoon	150.1926	-28.56679
Border Rivers	Callandoon	150.1865	-28.56644
Border Rivers	South Talwood	149.391	-28.56588
Border Rivers	Callandoon	150.2292	-28.56513
Border Rivers	Callandoon	150.1852	-28.56484
Border Rivers	Whetstone	150.867	-28.5636
Border Rivers	South Talwood	149.2601	-28.56257
Border Rivers	Whetstone	150.8684	-28.56046
Border Rivers	Callandoon	150.2324	-28.55967
Border Rivers	South Talwood	149.5313	-28.55941

Basin	Locality	Longitude	Latitude
Border Rivers	Glenarbon	150.8685	-28.55816
Border Rivers	Goondiwindi	150.3389	-28.55655
Border Rivers	Goondiwindi	150.344	-28.55574
Border Rivers	Goondiwindi	150.3414	-28.55514
Border Rivers	South Talwood	149.5384	-28.55278
Border Rivers	Callandoon	150.2491	-28.55171
Border Rivers	Callandoon	150.1535	-28.55064
Border Rivers	Whetstone	150.8695	-28.5506
Border Rivers	South Talwood	149.5446	-28.54996
Border Rivers	Whetstone	150.8727	-28.54957
Border Rivers	Whetstone	150.8749	-28.54933
Border Rivers	Glenarbon	150.8763	-28.54908
Border Rivers	Whetstone	150.8756	-28.54907
Border Rivers	Toobeah	149.8168	-28.54848
Border Rivers	Whetstone	150.8796	-28.54832
Border Rivers	Goondiwindi	150.3353	-28.54793
Border Rivers	Goondiwindi	150.3303	-28.54763
Border Rivers	Callandoon	150.0054	-28.54757
Border Rivers	Goondiwindi	150.3456	-28.54732
Border Rivers	Toobeah	149.8154	-28.54718
Border Rivers	South Talwood	149.5653	-28.54713
Border Rivers	Toobeah	149.8065	-28.54642
Border Rivers	South Talwood	149.5662	-28.5464
Border Rivers	Toobeah	149.8137	-28.54627
Border Rivers	Goondiwindi	150.3355	-28.54513
Border Rivers	Goondiwindi	150.3366	-28.54456
Border Rivers	Toobeah	149.8056	-28.54428
Border Rivers	Callandoon	150.2296	-28.54352
Border Rivers	Goondiwindi	150.3382	-28.54343
Border Rivers	Goondiwindi	150.3302	-28.54229

Basin	Locality	Longitude	Latitude
Border Rivers	Callandoon	150.2372	-28.54224
Border Rivers	Callandoon	150.2388	-28.54179
Border Rivers	Goondiwindi	150.3293	-28.54096
Border Rivers	Goondiwindi	150.3246	-28.5381
Border Rivers	Callandoon	150.2006	-28.53769
Border Rivers	Callandoon	150.1979	-28.53668
Border Rivers	Callandoon	150.1958	-28.5351
Border Rivers	Goondiwindi	150.318	-28.53473
Border Rivers	Callandoon	150.1908	-28.5327
Border Rivers	Toobeah	149.7845	-28.53104
Border Rivers	Toobeah	149.9523	-28.53061
Border Rivers	Toobeah	149.8692	-28.53012
Border Rivers	Callandoon	150.1661	-28.52985
Border Rivers	Callandoon	150.14	-28.52937
Border Rivers	Bungunya	149.5958	-28.5249
Border Rivers	Toobeah	149.8972	-28.52374
Border Rivers	Goondiwindi	150.3445	-28.5218
Border Rivers	Toobeah	149.8456	-28.52179
Border Rivers	Toobeah	149.8524	-28.5207
Border Rivers	Bungunya	149.598	-28.52012
Border Rivers	Goondiwindi	150.3426	-28.51993
Border Rivers	Callandoon	150.1203	-28.51954
Border Rivers	Goondiwindi	150.3419	-28.51914
Border Rivers	Toobeah	149.9625	-28.51902
Border Rivers	Bungunya	149.6261	-28.51661
Border Rivers	Bungunya	149.5995	-28.51549
Border Rivers	Bungunya	149.6048	-28.51429
Border Rivers	Bungunya	149.6227	-28.51416
Border Rivers	Callandoon	150.1044	-28.51396
Border Rivers	Bungunya	149.6389	-28.51389

Basin	Locality	Longitude	Latitude
Border Rivers	Callandoon	150.1086	-28.51372
Border Rivers	Bungunya	149.6165	-28.51207
Border Rivers	Bungunya	149.6105	-28.51136
Border Rivers	Bungunya	149.6396	-28.51053
Border Rivers	Bungunya	149.6031	-28.51028
Border Rivers	Bungunya	149.6087	-28.5101
Border Rivers	Bungunya	149.6408	-28.5101
Border Rivers	Bungunya	149.64	-28.50632
Border Rivers	Goondiwindi	150.3338	-28.50543
Border Rivers	North Talwood	149.2798	-28.50446
Border Rivers	Bungunya	149.6484	-28.50251
Border Rivers	Toobeah	149.977	-28.49963
Border Rivers	Callandoon	150.004	-28.49954
Border Rivers	Bungunya	149.6735	-28.49917
Border Rivers	Callandoon	150.0061	-28.49895
Border Rivers	Toobeah	149.8347	-28.49888
Border Rivers	Yelarbon	150.6319	-28.4987
Border Rivers	Goondiwindi	150.4176	-28.4981
Border Rivers	Callandoon	150.0109	-28.49671
Border Rivers	Toobeah	149.9841	-28.49474
Border Rivers	Toobeah	149.9908	-28.49161
Border Rivers	Goondiwindi	150.3652	-28.49015
Border Rivers	Callandoon	150.0558	-28.48973
Border Rivers	Callandoon	150.0532	-28.48903
Border Rivers	Wondalli	150.5137	-28.48883
Border Rivers	Toobeah	149.8205	-28.48862
Border Rivers	South Talwood	149.495	-28.48755
Border Rivers	South Talwood	149.4952	-28.48673
Border Rivers	Callandoon	150.0724	-28.48578
Border Rivers	Callandoon	150.0617	-28.48421

Basin	Locality	Longitude	Latitude
Border Rivers	North Talwood	149.4999	-28.4838
Border Rivers	Callandoon	150.0393	-28.48336
Border Rivers	Callandoon	150.0612	-28.48305
Border Rivers	Goondiwindi	150.2676	-28.4828
Border Rivers	Toobeah	149.7653	-28.48256
Border Rivers	Toobeah	149.961	-28.48096
Border Rivers	Callandoon	150.0683	-28.47703
Border Rivers	Callandoon	150.059	-28.47697
Border Rivers	Callandoon	150.066	-28.47681
Border Rivers	Callandoon	150.0614	-28.47624
Border Rivers	Goodar	150.1244	-28.47494
Border Rivers	Goodar	150.084	-28.47383
Border Rivers	Goodar	150.0766	-28.47373
Border Rivers	Callandoon	150.0234	-28.47081
Border Rivers	Coolmunda	151.2347	-28.47043
Border Rivers	Coolmunda	151.2348	-28.46975
Border Rivers	Toobeah	149.7465	-28.46971
Border Rivers	North Talwood	149.3542	-28.46949
Border Rivers	Bungunya	149.7397	-28.46903
Border Rivers	North Talwood	149.3535	-28.46855
Border Rivers	Bungunya	149.7381	-28.46852
Border Rivers	North Talwood	149.3508	-28.46792
Border Rivers	Toobeah	150.0173	-28.46771
Border Rivers	Goodar	150.0716	-28.46766
Border Rivers	Inglewood	150.9548	-28.46691
Border Rivers	Bungunya	149.7345	-28.4663
Border Rivers	Inglewood	150.9576	-28.46614
Border Rivers	Bungunya	149.7318	-28.46594
Border Rivers	Callandoon	150.0279	-28.46368
Border Rivers	Toobeah	149.7541	-28.46306

Basin	Locality	Longitude	Latitude
Border Rivers	Toobeah	149.8083	-28.46222
Border Rivers	Bungunya	149.7273	-28.46089
Border Rivers	Bungunya	149.7228	-28.46017
Border Rivers	Toobeah	149.8295	-28.45894
Border Rivers	Coolmunda	151.2509	-28.45886
Border Rivers	Toobeah	149.8378	-28.45881
Border Rivers	Coolmunda	151.2506	-28.45858
Border Rivers	Toobeah	149.8232	-28.45853
Border Rivers	Coolmunda	151.2503	-28.45831
Border Rivers	Coolmunda	151.2498	-28.45803
Border Rivers	Coolmunda	151.2493	-28.45775
Border Rivers	Toobeah	149.8039	-28.45757
Border Rivers	Coolmunda	151.2489	-28.45748
Border Rivers	Coolmunda	151.2478	-28.45719
Border Rivers	North Talwood	149.5328	-28.45654
Border Rivers	Bungunya	149.7543	-28.45645
Border Rivers	Toobeah	149.8456	-28.45644
Border Rivers	Coolmunda	151.239	-28.45491
Border Rivers	Coolmunda	151.2393	-28.45465
Border Rivers	Coolmunda	151.2396	-28.45438
Border Rivers	Coolmunda	151.2399	-28.45411
Border Rivers	Coolmunda	151.2402	-28.45331
Border Rivers	Bungunya	149.7668	-28.4513
Border Rivers	Bungunya	149.7747	-28.451
Border Rivers	Bungunya	149.6193	-28.44908
Border Rivers	Bungunya	149.7703	-28.44854
Border Rivers	Toobeah	149.9713	-28.44804
Border Rivers	Bungunya	149.7304	-28.44794
Border Rivers	North Talwood	149.5436	-28.4474
Border Rivers	North Talwood	149.5439	-28.44686

Basin	Locality	Longitude	Latitude
Border Rivers	North Talwood	149.5301	-28.44671
Border Rivers	North Talwood	149.5479	-28.44665
Border Rivers	North Talwood	149.546	-28.446
Border Rivers	North Talwood	149.5528	-28.44588
Border Rivers	North Talwood	149.5411	-28.44542
Border Rivers	North Talwood	149.5457	-28.4452
Border Rivers	Toobeah	149.9993	-28.44465
Border Rivers	North Talwood	149.5451	-28.44399
Border Rivers	Toobeah	149.9622	-28.44396
Border Rivers	North Talwood	149.5438	-28.44388
Border Rivers	North Talwood	149.5353	-28.44381
Border Rivers	North Talwood	149.5374	-28.44373
Border Rivers	North Talwood	149.5388	-28.4437
Border Rivers	North Talwood	149.5539	-28.44369
Border Rivers	Goondiwindi	150.2848	-28.44356
Border Rivers	Wondalli	150.6038	-28.44305
Border Rivers	North Talwood	149.3621	-28.44161
Border Rivers	North Talwood	149.2915	-28.44133
Border Rivers	Bungunya	149.7335	-28.43973
Border Rivers	Toobeah	149.9762	-28.43876
Border Rivers	Coolmunda	151.1958	-28.43864
Border Rivers	North Talwood	149.5587	-28.43846
Border Rivers	Coolmunda	151.2241	-28.43807
Border Rivers	North Talwood	149.5636	-28.43728
Border Rivers	Coolmunda	151.216	-28.43648
Border Rivers	Coolmunda	151.2157	-28.4362
Border Rivers	Coolmunda	151.1873	-28.43603
Border Rivers	Coolmunda	151.1832	-28.43578
Border Rivers	Bungunya	149.7362	-28.43554
Border Rivers	Goondiwindi	150.4179	-28.43527

Basin	Locality	Longitude	Latitude
Border Rivers	Toobeah	149.9851	-28.43525
Border Rivers	Bungunya	149.7402	-28.43479
Border Rivers	Bungunya	149.7377	-28.4347
Border Rivers	Bungunya	149.7278	-28.43436
Border Rivers	Bungunya	149.7386	-28.43387
Border Rivers	Bungunya	149.7268	-28.43339
Border Rivers	Inglewood	151.0035	-28.43298
Border Rivers	Bungunya	149.7303	-28.43214
Border Rivers	Toobeah	149.961	-28.43029
Border Rivers	Goodar	150.1888	-28.43028
Border Rivers	Goodar	150.1852	-28.42956
Border Rivers	Toobeah	149.9997	-28.42701
Border Rivers	Goodar	150.2039	-28.42606
Border Rivers	Goodar	150.1901	-28.42552
Border Rivers	Bungunya	149.5858	-28.4255
Border Rivers	Bungunya	149.5881	-28.42545
Border Rivers	Bungunya	149.5896	-28.42515
Border Rivers	Bungunya	149.5905	-28.42446
Border Rivers	Goodar	150.1911	-28.42428
Border Rivers	Goodar	150.1169	-28.42303
Border Rivers	Goodar	150.1176	-28.42274
Border Rivers	Toobeah	149.791	-28.42252
Border Rivers	Coolmunda	151.234	-28.42182
Border Rivers	Coolmunda	151.2337	-28.42155
Border Rivers	Coolmunda	151.2371	-28.42105
Border Rivers	Coolmunda	151.2346	-28.42027
Border Rivers	Inglewood	151.0703	-28.41716
Border Rivers	Coolmunda	151.2356	-28.41697
Border Rivers	Inglewood	151.0718	-28.41637
Border Rivers	Inglewood	151.0731	-28.4149

Basin	Locality	Longitude	Latitude
Border Rivers	Goodar	150.0473	-28.4035
Border Rivers	Wondalli	150.583	-28.40316
Border Rivers	Toobeah	149.9796	-28.40202
Border Rivers	Toobeah	149.8795	-28.40079
Border Rivers	Toobeah	150.0236	-28.39969
Border Rivers	Toobeah	149.963	-28.39913
Border Rivers	Toobeah	149.884	-28.39907
Border Rivers	Toobeah	149.8803	-28.39847
Border Rivers	Toobeah	149.9798	-28.39768
Border Rivers	Toobeah	149.8806	-28.39765
Border Rivers	Toobeah	149.884	-28.39704
Border Rivers	Goodar	149.992	-28.39633
Border Rivers	Toobeah	149.9908	-28.39622
Border Rivers	Toobeah	149.9614	-28.39619
Border Rivers	Goodar	149.9926	-28.39605
Border Rivers	Toobeah	149.996	-28.39598
Border Rivers	Toobeah	149.9966	-28.39569
Border Rivers	Toobeah	149.9601	-28.39405
Border Rivers	Bungunya	149.6234	-28.39311
Border Rivers	Toobeah	149.9594	-28.39244
Border Rivers	Toobeah	149.9568	-28.39196
Border Rivers	Toobeah	149.958	-28.39139
Border Rivers	Bungunya	149.6236	-28.38877
Border Rivers	Bungunya	149.6957	-28.38845
Border Rivers	Bungunya	149.6966	-28.38816
Border Rivers	Bungunya	149.6977	-28.38787
Border Rivers	Bungunya	149.6986	-28.38758
Border Rivers	Bungunya	149.6992	-28.3873
Border Rivers	Bungunya	149.7001	-28.38674
Border Rivers	Bungunya	149.7013	-28.38618

Basin	Locality	Longitude	Latitude
Border Rivers	Bungunya	149.6332	-28.3811
Border Rivers	Bungunya	149.6373	-28.38063
Border Rivers	Bungunya	149.6348	-28.38028
Border Rivers	Bungunya	149.6852	-28.37973
Border Rivers	Goondiwindi	150.3471	-28.37724
Border Rivers	Goodar	150.1648	-28.37457
Border Rivers	Goodar	150.1768	-28.37456
Border Rivers	Goodar	150.1836	-28.36993
Border Rivers	Toobeah	149.7991	-28.35839
Border Rivers	Toobeah	149.7718	-28.35688
Border Rivers	Bungunya	149.6478	-28.34013
Border Rivers	Goodar	150.2124	-28.30689
Border Rivers	Goodar	150.2087	-28.30644
Border Rivers	Goodar	150.2126	-28.30553
Border Rivers	Gore	151.4706	-28.29296
Border Rivers	Goodar	150.1427	-28.25298
Border Rivers	Goondiwindi	150.3762	-28.24856
Border Rivers	Goondiwindi	150.3771	-28.24799
Border Rivers	Goondiwindi	150.3777	-28.24771
Border Rivers	Goondiwindi	150.3806	-28.2471
Border Rivers	Goondiwindi	150.3788	-28.247
Border Rivers	North Bungunya	149.5171	-28.23299
Border Rivers	Billa Billa	150.2511	-28.21858
Border Rivers	Billa Billa	150.2526	-28.2176
Border Rivers	Billa Billa	150.3044	-28.21663
Border Rivers	Billa Billa	150.2666	-28.20279
Border Rivers	Billa Billa	150.2675	-28.20142
Border Rivers	Billa Billa	150.2701	-28.19764
Border Rivers	Mosquito Creek	151.3335	-28.19573
Border Rivers	Goodar	150.0569	-28.18545

Basin	Locality	Longitude	Latitude
Border Rivers	Billa Billa	150.2853	-28.18232
Border Rivers	Billa Billa	150.2843	-28.18126
Border Rivers	Billa Billa	150.2834	-28.18074
Border Rivers	Billa Billa	150.2838	-28.17992
Border Rivers	Billa Billa	150.2856	-28.17843
Border Rivers	Billa Billa	150.2863	-28.17526
Border Rivers	Canning Creek	151.1337	-28.17033
Border Rivers	Billa Billa	150.45	-28.16934
Border Rivers	Billa Billa	150.1304	-28.14188
Border Rivers	Stonehenge	151.2795	-28.14029
Border Rivers	Billa Billa	150.2726	-28.13555
Border Rivers	Bringalily	151.1541	-28.09963
Border Rivers	Bringalily	151.1554	-28.09861
Border Rivers	Woondul	151.0927	-28.09288
Border Rivers	Bringalily	151.133	-28.07827
Border Rivers	Bringalily	151.1496	-28.06848
Border Rivers	Bringalily	151.1193	-28.06725
Border Rivers	Kooroongarra	151.2782	-28.06501
Border Rivers	Bringalily	151.1374	-28.06044
Border Rivers	Bringalily	151.193	-28.05701
Border Rivers	Bringalily	151.1671	-28.05328
Border Rivers	Kooroongarra	151.2814	-28.04799
Border Rivers	Bringalily	151.161	-28.03641
Border Rivers	Bringalily	151.1285	-28.03503
Border Rivers	Bringalily	151.1273	-28.0346
Border Rivers	Bulli Creek	150.8456	-28.03223
Border Rivers	Bulli Creek	150.8911	-28.02929
Border Rivers	Bulli Creek	150.8905	-28.02846
Border Rivers	Bringalily	151.1658	-28.01946
Border Rivers	Calingunee	150.3762	-28.01798

Basin	Locality	Longitude	Latitude
Border Rivers	Calingunee	150.2591	-27.97834
Border Rivers	Calingunee	150.2911	-27.97708
Border Rivers	Calingunee	150.2576	-27.97642
Border Rivers	Moonie	150.1958	-27.97436
Border Rivers	Calingunee	150.3202	-27.96331
Border Rivers	Calingunee	150.3343	-27.94626
Border Rivers	Calingunee	150.3569	-27.93235
Border Rivers	Moonie	150.3548	-27.91147
Border Rivers	Moonie	150.4363	-27.88705
Border Rivers	Moonie	150.3761	-27.86749
Border Rivers	Moonie	150.403	-27.85708
Border Rivers	Moonie	150.3774	-27.76331
Border Rivers	Dunmore	150.9314	-27.75674
Border Rivers	Weir River	150.5442	-27.75663
Border Rivers	Moonie	150.4477	-27.73918
Border Rivers	Moonie	150.4502	-27.72082
Border Rivers	Moonie	150.4512	-27.71976
Border Rivers	Moonie	150.5463	-27.66707
Border Rivers	Cattle Creek	150.8352	-27.63534
Border Rivers	Dunmore	150.9335	-27.60733
Border Rivers	Dunmore	150.8643	-27.59781
Border Rivers	Dunmore	150.862	-27.57944
Border Rivers	Dunmore	150.8645	-27.57578
Moonie River	Mungindi	148.7372	-28.93521
Moonie River	Mungindi	148.7378	-28.93277
Moonie River	Mungindi	148.7384	-28.93114
Moonie River	Mungindi	148.7404	-28.92949
Moonie River	Mungindi	148.7435	-28.92891
Moonie River	Mungindi	148.7991	-28.87836
Moonie River	Mungindi	148.8062	-28.87827

Basin	Locality	Longitude	Latitude
Moonie River	Mungindi	148.8129	-28.87006
Moonie River	Mungindi	148.8179	-28.86633
Moonie River	Mungindi	148.8197	-28.86455
Moonie River	Mungindi	148.8206	-28.86345
Moonie River	Mungindi	148.8301	-28.80594
Moonie River	Thallon	148.8584	-28.65138
Moonie River	Thallon	148.8573	-28.6499
Moonie River	Thallon	148.8555	-28.64479
Moonie River	Thallon	148.8546	-28.64371
Moonie River	Thallon	148.8558	-28.64343
Moonie River	Thallon	148.8521	-28.64307
Moonie River	Thallon	148.849	-28.64136
Moonie River	Thallon	148.8532	-28.63561
Moonie River	Thallon	148.8541	-28.63452
Moonie River	Thallon	148.855	-28.63396
Moonie River	Thallon	148.8559	-28.6303
Moonie River	Thallon	148.8535	-28.6283
Moonie River	Thallon	148.8515	-28.62778
Moonie River	Thallon	148.8512	-28.62725
Moonie River	Thallon	148.8508	-28.62644
Moonie River	Thallon	148.8506	-28.62441
Moonie River	Thallon	148.8502	-28.62049
Moonie River	Thallon	148.8536	-28.6042
Moonie River	Thallon	148.8569	-28.60132
Moonie River	Thallon	148.8566	-28.59929
Moonie River	Thallon	148.8348	-28.58172
Moonie River	Thallon	148.8286	-28.57991
Moonie River	Thallon	148.8334	-28.57416
Moonie River	Thallon	148.8371	-28.57411
Moonie River	Thallon	148.8345	-28.57076

Basin	Locality	Longitude	Latitude
Moonie River	Thallon	148.8331	-28.56685
Moonie River	Thallon	148.8336	-28.56495
Moonie River	Thallon	148.833	-28.56401
Moonie River	Thallon	148.8322	-28.55577
Moonie River	Thallon	148.8285	-28.55379
Moonie River	Thallon	148.8297	-28.55242
Moonie River	Thallon	148.8269	-28.5488
Moonie River	Thallon	148.8345	-28.54829
Moonie River	Thallon	148.8253	-28.54611
Moonie River	Thallon	148.8231	-28.54479
Moonie River	Thallon	148.8267	-28.53878
Moonie River	Thallon	148.8272	-28.53444
Moonie River	Thallon	148.8293	-28.53252
Moonie River	Thallon	148.8361	-28.51375
Moonie River	Thallon	148.8363	-28.51158
Moonie River	Thallon	148.8392	-28.50234
Moonie River	Thallon	148.8395	-28.50179
Moonie River	Thallon	148.8337	-28.4725
Moonie River	Thallon	148.8313	-28.46752
Moonie River	Thallon	148.831	-28.46699
Moonie River	Thallon	148.8288	-28.46431
Moonie River	Thallon	148.8269	-28.46081
Moonie River	Thallon	148.8237	-28.45612
Moonie River	Thallon	148.8159	-28.42996
Moonie River	St George	148.8199	-28.35478
Moonie River	Thallon	148.8412	-28.33175
Moonie River	Thallon	148.8411	-28.32756
Moonie River	Thallon	148.8516	-28.31537
Moonie River	Thallon	148.8519	-28.31388
Moonie River	Thallon	148.8663	-28.264

Basin	Locality	Longitude	Latitude
Moonie River	Thallon	148.9261	-28.20388
Moonie River	Thallon	148.9266	-28.20063
Moonie River	Thallon	148.9275	-28.19601
Moonie River	Thallon	148.9348	-28.17723
Moonie River	Tarawera	149.7696	-28.04536
Moonie River	St George	149.1053	-28.03758
Moonie River	St George	149.1042	-28.03593
Moonie River	St George	149.0771	-28.02813
Moonie River	North Bungunya	149.469	-28.01442
Moonie River	St George	149.4285	-28.01297
Moonie River	North Bungunya	149.4882	-28.00964
Moonie River	North Bungunya	149.4898	-28.00765
Moonie River	North Bungunya	149.491	-28.00687
Moonie River	St George	149.3963	-28.00658
Moonie River	St George	149.3977	-28.00594
Moonie River	St George	149.2375	-28.00584
Moonie River	St George	149.4074	-28.00498
Moonie River	St George	149.0689	-27.99543
Moonie River	St George	149.0661	-27.99536
Moonie River	St George	149.0706	-27.99494
Moonie River	St George	149.0712	-27.99469
Moonie River	St George	149.0725	-27.99337
Moonie River	St George	149.074	-27.99179
Moonie River	St George	149.1881	-27.98351
Moonie River	St George	149.075	-27.98128
Moonie River	St George	149.0763	-27.97996
Moonie River	St George	149.1702	-27.9772
Moonie River	St George	149.1073	-27.97489
Moonie River	St George	149.1122	-27.97314
Moonie River	St George	149.2601	-27.97305

Basin	Locality	Longitude	Latitude
Moonie River	St George	149.1161	-27.97298
Moonie River	St George	149.1375	-27.97263
Moonie River	St George	149.3491	-27.97233
Moonie River	St George	149.1592	-27.97135
Moonie River	St George	149.147	-27.97087
Moonie River	St George	149.1456	-27.97083
Moonie River	St George	149.14	-27.97013
Moonie River	St George	149.1435	-27.96996
Moonie River	St George	149.1412	-27.9699
Moonie River	St George	149.147	-27.96925
Moonie River	St George	149.1496	-27.96905
Moonie River	St George	149.3681	-27.96851
Moonie River	St George	149.148	-27.96847
Moonie River	St George	149.152	-27.96831
Moonie River	St George	149.1468	-27.96816
Moonie River	St George	149.1526	-27.96805
Moonie River	St George	149.1532	-27.9678
Moonie River	St George	149.2158	-27.96764
Moonie River	St George	149.0775	-27.96764
Moonie River	St George	149.1552	-27.96758
Moonie River	St George	149.1538	-27.96755
Moonie River	St George	149.3443	-27.96652
Moonie River	St George	149.3452	-27.96498
Moonie River	St George	149.0971	-27.96405
Moonie River	Westmar	149.8357	-27.96329
Moonie River	St George	149.1284	-27.96247
Moonie River	St George	149.2737	-27.96192
Moonie River	St George	149.3798	-27.96124
Moonie River	Lundavra	149.8833	-27.96104
Moonie River	St George	149.3819	-27.95724

Basin	Locality	Longitude	Latitude
Moonie River	Lundavra	149.868	-27.95714
Moonie River	St George	149.3918	-27.95561
Moonie River	St George	149.3846	-27.95514
Moonie River	St George	149.3867	-27.95493
Moonie River	St George	149.4031	-27.91965
Moonie River	St George	149.4492	-27.91314
Moonie River	Flinton	149.6098	-27.91219
Moonie River	St George	149.4247	-27.91183
Moonie River	Flinton	149.6094	-27.91163
Moonie River	Westmar	149.7419	-27.91064
Moonie River	Westmar	149.7427	-27.90931
Moonie River	Westmar	149.7391	-27.90909
Moonie River	Westmar	149.7464	-27.90764
Moonie River	Westmar	149.7584	-27.9044
Moonie River	Flinton	149.5591	-27.89713
Moonie River	St George	149.4488	-27.89676
Moonie River	Flinton	149.5595	-27.89619
Moonie River	Flinton	149.524	-27.89598
Moonie River	Flinton	149.5446	-27.89582
Moonie River	Westmar	149.7066	-27.89581
Moonie River	Flinton	149.5598	-27.89512
Moonie River	Westmar	149.702	-27.89441
Moonie River	Flinton	149.5715	-27.8923
Moonie River	Westmar	149.7387	-27.89176
Moonie River	Flinton	149.521	-27.89166
Moonie River	Flinton	149.6169	-27.89126
Moonie River	Flinton	149.5755	-27.88996
Moonie River	Flinton	149.5739	-27.88884
Moonie River	Flinton	149.5494	-27.888
Moonie River	St George	149.3579	-27.88749

Basin	Locality	Longitude	Latitude
Moonie River	Westmar	149.7458	-27.88733
Moonie River	Flinton	149.5933	-27.88608
Moonie River	Westmar	149.6883	-27.88411
Moonie River	Southwood	149.8705	-27.88291
Moonie River	Westmar	149.7569	-27.87758
Moonie River	Flinton	149.59	-27.87477
Moonie River	Southwood	149.9681	-27.86128
Moonie River	Westmar	149.7736	-27.85984
Moonie River	Westmar	149.7976	-27.85661
Moonie River	Westmar	149.7848	-27.85485
Moonie River	Westmar	149.7306	-27.84517
Moonie River	St George	149.3052	-27.84402
Moonie River	Westmar	149.8035	-27.84038
Moonie River	Westmar	149.79	-27.8398
Moonie River	Flinton	149.6651	-27.83778
Moonie River	Westmar	149.7962	-27.83737
Moonie River	Westmar	149.7912	-27.83671
Moonie River	Westmar	149.7724	-27.83249
Moonie River	Westmar	149.7381	-27.82924
Moonie River	Westmar	149.7384	-27.8257
Moonie River	Westmar	149.7282	-27.82333
Moonie River	Westmar	149.7044	-27.82087
Moonie River	Westmar	149.8285	-27.81972
Moonie River	Flinton	149.5527	-27.81897
Moonie River	Flinton	149.653	-27.81824
Moonie River	Flinton	149.6536	-27.81721
Moonie River	Flinton	149.6543	-27.81549
Moonie River	Flinton	149.5537	-27.81015
Moonie River	St George	149.2683	-27.80875
Moonie River	St George	149.2663	-27.80808

Basin	Locality	Longitude	Latitude
Moonie River	St George	149.2193	-27.80573
Moonie River	St George	149.2503	-27.80278
Moonie River	Southwood	149.8972	-27.79773
Moonie River	St George	149.2944	-27.7945
Moonie River	Southwood	149.863	-27.79345
Moonie River	Flinton	149.5612	-27.79198
Moonie River	Flinton	149.5622	-27.79115
Moonie River	Flinton	149.5625	-27.79035
Moonie River	Southwood	149.9404	-27.79018
Moonie River	Southwood	149.9402	-27.78895
Moonie River	Southwood	149.9557	-27.78794
Moonie River	Southwood	149.9467	-27.78768
Moonie River	Southwood	149.9572	-27.78744
Moonie River	Southwood	149.942	-27.7871
Moonie River	Southwood	149.9439	-27.78709
Moonie River	Southwood	149.9389	-27.78698
Moonie River	Southwood	149.9591	-27.78694
Moonie River	Southwood	149.9542	-27.78683
Moonie River	Southwood	149.9604	-27.78642
Moonie River	Southwood	149.9615	-27.78618
Moonie River	Southwood	149.9624	-27.78593
Moonie River	Southwood	149.9516	-27.78515
Moonie River	Southwood	149.8762	-27.78427
Moonie River	Southwood	149.964	-27.78404
Moonie River	Southwood	149.9652	-27.78274
Moonie River	St George	149.397	-27.78234
Moonie River	Southwood	149.9718	-27.77829
Moonie River	Southwood	149.973	-27.77696
Moonie River	Southwood	149.9744	-27.77577
Moonie River	Southwood	149.8859	-27.77556

Basin	Locality	Longitude	Latitude
Moonie River	Westmar	149.7144	-27.76834
Moonie River	Southwood	150.0674	-27.76465
Moonie River	Southwood	150.0698	-27.76308
Moonie River	Inglestone	149.8326	-27.76217
Moonie River	Flinton	149.6595	-27.76195
Moonie River	Inglestone	149.8319	-27.75999
Moonie River	Flinton	149.674	-27.74614
Moonie River	Flinton	149.6795	-27.74613
Moonie River	Teelba	149.4223	-27.7435
Moonie River	Moonie	150.1535	-27.73236
Moonie River	Inglestone	149.7976	-27.73174
Moonie River	Moonie	150.2142	-27.73143
Moonie River	Moonie	150.2148	-27.73062
Moonie River	Inglestone	149.7017	-27.7303
Moonie River	Moonie	150.1921	-27.71853
Moonie River	St George	149.4088	-27.71387
Moonie River	Moonie	150.2269	-27.71355
Moonie River	St George	149.4008	-27.71129
Moonie River	Coomrith	149.5971	-27.71004
Moonie River	Inglestone	149.7778	-27.70544
Moonie River	Moonie	150.1309	-27.70146
Moonie River	Moonie	150.1299	-27.70128
Moonie River	Moonie	150.1281	-27.69981
Moonie River	Moonie	150.1274	-27.69798
Moonie River	Moonie	150.2771	-27.69776
Moonie River	Moonie	150.1285	-27.6976
Moonie River	Moonie	150.2778	-27.69615
Moonie River	Moonie	150.2844	-27.69493
Moonie River	Moonie	150.2868	-27.69362
Moonie River	Moonie	150.1286	-27.69287

Basin	Locality	Longitude	Latitude
Moonie River	Moonie	150.1323	-27.69248
Moonie River	Moonie	150.1296	-27.69119
Moonie River	Moonie	150.1299	-27.68937
Moonie River	Moonie	150.1305	-27.68817
Moonie River	Inglestone	149.856	-27.68776
Moonie River	Moonie	150.1312	-27.68724
Moonie River	Inglestone	149.8549	-27.68556
Moonie River	Moonie	150.3648	-27.68308
Moonie River	Moonie	150.3654	-27.68296
Moonie River	Moonie	150.366	-27.68243
Moonie River	Hannaford	150.052	-27.67773
Moonie River	Moonie	150.1254	-27.67616
Moonie River	Hannaford	150.0795	-27.67506
Moonie River	Moonie	150.3732	-27.66662
Moonie River	Inglestone	149.6987	-27.6665
Moonie River	Coomrith	149.622	-27.66547
Moonie River	Moonie	150.3762	-27.66422
Moonie River	Moonie	150.3769	-27.66207
Moonie River	Teelba	149.4541	-27.64576
Moonie River	Teelba	149.4533	-27.64528
Moonie River	Moonie	150.4025	-27.64387
Moonie River	Moonie	150.1779	-27.64111
Moonie River	Inglestone	149.8833	-27.6375
Moonie River	Teelba	149.3965	-27.63727
Moonie River	Moonie	150.1138	-27.63654
Moonie River	Moonie	150.1143	-27.63601
Moonie River	The Gums	150.1128	-27.6355
Moonie River	The Gums	150.1131	-27.63247
Moonie River	The Gums	150.1144	-27.63181
Moonie River	The Gums	150.1138	-27.63112

Basin	Locality	Longitude	Latitude
Moonie River	Moonie	150.3153	-27.62976
Moonie River	The Gums	150.1147	-27.62952
Moonie River	Moonie	150.188	-27.62819
Moonie River	Inglestone	149.7069	-27.62747
Moonie River	Inglestone	149.8942	-27.62692
Moonie River	The Gums	150.1064	-27.62312
Moonie River	Inglestone	149.8565	-27.62282
Moonie River	Hannaford	150.0949	-27.62234
Moonie River	Inglestone	149.7725	-27.62008
Moonie River	Coomrith	149.6263	-27.61786
Moonie River	Inglestone	149.7121	-27.61451
Moonie River	Moonie	150.2926	-27.61443
Moonie River	Moonie	150.1935	-27.61368
Moonie River	Moonie	150.2929	-27.61336
Moonie River	Inglestone	149.7031	-27.60611
Moonie River	Hannaford	150.078	-27.60385
Moonie River	Coomrith	149.6422	-27.60291
Moonie River	Hannaford	150.0708	-27.60262
Moonie River	Moonie	150.2509	-27.60062
Moonie River	Hannaford	150.0698	-27.60033
Moonie River	Hannaford	150.0674	-27.59596
Moonie River	Teelba	149.372	-27.5957
Moonie River	Moonie	150.276	-27.59056
Moonie River	Moonie	150.2774	-27.59043
Moonie River	Inglestone	149.7158	-27.58993
Moonie River	The Gums	150.1275	-27.58865
Moonie River	Coomrith	149.651	-27.58784
Moonie River	The Gums	150.1265	-27.58768
Moonie River	Coomrith	149.6515	-27.58718
Moonie River	The Gums	150.1292	-27.58638

Basin	Locality	Longitude	Latitude
Moonie River	Coomrith	149.5514	-27.58418
Moonie River	Inglestone	149.7584	-27.58105
Moonie River	Inglestone	149.718	-27.58065
Moonie River	Coomrith	149.5809	-27.57625
Moonie River	Moonie	150.3052	-27.5753
Moonie River	Inglestone	149.7669	-27.57476
Moonie River	Coomrith	149.6385	-27.57469
Moonie River	Teelba	149.2901	-27.57392
Moonie River	Moonie	150.3276	-27.5737
Moonie River	Hannaford	150.0286	-27.57358
Moonie River	The Gums	150.1318	-27.57076
Moonie River	Inglestone	149.7518	-27.56873
Moonie River	Inglestone	149.7784	-27.56813
Moonie River	Moonie	150.4571	-27.56747
Moonie River	Inglestone	149.8261	-27.5672
Moonie River	Inglestone	149.7224	-27.56587
Moonie River	Coomrith	149.6711	-27.56564
Moonie River	Moonie	150.3044	-27.56459
Moonie River	Teelba	149.3876	-27.56265
Moonie River	Hannaford	150.0688	-27.56203
Moonie River	Coomrith	149.4926	-27.55944
Moonie River	Hannaford	150.1093	-27.55891
Moonie River	Hannaford	150.0216	-27.55881
Moonie River	Inglestone	149.7478	-27.557
Moonie River	Coomrith	149.552	-27.55471
Moonie River	The Gums	150.1568	-27.55353
Moonie River	The Gums	150.1446	-27.55314
Moonie River	Hannaford	150.0174	-27.5525
Moonie River	Inglestone	149.7782	-27.55236
Moonie River	Inglestone	149.8319	-27.55231

Basin	Locality	Longitude	Latitude
Moonie River	Hannaford	150.0162	-27.55166
Moonie River	Inglestone	149.7135	-27.55024
Moonie River	Hannaford	150.004	-27.5495
Moonie River	Hannaford	150.0049	-27.54925
Moonie River	Moonie	150.2948	-27.54925
Moonie River	Coomrith	149.5983	-27.54881
Moonie River	Coomrith	149.6125	-27.54687
Moonie River	Marmadua	150.6445	-27.5456
Moonie River	Coomrith	149.671	-27.54287
Moonie River	Inglestone	149.9349	-27.54055
Moonie River	Inglestone	149.7711	-27.53698
Moonie River	Moonie	150.4227	-27.53382
Moonie River	Teelba	149.4089	-27.53317
Moonie River	Moonie	150.5249	-27.5327
Moonie River	Moonie	150.4325	-27.52939
Moonie River	Inglestone	149.8206	-27.52662
Moonie River	Coomrith	149.6686	-27.52563
Moonie River	Moonie	150.432	-27.52478
Moonie River	Moonie	150.39	-27.52265
Moonie River	Moonie	150.3926	-27.5208
Moonie River	Teelba	149.4073	-27.51911
Moonie River	Moonie	150.4349	-27.5178
Moonie River	Coomrith	149.6219	-27.51746
Moonie River	Moonie	150.5465	-27.5102
Moonie River	Moonie	150.5462	-27.50909
Moonie River	Coomrith	149.5817	-27.50552
Moonie River	Teelba	149.3965	-27.50477
Moonie River	Moonie	150.5302	-27.50437
Moonie River	Teelba	149.4601	-27.50027
Moonie River	Coomrith	149.6432	-27.49931

Basin	Locality	Longitude	Latitude
Moonie River	Tara	150.4773	-27.46796
Moonie River	Teelba	149.3134	-27.46363
Moonie River	Teelba	149.3137	-27.4631
Moonie River	Teelba	149.3658	-27.45798
Moonie River	Teelba	149.4212	-27.45576
Moonie River	Marmadua	150.6891	-27.45566
Moonie River	Marmadua	150.7078	-27.45516
Moonie River	Marmadua	150.7691	-27.44722
Moonie River	Marmadua	150.7668	-27.44069
Moonie River	Marmadua	150.7261	-27.43976
Moonie River	Teelba	149.3728	-27.42867
Moonie River	Teelba	149.3731	-27.42679
Moonie River	Teelba	149.373	-27.4257
Moonie River	Marmadua	150.7565	-27.41457
Moonie River	Teelba	149.372	-27.41265
Moonie River	Marmadua	150.7027	-27.40527
Moonie River	Marmadua	150.7278	-27.40513
Moonie River	Marmadua	150.727	-27.39835
Moonie River	Marmadua	150.6864	-27.39775
Moonie River	Marmadua	150.7595	-27.39563
Moonie River	Marmadua	150.7254	-27.38926
Moonie River	Goranba	150.6622	-27.37833
Moonie River	Goranba	150.6598	-27.37734
Moonie River	Marmadua	150.768	-27.3576
Moonie River	Marmadua	150.7237	-27.3532
Moonie River	Marmadua	150.8074	-27.34861
Moonie River	Marmadua	150.7591	-27.34067
Moonie River	Marmadua	150.826	-27.32819
Moonie River	Marmadua	150.8268	-27.32766
Moonie River	Marmadua	150.8133	-27.32664

Basin	Locality	Longitude	Latitude
Moonie River	Weranga	150.8029	-27.28722