Development of coal mines and coal seam gas (CSG) resources can significantly impact groundwater systems, hydrogeological processes and the surface environment. Consequently, an understanding of regional scale hydrogeology is critical to developing effective water management strategies.

The Department of the Environment funded investigation of the potential impacts of the development of coal mining and CSG production in several Australian coal-bearing geological basins.

The Laura Basin was investigated as part of this programme due to the significant environmental and cultural heritage values of the region which include several National Parks and the Great Barrier Reef Marine Park. The project involved a desktop study of diverse data sets, to develop a regional scale understanding of the hydrogeology of the Laura Basin. Full details of the method and findings of the study are provided in the final technical report (Yates et al, 2015).

Geology and coal resources

The Laura Basin is a sedimentary basin deposited between 168–102 million years ago (Ma) during the Middle Jurassic and Early Cretaceous (Mesozoic). Overlying the Laura Basin are Cenozoic sedimentary deposits of the Kalpowar Basin, which have been intermittently deposited since approximately 60 Ma.

Location

The Laura Basin is a geological basin on Cape York Peninsula, QLD (Figure 1). There are very few populated places in the Laura Basin. The only major settlement is the town of Laura, with a population of 80. The region has minimal infrastructure or development and there are few roads, most of which are unsealed.

Figure 1. Laura Basin extent and DEM.
The strata of the Laura Basin have a maximum thickness of about 1 km in the northern-central onshore basin. There are three major stratigraphic units, the Middle to Upper Jurassic Dalrymple Sandstone, deposited in lagoonal-fluvial environments and which contains some coal; the Jurassic to Lower Cretaceous Gilbert River Formation, deposited in lagoonal to marginal marine environments; and the Cretaceous (Late Aptian to Albian) Rolling Downs Group, deposited in a shallow marine environment. The sediments of the overlying Kalpowar Basin are much thinner in comparison to those of the Laura Basin (with a maximum thickness of about 70 m). They are grouped into three continuous cycles of erosion and deposition. The Kalpowar Basin sediments mainly consist of semi-consolidated to consolidated sand/sandstone, gravel, conglomerate and clay (Figure 2).

There are currently no operating coal mines or coal seam gas fields within the Laura Basin. However, there is one proven black coal resource in the Bathurst Range. The coal is a high quality coking (thermal) coal with a total resource of 47 Mt. Whilst approximately 25% of the onshore area of the Laura Basin is covered by coal exploration tenements and coal exploration has occurred in the basin for many years (dating back to 1879), there have not been any other significant coal resources identified.

### Hydrogeology

The principal aquifers of the Laura Basin are the Gilbert River Formation and the Dalrymple Sandstone (Figure 2). Due to the relatively limited data coverage and the low intensity of groundwater use, the Dalrymple Sandstone and the Gilbert River Formation are commonly classed as a single aquifer. There is potentially a region of Normanton Formation sandstone in the north-eastern Laura Basin. This sand-rich facies of the Rolling Downs Group also functions as an aquifer and may be locally important for spring discharge, particularly on the southern side of Bathurst Range. There are also aquifers in the Cenozoic sediments of the Kalpowar Basin that overlie the Laura Basin.
In the Laura Basin, the main confining unit (aquitard) of the Mesozoic sedimentary sequence is the Rolling Downs Group, in particular the Wallumbilla Formation. The Wallumbilla Formation forms an aquitard that is thickest and most extensive in the central parts of the Laura Basin. It is absent in the north-east of the basin and around the eastern and southern rim and also thins towards the south-west.

Previous hydrogeological studies have included the Laura Basin within regional investigations of the groundwater resources of Cape York Peninsula. The hydrostratigraphic units defined by these studies have informed the aquifer-aquitard framework developed in this study (Figure 3). However, there has been limited stratigraphic mapping across the whole basin. One of the major tasks of this project was to interpret the stratigraphy of existing borehole logs and map the thickness of the main hydrostratigraphic units at the basin-scale.

**Groundwater and Ecosystems**

Groundwater provides about 95% of the water supply within the Laura Basin and is used primarily for stock and domestic purposes (cattle grazing), and water supply for the town of Laura. Groundwater use is generally of low intensity and is typically concentrated around the edge of the basin where the Mesozoic aquifer outcrops or occurs close to the surface. Artesian groundwater pressures are recorded for many bores and there is currently about 588 ML/yr of groundwater use in the basin. There is limited use of groundwater from the Cenozoic sediments of the Kalpowar Basin.

![Figure 3. Hydrostratigraphy of the Laura Basin.](image-url)
Desk-based studies have identified groundwater dependent ecosystems for many watercourses across the Laura Basin. Groundwater baseflow to streams and lakes and evapotranspiration from the watertable are significant components of the water balance that are currently poorly informed and difficult to estimate. No field-based validation of the groundwater dependent ecosystems in the basin is available, and groundwater discharge processes are poorly constrained.

**Groundwater Flow System Conceptualisation**

Particular emphasis was placed on new stratigraphic interpretation of limited groundwater bore lithology records available for the basin. Recognised hydrostratigraphic units were mapped across the basin (Figure 4) and a potentiometric surface was developed for the regional Mesozoic aquifer (Figure 5). In combination with mapped faults and other major structures and records of artesian groundwater (Figure 6), Cenozoic sediment cover, Mesozoic sediment outcrop, location of artesian wells and fault structures for understanding flow systems. Note: Cenozoic sediments also cover the Wallumbilla Formation across much of its extent), a conceptual model of groundwater flow systems was developed. The study indicated that at the sub-regional scale, flow systems are compartmentalised and controlled by fault structures and litho-facies variation.

*Figure 4. Mesozoic Aquifer thickness, Laura Basin.*
There is limited information available to characterise the groundwater systems of the Laura Basin. In particular, there are <30 hydraulic head measurements for bores in the Mesozoic aquifer and <10 in the Cenozoic aquifers. There are also very few groundwater chemistry records, and identifying exact hydrostratigraphic units is difficult due to the variable quality of bore construction records.

There are no time-series hydraulic head or groundwater chemistry records available for any bores in the basin, and previous monitoring has been opportunistic for stand-alone research projects, rather than enabled by a systematic monitoring program.

These data limitations affect the capacity to understand groundwater system changes over-time, and in particular, its response to stresses (for example, groundwater extraction or changes to recharge volumes). Recharge and discharge components are poorly understood and no previous study attempted to analyse the volumes of these components at a basin-scale. Consequently, a new water balance components analysis prepared for this study helped bring together available data to improve the understanding of groundwater recharge and discharge in the Laura Basin. This provided a tool to highlight major data and knowledge gaps.

Figure 5. Mesozoic Aquifer Potentiometric Surface, Laura Basin.
Conclusions

The work undertaken and reported on for this study forms the basis for underpinning future investigations to better understand the potential for groundwater impacts resulting from coal resource development in the Laura Basin. Our lack of data and knowledge to understand recharge and discharge processes and dynamics are significant. Decision making around future development of water or mineral resources in the basin will require a deeper investigation of these processes at both local and regional scales, including the collection of additional data.

References


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Figure 6. Map of regional aquitard (Wallumbilla Formation), Cenozoic sediment cover, Mesozoic sediment outcrop, location of artesian wells and fault structures for understanding flow systems. Note: Cenozoic sediments also cover the Wallumbilla Formation across much of its extent.