

Queensland Murray Darling Basin – deep

Sediments of the Bowen Basins Groundwater Background Paper

July 2018

This publication has been compiled by Water Policy, Department of Natural Resources, Mines and Energy.

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Introduction

This paper summarises background information about the Queensland Murray-Darling Basin deep (QMDBD) groundwater sustainable diversion limit (SDL) resource unit (GS56). The purpose of the paper is to provide a context for the QMDBD, including location, climate, geology, hydrogeology, ecological profiles, uses and management practices.

Location

The QMDBD spans areas shown in Figure 1. The Basin Plan (2012) defines the QMDBD as all groundwater in aquifers below the Great Artesian Basin (GAB).

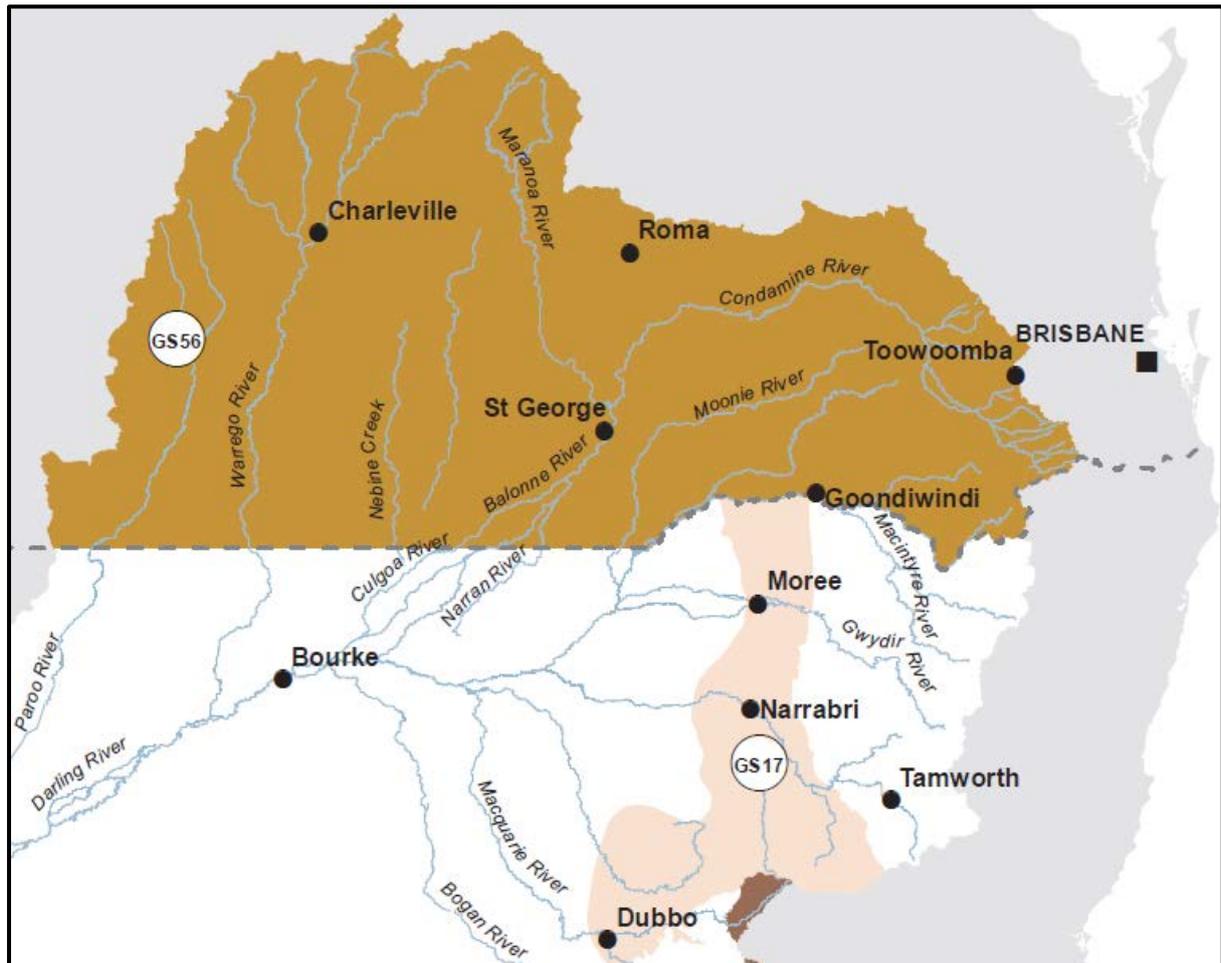


Figure 1: Location of the QMDBD (GS56)

To date, groundwater in the QMDBD has only been accessed within the Bowen Basin and little is known about the extent of some of the water resources. This is because the groundwater resources within the associated basins are very deep and there are more easily accessible and readily available water resources above these basins.

The Bowen Basin is the deepest and oldest of the geological formations and aquifer resources within the Murray-Darling Basin (MDB) area. It stretches from north to south through the centre of the region and extends from central Queensland, south beneath the Surat Basin, into New South Wales where it eventually connects with the Gunnedah-Oxley Basin.

Extraction of groundwater in the Bowen Basin is associated with coal seam gas (CSG) extraction (from Bandanna Formation) in the area between Injune and Roma where it underlays the Condamine and Balonne catchment.

The main extent of the QMDBD managed under the water plans is defined by the potential water resource within the Bowen Basin (Figure 2) which aligns with the Gunnedah-Oxley Basin (GS17) south of Goondiwindi (Figure 1). Figure 3 illustrates the conceptual layering of aquifers in the Bowen Basin area in the QMDBD.

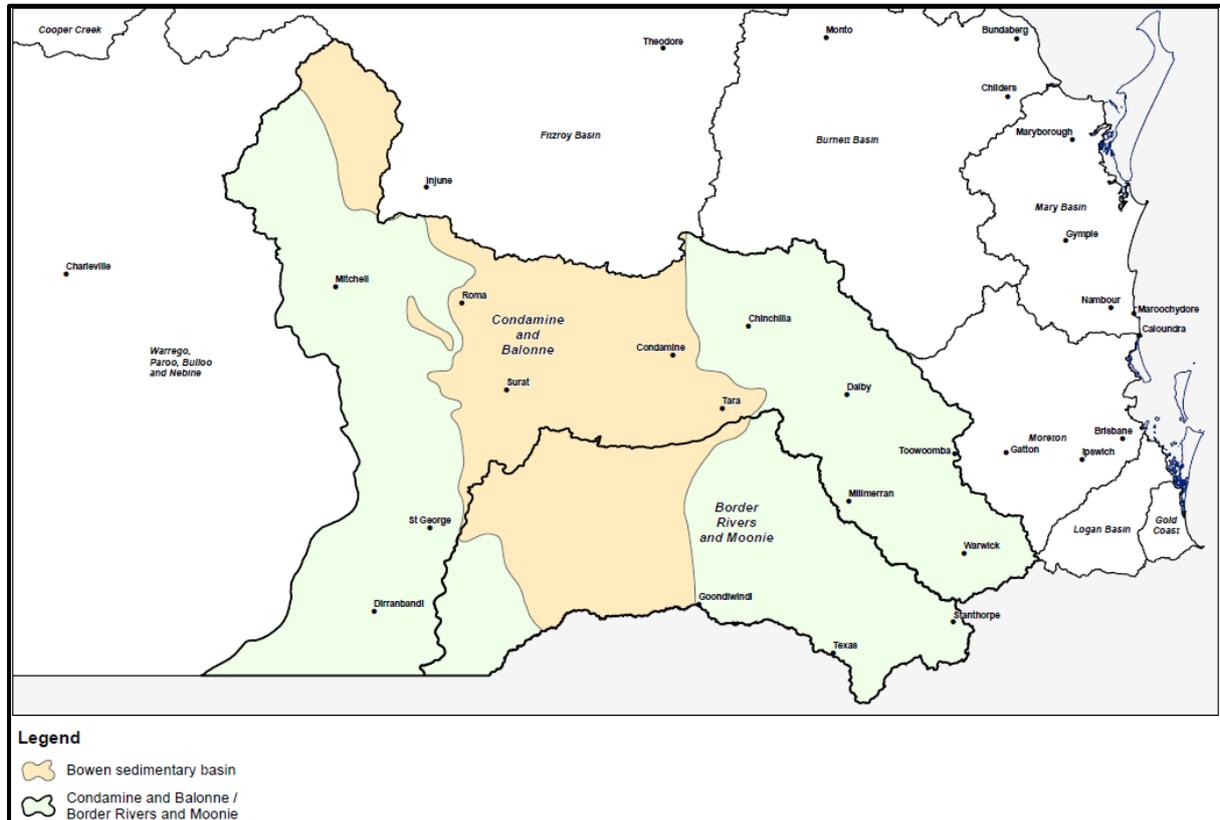


Figure 2: The Bowen Basin geological formation.



Figure 3: Conceptual sequencing of aquifers above the QMDBD resource (not to scale).

The inclusion of the QMDBD acknowledges the extent of the water resources and their potential connection with New South Wales (NSW) users through the Bowen Basin sediments into the Gunnedah-Oxley Basin.

Land use

Due to the depth of groundwater, and the associated costs of pumping, exploration and/or production of natural resources is the only land use of significance in the QMDBD. CSG activities intercept the overlying Surat (Walloon Coal measures) and underlying Bowen basins (Bandanna and Cattle Creek Formations in the southern Bowen Basin).

Climate and rainfall

Monthly average rainfall statistics vary from 579 mm at Roma in the west to 648 mm at Miles in the east although annual rainfall is highly variable.¹ The climate of the area is sub-tropical with most rainfall occurring in summer. Much of the area is categorised as semi-arid and the average annual potential evapotranspiration ranges between 1800 mm/year and 2500 mm/year, a loss of surface water which exceeds rainfall by a factor of three. Because rainfall and subsequent runoff (depending on antecedent conditions) is highly variable many of the rivers and streams in the area are ephemeral. Intermittency is an important feature of the natural hydrology and, under natural conditions, prolonged base flows occur only in wetter years in most watercourses (OGIA 2016). In comparison the QMDBD water resource has very long residence times and is little affected by annual fluctuations in climatic conditions.

¹ Data sourced from the Bureau of Meteorology monthly climate statistics (all years); www.bom.gov.au

Geology and hydrogeology

Little is known about the hydrogeology of the QMDBD, and information about geology and hydrology is mainly derived from resources sector (mining, petroleum, conventional gas and CSG) investigations. Figure 4 shows the extent and strata of the Bowen Basins and the overlying Surat Basin and GAB formations in the MDB area (Warrego through to Border Rivers catchments).

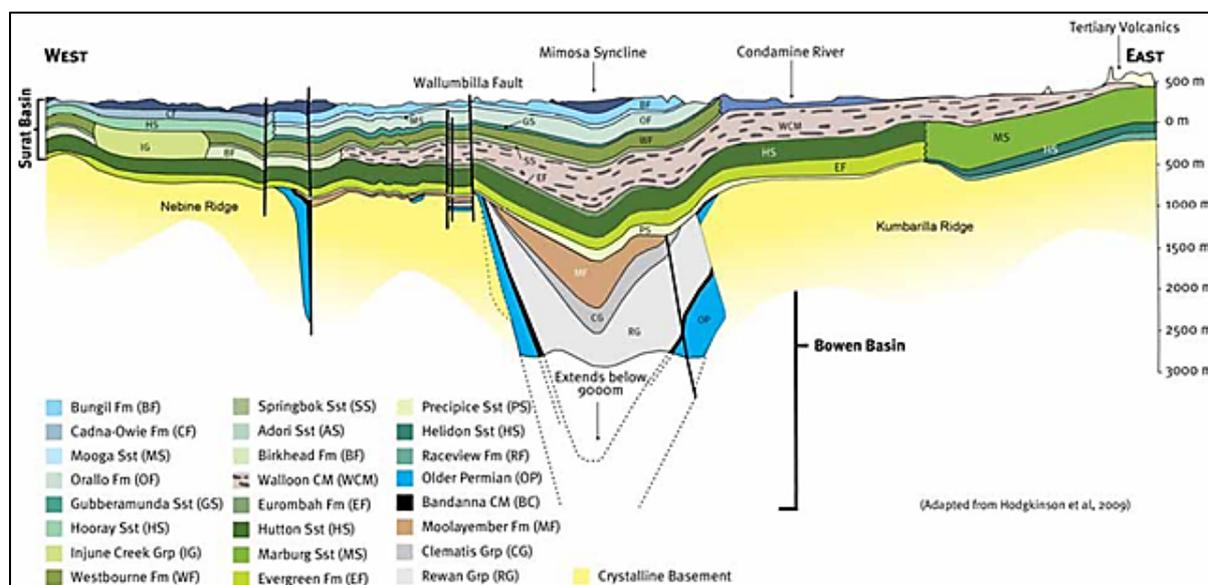


Figure 4: Position and layering of the geological formations of the Surat Basin (upper layers)

Major formations

Geology

Geological formations of the Bowen Basin are mainly comprised of alternating layers of sandstones, shale, tuff, siltstones and mudstones from the Permian to Triassic sediments (formed 252 to 541 million years ago) with a thickness extending below 9000 m (OGIA, 2016).

Overlying the older Bowen Basin is the Surat Basin, which covers most of the Condamine-Balonne, Moonie, and Border Rivers plan areas. The basins are overlaid by extensive areas of unconsolidated younger alluvial sediments and volcanics (OGIA, 2016), such as the Central Condamine Alluvium and the Main Range Volcanics.

Because sedimentation was not continuous across the Bowen Basin, the formations are not as laterally extensive as those in the GAB. The formations have complex geology and display laterally variable hydraulic properties. Hydrostratigraphic units are provided in Figure 5.

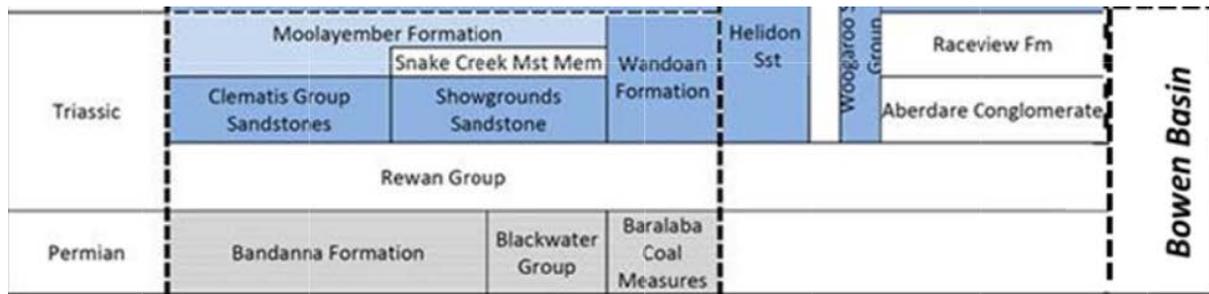


Figure 5: Bowen Basin hydrostratigraphy (adapted from QWC, 2012)

Hydrogeology

In the Bowen Basin, the sandstone units generally form aquifers while the units of marine origin generally form the intervening confining beds, or aquitards (Figure 5). A survey of the underground water resources of most of the area was made by the Geological Survey of Queensland and the Irrigation and Water Supply Commission of Queensland. All of the water-bearing units exist as confined units that contain reservoirs of isolated porewater of generally poor quality.

The major aquifer units include the late Permian coal measures (Bandanna Formation) and the Clematis/Showgrounds Sandstone units. The Clematis/Showgrounds Sandstone is not considered part of the QMDBD resource. It is managed under the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017.

Recharge and discharge

Recharge to the Bowen Basin occurs by infiltration of rainfall into the outcropping sandstone aquifers and leakage through unconsolidated sediments overlying the aquifers from the north in Roma in a south west direction towards St George and the Queensland/New South Wales border. Groundwater is expected to be broadly topographically controlled, away from the outcropping recharge zones (DNRM 2012, OGIA 2016). The Basins are deep and generally isolated from overlying aquifers (except the GAB Precipice Sandstone in some central and eastern areas) and are non-artesian. Discharge from the Queensland Bowen Basins has not been estimated but is expected to be small and generally restricted to connected Bowen sub-basins, with a trend towards to the southern Basins including the Gunnedah-Oxley Basin in NSW.

Due to the degree of uncertainty about the extent, depth (depths of up to 9000 m) layering, connectivity and potential production from the basins for water extraction, there is insufficient information to report on the transmissivity and yield of the basins for commercial purposes. Holland et al. (2017) noted that there is minimal interference with this low quality groundwater resources from non-petroleum and gas production activities. What is known is that there are several deep non-artesian sedimentary and coal layers below the GAB that often vary from 70 m to 250 m thick which have very low permeability and flow rates (OGIA 2016).

Water resource connections

Connections between aquifers due to breaks in aquicludes are expected to provide cross sectional connections or inflows including:

- links with the overlaying GAB sedimentary layers (e.g. Precipice and Evergreen layers) and the Surat Basin particularly around the Bowen Basin rim in central and eastern areas with potential loss from the GAB and Surat to the Bandanna coal beds caused by CSG drawdown (Figure 4)
- known linkage between the Queensland Bowen Basin and New South Wales Gunnedah-Oxley Basin.

Management of the GAB is outside the basin plan but monitoring and assessment of CSG gas-well impacts on GAB, Surat and underlying Bowen Basin water resources is conducted by the Office of Groundwater Impact Assessment (OGIA) as required under the *Water Act 2000*. Management of the resource across State boundaries is required under the Basin Plan. Refer to section 5.1 and 5.2 for additional information about structural connections and groundwater movements.

Table 1 summarises connectivity status of groundwater in the QMDBD with other connected resources, and indicates whether connection is significant or not.

Table 1: Hydrologic connectivity between the QMDBD and other water resources

Connected resource units	Significant connection*
Gunnedah-Oxley Basin (GS17)	Yes
Great Artesian Basin (not a Murray–Darling Basin resource)	No

* Two water resources are considered to have a significant hydrological connection to one another if both water from a resource is physically able to move to the other resource and activities in one resource may have a material impact on the state or condition of the other. "No" status was assigned in case there was no evidence of significant, or high, connectivity between the resources based on hydrological studies or local, expert knowledge.

Groundwater quality

Water quality is generally poor, with salinity reaching 9000 mg/L in some places (OGIA 2016) which is not suitable for agricultural or commercial uses.

Groundwater dependent ecological assets

There are no known connections between the QMDBD and surface water (including with GAB springs sourced from the above water resources), and no risks to environmental assets have been identified (DNRM 2017a, 2017b, 2017c).

Entitlements and use

There are no licenced entitlements in the GS56 SDL unit. CSG and conventional gas and petroleum extraction and coal mining are the principal users of groundwater in the QMBDD (DNRM 2017d, 2017e, 2017f; DSITI 2016). It is anticipated that CSG and coal mining activities will grow over the lifespan of the MDB water plans, which may impact groundwater resources due to dewatering and water releases. The impacts will however occur primarily in the overlying and unconnected Surat Basin (OGIA 2016; Sander et al. 2014). The interference with groundwater levels from non-petroleum and gas production activities is minimal (Holland et al., 2017).

Table 2 summarises current levels of estimated extraction in the unit. There is currently no take for consumptive or industrial uses. Note the usual depth for access to the Bowen Basin ranges from 1000 to 2500 m.

Table 2: Estimated groundwater use in the QMDBD

Formation	Number of bores	Estimated extraction (ML/year)
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	Stock and Domestic	Other	Stock and Domestic	Other
Bandanna Formation	10	0	<15	0

Management arrangements

The groundwater use in the QMDBD and the associated risks are minimal, so that this resource unit has no prescribed requirements for groundwater take. There are no regulatory controls for use and sharing. However, areas of the southern Bowen Basin fall within the Surat Cumulative Management Area with tenure and impact assessment managed under the *Water Act 2000* to protect commercial resources and groundwater resources. The status of water resources within the cumulative management area is evaluated and reported by the Office of Groundwater Impact Assessment (OGIA), which as a statutory body of the *Water Act 2000*.

The baseline diversion under the Basin Plan is 0 ML (Commonwealth of Australia, 2012). Due to the large potential size of the aquifer and the large capacity to sustain take, the Basin Plan has assigned a sustainable diversion of 100 GL/year. This large allowance is anticipated to have no effect on access within NSW where the resource is shared. Interstate management of the resource has effect under the Basin Plan (Commonwealth of Australia, 2012).

The department doesn't maintain an ambient water level monitoring network. Some information can be obtained from private sources' bores or bores sunk for gas, petroleum or mining purposes. Monitoring of take and the potential impact of commercial extractions by the resources sector is conducted by OGIA, which publishes regular reports about the operations and the associated impacts on the groundwater resources. This occurs primarily in CSG fields and current information indicates no discernible effect of extraction from the Bowen Basin on water levels within the overlaying GAB and Precipice Sandstone (OGIA 2016).

Proposed future management – new water plans in 2019

Draft new water plans and water management protocols for the Condamine and Balonne and the Border Rivers and Moonie catchments were released in April 2018. Due for finalisation in early 2019, these new statutory planning instruments include revised management arrangements for the QMDB.

It is proposed that the new water plans provide for the licensing of groundwater take from the unit. The licences will be specified volumetrically which will allow for straightforward accounting against permitted take. Growth in take may be accommodated through the establishment and releases of unallocated water reserves. However, due to the very low risk status to these resources, no additional regulatory measures are likely to be required.

Overall status

The overall condition of the resource is relatively undisturbed as current use is approximately 0.015 GL/yr (against the SDL 100 GL/yr). However, there is low potential for increased utilisation due to its depth (1500 to 9000 m) and generally poor water quality (OGIA 2016). Based on current and anticipated future use, risk assessments identified no risks to users, the environment or to groundwater quality (DNRM 2017a, 2017b, 2017c).

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Draft

Attachment A: Regional landscape and geological setting

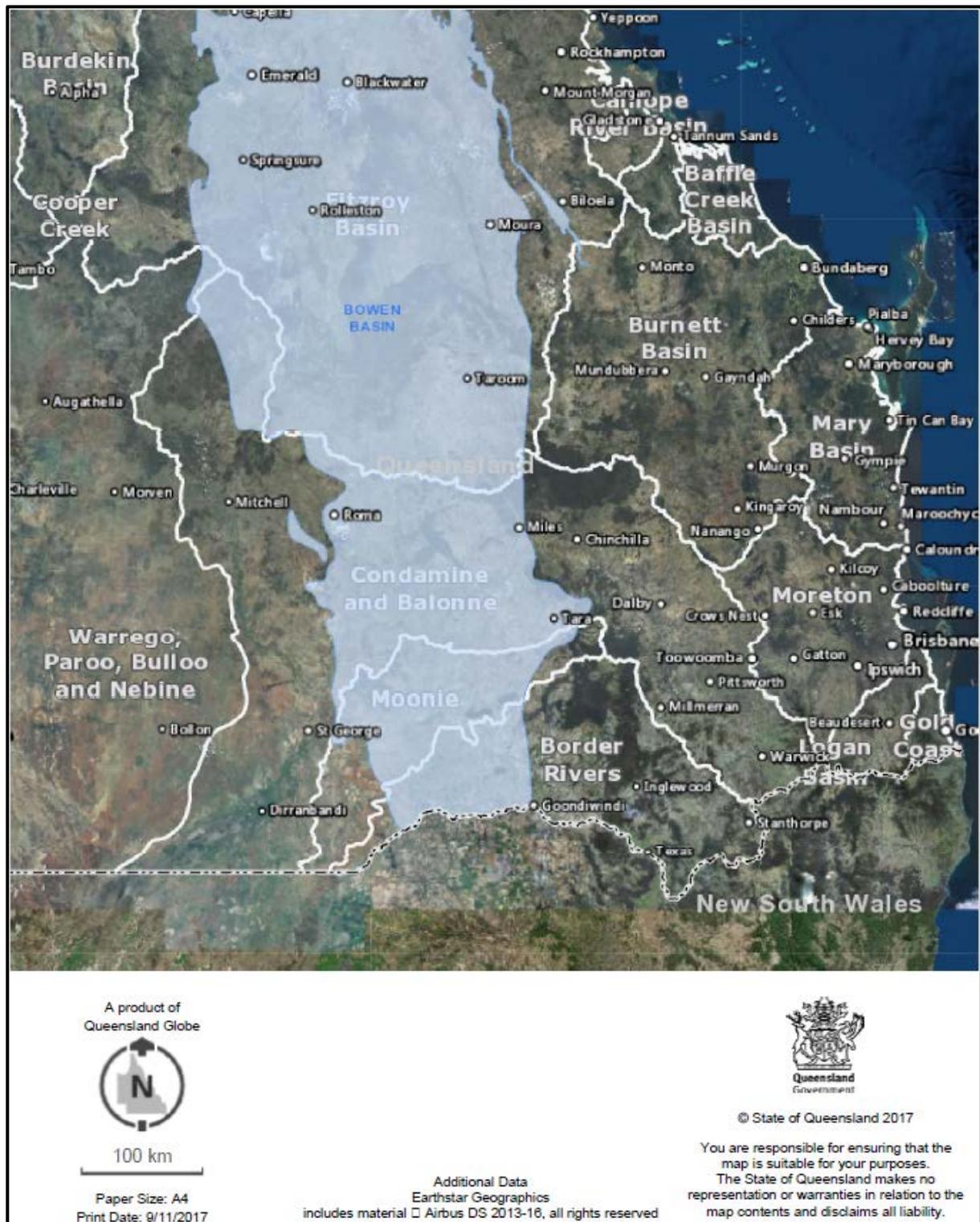


Figure A1: General extent of the primary Bowen Basin from the Rolleston area of the Fitzroy Basin to Goondiwindi in the Border Rivers catchment, Queensland (Queensland Globe < <https://qldglobe.information.qld.gov.au/> (viewed 09/11/2017)).