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Gulf Water Study

Limmen Bight & McArthur Rivers Region



Australian Government
Water Smart Australia

Front cover:

Waterhole downstream from Jandanku, (Bauhinia Spring)

Isolated waterhole on Tanumbirini Creek

Ronnie Raggett and Lewis Raggett at Wee-ak on the McArthur River.

GULF WATER STUDY



Limmen Bight River at the Nathan River Road crossing.

WATER RESOURCES OF THE LIMMEN BIGHT AND MACARTHUR RIVERS REGION

REPORT 17/2009D

U. ZAAR

DARWIN NT

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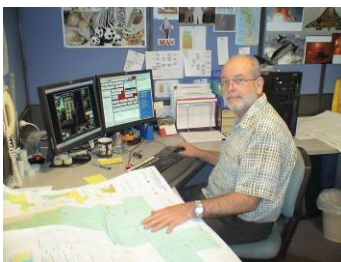
I take pleasure in also thanking members of our technical working group; Max Gorringe, manager of Eley Station, Frank Shadforth, manager of Seven Emu Station and Glenn Wightman – ethnobiologist who all kindly took the time to provide advice at our meetings. All were always ready to help.

I am very much indebted to the local people in the region. There is little recorded surface water data in the region so the information provided by locals has been vital to the project. I thank the station owners and managers; Alec Anderson, Bill Bright, Bill Darcy, David Daniels, Jimmy Mawson, Tim and Judy Mc Farlane, Chris and Christine Shilling, Rhett Walker the Parks and Wildlife rangers; Shaun Evans, Ben Senge, Eddie Webber, Stewart Woerle and from the minerals sector Simon Fell-Smith, Tim Lewis and Bruce Maycock.

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I humbly thank all these people as it has been no less than fascinating to learn about water in the Gulf.



Lynton Fritz



Technical working group



Field guides, Vanderlin Island

SUMMARY

This report provides details of the groundwater and Dry season surface water resources of the Limmen Bight River Region and the McArthur River Region of the Gulf as depicted on the accompanying two water resource maps. These are two of five regions which make up the mapping area of the Gulf Water Study (Figure 1.1). The study was co-funded by the Australian Government Water Smart Australia Program and the Department of Natural Resources, Environment, the Arts and Sport of the Northern Territory Government.

The purpose of this work is to provide readily accessible, easily understandable and user friendly information products on water resources in the region. The project was undertaken with the dual perspective of western science and indigenous knowledge and both are represented in the products of this study. It is hoped that common understandings will develop between Indigenous people and land managers about water in the region. The key aim is to provide a fundamental data set to guide development of water resources in the region maintaining healthy groundwater and rivers as well as the ecosystems which depend upon them.

Each map region encompasses cattle stations, Aboriginal land and National Park. The town of Borroloola, located in the McArthur River Region, services the two regions. Domestic water supplies are sourced from groundwater, springs, river water and rainwater. The main industries of the regions are cattle grazing, tourism and mining. Cattle are watered by groundwater, river water, natural waterholes and dams.

The groundwater resources of the two map regions have been classified into seven aquifer types:

- | | |
|--|-----------------------|
| • Sedimentary Rocks with intergranular porosity | (yields 1.0 – 10 L/s) |
| • Fractured and Karstic Rocks – regional scale aquifer | (yields 0.5 - 10 L/s) |
| • Fractured and Karstic Rocks – local scale aquifers | (yields up to 10 L/s) |
| • Fractured and Weathered Rocks – carbonate rocks | (yields 0.5 – 10 L/s) |
| • Fractured and Weathered Rocks – carbonate rocks | (yields 0.5 – 5 L/s) |
| • Fractured and Weathered Rocks | (yields 0.5 – 5 L/s) |
| • Fractured and Weathered Rocks with minor groundwater resources | (yields 0 - 0.5 L/s) |

Few bores exist in the Sedimentary Rock aquifer and water quality can be marginal. It lies on the eastern coast of the McArthur River Region map.

The Fractured and Karstic regional scale aquifers lie in the south-west of each map. The aquifers are situated in Cambrian aged limestone formations, namely the Anthony Lagoon Beds and Gum Ridge Formation. The latter is equivalent to the Tindall Limestone. These regional scale aquifers cover an area from Tennant Creek to Mataranka and provide the key groundwater resource in the western Gulf region. As part of the Gulf Water Study this entire aquifer was modelled. This work was undertaken by A.

Knapton (2009) and a report is available. The fractured and karstic local scale aquifers are small in extent in the two map regions and have yet to be tested.

The dominant aquifer type of the regions occurs in fractured and weathered rocks. The better yielding carbonate aquifer is situated within the Karns Dolomite and lies in the eastern McArthur River region. It provides baseflow to the Wearyan River. Bores commonly yield 3 L/s. Other fractured and weathered carbonate aquifers occur in hard old (Proterozoic) rocks which predominantly rely on fracturing for aquifer development. Fractures are targeted for supplies.

Non carbonate fractured and weathered rocks with yields typically between 0.5 – 5 L/s are associated with sandstones. Of particular interest is the Abner Sandstone located in the Borrooloola area where yields up to 10 L/s have been achieved, however, the formation has not been extensively drilled elsewhere. It is possible that these high yields are a localised feature.

With the dominant aquifer type in the region being fractured and weathered rocks with local scale aquifers only small spring discharges are observed, generally less than 40L/s. The springs host dependent ecosystems often denoted by lush vegetation pockets. These are refuges for terrestrial and aquatic wildlife.

River flow has been classified on the maps according to the minimum recorded flow at the end of the Dry season during a dry period. There are three categories that describe river flow;

- River with a minimum flow of between 10 and 100L/s at the end of the Dry season
- River with permanent waterholes and minimum flows up to 10 L/s at the end of the Dry season
- River which is dry at the end of the Dry season

Only short river reaches are listed under the first category. They include the upper McArthur River, upper Rosie Creek and other discharge channels from localised springs often associated with faults. Although most of the rivers in the region cease to flow by the end of the Dry season some rivers maintain large pools such as those along the McArthur River and Batten Creek. The largest permanent lake across the two regions is Lake Eames. It is located on Vanderlin Island.

Indigenous knowledge on specific sites has been provided by traditional owners and is documented in this report. Many of the sites are shown on the map. Indigenous people believe that the Spirit Ancestors created their environment as well as a charter that is the Law for existence and through this law all land, water, plants, animals, natural phenomena, people and the Spirit Ancestors (Dreamings) are inextricably connected. It is through these intricate connections that indigenous people relate to water and everything else. Water sites not only have a physical entity and a purpose in the connected environment but also social, emotional, cultural and spiritual significance. Effective management of land and water therefore involves consideration of all these realms. Understanding how indigenous people relate to land and water enables the documented knowledge on waterholes to be put into perspective. Much can be learnt from their holistic view as it engenders responsible land and water management.

Aside from the map and this report other products from the Gulf Water Study include a GIS, posters and photographic and video collection which are all available on a data DVD.

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1. INTRODUCTION

This report provides details of the groundwater and Dry season surface water resources of the Limmen and McArthur Rivers regions of the Gulf of Carpentaria as depicted on the accompanying water resource maps. They represent two of the five regions which make up the mapping area of the Gulf Water Study (Figure 1.1). The study was co-funded by the Australian Government Water Smart Australia Programme and the Department of Natural Resources, Environment, the Arts and Sport of the Northern Territory Government.

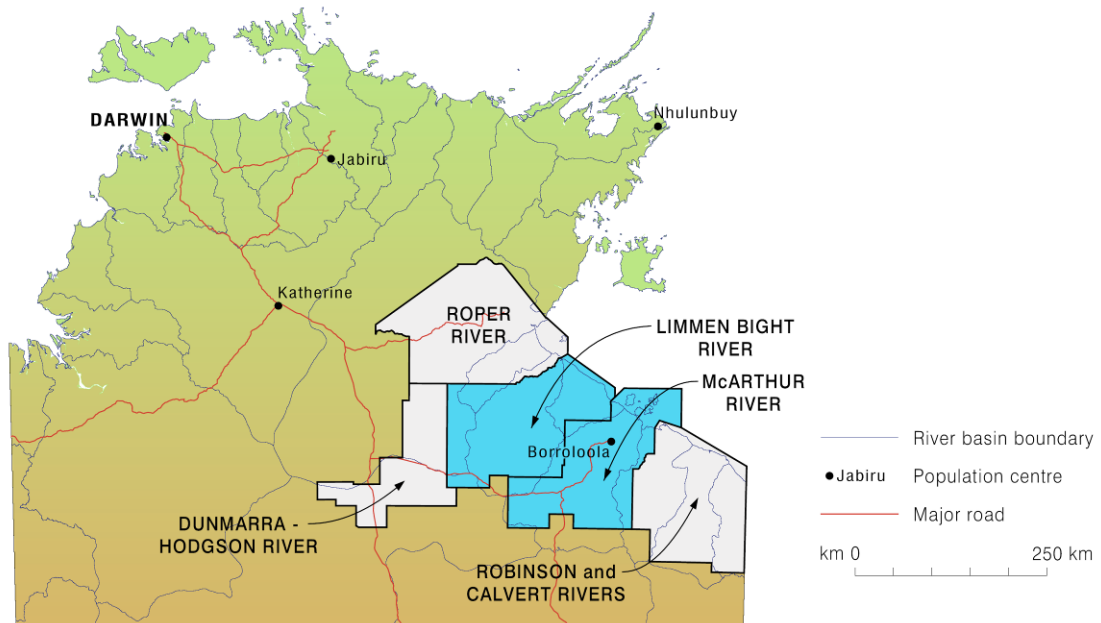


Figure 1.1 Study Regions

Ancillary to this report and map are posters, GIS and a photographic and video collection. All products from the study are available on DVD.

The purpose of this work is to provide readily accessible, easily understandable and user friendly information products on water resources in the region. The project was undertaken with the dual perspective of western science and indigenous knowledge and both are represented in the products of this study. It has been targeted to inform all stakeholders from station managers, traditional owners and land developers through to water allocators and government bureaucrats. The key aim is to provide a fundamental data set to guide development of water resources in the region maintaining healthy groundwater and rivers.

The water resources map is an interpretation of the regions geology, topography, bore data, stream flows and vegetation patterns. Where data was lacking investigations were carried out including geophysical surveys, water quality sampling and stream gauging. The contribution from local people, in particular their knowledge of the waterways has been vital to this mapping exercise, especially in areas where access was difficult and scientific information scant.

2. LOCATION

Limmen Bight River Region

Three cattle stations operate in this region; Tanumbirini, Broadmere and Lorella. Lorella Station also operates a wilderness park where a key tourist attraction is the hot springs. Aboriginal Land includes the Alawa Aboriginal Land Trust and the Jandanku Aboriginal Land Trust. The Limmen National Park is situated on pastoral land encompassing Nathan River and Billengarrah Stations. The park was recently established in order to protect the natural and cultural values of the Gulf region and to provide access to tourism sites for visitors travelling the Nathan River Road which is part of the tourist route called the Savannah Way. Some visitor facilities are provided in the park with more planned in the future. The park is known for its 'lost cities' where erosion of sandstone escarpments has formed numerous large sandstone spires and rounded domes. (www.nt.gov.au/nteta/parks).

Access to the region is by the Carpentaria Highway which runs from the Stuart Highway to Borroloola and the unsealed Nathan River Road (Highway 1) which runs from the Carpentaria Highway to the north passing through the Limmen National Park. There are no services provided in the area apart from the campgrounds with basic facilities.

The major river in the area is the Limmen Bight River and its tributary the Cox River. West thereof is the Arnold River and in the north-east is Rosie Creek situated on Lorella Springs Station

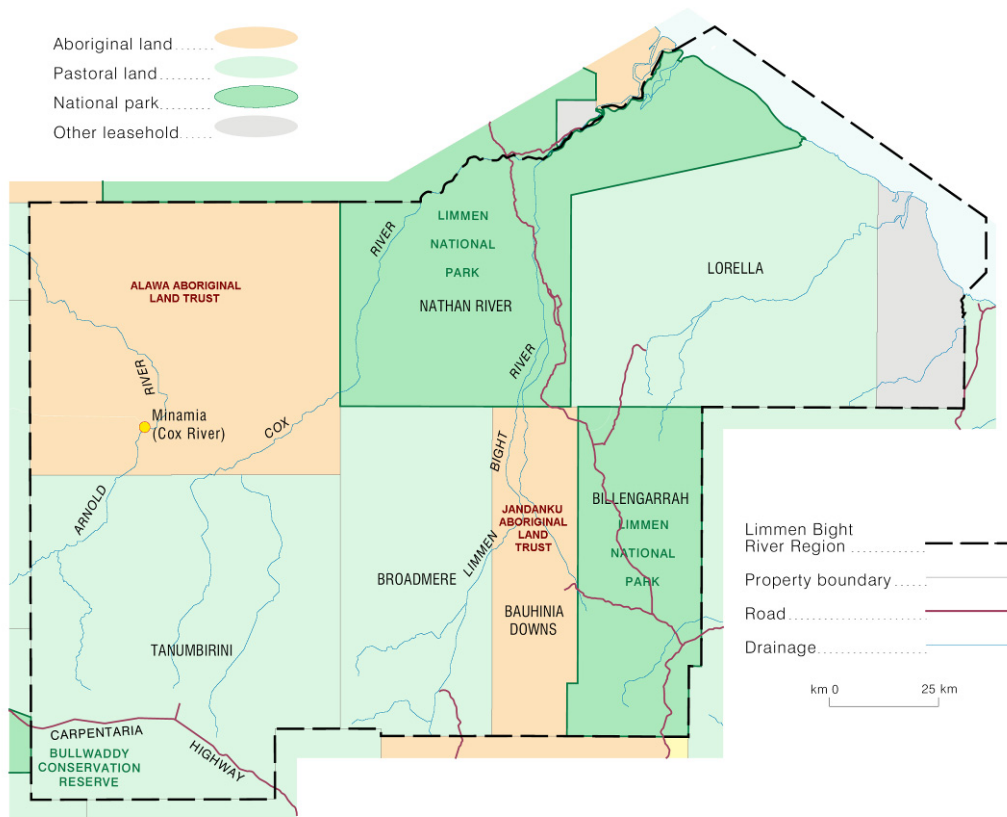


Figure 2.1 Land use in the Limmen Bight River Region

McArthur River Region

Borroloola is the largest population centre in the area and provides services to the region. A roadhouse is also located at Cape Crawford and services are also provided at Batten Point at the King Ash Bay Fishing Club.

The major land use in the area is cattle grazing. There is one freehold block, Leila Creek Station and four pastoral leases, the largest of which is McArthur River Station. The other leases are Mallapunyah, Manangoora and Spring Creek. The latter two are indigenous owned and operated. Aboriginal lands include the Narwinbi Aboriginal Land Trust which surrounds Borroloola, the Wurralibi Aboriginal Land Trust which encompasses two large islands and the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust in the south-west. This latter land trust is sub leased for cattle grazing.

Two mines operate in the region; the McArthur River mine which mines lead and zinc and the Merlin Diamond Mine. To extend the life of the McArthur River mine it has converted to open pit operations. This has required the rechanneling of a section of McArthur River and Barney Creek.

Fishing is a key tourist attraction in the region. The King Ash Bay Fishing Club is situated at Batten Point. The Barranyi National Park is located on North Island and the Caranbirini Conservation Reserve is located central in the map sheet.

The sealed Carpentaria Highway provides access from the Stuart Highway to Borroloola. Major unsealed roads branch off from this highway; the Nathan River Road which heads north to the Roper region, the Tablelands Highway which heads south from Cape Crawford to the Barkly Highway and the Wologorang Road which leads from Borroloola south-east to Queensland.

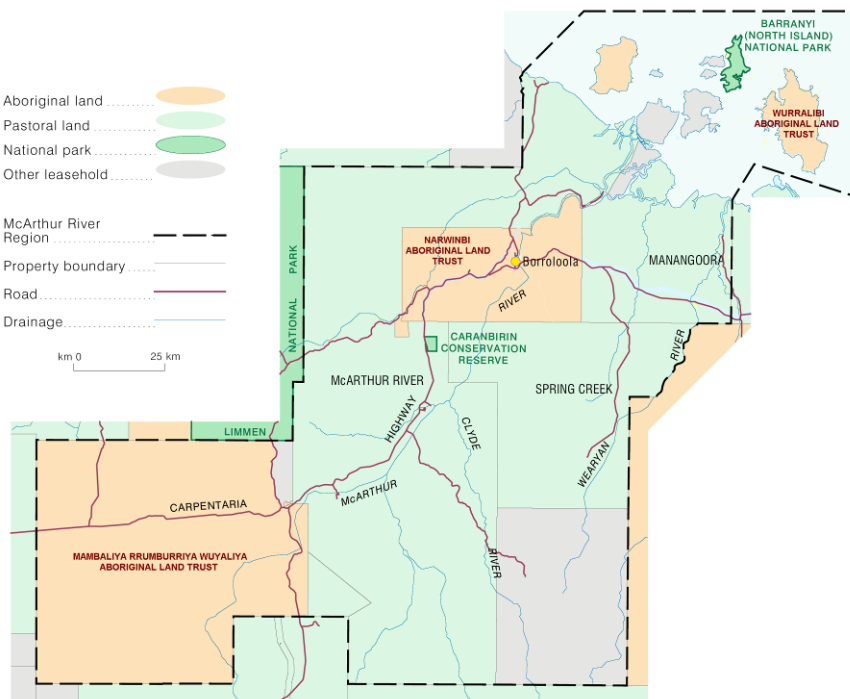


Figure 2.2 Land use in the McArthur River Region

3. CLIMATE

The map regions lie in the Wet/Dry tropics. With 6 months of negligible rain in the Dry season most streams cease to flow unless they are groundwater fed. Annual evaporation exceeds rainfall. The last 9 years has been the wettest for the period of interpolated record, that is 118 years.

The map regions have a tropical savanna climate with a marked Wet season from November to April and Dry season from May to October (Figure 3.1). Most of the area has an average annual rainfall of between 600 – 800 mm whereas the north-eastern coastal strip receives between 800 – 1000 mm. (Figure 3.2). Average annual rainfall decreases from the coast inland. Annual rainfall has varied widely over the last century.

The long term record is represented in Figure 3.3 for three sites in the Limmen Bight and McArthur Rivers region and consists of interpolated data obtained from SILO Data Drill (www.longpaddock.qld.gov.au/silo). Note how annual rainfall is generally higher at the coast, at Borrooloola, and lowest inland, at Tanumbirini. A listing of rainfall recorder sites is provided in Appendix G. Figure 3.3 clearly shows the large fluctuations in rainfall and how the latter 9 years have been exceptionally wet with an average rainfall of 933 mm at McArthur River Station (DR014715) compared with the long term average of 684mm.

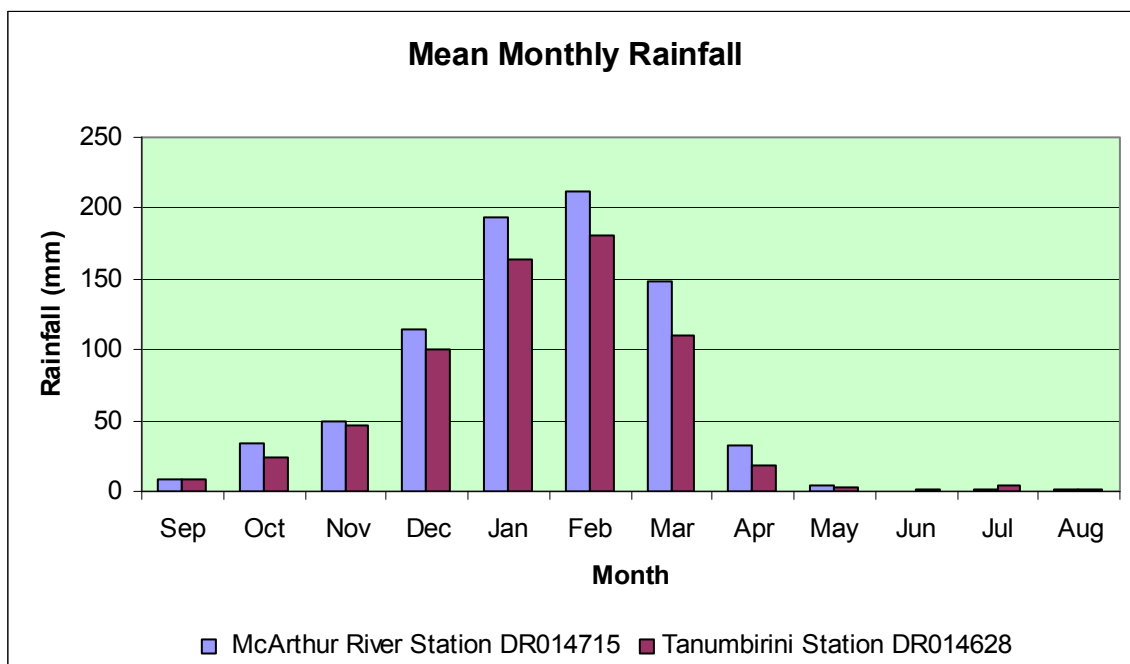


Figure 3.1 Average monthly rainfall for McArthur River and Tanumbirini Stations.
(From Bureau of Meteorology web site: www.bom.gov.au/climate/averages)

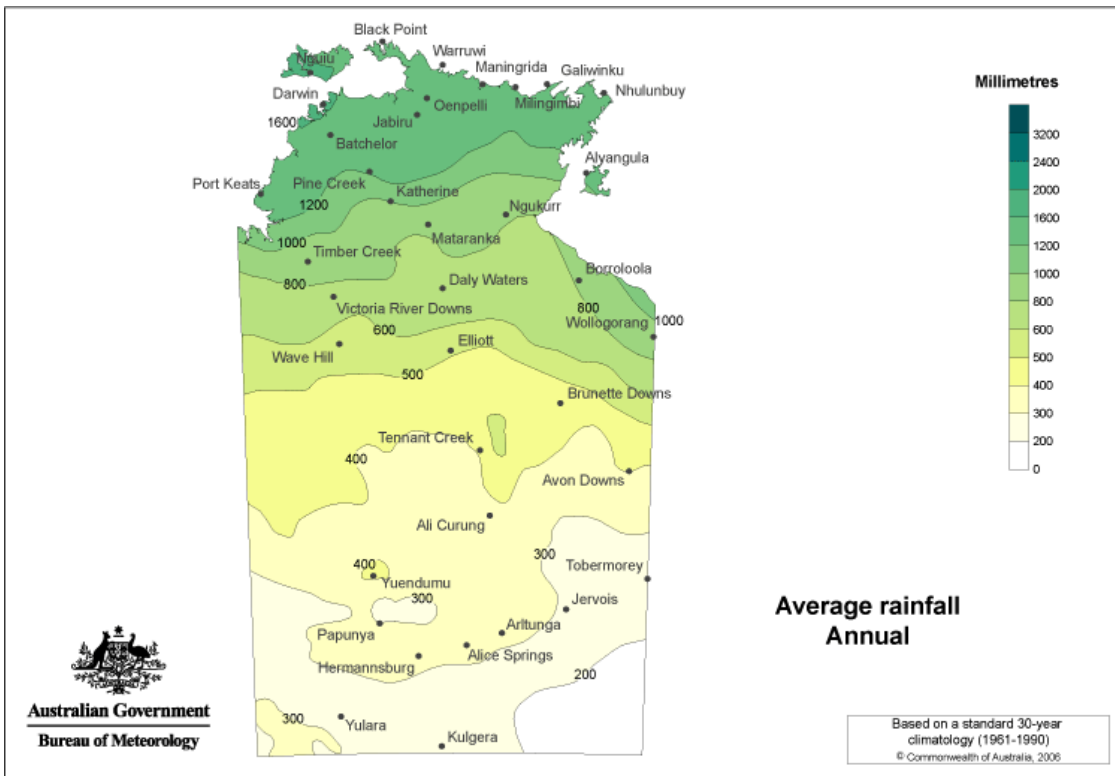


Figure 3.2 Average annual rainfall for the Northern Territory
 (From BOM website: www.bom.gov.au/jsp/ncc/climate_averages/rainfall)

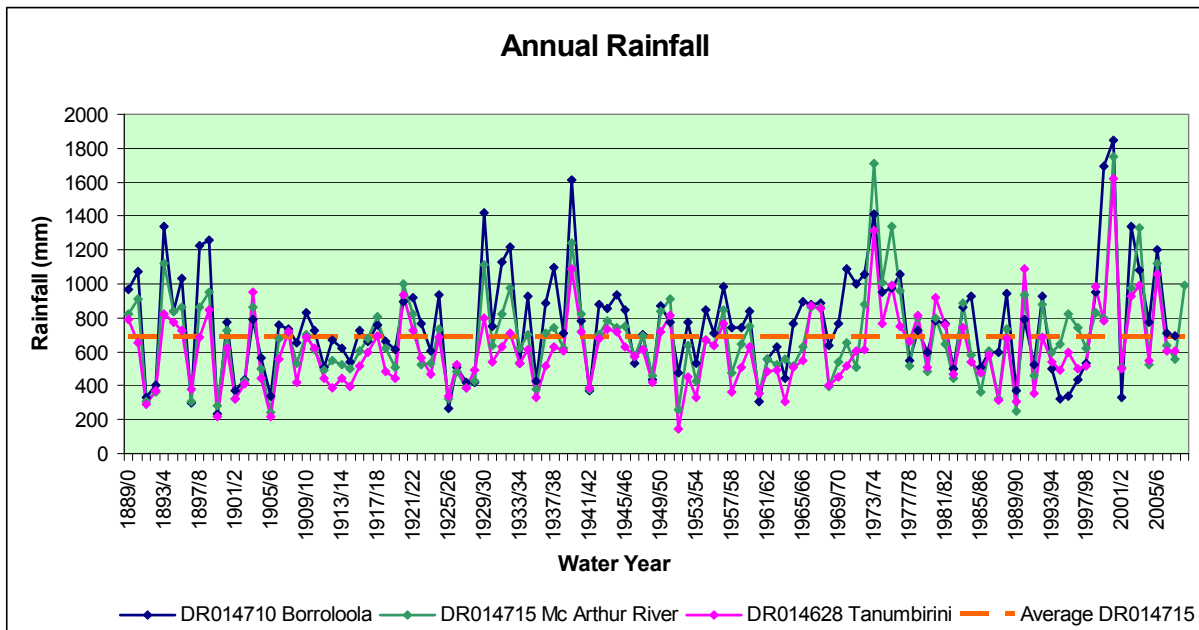


Figure 3.3 Annual rainfall in the Limmen Bight and McArthur Rivers Area. Calculated over the Water year = September to August of the following year. This is interpolated data for the sites listed, obtained from SILO Data Drill data made available by the State of Queensland through the Department of Natural Resources.

At McArthur River Station mean daily minimum temperature varies from 12 to 25°C and mean daily maximum from 30 – 39°C. Average annual evaporation is about 2600 mm for the region which exceeds the annual rainfall in even the wettest of years. Mean 3 pm humidity varies from 21 – 53 percent. (www.bom.gov.au/climate)

The Wet/Dry season contrast has significant implications for water resources. The monsoon brings wet season rainfall but cyclones, and the lows before and after cyclones, bring large rainfall events. These events cause major flooding and can provide good recharge to aquifers. In Figure 3.4 we can see that for the period available (1906-2006) there have been 36 cyclones within 200 km of McArthur River Station (DR014715) and 6 between 2000-2006 showing that in these latter years there has been frequent cyclone activity. This has brought exceptional rainfall to this region.

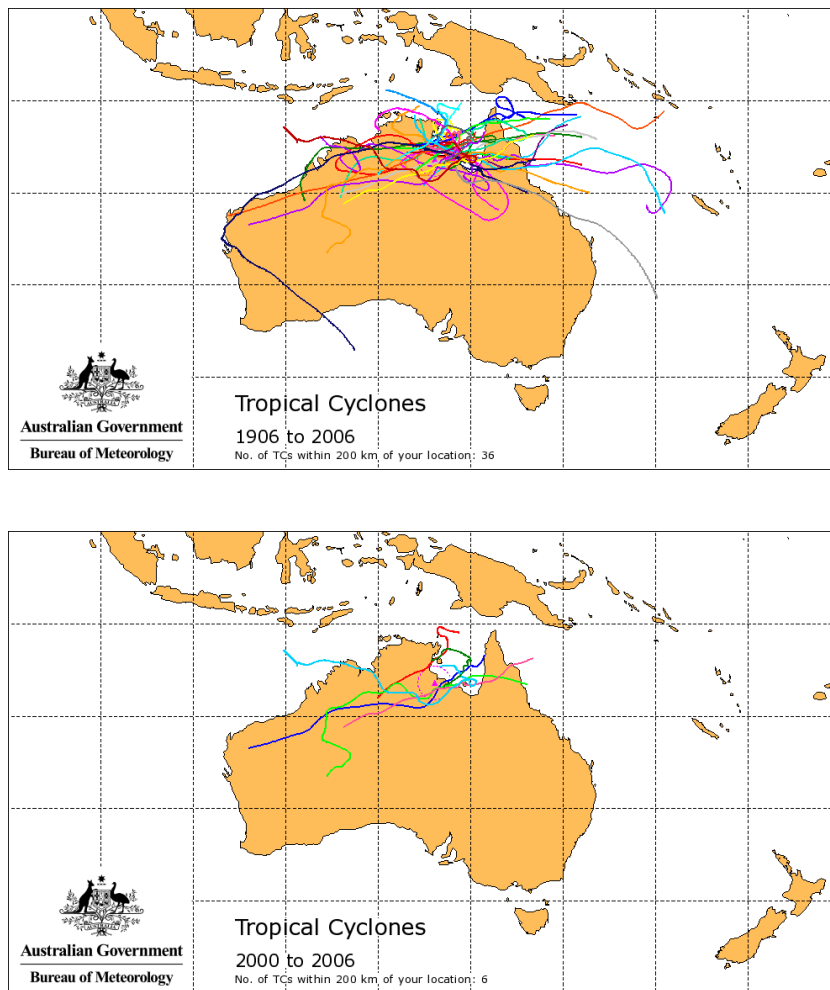


Figure 3.4 Tropical cyclones between 1906 – 2006 and 2000 – 2006 in the map region
(From BOM website: www.bom.gov.au/cgi-bin/silo/cyclones.cgi)

Although the Wet season brings significant rainfall over a short period, the ensuing Dry, with months of negligible rain, results in most rivers in the region ceasing to flow unless they are groundwater fed such as the upper reaches of the McArthur River.

4. CURRENT WATER USAGE

The level of water usage in the region is low, with groundwater (bores), rainwater (tanks and dams), natural waterholes and rivers providing water for domestic usage and cattle grazing.

Groundwater is used for domestic supplies wherever possible. The Borroloola Community sources its water from bores as do the mines and the King Ash Bay Fishing Club.

Outstations mainly use bores and rainwater but some use river water for their domestic water supply.

The cattle stations use bores, rainwater tanks, waterholes or river water for their domestic supply. (Plate 4.1, Table 4.1 & 4.2). Tanumbirini, McArthur River, Leila Creek and Broadmere Stations and the grazing leases on Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust are largely reliant on bores to water their cattle however dams, river water, springs and waterholes also provide supplies. Cattle stations have reported dams drying up late in the Dry season due to the months of no rain and high evaporation rates. The main industry in the area is cattle grazing. Wild cattle are also mustered throughout the region.



Plate 4.1 Broadmere Waterhole. Domestic supply to Broadmere Station.

Table 4.1 Current water use in the Limmen Bight River map Region.

Location	Water Supply	Water supply to cattle
Alawa Aboriginal Land Trust	River waterhole	
Broadmere Station	Waterhole	Bores, waterholes
Jankanku Aboriginal Land Trust, Bauhinia outstation	Spring fed waterhole	
Limmen National Park, Nathan River Ranger Station	Spring fed waterhole	
Lorella Springs Station	Spring fed waterhole	Waterholes
NT Por 2432 – Wadawarra, Bone Lagoon outstation	Bore, rainwater	
Tanumbirini Station	Bores, rainwater	Bores, dams, waterholes

Table 4.2 Current water use in the McArthur River map Region.

Location	Water Supply	Water supply to cattle
Borrooloola (including Garawa, Mara, Yanyula)	Bores	
Batten Point (King Ash Bay)	Bore	
Cape Crawford Roadhouse	Bores	
Leila Creek Station	Bore	Bores, waterholes
Mallapunyah Station (NTPor 4152)		Waterholes
Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust		Bores, waterholes, rivers
Manangoora Station, Warby	Lagoon	Waterholes
McArthur River Station	Spring fed waterhole, rainwater	Bores, dams, waterholes, springs, rivers
Spring Creek Station	Waterhole, rainwater	Waterholes
McArthur River Mine	Bores	
Merlin Mine	Bore	
Babanji (Vanderlin Island)	Well, rainwater	
Barranyi (North Island)	Well	
Budjanga (East Wearyan)	Bore	
Cow Lagoon	Bore, rainwater	
Doolgarina	?	
Goolminyini (Devil Springs)	Spring fed waterhole, rainwater	
Jimilaya	Soak (Water level can drop)	
Little River	Waterhole in creek, rainwater	
Manmathanbulu (West Island)	Bore (can dry out), rainwater	
Milibunthurra, Sandridge, Wada Wadalla, Wandangula	Supplied through pipeline running from bore at Garawa.	
Mooloowa (Vanderlin Island)	Well, rainwater	
Munyalini (Campbell Spring)	Bore, rainwater	
Tjougouri	Bore	
Uguie (Vanderlin Island)	Waterhole, well, rainwater	
Wathanka (South West Island)	Bore, rainwater	
Wonmurri	Bore, rainwater	
Wurlbu	Bore	
Wurlguwurlgu (Kangaroo Island)	Lagoon (quality deteriorates), rainwater, cart water.	
Yulbara (Vanderlin Island)	Spring fed waterhole	

Outstations serviced by Mabunji Aboriginal Resource Association highlighted in blue.

5. INDIGENOUS KNOWLEDGE

To indigenous people water sites not only have a physical entity and a purpose in the connected environment, but also social, emotional, cultural and spiritual significance. Effective management of land and water therefore involves consideration of all these realms.

'... nothing is without meaning, because to have no meaning would be to have no Law, if something has no Law it has no place and this cannot be for Indigenous plants and animals, (and land and water) all have ngalki, they have essence or substance that relates them to all other living things including humans.' (Bradley et al. 2006)

Western science provides a view of water resources in terms of its physical characteristics. On the water resource map rivers are classified according to their minimal flow, groundwater classified according to aquifer type and waterholes depicted as to whether they are permanent or intermittent. Aboriginal people however view and classify the natural environment differently and kinship plays a major role. Just as any scientific based management of water requires an understanding of scientific principles and classification, so too indigenous environmental management requires an understanding of indigenous views and classification of the environment.

To begin to comprehend the indigenous perspective is no easy task when coming from a Western European perspective. *'Many cross-cultural differences exist in relation to environmental perceptions, knowledge of scientific practices, spirituality and language. Bradley notes that it was only after he had become quite fluent in Yanyuwa that he began to really understand how the Yanyuwa view their environment.'* (Bradley et al. 2006) Bradley is an anthropologist who has worked with the Yanyuwa people since 1980. The work of Bradley and others is presented following as it gives a clear overview of how one language group, the Yanyuwa view the environment, thus providing an example of indigenous perspectives in the Gulf region. The Yanyuwa people are one of several language groups situated in the Gulf Region. Other groups include Alawa, Marra, Warndarrang, Mangarrayi, Ngalakgan, Garawa, and Gudanji as well as others. Cultural differences exist between the language groups but the underlying world view often has similarities. Yanyuwa traditional country is situated north-east of Borroloola and encompasses the Sir Edward Pellew Group of islands.

The following overview has been heavily resourced and quoted from Bradley et al. 2003 and Bradley et al. 2006 and is denoted by the grey font. The information presented is the result of years of research by Bradley.

For Yanyuwa people the environment is both a physical, spiritual and cultural landscape. To begin to understand their interconnected view of the environment it is necessary to explain their view on how life and land came into being.

The Yanyuwa believe all was created by the Spirit Ancestors, commonly called Dreamings or in Yanyuwa *Yijan* 'who rose up from the earth or travelled from distant places, and created and /or changed geographical features and placed different plants and animals on the earth'.

'The Spirit Ancestors also created a charter that is the Law for existence. ... The Law is the reason why things are as they are, or are done in a particular fashion'. As 'the Spirit Ancestors set out the forms of Law, and established the natural order and shape of the landscape they also left their creative potency. At some point in time, most of the Spirit Ancestors changed into a number of forms. Some became life forms or phenomena, as we know them today, such as certain species of plant and animal, celestial bodies, winds and tides. Others transformed themselves into rocks, trees and watercourses, and their power became localized at certain sites'.

'The Yanyuwa believe that these Spirit Ancestors and their power still exist in the land. They also believe that their power is still active and that through ceremony, song and certain forms of ritual action, they can be contacted. It is because of this that the country is said to be able to 'hear', that a rock for example, can make certain things happen, and that places when visited can be describes as being happy, sad, generous or ungriving'.

The land and water is *'criss-crossed with the tracks or paths of these Spirit Ancestors, and these tracks are marked with places where the Spirit Ancestors danced, ate, fought, slept, urinated and so on. All of these places are seen to be repositories of power and the consciousness of the Spirit Ancestors. Thus the whole landscape is seen as a vast network of interconnected meaning'*. An example is provided in Figure 5.1 which provides a listing of the Spirit Ancestors and shows their tracks in the Foelsche and Wearyan Rivers area (south-eastern Gulf). Figure 5.2 shows the place names associated with these Spirit Ancestors for the same area. Figure 5.3 provides part of one of the dreaming stories for this area, namely that of Walalu, the Stranger Rainbow Serpent. This area forms part of the Law that comes from the Mainland.

The tracks that the Spirit Ancestors took 'are also the song cycles, kujika, which are sung during ceremonial performances. The song cycles for the travelling Spirit Ancestors follow a particular track and have offshoots that diverge from the main track to bring into the song all the stationary Spirit Ancestors that may be associated with a particular tract of land. Both the songs and the creatures can be called kujika, as they play a creative role.' It is believed that 'the songs are still moving through country even if no one is singing them, it is like they have a life of their own. People who know the Kujika can join in and sing, and once they start singing it is like the country is singing through that person.' The Spirit Ancestors and their songs are inseparable from each other and from the sites that they created through the action of singing. Thus, the Spirit Ancestors are the creators, the singers of songs, which sang the Yanyuwa environment into being. Everything they did is recorded in these songs: the names of country, fauna, flora, events and names of people and places are all recorded'. 'The Kujika is said to preserve the way the country was in the Dreaming and how it still is, and how the



Figure 5.1 Spirit Ancestors and their tracks in the Foelsche and Wearyan Rivers area. (From Bradley et al, 2003)

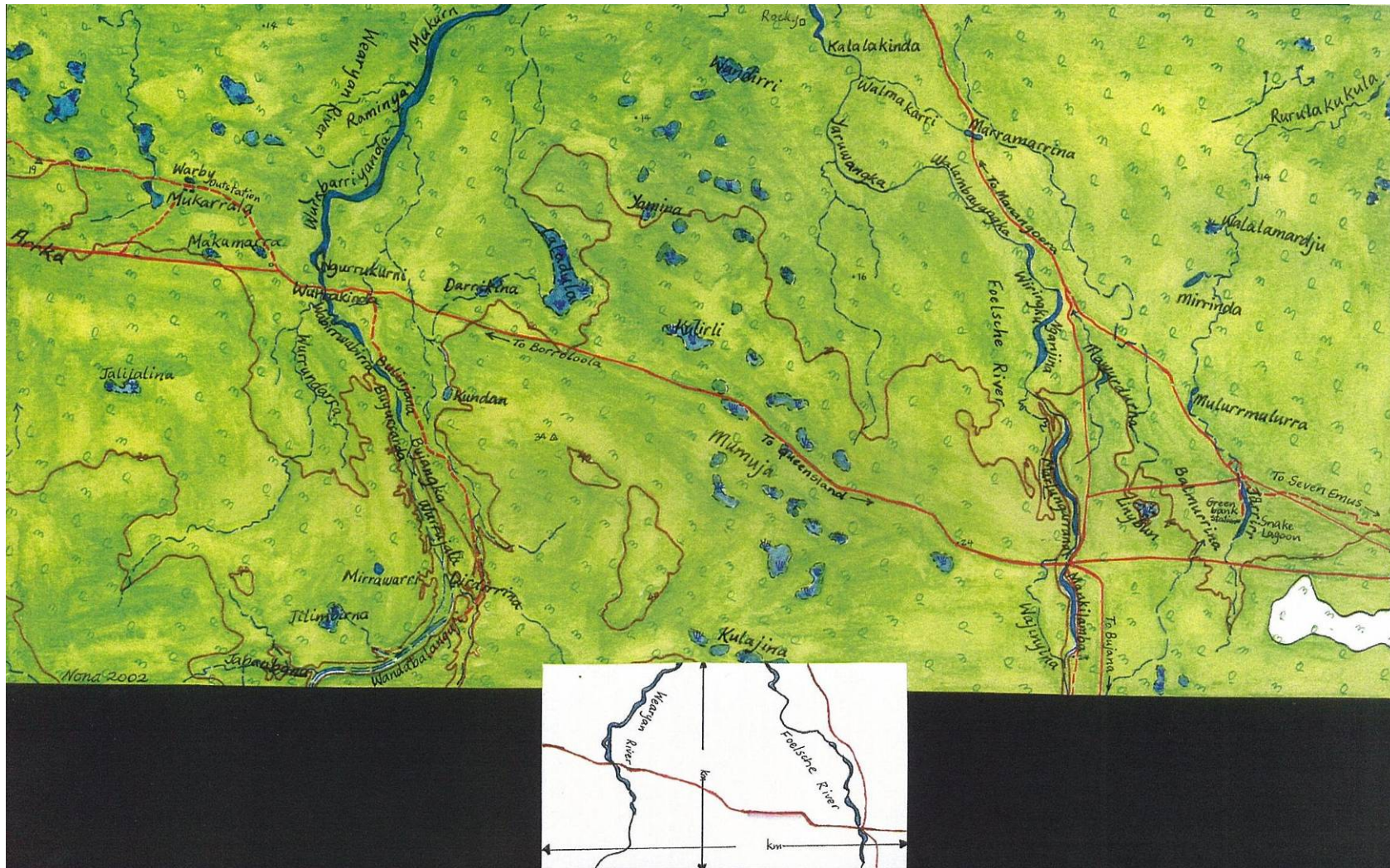


Figure 5.2 Place names associated with the Spirit Ancestors and their tracks in the Foelsche and Wearyan Rivers area.
 (From Bradley et al, 2003)

Other Stories:

1. The story of the Walalu, Stranger rainbow Serpent is very important and very sacred. The Walalu is really important to the a-Kunabibi ceremony and the story of his journey and the things he did are really sacred. His *kujika* is also very important and very sacred. The stories told here are all outside versions of his travels. The Walalu is sometimes called *Yankarra* which is Yanyuwa for "the Stranger", he is called this because he came from such a long way away and, once he moves through Garrwa and Yanyuwa country he keeps moving all the way into Marra country, he moves through Alawa and Mangarrayi country, and finishes his journey at the Mataranka hot springs which is far to the west. The Walalu has many other different names that are sung in his *kujika* but these names are only known to men. Some of the Walalu's journey is sung in the public *kujika* used in the a-Marndiwa initiation ceremonies. (see *Wandayarra a-yabala* and the Mambaliya *kujika* in particular)

2. The *ma-jabanda* forked pole is seen by men, women and children at the end of the a-Kunabibi ceremony. It is stood up on the women's ceremony ground.

3. Wabirrwabirra is the Yanyuwa name for this important rock hole, in Garrwa this place is called Wabirrwabirrnnyina. Some places have two names like this when they are near places where one language takes over from another language. The Wearyan River is a place where in the old days Yanyuwa and Garrwa people were always moving together.

4. The Walalu is an important figure in the a-Kunabibi ceremony, but this ceremony does not just belong to the Yanyuwa people. When this ceremony is being held on Yanyuwa country people from many other communities have to be asked to attend. Garrwa people come from Doomadgee and Robinson River, Marra and Alawa people come from Roper River, Nunggubuyu people come from Rose River and Gudanji people from the Tablelands. It is not just men that have to come because women too, have their own very important ceremonies that belong to a-Kunabibi. Today these people travel by car, plane and motor boat to come to this ceremony, in the old days they travelled by foot and dugout canoe. Once this ceremony starts all of these different people have to come, this ceremony has a lot of power and is very sacred. In Yanyuwa the words for power are *wurrama* which is like "authority" and *wirrimalaru* which is like "spiritual power".

MAP: Foelsche and Wearyan Rivers

DREAMING: Walalu, Stranger Rainbow Serpent

CLAN: Mambaliya

The Walalu, Stranger Rainbow Serpent came far from the east, from Mangkabarra which is in the sea near Massacre Inlet in Queensland. He travelled from the east, as a whirlwind, passing over the Calvert, Robinson, Foelsche, Wearyan and McArthur Rivers. 1. Just to the east of the Foelsche River is the large long lake called Kalajanku, it is not far from the Manangoora turn off. The Walalu created that lagoon and then came to the Foelsche River at Bujana where the outstation is now located. He then headed southwest and came to the Wearyan River. He arrived at the Wearyan River at Bulukwanja and then began going down stream and came to Jabanbana where he left behind a sacred ma-jabanda forked pole. 2. He then passed through Dirdirrina, Wurrujala, Bujangka, Buyurranda, Bulinjana and then came to Wabirrwabirra. 3.

At Wabirrwabirra he met up with a lot of Dreaming Women [a-Mararabarna], which had also come up out of the sea at Mangkabarra, but they had been trying to keep away from the Walalu Stranger Rainbow Serpent because they were brother and sister and they should have been avoiding each other. At Wabirrwabirra they danced together very important dances from the a-Kunabibi ceremony. The Sugar Glider Possum [warnkirra] is also a Dreaming at this place. Today there is a very large rock hole at Wabirrwabirra and there is a Rainbow Serpent Dreaming there that was left behind by the Walalu. The Walalu kept going downstream and came to the Wurrakinda where the road now crosses the Wearyan River, he then came to a small creek on the west bank of the Wearyan River called Wurrbarriyanda and this is where he left the Wearyan River and continued to travel west, heading towards Kawurrukuma near Marrinybul. 4. (see Map Fletcher and McPherson Creek.)

Figure 5.3 Dreaming story. (From Bradley et al, 2003). Right: one of the dreaming stories relating to the Foelsche and Wearyan Rivers area. Left: other stories associated with that Dreaming, Walalu. This story in particular has been presented here because, as detailed under 'Other Stories 1' the story of Walalu travels right across the Gulf region and ends at Bitter Springs at Mataranka, thereby traversing several language groups and providing an example of how the stories link people from different language groups.

old people would like it to stay.' The songs are also about power and the sound of the song creates power that can make things happen. For example, Stephen Roberts, a senior elder living at Minyeri, in talking to Zaar about the rain dreaming at Mambilila spring, located south of Ngukurr, explained:

"If the heavy storm come, you can stop that rain (by) singing, ... (sings song). That's how you stop that rain, he wont come rough. You sing ... backwards. (sings song) You sing like that. You stop that rain, never come. That cloud will go right back Minimeer, that's all. (Stephen Roberts, pers. comm.)"

An example of part of a *Kujika* is provided in Figure 5.4. These are the final verses from a *kujika* which has in it Walalu, the Stranger Whirlwind Rainbow Serpent Dreaming amongst others. The *kujika* starts at *Marrinybul* rockhole.

Bradley explains that *'every kujika has its own Ngalki'*. *'Ngalki is a very complex word that identifies and gives distinction to its owner or owners. It is often translated as 'essence', 'skin' or 'sweat'. For example the ngalki of a flower is its smell; of food, its taste and a songs' ngalki is its tune. The Yanyuwa believe that the Spirit Ancestors were imbued with ngalki, which was also a classifying agent that divided all things into one of four clans'*¹. As the Spirit Ancestors called and named places, animals, plants and other environmental features they also classified them, with a *ngalki*, which places them within the Yanyuwa clan system. The names of these four clans are:

- Wurdaliya,
- Wuyaliya,
- Rrumburriya and
- Mambaliya-Wawukarriya.

The interrelationship between *Kujika*, *Ngalki*, Dreaming and clans is portrayed in the following example: *'the kujika starting at Manankurra belongs to the Tiger Shark Dreaming and the Tiger Shark Dreaming is Rrumburriya. Rrumburriya is the name of the ngalki, it is also the name of the clan that owns the Manankurra Kujika.'*

The map in Figure 5.5 shows Yanyuwa clan areas and Table 5.1 provides a listing of plants and animals according to the clan classification. This clan classification is not restricted to the Yanyuwa, and other language groups in the Gulf identify with it. An example is provided by the Aboriginal land trust named 'Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust' which is situated on the McArthur River and is connected with a number of language groups. The trust has used clan names rather than language group names for identification. The four clans can be called different names in different languages. When Zaar undertook field work with indigenous people from differing language groups, they often referred to land and water areas in terms of the four clan names.

¹ Baker (1999) describes the social groups of the Yanyuwa as consisting of two moieties which each have two semi-moieties. The semi moiety groups are equivalent to the clan groups noted by Bradley et al. (2006)

Using the *Kujika* paths

These are the verses of the *kujika* and their English translation. They each have a number that matches to the pictures in the next section below called Moving through country.

This is the song moving through the country, rivers, creeks or over the sea. The pictures are all the things that are sung in the *kujika*. The number with each picture matches a number that is in the section above called *kujika* verses.

This section tells you where the *kujika* is travelling. The old men recorded these song journeys and they were translated into English.

1. Jangkalawuna The Wedge-tailed Jarrabanganja Eagle kinsman from Jangkala rests in the waters of Marrinybul	2. Wurdirdinganja Wedge-tailed Jangkalanganja Eagle rests in the waters of Marrinybul	3. Ngayi barramanka Wedge-tailed Barramanka Eagle strong in body
4. Ngardurra Wedge-tailed Ngardurrayi Eagle with strong Barramanka grasping talons	5. Mulunbirribirri The Wedge-tailed Mulunbirribirri cries out, "Kiyak! Bijangka dijangka Kiyak!"	6. Karnarra kurda The song rises Jirminji kurda from the waters of Marrinybul
7. Karnarra wurryi The song Jirminji wurryi is lifted from waters of Marrinybul	8. Yunbuliba The Crow calls Yunbuliba calls continually Yunbuliba out over her country, Yunbuliba the Crow feels content Wangkalarrabarra Wangkalarrabarra	9. Ngarnima The Crow calls out to cold season Mardumarduyuka Ngarnima Mardumarduyuka she calls out Wangkalarrabarra over her Wangkalarrabarra country
10. Manbakuwaku The Storm Bird Ni-Manbakuwaku calls out it's name	11. Manbakuwa The Possum moves Nawadinya through it's country Yirrijiji nawadinya	12. Kiljarra The Stranger Yiwarinawuyu Rainbow serpent travels from the east
		13. Lirrbaniji The Whirlwind Kangka Rainbow Serpent names Jurrajurra himself the Stranger Yankarra he has traveled a great distance
		14. Jiwaniwankala The Stranger Mayangurrulubi Rainbow Serpent names himself Jiwaniwankala
		15. Mijingijiyaraya The Stranger Kambarrkambarr Whirlwind Yaraya Rainbow Serpent spins dust high into the air
		16. Dajbawulu Tasseled spear Dajbalinja thrower kin to Kuyamarra the Wawukarriya Dabiyamarra people
		17. Ngakijba Hooked barbed spear Karna stands at Ngurlungka wuyarrukarna



The *kujika* rises up from the waters of the rock hole at Marrinybul and after moving around the rock hole it moves north east and travels to Ngurlungka.

Figure 5.4 The beginning versus of the Mambaliya-Wawukarriya Kujika. It travels from Marrinybul rockhole to Jarrka.

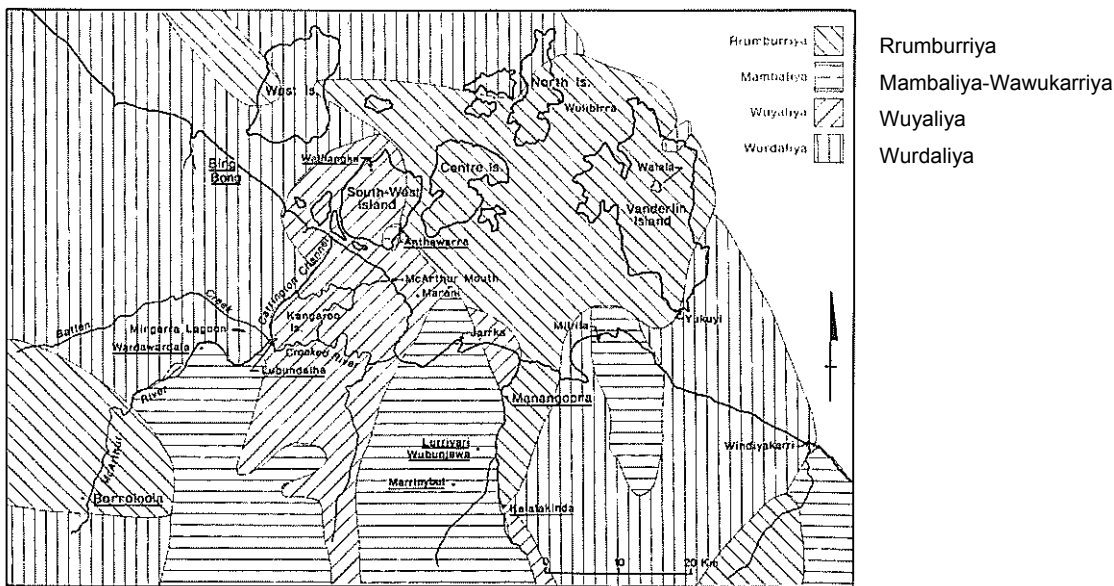


Figure 5.5 Clan areas in the Borroloola area. (Baker, 1999)

Table 5.1 Examples of Yanyuwa clan classification (Bradley et al., 2006, p12)

Rrumburriya	Mambaliya-Wawukarriya	Wurdaliya	Wuyaliya
<i>li-maramaranja</i> dugong hunters	<i>murndangu</i> long necked turtle	<i>malurrba</i> green turtle	<i>wardali</i> dingo
<i>wariyangalayavu</i> hammerhead shark	<i>kurdarrku</i> brolga	<i>karrubu</i> hawksbill turtle	<i>a-kuridi</i> groper
<i>ngurdungurdu</i> tiger shark	<i>a-kilyarrkilyarr</i> wedge-tailed eagle	<i>a-wurrkayny</i> large bodied mosquito	<i>kirdil</i> sandfly
<i>ma-arnbaka</i> cycad palm	<i>kinybutha</i> little read flying fox	<i>ngabaya</i> spirit man	<i>li-jakarambirri</i> blue ringed octopus
<i>a-warrantyuka</i> black flying fox	<i>wakuwaku</i> cyprus pine	<i>balubalu</i> pelican	<i>ma-lhalhaki</i> northern kurrajong tree

People also carry *ngalki*. A person follows the *ngalki* of their father and father's father. There are *four terminological lines of descent, which are distinguished at a grandparental level* and which can be matched to a clan. These are:

- *Father's father*
- *Mother's father*
- *Father's mother's (brother)*
- *Mother's mother's (brother)*

This is the basis of Yanyuwa kinship. 'The clans are categories that codify relationships of importance in ritual activity and in daily life.' For example 'the Yanyuwa are *ngimarringki* for their father's country and *jungkayi* for their mother's country. The former is usually translated into English as 'owner' and the latter term is translated by the Yanyuwa into English as 'manager'. (Baker, 1999) People relate to country after

the relatives that come from it; if, for example they were Rrumburriya, and they were referring to land that was Rrumburriya, they would call it 'country of my father's father'.

As mentioned earlier, the Spirit Ancestors set out the Law and the Law that belongs to country provides the rules for how people should interact with their environment and with others. It also determines how ceremonies are to be performed and what each person's role is in a ceremony. This again is interrelated to a person's clan. For example *'the secret and sacred a-Kunabibi ceremony is for the Mambaliy-Wawukarriya and Rrumburriya clans and they are ngimarringki while the Wuyaliya and Wurdaliya clans are jungkayi'*. Each has particular responsibilities in the ceremony. Hence *'everyone is dependent on others to carry out the life-sustaining ceremonies associated with the land'* (Baker, 1999). This was noted by Zaar when in conversation with Donald Blitner, a Marra man from Ngukurr who said:

"I am the last child from my uncle and father who taught me the Willy Wagtail ceremony and song. If it's a dry time, my old people used to sing the rain song and my uncle and brother in law would sing at the cold weather time for rain. The Jungayi, that is, the Joshua family for the area have passed away so no ceremony is done anymore. That's the way it goes. My eldest brother knew more than me but he has passed away". (Donald Blitner, pers. com.)

Because people, land, animals, plants and other natural phenomena all belong to a clan, a person belonging to one clan will know how to relate to everything else in their natural environment. Hence the existence of an intricate web of spiritual, cultural and social relationships between people and their environment. For example: *'The Brolga is Mambaliya-Wawukarriya so people from this clan are ngimarringki for the brolga and call it father's father, while people from the Wuyaliya and Wurdaliya clans will be jungkayi for it because it is either their mother or father's mother. Rrumburriya people call the brolga, mother's mother'*.

Aside from the spiritual and social way in which Yanyuwa view their environment they also view it in terms of the *'physical landscape and the habitat an organism occupies'*. They have developed habitat classifications; birds for example are classified into many habitats including mangroves, freshwater and lagoons amongst others. They have divided the *'physical landscape into distinctive 'land units' reflecting topography, soil and vegetation.'* One of these units is presented in Figure 5.6. In it freshwater is associated with riparian vegetation such as river pandanus and paperbark trees which is a familiar association also in Western science. The Yanyuwa are aware of how their seasons and animal and food resources all interact with the land units and habitats. They are acutely aware of environmental changes and the causes.

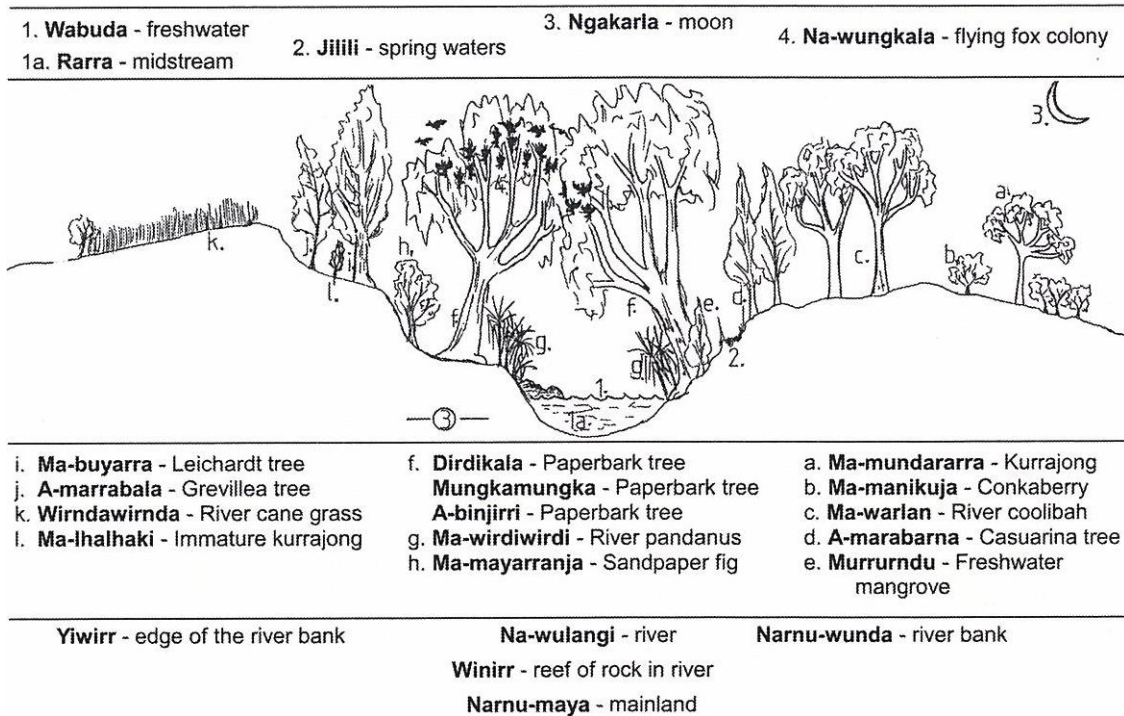


Figure 5.6 Some of the land units associated with the mainland as identified by Yanyuwa. (Bradley et al., 2006) The land unit is listed at the bottom of the diagram ie *Yiwirr*, environmental detail is listed above this, and other environmental detail is provided at the top.

Land and water management for the Yanyuwa incorporates the intricate web of physical, spiritual and cultural connections. Examples of how indigenous people manage the environment sustainably include:

- There is total prohibition on some species and, typically, these are attributed with the power to preserve particular resources. For example, the survival of the 'quiet' water snake is thought to maintain waterholes. (Baker, 1993)
- Permission from the ngimarringki is required to hunt in areas. These rights are jealously guarded in areas of plentiful resources, such as small islands rich with bird or turtle eggs. (Baker, 1999)
- Undertaking log coffin funeral practices to return spirits to the land and revitalize the country. This practice has ceased amongst the Yanyuwa and hence people say the 'land's getting weak, (because) no people, no spirit come back now'. (Baker, 1999)

Now let's look specifically at water in relation to the above dissertation on the indigenous perspective of the environment. Let's take the example of a waterhole, any waterhole. Each waterhole has been named and created by a Spirit Ancestor as it travelled on its path. The waterhole would be named in one or more songs which would have a particular tune. The songs would explain what events occurred at the waterhole. The waterhole would have its unique *Ngalki* or essence. The waterhole would be part of land belonging to a clan. There would be owners and managers for the waterhole. Each of these people would carry responsibilities in relation to caring for the waterhole. Ceremonies may take place at the waterhole. There may be a particular way in which people must interact with the waterhole as determined by the law. The waterhole forms part of a land unit, a habitat that is used by flora, fauna and people. The waterhole has a purpose. The waterhole would be managed in a sustainable way because it has a role to play in the interconnected

spiritual, social and physical realm of the indigenous people. In fact management of the waterhole includes all these aspects.

Les Hogan Warramurru a Garawa elder from Borroloola had similar words to say when interviewed by Zaar:

“Every waterhole has a story of how it was created. It got story that one. Every lagoon, every waterhole, all the way down (the river) all that story, that one. We know (the story). We show our children when we go there. We tell them. This is the country that dreaming been say, he’s here somewhere, something like that. We show them the right waterhole, the dreaming there. Some places all right (to visit), when that dreaming been talk, he’s all right, they still can fish or catch turtle. (When going to a waterhole we talk to the dreaming) I’m here, I’m the boss for this country, you got to talk yourself. You tell the old people (the ancestors), they belong to there, they are there somewhere but you can’t see them.” (Les Hogan, pers. com.)



Plate 5.1 Les Hogan Warramurru

The West has in recent decades become more aware of interconnections of water and the environment through such fields as hydroecology; it recognises the beneficial uses of water which include cultural and environmental uses and it realises people have to be responsible in managing the environment. This has been the awareness of the indigenous people for thousands of years only their world view takes one step further – that of the spiritual. Their holistic view engenders responsible land and water management.

As a means of presenting indigenous knowledge on water, indigenous waterhole names collected as part of this study are marked on the water resource maps and information pertaining to the waterholes and who provided that information is given in Appendix A. This information, which has often been provided by elders, provides a little insight into the significance of water to indigenous people in this map area. It presents a fragment of the indigenous knowledge of the vast Gulf region that has been passed on through generations by word of mouth, song, dance, painting and ceremonies. It is hoped that this introduction which has very much simplified what is really an interconnected complex system, has provided enough background so that the information in Appendix A can be put into perspective.

Ancillary to this report, indigenous knowledge has also been documented through photographs and video and is available on The Gulf Water Study DVD.

6. GROUNDWATER

6.1 The Water Cycle

To understand the groundwater system, it helps to have an understanding of the water cycle (Figure 6.1). When rainfall hits the ground, some of it runs off into streams and creeks (surface runoff), some of it evaporates and some of it seeps into the ground (infiltration). The amount of water that infiltrates depends on many factors, including the soil and rock type, the slope of the land and the intensity and duration of rainfall. As the water infiltrates it wets up the soil and moves down. Some of this water will be evaporated or used by plants, and the rest will move downwards until it reaches the watertable to become groundwater. The process of adding water to the groundwater system is called recharge. Porous rocks and soil allow the groundwater to slowly move from high areas to low areas, usually discharging to the surface at some point. If a useful amount of water can be extracted from a rock unit, then it is referred to as an aquifer.

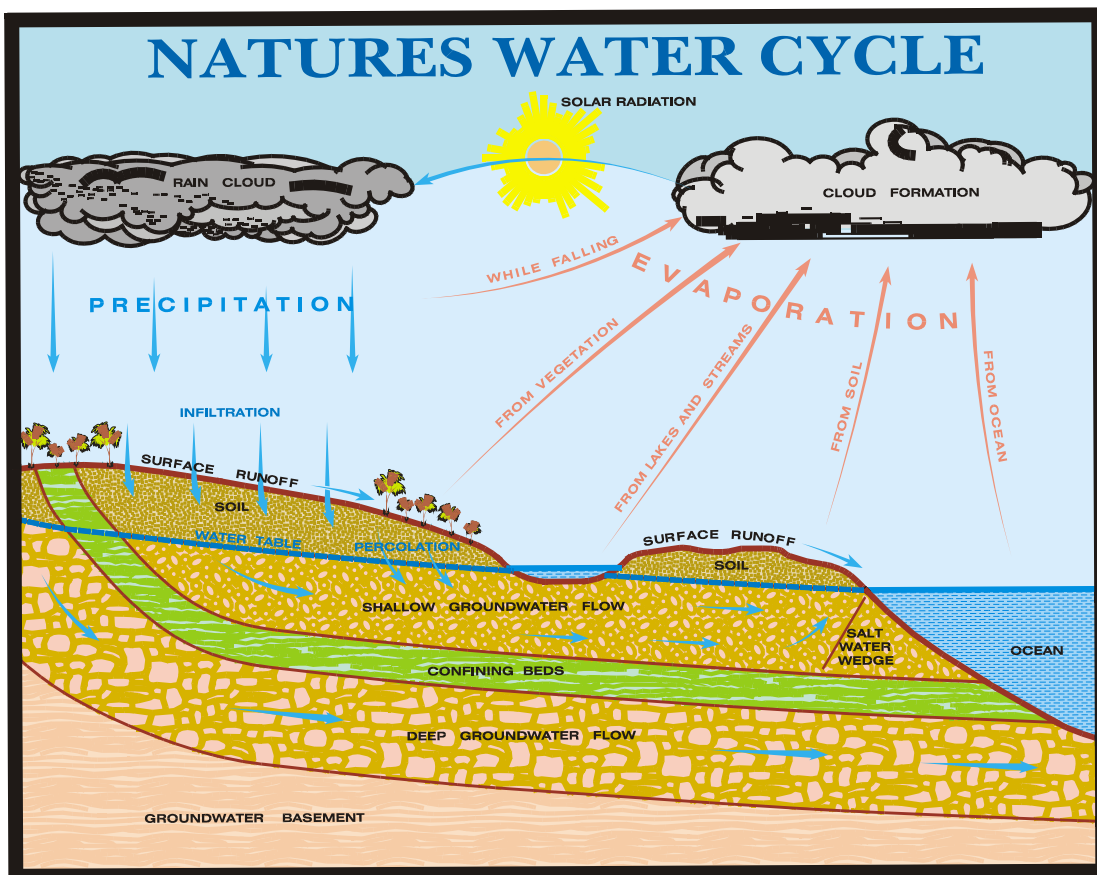


Figure 6.1 The Water Cycle

6.2 Geology

Geology is the science of rocks and its characteristics. Rock type and geological structure are some of the main factors influencing groundwater occurrence and the location of springs.

6.2.1 Rock Formations

Rock formations are made up of one or several rock types. These are shown on geology maps. The groundwater potential of each formation is assessed and those with similar aquifer characteristics are grouped together and mapped under one of the aquifer types shown on the water resources map.

Rocks are classified into rock formations as characterised by their physical and chemical features. Rock formations can consist of one or several rock types i.e. sandstone, dolomite. When a number of rock formations have common characteristics, they are grouped together in a rock group. The age of the rock is categorized by a geologic time frame. Table 6.1 provides a broad outline of many of the rock groups and formations in the map regions and their ages.

The surface extent of each rock formation is depicted on geology maps. The map regions are covered by the following 1:250000 scale geology maps:

- BAUHINIA DOWNS
- CALVERT HILLS
- HODGSON DOWNS
- MT YOUNG
- ROBINSON RIVER
- TANUMBIRINI
- WALLHALLOW

A number of the rock formations noted in Table 6.1 will be referred to in this report. The groundwater potential of each formation has been assessed and formations with similar aquifer characteristics are grouped together under one of the aquifer types. The geology maps, which show the area covered by each formation, are used to map out the area of each aquifer type shown on the water resource map (Figure 6.2). Put simply, formations with similar aquifer characteristics are mapped together under one of the aquifer types. Aquifer type delineates the groundwater resources on the water resource map.

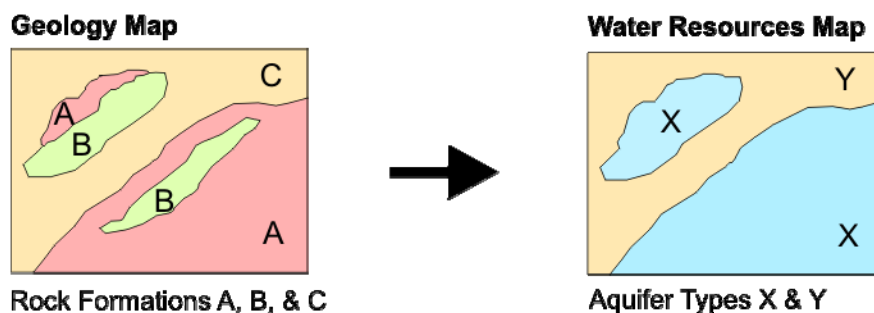


Figure 6.2 Example of grouping of rock formations into aquifer type. Here Formations A and B have similar aquifer characteristics whereas Formation C is different.

Table 6.1 Rock groups, formations and their ages.

GROUP	ROCK FORMATION	AGE: IN MILLIONS OF YEARS	GEOLOGIC TIME FRAME	
	Undivided Cenozoic (alluvial, colluvial, eluvial deposits)	0 - 65	(Youngest) Cenozoic	
	Golliger Beds			
	Sandstone, sandy claystone & siltstone	65 - 145	Cretaceous	
	Anthony Lagoon Beds	488 - 542	Cambrian	
	Gum Ridge Formation			
	Antrim Plateau Volcanics			
	Cox Formation			
	Bukalara Sandstone			
Roper (Not all Formations listed)	Velkerri Formation Bessie Creek Formations Corcoran Formation Hodgson Sandstone Jalboi Member Arnold Sandstone Crawford Formation Limmen Sandstone	542 - 2500	Proterozoic	
Nathan Group (Not all Formations listed)	Karns Dolomite Balbirini Dolomite Smythe Sandstone			
McArthur Group (Not all Formations listed)	Stretton Sandstone Yalco Formation Donnegan Member... Coxco Dolomite Member... Masterton Sandstone			
Tawallah (Not all Formations listed)	Gold Creek Volcanics Wollogorang Formation Settlement Creek Dolerite... Aquarium Formation... Sly Creek Sandstone Yinyintyi Sandstone			(oldest)

6.2.2 Geologic Structure and depositional history

The region contains rocks primarily from the McArthur Basin which include the Roper, McArthur and Tawallah Groups. These are old rocks from the Proterozoic eon (Table 6.1). The McArthur Basin is the name given to a sequence of rocks which roughly form the shape of a basin as they overlay each other. The oldest rocks lie at the bottom of the basin. These rocks are from the Tawallah group.

The Tawallah and the McArthur Groups of rocks are associated with the north trending Batten Fault Zone which runs through the centre of the McArthur River Region map and continues into the eastern sector of the Limmen Bight Region map. The zone is about 50 – 80 km wide. The McArthur Group of rocks is confined to this area as it is believed that they were deposited in a trough, called the Batten Trough. The trough is a depression controlled by faults, which in this case are the faults of the Batten Fault Zone. There is considerable faulting throughout the Batten Fault Zone. (Haines et al., 1993) Faults and fractures can increase the permeability of rocks and hence bore yield.

Nathan Group sediments overly the McArthur River Group rocks. These include the Karns Dolomite which is located in the eastern part of the McArthur River Region map and the Balbirini Dolomite located in the northern area of the Limmen Bight Region map.

Younger Roper Group Sediments consisting of sandstones, siltstones and mudstones overly Nathan Group sediments and are situated around and south of Borroloola and in the eastern areas of both water resource map regions.

The Bukalara Sandstone, a younger rock from the Georgina Basin, is plateau forming and lies in the centre of the Limmen Bight River map sheet and in the south east of the McArthur River map sheet.

The Gum Ridge Formation and Anthony Lagoon Beds are limestone formations which are younger than the Bukalara Sandstone. They are situated in the south-west of both maps and are overlain by Cretaceous sediments. Cretaceous sediments can also be found in pockets overlying various rock formations throughout the two map regions.

The most recent deposits are from the Cenozoic primarily consisting of sands and clays. They are dominant along the coast and may only be several metres thick but mask the underlying rocks.

Topographically the map regions lie within the Gulf Fall and the Coastal Plain. The Gulf Fall is defined as the dissected hilly country surrounding the Gulf of Carpentaria. The Coastal Plain is the low lying area between the Gulf Fall and the coast. The maps extend over plateau country in the south-west, to dissected hills, to coastal plain in the north-east. Drainage is from the higher plateau region towards the coast.




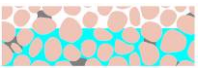

6.3 Aquifer Type

An aquifer is a body of rock that contains water and releases it in useable quantities. The rock contains water-filled spaces that are sufficiently connected to allow the water to flow through the rock. The spaces can develop from fractures, rock dissolution or occur naturally due to voids between the grains in the case of sandstone. Aquifers are primarily classified according to the type of spaces.

When assessing the groundwater resource potential of a rock formation, bore yields, springs, water quality, sinkholes and importantly rock type and the nature of the spaces in the rock is taken into account. The latter

delineates aquifer type. The properties of the spaces determine how extensive an aquifer is, how easily water moves through it, and how much water can be stored in it. Aquifer type is related to rock type. There are three basic aquifer types (Table 6.2). Aquifers can consist of combinations of the basic aquifer types.

Table 6.2 Aquifer types and their characteristics. (Adapted from Tickell, 2008)

Aquifer type	Description	Rock type that contains this aquifer type
Fractured 	Networks of fractures in the rock provide space for water to collect and move through. The degree of fracturing can vary greatly. Fractures are normally very small, less than a millimetre, but if there are enough of them an aquifer can exist. Where fracturing is extensive and interconnected throughout a formation a widespread aquifer results. Localised fracturing results in a localised aquifer which is usually not very productive.	All rock types. It is the main aquifer type for hard, impermeable rocks such as granite, schist, dolerite and silicified sandstone.
Fractured and Karstic 	This aquifer is created by the dissolution of the rock by water passing through it. It forms in carbonate rocks – limestone or dolomite. Over geological time frames these rocks are slightly soluble in water. As water moves through fractures, it gradually enlarges them as the rock is slowly dissolved. The process can form caverns but more commonly openings of millimetre to centimetre in scale.	Carbonate rocks – Limestone and dolomite 
Sedimentary Porous rock 	This aquifer occurs in sands and sandstone. Pore spaces between the grains provide storage and a flow path for water. Not all sandstones have sufficient intergranular porosity to form an aquifer. Also over time, minerals may fill or partially fill the pore spaces hence the younger the sandstone the more likely it is to have its intergranular porosity intact.	Sands and sandstones 

The effects of weathering can increase aquifer development and therefore has been included in the description of aquifer type. Weathering is the physical disintegration and chemical decomposition of rock. Physical weathering occurs from the alternate expansion and contraction due to temperature changes, and chemical weathering produces new minerals. Weathering can cause the development of new fractures or enhance existing fractures, resulting in better aquifers. Weathering can also cause the narrowing of fractures reducing aquifer development. The most productive aquifers commonly occur near the base of the weathered rock.

Weathering can be accelerated or enhanced by fracturing. When rock is fractured, open spaces develop in the rock mass, and water collects in the spaces. Aquifers can exist in rocks due to fracturing alone. Fracturing can occur in all rock types but the degree of fracturing can vary greatly. Faults are marked on geology maps but the degree of fracturing is not indicated. Fractures can be targeted for potential water supplies but specialist scientific advice should be sought.

6.3.1 Flow system description of aquifers

Aquifers can be described according to the distance groundwater moves through the aquifer, from where it enters the ground (recharge areas) to where it discharges to the surface (discharge areas) (Figure 6.3). The distance it flows depends on the extent of the aquifer. It can vary from hundreds of kilometres to less than a

kilometre. The scale of groundwater flow has been categorized by Coram and others (2000). These are termed groundwater flow systems (Table 6.3) and are used to describe the aquifers on the water resource map.

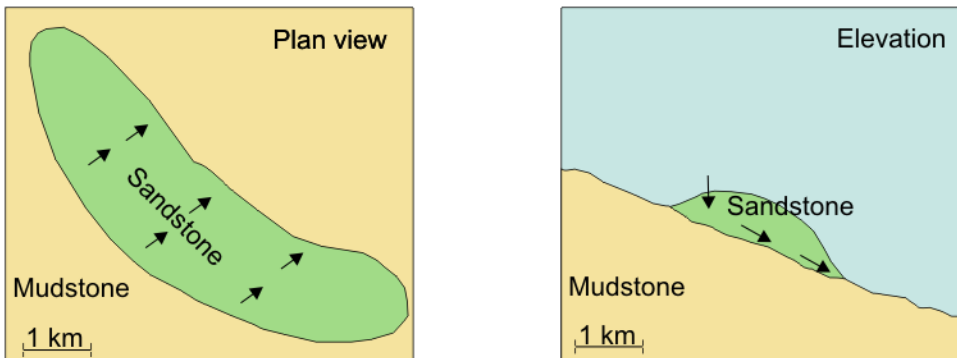


Figure 6.3 Flow path of water in a fractured rock aquifer. This is a local system.

Table 6.3 Aquifer flow systems (Coram, 2000)














Groundwater flow system	Flow path distance of groundwater	Example
Local	< 5 km	Fractured rock aquifers in dolerite (a hard rock) often have a short flow path because the aquifer is only as extensive as the group of fractures.
Intermediate	5 to 50 km	Carbonate rocks that extend for tens of kilometres can have longer flow paths as provided by the interconnected caverns.
Regional	> 50 km	In large sedimentary basins, like the Great Artesian Basin, the flow path is long because the sediments have been deposited over a very large area and remain connected. These aquifers usually have high transmissivity.

The rate at which groundwater flows is usually very slow compared to river flows. It can vary from a few millimetres to several metres per year. Karstic aquifers are an exception where water can flow almost like a river through caverns when they exist. Depending on the size and type of an aquifer, it can take days to thousands of years for rainwater to complete its journey through an aquifer from when it infiltrates into the ground to when it discharges. The water we drink from some springs could be very old indeed.

6.3.2 Mapped aquifers / Groundwater Resources

Between the two map regions seven aquifer categories have been identified (Table 6.4). Each aquifer category has been determined by its aquifer type, flow system, typical bore yield and whether or not it consists of carbonate rock. Carbonate rocks impart a particular water quality to groundwater.

Table 6.4 Aquifer categories in the map region represented on the water resource map.

Representative colour on the map	Diagram of aquifer type	Aquifer Type	Flow system	Typical bore yield
		Sedimentary rocks with intergranular porosity	Local to intermediate scale	0.5 – 5 L/s
		Fractured and karstic rocks – carbonate rocks	Regional scale	0.5 to 10 L/s
		Fractured and karstic rocks – carbonate rocks	Local scale	Up to 10 L/s may be encountered
 		Fractured and weathered rocks – Carbonate rocks	Local to intermediate scale	0.5 – 10 L/s (2 categories) 0.5 – 5 L/s
		Fractured and weathered rocks	Local scale	0.5 – 5 L/s
		Fractured and weathered rocks with minor groundwater resources	Local scale	0 – 1 L/s

The occurrence and characteristics of each of these aquifers is detailed below. The extent of each of the aquifer categories has been determined by use of the geological maps and grouping together rock formations that contain the same aquifer characteristics. Drilling information is used to confirm the interpretation of aquifer type, its extent and its yield. When water bores are drilled in the Northern Territory they are given a Registration Number (RN) for easy identification. These are plotted on the water resource maps. Details of each bore are provided in Appendix C and D.

Aquifer areas are plotted according to the most productive aquifer category that would be encountered to a depth of 100m. For example if there is a higher yielding aquifer, situated at 70 m depth, that lies below a lower yielding aquifer, then the higher yielding aquifer will be plotted on the map. Each aquifer category is detailed below.



Sedimentary rocks with intergranular porosity

This aquifer type occurs on the McArthur River Region map. It is local to intermediate in scale. The aquifer exists in the interconnected pore spaces between the sand grains or particles. This aquifer type often occurs in younger sedimentary rocks as is the case here. There are two identified aquifers separated by a clay confining layer; a top or shallow aquifer and a deeper sandstone aquifer.

Sedimentary rocks lie along the north coast of the McArthur River map region. The top (shallow) aquifer occurs in sediments consisting of poorly consolidated alluvium, sand, clays and gravels. Mutton (2006) considered the sediments to be of Cretaceous age or younger, belonging to the Carpentaria Basin. The sediments were intersected in RN28349, RN28470 (near Wonmurri on Manangoora), RN35922 and RN35923 (on the adjoining Greenbank Station) as well as in drill holes from mining companies that explored on Seven Emu, Greenbank and Manangoora stations (See Mutton 2006, Poltock 1993 for mineral exploration bore information). Not all bores drilled into the sediments yielded water. In RN28349 3 L/s was airlifted from this aquifer. The aquifer was generally encountered above 40 m.

Below the shallow aquifer a Cretaceous grey mudstone was encountered in a number of the bores. The mudstone varied in thickness from about 10 m in the bores near Wonmurri (RN28349, RN28470) to 45 m in RN35922. Below the mudstone a deeper aquifer in soft, possibly Cretaceous, sandstone was intercepted in the Wonmurri bores around 50 m depth and was high yielding (airlifting 10 L/s). This reflects known sequences in the Carpentaria basin where sandstone was deposited by fluvial deposition in the Jurassic to Early Cretaceous followed by mudstone in a marginal and shallow marine setting in the middle Cretaceous (Mutton 2006).

Poltock (1993) offers a completely different interpretation to the sedimentary rock discussed and suggests that they are in part weathered Karns Dolomite. He noted difficulty in 'differentiating between unconsolidated cover sediments and weathered Proterozoic lithologies' and interpreted 'clays and interlayered friable sandstones to represent dolomites and dolomitic sandstone' in mineral exploration drill holes on Southern Greenbank Station. No matter what the origin, what is for certain is that these sediments generally provide yields of about 2 L/s with moderate success rate.

Bores RN28349 and RN35922 were initially drilled with air but once water was encountered problems arose with clays collapsing into the hole. This problem also arose in mineral exploration holes. Drilling with mud is therefore advised.



Fractured and Karstic Rocks – carbonate rocks – regional flow system

There are two aquifers listed under this category. They are situated in the Cambrian aged Anthony Lagoon Beds and Gum Ridge Formation and hence are referred to as the Cambrian limestone aquifers. The aquifers are located in the south west corners of the two water resource maps. These areas only represent a small part of these aquifers. The Gum Ridge Formation is the more extensive of the two aquifers and covers an area running from Tennant Creek to Mataranka. They have a regional scale flow system with groundwater travelling roughly north towards Mataranka. The aquifer within the Gum Ridge Formation and its lateral equivalent – the Tindall Limestone, is the aquifer which discharges to the Roper River and has been modelled as part of the Gulf Water Study. This work was undertaken by Knapton and a report is available. (See Knapton, 2009) The Anthony Lagoon Beds consists of calcareous and dolomitic siltstone, fine grained sandstone, limestone and dolomite. It overlies the Gum Ridge Formation which consists of

limestone, dolomitic limestone, siltstone and chert. The extent of the two formations on Tanumbirini Station (Limmen Bight River map) is shown in Figure 6.4. There is insufficient data to differentiate between the two formations on the McArthur River map sheet.

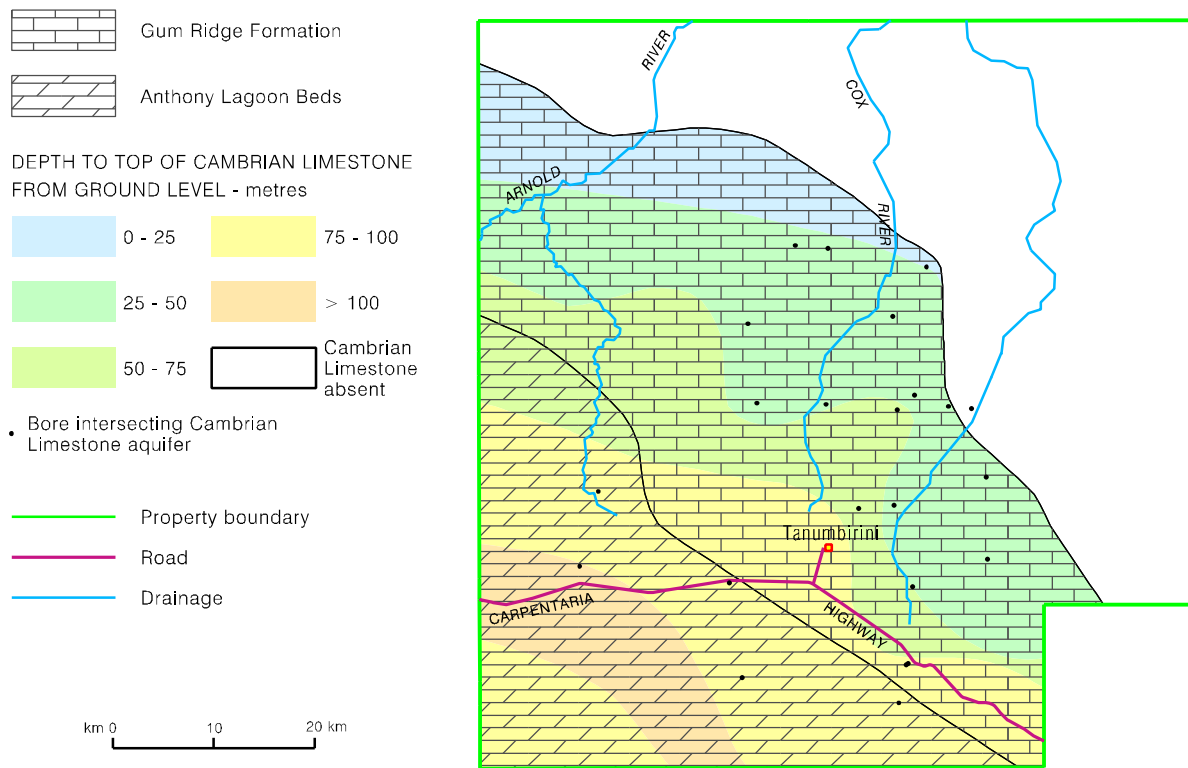


Figure 6.4 Depth to the top of the Cambrian limestone from ground level on Tanumbirini Station.

The Cambrian limestone aquifers do not outcrop on the map sheets. To access the aquifers you need to drill through Cenozoic and Cretaceous deposits which lie above it. These deposits largely consist of siltstone and sandstone. On Tanumbirini Station these overlying deposits range in thickness from less than 25 m in the north to over 100 m in the south. Figure 6.4 and Table 6.5 provide an indication of the drilling depth to the top of the Cambrian limestone formations for Tanumbirini and the McArthur River map respectively.

Table 6.5 Depth to top of Cambrian Formations and water table on the McArthur River map.

Bore	Depth to top of Cambrian Formations (m)	Supply intercepted at: (m)	Standing water level (m)	Airlift yield L/s
RN27945		47, 52	28	14
RN35534	33	32, 45	25.6	5.25
RN7696	18	49, 61	30.5	6
RN7699	9	71	36	2.6
RN23350	72	72	48	3
RN27848	60	>77.8	77.8	13 pump tested
RN23351	45	47-65	41	4
RN25714	35	NA	55	NA

To tap the water resource it is necessary to drill into the Cambrian formations until groundwater is intersected; this may involve drilling tens of metres below the physical top of the Cambrian limestone Formations.

The drilling depth to the water table is indicated in Figure 6.5 for Tanumbirini and Table 6.5 for the McArthur River map. Yields generally range between 0.5 to 10 L/s. Higher yields may be achieved by greater penetration of the aquifer.

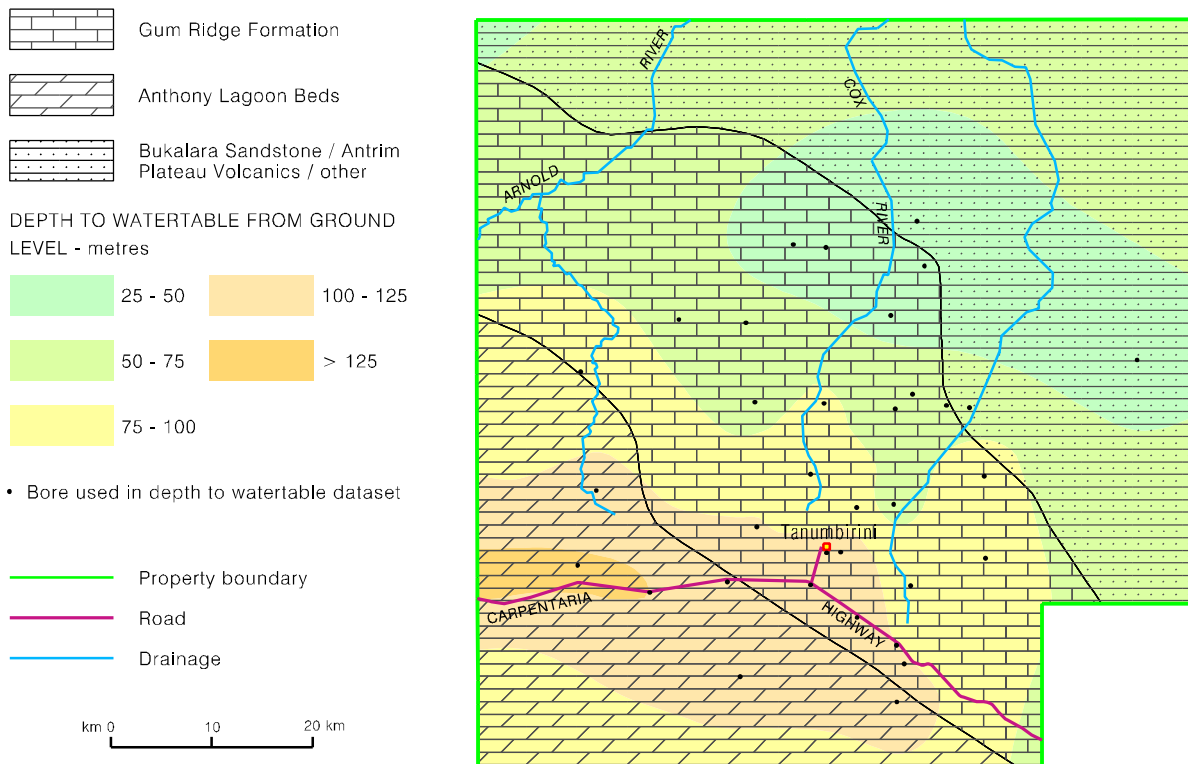


Figure 6.5 Depth to the water table from ground level on Tanumbirini Station.

Rotary percussion drilling using air is normally used in these aquifers because formations are generally hard and holes stable. Problems are often encountered when cavities are intersected and drilling circulation is lost. Cuttings and groundwater may not be returned to the surface, so information about the formations and water intersections is lost. Running casing as drilling progresses is a technique used to avoid this problem.

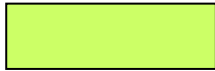


Fractured and Karstic Rocks – carbonate rocks – local flow system

On the McArthur River Region map this aquifer type is located in a small area in the north situated in the Yalco Formation of the McArthur Rock Group. Although this formation is located elsewhere in the region, it is only here that sinkholes have developed indicating a potentially localised karstic aquifer. No bores have been drilled into this aquifer however it is anticipated that yields up to 10 L/s or more are possible.

In the Limmen Bight River Region an aquifer of this type is located in the north-east situated in calcrete. Calcrete is a limestone precipitated at, or near the surface by the evaporation of soil moisture. It is formed in

the zone where the water table fluctuates. The deposits are often shallow, less than 20m (Tickell, 2008). Drilling investigations by Sandfire Resources encountered 4 m of calcrete above the water table at a site east of the mapped aquifer. When the aquifer area was visited in August 2008 approximately 10 L/s was discharging from the aquifer to a tributary of the Nathan River. The aquifer is the likely source of baseflow to the Nathan River. Calcrete was observed in outcrop in the mapped area. Given that it is shallow and likely to also drain quickly, water supplies from the aquifer may be limited as the Dry season progresses.



Fractured and weathered rocks – carbonate rocks (Yields 0.5-10L/s)

Carbonate rocks have been identified separately under the fractured and weathered rocks aquifer category because they impart a very distinct water quality to the rocks. The carbonate is present in the form of dolomite.

This aquifer type lies in the Karns Dolomite which is located in the south-east and north-east of the McArthur River Region map. These areas represent the western boundary of the aquifer which is widespread on the adjoining Robinson and Calvert Rivers map. The flow system is local to intermediate.

Carbonate rocks have the potential to be karstic and there is an area of the Karns Dolomite that is karstic on the adjacent map, however aside from this area, the Karns Dolomite does not display karstic features. Hence it has been mapped under this category. Some dissolution of the rock is likely to have occurred, such as enlarging fractures, but broadscale interconnected cavity development has not taken place.

Bores drilled into the Karns Dolomite have generally yielded water. Yields have varied up to 25 L/s but 3 L/s appears most common. In some of the bores higher yields may have been obtained if drilling had continued. Aquifers have usually been intercepted within the first 60 m of drilling. The deepest bore drilled was RN35920 (163 m) located on the adjoining map sheet, which also had the highest airlift yield at 25 L/s. This bore intersected a variety of strata sequences including dolomitic siltstone, chert, dolomitic sandstone and dolomite reflecting the sedimentary origins of the rock. The yield in the bore increased with increasing depth as aquifers were encountered in fractured and weathered sections. On the McArthur River Region map only one bore has been drilled into the formation (RN035924) air lifting 5 L/s. The standing water level was 9.8 m.

The Karns Dolomite provides the source of baseflow to the upper and lower Wearyan River. The discharge in the upper Wearyan River is only able to maintain flow for up to a few kilometres downstream (J. Mawson, personal communication), however spring discharges to the lower Wearyan River can maintain flow for 10 km, to the tidal limit of the river, during wetter periods.

Fractured and weathered rocks – carbonate rocks (Yields 0.5 - 5L/s)

This aquifer type is located through the centre of both maps and is associated with the Batten Fault Zone. It occurs in most of the rock formations of the McArthur Group and the Balbirini Dolomite of the Nathan Group.

These formations contain dolomitic rocks such as dololutite and dolomitic siltstone. These rocks are largely reliant on fracturing for aquifer development. They are identified as lower yielding and faults and fractures should be targeted. The flow system is local. Dry holes are not uncommon in this rock type. A poster titled 'fractured rock aquifers' has been produced showing how scientists are able to locate fractures. Supplies from fractured rock aquifers are commonly small (0.5 – 5 L/s), sufficient for stock and domestic uses. Occasionally airlift yields of the order of 10L/s can be encountered but may not be sustainable. Where fracturing has occurred throughout the mass of rock and weathering has enhanced these fractures better yields may be sustained.



Plate 6.1 Typical carbonate rock of the McArthur Group.

Fractured and weathered rocks (Yields 0.5-5L/s)

This aquifer type occurs in the Bukalara Sandstone and rock formations of the Roper Group which primarily consist of sandstone. Over time these rocks have become indurated (cemented) so little primary porosity remains. However, the effects of fracturing and weathering have provided permeability to the rocks allowing aquifer development. The rocks are located throughout the two map regions. Each formation is discussed separately below. Bores typically yield between 0.5 – 5 L/s.

The Moroak, Bessie Creek, Hodgson and Arnold Sandstones of the Roper Group are similar, consisting of quartzarenite and form resistant pseudokarstically weathered outcrop occurring as low ridges and small scarps. The spectacular joint-controlled karst topography often referred to as 'the lost city' occurs in these rocks, particularly in the Hodgson Sandstone (Plate 6.2).



Plate 6.2 'Lost City' karst topography in Hodgson Sandstone

The Moroak Sandstone

This sandstone is largely located on the Limmen Bight Region map on Broadmere and Bauhinia Downs Stations. No water supply bores have been drilled into the formation but given its similarity to the other Roper Group sandstones, similar yields are anticipated.

The Bessie Creek Sandstone

No supply bores have been drilled into this formation in the two map regions. However drilling investigations undertaken at Minyerri, which is located on the Roper River Region map, established that 'aquifers exist at the contact zone of the Bessie Creek Sandstone with the overlying Velkerri Formation and underlying Corcoran Formation' (Jamieson, 1992). The latter was found to be the more productive of the two aquifers. Pump tests undertaken have recommended pump rates in these aquifers of below 1 L/s. The Bessie Creek Sandstone was mapped under this aquifer category as an indication to the location of the two contact zones. At Minyerri the Bessie Creek Sandstone varied in thickness between 20 – 56 m but on these map regions it is generally much thicker, generally greater than 100 m and up to 300 m thick.

The Abner Sandstone – This includes the Hodgson Sandstone and the Arnold Sandstone

The Abner Sandstone is composed of three members; the Hodgson Sandstone, the Jalboi Member and the Arnold sandstone at the base. The Hodgson and Arnold Sandstones are very similar sandstones. The Jalboi Member largely consists of a red mudstone which would act as a semi-confining layer between the sandstones and make a poor aquifer. It belongs to the 'fractured and weathered rocks with minor groundwater resources' category. The sequence occurs on both map regions but the thickness of the members can vary greatly. Where the Jalboi Member is thin, less than 70 m or even missing it has not been differentiated on the maps (which is the case for all the McArthur River Region map), but where it is thicker it has been separately mapped. This fulfils the criteria of mapping the highest yielding aquifer that occurs

within 100 m depth. Above the Hodgson Sandstone lies the Corcoran Formation which is mainly made up of mudstone.

The Abner Sandstone has primarily been drilled at Borrooloola to secure a water supply for the town. These investigations reported the thickness of the Abner Sandstone to be no greater than 40 m and hence did not differentiate between the members and simply referred to an aquifer occurring in the Abner Sandstone (Woodford et al. 1995). Pietsch et al. (1991) also note that the Abner Sandstone 15 km to the south-east of Borrooloola is thin compared to the western areas and that the three members of the sandstone cannot be differentiated there. Pietsch et al. have however differentiated the three units around Borrooloola on the Bauhinia Downs geology map. This mapping conflicts with results from the water resource investigations, and what Pietsch maps as the Hodgson Sandstone has been interpreted as Bessie Creek Sandstone by Woodford. Further investigations in the area can clarify this anomaly but the difference in opinion is not critical to the water resource mapping. Although the Abner Sandstone outcrops at Borrooloola much of it lies beneath the mudstones of the Corcoran Formation so to access the aquifer it is therefore necessary to drill through the mudstone and into the Sandstone. The aquifer deepens with distance south of Borrooloola and at the Cricket Club the aquifer was intercepted below about 80 m of siltstone. It is uncertain at what depth the aquifer lies further south of the cricket club.

Weathering effects, more specifically the 'dissolution of a carbonate cementing medium in the sandstone is postulated as the probable mechanism for permeability development' in the Abner Sandstone (Woodford et al. 1995). Permeability was also noted to be higher in outcropping areas where greatest weathering would have occurred. The water supply investigations intercepted high airlift yields, greater than 10 L/s, in the bottom 10 m of the Abner Sandstone in a medium grained sandstone. This is likely to be the Arnold Sandstone. It has been identified at Devil Springs 25 km south-west of Borrooloola on by Pietsch et al (1991) who note 5 m of white, friable, well sorted medium sandstone lies at the base of the Arnold Sandstone. This strata would provide high yields and is probably what was intercepted at Borrooloola. The high yielding aquifer may be limited to the Abner Sandstone basin in the Borrooloola region which stretches as far as the Devil Springs area to the west. Drilling into the Abner Sandstone outside of the Borrooloola area has not replicated these high yields. Pietsch notes that this strata was not intercepted in an investigation bore on the Jandanku Aboriginal Land Trust that penetrated the Abner Sandstone. The strata may be limited to basin around Borrooloola. However there has been no extensive drilling into the lower Abner sandstone outside of Borrooloola. It should be noted that although good yields have been intercepted in individual bores at Borrooloola, modelling of the aquifer has established that the sustainable yield of the aquifer in the area of the borefield at 30L/s (Woodford et al. 1995).

Bukalara Sandstone

The Bukalara Sandstone is generally a fine to coarse grained feldspathic sandstone. It is commonly plateau forming with well developed jointing. It dominates the south-east of the McArthur River Region map with the Bukalara Range. It also occurs in the centre of the Limmen Bight River Region map in outcrop and under

the cover of the Cox Formation which is up to 50 m thick. The Cox Formation consists of very fine sandstone and siltstone.

Jointing (fracturing) within the sandstone is likely to increase the potential yield of the aquifer. Between the two map regions the Bukalara Sandstone has only been drilled in the McArthur River Region where all four bores provided airlift yields between 3.5 and 7 L/s. On the Dunmarra and Hodgson River Region map the Bukalara Sandstone has been more extensively drilled with yields ranging from 0.3 to 5 L/s.



Plate 6.3 Bukalara Sandstone at Merlin Mine. The circle highlights the jointing (fracturing) in the rock.



Fractured and weathered rocks with minor groundwater resources

In both map regions are areas covered by Proterozoic rock formations consisting of siltstone, mudstone, sandstone and volcanic rocks. Many of these are old rocks that have hardened over millions of years. Fracturing is the most common source of aquifer development in these rocks. Airlift yields can vary considerably dependent on the degree of fracturing. Long term sustainability however is usually limited to small supplies less than 2 L/s. The aquifer flow system is local. Rotary percussion drilling using air is the most common technique used in these aquifers. The rock formations are generally hard resulting in stable boreholes.

Other groundwater supplies

Alluvial deposits and sand dunes can also provide minor groundwater supplies. These unconsolidated sediments belong to the sedimentary rock aquifer type. They are limited in extent and are not shown on the map. Bores generally yield less than 0.5 L/s.

Aquifers can be found in alluvial deposits built up along rivers or on floodplains, particularly where sediments consist of well rounded gravels and are well sorted (of similar size). Bores drilled in alluvial deposits have a low success rate because of their limited extent, variability in thickness, and gravel, silt and sand content.

Small supplies can be attained from aquifers in sand dunes. Although sand dunes exist within the map sheet they have not been drilled for water supply. The well located on Mooloowa on Vanderlin Island taps groundwater discharging from sand dunes. Interestingly the water quality of the well (G9075065) indicates a carbonate source. The Vanderlin Limestone outcrops on the western side of the island. It is possible that this limestone lies under the sand dunes adjacent to Mooloowa. Infiltration galleries rather than bores are recommended for extracting water from sand dunes to ensure water quality is maintained.



Plate 6.4 Sand dunes on northern Vanderlin Island

Localised shallow aquifers can also occur in laterite. These are also small in area and are not depicted on the Water Resource maps. They often develop in Cretaceous aged claystone. Through weathering, small cavities (up to centimetre scale) can form in laterite. Root holes and fractures also contribute to the porosity and permeability. Laterite aquifers can provide short term yields of up to 5 L/s but long term yields are usually much lower. This is because the aquifers are shallow, less than 10 m deep, and fill in the Wet season but drain quickly over the Dry season (Tickell, 2008). The well at Clarkson Point on Vanderlin Island is situated in laterite (See Appendix A).

6.4 Groundwater Quality

Groundwater quality is affected by evapotranspiration of rainfall and rock type.

Rainwater contains salts. As rainwater moves down through the soil to the water table evapotranspiration concentrates the salts. Salts are made up of ions. For example table salt (Sodium Chloride) is made up of the ions Sodium and Chloride. Common ions used to describe water quality are listed in Appendix D. If recharge is low then the salts can become so concentrated that the water becomes unsuitable for human consumption. Low recharge can be due to low rainfall but it is also related to rock type. Fine sandstone for example would have low recharge because the small particle size of the rock allows little water through.

Rock type effects water quality because, as water moves through them, it picks up (dissolves) salts from the surrounding rock. This process is particularly evident in limestone and dolomite because they contain high amounts of calcium or magnesium carbonate which dissolves in acidic conditions (Plate 6.5) and our rainfall is naturally acidic. When these rocks dissolve, calcium, magnesium and bicarbonate ions are released into the water. Hence groundwater rich in these ions is likely to have come from a limestone or dolomite Formation.



Plate 6.5 A drop of acid dissolving limestone as shown by the fizz. This is a common field test for carbonate rocks.

6.4.1 Water quality measurements

In order to describe the quality of water and its suitability for drinking or other use, a number of parameters can be measured in the field and in the laboratory. One of these parameters is Total Dissolved Solids (TDS) which is a measure of the saltiness of the water. It is usually described in terms of milligrams of salt in a litre of water (mg/L).

The Australian Drinking Water Guidelines (ADWG, 2004) define good quality drinking water from the perspective of health and aesthetics. The guidelines state that good drinking water has a TDS of less than 500 mg/L, and that a TDS of 500 – 800 mg/L is fair. A TDS of greater than 1000 mg/L is considered unacceptable. High TDS may be associated with excessive scaling, corrosion and unsatisfactory taste. A simple way of estimating TDS in the field is by measuring the water's electrical conductivity (EC). Salt present in the water will make it more conductive for an electrical current and this can be easily measured with a small field probe (Plate 6.6). EC is measured in microSeimens per centimetre, $\mu\text{S}/\text{cm}$. TDS is approximately equal to $0.6 \times \text{EC}$.



Plate 6.6 Ursula Zaar measuring the EC of Rosie Creek with an EC meter.

Water can also be described as being 'hard' or 'soft'. 'Hard' water requires more soap to produce suds than 'soft' water, and is generally associated with groundwater occurring in limestone and dolomite aquifers. These aquifers contain calcium or magnesium. Hardness is measure of the amount of calcium and

magnesium in the water. Water having more than 150 mg/L Calcium Carbonate can deposit scale in pipes and water heaters.

Another parameter which can be easily measured in the field, and give an immediate indication of water quality and suitability is pH. pH is a measure of the hydrogen ion concentration. Water is said to be either acidic or alkaline, depending on the relative concentration of hydrogen ions. A pH of 7 indicates neutrality, a pH of less than 7 indicates an acidic water, and a pH of greater than 7 indicates an alkaline water (Table 6.6). A low pH can be caused by high levels of dissolved carbon dioxide. Acidic water is corrosive to metal bore casing and pipes, but is still suitable for consumption if plastic or PVC bore casing and pipes are used to distribute the water. Alternatively, the water can be treated by aeration, which allows the dissolved carbon dioxide to be released to the atmosphere, causing the pH to increase. Alkaline water is generally associated with limestone or dolomite aquifers, and is a good indicator of the aquifer rock type. High alkaline waters can also be treated to lower pH. It should be noted that pH measurements taken from airlifted water during the drilling process may not give a true indication of the pH.

Table 6.6 pH and water quality

Acidic	Neutral	Alkaline
pH < 7 Often due to high levels of dissolved carbon dioxide	pH = 7	Ph > 7 Can be due to high carbonate content sourced from dolomite or limestone
Generally EC < 150 μ S/cm indicating low mineral content in the water. The surrounding rocks may be inert.		Generally EC > 300 μ S/cm indicating that the water may contain dissolved minerals from the surrounding rock.

Measurement of pH in the field is important, as during sampling, storage and transportation to a laboratory, there may be changes in pH due to chemical reactions. Field measurement is easy, and generally done by using a small probe which can give excellent results if regularly calibrated.

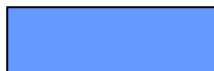
Besides undertaking field measurements of pH and Ec, water samples were also taken from a number of springs, creeks and bores prior to and during this project. These samples were then analysed in a laboratory where the quantity of common ions in the water was determined. These results are detailed in Appendices D. The water quality could then be characterised for a stream or an aquifer.

Most of the bores which have supplied salty water have been drilled close to the sea, estuary or mangrove and swamp areas. Near the coastline or tidal streams, fresh water in aquifers can become mixed with sea water. This can happen naturally on a seasonal basis, or when water is pumped from an aquifer close to the ocean. These waters have a high TDS, sodium and chloride concentrations.

6.4.2 Water Quality and Aquifer Type

Below is a basic description of water quality for each of the aquifer types denoted on the water resource map. In general the Australian Drinking Water guideline values for TDS and hardness can be high in the

carbonate rock aquifers and pH can be an issue in the Fractured and Weathered Rock aquifers. Although not noted in detail below, the guideline value for iron (0.3 mg/L) is often exceeded in all the aquifer types. Above this limit taste may be unacceptable but it does not pose a health problem. Iron can stain laundry, cause scaling and odour problems. Detailed water quality of bores is provided in Appendix D.



Sedimentary rocks with intergranular porosity

Only 3 water bores have intercepted this aquifer in locations close to the coast and hence are likely to be affected by salt water. They are all located on the adjoining map region; Robinson and Calvert Rivers Region. Two are located near Wonmurri which borders the McArthur River Region map. Only one water quality reading is available for the shallow aquifer in RN28349 (at Wonmurri) which had a high TDS of 1143 (Calculated from Ec) and slightly acidic pH at 6.43. This TDS is considered unacceptable in taste. At the Wonmurri bores the lower aquifer had a pH of 8.1 and a lower TDS of 908, total hardness was 246 mg/L and Chloride 353 mg/L. This water quality is marginal. One of the Wonmurri bores, RN28329 was also tested for Arsenic and the results showed the guideline value for health was exceeded. RN35922 on Greenbank Station also had a high TDS (over 1600) which would be acceptable to stock only.



Fractured and Karstic Rocks – carbonate rocks – regional flow system

An overview of the water quality in the Cambrian limestone aquifers on the two maps is provided in table 6.7. The water quality is typical of a carbonate aquifer with high TDS and hardness resulting from the dissolution of the limestone.

Table 6.7 Water quality in the Cambrian limestone Aquifer

Map	Land Portion	pH	TDS (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Magnesium (mg/L)
Limmen Bight River Region	Tanumbirini	7.2 – 8.3	332 - 1590	322 - 738	28 - 140	20 - 116
McArthur River Region	Mambaliya, Rrumburriya Wuyaliya Aboriginal Land Trust	6.9 – 7.9	610 - 1080	407 - 618	58 - 131	56 - 102

The aesthetic guide for hardness is 200 mg/L and TDS 500mg/L. Above these limits taste may be unacceptable but it does not pose a health problem. The high hardness can cause the build up of scale in pipes and fittings



Fractured and Karstic Rocks – carbonate rocks – local flow system

No water bores have been drilled in these aquifers. The aquifer on the McArthur River map lies in the Yalco Formation which is one of the many carbonate formations of the McArthur Group of rocks. The water quality of these rocks is outlined in the 'Fractured and Weathered – carbonate rock (yields 0.5 – 5L/s)' category.

This aquifer type on the Limmen Bight River map lies in calccrete. No detailed water quality analysis has been undertaken however the TDS was approximately 370 – 580 mg/L and pH was 8.



Fractured and weathered rocks – carbonate rocks (Yields 0.5-10L/s)

There has only been one bore, RN35924, drilled into this aquifer within the McArthur River region map. The water quality is typical of water from the Karns Dolomite aquifer and an overview is presented below. This is good drinking water quality which fits within guideline values.

Table 6.8 Water quality in the Karns Dolomite aquifer at RN35924

Map	Land Portion	pH	TDS (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Magnesium (mg/L)
McArthur River Region	Budganga on Manangoora Station	8.2	200	176	30	25



Fractured and weathered rocks – carbonate rocks (Yields 0.5 - 5L/s)

Like the other carbonate rock aquifers noted above the water quality reflects the dissolution of the calcium-magnesium carbonate from the rocks. As noted earlier the aesthetic guide for hardness is 200 mg/L and TDS 500mg/L. Above these limits taste may be unacceptable but it does not pose a health problem. The high hardness can cause the build up of scale in pipes and fittings.

Table 6.9 Water quality in fractured and weathered carbonate rocks

Map	Land Portion	pH	TDS (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Magnesium (mg/L)
Limmen Bight River Region	Lorella Station, Limmen National Park (Billengarra Station)	7 – 8.4	177 - 490	80 - 339	15 - 43	14 - 81
*McArthur River Region	Mambaliya, Rumburriya Wuyaliya Aboriginal Land Trust, Leila Creek Station, McArthur River Station, Narwinbi Aboriginal Land Trust	7.1 – 8.5	300 - 770	233 - 594	10- 96	38 - 128

*3 bores RN9910, RN26772 and RN26738 were above the TDS / hardness range noted



Fractured and weathered rocks (Yields 0.5-5L/s)

This aquifer type is located within the Bukalara Sandstone and a number of the sandstones of the Roper Group. Between the two map regions, most bores have been drilled into these sandstones within the

McArthur River Region map. Only 4 bores have been drilled into the Bukalara Sandstone whereas approximately 40 bores have been drilled into the Abner Sandstone in the Borroloola area. An overview of water quality is provided in Table 6.10. This is good drinking water however the pH can be low in the Abner Sandstone aquifer and this can cause corrosion to metal pipes and bore casing. This has been a problem in the Borroloola water supply. Water treatment has involved flushing the bore water through marble chips to raise the pH, but this was found to be ineffective and aeration was recommended. PVC or other form of plastic should be used for pipes.

Table 6.10 Water quality of bores within the Abner and Bukalara Sandstones.

Rock Formation	Area	pH	TDS (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Magnesium (mg/L)
Abner Sandstone	Borroloola precinct	5.3 – 8.2	26 - 142	4 - 72	1 - 11	1 - 12
Bukalara Sandstone	NT Por 4412	7.1 – 8.5	81 - 82	7 - 9	1 - 2	7.2 – 7.7



Fractured and weathered rocks with minor groundwater resources

Aquifer occurrence in these rocks is largely dependent on localised fracturing. Very few bores have been drilled into this aquifer type and many are located on coastal areas where they have intercepted brackish or salty groundwater. Away from the coast, water quality in these bores within the two map regions has generally shown to be within guideline values with the exception of pH which can often be low.

6.5 Recharge

Recharge is where water is added to an aquifer. Recharge can be observed by monitoring water levels in bores. It is important to keep recharge areas clean of pollutants to ensure groundwater quality is maintained.

Recharge is where water is added to an aquifer. It occurs during the wet season. Recharge amounts vary with rainfall, soil and geology. It occurs through three main mechanisms; diffuse, point source and stream bed. Diffuse recharge is the widespread downward seepage of rainwater, point source recharge occurs through an opening in the ground such as a sinkhole allowing direct drainage to the aquifer, and stream bed recharge is where water drains from a stream to an aquifer (the water level of the aquifer must be lower than river level for this to occur).

High rainfall usually results in better recharge. Recharge is indicated by the rise of groundwater levels and can be observed in bores which are monitored. Currently there are no bores being monitored in the map regions however a number of bores were monitored at Borroloola from 1985 to 1999. Water levels from some of these bores are shown in Figure 6.6. Also shown in the figure is the rainfall from Bing Bong which is situated 50 km north of Borroloola. (Daily rainfall for Borroloola for the time period was not available) Note how the water levels in the bores respond to rainfall; increasing over the wet season and decreasing during

the dry season. In good wet seasons, such as that of 1988-89 there is good recharge and the water levels in some of the bores increased 3 m, but in poor wet seasons, such as 1989-90 recharge was minimal as reflected by the low increase in water level.

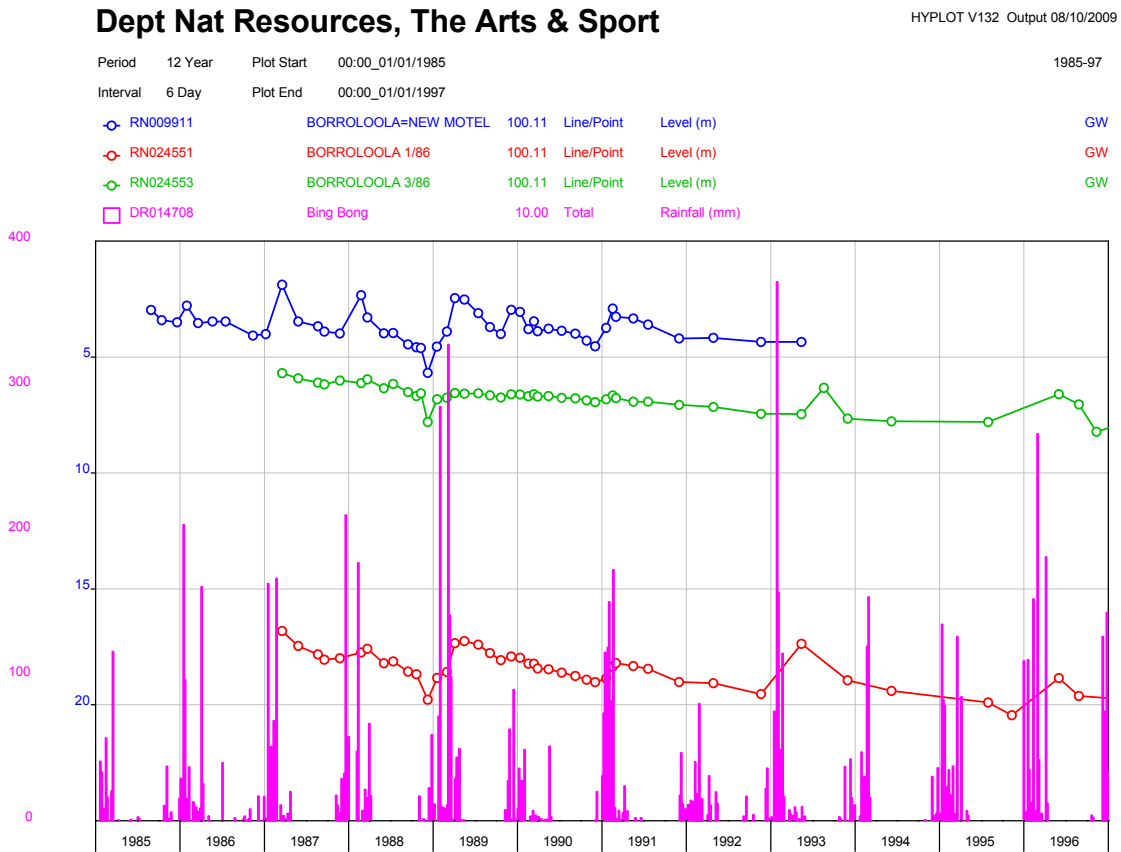


Figure 6.6 Monitored groundwater levels in bores at Borroloola and rainfall at Bing Bong.

Recharge is affected by geology or rock type and soil type. The amount of water that reaches an aquifer is dependent on the rock types or soils that overly the aquifer as well as in the aquifer. Water moves through some rocks and soils better than others, that is, they have a better permeability. Permeability is effected by the size and shape of the voids in the rock and how well the voids are interconnected. A coarse sand, for instance, has a high permeability whereas a mudstone or a poorly fractured hard sandstone has a low permeability. If a sand is confined (overlain) by a mudstone or clay, then it will be poorly recharged, but if it is unconfined it will be better recharged (Figure 6.7). When an aquifer is confined the recharge area can be restricted to the area where the rock is in outcrop (Figure 6.7). Recharge areas should be managed to ensure water quality is maintained. For example, sewage works should not be located over recharge areas. At Borroloola outcropping sandstone along the McArthur River and in the north of the town is a recharge zone and any proposed developments in this area should be critically reviewed.

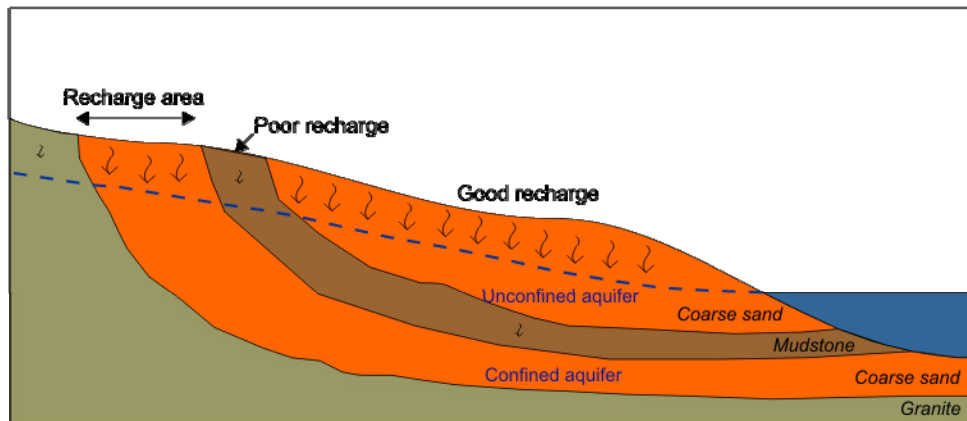


Figure 6.7 Recharge to a confined and unconfined aquifer.

Recharge is often described as the amount of rainfall entering an aquifer in mm/year or by the rise in water level in an aquifer in metres. Between 0-20% of annual rainfall results in groundwater recharge.

The sustainable yield of an aquifer can be considered as that amount that can be extracted from an aquifer without adversely affecting the environment and reducing the average groundwater level in that aquifer. In other words the extraction rate should be less than the average recharge rate. Hence the importance of determining recharge rates. When detailed water resource investigations are carried out, recharge, permeability and sustainable yield values are determined. This has been undertaken for Borroloola by Woodford et al. 1995 who modelled the aquifer and concluded that the sustainable yield was approximately 30L/s.

6.6 Groundwater discharge and dependent ecosystems

All isolated springs in the map areas maintain lush vegetation pockets which are refuges for wildlife. These are groundwater dependent ecosystems.

One way groundwater discharges is through springs. Springs and seeps are marked on the water resource map. Wee-ak spring south-west of Cape Crawford and the hot springs on McArthur River and Lorella Stations are localised springs as they discharge from one point, but groundwater can also discharge as diffuse flow along a river bed. Diffuse or streambed seepage is where a stream cuts through an aquifer allowing water to drain into the stream. The area of drainage forms the discharge zone, which is marked by a gradual increase in river flow. On both map sheets diffuse flow is limited to short reaches of streams. Another less obvious way in which groundwater discharges is through evapotranspiration. Plants can tap into groundwater when it is shallow enough and similarly groundwater can be directly evaporated through the soil when it is within metres of the surface.

Springs occur where the water table is at or above the ground surface. They can be permanent (perennial) or periodic (ephemeral) due to fluctuations in the local water table. Invariably denser vegetation communities (ie rainforests) occur at these springs. Such communities are dependent on groundwater. Riparian (riverbank) vegetation can also be reliant on groundwater although it may not be situated in a spring area.

O'Grady et al. (2002) in their study along the Daly River found Silver-leaved Tea Tree (*Melaleuca argentea*) and Freshwater Mangrove (*Barringtonia acutangula*) were associated with river banks with shallow water tables and were shown to be reliant on groundwater. O'Grady et al. (2002) state that 'further work is required to fully assess the level of groundwater dependency and the environmental flow requirements of riparian vegetation'.

Rainforest vegetation communities associated with riparian (river bank) zones, springs and coastal/dry areas have been mapped throughout the Top End by Russell-Smith (1991) and are shown on the Water Resource maps. These are likely groundwater dependent ecosystems. They provide refuges for wildlife for both aquatic and terrestrial fauna and flora. The coastal/dry vegetation areas have been included because they often occur in areas where groundwater can be close to the surface such as in the swales of sand dunes. In 2009 a trial vegetation mapping project was completed which mapped detailed vegetation units across the McArthur River catchment at 1:100 000 scale (Cuff et al. 2009). A number of vegetation mapping units (VMU) pertained to vegetation dependent on, or potentially dependent on groundwater. Three of these units (VMU 46, 37,38, Cuff et al. 2009) are shown on the McArthur River map for the McArthur River catchment only; VMU 46 has been combined with Russell-Smith's rainforests associated with springs and VMU 37 and 38 are together shown as 'Riparian vegetation – likely groundwater dependent'. These units include Silver-leaved Tea Tree and Freshwater Mangrove.

Various types of springs have been recognised in the mapped regions and an overview is provided below.

Depression Springs

This type of spring results when the water table is intersected by a low point (a depression) in the landscape such as a valley or escarpment, allowing drainage to occur from the surrounding rock. (Figure 6.8) Sometimes the low point in the landscape is resultant of a fracture or fault and the aquifer can be very localised to that feature. Some springs can be a temporary feature occurring only when the water table reaches the surface after periods of good rainfall.

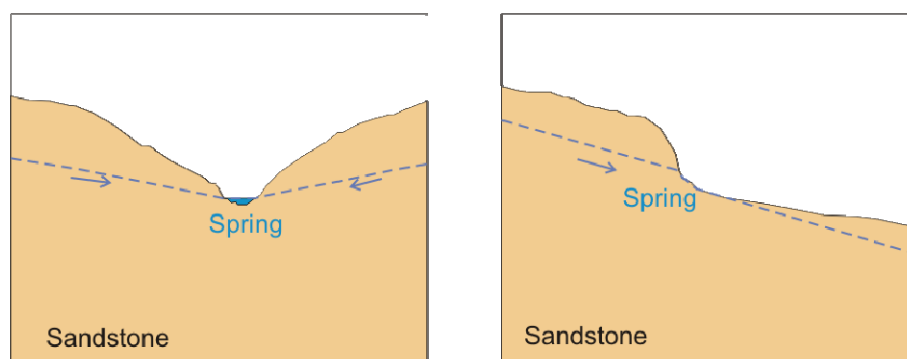
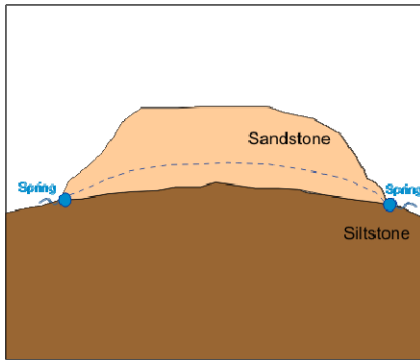


Figure 6.8 Depression spring in a valley and at an escarpment

Contact spring



This type of spring arises when a more permeable rock such as sandstone, lies above a less permeable rock such as siltstone. Water stored in the upper layer seeps out at the contact between the two rock types because it is unable to penetrate into the lower layer. Also at the contact there is often increased weathering resulting in a preferential pathway for groundwater flow. Often there is a zone of seepage or swampy area at the contact. Seepage along the contact can eventually coalesce to form a creek. These springs are often seen at the base of escarpments.

Figure 6.9 Contact spring

In the map regions springs commonly occur at escarpments. They can be of depression or contact spring type or a combination of the two. These springs discharge primarily from the fractured and weathered aquifers in the Bukalara, Bessie Creek, Hodgson and Arnold Sandstones. Contact springs in particular result from the Bessie Creek and Arnold sandstones overlying mudstones of the Corcoran and Crawford Formations and are commonly observed on the Abner Range in the McArthur River map region. Most of these springs discharge less than 10 L/s and provide water to lush vegetation pockets (Plate 6.7, 6.8). When the water table drops below the land surface the spring stops flowing. At times the groundwater in sandstone escarpments does not break out in the form of a spring but comes close to the surface. These areas are often marked with lush vegetation as tree roots find their way to the watertable. Such vegetation can effectively be considered groundwater dependent. The springs are easily spotted on satellite imagery by the vegetation. (Plate 6.9) These small vegetation pockets are scattered throughout the map sheets and form refuges for wildlife.



Plate 6.7 & 6.8 Rainforest pocket at the base of an escarpment on McArthur River Station.

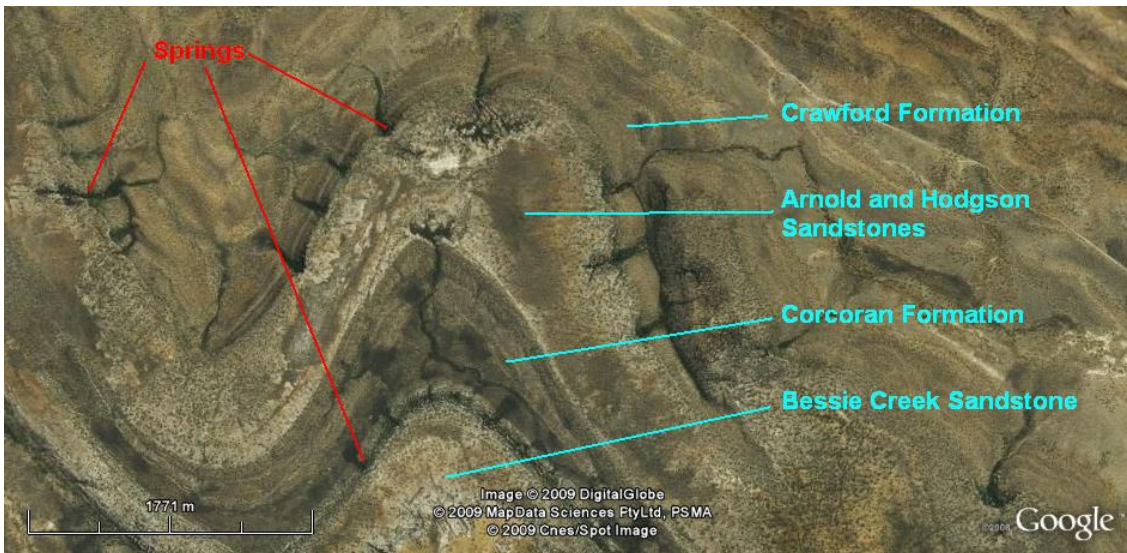


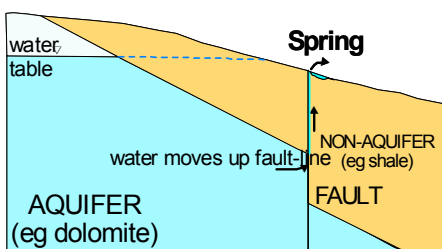
Plate 6.9 Vegetation lined spring discharges from the Abner Range, McArthur River Station

Depression springs also occur in sand dune country. Groundwater within the sand dunes discharges to low points which often maintain swamp environs or small waterholes like those at Wilundu on Vanderlin Island.



Plate 6.10 Swamp situated next to sand dunes near Wilundu on Vanderlin Island.

Fault Spring



This type of spring occurs when a fault or fracture provides a pathway to allow groundwater to rise to the surface, in areas where it is normally confined beneath a low permeability rock. Sometimes hot water emerges from these springs because they are sourced from some depth below the surface. The temperature of the water increases with depth.

Figure 6.10 Fault spring

Hot water fault springs occur on both map regions and are a feature of the regions. They occur on McArthur River station on the McArthur River region map and on Tanumbirini and Lorella Stations, Jandanku Aboriginal Land Trust and the Limmen National Park on the Limmen Bight River region map Figure 6.11. Some of the springs are over 70 degrees celcius and indigenous people remark how you can make tea with the hot water from the springs. Often the fault associated with the spring is marked on the geology map and can be clearly seen on aerial photography or satellite imagery as shown in Figure 6.11. As part of this study a poster on springs has been produced titled 'Springs of Lorella Springs Station'.



Plate 6.11, 6.12, 6.13 Hot Water Springs. At Lorella 47 °C, Tanumbirini > 60 °C, and McArthur River Station 50 °C.



Figure 6.11 Geology map showing faults associated with Wununnahtyala, Warrapirratila and Lorella Springs, satellite image showing the same and photo of Lorella Spring.

All springs visited by the study team are noted on the water resource maps by their site number. This number can be looked up in Appendix E to obtain flow information or Appendix F for water quality information pertaining to that spring.

7. SURFACE WATER

Most of the rivers on the map sheets cease to flow or dry to isolated waterholes by the end of the Dry season.

Surface water occurs as rivers, springs, lakes and billabongs and can be characterised into two main sources: directly from rainfall and rainfall runoff; or from groundwater discharge which provides baseflow to many rivers in the Top End. Baseflow can be sourced through diffuse flow as shown in Figure 7.1 or it can be sourced from a localised spring.

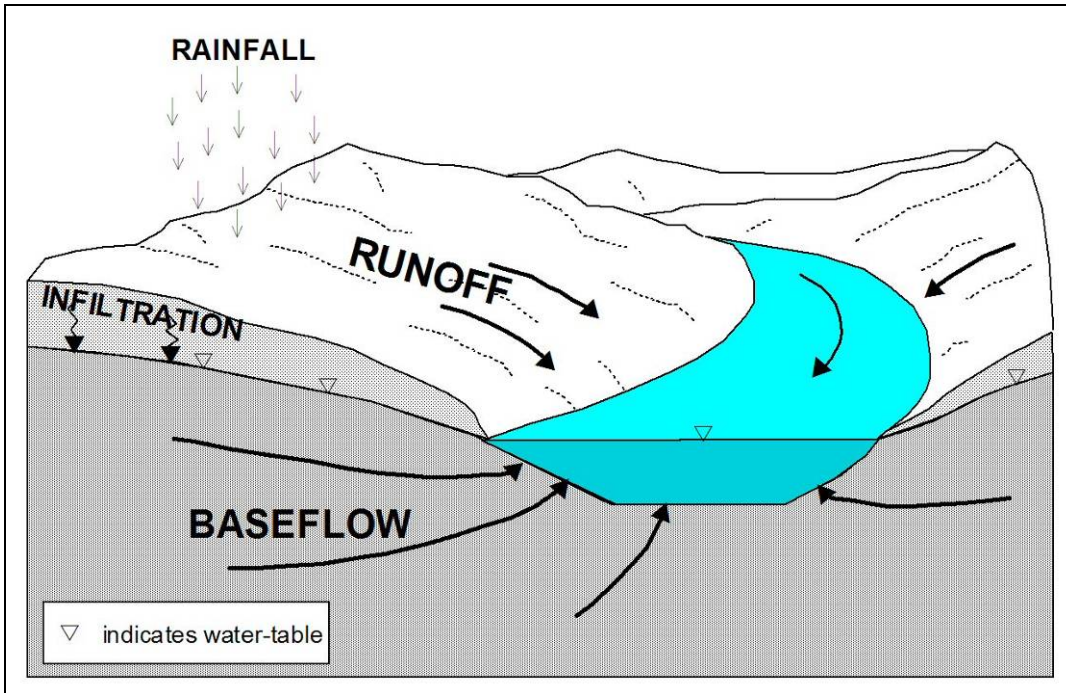


Figure 7.1 Runoff and Baseflow Components of Surface Water

When examining surface water occurrence it is important to distinguish between baseflow and rainfall runoff sourced flow. Surface water derived only from wet season rainfall and runoff will only persist if storage is adequate to last through the Dry season: waterholes, lakes, dams all need to be deep enough to account for the high evaporation rate and months of negligible rain. It is the baseflow component that keeps rivers and creeks flowing through the long Dry season.

Flow in a river is often presented as a hydrograph, which usually shows daily or monthly variations in water flow or height. Figure 7.2 depicts the variation in flow for the Wearyan River in 1977. The two components of baseflow and runoff are easily distinguished.

The baseflow component of flow slowly diminishes as the Dry season progresses. This is because less groundwater discharges to the river due to the lowering of the water table (Figure 7.3). If the water table falls below the river bed level then no groundwater is able to discharge to the river and it would cease to flow or may even dry out.

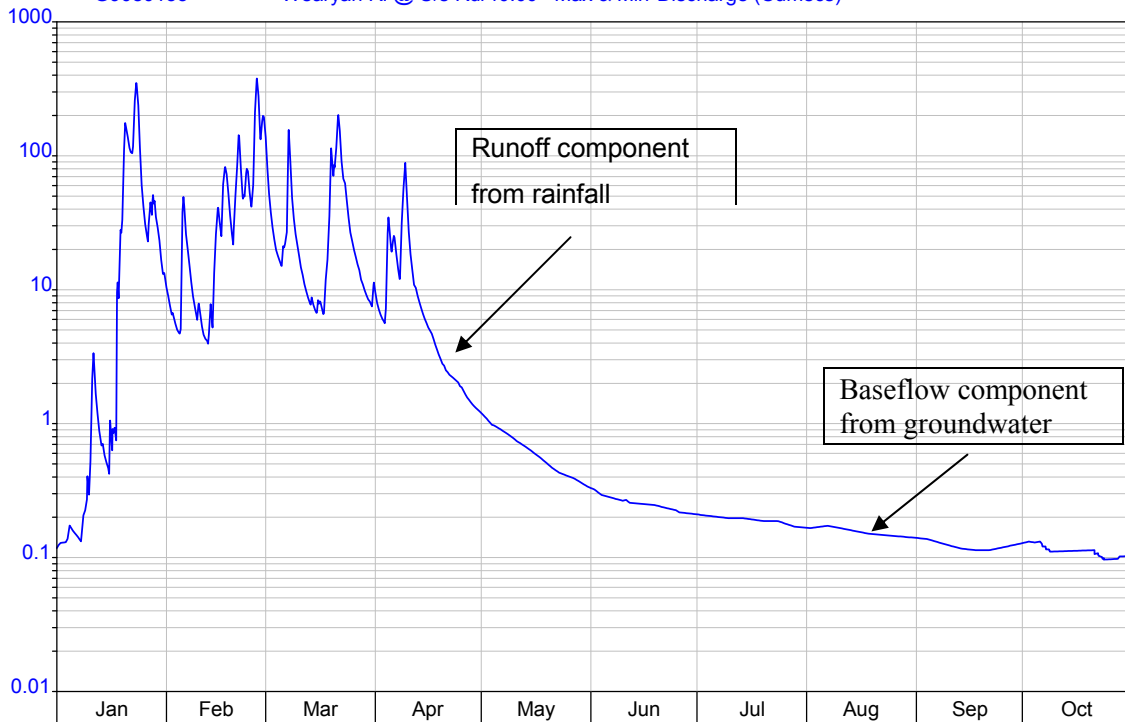
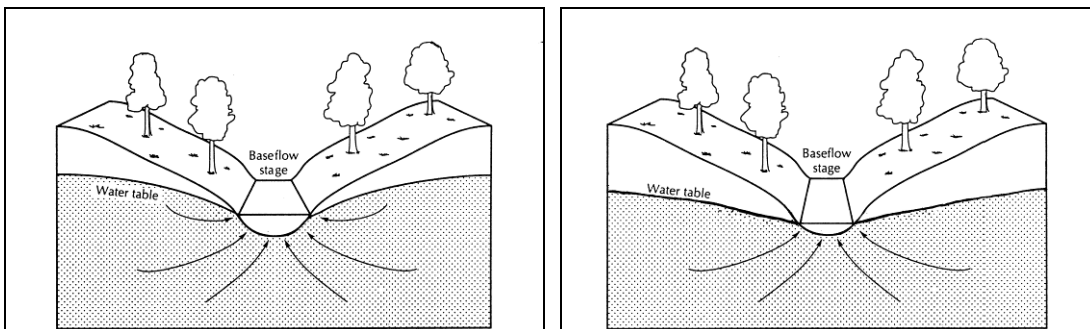


Figure 7.2 Discharge hydrograph in the Roper River at Red Rock G9030250 in 1995.



High water table = large flow in river Low water table = low flow in river

Figure 7.3 Effect of Water Table Level on River Flow (Adapted from Fetter, 1994)

One way a river can be classified is by whether it gains water as it flows downstream, which is called a gaining stream or loses water as it flows downstream which is called a losing stream. Rivers can have gaining and losing reaches. In the two map regions the gaining reach of a river is often very short and often fed by a localised spring. From that point onwards the river becomes a losing stream as no further springs discharge to the river but water is lost to evapotranspiration. There are very few river reaches on the maps which have permanent flow. Most are listed in the table below and are generally less than 10 km long. The lack of baseflow in rivers is a reflection of the rock types and aquifer types in the two map regions. The

areas largely consist of fractured and weathered rocks where aquifer development is controlled by the degree of fracturing and associated weathering which is usually localised. Hence small localised spring discharges are dominant throughout the maps.

Table 7.1 Rivers with permanent flow.

McArthur River Region Map	Comment
Upper McArthur River	Discharge at G9075082 on the McArthur River was approximately 50 L/s on 18.10.08. Ronnie Raggett, a traditional owner for the area explained that water is sourced from springs further upstream. He said that the flow can stop in drier years another 7 km further downstream. The water quality indicated the water was sourced from a carbonate aquifer.
Bessie Creek in the Abner Range	Discharge was estimated at 10L/s on 14.8.08 at G9075002. This water discharges from the McArthur Group sandstones on the Abner Range.
Windy Gully Spring creek at the Abner Range	Discharge was estimated at 40 L/s on 12.8.09 at G9075059. This water discharges from the McArthur Group sandstones on the Abner Range.
Upper Leila Creek around Crocodile Hole.	Discharge was estimated at 15 L/s 19.10.08 at G9075083. This water is sourced from a carbonate aquifer.
Upper and lower reaches of the Wearyan River.	91 L/s was measured on the lower Wearyan River at the Wollogorang Road crossing on 24.11.07. A gauging station G9080133 is located here and cease to flow has been recorded here in past years. Traditional owners explained however that a permanent spring is located upstream at Doolgarina. Water is sourced from the Karns Dolomite aquifer. The upper reaches of the Wearyan was not visited by the study team but again traditional owners explained that there are permanent springs there with a limy quality. This water is likely sourced from the Karns Dolomite.
Limmen Bight River Region Map	All the following permanent streamflows are sourced from fault springs discharging hot water. (generally > 40° C)
Rosie Creek	The localised Lorella spring discharges into Rosie Creek maintaining flow for several kilometres. 30 L/s was flowing on 27.11.07, site G9065002.
Beauty Creek (Tanumbirini Station)	Flow is maintained along a short tributary of Beauty Creek due to discharge from a fault spring. An estimated 30 L/s was flowing on 18.9.08 at G9055086.
Bauhinia Creek	Spring discharge from Jandangu Spring maintains flow for a short distance along Bauhinia Creek. 45 L/s was measured on 27.11.07 at G9055050.
Limmen Bight River Tributary	The spring behind the ranger station maintains flow along the tributary. The estimated flow on 27.11.07 was 20 L/s, site G9055060.

7.1 How surface water sites are recorded

All NRETAS surface water sites have a unique 'gauge site', 'G' number and name eg. G9080133 Wearyan River at upstream road crossing. Sites are numbered according to which basin (catchment) they lie within. The first 3 digits of the 'G' number refer to the basin number and the following digits identify the site. Figure 7.4 shows all the basins within the two map regions. A listing of all the NRETAS surface water sites within

the mapped areas is provided in Appendix E. The amount of data collected at each site can vary greatly: from one water quality record to detailed water level and quality records over several decades.

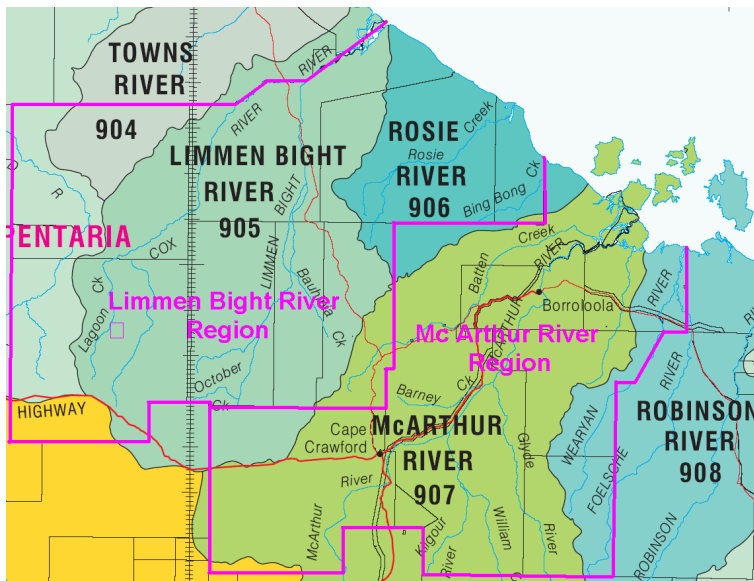


Figure 7.4 Basins in the study areas. (Excerpt from River Basins map DIPE, 2002)

The surface water sites marked with a 'G' number on the maps include:

- Gauging stations which are sites where river height has been continuously recorded and flow measurements made. (See Glossary)
- Gauge sites where a number of flow measurements have been made
- Springs where water quality and flow measurements have been made
- Permanent waterholes where water quality measurements have been made.

The gauging stations have a period of record from 1968 to 1986 (See Appendix E for details) aside from those on the McArthur River which are still in operation.

7.2 Gauging stations

At a gauging station river height is continuously recorded. Manual flow measurements (gaugings) of the stream are made at different river heights. This allows a relationship between height and flow to be determined so a continuous flow record can be obtained. When gauging stations remain in operation over many years the dynamics in river flow is recorded. This is important for future development planning and land and water management. The height and flow records of all the gauging stations in the map regions are provided in Appendix E. When there are inadequate flow measurements at the gauging station, no continuous flow record can be achieved. This is the case for G9050003.

At all the gauging stations in the two map regions, flow commonly ceases by the end of the Dry season, however during wetter periods baseflow can be maintained over the Dry season at some of the stations. Discussion on these gauging stations follow.

7.2.1 McArthur River



Plate 7.1, 7.2, 7.3 Gauging station G9070132 in 1981, again in flood and G9070142.

There are two operating gauging stations situated on the McArthur River in the non-tidal reaches: G9070132 and G9070142 (Plate 7.1, 7.2, 7.3). There was also one gauging station G9070229 located on the Glyde River, a tributary of the McArthur. These sites can maintain a baseflow throughout the year during wetter periods as shown in Figure 7.5. The figure plots minimum annual flow for these gauging stations and rainfall is also presented.

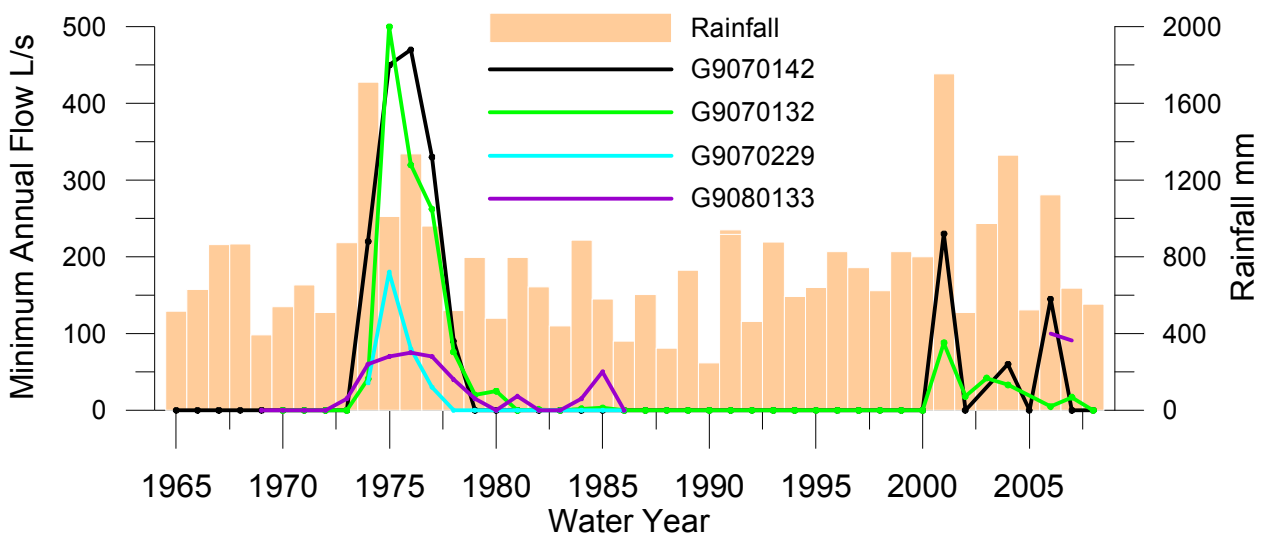


Figure 7.5 Minimum annual flow at gauging stations and annual rainfall.

G9070142, G9070132 are on the McArthur River, G9070229 lies on the Glyde River, and G9080133 is on the Wearyan River. Only available data is shown on the graph. Rainfall consists of interpolated rainfall obtained from SILO Data Drill for the McArthur River Station site, DR014715.

The figure shows that at these locations, river baseflow occurs only in the high rainfall years. Only when rainfall is high enough will the aquifer draining to the river be recharged sufficiently to provide baseflow. Because there is a sharp increase in minimum flow in response to high rainfall in the mid 70's followed by a sharp decrease with falling rainfall we know that the aquifer which provides the baseflow drains quickly.

Baseflow along the McArthur River

Baseflow at G9070142 is most probably sourced from the springs located much further upstream as shown by the perennial McArthur River reach on the map. This baseflow is sourced from a carbonate aquifer as indicated by the water quality. At this upstream location baseflow is likely to be greater than at G9070142.

As water flows from this upper spring area evapotranspiration losses would steadily cause the flow to decrease with distance downstream as no further inflows are assumed. The McArthur River in this reach is a losing stream. Downstream from G9070142 the McArthur River will continue to be a losing stream as no further groundwater inflows are expected unless it gains some flow from adjoining tributaries. Bessie Creek is one tributary which can contribute baseflow. Baseflow in Bessie Creek which is sourced from an aquifer in the Abner Sandstone, is however not very large. In October 2008 20 L/s was estimated. Hence G9070132 located downstream from Bessie Creek on the McArthur River has a similar minimum flow to that of G9070142. The upper McArthur River spring area warrants further investigation in terms of baseflow source. It may be completely sourced from a fractured and weathered carbonate aquifer or it could partly be sourced from the Gum Ridge Formation (Cambrian limestone) which hosts a fractured and karstic aquifer.

7.2.1 Wearyan River

The Wearyan River drains the Karns Dolomite in its upper and lower reaches. In the lower reach it meets with the dolomite from Doolgarina downstream. Just upstream of Doolgarina the Wearyan stops flowing each Dry season. Springs are located at Doolgarina. A gauging station G9080133 (Plate 7.4, 7.5) is situated approximately 7 km downstream from Doolgarina, near the Wollogorang Road. Within 2 kilometres downstream of the Wollogorang Road the river becomes tidal.



Plate 7.4, 7.5, 7.6 Gauging Station on the Wearyan River, Gauge boards and the Wollogorang Road Crossing just downstream from the gauging station.

Baseflow variation at the gauging station

Basflow at G9080133 occurs only during high rainfall periods as shown in Figure 7.5 and 7.6.. To gain a perspective on how minimum flow may vary over a longer period regression analysis was undertaken with the 2 year moving average data drill rainfall record from Calvert Hills to obtain predictive values. Calvert Hills rainfall was used because it is located more central to the aquifer. The results are provided in Figure 7.6. The correlation indicates that the high baseflows experienced since 2001 are a result of extremely high rainfall which occurred for the first time in over 100 years.

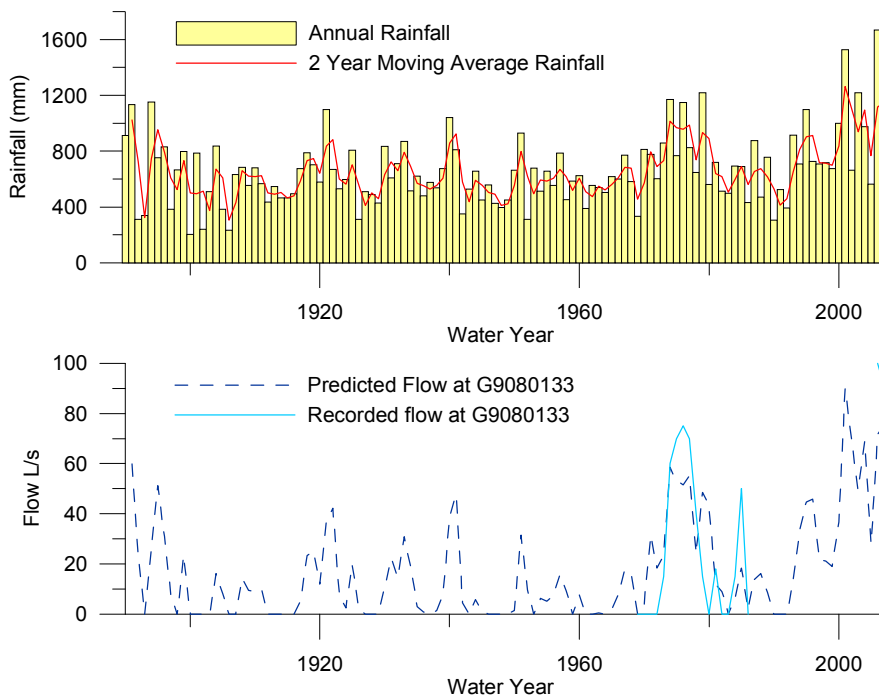


Figure 7.6 Annual rainfall at Calvert Hills and minimum flow at G9080133

Calvert Hills annual rainfall at DR014705. Calculated over the Water year = September to August of the following year. (Interpolated data obtained from SILO Data Drill data made available by the State of Queensland through the Department of Natural Resources) Correlation coefficient between rainfall and recorded minimum flow = 0.71.

7.3 Other surface water sites

There are a number of important wetlands in the map regions which are listed in the Directory of important Wetlands in Australia (Environment Australia, 2001). These are the:

- Limmen Bight (Port Roper) Tidal Wetlands System. It is a tidal wetland with a high volume of freshwater inflow over the Wet season. It is an important shorebird and seagrass site for dugong feeding and prawn breeding.
- Borroloola Bluebush Swamps which are dry by the end of the Dry season. It is a significant breeding area for birds and has a unique combination of vegetation types.
- Port McArthur Tidal Wetlands System. It has a substantial area of inter-tidal mudflats and mangrove swamp. It also encompasses Lake Eames which is the largest permanent freshwater lake in the two map regions.

Lake Eames is known as Walala by the Yanyuwa people (Appendix A). It is surrounded by Masterton/Echo Sandstone and coastal sand dunes. The water quality is fresh and site G9075064 in Appendix F provides detailed water quality analysis.

7.4 Availability of river water

7.4.1 Mapping minimum baseflows

To provide an overview of water availability all rivers on the Water Resources map have been plotted according to their minimum flow, thereby reflecting the environment at its driest. It is intended to raise awareness of how supplies from these rivers can be limited. In cases where there was little recorded data, site visits, flow gaugings and local knowledge were used to determine minimum flows. Local knowledge

proved vital to this task as this project was conducted during a period of above average rainfall and higher than minimum flows were observed in most rivers. The minimum flow categories of some rivers have been estimated from anecdotal evidence or scientific interpretation, as not all sites could be visited during the project duration. There are three categories of minimum flow shown on the water resource map:

————— River with a minimum flow between 10 and 100 L/s at the end of the Dry season



Plate 7.7 Upper McArthur River

The upper McArthur River and upper Rosie Creek are marked under this category. These river reaches will always be flowing due to baseflow.

————— River with permanent waterholes or flows up to 10 L/s at the end of the Dry season



Plate 7.8 Rosie Creek

This category includes rivers which can cease to flow, but maintain permanent waterholes. They can provide a small supply throughout the year. Some of the waterholes can be small but others can be long and deep. Reaches of the McArthur River, Rosie Creek and Wearyan River fall into this category.

————— River which is dry at the end of the Dry season



Plate 7.9 Tributary of Branch Creek

These rivers are not suited to supply water reliably throughout the year. Although most of the rivers in this category are dry by the end of the Dry season some of them may continue to flow throughout the year after periods of average and above average rainfall, but will dry out in drier times. Rivers which can have long stretches of dry riverbed with only the occasional waterhole are also marked under this category. Where possible these isolated permanent waterholes are marked on the map

7.4.2 Baseflow Water Quality

Baseflow is groundwater discharge. The water quality of groundwater discharges are directly related to the geology of the aquifer supplying that particular spring. Detailed water quality of springs and other surface water sites are provided in Appendix F.

Baseflow of rivers sourced from sandstone aquifers in the two map regions generally have neutral or low pH (less than or equal to 7) and low TDS (below 100mg/L) reflecting the overall low salt content. Within the McArthur River region Bessie Creek is a prime example of such a river as its baseflow is sourced from the sandstones of the Roper Group of rocks. There are many springs which discharge from these sandstones, particularly around the Abner Range, that maintain baseflow to small creeks and all have a similar water quality, Table 7.2. In the Limmen Bight River Region the Abner Sandstone also outcrops as escarpment on the Jandanku Aboriginal Land Trust and again there are numerous springs and creeks with similar water quality. Included are Bauhinia Springs, Bauhinia Creek and the Limmen Bight River at the gauging station G9050003.

Table 7.2 Water quality of baseflow discharging from sandstone aquifers

Site	Site	pH	TDS mg/L
G9075002	Bessie Creek	6.4	33
G9075059	Windy Gully Spring Creek (Abner Range)	N/A	8 (Calculated from Ec)
G9050003	Limmen Bight River	7	20 (Calculated from Ec)
G9055009	Downstream Bauhinia Spring	6.9	56 (Calculated from Ec)

The hot springs on Lorella Station also have a low TDS (Table 7.3). The aquifer which is the source of the spring water is thought to be the Yinyinti Sandstone. The elevated temperature of the springs suggest that it comes from considerable depth.

Table 7.3 Water quality of hot springs on Lorella Station.

Site	Site Name	pH	TDS mg/L	Hardness mg/L	Calcium mg/L	Magnesium mg/L	Sodium mg/L	Chloride mg/L
G9055020	Kulampirri Ck, hot spring	6.2	40	4.5	.5	.8	2.2	4
G9065016	Hot spring at tributary to Little Rosie Creek.	6.6	50	9.5	.6	2	2.3	4
G9065001	Lorella spring.	7.3	80	40	4.5	7.1	4	4

Where river baseflow is sourced from carbonate aquifers pH is usually above 7 and TDS above 200 mg/L. These rivers include the McArthur River, the Wearyan River, Leila Creek and Batten Creek. The dominant salts in carbonate aquifers are Calcium and Magnesium carbonate. An overview of water quality of these rivers is provided in Table 7.4 and Table 7.5 provides water quality information for hot springs discharging from carbonate aquifers.

Table 7.4 Water quality of baseflow discharging from carbonate aquifers.

These sites are all located on the McArthur River region map.

Site	Site Name	pH	TDS mg/L	Hardness mg/L	Calcium mg/L	Magnesium mg/L	Sodium mg/L	Chloride mg/L
G9070142	McArthur River	7.7	310	276	48	38	7	20
G9075071	Batten Creek upstream Crocodile Creek	8	310*	N/A	N/A	N/A		
G9075083	Leila Creek at Crocodile pool	8.1	530	507	85	72		
G9080133	Wearyan River	8.5	200	194	35	26		

*calculated from Ec

Table 7.5 Water quality of hot springs discharging from carbonate aquifers.

Site	Site Name	pH	TDS mg/L	Hardness mg/L	Calcium mg/L	Magnesium mg/L	Sodium mg/L	Chloride mg/L
G9055060	Nathan River Ranger Station hot spring (Limmen Bight River Region map)	7.9	273	277	55	34	3	5
G9075078	Hot Spring A on tributary to Barney Creek (McArthur River Region map)	7.2	310	202	49	19	5	6.1

The hot springs on northern Tanumbirini Station have a pH of 6.8 or higher and a TDS also above 200mg/L. However the water has a different mix of salts. It contains calcium and magnesium bicarbonate but also notable amounts of sodium and chloride (Table 7.6).

Table 7.6 Hot springs on Tanumbirini Station

Site	Site Name	pH	TDS mg/L	Hardness mg/L	Calcium mg/L	Magnesium mg/L	Sodium mg/L	Chloride mg/L
G9055076	Hot spring R/B Lagoon Ck	6.8	350	77	20	7	76	155
G9055086	Very hot spring on tributary to Beauty Creek.	7.2	310	108	31	7	48	97
G9055081	Spring area to upper Cox River, Tanumbirini station	6.8	280	58	15	5	59	119

An interesting feature of the regions related to the carbonate waters is tufa. Tufa is a type of limestone. It forms when evaporation causes spring water to become super-saturated with calcium carbonate. The mineral precipitates out of solution when triggered by turbulence. Hence tufa deposits are often seen at cascades and rock bars often forming tufa dams. Sometimes tufa deposits are left behind by springs which no longer flow (Plate 7.10). Tufa deposits have been marked on the water resource map.



Plate 7.10 Tufa deposit on the McArthur River.

7.5 Wet Season Flows

In the Wet season, river flows increase due to rainfall runoff. Figure 7.7 provides an example showing how flow in the McArthur River at G9070142 increases with rainfall events at the site. The increase in flow at a point along the river is dependent upon the rain that has fallen in the catchment upstream from that point. For the same amount of rainfall, larger catchments have larger flows. Major catchment boundaries are shown on the Water Resource Map. Appendix E provides plots of the flow record for the gauging stations. Note the large variations in maximum flow over the years on these plots. Large quantities of rainfall runoff can discharge along the rivers in the regions. This presents a substantial resource.

For further information on rainfall runoff The CSIRO North Australia Sustainable Yields (NASY) project is best referenced. (www.csiro.au/science/NASY-Gulf-of-Carpentaria.html) It assesses surface water and groundwater resources in the region under varying scenarios including the historical, recent (last 10 years) and future (2030) climates.

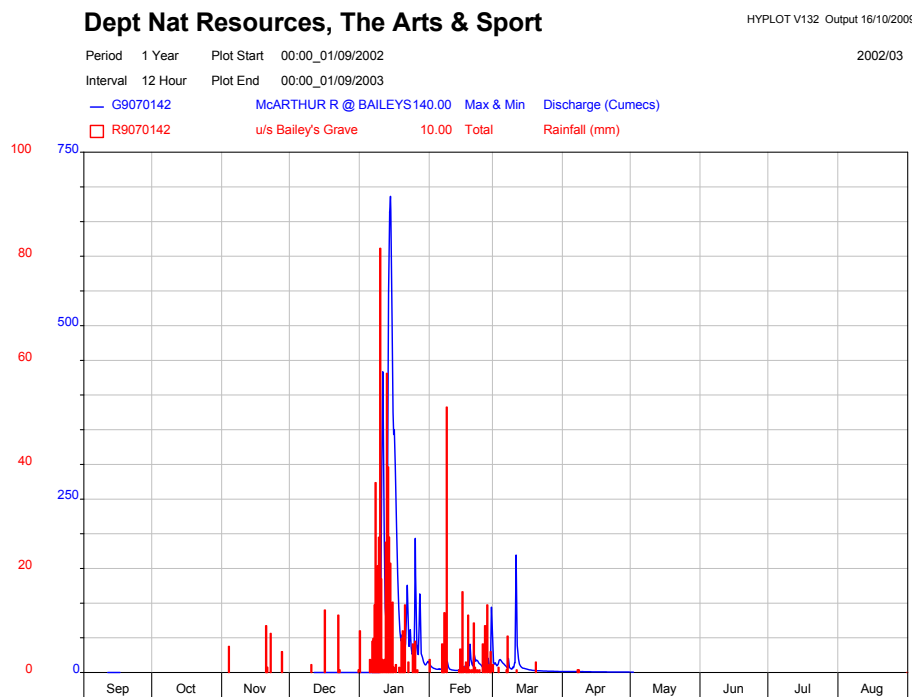


Figure 7.7 Flow increases in the Calvert River in response to rainfall.

8. WATER RESOURCE DATA AND AVAILABILITY

NRETAS reports pertaining to this map area are listed in Appendix B and many are available in digital format.

The Water Resource Map that accompanies this report was produced by NRETAS. It can be reprinted at any time and made available to interested parties.

All products produced for the Gulf Water Study are available in digital format on DVD. The DVD titled 'The Gulf Water Study' contains the following products:

- This report and the reports for the other regions of the study
- Posters pertaining to the study area
- A GIS which uses the program Arc Explorer
- A photographic and video database which is geo referenced

The DVD is available through the Natural Resources Division of NRETAS.

All detailed information on surface water sites is kept on the NRETAS 'Hydstra' database. Requests for such data can be made to: Spatial Data and Mapping Branch, NRETAS Phone (08) 8999446, Email: DataRequests.NRETA@nt.gov.au

All bore reports are available through the internet site www.nt.gov.au/nretamaps. These are regularly updated.



Plate 8.1, 8.2, 8.3 Scientific data collection:

Field survey work visiting springs with Rhett Walker – owner of Lorella Station, measuring the water level in a bore with Bruce Maycock from Merlin Mine and examining drilling chips with geologist Tim Lewis from Sandfire.

9. GLOSSARY

Airlift Yield: The rate at which water is extracted from a bore using compressed air downhole.

Aquifer: A body of rock which is sufficiently permeable to conduct groundwater and to yield useable quantities of groundwater to bores and springs

Baseflow: The groundwater contribution to a stream. Baseflow often maintains the flow in a stream over the Dry season.

Catchment: Area in which rainfall collects to form the flow in a river.

Confined aquifer: A confined aquifer occurs where an aquifer is overlain by a confining bed. The confining bed prevents upward movement of the groundwater. Such aquifers are usually completely saturated with water which is commonly under pressure. Therefore when a bore intersects the aquifer, water rises up the bore. If the pressure is sufficient to drive the groundwater above the ground level, the bore is called artesian.

Carbonate rock: A rock such as limestone or dolomite, consisting largely of the carbonate minerals; calcium carbonate or calcium magnesium carbonate.

Consolidate: Any process whereby soft or loose earth materials become firm, for example the cementation of sand or the compaction of mud.

Dhuwa and Yirritja: These are the two moiety names often used in Arnhem Land. Everyone and everything is either Dhuwa or Yirritja. This is one of the fundamentals of Aboriginal culture.

Dolomite: A sedimentary rock composed mainly of the mineral dolomite (calcium magnesium carbonate)

Electrical conductivity, EC: The measure of the ability of water to conduct electrical current. The magnitude is directly related to the dissolved mineral content of the water. EC is measured in microseimens per centimetre, $\mu\text{S}/\text{cm}$.

Ephemeral: A creek or river that dries up in the dry season.

Evaporation: The process whereby liquid water turns to vapour. It accounts for the movement of water to the air from sources such as the soil, canopy interception, and waterbodies.

Evapotranspiration: The sum of evaporation and plant transpiration from the Earth's surface to the atmosphere. Transpiration accounts for the loss of water from plants as vapour through its leaves.

Fractured: A fractured rock is one that is broken by joints, cracks or faults.

Gauging station: Instrumented site on a stream where direct observation of water heights are continuously made and recorded.

Geology: Science of earth's composition, crust, rocks, origin, structures, historical changes and processes.

Geographic Information System (GIS): A computer system that captures, stores, analyses, manages and presents data that is linked to location. Data can be viewed and accessed using a computerised map.

Geophysics: The use of specialised surveys to give an indication of underlying rock type. Techniques such as magnetics, gravity, electro-magnetics, and seismics can be used on the earth's surface in order to indicate geology.

Groundwater: Water beneath the surface of the earth that is in the saturated zone.

Groundwater dependent ecosystems: A community of plants and animals that rely partially or completely on groundwater for its existence.

Groundwater Discharge: The release of groundwater to the surface by seepage, evaporation or transpiration (from plants).

Hardness: A measurement of the level of calcium carbonate in water.

Hydrograph: A graph that shows water levels or flow in a stream, or the watertable level in a bore.

Impermeable: An impermeable soil, rock or sediment is that in which fluid (water) is unable to pass through.

Jungkayi: People who have responsibilities to their mother's clan, ritual managers of one's mother's country. The term can be translated in English as 'manager', 'caretaker' or 'policeman'.

Karst: A term describing typical geologic/topographic attributes of limestone or dolomite resulting from mineral solution such as caves and sinkholes.

Monitoring/Observation bore: A bore used for measuring groundwater levels.

Ngimarringki: Yanyuwa term for traditional land owners.

Perennial: A stream, lake or waterhole which retains water throughout the year.

Perennial flow: Flow that is retained throughout the year.

Permeability/Permeable: The capability of sediments and rocks to allow water to move through them.

pH: A measure of acidity (low pH) or alkalinity (high pH). A pH of 7 indicates neutrality whereas lower pH levels indicate acidity.

Porosity: The total amount of pore space in a soil or rock.

Primary porosity: Voids in a rock formed when the rock was deposited. The spaces between sand grains are an example of primary porosity.

Recession: The part of the hydrograph where the water level or flow diminishes.

Recharge: Addition of water to an aquifer to become groundwater.

Runoff: Rainwater that leaves an area as surface flow.

Sandstone: A sedimentary rock composed of sand grains cemented together.

Spring: Outflow points for groundwater where the watertable is near or above the ground surface.

Siltstone: A sedimentary rock composed of silt sized particles.

Standing Water Level: The level below ground surface, to which groundwater rises in a bore.

Surface Water: Water that is on the earth's surface, such as a stream, river, lake or reservoir.

Sustainable: maintain (without adverse effect)

Topography: The shape and height of the land surface.

Total Dissolved Solids (TDS): The amount of dissolved material in water, usually expressed as milligrams per litre (mg/L).

Unconsolidated: A sedimentary deposit in which the particles are not cemented together.

Water table: Level of the surface of the groundwater. It is often measured in observation bores.

Water quality: Physical, chemical, biological characteristics of water and how they relate to it for a particular use.

Water Year: The water year splits the year from September of one year to August of the next year. Hence the total Wet season rainfall is accounted for.

Wetland: Land which remains wet for a large part of the year.

Yield: Amount of water which can be supplied by an aquifer or pumped from a bore over a certain time period.

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APPENDIX A: INDIGENOUS KNOWLEDGE

All cultural perspectives need to be recognised when undertaking land and water management and development. In effort to present the indigenous cultural perspective pertaining to water, care has been taken to present indigenous place names on the maps and detail cultural information relevant to the places in this report. All indigenous place names relate to the people, their ancestors and the country. It is hoped that aside from producing a cross-cultural user friendly map, non-indigenous readers can gain some insight into the rich heritage of the indigenous people of this region.

The following information was collected during field trips when indigenous people were interviewed or accompanied field workers and guided them to water sites. At all times when collecting indigenous knowledge, it was made clear that the information would be public, so culturally sensitive information was not recorded. Where possible, the language of the place name was recorded. Efforts were made to transcribe the names correctly.

Where substantial information has been supplied it is presented in alphabetical name order of the individual or group who supplied the information. A photo of the individual is shown where possible and this is followed by detailed information and photos of some sites. A table is provided with location and transcription details of all sites discussed. Information from other individuals is presented in tabular form at the end of the Appendix. In the tables it is noted if the site was visited or the location only estimated by use of maps and through discussion. A draft 1:250000 water resource map was used to identify locations. Eastings and Northings were then approximated using 1:50000 topographic maps. Where there is too much uncertainty on location, no co-ordinates were supplied. Some of the locality names are non-indigenous but are none the less recorded here.

Indigenous and non-indigenous people provided information on water resources and their dynamics that has helped with mapping and scientific understandings. This information such as spring locations and whether or not waterholes are permanent or intermittent is knowledge gained through experience and observation. Such information has been invaluable, particularly as such a vast area was covered and access difficult.

Ancillary to this report, indigenous knowledge has also been documented through photographs and video and is available on the Gulf Water Study DVD.

LIMMEN BIGHT RIVER REGION

Donald Blitner



Donald is a spokesperson for the Marra area which is located along the coast south of the Roper River. Donald talked about life in the early days in the Marra area.

Donald Blitner

The Marra country was a hard place for water in the old days – the Limmen and Towns River area. We had to go to the special places where there was water, which had to last until we got to the next waterhole. The coastal area was not good for water. We carried water with us in the canoe. We travelled along areas where there was water. When travelling up the Limmen Bight River we would get water from Wamungu and then travel to Namanuwal for water.

Table A1 Indigenous place names and details supplied by Donald Blitner.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Namanuwal waterhole		Near Limmen River. Main water supply.	559700	8315600	Existent on Topographic map
Wamungu	Area	Limmen River at the mouth. We got water from here.	574000 Location estimated	8330000	Ursula Zaar

Barney Ellaga

Barney Ellaga is an Alawa spokesperson for the old Cox River Station which is now the Alawa Aboriginal Land Trust. Barney lives at Minyerri. He explained that access was poor in the Cox River region but at one time people lived at an outstation at Cox River called Dumdumngadanyana (Minamia). He explained the following about the area.

Table A2 Indigenous place names and details supplied by Barney Ellaga.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Dumdumgadany ana (Dumyungardan garna) or Nurlurnambaru	Minamia (outstation)	This is the area name for the outstation and surrounds. The sugarcane made the land. Land of the Nooralinji people.			Ursula Zaar Alawa language,
Mambaliya country	Area	Around the hot spring in north Tanumbirini station.			Ursula Zaar

Roy Hammer (Deceased)



Roy Hammer
(Photo supplied by and with the permission of his wife Violet Hammer)

It was late in November 2007 that Ursula Zaar finally met with Roy Hammer. He was an elder of the Marra clan and had worked as a stockman for most of his life. He spent a lot of his time as a stockman on Bauhinia, Billengarah, Nathan River, Hodgson, Nutwood, Tanumbirini, Bing Bong stations and numerous other stations. He was the head stockman at Bauhinia for many years and actually took on the name Hammer after Ken Hammer who was then the owner of Bauhinia. Roy's proper surname is Riley. Roy was a great jockey and was the first man to win the Borroloola cup races twice. He was a very well respected man by all people. He was the Borroloola council President for 6 years. He was well known for his beliefs in, and faultless knowledge of, aboriginal law. He travelled to Japan to show the world his Traditional Dancing. (Information provided by Frank Shadforth, pers. Comm. and memorial service notes) When Ursula interviewed Roy she was impressed by his excellent memory and how he was able to read maps and locate water sites very quickly, naming and describing them. Some of his knowledge of water sites is recorded below.

Table A3 Indigenous place names and details supplied by Roy Hammer.
These would be in the Marra language.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Awurriyarra	Waterhole/ soak	This is a permanent soak	512800 From topo map	8275600	Already noted on 50k topo map
Djowunda	spring	This is a permanent spring which bubbles from the ground but can stop flowing.	544900 As per topo map	8293200	Already noted on 50k topo map
Dunyalah	Lagoon	This lagoon dries out.	543000 As per topo map	8222500	Ursula Zaar. Nanji Language
Galiba	Waterhole	Permanent waterhole related to the rain dreaming. Located on Tawallah Creek.	557800 From topo map	8220000	Already noted on 50K topo map.
Kalalanjunma	Waterhole	This waterhole is permanent	513500 As per topo map	8287600	Already noted on 50k topo map
kingirrakalkuma	waterhole	This is a sacred site which can dry out	547700	8267600	Already noted on 50k topo map
Kulampirri	Permanent soak. At old ruin site on Lorella station.	This area relates to the dreamtime dugong killer - Marbingarri. It is a sacred area.	566200 Location estimated	8274000	Already noted 50 k topo map as a creek
Lurella (Lureralla)	Lorrella spring	This is a permanent hot water spring which always runs.	569000 As per topo map	8261300	Lurella noted on 50k topo map. Mara word.
Manabura	Waterholes, permanent	Located on Bauhinia Downs	539500 As per topo map	8222300	Already noted on 50k topo map
Namanuwal	waterhole	Roy travelled by canoe to Lamahda spring to get water and come back to camp here.	559800 From topo map	8315600	As per 50K Topo map.
Tyurrarrani	Soak / spring	This is a permanent soak	513500 As per topo map	8273400	Already noted on 50k topo map
Wamunguwadi	waterhole	A small waterhole which is permanent. It is the whirlwind dreaming.	546200 Location estimated	8305200	Ursula Zaar
Wardawarra	Area name	Area around tidal region of Rosie Creek. There are permanent waterholes in this area.	621000 Generalise d location	8393000	As per 50K map for Wardawarra Headland.
Warramarnda	waterhole	Permanent waterhole on Warramana Ck	594500	8248800	Already noted on 50k topo map
Wirinangu	Intermittent swamp	This is a paperbark swamp. It is incorrectly called Wulkulyi swamp which is located further south	564000 Location estimated	8310500	Ursula Zaar
Wununmantyla	Spring	There is permanent water here but it can stop flowing	567000 As per topo map	8263400	Already noted on 50k topo map.
Yalayalakamirra	spring	This is a permanent spring.	544700 As per topo map	8295800	Already noted on 50k topo map
Yambaranguyi	Spring/soak	This is a permanent soak	514500 As per topo map	8293500	Already noted on 50k topo map
Yarrngalarra	Waterhole	This is a spring with boiling water	572600 As per topo map	8304500	Already noted on 50k topo map

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Yirangalangala	Waterhole	This is a permanent waterhole	510500 As per topo map	8286800	Already noted on 50k topo map
Yumunguni	Beatrice Island	There was a well here but now it is dry.	584500 As per topo map	8330800	Noted on topo map. Mara language.
	soak	A permanent soak near the Limmen Bight River left bank opposite the Four Arches.	543600 Location estimated	8290800	
	soak	This is a soak located downstream from Buyubuyula Waterhole on Nathan River	559800 Location estimated	8304700	
	Hot spring	On Lorella station on tributary of Kulampirri Creek.	564000 Location estimated	8274700	
	Soaks at Yinyinti range	There are soaks on this range but it is sacred and no access is allowed in these areas.			
	Spring / waterhole	This is a bubbling permanent spring. Located on Broadmere Station north of the homestead.	518300 As per topo map	8197200	
	Nathan River	Upstream of Buyubuyula Waterhole are paperbarks from which dugout canoes would be cut.			

'topo' map refers to the 1:50 000 topographic map series.

Les Hogan and Bruce Joy

Rosie Creek area

There is a ceremony song which comes from the coast. There is a story of girls who travelled up Rosie Creek and created some waterholes. Ngalandjaja is on the Billengarra side.

Table A4 Indigenous place names and details supplied by Les Hogan and Bruce Joy.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Ngalandjaja	Waterhole	On Rosie Creek on Billengarra side. Relates to the dreamtime story of girls who travelled up Rosie Creek			Ursula Zaar

Harry Lansen

Table A5 Indigenous place names and details supplied by Harry Lansen.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Ambulyanangi	Spring	The hot spring above the jump up.	546800 Location estimated	8211700	Ursula Zaar
Jandangu	Spring	Spring and station area at Bauhinia Downs Station. This water is permanent.	549500 As per 50K topo map	8207200	Ursula Zaar
Manabura	Waterholes	Permanent waterholes	539500	8222300	Already noted on 50k map

Stephen Roberts



Stephen Roberts

Stephen Roberts is a well respected elder of the Budal clan. He lives in Minyerri. Having being born in 1925, he experienced a traditional upbringing learning about, and living his culture as it was for thousands of years. He also saw the changes that came with the Europeans. In talking with Stephen one quickly recognises that he has an extensive knowledge of the waterholes over a vast tract of country as he related the names and dreamtime stories of waterholes and their interconnections. The knowledge of the region he provided is documented below.

Moynmin

This is the old Tanumbirini Station homestead area. Moynmin means upset or cranky. This is where the devil devil was angry. There were two devil devils who got angry and argued about country. The desert devil devil won. There is black rock there that marks the devil devil. The people from there have died out.



Moynmin Waterhole

Table A6 Indigenous place names and details supplied by Stephen Roberts.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Moyndmin Munmin	The old Tanumbirini station area.	This is where the devil devil was angry. There were two devil devil who got angry and argued about country.			Ursula Zaar Binbingarr language. Listed as Munmin waterhole on topo map
Noorbayin (Ngubaiyin)	Hot spring in north of Tanumbirini station.	The people from there have died out.			Ursula Zaar Binbingarr language.
Yilbindjila	Spring at Nathan River station		547917	8279001	As written on 50K topographic map.

MACARTHUR RIVER REGION

Alec Anderson



Alec Anderson

In July 2008 Alec Anderson and his son Alec Anderson guided the survey team to a number of waterholes on Manangoora Station. Alec is a station owner but also a Traditional owner of the station and was able to provide the place names of sites as well as explain the indigenous significance.

Marringul Waterhole



Marringul

This is the only permanent waterhole on Manangoora. It is fringed with laterite. The waterlevel varies a total of about 3.5 m. Across from the waterhole is a place for ceremony to make young men in the old days. The waterhole relates to the eaglehawk Dreaming. Next to Marringul is Darwanna, which is the crow dreaming. Years ago the old people told us that there is a big hole between the two waterholes so water could flow between them.

Doolgarina waterhole



Doolgarina Waterhole



Spring on the river bank at Doolgarina.

This is a permanent waterhole on the Wearyan River called Doolgarina. There is a big spring here in the river but you cannot see it now. There is water at the side of the banks. There are permanent waterholes from here all the way to the highway crossing. From upstream to downstream they are called Barmanana, Doolgarina, Doolgarina Crossing, Djabanbanna, Diddireena, Biddjililli, Gunanda, Budjanga, Buyarranna that's the waterfall, down from the waterfall is Wardbirrwardbirr and the crossing is Wurraginna.

I walked around with the old people who told me the names. We used to work hard in those days. We would walk all the way along the Wearyan River, from Marringul all the way up to Spring Creek (Homestead) and across to Robinson River. We knew where the waterholes were. We would move camp between the waterholes.

Warruwarri and Mukaralla



Alec and son Alec Anderson at Warruwarri



Mukaralla or Warby Lagoon

Mukaralla, Warruwarri and Lurriari waterholes can all dry out.

Table A7 Indigenous place names and details supplied by Alec Anderson.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Barmarnanna	Waterhole	Located south of Doolgarina			
Biddjililli		Area south of the highway along the Wearyan River	690000 Location estimated	8208500	Ursula Zaar
Budjanga	Site, Outstation		689100 As per topo map	8210400	Already noted on 50K topo map.
Bulugwy	Waterfall	Upstream of Doolgarina waterhole on the Wearyan River.			
Buyarranna	Waterhole on the Wearyan River	On the Wearyan River about 1 km south of the highway.	688300 Location estimated	8210800	Daphne Mawson
Darrwanna	Waterhole	Relates to the Crow dreaming. Located near Marringul	684944 Location estimated	8218600	Ursula Zaar
Diddireena	Waterhole Permanent	Large waterhole on the Wearyan River	689700 Location estimated	8208000	Ursula Zaar
Djabanbanna	Area		689184	8204761	Daphne Mawson
Doolgarina	Waterhole, spring area G9085092	Spring, and permanent waterhole on the Wearyan River	687870 Visited	8203655	As noted on 50K topo map
Lurriarri	Waterhole Intermittent G9085090		689819 Visited	8228814	Ursula Zaar
Marringul	Waterhole Permanent G9085091	This is the only permanent waterhole on Manangoora. It is fringed with laterite. The waterlevel varies a total of about 3.5 m. Across from the waterhole is a place for ceremony to make young men in the old days. The waterhole relates to the eaglehawk Dreaming.	684904 Visited	8218628	Ursula Zaar
Mukaralla	Warby Lagoon Intermittent G9085013	The Lagoon can dry out	685622 Visited	8213627	Ursula Zaar
Wardbirrwardbirr (Wardbirrwardbirrina)	waterfall	Waterfall on the Wearyan river just south of the highway.	688200 Location estimated	8211200	Ursula Zaar
Warruwarri	Waterhole Intermittent G9085089		689988 Visited	8225527	Ursula Zaar
Wowyamma			687800 Location estimated	820350	Ursula Zaar
Wurraginna	Site on the river	Location at the highway crossing on Wearyan	6879000 Obtained from topo map	8211700	Daphne Mawson. Not Garrwa language.

Roy Hammer (deceased)

Introduction on Roy Hammer is provided in the Limmen Bight River indigenous knowledge section.

Minngarra



This is a permanent fresh waterhole. If you travel east of here you will die for water.

Table A8 Indigenous place names and details supplied by Roy Hammer.

Indigenous names are in the Marra Language

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Arrawanja	Waterhole	This is a permanent waterhole	613000 As located on topo map	8228700	Already noted on 50k topo map
Manamanala	Waterhole	This is a permanent waterhole	615400 As located on topo map	8229300	Already noted on 50k topo map
Minngarra	Waterhole G9075076	This is a permanent fresh waterhole. If you travel east of here you will die for water.	659300 From topo map	8243650	Already noted on 50k topo map
Muluyuluma	Waterhole	This is a permanent waterhole	611500 From topo map	8224000	Already noted on 50k topo map
Ngamingambi	Sinkhole and permanent waterhole	This is the only sinkhole in the region. It is a sacred site and the water should not be touched.	614400 As located on topo map	8233300	Already noted on 50k topo map
Nguluwunyara	Soak (Kangaroo spring)	This is a soak	636200 From topo map	8232200	Already noted on 50k topo map
Tawarrila	Waterhole	This is a permanent waterhole	652200 As located on topo map	8255600	Already noted on 50k topo map
Wunugunumara	Waterhole	This is a permanent waterhole	589300 From topo map	8214600	Already noted on 50k topo map

Les Hogan (warramurru) and Bruce Joy



Les Hogan



Bruce Joy

Les is a senior Garrwa ceremony man for the Wearyan country. He is a Traditional Owner for that country. Les was born on Spring Creek Station in 1935. Bruce is a senior Gudanji elder. He is 91 years old. He is the Traditional Owner for Gudanji country. He was born on McArthur River station.

The project team caught up with Les on several occasions and at Cow Lagoon they met with Les and Bruce. Following is what the men had to say about the McArthur River Region and the life they led during their youth.

Les Hogan:

We lived the bush way. We carried our swag and walked. Walked to different waterholes to get bushtucker, turtle, kangaroo, fish. We made our own spears to spear fish. We travelled and stayed in one place for 5 days to collect food and then moved to the next place. We camped all the way down the Wearyan River at different waterholes. Every waterhole has a name. Wurraginna is the main crossing on the Wearyan. All the waterholes along the Wearyan are part of my song. That song is sung at ceremony time – young mans ceremony. We pass that song on to the young fellows. Different waterholes have different significance.



Wurraginna – looking downstream

Some are sacred. Some women cannot drink from the waterholes. These are sacred sites. Most waterholes are good for drinking, hunting and fishing. I learnt this from the old people. The Wearyan has no sacred sites. There is dreaming there, and that dreaming is in our song. The songs are kept within the family. It's our duty to carry this knowledge on from the old people. Ceremony belongs to country and people need to do ceremony as part of looking after country.

Les and Bruce:

The mob of devils

There were a mob of devils who came from Tanumbirini station. These sites mark the path of the devils. These are Gudanji names. This is an Alawa song. The devils carried with them the cycad tree called manja. This pathway of the devil is related to song and ceremony. This was the biggest mob of devils and the waterholes mark the track.



Yungurri



Goolminyini

The path of the devils:

- They came by Galah Creek – Wurringinni. They came to Wearinginni which is a permanent waterhole.
- Then they went to a big hill, Wowyunnu. This marks the devil tracks.
- Then to Alawa, a big lagoon – round lagoon – which is permanent
- Then to Walyalunburra at the point of a hill where there is a big cave.
- Then to Wadja which is a waterhole on Batten Creek. Wadja is Cow Lagoon.
- From Wadja they went to Bindeninni which is on Looking Glass Creek. The river here can go completely dry.
- Then they went to Wearwarwa which is a lagoon next to Batten Creek
- Then on to Ijarri which is on Batten Creek.
- They travelled on to Woybi (Hard Lagoon) which is a permanent waterhole on the side of Batten Ck.
- Then on to Yungurri where an outstation is and permanent waterhole.
- From there to Lugulula on Batten Creek. Here the devils turned.
- And on to Goolminyini, otherwise known as Devil Springs. There is an outstation there.
- They went on to Arrinyangu which is a spring called Yinbirri spring by the Whitefellas. It is located this way from Campbell spring.
- Then to Rralmanja which is a lagoon near the 10 mile jump up near frog dreaming. The frog is facing the lagoon – he is heading for the lagoon.
- The devils then travelled to Gunaringinni which is a hill
- Then on to Minjininni which is on the McArthur River at Holden Crossing. The water is permanent here.

- Then they went to Inganda
- Then to Wulingirrinna which is the main old crossing at the Frazer Creek and McArthur River junction.
- They continued on to the Wearyan River across the Fletcher Creek to Gallalargina which is on the Foelsche river
- They travelled downstream to Renburnunga
- Then on to Wonmurri
- Murrigi
- Lamaluma
- Magurrindji
- And stopped at Noorigi which is at the mouth of the Robinson River.

Waterholes on the McArthur River



Eight Mile Waterhole

The men described the following about the McArthur River from Eight Mile waterhole downstream.

- Eight mile waterhole is permanent
- Then Gandinni is the next waterhole
- Then one at old McArthur Station
- Then the river can go dry
- Then at the Glyde and McArthur River junction is Bibibi which is permanent
- Then Warrangurri
- Wananbirri
- Bulagarni which is at the junction of McArthur and Caranbirrini Creek
- Layarnginni a permanent waterhole in the river
- Minjininni
- Doordan
- Gandiyarminni which is at Weldon Crossing
- Inganda
- Wilingirrina
- Wayurwilli which is where a creek joins from the left

- Bijungujgini
- Warralungku, which is at the main road crossing.

The Red Legged Jabiru

The red legged Jabiru stopped at Spring Creek Station. This bird came from the west. It came from Stephen Roberts' country on the Roper River and came across. Minimeer is the name of the jabiru in the Alawa language. Minimeer is on the Hodgson River. See Stephen Roberts story at the end of this indigenous knowledge section.

Other information

Hammer and Yalco Creeks have permanent waterholes but the rest dries up.

At cow lagoon there are pine trees which are a sacred site. One fellow cut them down and he died the next day. The pine tree is a dreaming of the people. The tree was knocked down for nothing. It happened about 5-6 years ago.

Table A9 Indigenous place names and details supplied by Les Hogan and Bruce Joy.

All the following names were transcribed by Ursula Zaar.

Indigenous name	Site	Comment	Easting	Northing	Transcribed/ language
Alawa	Waterhole, permanent	Known as Round Lagoon.	598000 As per 50K map	8209100	Gudanji language
Arrinyangu	Spring	Called Yinbirri by whitefellas. Located towards Cow Lagoon from Campbell Springs.			Gudanji language
Balanjarna	Waterhole	Lagoon near Bulangarni			
Bibibi	Waterhole, Permanent	Glyde and McArthur River junction			Gudanji language
Bijungungini	Waterhole	McArthur River	642600 Location estimated	8219800	
Bindeninni	Waterhole, intermittent	On Looking Glass Creek. This creek can go completely dry.			Gudanji language
Bulagarni	Waterhole	Junction of McArthur River and Carnabirini Creek	629400 Location estimated	8201100	
Doordan	Waterhole	McArthur River			
Gallalargina	Waterhole	On the Foelsche River			Gudanji language
Gandinni	Waterhole	McArthur River			
Gandiyarminni	Waterhole	McArthur River at Weldon Crossing	641000 Location estimated	8216100	
Goolminyini	Waterhole, permanent	Also known as Devil Springs where the outstation is.			Gudanji language
Gunarigini	Hill	The hill marks the path of the mob of devils.	627000 As per 50K map	8214300	Gudanji language
Ijarri	Waterhole, permanent	On Batten Creek. Near the road. There is a spring.			Gudanji language
Inganda	Waterhole	Billabong of the McArthur River	642000 As per 50k map	8218000	Gudanji language
Kalwani	Waterhole	This is Goose Lagoon near			As noted on

Indigenous name	Site	Comment	Easting	Northing	Transcribed/ language
		the McArthur River			50K topo map
Lamaluma		Place which marks the path of the mob of devils.			Gudanji language
Lugulula	Waterhole, permanent	On Batten Creek. There is an outstation there. From here the river goes small and it is a long way to the next permanent waterhole.			Gudanji language
Magurrindji		Place which marks the path of the mob of devils.			Gudanji language
Minjininni	Waterhole, permanent	On McArthur River at Holden Crossing			Gudanji language
Minjininni	Waterhole	McArthur River			
Murrigi		Place which marks the path of the mob of devils.			Gudanji language
Noorigi		At the mouth of the Robinson River. This is where the devils stopped.			Gudanji language
Renburrununga	Waterhole	Downstream from Galalarginna on the Foelsche River			Gudanji language
Rralmanja	Lagoon	Near 10 mile jump up near Frog Dreaming. The frog is facing the lagoon – he is heading for the lagoon			Gudanji language
Wadja	Waterhole, permanent	On Batten Creek. Also known as Cow Lagoon. There is a cave in the vicinity. People camped here.			Gudanji language
Wananbirri	Waterhole	McArthur River			
Walyalunburra		Located at the point of a hill			
Warangurr	Waterhole	McArthur River	629800 As per 50K map	8200000	
Warralungku	Waterhole	McArthur River at the Wollogorang Road crossing			Already noted 50k topo map
Wayurrwilli	Waterhole	McArthur River where a creek joins from the left			
Wearinginni	Waterhole	On Galah Creek?			Gudanji language
Wearwarwa	Lagoon	Next to Batten Creek			Gudanji language
Wonmurri	Waterhole	Near the Foelsche River			Gudanji language
Wowyunnu	Big Hill	Marks the path of the devils from Tanumbirini			Gudanji language
Woybi	Waterhole, permanent	On the side of Batten Creek. Also known as Hard Lagoon			Gudanji language
Wulingirrina	River junction & crossing	Old crossing at the Frazer Creek and McArthur River Junction.			Gudanji language
Wurraginna	River	Place name for the Wearyan River where it is crossed by the Wollogorang Road (hwy)	687800	8211700	
Wurringinni	Creek	Galah Creek.			Gudanji language
Yugurri	Waterhole, permanent	On Batten Creek. An outstation is here.			Gudanji language
	Waterhole, permanent	Eight Mile Waterhole. McArthur River			
	Waterhole, permanent	At old McArthur Station			

Les Hogan Warramurru, Dulcie Mawson, Daphne Mawson, Jimmy Mawson & Katie Baker

In July 2008 Les Hogan, Dulcie Mawson, Jimmy Mawson, Frank Shadforth and Clarry Shadforth travelled with Ursula Zaar to Spring Creek Station to visit some of the water sites. It was a journey in which Les and Dulcie remembered the old days on the station. After the trip Katie Baker and Daphne Mawson helped transcribe and detail the sites Les, Dulcie and Jimmy described. Les is a Garrwa elder and Dulcie is his sister. Daphne is the assistant teacher at Borroloola primary school and teaches indigenous culture in Garrwa. She provided much help in transcribing Garrwa place names.



Left to Right: Les, Jimmy, Frank, Clarey and Dulcie at the old Spring Creek Station, Jininginna.



Dulcie at Marrawarri



Dulcie and Jimmy at Bugajinna



Billidji or Greenhide waterhole



Jininginna waterhole.



These photos were taken on the day of the visit. The waterholes are all located along the reach of the Wearyan River and its tributaries which dry to isolated pools. Already in July there was no flow in this section of the river and water levels were dropping.

The table below details the information provided by this family about the sites.

Marnarungu

Table A10 Indigenous place names and details supplied by Les Hogan and Dulcie and Jimmy Mawson. Indigenous place names are in the Garrwa (Karrwa) language.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Arrawunda	Site	Location where the track crosses Scrubby Creek	643800 Location estimated	8218400	Daphne Mawson
Barmarnanna	Permanent Waterhole	Fishing spot, camping, turtle can be found there.	Located north of Yirrinjirri		Daphne Mawson
Barngarra	Old waterhole	This was once a waterhole on the Wearyan River but now it is covered with sand.	668100 Location estimated	8179200	Daphne Mawson
Barrumbul	Permanent Waterhole	Large permanent waterhole with salt water crocodiles. In 91-92 it went to mud.	636100	8203000	Daphne Mawson
Bijungujini	Waterhole, permanent	Along McArthur River	642600 Location estimated	8219800	Daphne Mawson
Billidji	River waterhole, permanent G9085085	Greenhide Waterhole. Permanent waterhole on the Wearyan River	664500 Visited	8167200	Daphne Mawson
Billiliweena	Intermittent Waterhole	Waterhole on Spring Creek when a kid, now sandy.	664500 Location estimated	8171600	Daphne Mawson
Binmejarri	Permanent Waterhole	This is a big permanent waterhole. Located on tributary to Frazer Creek.	646700 Location estimated	8184700	Daphne Mawson

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Bugajinna	Intermittent Waterhole G9085086	Located on the Wearyan River. It can dry and sand can move over it. Georgies yard was around here.	667163 Visited	8176097	Daphne Mawson
Bullbu (Bulbo)	Permanent waterhole	Approximately 2 km downstream from Margarninjina on Wearyan R	675700 Location estimated	8182200	Daphne Mawson
Bulluguwandja	Permanent waterhole	Located at boundary of Spring Ck Station and Manangoora along the Wearyan River.	Located north of Wargunulli		Daphne Mawson
Buloowangarda	Permanent Waterhole	Honeymoon lagoon. Waterhole on tributary of Scrubby Creek.	645500	8214800	Daphne Mawson
Bunbulyi	Permanent Waterhole	Permanent waterhole on tributary to Scrubby Ck.	651200 Location estimated	8211200	Daphne Mawson
Buyamarla	Permanent waterhole	On the Wearyan River.	Located north of Bulluguwandja		Daphne Mawson
Buyarranna	Waterhole	On the Wearyan River about 1 km south of the highway.	688300 Location estimated	8210800	Daphne Mawson
Darngurrnunja	Permanent Waterhole	Permanent waterhole and campsite on Scrubby Ck.	650400	8205600	Daphne Mawson
Diddireena	Permanent waterhole	Large waterhole on the Wearyan River	689700	8208000	Daphne Mawson
Digarluna	Permanent Waterhole	This waterhole is up in the hills. The water tastes really sweet, fresh and cool.	650800 Location estimated	8183400	Daphne Mawson
Djarmendi	Intermittent spring	Spring Jimmy visited w limestone water. Dries	669500 Location estimated	8159200	Ursula Zaar
Duluwarra	Permanent Waterhole	Permanent waterhole and campsite on Scrubby Creek	650200 Location estimated	8195800	Daphne Mawson
Dulwadjina	Permanent Spring	File spring. located in the upper Foelsche River in escarpment country. Runs for about 1 km.	662500 Location estimated	8111400	Daphne Mawson
Dungirri	Permanent Waterhole	This is a big permanent waterhole. Located on tributary to Frazer Creek.	648500 Location estimated	8189100	Daphne Mawson
Gardarlina	Permanent waterhole	Located at Caroline yard	679500 Caroline Yard located on topo map	8188200	Daphne Mawson
Garrarana	Intermittent waterhole	On Spring Creek.	664000 Location estimated	8171400	Daphne Mawson
Gunarbunjarra	Permanent waterhole and campsite	Located on Scrubby Creek. There are cypress pine trees there.	651100 Location estimated	8190400	Daphne Mawson
Gundijarra	Permanent Waterhole	This is a big permanent waterhole. Located on tributary to Frazer Creek.	646000 Location estimated	8182600	Daphne Mawson
Gunjinman	Waterhole Intermittent	This waterhole is now covered with sand. It used to be a permanent waterhole with steep banks. It is also called One Mile Waterhole.	660200 Location estimated	8169400	Daphne Mawson
Gurrarni	Site on Frazer Creek	Confluence of Frazer Creek and tributary	644000 Location	8200200	Daphne Mawson

Indigenous name	Site	Comment	Easting	Northing	Transcribed
			estimated		
Inganda	Intermittent Bilabong	This was permanent but in recent years it has been filling with sand due to floods.	642000	8218000	Already noted on 50K topo map
Jarwunda	Waterhole	Permanent waterhole on tributary east of Frazer Creek.	648000 Location estimated	8196500	Daphne Mawson
Jillarra	Waterhole	Permanent waterhole on Scrubby Creek	651800 Location estimated	8187400	Daphne Mawson
Jininginna (Jininjinna)	Spring Creek Station	It is a spiritual place, very sacred and many people wont go there. It is the Red leg Jabiru dreaming place. This is the area name for the station.	659700 Location estimated	8168700	Daphne Mawson
Jininginna	waterhole G9085088	Waterhole at Spring Creek Station.	659628 Visited	8168807	visited
Margarnarnjina	Permanent waterhole.	Located along the Wearyan River. This was an old campsite. Get sugabag there	671300 Location estimated	8180500	Daphne Mawson
Marnarungu	Intermittent waterhole G9085087.	Located on tributary to the Wearyan River. There is usually water there but it may dry this year.	669022 visited	8182415	Daphne Mawson
Marrawarri	Permanent Waterhole G9075087	This is a permanent waterhole and was a campsite.	669073 Visited	8204047	Daphne Mawson
Marrawi	Intermittent Swamp	This swamp dries out, long neck turtle	668500 Location estimated	8177500	Daphne Mawson
Mindilarra	Site	On Frazer Creek	642500 Location estimated	8206500	Daphne Mawson
Mundimundurri	Permanent Waterhole	This is a big permanent waterhole. Located on tributary to Frazer Creek.	648500	8192000	Daphne Mawson
Munmundarri	Spring	Also known as Taylor spring. It is at the top of the Foelsche R. Perennial. Runs for 2 km	658700 Location estimated	8129000	Daphne Mawson
Muwarguda	Intermittent waterhole	Intermittent.	661200 Location estimated	8169000	Daphne Mawson
Nudjunga	Site	Where Spring Ck Station track crosses Scrubby Ck	647400 Location estimated	8213200	Daphne Mawson
Nujarlulu	Junction Spring ck and Wearyan River		666900 Location estimated	8172900	Daphne Mawson
Nujarnga	Soak / waterhole	Located along Frazer Creek. It has been effected by sand.	644500 Location estimated	8210400	Daphne Mawson
Wallanju	Cave	Old Willy Shadforth's camp on the upper Foelsche R.	668300 Location estimated	8143200	Daphne Mawson
Wandabalangji	Waterhole on the Wearyan River		667300 Location estimated	8173600	Daphne Mawson
Wargunulli	waterhole		Located north of Warllabarlarra		Ursula Zaar
Warllabarlarra	Lagoons		North of		Daphne

Indigenous name	Site	Comment	Easting	Northing	Transcribed
			Barmarnanna		Mawson
Warralungku	Site	Where the highway crosses the McArthur River at Borroloola.			Already noted on 50K topo map. Yanyula Language.
Wilingirrina	Confluence	Junction of Scrubby Creek and McArthur River.	643500	8218800	Daphne Mawson
Yirrinjirri	Dingo ck	See dingos there. In the vicinity of Wearyan River.	Located north of Gardarlinn a		Daphne Mawson

Les Hogan (warramurru) and Jack (Wangurri)

Table A11 Indigenous place names and details supplied by Les Hogan and Jack

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Budjurri	Permanent waterhole	On tributary to the Wearyan River.	667700	8156200	Ursula Zaar
Djarmendi	Area	On tributary to the Wearyan River.	669500	8159200	Ursula Zaar
	Wallman Swamp	This swamp can dry out.	666000	8152800	Ursula Zaar

Daphne Mawson, Ngingina



Daphne Mawson

Daphne Mawson is a Garrwa woman whose family own Spring Creek Station. She lives in Borroloola and works at the Borroloola primary school and teaches indigenous culture in Garrwa. She remembers her childhood spent at the Station. She relates not only how her family lived off the land and sought out crucial water supplies but also a dreamtime story told to her by her grandmother.

I lived on Spring Creek Station up until the age of 8 or 9, after which I was sent to Alice Springs to St Philips college boarding School. At Spring Creek Station I lived with my extended family which included my grandmother, who was the most important person to me and her two sisters who were also my grandmothers. My grandmother's two sisters had grandchildren who were my playmates, there were about 20-30 kids all up.

Those early years of my life were the happiest years, everyday was like Christmas day. We would get up and go hunting with my grandmothers and we had goats which we would look after during the day because they were our source of meat and milk. When we went hunting, we hunted for berries and goanna and roots of all kinds, but our favourite food was the pandanus nut. We lived at the old spring creek station homestead. When we went hunting we would come back in the evening.

But when dad left droving he would be away for 6 months, so then we would go into the hills because all the men were gone droving and only the women and kids were left. My father was worried that the welfare mob would come and take us away so we went with our grandmothers into the hills. This is when we lived off the bush tucker. We had tea and flour but when that was finished we lived off the land. Kangaroo, emu and sugarbag were our staple food.

In the hills, that is the Bukalara range, we would go to Bull Creek and up to a place called Ngunumunjina waterhole. That was where our permanent camp was. But before we got there my grandmother walked very slowly and we stayed with her whilst our mothers hunted further out looking for bush tucker. With our grandmothers we got very thirsty as we walked over the rocky range and we would start winging and crying for water and grandmother used to stop on a high ridge and point out the blue leaf trees in the distance that marked where the water was. She had a little bit of water in the billycan and we would have a little to survive until we got to the blue leafed trees where there was beautiful, crystal clear, sweet water from a spring; it was a pool that had flowing water. The trees were called Binjirri, the blue leafed tree and they only grow where there is water. There were lilies in the water.

During our journey I remember how my grandmother would come to a place on a rock where she would remove a stone that was covering a pool of water. She would get water out of the hole with the billy can on a long rope. After getting the water she would put the rock back over the hole to protect the water from fouling up from animals. This was an important waterhole for us. There was also another place that was an opening in the rock and Katie used to climb part way down and then throw in the billy can which was tied to a rope and collect the water. She had to hang on to the rock wall with one hand with the rope in the other. This was another important water hole for us. Our main camp was at Ngunumunjina but sometimes we would camp away for a night to hunt for porcupine.

In our culture every waterhole has a story. Every waterhole has a name. This helps pass on knowledge of where there is water. In the old days when we lived a traditional life it was very important to pass on the knowledge on waterholes and if they were permanent and that way we could survive. When I was a kid everything was done as a matter of survival but we enjoyed it. We were away for 6 months living a traditional life. There was one old man with us who used to spear the kangaroo and emu. These were happy times, it was like going away on holidays. My grandmother and mother were not worried for water or food. They knew where to go and find it.

Story about the frog and the Pee Wee

Every night when I was little, my grandmother told me a story about the frog and the Pee Wee. It is a story of how the rivers came to be and not to be greedy. She said that a long, long time ago in the dreamtime there was a Pee Wee and a frog. The Pee Wee was the owner of a coolamon of water. He used to carry it around.

One day the Pee Wee camped under a tree and hid the Coolamon of water. The frog came to the Pee Wee to ask where he got water from. The Pee Wee said go north and the frog went north. In the evening he came back tired and weary and said there was no water there. 'Where did you get the water from' he asked? The Pee Wee replied 'ah I forgot, I got the water from the east'. So the frog went to the east and as he traveled he was getting very tired but he made it back to the Pee Wee. Once again he asked 'where did you get the water from'? The Pee Wee said 'Oh silly me, that's right I got it from the south'. Off he slowly went, he was getting very tired and very thirsty. But the frog still didn't find the water and went back to the Pee Wee. He asked the Pee Wee again, his lips were dry and parched, his voice was croaky 'Where did you get the water from'? The Pee Wee said 'I'm getting old, I keep forgetting, that's right, I got it from the west'. So off went the frog, he was very tired and dehydrated. By this time the Pee Wee was getting tired because he hadn't slept for days as he was guarding his coolamon from the frog. He fell asleep. Poor old frog slowly dragged himself back after not finding any water. He saw the Pee Wee had fallen asleep and grabbed a rock and smashed the coolamon. Water gushed everywhere and that's how the rivers were created. The Pee Wee woke up with a start and found his water gushing everywhere, he ran and grabbed the stick and bashed himself over the head crying for his water. Blood streamed all over his body and that's why today the black marks you see on the Pee Wee are the blood stains for when he cried for his water. Today when you hear the first storms you hear the frogs in the lagoons, that's the frogs teasing the greedy Pee Wee who wouldn't share his water.

This was the story my grandmother told to teach us to share everything, especially water which is needed for everyone's survival.

Table A12 Indigenous place names and details supplied by Daphne Mawson

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Ngunumunjina	Spring / Waterhole, permanent	Main camp area in the Bukalara Range			Daphne Mawson
Binjirri		The blue leafed tree which only grows where there is water. This could be groundwater dependent vegetation.			Daphne Mawson

Stephen Johnston



Stephen Johnston

Stephen is a Traditional Owner of Vanderlin Island and is a Yanyuwa elder. Stephen was born on Vanderlin Island and has lived on the island all his life. Stephen offered key information about water resources on the island. This is documented below.

Arkarunda

This site is located on the eastern side of the island on the coast. At Arkarunda a spring discharges from limestone which is in outcrop there. In the wet season at high tide you can dive under the sea and have a drink of fresh water out of the hole in the limestone. The hole is about 6 inches in diameter. At low tide you can see the water pouring out of the hole. The spring runs till about March or April.

Well at Clarkson Point

This well used to supply Clarkson Point community but it has become too brackish to drink. It is located in a



creek bed which is currently dry. The well is about 12 foot deep and situated in laterite. Stephen's dad dug the well many years ago. An older traditional well was located a little further downstream. Last year there was a king tide and a westerly wind which forced sea water up the creek causing it to become brackish. The well supplied enough water for the community but when there are visitors it is unable to keep up supply.

Stephen Johnston, Ian Mc Masters & Ben Senge at the well at Clarkson Point.

Wilundu



Wilundu



Smaller waterhole upstream of Wilundu

This is a permanent waterhole which supplies water to Clarkson Point. We also call it geese lagoon. It is part of the wind dreaming. The eye of the wind dreaming is a little further downstream from here where there is a bigger waterhole and a tunnel that goes out to sea. The old people reckon that the crocodile used to swim through the tunnel and come out in the swamp here. When the creek is flowing the water would flow through the tunnel and over the top of it. All the springs further upstream come alive in the wet and start running. They continue to flow until July or August. Further upstream there are waterholes like this one but not as deep.

Table A13 Indigenous place names and details supplied by Stephen Johnston

Indigenous names are in the Yanyuwa language.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Arkarunda	Spring	Freshwater spring within tidal zone. Vanderlin Island	723000 Location estimated	8263800	Ursula Zaar
Wilundu	Permanent waterhole G9075066	Permanent waterhole on Vanderlin Island This is the water supply to Clarkson Point.	719486 Visited	8250075	Ursula Zaar
	Permanent waterhole	Vanderlin Island	713300 Location estimated	8264600	
	Semi permanent waterhole	This waterhole can get brackish. On Vanderlin Island	723700 Location estimated	8250700	
	Permanent waterhole	Vanderlin Island	717200 Location estimated	8256300	
	Well at Clarkson Point G9075067	Located in a wet season creek locally known as Garden creek. On Vanderlin Island	718931 Visited	8248982	

Wailo Mc Kinnon, Wedamara



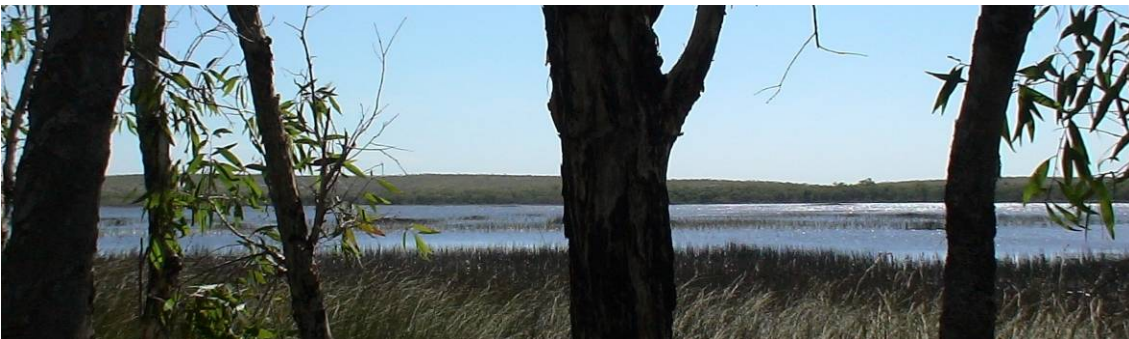
Wailo Mc Kinnon

Wailo is a Traditional owner of Vanderlin Island and North Island. He is an elder of the Yanyuwa clan.

When seeking out information on Vanderlin Island people also refer to Wailo for cultural knowledge. He was happy to discuss water sites on the island and provided many place names. Due to health reasons he no longer lives on the island permanently. The following was transcribed from an interview with Wailo.

I was born on North Island and was brought up living on the islands. We lived a traditional life eating bushtucker like turtle and dugong. Stephen Johnston was brought up the same way. There was no tea. We would milt the nanny goats for milk. We used to make dug out canoes with the special paperbark trees from the McArthur River and then paddle down the river and across to the islands. We speared the dugong and the rope came from a special wattle tree on the island. The men made the rope. We knew all the water holes and where to find water at any time of year.

Walala (Lake Eames)



This is a permanent lake. It was created by the rainbow serpent. The serpent laid in the middle of the lake. If a stranger jumps into the lake it will cause a lot of rain. Walala is a ceremony place. The southern part of the lake is called Milgunda. Permission is required to visit this lake.

Narwurlunda

This is a permanent flowing spring on Vanderlin Island. It discharges right at the beach. Because it is a sacred site the location will not be divulged. This is to protect the integrity of the site.

Mandatharumpa

This waterhole was created by the man who was the dugong killer. He came from Mornington Island on a canoe. When the surface water level drops you can always dig a well for water. Water is always there.

West Island

On this island you can dig for water in the sand along the coast. When the tide comes in the well will be salty and when the tide goes out the well will be fresh. You need to dig the well about 1.2 metres deep. You can dig anywhere along the sand.

Table A14 Indigenous place names and details supplied by Stephen Johnston

Indigenous names are in the Yanyuwa language.

These names were provided by Wailo and Stephen Johnston.

Indigenous name	Site	Comment	Easting	Northing	Transcribed
Wabuwa	Permanent Lagoon	Lagoon or creek with permanent water which discharges to the coast. A sand bar blocks the mouth in the dry but the water breaks through in the wet. There is an old cattle yard there. This was the water supply for the cattle. It is on Vanderlin Island.	723000 Location estimated	8262500	Ursula Zaar
Ringbanda	Well	Along the beach here you can dig a small well for freshwater. The freshwater is always there. Vanderlin Island.	717800 Location estimated	8270800	Ursula Zaar
Walala	Permanent lake G9075064	The lake was created by the rainbow serpent. English name is Lake Eames. Located on Vanderlin Island.	717500 As located on topo map	8266000	Ursula Zaar
Gurlupurlamba	Permanent waterhole	Permanent pool in the creek which is the outlet channel to Walala on Vanderlin Is.	717700 Location estimated	8268500	Ursula Zaar
Wamarla	Permanent waterhole	Permanent pool in the creek which is the outlet channel to Walala. Vanderlin Island	717700 Location estimated	8267700	Ursula Zaar
Milgunda	Area	Southern area of Lake Eames. Vanderlin Island.	717500 Location estimated	8265000	Ursula Zaar
Wanguwidji	Permanent waterhole.	Permanent waterhole on Vanderlin Island.	717050 Location estimated	8262300	Ursula Zaar
Mandatharumpa	Waterhole/ well G9075065	Permanent waterhole/well in a swamp. Water supply to Muluwa (Base Bay) outstation. Vanderlin Island	714570 Visited	8271587	Ursula Zaar
Babangi	Well	A well in the sand is used as a water supply here. Vanderlin Island	711900 Location estimated	8258300	Ursula Zaar
Wilalamba	Permanent waterhole	This is a waterhole or rockpool on North Island which is	N/A	N/A	Ursula Zaar

Indigenous name	Site	Comment	Easting	Northing	Transcribed
		always running. It is a sacred site.			
Wurlubirra	Island name	This is the name for the whole of North Island	701000	8276000	Ursula Zaar
Ulbara	Creek	This is the only permanently flowing creek on Vanderlin Island.	714300 Location estimated	8254500	Ursula Zaar
Warraleera	Island name	Name of White Islet.	684000	8273400	Ursula Zaar
Limiyimiyila	Island name	Name of Black Islet	678500	8274500	As noted on 50K topo map
	West Island	You can dig a well for water in sand along the coast			
Narwurlunda	Spring	Permanent flowing spring on Vanderlin Island	N/A	N/A	Ursula Zaar
Marjingangya	Permanent waterhole	Permanent waterhole on West Island.	661500	8271100	Ursula Zaar



Photos left to right:

Wild horses, cattle, donkeys, goats and wallabies inhabit the island. High sand dunes are a feature of the island.

One of the old buildings at Clarkson Point.

One quad bike with trailer provides access around Clarkson Point.

Billy Miller, Bunmega



Billy Miller

Billy is a Traditional Owner of Kangaroo Island. Following is an outline of what he had to say together with Wailo about the region.

The Traditional Owners to consult for Vanderlin and North Islands are Wailo Mc Kinnon and Stephen Johnston. They are Nimmirringi which means Traditional Owner. The guardian or Djunggayi however is me, Billy, along with other men like Graham Friday. Nimmirringi and Djunggayi are determined by birth through kinship.

Ceremony is an important part of looking after country. On North Island is the eagle dreaming and there is a big ceremony conducted in relation to this – the white chested sea eagle – Argangangar.

When I was brought up I was taught culture right away. Not like the young people today. We try to teach the young people ceremony but they don't understand. Ceremony was part of our duty to the land, to keep the country strong.

Ronnie Raggett



Ronnie Raggett

When asking about water on McArthur River Station we were referred to Ronnie Raggett. Ronnie accompanied project officers on a number of field trips to visit water sites. He has a long history of working on cattle stations in the region. He has a wealth of knowledge and provided excellent and good humoured guidance to water sites.

Wee-ak



Ronnie Raggett and Lewis Raggett at Wee-ak

Wee-ak is a spring which discharges from the side of the bank. From Borroloola it was a full day trip to get to Wee-ak, which is near the headwaters of the McArthur River, but it was well worth the journey. The spring was forcibly discharging about 8L/s from a cavity in the side of the bank. Ronnie explained that there is a dreamtime story associated with the spring but that they keep the story within their family.

Table A15 Indigenous place names and details supplied by Ronnie Raggett

Indigenous name	Site	Comment	Easting	Northing	Transcribed
	River waterhole, permanent	Bullock Hole, permanent waterhole on Leila Creek	557400 Location estimated	8169500	
	Spring/waterhole permanent	Bullock spring. Permanent pool at escarpment on Abner range	602900 Location estimated	8146900	
	Spring/waterhole permanent	Cockatoo spring. There is a permanent waterhole there.	545500 As located on topo map	8157800	
	River waterhole, permanent G9075083	Crocodile Hole. Permanent waterhole on Leila Creek	554089 Site visited	8165447	
	Waterhole, permanent G9075084	Paddy Spring. Permanent spring / waterhole	573885 Site visited	8154027	
	Spring G9075059	Windy Gully Spring. Permanent spring	605333 Site visited	8130607	
Dunganminnie	Spring	Permanent waterhole at the side of the Abner Range	583200 Location estimated	8140200	Already noted on 50K topo map
Gayarranni	River waterhole, permanent G9075002	Bessie Spring. Large permanent waterhole	590685 Visited	8156967	Ursula Zaar
Garranjinni	Waterhole, permanent	Paradise Pool			
Gulanabu	Spring G9075063	Beetle Spring. Located at the Abner Range escarpment.	605800 As located on topo map	8143700	Ursula Zaar
Jaykba	Spring G9075061	Permanent spring	621281 Site visited	8129155	Ursula Zaar
Meermulla	Waterhole G9075062	This waterhole is permanent	609700 As located on topo map	8144300	Ursula Zaar
Nunmunbudja	River waterhole, permanent	Catfish Hole	631800 Location estimated	8150300	Ursula Zaar
Wee-ak	Spring area G9075081	The McArthur river flows permanently at this site. There are permanent springs located here.	555883 Site visited	8125175	Ursula Zaar



Paddy Spring



Ronnie and Ursula at Windy Gully Spring discharge creek

Stephen Roberts

Information on Stephen Roberts is provided in the Limmen Bight River Region indigenous knowledge section. This story has been noted here because it is the same story as told by Les Hogan, although Stephen is from a different language group.

The Red legged Jabiru

The Red legged Jabiru started from Marlringa, a swamp near Old Newcastle Waters near Elliot and then went to Minimere. From Minimere it travelled to different places but its journey ended at Spring Creek Station. If you bring that helicopter I can take you to these places.

APPENDIX B: DEPARTMENTAL WATER RESOURCES REPORTS

These reports are available from NRETAS. They are listed in order of area. Scanned reports are available in digital format.

SW – Surface Water

GW - Groundwater

Limmen Bight River Region

Scan No:	NRD No:	Title	Type	Area	Author
WRD88006	06/88D	Baseflow Water Quality Surveys in Rivers in the N.T. Vol.8. Limmen Bight and McArthur River	SW	Limmen Bight & McArthur River	

McArthur River Region

Scan No:	NRD No:	Title	Type	Area	Author
WRD74028	28/74D	Investigation of Borroloola Flooding	SW	Borroloola	Huq, M. N
WRD83027	27/83D	Borroloola Groundwater Resource Investigation 1982	GW	Borroloola	
WRD87014	14/87D	Borroloola Floodplain Mapping	SW	Borroloola	
WRD95059	59/95D	Borroloola Groundwater Investigations	GW	Borroloola	
WRD87039	39/87D	Bore completion - Boomerang Lagoon	GW	Boomerang Lagoon	
WRD88006	06/88D	Baseflow Water Quality Surveys in Rivers in the N.T. Vol.8. Limmen Bight and McArthur River	SW	Limmen Bight & McArthur River	
WRD97030	30/97D	McArthur River Water Quality Surveys of 1992 and 1993	SW	McArthur River	Cumberland, D
WRD89009	09/89D	Groundwater Assessment of the McArthur River Mine Area	GW	McArthur River Mine	
WRD88076	76/88D	Bore completion - Numultja Outstation	GW	Numultja, Maria Lagoon	
WRD90092	92/90D	Bore completion - South West Outstation	GW	South West Island	
WRD93055	55/93D	Bore Completion Report, Tawallah Outstation	GW	Tawallah	
WRD96043	43/96D	Bore Completion Report, NT Por.4630 Tawallah Pastoral Lease	GW	Tawallah	
WRD88049	49/88D	Bore Completion Report, Wada Wadalla Outstation.	GW	Wada Wadalla	
WRD84048	48/84D	Bore completion - Bing Bong	GW	Bing Bong	

APPENDIX C: SUMMARY OF BORE INFORMATION

Monitoring bores

There are no bores in the Limmen Bight River Region which have been or are currently monitored by NRETAS.

The bores which have been monitored in the McArthur River Region are listed below. There are no bores in this region which are currently monitored.

Borroloola – previous monitoring

Bore	Zone 53 Easting	Northing	Commence	Cease	No. Records
RN004397	639725	8223767	29/08/1985	15/11/1999	52
RN009079	639725	8224346	20/03/1986	21/08/1987	9
RN009911	639925	8223967	29/08/1985	14/05/1993	48
RN021350	639025	8224367	29/08/1985	20/09/1999	54
RN021351	639425	8224067	19/12/1985	20/09/1999	49
RN021355	639925	8222567	29/08/1985	20/09/1999	56
RN021356	638925	8224367	29/08/1985	20/09/1999	56
RN021357	638925	8224467	29/08/1990	20/09/1999	247
RN021358	639025	8224467	29/08/1990	20/09/1999	241
RN021359	638925	8224267	29/08/1990	20/09/1999	251
RN024550	638525	8226117	19/08/1993	20/09/1999	9
RN024551	638525	8226117	19/03/1987	20/09/1999	46
RN024552	637165	8222367	19/03/1987	20/09/1999	45
RN024553	638565	8221167	19/03/1987	20/09/1999	48

Summary data on bores

The following bore summary data is provided in alphabetical order of land parcel name. Limmen Bight River Region is listed first followed by McArthur River Region.

LIMMEN BIGHT RIVER REGION

Bauhinia Downs

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN022770	AMOCO W.B. NO. 1 BROADMERE STN.	53	534545	8194766	2/05/1984	274	none	0	0
RN022771	AMOCO W.B. NO. 2 BROADMERE STN.	53	536525	8194746	7/05/1984	122	none	0	0

Broadmere

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN008025	SITE A ADV.68/72 BROADMERE STN	53	528226	8177596	16/10/1972	106.8	none	0	0
RN008486	30 MILE TANUMBIRINI STN	53	513726	8247416	1974	NA	NA	NA	NA
RN021127	W.M.C. E.L. 2715 LANSEN CREEK	53	504526	8211166	1981	40+	NA	20	10
RN021128	W.M.C. E.L. 2715 LANSEN CREEK	53	510476	8183766	1981	30+	NA	26	0.5
RN021129	W.M.C. E.L. 3123 CROOKED CREEK	53	501606	8217386	1981	20	NA	3	8
RN031241	CARWOOLA PASTORAL Co PTY LTD (BROADMERE)	53	504568	8211142	10/10/2007	48	48	18	5
RN031242	CARWOOLA PASTORAL Co PTY LTD (BROADMERE)	53	501087	8199577	11/10/2007	177	nil	dry	dry
RN035539	CARWOOLA PASTORAL Co PTY LTD (BROADMERE)	53	502931	8192222	3/09/2007	133	133	8	15

Limmen National Park (Billengarah)

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN007929	SITE E ADV.23/72 BILLENGARAH STN	53	573025	8184976	11/07/1972	91.5	none	45.75	0.9
RN007930	SITE I ADV.24/72 BILLENGARAH STN	53	577025	8199466	6/07/1972	91.5	18.3	10.68	0.6
RN007931	SITE C ADV.22/72 BILLENGARAH STN	53	561325	8182566	9/07/1972	91.5	none	24.4	0.1

Limmen National Park (Nathan River)

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN032160	T & W SITE A NATHAN RIVER (ABANDONED)	53	545625	8277966	8/06/1999	70	70	0	0
RN032161	T & W SITE B NATHAN RIVER STATION	53	546075	8278066	9/06/1999	63	5.8	NA	0.4

Lorella

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN021155	WESTERN MINING CO. ROSIE CREEK E.L. 1710	53	579535	8264036	1981	36+	NA	24	10
RN021156	WESTERN MINING CO. ROSIE CREEK E.L. 1710	53	580335	8277716	1981	30+	NA	22.5	10
RN021157	WESTERN MINING CO. ROSIE CREEK E.L. 1710	53	578435	8264066	1981	30+	NA	20	12
RN021803	WMP 5 LORELLA SPRINGS STN	53	604475	8280416	31/08/1982	101	52	NA	2.5
RN021804	WMP 6 LORELLA SPRINGS STN	53	605525	8280366	6/09/1982	98	3	NA	NA
RN021805	WMP 7 LORELLA SPRINGS STN	53	593325	8280366	8/09/1982	98	3	FLOWING	<.6
RN021806	WMP 8 LORELLA SPRINGS STN	53	592125	8280366	10/09/1982	95.2	3	NA	<.6
RN021807	WMP 9 LORELLA SPRINGS STN	53	601225	8277666	10/09/1982	82	3	NA	6.3
RN021808	WMP 10 LORELLA SPRINGS STN	53	602525	8277666	13/09/1982	100	52	NA	2.5
RN021809	WMP 11 LORELLA SPRINGS STN	53	610572	8267827	17/09/1982	62	none	NA	NA
RN021810	WMP 12 LORELLA SPRINGS STN	53	609084	8267834	18/09/1982	86	none	NA	NA
RN021811	WMP 13 LORELLA SPRINGS STN	53	6080293	8265382	20/09/1982	70	none	NA	NA
RN021812	WMP 14 LORELLA SPRINGS STN	53	607268	8261698	21/09/1982	74	none	NA	NA
RN021813	WMP 15 LORELLA SPRINGS STN	53	606523	8261701	22/09/1982	100	none	NA	NA
RN028231	M.I.M. EXPLORATION LORELLA SPRINGS	53	604691	8274655	29/07/1993	54	54	18	1.4
RN028232	GEOPEKO STOCK BORE LORELLA STATION	53	608108	8288026	28/08/1993	54	54	18	3
RN028269	M.I.M. LB 8 LORELLA SPRINGS	53	595987	8276365	9/09/1992	37	37	9	3
RN028293	M.I.M.LB 7 LORELLA SPRINGS	53	605823	8276300	17/08/1992	55	55	15	2
RN029531	LANDMARK DEVELOPMENTS LORELLA SPRINGS STN. 1/94	53	564325	82594663	28/09/1994	72	5.5	25	10

Lorella

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN029532	LANDMARK DEVELOPMENTS LORELLA SPRINGS STN. 2/94	53	563325	8253966	29/09/1994	96	5.5	28	6
RN029533	LANDMARK DEVELOPMENTS LORELLA SPRINGS STN. 3/94	53	563825	8256166	30/09/1994	96	5.5	26	7.5
RN036724	Sandfire Exploration	53	572465	8291049	24/09/2008	60	Nil	NA	NA

NT Portion 2432

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN028429	BONE LAGOON BING BONG STN.	53	623100	8287513	7/08/1994	84	84	2	4
RN028430	NORTH EXPLORATION BORE 2/93 BONE LAGOON	53	622750	8280134	17/08/1994	60	60	2.5	3
RN022802	BONE LAGOON BING BONG STN	53	635025	8259267	6/06/1984	54	54	8	10
RN022538	BHP MA 14 BING BONG STN	53	633405	8257107	11/10/1985	48	48	10.5	0.88
RN022537	BHP MA 13 BING BONG STN	53	629015	8248827	12/10/1983	30	30	9	3.78

Tanumbirini

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN005782	CCH TANUMBIRINI STN	53	438240	8177397	21/05/1967	92	nil	NA	0
RN005783	NO CC1 TANUMBIRINI STN	53	452588	8177691	24/05/1967	134.4	104.9	118.3	1.25 pumped
RN005864	NO CCJ TANUMBIRINI STN	53	470913	8169467	6/08/1967	91.4	NA	NA	NA
RN006067	CARPENTARIA HIGHWAY ROAD BORE	53	444902	8176646	10/12/1967	138.6	138.6	128	1.9 pumped
RN006644	JAC TANUMBIRINI STN	53	465453	8174155	19/07/1969	65.5	nil	20	0.1
RN006645	JAC ALTERNATIVE TANUMBIRINI STN	53	469369	8171393	25/07/1969	103.6	60.9	9.1	3
RN006822	MT BROWN TANUMBIRINI STN	53	459748	8184510	16/08/1969	26.8	nil	NA	NA
RN007656	NO 5 TANUMBIRINI STN	53	462177	8195373	6/11/1971	97.5	97.5	82.3	1
RN007657	NO 8 TANUMBIRINI STN	53	476613	8194936	4/11/1970	85.3	85.3	77.7	1
RN007658	A=71/49 NO 3 TANUMBIRINI STN	53	470769	8177327	11/06/1971	94.4	90	79.2	1.1
RN007659	BORE NO. 2 TANUMBIRINI STN	53	470936	8196267	13/06/1971	85.3	80.8	64	0.8
RN007660	A=71/50 NO 4 TANUMBIRINI STN	53	455324	8195498	15/06/1971	76.2	71.6	54.9	1.1
RN007925	A=72/35 NO 10 TANUMBIRINI STN	53	459147	8211106	3/07/1972	53.3	45.7	30.5	1.26
RN007926	A=72/34 NO 9 TANUMBIRINI STN	53	469073	8185377	3/07/1972	91.4	91.4	61	1
RN008101	NO 6 TANUMBIRINI STN	53	468890	8185378	8/11/1970	94.5	72	NA	0.7
RN008102	NO 7 TANUMBIRINI STN	53	464023	8180650	NA	137.1	137.1	NA	1.9
RN008453	NO 13 SITE A11 TANUMBIRINI STN	53	477957	8170985	19/11/1973	64	nil	NA	NA
RN008481	A=73/12 NO 11 TANUMBIRINI STN	53	478042	8188166	7/10/1974	117	117	84	1

Tanumbirini

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN008485	A=74/21 TANUMBIRINI STN	53	478185	8180032	13/10/1974	74	74	45	0.5
RN021325	NO 10 REPLACEMENT TANUMBIRINI STN	53	454426	8203367	8/11/1981	91	78	56	3
RN025291	A=38/86 TANUMBIRINI STN	53	455539	8183160	25/08/1987	150	150	103	1
RN028316	ESTATE OF THE LATE R. BEEBE TANUMBIRINI	53	463841	8180638	26/06/1993	168	168	118.7	4
RN028317	PACIFIC OIL & GAS 5/93 TANUMBIRINI	53	447809	8203688	28/06/1993	150	147.5	57.9	3
RN029025	NT. TRANSPORT & WORKS ROADBORE CARP. H/WAY 140KM	53	460866	8177397	23/11/1993	144	137	125	2.5, 10 pump
RN029026	NT. TRANSPORT & WORKS ROADBORE CARP. H/WAY 122KM	53	444902	8176646	28/11/1993	142	139.2	128	2.5, 10 pump
RN029027	REPLACEMENT FOR RN 7659 15KM N. OF TANUMBIRINI HMSTD.	53	469226	8194827	1/12/1993	98	84	65	2.5
RN029302	PAWA TANUMBIRINI NO.1 EARTH. TANUMBIRINI STN	53	470106	8169557	22/06/1994	138	132	91	0.5
RN029303	TANUMBIRINI NO.2 EARTH TANUMBIRINI STN	53	470326	8169667	26/06/1994	122.5	122.5	NA	0
RN029697	NO 1/96	53	472126	8208967	7/07/1996	60	60	23.4	2.5
RN030323	NO 1/95	53	472126	8208967	27/10/1995	41	39.5	24.6	3
RN030324	NO 2/95	53	471126	8215767	28/10/1995	78	nil	NA	0
RN030325	H. & J. SCHIMMEL 95/3 STOCK BORE TANUMBIRINI STATION	53	465426	8185067	3/11/1995	101	95	88.6	0.8
RN031244	Judy's	53	469387	8165787	7/11/2007	159	158	124	1.5
RN031245	Wendy's	53	453860	8168289	12/11/2007	144	143	115	2
RN031246	No Water	53	494731	8186797	23/11/2007	129	nil	NA	0
RN031247	Bullwaddy	53	437769	8179328	023/12/2007	182	182	133	2
RN032231	NO 8 BORE 1/99	53	474326	8195167	28/09/1999	54	47.5	27	5

Tanumbirini

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN033129	TANUMBIRINI STATION	53	489071	8193936	16/08/2001	120	6	NA	0
RN033240	TANUMBIRINI STATION	53	493195	8199675	15/08/2001	40.5	40.5	11.4	3
RN033608	H & M TOWNSEND	53	462423	8180573	22/10/2002	156	156	120	5
RN033609	H & M TOWNSEND	53	462395	8210822	23/10/2002	48	48	28	3
RN033670	H & M TOWNSEND	53	468773	8204108	25/10/2002	60	60	36.4	3
RN033671	H & M TOWNSEND	53	460859	8188364	25/10/2002	114	114	75.4	3
RN033672	H & M TOWNSEND	53	489673	8191707	27/10/2002	100	100	NA	0.6
RN034174	TOWNSEND (TANUMBIRINI STATION)	53	471367	8213422	7/08/2004	65	65	23.5	2.5
RN034477	TOWNSEND (TANUMBIRINI STATION)	53	439617	8186737	4/05/2005	145	145	114.5	5
RN034478	TOWNSEND (TANUMBIRINI STATION)	53	438057	8198516	7/05/2005	126	126	94	3

MACARTHUR RIVER REGION

Budganga

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN035924	D. KALINIC (WEARYAN RIVER)	53	689236	8210424	12/11/2007	61.2	61.2	9.85	5

Cape Crawford (NT1212)

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN008270	HEARTBREAK HOTEL (3 WAYS) BALBARINI	53	577435	8155457	21/11/1973	70	70	NA	1.9
RN022539	CAPE CRAWFORD ROADHOUSE BALBARINI	53	577405	8155467	14/11/1983	120	103	48	0.8
RN026143	WATSON D HEARTBREAK HOTEL	53	577395	8155217	24/02/1989	123.5	117	22	2

Centre Island

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN021268	WATER RESOURCES 1/80 CENTRE ISLAND	53	688324	8267966	25/06/1980	15.4	none	NA	NA
RN021269	WATER RESOURCES 2/80 CENTRE ISLAND	53	688424	8262826	26/06/1980	17.6	none	NA	NA
RN021270	WATER RESOURCES 3/80 CENTRE ISLAND	53	687924	8266366	27/06/1980	17.5	none	NA	NA
RN021271	WATER RESOURCES 4/80 CENTRE ISLAND	53	687924	8266166	30/06/1980	17.5	none	NA	NA
RN021272	BUCHANAN BAY = CENTRE ISLAND 5/80	53	6876248	8265766	1/07/1980	17.5	none	NA	NA
RN021273	WATER RESOURCES 6/80 CENTRE ISLAND	53	687224	8266266	2/07/1980	15.6	none	NA	NA
RN021274	WATER RESOURCES 7/80 CENTRE ISLAND	53	687524	8266166	3/07/1980	17	none	NA	NA
RN021275	WATER RESOURCES 8/80 CENTRE ISLAND	53	687524	8266166	4/07/1980	6.5	none	NA	NA
RN021276	WATER RESOURCES 9/80 CENTRE ISLAND	53	687524	8266166	4/07/1980	10.2	none	NA	NA
RN021277	SPEAR POINT 10/80 CENTRE ISLAND (CAMP BEACH)	53	688024	8269066	8/07/1980	4.1	4.1	NA	NA

Leila Creek

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN026144	HEADS I LEILA CREEK STN	53	573625	8159907	26/02/1989	31	25	8	4
RN026475	A=90/63EX LEILA CREEK	53	574725	8167966	17/05/1990	33	29	17	1.2
RN034475	MORA AND SCHILLING (LEILIA CREEK STATION)	53	576628	8157608	21/04/2005	33	33	13	10
RN034476	MORA AND SCHILLING (LEILIA CREEK STATION)	53	576890	8163568	22/04/2005	45	45	11.6	0.7
RN034807	MORA & SCHILLING (LEILA CREEK STATION)	53	574354	8172180	18/09/2005	33	33	13	0.9

McArthur River

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN006577	SITE B MCARTHUR RIVER	53	616915	8189916	27/06/1969	38.1	38.1	14.32	6.06
RN006578	SITE C MCARTHUR RIVER STN	53	593825	8157167	30/06/1969	38.1	38.1	14.37	3.03
RN006585	B.F.D. 3 DILLINGHAM CONST. MCARTHUR RIVER	53	599575	8166397	6/07/1969	67.1	67.71	18.3	1.89
RN007803	NO.1 ADV.120/70 MCARTHUR RIVER	53	602125	8160067	19/10/1970	73.2	73.81	NA	12.62
RN007804	NO. 2 ADV.119/70 MCARTHUR RIVER	53	607535	8159667	22/10/1970	92.9	none	NA	0.15
RN007805	NO.3 ADV.118/70 MCARTHUR RIVER	53	613125	8171167	23/10/1970	106.7	106.37	NA	NA
RN009852	BLACKJACK LANDING BING BONG STN	53	662825	8240016	20/08/1979	27	NA	9	0
RN009905	A=33/79 BING BONG STN	53	643625	8238466	22/08/1979	28	28.5	NA	NA
RN009906	A=34/79 BING BONG STN	53	648625	8240666	23/08/1979	30	28	6	3.785
RN009907	A=35/79 BING BONG STN	53	653625	8243466	25/08/1979	90	none	NA	NA
RN009908	BLACKJACK WEST BING BONG STN	53	660325	8241466	28/08/1979	14	none	8	0.126
RN009909	CRAWFORD YARD ADV.38/79 MCARTHUR RIVER STN	53	582225	8159267	18/08/1979	45	45.5	10	3.154
RN009910	KILGOUR REPLACEMENT MCARTHUR RIVER STN.	53	602125	8160067	19/08/1979	58	58.5	21	1.767
RN021158	W.M.C. E.L. 1710 ROSIE CREEK	53	590825	8221666	1981	30	NA	3	20
RN022536	BHP MA 12 BING BONG STN	53	630572	8240739	8/10/1983	60	60	15	8
RN022866	ADV. 20/84 MCARTHUR RIVER	53	595125	8173766	7/06/1984	51	51	20	1.893
RN024054	COLINTA HOLDINGS A=67/85 BING BONG STN	53	647125	8256166	27/10/1985	46	none	0	0
RN024407	COLINTA HOLDINGS A=118/85 BING BONG STN	53	648225	8258966	29/10/1985	56	none	0	0
RN025711	A=88/40 BING BONG	53	645905	8268366	15/06/1988	58	NA	8	3

McArthur River

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN025712	A=88/38 BING BONG	53	645425	8258366	15/06/1988	90	NA	0	0
RN025713	A=88/39 FEDERATION BORE BING BONG	53	644425	8253266	16/06/1988	49	49	12	1.2
RN026473	A=90/59 MCARTHUR RIVER	53	617125	8185666	15/05/1990	40.5	33.5	18	1.5
RN026474	A=90/60 MCARTHUR RIVER	53	609975	8139267	16/05/1990	46.5	46.5	11	2
RN026735	MIMETS O 18/50 MCARTHUR RIVER	53	618225	8182466	4/09/1989	434.7	434.7	14.6	1.9
RN026736	MIMETS L 18/00 MCARTHUR RIVER	53	617975	8182466	5/09/1989	317.7	317.7	0	1.9
RN026737	MIMETS J 16/00 MCARTHUR RIVER	53	617775	8182266	10/09/1989	251.9	NA	10.4	2.5
RN026738	MIMETS M 21/50 MCARTHUR RIVER	53	618025	8182766	1/09/1989	NA	NA	2.02	NA
RN026739	MIMETS O 17/50 MCARTHUR RIVER	53	618185	8182366	28/08/1989	422.5	NA	14.5	1.5
RN026770	MIMETS N 17/50 MCARTHUR RIVER	53	618085	8182366	12/09/1989	152	NA	NA	NA
RN026771	MIMETS L 19/50 MCARTHUR RIVER	53	617925	8182566	25/08/1989	319.6	225	9.3	2.3
RN026772	MIMETS I 17/70 W MCARTHUR RIVER	53	617695	8182366	1/08/1989	NA	NA	NA	NA
RN026773	MIMETS K 27/40 MCARTHUR RIVER	53	617815	8183366	1/08/1989	NA	NA	NA	NA
RN026774	MIMETS L 21/50 MCARTHUR RIVER	53	617925	8182766	1/08/1989	NA	NA	NA	NA
RN026775	M.I.M. BORE MCARTHUR RIVER MINE	53	615775	8180716	1/08/1989	NA	NA	NA	NA
RN027094	AMELIA BASIN BORE NO.3 MCARTHUR RIVER	53	622375	8162267	9/06/1990	37	37	NA	NA
RN027959	MIMETS-HWO3/50R MCARTHUR RIVER	53	614925	8181266	12/11/1991	54	54	13.7	6
RN028471	TAWALLAH 1/92 TAWALLAH BORROLOOLA	53	607675	8207266	7/12/1992	105.3	NA	NA	NA
RN028472	TAWALLAH 2/92 TAWALLAH BORROLOOLA	53	607425	8207066	9/12/1992	39.4	39.4	0	5.5
RN028473	TAWALLAH 3/92 TAWALLAH BORROLOOLA	53	607424	8207056	10/12/1992	39.4	39.4	0	7.8

McArthur River

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN028678	BATTEN PT. FISHING CLUB McARTHUR RIVER	53	649925	8240866	17/08/1993	30.7	NA	NA	0.2
RN029021	N.T. TRANSPORT & WORKS CARPENTARIA H/W.McARTHUR R STN	53	603875	8167967	16/11/1993	100	63	17.5	2
RN029304	McARTHUR RIVER MINE NO.1 (EARTHING)	53	614735	8181866	2/07/1994	49.5	49.5	NA	NA
RN029522	NO 1/94	53	642525	8260766	8/09/1994	30	NA	NA	NA
RN030010	McARTHUR RIVER MINE P.W. 10	53	618125	8183666	2/06/1995	43	39.5	0	12
RN030352	ABORIGINAL LAND TAWALLAH PASTORAL LEASE	53	601626	8208098	15/11/1995	31	22.5	10.3	8
RN030353	ABORIGINAL LAND TAWALLAH PASTORAL LEASE	53	589119	8201452	16/11/1995	31	24.2	12.5	5
RN033257		53	657024	8241550	3/11/2001	24	0	11.2	1
RN033258		53	653464	8241580	4/11/2001	42	41	4.7	10
RN034253	M.R.M. XTRATA (McARTHUR RIVER MINE)	53	617230	8181669	10/11/2004	31.5	31.5	11	4.5
RN034256	M\044R\044M\044 XTRATA (McARTHUR RIVER MINE)	53	616463	8180976	17/11/2004	18	18	10	0.5
RN034257	M.R.M. XTRATA (McARTHUR RIVER MINE)	53	615935	8181113	18/11/2005	18	18	11.3	0.5
RN034394	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	617713	8182000	4/10/2005	24	20	10.5	1
RN034395	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	615037	8205760	18/10/2005	110	6	NA	NA
RN034396	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	614638	8203123	29/10/2005	122	NA	NA	NA
RN034397	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	614717	8205704	31/10/2005	122	NA	NA	NA
RN034398	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	614688	8203942	1/11/2005	122	NA	NA	NA
RN034399	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	614611	8206579	3/11/2005	56	47	21.5	3
RN028474	BORROLOOLA CRICKET CLUB 1/92 BORROLOOLA	53	639737	8220631	29/11/2007	105.4	0	0	6.2
RN035440	XSTRATA (McARTHUR RIVER MINE)	53	618620	8183294	19/10/2006	90	90	0	5.7

McArthur River

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN035442	XSTRATA (McARTHUR RIVER MINE)	53	617963	8181689	24/10/2006	24	0	0	0
RN035443	XSTRATA (McARTHUR RIVER MINE)	53	618109	8181856	26/10/2006	24.5	24.5	15	0.2
RN035444	XSTRATA (McARTHUR RIVER MINE)	53	613416	8185695	2/11/2006	10	10	5	0.1
RN035445	XSTRATA (McARTHUR RIVER MINE)	53	614739	8185039	5/11/2006	16	16	3	0.1
RN035446	XSTRATA (McARTHUR RIVER MINE)	53	614564	8185277	7/11/2006	7.5	7.5	0	0
RN035447	XSTRATA (McARTHUR RIVER MINE)	53	614428	8185462	8/11/2006	5.7	5.7	0	0
RN035448	XSTRATA (McARTHUR RIVER MINE)	53	614330	8185566	8/11/2006	17.5	4	0	0
RN035449	XSTRATA (McARTHUR RIVER MINE)	53	614143	8185633	8/11/2006	5	5	0	0
RN035450	XSTRATA (McARTHUR RIVER MINE)	53	614211	8185395	15/11/2006	22	17	5	1
RN035451	XSTRATA (McARTHUR RIVER MINE)	53	614112	8185476	21/11/2006	10	9	0	0
RN035452	XSTRATA (McARTHUR RIVER MINE)	53	613889	8185668	22/11/2006	6	6	0	0
RN035453	XSTRATA (McARTHUR RIVER MINE)	53	613657	8185701	22/11/2006	6	6	0	0
RN035454	XSTRATA (McARTHUR RIVER MINE)	53	613655	8185779	23/11/2006	15	8	0	0
RN035455	XSTRATA (McARTHUR RIVER MINE)	53	613812	8185679	24/11/2004	18	18	0	0
RN035456	XSTRATA (McARTHUR RIVER MINE)	53	614713	8185025	27/11/2006	19	19	5	2.5
RN035457	XSTRATA (McARTHUR RIVER MINE)	53	613279	8185611	29/11/2006	14	14	0	0
RN035458	XSTRATA (McARTHUR RIVER MINE)	53	614705	8185195	30/11/2006	13.5	13.5	0	0
RN035459	XSTRATA (McARTHUR RIVER MINE)	53	614004	8185625	1/12/2006	15	14.5	0	0
RN035550	XSTRATA (McARTHUR RIVER MINE)	53	613816	8185669	2/12/2006	17	17	4.9	2.5
RN035551	XSTRATA (McARTHUR RIVER MINE)	53	613591	8185697	4/12/2006	20	20	4	3

McArthur River

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN035552	XSTARTA (McARTHUR RIVER MINE)	53	614160	8185634	4/12/2006	18	15	4	2
RN035553	XSTRATA (McARTHUR RIVER MINE)	53	614304	8185585	5/12/2006	17.5	17	4	2
RN035554	XSTRATA (McARTHUR RIVER MINE)	53	614455	8185414	6/12/2006	18	18	4.5	1
RN035555	XSTRATA (McARTHUR RIVER MINE)	53	614415	8185119	13/12/2006	24	0	0	0
RN035556	XSTRATA (McARTHUR RIVER MINE)	53	614385	8185157	13/12/2006	16	0	0	0
RN035557	XSTRATA (McARTHUR RIVER MINE)	53	612186	8184171	20/12/2006	30	14	0	0
RN035558	XSTRATA (McARTHUR RIVER MINE)	53	613718	8183743	5/01/2007	18	18	7.9	0.5
RN035559	XSTRATA (McARTHUR RIVER MINE)	53	613564	8183563	6/01/2007	17	17	0	0
RN035560	XSTRATA (McARTHUR RIVER MINE)	53	614064	8184655	8/01/2007	21	19	0	0
RN035561	XSTRATA (McARTHUR RIVER MINE)	53	614414	8184341	9/01/2007	24	24	15	5
RN035562	XSTRATA (McARTHUR RIVER MINE)	53	614005	8183802	10/01/2007	25	25	12	2
RN035563	XSTRATA (McARTHUR RIVER MINE)	53	613774	8183601	11/01/2007	13	11	0	0
RN035564	XSTRATA (McARTHUR RIVER MINE)	53	613985	8183750	11/01/2007	12	10	0	0
RN035565	XSTRATA (McARTHUR RIVER MINE)	53	614391	8184066	12/01/2007	14.5	14.5	0	1
RN035689	XSTRATA (McARTHUR RIVER)	53	617055	8184346	20/12/2007	12	12	0	0
RN036012	XSTRATA (McARTHUR RIVER)	53	613062	8185207	11/12/2007	20	20	9.5	1
RN036013	XSTRATA (McARTHUR RIVER)	53	612705	8184777	12/12/2007	20	19.5	10	0.5
RN036014	XSTRATA (McARTHUR RIVER)	53	613154	8184372	13/12/2007	24	24	11	0.5
RN036015	XSTRATA (McARTHUR RIVER)	53	613507	8184050	14/12/2007	26	26	10.5	0.5
RN036016	XSTRATA (McARTHUR RIVER)	53	613558	8184919	15/12/2007	26	26	13	0.5

McArthur River

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN036017	XSTRATA (McARTHUR RIVER)	53	616486	8183255	18/12/2007	20	20	9.8	0.5
RN036018	XSTRATA (McARTHUR RIVER)	53	610037	8182834	18/12/2007	18	18	5.3	0.5
RN036019	XSTRATA (McARTHUR RIVER)	53	617055	8184330	19/12/2007	33	30	14	2
RN036720	Legend Exploration A	53	620758	8166486	NA	59.95	NA	8.85	NA
RN036721	Legend Exploration B	53	620355	8166426	NA	68	NA	10.6	NA
RN036722	Legend RC 13	53	587185	8141970	NA	42.95	NA	8.65	NA
RN036723	Legend RC17	53	588040	8142015	NA	96.7	NA	10.49	NA

Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust NT Portion 5706

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN000641	D/R BORE MALLAPUNYAH STN.	53	577225	8129967	19/08/1952	123.4	123.4	NA	1.9
RN006530	WORKS BORE MCARTHUR RIVER	53	577325	8155467	2/06/1969	54.9	47.2	23.77	1.5
RN007313	ADV. 114/70 BALBARINI STN.	53	548625	8154867	3/09/1970	64	none	0	0
RN007661	ANTHONY LAGOON - 225 MILE BORROLOOLA BEEF RD.	53	581625	8143977	1969	25.9	25.9	NA	3.2
RN007694	G.C. 1/71 BALBARINI STN.	53	547335	8153167	8/06/1971	79.3	79.3	33.5	1.8
RN007695	G.C. 6/71 BALBIRINI STN.	53	544375	8166246	15/05/1971	91.5	91.5	18.3	1.1
RN007696	G.C. 5/71 BALBIRINI STN.	53	522116	8158626	13/06/1971	91.5	91.5	30.48	6.3
RN007697	G.C.4/71 BALBIRINI STN.	53	521106	8164966	11/06/1971	79.3	79.3	30.5	1.1
RN007698	G.C. 3/71 BALBIRINI STN.	53	528326	8165376	10/06/1971	53.4	42.1	30.5	3.8
RN007699	G.C. 2/71 BALBIRINI STN.	53	534626	8159266	9/06/1971	71.7	71.7	36.6	2.5
RN007700	NO. 7 BALBIRINI STN.	53	535946	8154967	17/06/1971	103.7	none	0	0
RN008060	SITE 4 BALBARINI STN	53	561325	8147667	25/10/1972	109.8	NA	NA	NA
RN008061	SITE 3 BALBARINI STN	53	565925	8151367	24/10/1972	86.9	NA	18.2	0.3
RN008062	SITE 2 BALBARINI STN.	53	561025	8161267	22/10/1972	21	18.3	4.5	12.6
RN021894	HOMESTEAD BORE BALBARINI STN.	53	578905	8149967	21/11/1982	30	30	10.5	3.2
RN022865	A=85/87 BALBARINI STN	53	559325	8151267	9/11/1987	105	none	0	0
RN023350	ADV.107/84 BALBARINI	53	536056	8155667	10/10/1984	85	85	48	3
RN023351	ADV. 108/84 BALBARINI	53	534126	8138867	12/10/1984	67	67.5	41	4
RN024503	A=87/77 BALBARINI STN	53	540126	8161166	9/10/1987	80	none	0	0

Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust NT Portion 5706

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN024516	NEW TOOGANGINI BALBARINI STN	53	559325	8150767	10/11/1987	40	40.5		
RN024788	ROAD BORE BALBARINI STN	53	548725	8152517	8/10/1986	103	8	31	1.2
RN024789	ROAD BORE BALBARINI STN	53	551675	8152807	8/10/1986	50	50.5	6	0.9
RN025714	HOLT M BALBARINI STN.	53	532976	8133517	18/06/1988	98.4	99	55	NA
RN025715	HOLT M BALBARINI STN	53	540326	8120667	19/06/1988	94.5	94.5	46	2.5
RN026471	BALBIRINI STN.	53	571825	8167066	14/05/1990	28	28.5	8.5	2
RN027848	ROAD BORE-CHAIN 209 CARPENTARIA HWY.	53	519376	8149867	23/10/1991	101.5	6.5	NA	NA
RN027945	DUPLICATE NO.6 BALBARINI	53	521066	8164866	6/10/1991	58.8	59.3	28	0.5
RN028083	WR ROAD BORE-CHAIN 248 CARPENTARIA HWY	53	558175	8153117	19/05/1992	84.3	none	NA	seepage
RN028084	WR ROAD BORE-CHAIN 259.2 CARPENTARIA HWY	53	568125	8153517	19/05/1992	84.3	NA	0.1	0
RN029020	N.T. TRANSPORT & WORKS TABLELANDS H/WAY (MALLAPUNYAH)	53	579575	8129167	15/11/1993	46.7	41	8.6	10
RN035525	NORTHERN LAND COUNCIL (CARPENTARIA HIGHWAY BALBIRINI)	53	548722	8152842	14/01/2007	110	110	21	0.6
RN035534	NORTHERN LAND COUNCIL (CARPENTARIA DOWN'S)	53	528318	8165307	1/08/2007	55	55	25.6	5.3
RN035535	NORTHERN LAND COUNCIL (BALBARINI STATION)	53	577447	8140694	2/08/2007	30	30	4	3

Narwinbi Aboriginal Land Trust and Borroloola Area

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN000986	NO. 1 BORROLOOLA	53	639934	8221673	NA	157.7	NA	NA	NA
RN000987	NO. 2 BORROLOOLA	53	639935	8221672	NA	306.5	NA	NA	NA
RN000988	NO. 3 BORROLOOLA	53	639935	8221672	NA	146.4	NA	NA	NA
RN003525	OLD POLICE STN. BORE BORROLOOLA	53	639525	8223266	14/09/1962	102.1	102.1	NA	2
RN004397	NO:2 BORROLOOLA	53	639725	8223766	1/06/1964	44.2	27.8	NA	0.8
RN007922	T.SMITH 1/72 BORROLOOLA	53	643325	8222846	13/07/1972	44.2	8.54	0.31	3.8
RN007964	BORROLOOLA INN ADV.1/72 BORROLOOLA	53	640025	8222646	4/07/1972	57.9	18.5	0.31	50
RN008003	HOMESTEAD BORE (DUD) BORROLOOLA	53	640125	8226166	19/07/1972	85.4	NA	NA	NA
RN008004	RACECOURSE G.C. 1/72 BORROLOOLA	53	640025	8221676	19/07/1972	44.2	44.2	21.3	1.9
RN009075	GARAWA 1/77 BORROLOOLA	53	645925	8223076	1/06/1977	63.5	43.7	NA	4
RN009076	GARAWA BORROLOOLA 2/77	53	647225	8222866	3/06/1977	63.3	47	1.95	2.8
RN009077	YANYULA 1/77 BORROLOOLA	53	639725	8223666	6/06/1977	45	29.1	NA	1.5
RN009078	DULU 1/77 BORROLOOLA	53	639635	8224166	8/06/1977	48.6	29.7	14.7	6
RN009079	DULU 2/77 BORROLOOLA	53	639725	8224346	9/06/1977	45	28.9	17.6	6.6
RN009911	NEW MOTEL BORROLOOLA	53	639925	8223966	2/09/1979	27	27	0.09	3.2
RN020201	WATER RESOURCES 1/80 WADA WADALA	53	651925	8235866	3/05/1980	20.8	NA	NA	NA
RN020202	WATER RESOURCES 2/80 WADA WADALA	53	651925	8235866	3/05/1980	12.8	NA	NA	NA
RN020203	WATER RESOURCES 3/80 WADA WADALA	53	651925	8235866	5/05/1980	10	NA	NA	NA
RN020204	WATER RESOURCES 4/80 WADA WADALA	53	651925	8235866	6/05/1980	16	16	1.2	2

Narwinbi Aboriginal Land Trust and Borroloola Area

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN020205	WATER RESOURCES 5/80 WADA WADALA	53	651925	8235866	7/05/1980	6	5.5	NA	NA
RN020206	WATER RESOURCES 6/80 WADA WADALA	53	651925	8235866	8/05/1980	15	15	1.4	2
RN020207	WATER RESOURCES 7/80 WADA WADALA	53	651925	8235866	9/05/1980	18	6.5	NA	NA
RN020208	WATER RESOURCES 8/80 WADA WADALA	53	651925	8235866	10/05/1980	8	NA	0	8
RN020209	WATER RESOURCES 9/80 WADA WADALA	53	651925	8235866	10/05/1980	7.2	6.5	NA	NA
RN021350	WATER RESOURCES BOROLOOLA	53	639025	8224366	19/04/1982	98.9	98.9	5.3	9
RN021351	WATER RESOURCES BORROLOOLA	53	639425	8224066	24/04/1982	79	76	5.88	11
RN021352	TOWNSHIP BORROLOOLA	53	639625	8223016	26/04/1982	8	None	0	0
RN021353	TOWNSHIP BORROLOOLA	53	640025	8222766	27/04/1982	25.9	None	NA	6
RN021354	TOWNSHIP BORROLOOLA	53	639425	8222866	27/04/1982	80.7	80.7	2.15	6.1
RN021355	WATER RESOURCES BORROLOOLA	53	639925	8222566	29/04/1982	99.9	99.9	NA	10
RN021356	WATER RESOURCES BORROLOOLA	53	638925	8224366	4/05/1982	74.7	0.8	NA	8.5
RN021357	TOWNSHIP BORROLOOLA	53	638925	8224466	19/05/1982	74.9	74.9	NA	10
RN021358	TOWNSHIP BORROLOOLA	53	639025	8224466	29/05/1982	84.7	80.6	3.7	10
RN021359	TOWNSHIP BORROLOOLA	53	638925	8224266	11/06/1982	74	74.1	2.7	10
RN021471	WATER RESOURCES 1/82 WADA WADALA	53	651925	8235866	27/06/1982	24.6	24.6	NA	10
RN021472	WATER RESOURCES 2/82 WADA WADALA	53	651925	8235866	28/06/1982	19.6	None	NA	1
RN021473	1/82 MUNYALANI O/STN(CAMPBELL SPGS)	53	627325	8220566	29/06/1982	117.6	117.6	NA	10
RN021474	M/82 TJUNGARI O/STN.(RYAN'S BEND)	53	611525	8211966	2/07/1982	105.2	105.2	4.2	1.1
RN022800	1/84 POLICE LAGOON BORROLOOLA	53	642034	8222916	5/06/1984	55	None	0	0

Narwinbi Aboriginal Land Trust and Borroloola Area

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN022801	2/84 POLICE LAGOON BORROLOOLA	53	642034	8222916	6/06/1984	54	54.8	12	2.5
RN024551	WATER RESOURCES 1/86 BORROLOOLA	53	638525	8226116	21/05/1986	55.5	55.5	17	10
RN024552	WURLBU 2/86 BORROLOOLA	53	637165	8222366	27/05/1986	115	115	Artesian	3
RN024553	WATER RESOURCES 3/86 BORROLOOLA	53	638565	8221166	14/06/1986	150	150	17	7
RN024554	WATER RESOURCES 1/86 GARAWA	53	640975	8222266	18/06/1986	73	73	5.6	3.6
RN025318	WADDA WADDALA 1/87 WADDA WADDALA	53	651765	8234566	28/09/1987	86	55.2	NA	NA
RN026072	DCD GOOLMINIYI O/STN	53	617025	8213466	27/10/1988	120.5	NA	NA	NA
RN026073	2/88 GOOLMINIYI O/STN	53	617025	8213467	29/10/1988	110	NA	NA	NA
RN026074	3/88 GOOLMINIYI O/STN	53	617026	8213466	31/10/1988	110	NA	NA	NA
RN028234	CDEP MABUNJI RESOURCE ASSOC POLICE LAGOON	53	644125	8225366	9/10/1993	60	NA	NA	NA
RN028235	CDEP MABUNJI RESOURCE ASSOCIATION WANDANGULA BORE	53	644325	8224666	9/10/1993	60	NA	NA	NA
RN028236	CDEP MABUNJI RESOURCE ASSOCIATION WANDANGULA BORE	53	645125	8224466	10/10/1993	90	NA	NA	NA
RN028474	BORROLOOLA CRICKET CLUB 1/92 BORROLOOLA	53	639626	8220726	11/12/1992	105.4	1.5	NA	NA
RN028676	BORROLOOLA TOWN SUPPLY=YANGULA	53	639975	8223666	9/08/1993	45	44.3	0	6
RN028677	BATTEN PT. FISHING CLUB McARTHUR RIVER	53	658025	8237716	11/08/1993	138.3	none	15	10
RN029954	WURLBU ABORIGINAL LAND BORROLOOLA	53	637125	8222166	13/05/1995	60.2	60.2	16.9	1
RN030236	BORROLOOLA TOWN COUNCIL BORE No 1/95	53	637644	8225278	18/10/1995	85.5	82.5	12.5	18
RN030237	BORROLOOLA TOWN COUNCIL BORE No 2/95	53	636682	8223722	19/10/1995	103.5	100	12.6	15
RN030238	BORROLOOLA TOWN COUNCIL BORE No 3/95	53	638108	8224143	21/10/1995	85.5	82.5	0	0.4
RN030239	BORROLOOLA TOWN COUNCIL BORE No 4/95	53	638154	8224236	24/10/1995	85.6	85.6	3.9	0.9

Narwinbi Aboriginal Land Trust and Borroloola Area

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN030340	BORROLOOLA TOWN COUNCIL BORE No 5/95	53	637175	8224115	30/10/1995	86.3	86.3	-0.8	0.2
RN030341	BORROLOOLA TOWN COUNCIL BORE No 6/95	53	636861	8223960	1/11/1995	63.5	63.5	-0.7	1.3
RN030342	BORROLOOLA TOWN COUNCIL BORE No 7/95	53	640185	8224252	3/11/1995	23.5	3.4	8	0.1
RN031835	NO 1/99	53	641270	8221758	28/05/1999	120.3	119.8	0	1.5
RN034399	XSTRATA (M.R.M.) McARTHUR RIVER MINE	53	614611	8206579	3/11/2005	56	47	21.5	3
RN035925	BORROLOOLA CRICKET GROUND	53	639720	8220796	28/11/2007	110.2	110.2	0	5.7

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Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN030332	ASHTON MINING (MERLIN PROJECT)	53	642809	8135847	24/05/1998	113	113	23	6.5
RN030333	ASHTON MINING (MERLIN PROJECT)	53	642368	8136451	30/05/1998	89	89	16.9	7
RN030334	ASHTON MINING (MERLIN PROJECT)	53	643054	8135280	31/05/1998	83	83	8	3.5
RN031833	1/99 MERLIN DIAMOND MINE	53	641125	8135167	4/03/1999	84	77.3	2.9	5

South West Island

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN026835	SOUTH WEST ISLAND 1/90	53	677824	8264466	5/01/1990	8	none	0	0
RN026836	SOUTH WEST ISLAND 2/90	53	677824	8264266	6/01/1990	10.5	7.8	0.9	2.3
RN026837	SOUTH WEST ISLAND 3/90	53	677824	8264066	9/01/1990	6.8	6.8	0	0
RN026838	SOUTH WEST ISLAND 4/90	53	677824	8264266	11/01/1990	11	7.4	0.6	2

Spring Creek

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN029523	A.E. MAWSON SPRING CREEK STATION 1/94	53	659625	8168667	10/09/1994	54	none	NA	NA
RN029524	SPRING CREEK A.E. MAWSON 2/94	53	659625	8168667	13/09/1994	181	none	NA	NA
RN029525	SPRING CREEK A.E. MAWSON 3/94	53	659625	8168667	13/09/1994	82	none	NA	NA

West Island

Site	Site Name	Zone	Easting	Northing	Start Date	Drill Depth	Casing Depth	Standing water level	Yield L/s
RN026830	WEST ISLAND 1/89	53	661425	8270166	17/11/1989	8.7	none	5.49	0
RN026831	WEST ISLAND 2/89	53	660825	8270066	20/11/1989	10.4	none	9.5	0.01
RN026832	WEST ISLAND 3/89	53	661445	8270966	21/11/1989	10.8	9.2	7.4	0.7
RN026833	WEST ISLAND 4/89	53	661375	8270916	24/11/1989	4.2	none	NA	NA
RN026834	WEST ISLAND 5/89	53	661525	8271066	24/11/1989	8.7	none	NA	NA

APPENDIX D: BORE WATER CHEMISTRY

All groundwater contains various kinds of dissolved salts (minerals). Small quantities of many of these salts are essential to good health. Excessive concentrations however, can limit the uses of the water.

Following is some information to help you interpret the water quality represented on the following pages.

The information has been summarised from NRETAS technical fact sheets @

www.nt.gov.au/nreta/publications/natres/waterfactsheets.html. More information is available from this site.

Source of dissolved salts:

Salts in the water originate from minute quantities dissolved in rain water and from the chemical breakdown of rocks. Nitrate is also produced in the soil by natural biological activity. Over long periods of time evaporation concentrates them to varying degrees.

Guideline Values:

The maximum recommended values listed beside each salt are guidelines rather than strict limits. The reason for this is because there are often many factors governing how a particular salt affects the user. These can include a person's age and the total volume of water consumed. The guidelines given below are conservatively chosen in order to cover most situations. (Guideline values for stock noted in brown)

Fluoride 1.5 mg/L (Stock 2 mg/L)	This limit is based on health considerations. Excess fluoride can be removed by water treatment.
Hardness 200 mg/L (Aesthetic guideline only)	Hardness is a measure of the amount of calcium and magnesium in the water. Hard waters can cause the build up of scale in hot water pipes and fittings. They also require more soap to obtain a lather.
Iron 0.3 mg/L	Above this limit, taste may be unacceptable but it does not pose a health problem. High iron concentrations give water a rust brown appearance resulting in staining of laundry, pipe encrustation and odour problems. A common way to remove iron is to aerate the water by cascading it into a tank and allowing the iron to floc or settle.
Nitrate 50 mg/L (Stock 400 mg/L)	Based on health considerations a limit of 50mg/L is recommended for babies less than three months old and 100mg/L for older children and adults. Nitrate levels can be reduced if necessary by water treatment.
pH 6.5 - 8.5 (Stock 5.5 – 9.0)	This is a measure of the acidity or alkalinity. Values less than 6.5 indicate acidic water and can result in corrosion of pipes and fittings. When pH is more than 7.5, the water is alkaline and encrustation of pipes with calcium carbonate can occur. pH can be treated.
Total Dissolved Solids (TDS) 500 mg/L (Stock 10000 mg/L) Chloride 250 mg/L Sulphate 250 mg/L (Stock 2000 mg/L) Sodium 180 mg/L	Above these limits for TDS, chloride, sulphate and sodium, taste may be unacceptable but it does not pose a health problem. (Aesthetic guideline only) TDS is approximately equal to 0.6 x EC

The following bore water chemistry data is provided in alphabetical order of land parcel name.

LIMMEN BIGHT RIVER REGION

Broadmere

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN008486	13/10/1974	17019	6170	7.4	169	206	1531	4500	232	1397	2302	232	2	6	840	1220	1.6	2.6	16	
RN021127	1/12/1981	38743	110	6.9	43	52	46	65	8	8	13	7	2	1	3	3	0.1	0.6	9	
RN021128	1/12/1981	38744	530	7.8	245	299	30													
RN021129	1/12/1981	38745	220	7.1	96	117	93	120	17	10	15	12	1	5	6	6	0.2		15	

Limmen National Park (Billengarrah)

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN007929	8/07/1972	14903	690	8.2	332	405	339	490	24	47	77	68	3	15	34	40	0.6	0.1	62	
RN007930	12/07/1972	14904	690	8.1	269	328	254	430	36	54	89	40	2	23	45	40	0.9	34	29	
RN007930	12/10/1972	14905	610	8	298	364	332	380	39	30	49	58	1	8	20	50	0.8	1.4	17	
RN007930	12/10/1972	14906	540	8.1	261	318	282	380	23	29	48	55	1	8	21	55	0.7	6.2	24	
RN007930	17/10/1972	14907	720	7.6	258	315	218	410	38	48	79	30	4	20	66	45	1.1	0.7	14	
RN007931	11/07/1972	14908	740	8.4	381	460	262	470	12	33	54	81	3	30	20	20	0.8	1.4	40	

Limmen National Park (Nathan River)

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN032161	10/06/1999	163802	222	6.8	47	57	43	124	4	28	46	8		11	19	14	0.4		13	

Lorella

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN021155	13/12/1981	38764	210	7.1	85	104	85	110	11	12	20	15	1	4	9	7	0.6	1.6	11	
RN021156	1/12/1981	38765	110	6.5	20	24	24	80	6	18	28	3	1	6	8	6	0.1		21	
RN021157	12/12/1981	38766	320	7.1	155	189	150	180	31	8	13	17	1	6	4	6	0.1		20	
RN021807	12/09/1982	40124	591	7.3	242	295	230			35	58									Arsenic, Copper, Lead, Zinc
RN021808	14/09/1982	40125	603	7.3	216	263	180			49	81									Arsenic, Copper, Lead, Zinc
RN021809	14/09/1982	40126	285	7	105	128	80			23	38									Arsenic, Copper, Lead, Zinc
RN021810	16/09/1982	40127	360	7	110	134	98			41	68									Copper, Lead, Zinc
RN021811	18/09/1982	40128	340	7.5	133	144	122			32	53									Arsenic, Lead, Mercury, Zinc
RN021812	20/09/1982	40129	370	7.2	118	144	126			32	53									
RN021813	16/09/1982	40130	308	6.7	113	138	105			24	40									Copper, Lead, Zinc
RN028269	10/09/1992	51307	118	6.5	49	60	41	82	8	6	10	5	1	5	6	1	0.1	0.1	23	
RN028293	18/08/1992	51320	695	7.4	184	224	223	391	43	107	176	28	1	9	56	9	0.2	0.1	29	
RN029531	28/09/1994	140076	448	8	220	268	210	253	38	18	30	28	1	21	10	9	0.4	4.5	16	
RN029532	29/09/1994	140074	264	7.2	103	125	95	177	15	12	20	14	1	23	8	28	0.4		8	
RN029533	30/09/1994	140075	318	8.1	148	180	123	182	23	16	26	16	1	12	17	8	0.2	0.3	18	
RN036724	24/09/2008		1370	7.9	237	237	230	770	23.6	235		41.5	0.02	7.2	200	129	1.5	7.98	13.2	Trace metals

NT Portion 2432

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN022802	4/07/1984	42526	400	7	178	217	139	270	18	26	43	23	1	5	36	6	0.4	2.5	24	
RN022802	13/07/1989	42527	450	8.2	187	228	156	260	23	33	54	24	1	5	41	7	0.5	1.9	22	
RN022802	19/07/2000	359	414	7.4	158.3	193	132.7	231	17	33	54.4	22	1	4	32	7	0.5		22	
RN028429	8/08/1994	135675	5560	7.8	218	266	442	2890	35	1570	2587	86	1	28	909	78	0.6	2.4	12	

Tanumbirini

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN005783	14/06/1967	10390	1252	8	350	214	630	784	70	120		109	1	16	105	66	1	5		
RN005783	11/09/1967	10391	1150	7.6	334	204	520	760	85	70		76		25	87	200	0.8	8		
RN005783	12/09/1967	10392	1190	7.7	370	226	535	796	87	35		64		22	85	150	0.8	1.1		
RN005783	1/10/1968	10393	1150	7.7	370	226	468	710	47	110		52	1	12	85	146	1.1	0.1	21	
RN006067	23/10/1993	10832	1190	7.4	395	482	522	736	130	91	150	48	1	10	70	144	0.6	0.4	38	
RN006645	9/09/1969	12081	545	7.3	349	425	322	332	28	16		61	1	22	9	6	0.6	21	22	
RN007658	23/08/1971	14250	1850	7.7	288	351	703	1320	117	184		100	1	25	132	470	1.4	0.6	18	
RN007659	23/08/1971	14251	1720	7.7	284	346	473	1080	61	223		78	3	30	175	305	1.2	1.2	15	
RN007660	23/08/1971	14252	1810	7.8	276	337	475	1140	54	243		83	2	34	195	325	1.3	1.8	20	
RN007925	4/07/1972	14891	1280	8.1	183	223	452	820	63	134		72	2	16	92	290	0.4	0.5	32	
RN007926	3/07/1972	14892	600	8.3	214	261	179	380	39	65		20	5	6	69	30	0.5	1.7	27	

Tanumbirini

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN007926	21/09/1983	14893	2240	7.3	440	537	727	1520	140	220	356	92	1	42	215	475	1	0.3	16	Manganese, Zinc, Copper
RN007926	21/09/1983	14894	2380	7.8	426	519	738	1590	128	240	396	102	1	47	248	518	1.3	0.4	20	Manganese, Lead, Copper, Zinc
RN007926	21/09/1983	14895	2250	7.2	422	515	707	1480	132	220	364	92	16	43	230	481	0.9	0.5	16	
RN008102	27/03/1974	15465	1280	7.5	385	469	507	780	114	115		54	1	14	85	164	0.8	3.5	21	
RN008481	8/10/1974	17014	1170	7.7	285	347	407	700	84	118	198	48	3	12	80	158	0.8	40	15	
RN008485	14/10/1974	17018	2350	8	298	363	686	1550	84	305	503	116	4	36	250	535	1.6	2.9	14	
RN025291	27/08/1987	48963	1010	7.8	223	272	347	635	52	108	178	53	1	11	73	154	0.5	2.4	21	
RN028316	30/07/1993	51336	1150	7.9	310	378	442	716	88	109	180	54	2	12	80	164	0.5	0.6	23	
RN029025	19/01/1994	51717	1260	7.3	387	472	541	771	126	100	165	55	1	14	80	174	0.6	0.7	23	
RN029026	18/01/1994	51718	1240	7.2	400	488	536	733	129	98	162	52	1	11	75	156	0.6	0.4	29	
RN029027	5/12/1993	51719	1645	8	283	345	511	1030	91	195	321	69	1	28	164	336	1.1		16	
RN032231	29/09/1999	414	1393	7.8	239.5	292	517.9	935	94	119	196.1	69	1	16	97	378	0.5	2.9	19	

MACARTHUR RIVER REGION

Budganga

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN035924	12/11/2007	EL09256	339	8.2	180	180	176	200	29.5	6.8		24.8	.005	3.6	4.8	.1	.1	.14	30.2	Trace Metals

Cape Crawford (NT1212)

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN008270	19/05/1982	15981	980	7.3	500	605	478	530	72	42	70	71	1	13	36	21	0.5	6.4	17	
RN026143	25/02/1989	49733	715	7.6	353	430	360	415	52	23	38	56	1	8	24	26	0.4		14	

Centre Island

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN021272	7/07/1980	138648		5.9	17	21	85	785	6	367	605	17	1		238	116	0.3	1.6		
RN021276	8/07/1980	138649		6.7	65	79	110	1680	8	804	1325	22	1		576	230	0.5	11.5		
RN021277	10/07/1980	138650		6	5	6	4	71		18	30									
RN021277	10/07/1980	138651	132	6.2	6	7	4	47	1	17	28	1	1	1	11	5	0.1	1.8	14	

Leila Creek

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Flou-ride	Iron	Silica	Other Analysis
RN026144	26/02/1989	49734	805	7.9	435	528	428	475	48	25	41	75	1	6	17	17	0.6	1.8	28	
RN026475	17/05/1990	49979	675	8.2	322	393	348	390	20	3	5	69	1	9	16	27	0.4		38	

McArthur River

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Flou-ride	Iron	Silica	Other Analysis
RN006577	14/07/1969	11905	810	8	417	509	440	490	68	45		63	1	6	23	42	0.4	2.4	27	
RN006578	14/07/1969	11906	810	7.9	490	598	455	480	53	40		76	1	12	24	27	0.5	7.8	23	
RN006578	2/03/1971	11907	500	7.8	313	385	296	300	56	7	12	38	13	6	7	6	0.3	18	18	
RN006585	22/12/1969	11920	620	8	338	412	338	370	10	16		88	4	11	13	15	0.2	0.9	18	
RN007805	2/03/1971	14518	890	8.2	220	268	279	590	18	50		57	11	6	75	192	0.8	15	9	
RN009852	22/08/1979	23079	47600	8	167	203	6240		17640	29071										
RN009905	23/08/1979	23201	130	7.1	35	43	39	90	7	18	30	5	1	4	11	5	0.3	14	18	
RN009905	23/08/1979	23202	150	7.1	42	51	43			21	35									
RN009906	24/08/1979	23203	780	7.8	154	188	195	410	32	144	237	28	1	5	82	24	0.2	0.7	27	
RN009908	1/09/1979	23204	45900	7.9	169	206	6220			17738	29232									
RN009909	2/03/1971	23205	800	7.7	405	494	406	490	41	32	53	74	1	9	32	34	0.7	5.8	23	
RN009909	19/08/1979	23206	800	7.7	405	494	406	490	41	32	53	74	1	9	32	34	0.7	5.8	23	
RN009910	20/08/1979	23207	1740	7.8	265	323	594	1210	57	218	359	110	4	11	150	390	0.7	1.4	22	
RN021158	1/12/1981	38767	480	7.7	241	294	235	260	4	12	18	31	1	7	9	8	0.3	13	18	

McArthur River

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis	
RN022866	8/08/1984	42637	1350	7.8	288	351	376	770	42	180	302	66	1	10	142	168	0.3	10	14		
RN025711	15/06/1988	49292	110000																		
RN025713	16/06/1988	49293	490	7.1	108	131	42	300	2	77	127	9	1	9	86	17	0.5		27		
RN025713	20/10/1993	49294	1280	8.3	185	226	201	680	18	276	455	38	1	10	173	23	0.5	0.1	30		
RN025713	1/04/1994	49295	545	6.7	170	207	46	296	2	69	114	10	1	3	108	12	0.8	6.8	13		
RN025713	20/07/2000	365	1060	7.2	124.7	152	182.6	547	14	239	393.9	36	1	7	129	48	0.4	0.3	22		
RN026738	15/09/1989	50107	5920	7.4	279	340	1785	3925	261	1550	2554	276	1	38	630	801	0.4		16		
RN026738	15/09/1989	50108																			Heavy Metals
RN026770	12/09/1989	50154	1160	7.8	423	516	385	705	44	77	127	67	1	28	101	120	0.7	2.8	20		
RN026772	1/10/1989	50155	1825	7.7	348	425	656	1115	67	292	481	119	1	18	130	246	0.4	0.9	27		
RN036720	16/10/2008		948	8	562	562	512	580	85.1	18		72.7	0.015	8	8.4	4.8	0.5	0.02	28.6		Heavy Metals
RN036722	17/10/2008		130	6	12	12	9.5	90	0.6	25.9		1.9	0.01	0.8	20.9	0.2	0.1	4.88	24		Heavy Metals
RN036723	17/10/2008		311	6	10	10	16.7	180	0.7	85.9		3.6	0.11	0.4	52.9	0.2	0.1	0.08	19		Heavy Metals

Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust. NT Portion 5706

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN000641	13/09/1968	994	1000	7.5	288	176	288	730	54	153		57	1	8	46	233	0.9	3.9	21	Phosphate
RN006530	11/06/1969	11729	690	7.5	374	456	382	360	50	14		60	1	6	11	8	0.3	14.9	25	
RN007694	30/07/1971	14279	960	7.5	331	403	400	610	68	66		56	1	9	47	110	0.4	4.9	24	
RN007694	30/07/1971	14280	600	7.8	308	376	264	360	30	21		46	1	25	13	13	0.5	3	19	
RN007694	30/07/1971	14279	960	7.5	331	403	400	610	68	66		56	1	9	47	110	0.4	4.9	24	
RN007694	30/07/1971	14280	600	7.8	308	376	264	360	30	21		46	1	25	13	13	0.5	3	19	
RN007695	30/07/1971	14281	62	6.9	22	27	15	53	1	6		3	1	2	6	2	0.4	20	15	
RN007695	30/07/1971	14281	62	6.9	22	27	15	53	1	6		3	1	2	6	2	0.4	20	15	
RN007696	30/07/1971	14282	1210	7.9	406	495	484	750	74	93		73	1	8	76	150	1	2.4	18	
RN007696	30/07/1971	14282	1210	7.9	406	495	484	750	74	93		73	1	8	76	150	1	2.4	18	
RN007697	30/07/1971	14283	970	7.6	328	400	407	610	58	68		64	1	8	47	114	0.4	34	25	
RN007697	30/07/1971	14283	970	7.6	328	400	407	610	58	68		64	1	8	47	114	0.4	34	25	
RN007698	30/07/1971	14284	1600	7.7	450	549	618	1080	80	141		102	1	15	107	264	0.8	10	55	
RN007698	30/07/1971	14284	1600	7.7	450	549	618	1080	80	141		102	1	15	107	264	0.8	10	55	
RN008061	24/10/1972	15380	560	8.3	285	348	299	300	12	20	33	66	1	7	9	20	0.4	2.5	1	
RN008062	22/10/1972	15381	730	8.5	434	529	436	450	11	16	26	100	1	5	10	15	0.2	2.1	47	
RN008062	22/10/1972	15381	730	8.5	434	529	436	450	11	16	26	100	1	5	10	15	0.2	2.1	47	
RN008064	21/10/1972	15383	970	8.4	451	550	569	720	18	62	102	128	1	16	36	135	0.8	1.6	46	
RN021894	21/11/1982	40218	630	7.7	395	482	386	390	46	18	28	66	1	3	9	15	0.2	0.3	21	
RN021894	1/05/1984	40219	930	7.6	528	643	548	530	96	10	16	75	1	2	8	20	0.1	0.3	28	

Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust. NT Portion 5706

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN022865	10/06/1984	42636	460	7.7	252	307	249	250	44	2	3	34	1	3	2	8	0.2		23	
RN023350	11/10/1985	45415	1050	7.9	285	348	415	660	74	86	140	56	1	15	66	170	0.7	3.3	20	
RN023350	11/10/1985	45415	1050	7.9	285	348	415	660	74	86	140	56	1	15	66	170	0.7	3.3	20	
RN024788	8/10/1986	47690	810	7.9	405	493	417	470	29	25	41	84	1	14	16	17	0.4	9.6	42	
RN027848	7/11/1991	51055	1170	6.9	465	567	534	730	131	62	102	59	1	11	47	113	0.6	0.4	29	
RN029020	15/11/1993	51714	687	8.3	364	444	375	379	56	18	30	57	1	8	11	15	0.3	2.4	30	

Narwinbi Aboriginal Land Trust and Borrooloola Area

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN007922	18/07/1972	14888	720	8.4	217	254	231	440	42	73	120	31	4	7	58	56	0.4	0.6	31	
RN007922	22/04/1977	14889	46	4.9	2	2	1	36	1	10	16	1	1	2	7	2	0.1	1.1	14	
RN007922	2/05/1981	14890	55	6.9	17	21	22			4	7									
RN009075	8/07/1977	18810	120	6.8	40	49	37	90	13	10	16	1	1	1	8	3	0.1	2.4	13	
RN009075	9/07/1977	18811	60	5.2	5	6	7	51	1	12		1	1	1	7	3	0.1	1.1	15	
RN009075	16/05/1989	18817	90	5.9	14	17	13	55	2	19	31	2	2	1	12	1	0.1	6.7	11	
RN009075	24/11/1995	147070	49	5.6	7	8	7	62	1	9	15	1	1	1	6	2	0.1	0.1	14	
RN009076	25/07/1977	18818	56	6.1	7	9	9	45	2	15	25	1	1	1	8	2	0.3	0.7	15	
RN009076	16/05/1989	18826	55	5.3	7	9	7	35	1	12	20	1	1	1	7	1	0.1	1.5	5	
RN009076	14/07/1989	18827	55	5.3	6	7	4	35	1	12	20	1	1	1	7	3	0.1	0.1	15	
RN009076	16/08/1989	18828																		
RN009076	10/10/1990	18829	55	5.1	5	6	4	45	1	12	20	1	1	1	7	1	0.1	0.2	14	
RN009076	24/04/1991	18830	55	5.2	2	2	7	35	1	13	21	1	1	1	7	1	0.1	1.5	13	
RN009076	27/04/1992	18831	55	5.3	5	6	8	40	1	11	18	2	1	1	7	1	0.1	0.2	14	
RN009076	11/02/1997	158082	54	5.8	7	9	6.6	46	1	12	19.8	1	1	1	6	4	0.1	0.5	9	
RN020204	7/05/1980	36437	1620	7.3	155	189	143			314	517									
RN020204	7/05/1980	36438	1700	7.3	155	189	145			338	557									
RN020204	26/05/1980	36439	1560	7.1	130	159	167	810	24	323	532	26	1	12	219	103	0.3	6.1	49	
RN020206	26/05/1980	36440	1530	7.1	135	165	158	790	22	309	509	25	1	12	223	107	0.3	6.5	55	
RN020208	10/05/1980	36441	7100	6.7	70	85	752	3860	58	2009	3311	148	1	56	1055	365	0.3	12.7	29	

Narwinbi Aboriginal Land Trust and Borrooloola Area

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Flou-ride	Iron	Silica	Other Analysis
RN020209	12/05/1980	36442	1775	7.3	130	159	166	940	25	381	628	25	1	12	270	113	0.1	0.6	49	
RN021473	30/06/1982	39241	360	7.2	148	181	126	190	17	26	43	20	1	11	22	3	0.3	16	14	
RN021473	13/09/1982	39242	350	7	148	180	121	200	17	24	40	19	1	9	22	5	0.2	1.5	15	
RN021473	13/09/1982	39243	350	7	145	177	122			26	42									
RN021473	8/11/1996	158272	326	6.9	148	180	122.9	195	18	23	37.9	19	1	8	20	4	0.3	0.1	12	
RN021473	8/11/1996	155215	326	6.9	148	180	123	195	18	23	38	19	1	8	20	4	0.3	0.1	12	
RN021474	15/09/1982	39244	560	7.2	261	318	233	320	44	24	38	30	1	8	28	21	0.6	3.3	18	
RN021474	15/09/1982	39245	560	7.1	258	315	235			24	40									
RN021474	11/02/1997	158273	581	7.8	273	333	258	330	31	32	52.7	44	1	7	40	21	0.8	1.6	12	
RN022801	5/06/1984	42521	38	6.7	9	11	9	44	2	6	8	1	1	1	4	1	0.1		14	
RN022801	5/06/1984	42522	35	6.5	5	6	7	40	1	4	7	1	1	1	4	2	0.1	0.9	17	
RN022801	30/06/1984	42523	40	5.3	6	7	4	50	1	2	3	1	1	1	4	1	0.1	1.4	15	
RN022801	13/07/1989	42524	40	5.6	9	12	4	30	1	7	12	1	1	1	4	2	0.1	8.2	13	
RN022801	29/04/1992	42525	35	5.3	4	5	4	30	1	7	11	1	1	1	4	1	0.1	2.4	13	
RN022801	11/02/1997	158301	38	6.1	4	5	4.1	25	1	6	10	1	1	1	4	1	0.1	1	13	
RN024551	21/05/1986	47313	85	7.3	22	27	26	70	4	10	18	4	1	10	7	5	0.1		16	
RN024551	21/05/1986	47314	55	6.1	6	7	7	45	1	10	16	1	1	1	7	2	0.1	10	15	
RN024552	30/05/1986	47315	195	7.4	56	68	51	120	7	25	41	8	1	8	17	6	0.1	6.4	12	
RN024552	14/09/1989	47316	120	5.6	22	27	19	85	3	20	33	3	1	5	14	7	0.1	0.3	12	Heavy Metals
RN025318	1/10/1987	48993	1190	8	165	201	314	600	37	272	448	54	1	12	114	31	0.1	1.8	12	

Narwinbi Aboriginal Land Trust and Borroloola Area

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN025318	17/10/1987	48994	1365	7.6	165	201	361	760	41	317	522	63	1	13	129	31	0.1	0.6	14	
RN029954	26/05/1995	143380	222	7.3	72	88	40	143	6	29	48	6	1	5	28	12	0.2	0.4	14	
RN030236	19/10/1995	147788	47	5.9	8	10	7	52	1	11	18	1	1	2	6	3	0.1		16	
RN030237	20/10/1995	147794	114	6.4	29	35	19	142	6	23	38	1	1	1	28	15	0.5		28	
RN030237	20/10/1995	147792	62	6	12	15	7	50	1	11	18	1	1	3	11	10	0.1		17	
RN030238	23/10/1995	147796	154	6.4	45	55	45	105	5	22	36	8	1	5	13	7	0.1		14	
RN030238	23/10/1995	147795	123	6.3	38	46	35	77	4	17	28	6	1	7	10	8	0.1		14	
RN030238	23/10/1995	147789	48	5.9	8	10	7	37	1	11	18	1	1	2	6	6	0.1	0.6	15	
RN030239	24/10/1995	147797	187	6.8	69	84	52	103	6	18	30	9	1	12	14	9	0.3		11	
RN030239	28/10/1995	147791	53	6	9	11	7	51	1	11	18	1	1	2	7	5	0.1	7	16	
RN030239	23/11/1995	146634	47	5.3	6	7	4	37	1	9	15	1	1	1	6	2	0.1	0.2	14	
RN030239	25/11/1995	146592	45	5.5	7	8	4	39	1	10	16	1	1	1	6	3	0.1	0.1	14	
RN030340	30/10/1995	147798	238	6.6	76	93	72	131	9	25	41	12	2	8	18	14	0.3		11	
RN030340	1/11/1995	147787	45	7.3	11	14	7	41	1	9	15	1	1	2	6	6	0.1	0.1	16	
RN030340	28/11/1995	146593	46	5.4	7	9	4	35	1	9	15	1	1	2	6	2	0.1	0.1	13	
RN030340	29/11/1995	146594	45	5.5	7	9	4	26	1	7	12	1	1	2	6	2	0.1	0.1	13	
RN030341	2/11/1995	147793	86	6.4	31	38	21	63	2	8	13	4	1	3	8	9	0.1	2.3	15	
RN035925	28/11/2007		231	7.8	63	63	41	130	6.9	27.3		5.8	<.005	9.9	25.1	4.9	0.1	1.5	12.2	

South West Island

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN026835	5/01/1990	50191	4930	3.8	1	1	388	2780	11	1470	2423	88	1	29	830	206	0.1		33	
RN026836	12/01/1990	50192	65	4.9	1	2	6	45	1	17	29	1	1	1	8	4	0.1		12	
RN026836	15/01/1990	50193																		TSS
RN026838	14/01/1990	50194	70	5.8	11	14	22	55	7	15	24	1	1	1	7	4	0.1	0.1	12	

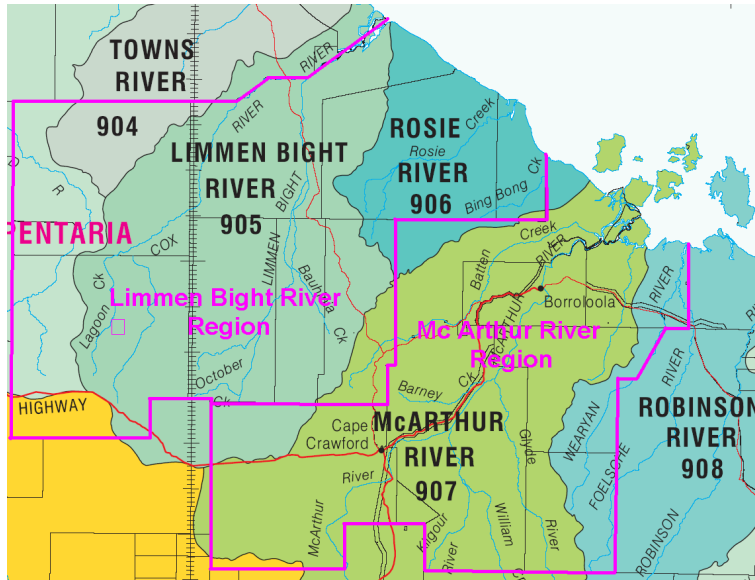
West Island

BoreRN	Sample Date	Sample No:	EC (uS/cm)	pH	Total Alkalinity	Bicarbonate	Total Hardness	TDS	Calcium	Chloride	NaCl	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Fluoride	Iron	Silica	Other Analysis
RN026830	20/11/1989	50188	2170	6.3	10	12	269	1180	25	647	1066	50	1	1	310	27	0.1	6	18	
RN026831	21/11/1989	50189	935	7.5	103	126	175	505	42	213	252	17	1	1	119	25	0.1		7	
RN026832	25/11/1989	50190	155	6.2	12	15	22	95	6	39	64	2	1	1	20	3	0.1	0.1	8	

APPENDIX E: SURFACE WATER SITES

Surface water sites include sites along a river, waterholes and springs.

The following surface water site lists are provided in numerical order of basin (catchment) number. Basins represented in the Limmen Bight and McArthur River regions are shown in the figure below.



River Basins across the map regions

The basins in each region which contain surface water sites are:

Limmen Bight River Region		McArthur River Region	
905	Limmen Bight River Basin	907	McArthur River Basin
906	Rosie River Basin	908	Robinson River Basin
907	McArthur River Basin		

Only those sites within the map sheet are listed.

In each of these basins data is listed in order of:

- River gauging stations with a continuous height record (and flow measurements)
- Water quality sites (Some of these sites have river flow measured)

For the river gauging stations that have a continuous height record and flow measurements, plots of river height and discharge, where possible, for the period of record are provided. The gauging stations are:

Limmen Bight River Region	McArthur River Region
G9050003	*G9070121, *G9070132, *G9070142
	G9070146, G9070229
	G9080133

*These are the gauging stations currently recording river level.

The Limmen Bight River Region data is followed by the McArthur River Region data.

LIMMEN BIGHT RIVER REGION

There is only one gauging station that was operational in the region, G9050003. Only height data is available because only one flow gauging was undertaken.

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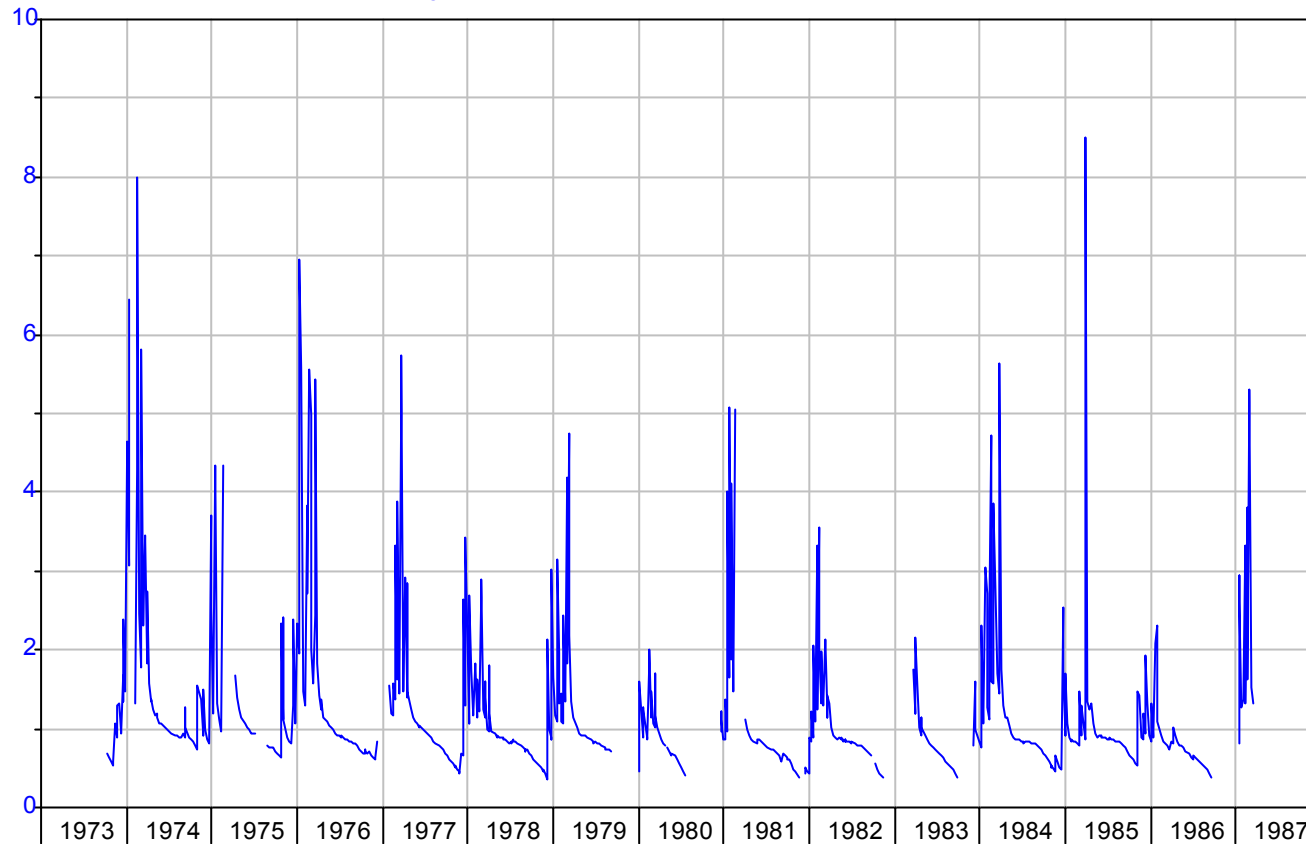
HYPLOT V132 Output 13/10/2009

Period 15 Year Plot Start 00:00_01/01/1973

1973-88

Interval 10 Day Plot End 00:00_01/01/1988

— G9050003 Limmen Bight Ri @ Rd00.00 Max & Min Level (m)



905 LIMMEN BIGHT RIVER

STATION	STATION NAME	EASTING	NORTHING	COMMENCE	CEASE	NUMBER OF FLOW RECORDS
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Gauging stations with a continuous height record and flow measurements

G9050003	Limmen Bight River At Rockholes	539340	8221972	29/09/1973	19/08/1987	1
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STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
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Water quality sites, some have river flow measured

G9050007	BAUHINIA SPRINGS at BAUHINIA STATION HOMESTEAD	549526	8207167		N/A	Spring	Spring source upstream
G9055000	Nathan River Station At Homestead Spring	545926	8277666	21/07/2007	15 est	River	Spring is upstream
G9055001	Broadmere Station At Lagoon	519426	8177367	29/09/2008	CTF	River	Permanent waterhole
G9055002	Broadmere Station At Spring	520426	8183467		N/A	Spring	
G9055003	Broadmere Station At Waterhole	521226	8184167		N/A	Waterhole	
G9055004	Broadmere Station At Spring	519426	8183367		N/A	Spring	
G9055005	Bauhinia Downs Station At Spring No.1 C	549726	8192566		N/A	Spring	
G9055006	Bauhinia Downs Station At Spring No.2d	550326	8195566		N/A	Spring	
G9055007	Bauhinia Downs Station At Spring No.3 E	550826	8197466		N/A	Spring	
G9055008	Bauhinia Downs Station At Spring No.f	551426	8199566		N/A	Spring	
G9055009	Bauhinia Downs Station At Bauhinia Spring 6 B	550126	8207567		N/A	Spring	
G9055010	Bauhinia Downs Station At Spring No.5 A	550426	8211867		N/A	River	
G9055011	Tanumbirini Station At Lagoon Creek Spring (Pt. Z)	464526	8229766		N/A	Spring	
G9055012	Tanumbirini Station At Beauty Creek Spring	468326	8225966		N/A	Spring	
G9055017	Kulampirri Creek 4km d/s ruins	565623	8278050	7/08/2008	CTF	River	
G9055018	Kulampirri Creek at spring at ruins	566290	8273880	7/08/2008	7 est	Spring	
G9055019	Kulampirri Ck hot spring trib, 1.5 km u/s confluence	564210	8275050	7/08/2008	5 est	River	
G9055020	Kulampirri Ck, Hot spring trib, 2.5 km u/s confluence	563550	8274439	7/08/2008	5 est	Spring	
G9055021	Tawallah Creek At Limmen Bight	557926	8220067		N/A	River	
G9055022	Cox River 18km U/S Highway	523526	8300266		N/A	River	

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
G9055023	Limmen Bight River U/S Maria Lagoon	552826	8312166		N/A	River, tidal	
G9055024	Limmen Bight River near Maria Lagoon	547626	8307566		N/A	River, tidal	
G9055025	Cox River at Limmen Bight Confluence	544626	8305366		N/A	River	
G9055026	Limmen Bight At Spring L	543626	8296665		N/A	River, tidal	
G9055027	Limmen Bight At Spring M	543926	8291466		N/A	River, tidal	
G9055028	Limmen Bight River At Spring N	542926	8288566	21/07/2007	5 est		
G9055029	Cox River At Crossing	537026	8305966	21/07/2007	0.5 est	River	
G9055031	Beatrice Island At Point Q	583825	8331066		N/A	River, tidal	
G9055032	Limmen Bight River At Mouth Point R	576125	8330666		N/A	River, tidal	
G9055033	Limmen Bight River At Point S	570426	8325366		N/A	River, tidal	
G9055034	Limmen Bight River At Point T	567926	8319966		N/A	River, tidal	
G9055035	Limmen Bight River At West Is Point U	561926	8317566		N/A	River, tidal	
G9055036	Nathan River At Point V	556826	8309766		N/A	River, tidal	
G9055037	Nathan River At Tidal Point W	558626	8303466	28/11/2007	34	River	
G9055038	Eastern Creek At Point X	550126	8245566		N/A	River	
G9055039	Cox River At Yellow Pool Point Y	502826	8269966		N/A	River	
G9055042	Cox River At Point Ab	464926	8231666		N/A	River	
G9055043	Cox River At Tributary Point Ac	481526	8254366		N/A	River	
G9055044	Cox River At Pool Point Ad	483326	8240466		N/A	River	
G9055045	Cox River At Tributary Point Ae	499326	8268266		N/A	River	
G9055047	AUGER HOLE NORTH ISLAND	697525	8278267		N/A	Well	
G9055048	MINAMIA COX RIVER	502886	8269976		N/A	River	
G9055049	Butterfly Springs downstream pool	549500	8272400	20/07/2007	trickle	Spring	Spring source upstream
G9055050	Bauhinia Springs downstream from upper pool	549362	8207124	27/11/2007	45	Spring	Spring source upstream
G9055051	Bauhinia Springs cold water spring u/s homestead	549372	8207134	27/11/2007	3 est	Spring	Spring source upstream
G9055052	Kulampirri Ck u/s confluence Nathan River	560109	8290247	7/08/2008	CTF	River	
G9055053	Nathan River d/d confluence Kulampirri Creek	559500	8290800	7/08/2008	CTF	River	
G9055054	Nathan River 1.5 km d/s Kulampirri ck confluence	559746	8292029	7/08/2008	CTF	River	
G9055055	Nathan River, eastern tributary, pt A	565800	8292400	7/08/2008	10 est	River	
G9055056	Nathan R. east tributary, pt B	566400	8291400	7/08/2008	1 est	Spring	
G9055057	Nathan River far eastern tributary at Yiyintyi range	573571	8295811	24/09/2008	5 est	Spring	
G9055058	Wulkulyi Swamp discharge channel	563796	8310486	27/11/2007	20 est	Spring	
G9055059	Yalalayakamirra ck at track crossing. Spring source.	544718	8295757	27/11/2007	CTF	Spring	
G9055060	Spring to Yilbindjila ck behind Nathan River Ranger stn	547917	8279001	27/11/2007	20 est	Spring	
G9055074	Tawallah Creek at Hwy Crossing	562800	8221200	9/08/2008	0.1 est	River	

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
G9055075	October Ck 2 km upstream Parsons Ck confluence	514807	8179712	20/09/2008	CTF	River	
G9055076	Hot spring R/B Lagoon Creek	465754	8227343	17/09/2008	0.3 est	Spring	
G9055077	Spring area South of Flying Fox Waterhole	519587	8176762	20/09/2008	CTF	Spring	
G9055078	October Ck u/s Flying Fox wh and sthn tributary	518950	8177120	20/09/2008	CTF	River	
G9055079	Pool at confluence October Ck and Southern Tributary	519050	8177115	20/09/2008	CTF	Spring	Pool in river
G9055080	Upper Cox River, Tanumbirini Stn	462932	8230221	17/09/2008	1 est	River	
G9055081	Spring area to upper Cox River, Tanumbirini station	462873	8229689	17/09/2008	0.5 est	Spring	
G9055082	Waterhole on tributary to Beauty Creek	472066	8221169	17/09/2008	N/A	River	
G9055083	Waterhole on Lagoon Ck, North Tanumbirini Stn	465513	8227454	17/09/2008	N/A	River	
G9055084	Spring, tributary west of Beauty Ck, Tanumbirini stn	468231	8224313	18/09/2008	seepage	Spring	
G9055085	Beauty Ck downstream from very hot spring	467094	8227298	18/09/2008	20 est	River	
G9055086	Very hot spring on tributary to Beauty Ck	468107	8227490	18/09/2008	30 est	Spring	
G9055087	Seep at rocks on tributary to Beauty Ck	468003	8229296	18/09/2008	0.2 est	Spring	
G9055088	Seep in gorge on tributary to Lagoon Ck	465480	8230990	18/09/2008	N/A	Spring	
G9055089	Seep on west tributary Cox River	455806	8232222	18/09/2008	0.5 est	Spring	
G9055090	Spring discharge on west trib Cox R, Site B	461956	8234080	18/09/2008	7 est	Spring	
G9055091	Large Waterhole on Tanumbirini Ck, 4 km sth Cox River	476469	8230983	18/09/2008	CTF	River	Permanent waterhole
G9055092	Five Mile Spring at tributary Tanumbirini Ck	490100	8217300	18/09/2008	1 est	Spring	
G9055093	Spring on tributary to 8 Mile Ck, Tanumbirini Stn	496378	8215143	18/09/2008	CTF	Spring	
G9055094	Munmin Waterhole at Old Tanumbirini Stn	484331	8213819	19/09/2008	CTF	River	
G9055095	Rocky Waterhole, Lagoon Ck, Tanumbirini Stn	467010	8219288	17/09/2008	CTF	River	Permanent waterhole
G9055096	Nathan River Ranger Station at 700 m downstream spring	547058	8278606			River	Downstream spring

906 ROSIE RIVER

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
<u>Water quality sites, some have river flow measured</u>							
G9065001	Lorella Station At Lorella Spring	569026	8261366		N/A	Spring	
G9065002	Lorella Springs d/s from station	568629	8261954	27/11/2007	30	River	Spring is upstream
				9/08/2008	40 est		
G9065003	Stoney Ck downstream from spring, Trib to Rosie Creek	569937	8268264	7/08/2008	0.1 est	Spring	
G9065004	Creek at track crossing d/s Warrapirrmantila Spring	569987	8264969	8/08/2008	CTF	River	Spring is upstream
G9065005	Ink Spot Waterhole	569483	8265093	8/08/2008	0.5 est	Spring	
G9065006	R/B Pool in Rosie ck near swamp	569318	8263820	8/08/2008	N/A	Spring	
G9065007	Rosie Creek opposite swamp	569317	8263820	8/08/2008	N/A	River	
G9065008	Swamp at right bank Rosie Creek	569455	8263337	8/08/2008	5 est	Spring	
G9065009	Rosie Creek d/s from swamp area	570414	8264015	8/08/2008	N/A	River	
G9065010	Creek d/s Wununmantyala spring at track crossing	568900	8263600	8/08/2008	20 est	River	Spring is upstream
G9065011	Northern Creek @ track Xing d/s Warrapirrmantila spring	570200	8265200	8/08/2008	2 est	River	
G9065012	Creek at downstream Wununmantyala Spring	567200	8263400	8/08/2008	N/A	River	
G9065013	Wununmantyala spring area	566800	8263300	8/08/2008	20 est	Spring	
G9065014	Rosie Creek at Drum flat	579300	8267700	9/08/2008	20est	River	
G9065015	Trib to Little Rosie Creek downstream hot spring	579612	8262325	9/08/2008	15 est	River	
G9065016	Hot spring at tributary to Little Rosie Creek	580717	8262443	9/08/2008	3 est	Spring	

907 McARTHUR RIVER

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/S	SITE TYPE	COMMENT
<u>Water quality sites, some have river flow measured</u>							
G9070002	Batten Creek At Roper Borrooloola Rd Xing	575976	8197577	21/03/1991	91	River	

MACARTHUR RIVER REGION

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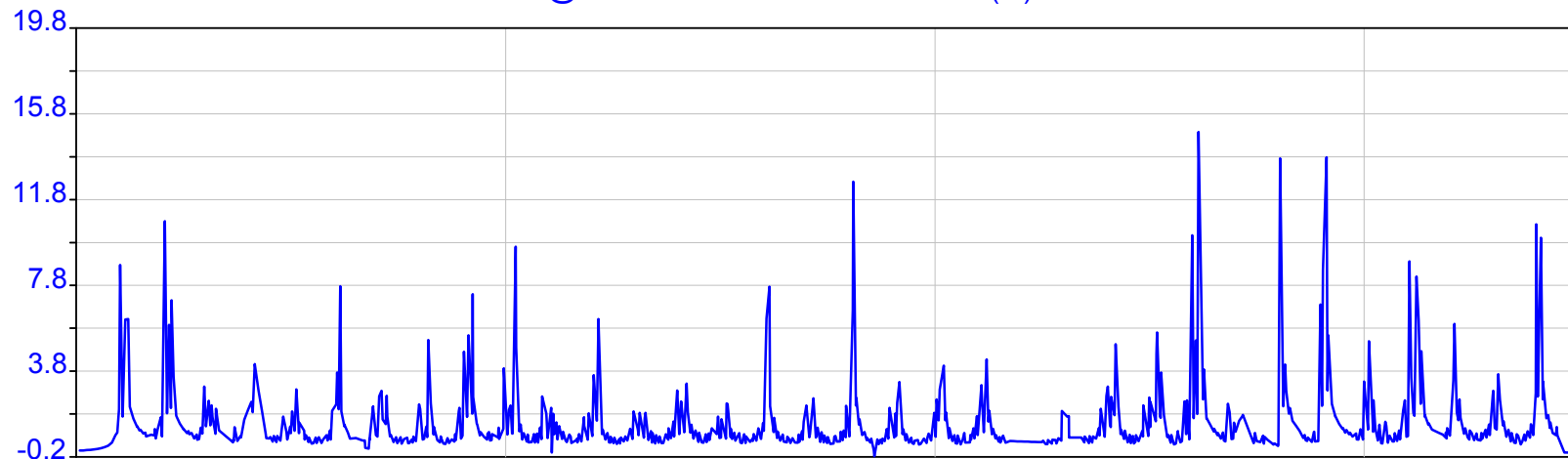
HYPLOT V132 Output 14/10/2009

Period 35 Year Plot Start 00:00_01/01/1975

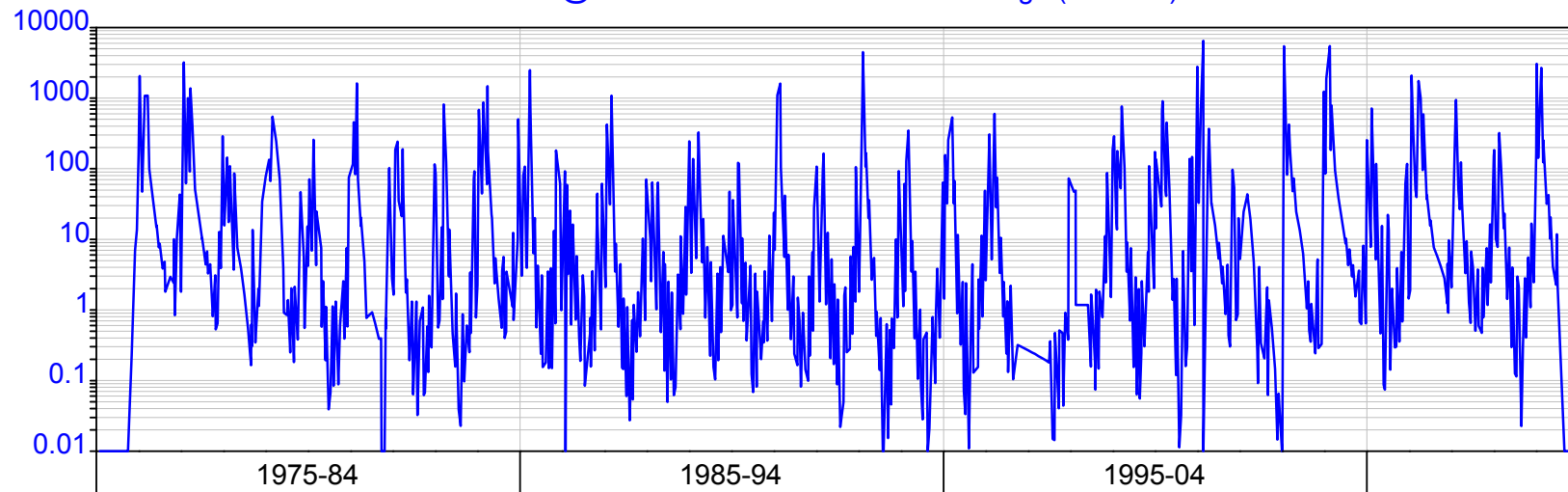
1975-10

Interval 1 Month Plot End 00:00_01/01/2010

— G9070121 McArthur Ri @ Borrol100.00 Max & Min Level (m)



— G9070121 McArthur Ri @ Borrol140.00 Max & Min Discharge (Cumeecs)



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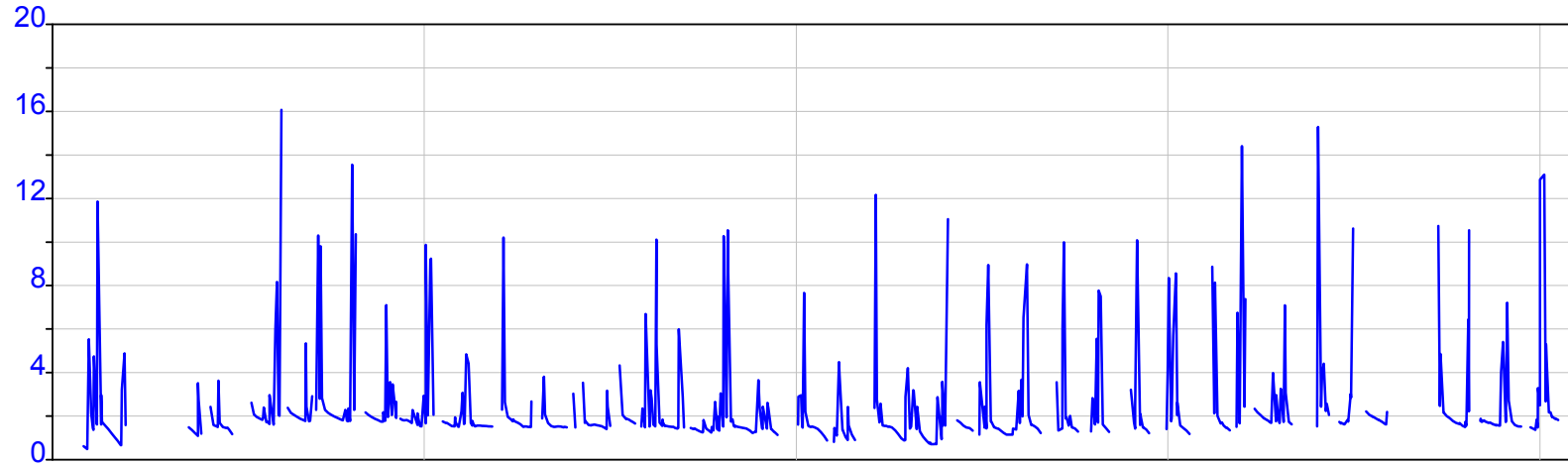
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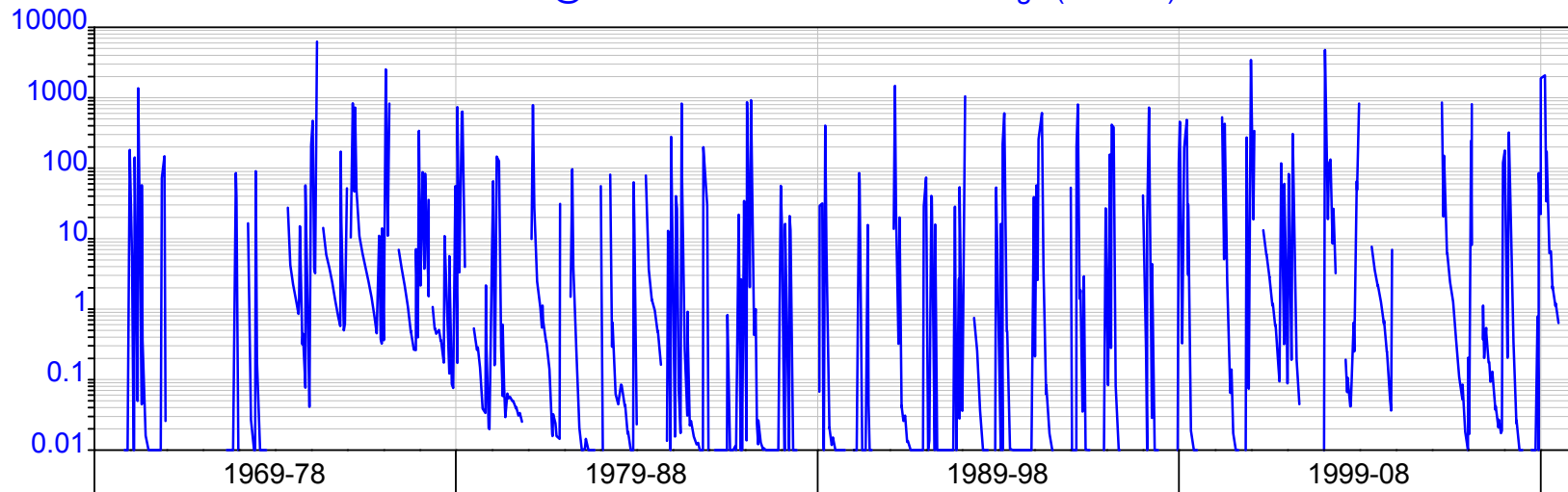
1969-10

Interval 1 Month Plot End 00:00_01/01/2010

— G9070132 McArthur R @ M.I.M. 100.00 Max & Min Level (m)



— G9070132 McArthur R @ M.I.M. 140.00 Max & Min Discharge (Cumeecs)



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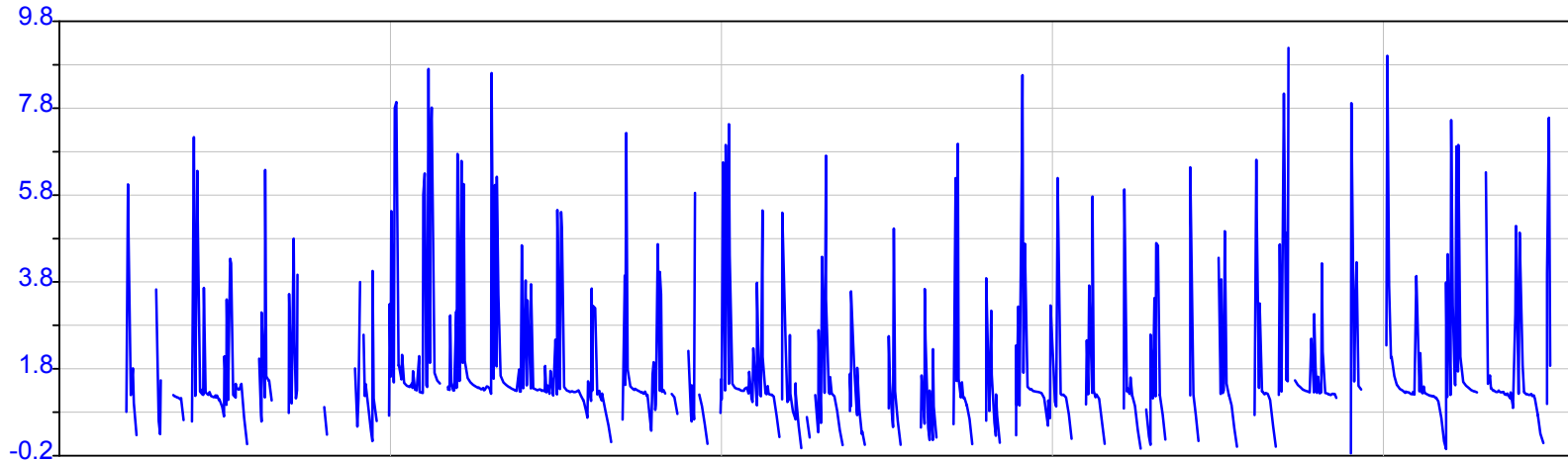
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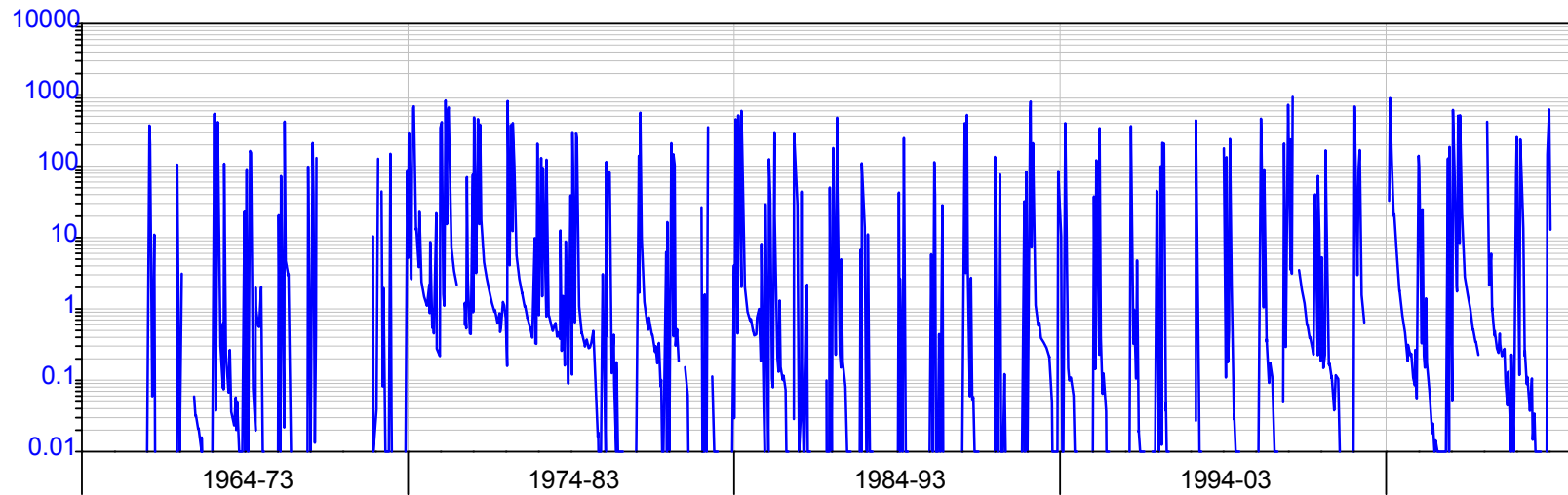
1964-10

Interval 1 Month Plot End 00:00_01/01/2010

— G9070142 McARTHUR R @ BAILEY\$00.00 Max & Min Level (m)



— G9070142 McARTHUR R @ BAILEY\$40.00 Max & Min Discharge (Cumeecs)



Dept Nat Resources, The Arts & Sport

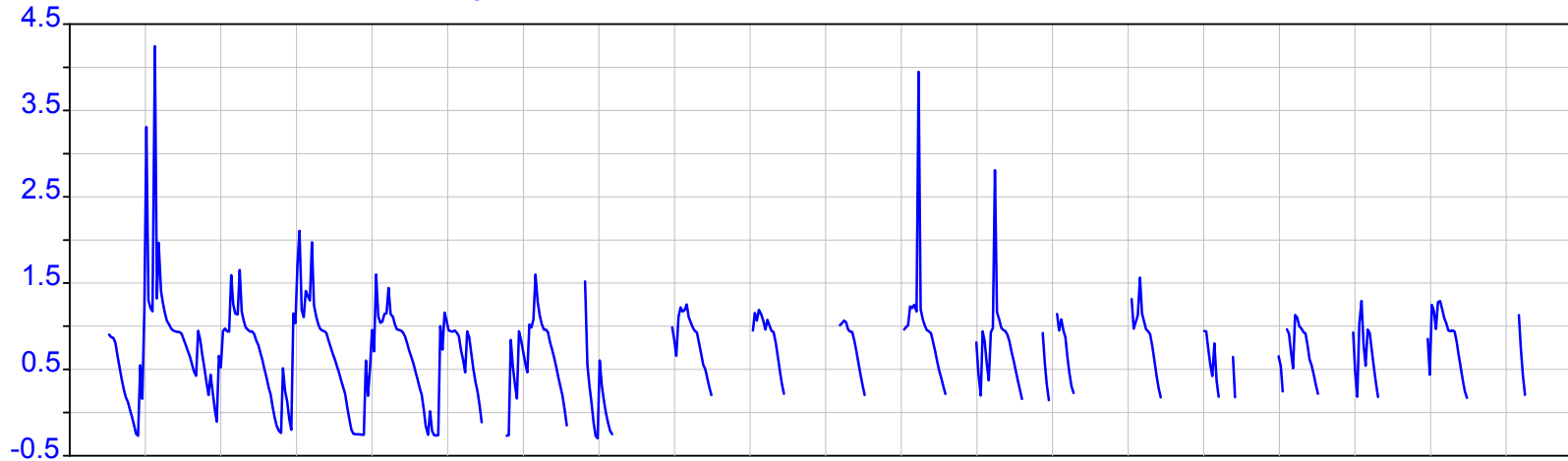
HYPLOT V132 Output 26/11/2009

Period 20 Year Plot Start 00:00_01/01/1973

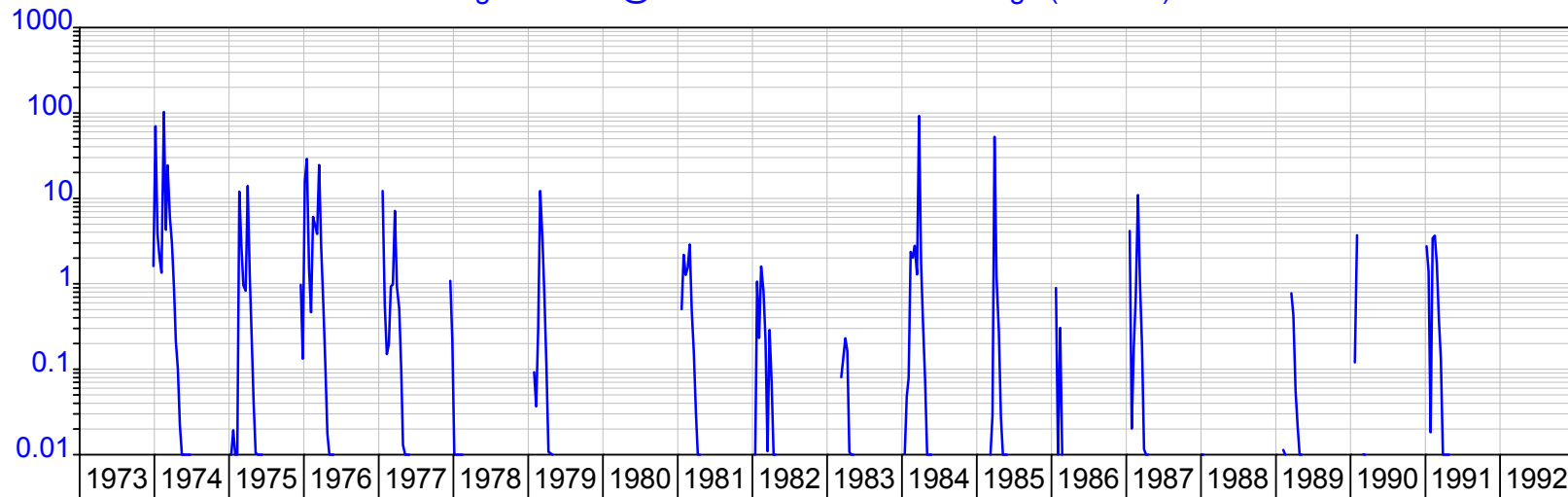
1973-93

Interval 10 Day Plot End 00:00_01/01/1993

— G9070146 Looking Glass Ck @ S300.00 Inst. Level (m)



— G9070146 Looking Glass Ck @ S40.00 Inst. Discharge (Cumeecs)



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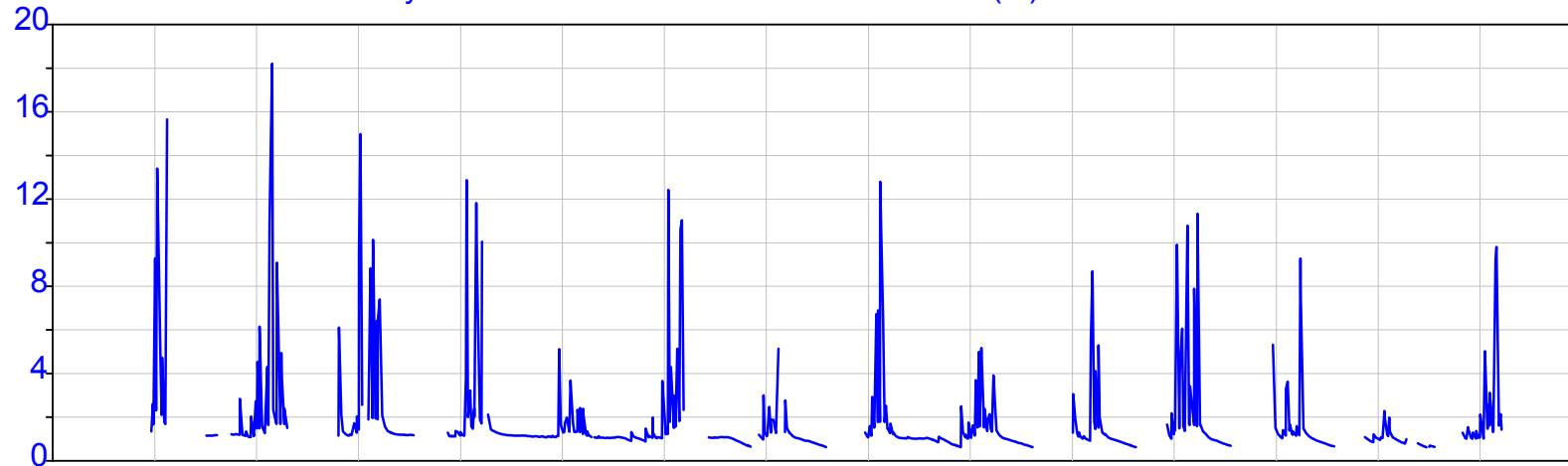
HYPLOT V132 Output 14/10/2009

Period 15 Year Plot Start 00:00_01/01/1973

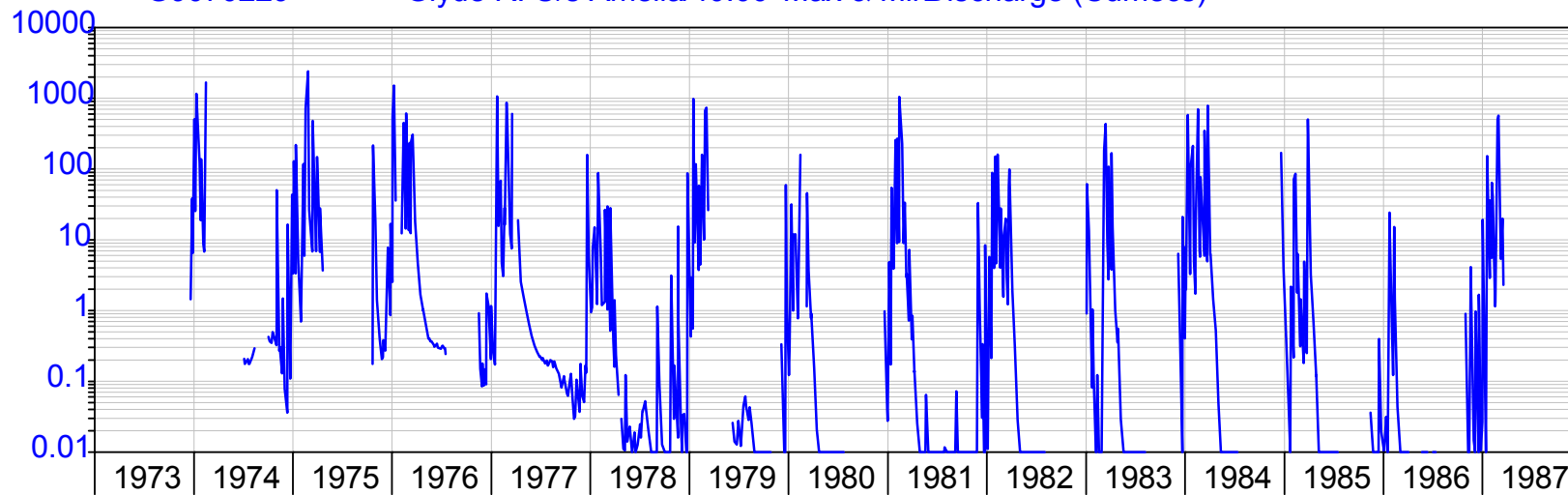
1973-88

Interval 10 Day Plot End 00:00_01/01/1988

— G9070229 Glyde R. U/s Amelia 00.00 Max & Min Level (m)



— G9070229 Glyde R. U/s Amelia 40.00 Max & Min Discharge (Cumeecs)



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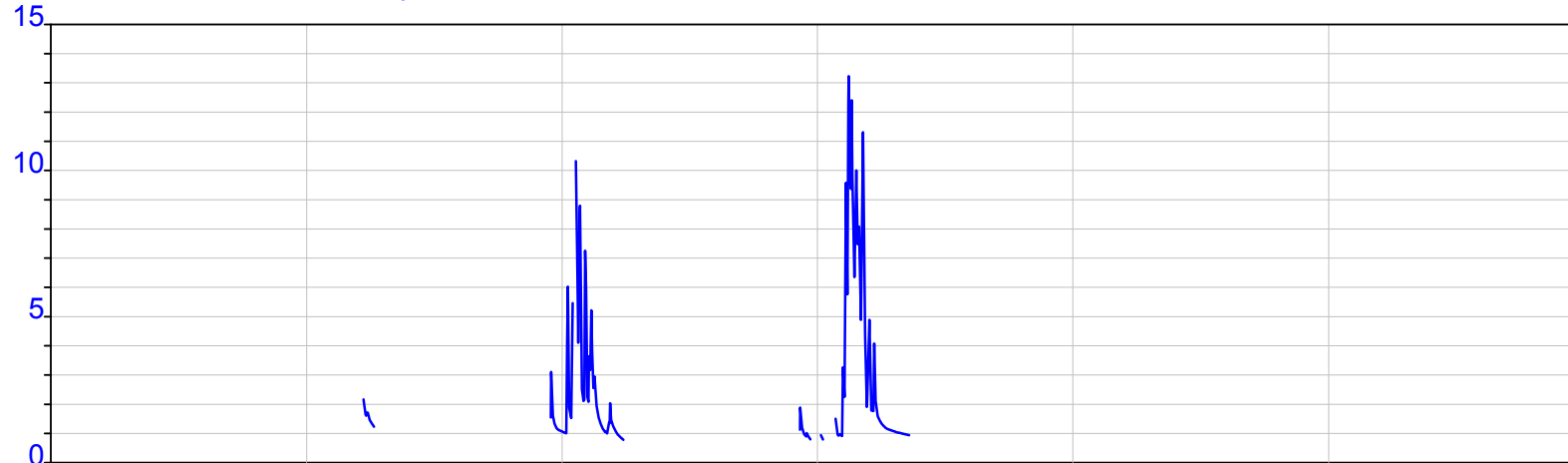
HYPLOT V132 Output 26/11/2009

Period 6 Year Plot Start 00:00_01/01/1964

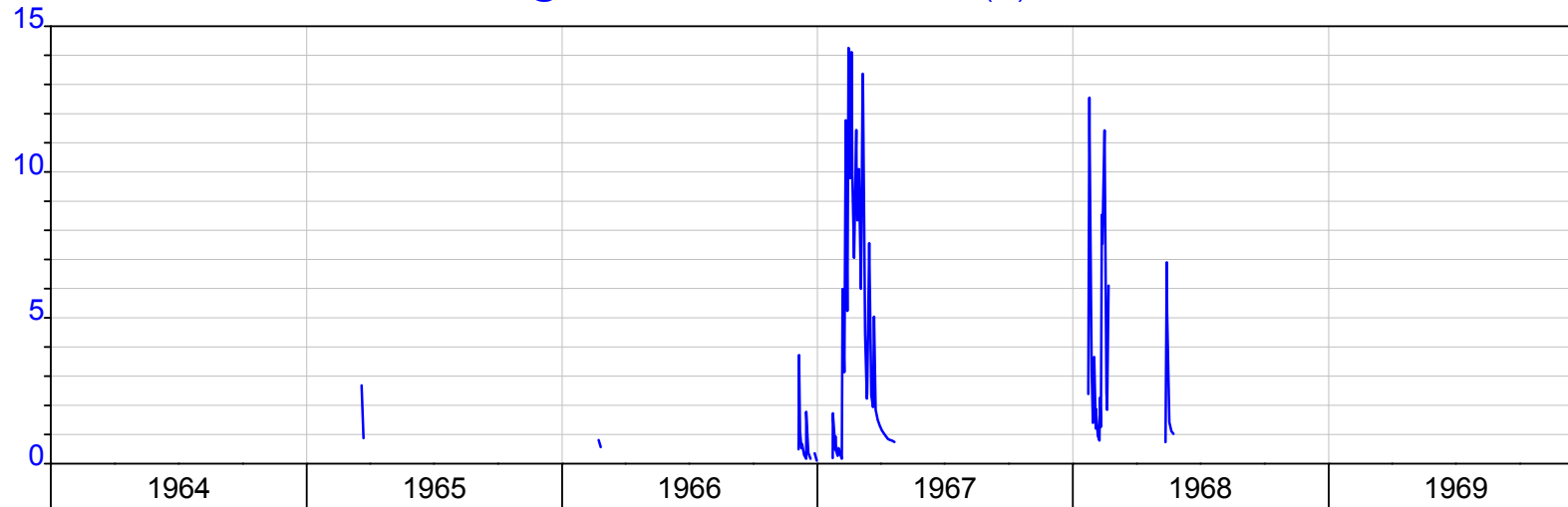
1964-70

Interval 3 Day Plot End 00:00_01/01/1970

— G9070228 Glyde Ri @ Old Mcart100.00 Max & Min Level (m)



— G9070131 Mcarthur Ri @ Old Md00.00 Max & Min Level (m)



907 McARTHUR RIVER

STATION	STATION NAME	EASTING	NORTHING	COMMENCE	CEASE	NUMBER OF FLOW RECORDS
<u>Gauging stations with a continuous height record and flow measurements</u>						
G9070121	Mcarthur River At Borrooloola Crossing	640990	8221723	1/04/1965	Open	85
G9070122	Centre Island Tide Gauge At Gulf Of Carpentaria	694761	8258041	4/12/1972	21/08/1987	N/A
G9070131	Mcarthur River At Old Mcarthur Homestead	617556	8181128	14/05/1962	8/05/1969	34
G9070132	Mcarthur River At M. I. M. Pump	615852	8180684	7/10/1969	Open	99
G9070142	McARTHUR RIVER at BAILEY'S GRAVE	580781	8144837	6/09/1964	Open	88
G9070146	Looking Glass Creek At Skipping Stones	601285	8203336	7/07/1973	13/05/1993	63
G9070228	Glyde River At Old Mcarthur River Homestead	623955	8179247	26/01/1965	15/06/1967	4
G9070229	Glyde River at Upstream Amelia Yards	626345	8163557	14/12/1973	18/06/1987	42

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
<u>Water quality sites, some have river flow measured</u>							
G9070001	Batten Creek At Upstream Rock Bar	648685	8245947		N/A	River	
G9070119	Mcarthur River At Seven Mile Creek	645315	8234067		N/A	River, tidal	
G9070120	Mcarthur River At Black Rock Landing	662479	8239853		N/A	River, tidal	
G9070501	Yanula O/flow At Borrooloola Sewage	639835	8238267		N/A	Dam	
G9070502	Yanula Final Outlet At Borrooloola	639835	8238267		N/A	Dam	
G9075000	Balbirini Station At Top Spring	579626	8149967		N/A	Spring	
G9075001	Batten Creek Waterhole At 10m From Rock Bar	649625	8245867		N/A	River	
G9075002	McArthur River Station At Bessie Spring	590686	8156967	14/08/2008	10 est	River	Permanent pool in river
G9075003	Poison Creek Billabong At 50m North Of Road	657825	8222967		N/A	River	
G9075004	Little Creek Billabong At 100m South Of Road	568126	8153317		N/A	River	Intermittent waterhole
G9075005	Bessie Creek Billabong At 5km East Balbirini	584276	8149167		N/A	River	
G9075006	Leila Lagoon At Along Side Stockyard	592126	8162967		N/A	Waterhole	
G9075007	Balbarini Station At Homestead Spring	578926	8150167		N/A	Spring?	
G9075008	Pt A At Mcarthur River Project	645225	8234067		N/A	River, tidal	
G9075009	Pt B At Mcarthur River Project	635225	8212467		N/A	River	

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
G9075010	Pt C At Mcarthur River Project	640025	8215167		N/A	River, tidal	
G9075011	Pt D At Mcarthur River Project	655225	8241367		N/A	River, tidal	
G9075012	Pt E At Mcarthur River Project	641625	8230867		N/A	River, tidal	
G9075013	Pt F At Mcarthur River Project	651625	8235267		N/A	River, tidal	
G9075014	Pt G At Mcarthur River Project	659225	8237667		N/A	River, tidal	
G9075015	Pt H At Mcarthur River Project	632125	8209177		N/A	River	
G9075016	Pt J At Mcarthur River Project	640425	8221747		N/A	River, tidal	
G9075017	Pt K At Mcarthur River Project	664625	8241367		N/A	River, tidal	
G9075018	Mt L At Mcarthur River Project	640725	8224667		N/A	River, tidal	
G9075019	Pt M At Mcarthur River Project	629525	8201367		N/A	River	
G9075020	Pt P At Mcarthur River Project	644425	8218767		N/A	River, tidal	
G9075021	Pt Q At Mcarthur River Project	572726	8142267		N/A	River	
G9075022	Pt R At Mcarthur River Project	565126	8140567		N/A	River	
G9075023	Pt V At Mcarthur River Project	584026	8159767		N/A	River	
G9075024	Pt U At Mcarthur River Project	611326	8174767		N/A	River	
G9075025	Pt X At Mcarthur River Project	597576	8161467		N/A	River	
G9075026	Pt Y At Mcarthur River Project	590626	8159667		N/A	River	
G9075027	Pt Z At Mcarthur River Project	636925	8215267		N/A	River	
G9075028	Pt S At McArthur R Project	605476	8165667		N/A	River	
G9075029	W/whole Andawaka Creek At South West Is	681925	8258667		N/A	River	
G9075030	Andawarra Creek At South West Is	681125	8259337		N/A	River	
G9075031	Barrett Creek At South West Island	683125	8260367		N/A	River	
G9075033	Mine Discharge At M.i.m. McArthur River	617615	8182677		N/A	?	
G9075034	No 1 Dam At M.i.m. McArthur River	615776	8180717		N/A	Dam	
G9075035	No 2 Dam At M.i.m. McArthur River	615776	8180717		N/A	Dam	
G9075036	Upper Tidal Point A At M.i.m. McArthur River	641525	8220967		N/A	River, tidal	
G9075037	Down Stream Crossing Point B At M.i.m. McArthur River	640625	8221667		N/A	River, tidal	
G9075038	Lower Boat Ramp Point C At M.i.m. McArthur River	640325	8223467		N/A	River, tidal	
G9075039	8 Mile Water Hole Point D At M.i.m. McArthur River	610326	8173667	19/10/2008	CTF	River	Permanent pool in river
G9075040	Esturine Point E At M.i.m. McArthur River	647325	8235467		N/A	River	
G9075041	Esturine Point F At M.i.m. McArthur River	643025	8230417		N/A	River, tidal	
G9075042	Barney Creek Crossing Point G At M.i.m. McArthur River	618325	8183367		N/A	River	
G9075043	Top Crossing Point H At M.i.m. McArthur River	580626	8144467		N/A	River	
G9075044	Balbarini Homestead Point J At M.i.m. McArthur River	579326	8150167		N/A	River	
G9075045	Glyde River Point K At M.i.m. McArthur River	624310	8180567		N/A	River	

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
G9075046	McArthur River Point L At M.i.m. McArthur River	626625	8191067		N/A	River	
G9075047	Trib McArthur River Point M At M.i.m. McArthur River	629325	8200967		N/A	River	
G9075049	King Ash Bay Point P At M.i.m. McArthur River	658625	8237567		N/A	River, tidal	
G9075050	McArthur River Point Q At M.i.m. McArthur River	623025	8186867		N/A	River	
G9075051	Tank Supply At Mcarthur River Mine	615016	8181967		N/A	Tank	
G9075053	McARTHUR R. nr GOOSE LAGOON	635397	8212527		N/A	River	
G9075054	WEBE POINT NATIVE WELL - NORTH ISLAND	697625	8278567		N/A	Well	
G9075055	Ryan Bend Waterhole on Batten Ck	615125	8216267	11/10/2008	CTF	River	Permanent pool in river
G9075056	Glyde River 1.5km North of Catfish Hole	631600	8151757	11/08/2008	CTF	River	Permanent pool in river
G9075057	Pool on Glyde River approx 3.5km north Catfish Hole	630934	8153457	11/08/2008	CTF	River	
G9075059	Windy Gully Spring, on tributary to the Kilgour R.	605333	8130607	12/08/2008	40 est	Spring	Permanent water, spring area
G9075060	Tributary of Kilgour River d/s from Windy Gully spring	608933	8129947	12/08/2008	15 est	River	
G9075061	Spring on tributary to William Creek	621281	8129155	13/08/2008	0.1 est	Spring	
G9075062	Meermulla Waterhole	609700	8144400		N/A	Waterhole	Permanent
G9075063	Beetle Spring	605800	8144000	13/08/2008	CTF	Spring	Permanent water in pool
G9075064	Lake Eames, Vanderlin Island	717880	8265888		N/A	Waterhole	Permanent lake
G9075065	Water supply soak to Base Bay, Mooloowa, Vanderlin Is	714570	8271587	9/10/2008	CTF	Waterhole	Permanent
G9075066	Wilundu, Waterhole on ck nth of Clarkson Pt Vanderlin I	719486	8250075	9/10/2008	CTF	River	Permanent waterhole
G9075067	Well, water supply to Clarkson Pt, Vanderlin Island	718931	8248982		N/A	Well	
G9075068	Munyalini, Campbell Spring, west of Borroloola	626387	8221815	11/10/2008	0.2 est	Spring	
G9075069	Waterhole on Batten Ck 3km upstream Ryans Bend	612272	8214606	11/10/2008	CTF	River	
G9075070	Yungurri Waterhole on Batten Creek	611453	8211924	11/10/2008	CTF	River	Permanent waterhole
G9075071	Batten Creek upstream Crocodile Ck	607727	8207805	11/10/2008	CTF	River	
G9075072	Devil Springs community water supply pool	617448	8213024	11/10/2008	0.1 est	Spring	Permanent waterhole
G9075073	Pool in creek upstream Devil Springs	617517	8212740	11/10/2008	CTF	River	
G9075074	1km upstream Devil Springs, waterhole	617728	8212146	11/10/2008	CTF	River	
G9075075	Caranbirini Waterhole	615400	8200800		N/A	Waterhole	
G9075076	Minngarra Waterhole near Batten Creek	569226	8243631		N/A	Waterhole	Permanent waterhole
G9075077	Batten Creek at Bing Bong Road crossing	641795	8242564		N/A	River	
G9075078	Hot Spring A on tributary to Barney Creek	586890	8180362	18/10/2008	2 est	Spring	
G9075079	Hot Spring B on tributary to Barney Creek	587575	8182469	18/10/2008	0.5 est	Spring	
G9075080	Hot Spring C on tributary to Barney Creek	587086	8179979	18/10/2008	2 est	Spring	
G9075081	Wee-ak spring on McArthur River	555883	8125175	18/10/2008	8 est	Spring	
G9075082	McArthur River upstream Wee-ak spring	555850	8125100	18/10/2008	50 est	River	Permanent flowing water
G9075083	Crocodile Pool, Leila Creek	554089	8165447	19/10/2008	15 est	River	Permanent waterhole

STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
G9075084	Paddy's spring/pool on Paddy Spring Creek	573885	8154027	19/10/2008	CTF	Spring	Permanent waterhole
G9075085	Marrwarri waterhole on The Fletcher Creek	669073	8204047	10/07/2008	CTF	Waterhole	Permanent waterhole

908 ROBINSON RIVER

STATION	STATION NAME	EASTING	NORTHING	COMMENCE	CEASE	NUMBER OF FLOW RECORDS
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Gauging stations with a continuous height record and flow measurements

G9080133	Wearyan River At Upstream Road Crossing	688000	8211750	22/10/1968	30/10/1986	70
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STATION	STATION NAME	EASTING	NORTHING	DATE OF FLOW RECORD	FLOW L/s	SITE TYPE	COMMENT
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Water quality sites, some have river flow measured

G9080132	Wearyan River At Manangoora	696338	8234048	2/05/1962	N/A	River, tidal	
G9085010	Manangoora At Rockholes [small Billabongs]	696625	8229967		N/A	Waterhole	
G9085013	Warby Lagoon At North Side Of Road	685625	8213767		N/A	Waterhole	Intermittent
G9085014	Fletcher Creek Billabong At East Side Of Road Crossing	673425	8214867		N/A	River	
G9085083	Wonmurri Lagoon At 20m East Of Road	696945	8225167		N/A	Waterhole	
G9085084	Downstream Taylor Spring, Upper Foelsche River	658231	8129740	22/09/2008	5 est	River	Permanent Waterhole
G9085085	Greenhide Waterhole, Billidji, on the Wearyan River	664500	8167200	10/07/2008	CTF	River	Permanent Waterhole
G9085086	Bugajinna waterhole on the Wearyan River	667163	8176097	10/07/2008	CTF	River	
G9085087	Marnarungu Waterhole on tributary to the Wearyan River	669022	8182415	10/07/2008	CTF	Waterhole	Intermittent
G9085088	Jininginna Waterhole on Spring Creek, near Station	659628	8168807	10/07/2008	CTF	Waterhole	Intermittent
G9085089	Warruwarri Waterhole west of Wearyan River	689988	8225527	12/07/2008	CTF	Waterhole	Intermittent
G9085090	Lurriarri Waterhole West of Wearyan River	689819	8228814	12/07/2008	CTF	Waterhole	Intermittent
G9085091	Marringul Waterhole on MacPherson Creek	684904	8218628	12/07/2008	CTF	River	Permanent Waterhole
G9085092	Spring at R/B Wearyan River, Doolgarina Area	687870	8203655	12/07/2008	0.2 est	Spring	
G9085099	Foelsche R at escarpment country	668909	8137062	21/06/2007	10 est	River	Permanent Waterhole

APPENDIX F: CHEMISTRY OF SURFACE WATER SITES

All water contains various kinds of dissolved salts (minerals). Small quantities of many of these salts are essential to good health. Excessive concentrations however, can limit the uses of the water.

Following is some information to help you interpret the water quality represented on the following pages.

The information has been summarised from NRETAS technical fact sheet @

www.nt.gov.au/nreta/publications/natres/waterfactsheets.html. More information is available from this site.

Guideline Values:

The maximum recommended values listed beside each salt are guidelines rather than strict limits. The reason for this is because there are often many factors governing how a particular salt affects the user. These can include a person's age and the total volume of water consumed. The guidelines given below are conservatively chosen in order to cover most situations. (Guideline values for stock noted in brown)

Fluoride 1.5 mg/L (Stock 2 mg/L)	This limit is based on health considerations. Excess fluoride can be removed by water treatment.
Hardness 200 mg/L (Aesthetic guideline only)	Hardness is a measure of the amount of calcium and magnesium in the water. Hard waters can cause the build up of scale in hot water pipes and fittings. They also require more soap to obtain a lather.
Iron 0.3 mg/L	Above this limit, taste may be unacceptable but it does not pose a health problem. High iron concentrations give water a rust brown appearance resulting in staining of laundry, pipe encrustation and odour problems. A common way to remove iron is to aerate the water by cascading it into a tank and allowing the iron to floc or settle.
Nitrate 50 mg/L (Stock 400 mg/L)	Based on health considerations a limit of 50mg/L is recommended for babies less than three months old and 100mg/L for older children and adults. Nitrate levels can be reduced if necessary by water treatment.
pH 6.5 - 8.5 (Stock 5.5 – 9.0)	This is a measure of the acidity or alkalinity. Values less than 6.5 indicate acidic water and can result in corrosion of pipes and fittings. When pH is more than 7.5, the water is alkaline and encrustation of pipes with calcium carbonate can occur. pH can be treated.
Total Dissolved Solids (TDS) 500 mg/L (Stock 10000 mg/L) Chloride 250 mg/L Sulphate 250 mg/L (Stock 2000 mg/L) Sodium 180 mg/L	Above these limits for TDS, chloride, sulphate and sodium, taste may be unacceptable but it does not pose a health problem. (Aesthetic guideline only) TDS is approximately equal to 0.6 x EC

The sites are listed in numerical order according to 'G' number.

LIMMEN BIGHT RIVER REGION

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9050003	17/05/1975	116142	87	6.9	30	37	20			12	20									
G9050003	17/03/1976	116143	38	6.4	14	17	8	33	3	4	7	1	2	2	2	5	0.1	4.9	8	
G9050003	15/02/1978	116144	57	6.9		18	16			1	2									
G9050003	15/09/1983	116145	40	6.3	13	16	11	20	1	6	8	2	1	1	2	1	0.1	0.1	14	
G9055000	26/09/1983	116146	320	7.7	171	209	167	190	19	6	10	29	1	3	4	7	0.1	0.2	17	
G9055000	21/07/2007		437																	
G9055001	15/09/1983	116147	140	7	64	78	65	85	19	4	7	4	1	2	3	1	0.1	0.9	13	
G9055001	29/09/2008		94	7																
G9055002	15/09/1983	116148	35	6.4	11	14	9	15	2	4	5	1	1	1	2	1	0.1	0.1	14	
G9055003	6/10/1982	116149	69	6.2	26	32	23		6	4	8	2	2	2	3	6	0.1	2	15	
G9055003	6/10/1982	116150	170	6.4	28	34	23		6	34	54	2	2	3	23	5	0.1	2.1	15	
G9055003	29/09/2008		55	6																
G9055003	29/09/2008	EL12594	60	7.1	24	24	19.9	50	4.1	3.1		2.4	0.06	1.6	2.9	0.7		0.24	15.6	
G9055004	15/09/1983	116151	20	4.9	1	1	3		1	4	7	1	1	1	1	1	0.1	0.1	14	
G9055005	15/09/1983	116152	20	5.8	2	2	3	30	1	4	7	1	1	1	3	1	0.1	0.1	14	
G9055006	15/09/1983	116153	15	5.4	1	1	3	20	1	2	3	1	1	1	2	6	0.1	0.1	13	
G9055007	15/09/1983	116154	15	6.2	3	4	3	30	1	4	5	1	2	1	2	1	0.1	0.7	16	
G9055008	15/09/1983	116155	15	6.1	3	3	3	20	1	4	5	1	1	1	2	1	0.1	0.1	13	
G9055009	15/09/1983	116156	110	6.9	43	53	38	100	2	6	8	8	1	4	5	2	0.3	0.1	41	
G9055010	15/09/1983	116157	115	6.9	47	57	38	95	2	6	10	8	1	6	5	3	0.2	0.1	40	
G9055011	19/09/1983	116158	410	6.9	34	41	61	240	16	106	174	5	1	6	54	4	0.1	0.6	18	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9055012	19/09/1983	116159	540	7.6	95	117	136	360	38	111	183	10	1	8	55	7	0.2	0.1	55	
G9055017	7/08/2008		63	6.8																
G9055018	7/08/2008		28	6.8																
G9055019	7/08/2008		28	6.8																
G9055020	7/08/2008		33	6.8																
G9055020	7/08/2008	EL12594	31	6.2	6	6	4.5	40	0.5	3.7		0.8		2.2	2.2	0.2		0.02	21.2	Trace metals
G9055021	15/09/1983	116162	110	7.2	47	57	46	55	10	6	10	5	2	2	3	1	0.1	0.4	12	
G9055022	17/09/1983	116163	75	6.5	17	20	20	80	3	10	15	3	3	4	6	3	0.1	4.5	14	
G9055023	24/09/1983	116164	39900	7.6	105	128	4900			14820	24410									
G9055024	29/09/1983	116165	35100	7.5	99	20691	4800			12560	20698									
G9055025	24/09/1983	116166	29900	7.6	95	116	2580			11020	18164									
G9055026	24/09/1983	116167	23500	7.4	85	103	3020			8640	14237									
G9055027	24/09/1983	116168	19880	7.4	81	98	2310			7320	12062									
G9055028	26/09/1983	116169	5130	7.3	61	74	574	3000	53	1680	2768	107	1	55	890	223	0.1	0.5	8	
G9055028	21/07/2007		671																	
G9055029	26/09/1983	116170	2790	7.5	75	91	385	1560	44	868	1430	67	1	30	430	102	0.1	0.5	16	
G9055031	23/09/1983	116171	58400	7.7	117	142	7240			22840	37640									
G9055032	24/09/1983	116172	57700	7.9	120	146	7360			22420	36951									
G9055033	24/09/1983	116173	56300	7.8	125	153	7300			22560	37179									
G9055034	24/09/1983	116174	53300	7.8	121	148	6800			20720	34132									
G9055035	24/09/1983	116175	46900	7.7	114	139	6120			17600	29020									

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9055036	24/09/1983	116176	37600	7.3	118	144	4710			13520	22273									
G9055037	26/09/1983	116177	19330	7.6	160	196	2400			7000	11539									
G9055037	28/11/2007		988																	
G9055038	17/09/1983	116178	700	7.9	398	485	395	410	72	8	13	53	1	7	8	10	0.2	0.3	26	
G9055039	19/09/1983	116179	90	6.7	24	30	33	90	5	8	13	5	3	6	6	8	0.1	7.3	16	
G9055042	19/09/1983	116180	410	7	36	44	66	230	15	103	170	7	1	6	52	4	0.2	0.4	14	
G9055043	19/09/1983	116181	70	6.3	14	17	7	50	1	14	23	1	3	2	10	1	0.1	0.6	2	
G9055044	19/09/1983	116182	120	6.9	32	40	45	120	8	11	18	6	3	6	9	10	0.2	9.9	18	
G9055045	19/09/1983	116183	110	6.5	34	42	34		7	10	16	4		6	10					
G9055047	7/12/1994	143018	388	5.2	3	4	21	252	2	95	157	4	1	4	65	32	0.1	14.9	12	
G9055048	19/09/1983	143397																		
G9055049	20/07/2007		26																	
G9055050	27/11/2007		113																	
G9055051	27/11/2007		44																	
G9055052	7/08/2008		264	7.6																
G9055053	7/08/2008		244																	
G9055054	7/08/2008		197	7.2																
G9055055	7/08/2008		623	8																
G9055056	7/08/2008		974																	
G9055057	24/09/2008		18	5																
G9055058	27/11/2007		1717																	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9055058	27/11/2007	EL12594	1710	7.8	65	65	278	1050	37.1	487		45		4.1	229	30.5	0.2	0.08	19.6	Trace metals	
G9055059	27/11/2007		80																		
G9055060	20/08/1999	888	462	7.2	251	306	216	252	29	3	5	35	1	3	1	6	.2	.1	25		
G9055060	27/11/2007		520																		
G9055074	9/08/2008		879																		
G9055075	20/09/2008		20	5.5																	
G9055076	17/09/2008		680	6																	
G9055076	17/09/2008	EL12594	574	6.8	42	42	77.2	350	19.9	155		6.7		4.4	75.6	3.8	0.2	0.48	29.8	Trace metals	
G9055077	20/09/2008		50	5.5																	
G9055078	20/09/2008		38	5																	
G9055079	20/09/2008		230	7																	
G9055080	17/09/2008		11	5																	
G9055081	17/09/2008		483	5.5																	
G9055081	17/09/2008	EL12594	447	6.8	33	33	58.1	280	14.7	119		5.2		3.3	58.9	1	0.2	10.3	23.8	Trace metals	
G9055082	17/09/2008		12	5																	
G9055083	17/09/2008		1084	7																	
G9055084	18/09/2008		36	5																	
G9055085	18/09/2008		553	7.7																	
G9055086	18/09/2008		577	7.5																	
G9055086	18/09/2008	EL12594	474	7.2	82	82	108	310	30.9	96.9		7.5		5.1	47.8	2.7	0.2	1.45	57.4	Trace metals	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9055087	18/09/2008		9	5																	
G9055088	18/09/2008		14	5																	
G9055089	18/09/2008		15	5																	
G9055090	18/09/2008		39																		
G9055091	18/09/2008		39	5.5																	
G9055092	18/09/2008		26																		
G9055093	18/09/2008		34	5																	
G9055093	18/09/2008	EL12594	31	5.6	1	1	2.6	30	0.2	5.9		0.5	0.015	1.3	3.1	0.7	0.1	0.02	11.4	Trace metals	
G9055094	19/09/2008		70	6																	
G9055095	17/09/2008		400	7																	
G9055095	17/09/2008	EL12594	406	7.2	45	45	102	270	17.7	56.8		13.9	0.58	6.3	36.1	56.1	0.2	0.5	23.6	Trace metals	
G9055096	20/08/1999	887	465	8.5	260	297	220	250	29	5	8	36	1	3	1	12	.2	.1	25		
G9065001	16/10/1974	116160	120	6.6	52	63	44	74	6	9	15	7	1	4	4	3	0.3	0.1	23	Boron	
G9065001	20/07/1979	116161	110	6.3	45	55	44	86	6	8	13	7	1	5	4	2	0.5	0.2	27		
G9065001	9/08/2008	EL12594	106	7.3	46	46	40.2	80	4.5	4.2		7.1	0	4.4	4	0.5	0.3		25.4	Trace metals	
G9065001	9/08/2008		115																		Temperature
G9065002	9/08/2008		108																		
G9065003	7/08/2008		26	6.8																	
G9065004	8/08/2008		22																		
G9065005	8/08/2008		15	6.8																	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9065006	8/08/2008		36	6.8																	
G9065007	8/08/2008		273																		
G9065008	8/08/2008		97	6.8																	
G9065009	8/08/2008		230	7.7																	
G9065010	8/08/2008		470	7.8																	
G9065011	8/08/2008		18																		
G9065012	8/08/2008		450	8																	
G9065013	8/08/2008		513																		
G9065014	9/08/2008		283																		
G9065015	9/08/2008		37																		
G9065016	9/08/2008		51	6.8																	
G9065016	9/08/2008	EL12594	45	6.6	12	12	9.5	50	0.6	3.6		2		4.1	2.3	0.4	0.1	0.02	25.6	Trace metals	

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Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9070121	11/11/1965	116185	12100	6.6				9430		4489										
G9070121	11/11/1965	116186	13800	6.7						5095										
G9070121	12/11/1965	116187	12300	6.6				9121												
G9070121	12/11/1965	116188	14700	6.7						5338										
G9070121	12/11/1965	116189	12100	6.7						4489										
G9070121	13/11/1965	116190	12500	6.7						4550										
G9070121	13/11/1965	116191	12500	6.5						4610										
G9070121	15/11/1965	116192	18100	6.6						6733										
G9070121	15/11/1965	116193	13500	6.5				10554		4974										
G9070121	16/11/1965	116194	14700	6.6						5338										
G9070121	17/11/1965	116195	13800	6.6						5095										
G9070121	17/11/1965	116196	15600	6.9				12611		5884										
G9070121	17/11/1965	116197	15200	6.8						5702										
G9070121	18/11/1965	116198	16300	6.7						6066										
G9070121	18/11/1965	116199	14900	6.7						5459										
G9070121	19/11/1965	116200	14400	6.7				11257		5338										
G9070121	19/11/1965	116201	17800	6.8						6915										
G9070121	19/11/1965	116202	14900	6.6						5763										
G9070121	20/11/1965	116203	14400	6.6						5399										
G9070121	20/11/1965	116204	16300	6.7				13483		6187										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9070121	22/11/1965	116205	14900	6.7						5520											
G9070121	22/11/1965	116206	14700	6.4						5338											
G9070121	22/11/1965	116207	14900	6.5						5581											
G9070121	23/11/1965	116208	15600	6.7						5823											
G9070121	23/11/1965	116209	14700	6.8				11774		5459											
G9070121	26/11/1965	116210	14700	6.6						5338											
G9070121	27/01/1967	116211																			Total Susp. Solids
G9070121	3/02/1967	116212																			Total Susp. Solids
G9070121	6/02/1967	116213																			Total Susp. Solids
G9070121	6/02/1967	116214																			Total Susp. Solids
G9070121	7/02/1967	116215																			Total Susp. Solids
G9070121	7/02/1967	116216																			Total Susp. Solids
G9070121	9/02/1967	116217																			Total Susp. Solids
G9070121	9/02/1967	116218	26.4	6.8						5											
G9070121	10/02/1967	116219																			Total Susp. Solids

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9070121	11/02/1967	116220																		Total Susp. Solids
Note from 11/2/67 to 7/3/67 there were 36 further measurements of Total Suspended Solids																				
G9070121	7/03/1967	116255																		Phosphate
G9070121	30/09/1968	116256	1500	7	160	98	284	800	49	374		38	1	9	210	42	0.8	0.1	19	
G9070121	24/02/1976	116257	120	7.4	52	64	50			4	7									Heavy Metals
G9070121	29/04/1976	116258	654	8.2	320	390	320			25	31									
G9070121	22/01/1977	116259	52	5.6	19	23	25	46	5	3	5	3	2	3	2	6	0.1	19	8	
G9070121	1/10/1977	116260	680	7.9	329	402	350			33	54									Heavy Metals
G9070121	12/08/1993	116261																		Heavy Metals
G9070121	12/08/1993	116262										42						0.095		Heavy Metals
G9070122	18/07/1969	116263								30										
G9070122	18/07/1969	116264								80										
G9070122	24/11/1969	116265	74	6.2	8	10	6	40	1	20		1	1	1	9	4	0.1	0.1	9	
G9070122	24/11/1969	116266	51							18										
G9070122	24/11/1969	116267	2580							910										
G9070122	24/11/1969	116268	43000							20900										
G9070131	14/01/1964	116269																		Total Susp. Solids
Note from 14/1/64 to 22/3/65 there were 8 further measurements of Total Suspended Solids																				
G9070131	12/07/1967	116277	696	7.9	410	250	406	413	42	22		72	1	6	14		0.5	1.8		
G9070131	21/02/1968	116278	113	6.7	52	31	62			4	7									

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9070132	2/10/1974	116279	560	7.7	267	326	259	300	46	25	35	35	1	4	10	10	0.3	0.2	16	Heavy Metals
G9070132	28/11/1974	116280	560	7.9	265	323	278	300	52	18	30	36	1	6	9	14	0.2	0.6	19	Heavy Metals
G9070132	28/11/1974	116281	670	8	331	403	336	380	64	24	40	43	1	6	13	19	0.2	0.4	20	Heavy Metals
G9070132	30/04/1975	116282	680	7.9	315	384	316	360	48	28	46	51	1	4	12	18	0.2	0.1	23	Heavy Metals
G9070132	16/05/1975	116283	360	7.7	165	201	166	190	25	12	20	25	2	4	7	13	0.2	0.1	15	
G9070132	18/05/1975	116284	730	7.9	345	421	355	400	60	29	48	50	1	5	13	16	0.2	0.9	22	Heavy Metals
G9070132	17/06/1975	116285	690	7.7	328	400	356	390	52	34	56	55	1	3	13	19	0.2	0.1	23	Heavy Metals
G9070132	27/06/1975	116286	690	8	322	393	346	380	48	29	48	55	2	3	12	18	0.2	0.1	23	Heavy Metals
G9070132	26/07/1975	116287	580	8.2	261	318	284	320	38	33	54	46	2	6	10	12	0.1	0.2	19	
G9070132	28/08/1975	116288	680	8.1	312	381	327	360	44	25	41	53	1	5	12	20	0.3	0.1	23	Heavy Metals
G9070132	28/08/1975	116289	690	8	319	389	331	360	47	27	44	52	1	5	13	18	0.3	0.1	23	Heavy Metals
G9070132	1/11/1975	116290	270	7.1	119	145	122	160	25	12	20	15	2	4	5	8	0.2	3.3	13	Heavy Metals
G9070132	1/11/1975	116291	270	7.1	117	143	267	150	25	14	23	15	2	4	5	9	0.1	3.4	13	
G9070132	4/12/1975	116292	410	7.5	184	224	189	230	38	14	23	23	2	4	7	2	0.2	0.1	18	Heavy Metals
G9070132	14/02/1976	116293																		Total Susp. Solids
G9070132	22/02/1976	116294																		Total Susp. Solids

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9070132	23/02/1976	116295	130	7.3	58	71	55			4	7										Heavy Metals
G9070132	27/02/1976	116296																			Total Susp. Solids
G9070132	29/02/1976	116297	270	7.2	117	143	117	150	22	8	13	15	2	4	4	9	0.3	6.2	18		Heavy Metals
G9070132	21/03/1976	116298	250	7.5	112	137	107	140	20	6	10	14	2	4	4	10	0.2	8.4	17		Heavy Metals
G9070132	4/05/1976	116299	710	8	329	401	345			29	48										Heavy Metals
G9070132	4/05/1976	116300	540	7.7	269	328	280			16	26										
G9070132	24/06/1976	116301	710	7.7	345	421	360			30	49										Heavy Metals
G9070132	24/06/1976	116302	720	7.3	354	431	365			30	49										
G9070132	19/08/1976	116303	670	7.5	365	445	349	616	42	19	31	60	1	7	13	16	0.2	0.1	13		
G9070132	19/08/1976	116304	700	7.8	343	418	346	360	48	31	51	55	1	3	15	5	0.4	0.2	24		Heavy Metals
G9070132	19/08/1976	116305	730	7.9																	Heavy Metals
G9070132	29/10/1976	116306	740	7.5	348	424	370			33	54										Heavy Metals
G9070132	13/12/1976	116307	560	7.2	258	314	265			28	46										Heavy Metals
G9070132	13/12/1976	116308	610	7.3	278	39	290			29	48										Heavy Metals
G9070132	22/01/1977	116309																			Total Susp. Solids
G9070132	15/03/1977	116310	550	8.2	281	342	285			25	41										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9070132	6/05/1977	116311	640	7.7	322	393	320			29	48										Heavy Metals
G9070132	29/09/1977	116312	680	8	329	402	356	380	47	33	54	58	1	4	14	22	0.2	0.1	25		Heavy Metals
G9070132	10/11/1977	116313	710	8.1	350	427	413														Heavy Metals
G9070132	15/01/1978	116314	200	7.2																	
G9070132	17/02/1978	116315	480	8.2																	Heavy Metals
G9070132	19/04/1978	116316	460	7.6																	Heavy Metals
G9070132	28/06/1978	116317	660	7.9	320	390	351	350	50	28	46	55	1	4	13	21	0.2	0.1	24		Heavy Metals
G9070132	25/08/1981	116318	770	7.8	381	464	398	490	56	38	62	63	1	6	21	30	0.3	1	23		
G9070142	23/03/1965	116319																			Total Susp. Solids
G9070142	11/07/1967	116320	512	7.8	286	174	296	291	28	14		54	6	3	6		0.4	0.1			
G9070142	21/02/1968	116321	107	6.7	52	31	58			4	7										
G9070142	3/11/1975	116322	420	7.6	192	234	205			10											
G9070142	24/01/1976	116323	600	7.7	281	342	276	310	48	20	33	38	1	5	7	17	0.3	1	24		Heavy Metals
G9070142	18/02/1976	116324	200	7.6	92	112	95			6	10										Heavy Metals
G9070142	19/03/1976	116325	230	7.3	103	126	110			8	13										Heavy Metals
G9070142	6/05/1976	116326	737	7.4	372	453	380			24	40										Heavy Metals
G9070142	27/06/1976	116327	760	7.8	390	476	400			23	38										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9070142	5/11/1976	116328	620	7.5	331	404	340			14	23									Heavy Metals	
G9070142	7/12/1976	116329	610	7.6	336	410	328			14	23										
G9070142	10/05/1977	116330	720	7.9	381	464	380			24	40									Heavy Metals	
G9070142	22/09/1977	116331	630	7.8	339	339	350			16	26									Heavy Metals	
G9070142	13/01/1978	116332	230	7.5	115	140	118			5	8										
G9070142	16/06/1978	116333	590	8.1	312	381	320			11	18										
G9070142	11/08/1978	116334	620	8.2																	
G9070142	2/06/1982	116335																		Total Susp. Solids	
G9070142	2/06/1982	116336																		Total Susp. Solids	
G9070142	10/08/1993	116337																0.01		Heavy Metals	
G9070146	17/05/1975	116338	55	6.3	12	15	12	60	3	8	13	1	1	3	6	4	0.1	1.3	14		
G9070146	10/02/1976	116339	50	6.4	16	20	7	57	1	8	13	1	2	3	7	2	0.1	1.2	15		
G9070146	25/02/1976	116340	36	6.4	12	15	7	54	1	6	10	1	2	3	4	4	0.1	1.4	16		
G9070146	17/03/1976	116341	32	6.5	12	15	3	41	1	4	7	1	1	2	3	4	0.1	1.4	10		
G9070146	5/05/1976	116342	70	6.6	18	22	9			6	10										
G9070146	14/03/1977	116343	41	6	10	12	7	45	1	5	8	1	2	3	4	2	0.1	1.9	17		
G9070146	15/02/1978	116344	49	6.6		21	9	62	2	6	10	1	2	4	6	5	0.1	0.2	15		
G9070146	27/01/1982	116345																		Note from 27/1/82 to 8/3/82 there were 28 further measurements of Total Suspended Solids	Total Susp. Solids

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9070146	3/06/1982	116374	45	6.1	11	13	7			10	15										
G9070228	19/03/1965	116375																			Total Susp. Solids
G9070228	24/03/1965	116376																			Total Susp. Solids
G9070228	29/02/1976	116377	140	7.1	56	68	54	80	10	4	7	7	2	3	3	2	0.4	0.7	10	Heavy Metals	
G9070228	21/03/1976	116378	98	7.1	40	49	36	61	6	4	7	5	2	3	3	4	0.1	0.2	10	Heavy Metals	
G9070229	15/10/1974	116379	660	7.8	328	400	301	360	30	21	35	55	1	7	19	13	0.6	0.1	4	Heavy Metals	
G9070229	27/11/1974	116380	230	7.4	100	122	107	130	20	14	23	14	2	5	5	14	0.1	0.6	3		
G9070229	3/04/1975	116381	59	6.3	20	24	16	40	3	6	10	2	2	3	4	8	0.1	0.9	10		
G9070229	16/05/1975	116382																			Total Susp. Solids
G9070229	18/05/1975	116383	350	7.5	155	189	158	190	24	16	26	24	2	5	10	11	0.3	0.1	12		
G9070229	24/09/1975	116384	450	8.1	312	381	304	330	31	22	36	55	1	9	14	17	0.3	0.1	8		
G9070229	16/10/1975	116385	690	7.9	334	407	327	360	24	20	33	65	1	9	16	17	0.2	0.3	6	Heavy Metals	
G9070229	9/12/1975	116386	140	7	57	70	54	79	10	6	10	7	3	5	5	5	0.1	0.1	2	Heavy Metals	
G9070229	21/03/1976	116387	46	6.6	17	21	9	34	2	4	7	1	2	2	3	2	0.1	1.4	7		
G9070229	30/04/1976	116388	460	7.8	204	249	210			16	26										
G9070229	13/12/1976	116389	660	7.7	343	418	333			21	35										
G9070229	26/01/1977	116390	74	6.3	27	33	20	58	8	6	10	3	3	4	3	8	0.1	1.9	12		

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9070229	15/03/1977	116391	130	6.4	52	64	49	108	8	8	13	7	2	4	5	2	0.1	0.9	10	
G9070229	28/09/1977	116392	650	7.9	332	405	330			24	40									Heavy Metals
G9070229	10/11/1977	116393	670	8	355	433	343			22	36									
G9070229	16/02/1978	116394	100	7	40	49	36			4	7									
G9070501	14/07/1993	116395	500	7.3				316												
G9070501	14/07/1993	116396	533	7.2				336												
G9070501	14/07/1993	116397	288	7.5				182												
G9070501	14/07/1993	116398	515	7.2				325												
G9070502	9/06/1993	116399																		Faecal Coliform
G9070502	13/07/1993	116400																		Faecal Coliform
G9070502	13/07/1993	116401																		Faecal Coliform
G9070502	13/07/1993	116402																		Faecal Coliform
G9070502	13/07/1993	116403																		Faecal Coliform
G9075000	16/08/1981	116404	630	7.4	358	436	363	380	106	10	16	24	1	1	4	12	0.2	6.5	16	
G9075000	26/08/1981	116405	440	8.1	230	281	232	240	24	8	14	42	1	3	5	12	0.2	0.3	7	
G9075001	18/09/1966	116406	7130							2025										
G9075001	18/09/1966	116407	16480							5750										
G9075001	18/09/1966	116408	1062							186										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075001	22/06/1987	116409																			Micro-organisms
G9075001	22/06/1987	116410																			Micro-organisms
G9075002	26/11/1965	116411	33	7	10	6	6	33	1	6		1						0.2			
G9075002	6/05/1971	116412																			Micro-organisms
G9075002	20/05/1971	116413																			Micro-organisms
G9075002	17/06/1971	116414																			Micro-organisms
G9075002	25/08/1981	116415	38	7.8																	
G9075002	14/12/1992	116416	29	6.4	8	10	4	34	1	3	5	1	1	2	3	4	0.1	0.3	17		
G9075002	14/12/1992	116417		6.2																	
G9075002	13/01/1995	140484	60	6.5	15.8	13							0.63								
G9075002	13/01/1995	151056	60	6.5	15.8	13							0.63								
G9075002	2/08/1995	146885																			Heavy Metals
G9075002	2/08/1995	146886	29	6.2	5.8	7.1							0.026								
G9075002	2/08/1995	152963	29	6.2	5.8	7.1							0.026								Heavy Metals
G9075002	21/11/1995	153742	30	6.1	7	8							0.006								Heavy Metals
G9075002	14/08/2008		23																		

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis		
G9075003	14/07/1965	116418	115	7.2	14	9	15	112	2	33		2		2	26							
G9075004	9/07/1965	116419	231	9.2	118	48	108	163	10	12		20		4	8							
G9075004	1/10/1968	116420	750	7.6	412	251	430	380	9	28		77	1	5	14	6	0.7	0.1	28			
G9075005	9/07/1965	116421	54	6.8	28	17	28		6	7		3		9	1							
G9075006	10/07/1965	116422	198	7.5	66	40	68	254	14	30		8		1	25	1						
G9075007	9/07/1965	116423	29	7.6	13	8	4	54	2	12				0.2	3			0.13				
G9075007	26/08/1981	116424	49	6	20	24	20	46	3	6	8	3	1	1	2	1	0.1	7.7	15			
G9075008	20/08/1981	116425	10320	8.1	177	216	1291	6450	108	3400	5600	249	2	99	1900	570	0.6	0.4	15			
G9075009	24/08/1981	116426	560	7.8	261	318	275	330	41	30	48	42	1	6	15	20	0.2	1.2	24			
G9075010	22/08/1981	116427	560	7.8	259	316	280	330	43	28	44	42	1	6	14	19	0.2	0.9	24			
G9075010	10/12/1992	116428	86	7	34	41	32	67	8	4	7	3	1	4	3	10	0.1	32	9			
G9075010	10/12/1992	116429																			Total Susp. Solids	
G9075010	11/08/1993	116430																				Heavy Metals
G9075010	11/08/1993	116431										90						0.29				Heavy Metals
G9075011	19/08/1981	116432	19520	7.7	153	186				6970	11480											
G9075012	20/08/1981	116433	6080	8.1	200	244	790	3570	78	1970	3250	151	1	61	1010	220	0.4	0.6	17			
G9075013	19/08/1981	116434	15190	7.7	160	195	1840			5290	8710											
G9075014	19/08/1981	116435	25400	7.6	141	172	3080			9070	14950											
G9075015	24/08/1981	116436	640	7.9	301	367	320	380	49	34	54	48	1	5	16	27	0.2	0.2	22			
G9075016	10/02/1967	116437	49.4	7						5												

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075016	11/02/1967	116438	67.3	7.2						5										
G9075016	11/02/1967	116439	66.2	7.3						5										
G9075016	12/02/1967	116440	65	7.4						5										
G9075016	12/02/1967	116441	61.7	7.6						5										
G9075016	12/02/1967	116442	61.7	7.6						5										
G9075016	13/02/1967	116443	62.3	7.7						5										
G9075016	14/02/1967	116444	36.1	7.7						7										
G9075016	15/02/1967	116445	52.9	7.6						6										
G9075016	15/02/1967	116446	26.9	7.6						6										
G9075016	16/02/1967	116447	52.9	7.9						6										
G9075016	16/02/1967	116448	49.4	7.9						5										
G9075016	17/02/1967	116449	52.7	7.9						6										
G9075016	17/02/1967	116450	52.4	7.4						6										
G9075016	18/02/1967	116451	43.4	7.1						5										
G9075016	18/02/1967	116452	43.4	7.2						8										
G9075016	18/02/1967	116453	46.1	7.3						7										
G9075016	18/02/1967	116454	50.9	7.5						6										
G9075016	20/02/1967	116455	50.9	7.2						5										
G9075016	20/02/1967	116456	54.6	7.4						6										
G9075016	21/02/1967	116457	56.8	7.7						7										
G9075016	21/02/1967	116458	59.1	7.3						7										
G9075016	22/02/1967	116459	64.1	7.3						7										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075016	22/02/1967	116460	64.1	7.7						7										
G9075016	23/02/1967	116461	70.3	7.7						8										
G9075016	23/02/1967	116462	70.3	7.8						8										
G9075016	24/02/1967	116463	73.4	7.6						8										
G9075016	24/02/1967	116464	67.6	7.4						8										
G9075016	20/08/1981	116465	610	8.1	248	302	266	380	39	72	120	41	1	5	41	23	0.3	0.3	21	
G9075017	19/08/1981	116466	32500	7.7	138	168	4200			12510	20620									
G9075018	6/05/1966	116467	466	7.7	66	40	70			102										
G9075018	6/05/1966	116468	466	7.5	64	39	86			101										
G9075018	6/05/1966	116469	438	7.4	64	39	83			102										
G9075018	7/05/1966	116470	438	7.3	64	39	83			102										
G9075018	7/05/1966	116471	438	7.2	62	38	92			104										
G9075018	7/05/1966	116472	500	6.8	65	40	97			98										
G9075018	7/05/1966	116473	466	7.1	64	39	87			108										
G9075018	8/05/1966	116474	500	7.2	66	40	86			103										
G9075018	8/05/1966	116475	500	7.1	64	39	89			6										
G9075018	9/05/1966	116476	500	7.2	64	39	87			106										
G9075018	9/05/1966	116477	500	7.3	65	40	94			113										
G9075018	9/05/1966	116478	530	7.3	64	39	90			111										
G9075018	9/05/1966	116479	500	7.3	66	40	86			114										
G9075018	10/05/1966	116480	530	7.2	67	41	86			116										
G9075018	10/05/1966	116481	530	7.4	63	38	84			120										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075018	10/05/1966	116482	530	7.4	66	40	87			114										
G9075018	11/05/1966	116483	466	7.1	65	40	86			115										
G9075018	11/05/1966	116484	500	7.2	66	40	87			126										
G9075018	11/05/1966	116485	500	7.2	63	38	83			116										
G9075018	12/05/1966	116486	466	7.5	68	41	90			112										
G9075018	12/05/1966	116487	450	7.4	70	43	78			127										
G9075018	13/05/1966	116488	438	7.3	65	40	81			118										
G9075018	13/05/1966	116489	500	7.3	61	41	79			118										
G9075018	14/05/1966	116490	466	7.2	69	42	79			118										
G9075018	14/05/1966	116491	500	7.5	65	40	80			120										
G9075018	14/05/1966	116492	500	7.5	70	43	83			124										
G9075018	15/05/1966	116493	500	7.4	70	43	91			121										
G9075018	15/05/1966	116494	500	7.4	60	40	83			122										
G9075018	16/05/1966	116495	500	7.3	64	9	82			118										
G9075018	16/05/1966	116496	466	7.2	70	43	87			124										
G9075018	16/05/1966	116497	438	7.2	68	41	84			119										
G9075018	16/05/1966	116498	500	7.3	72	40	83			129										
G9075018	17/05/1966	116499	500	7.1	64	39	85			131										
G9075018	17/05/1966	116500	500	7.1	72	44	84			128										
G9075018	17/05/1966	116501	500	7.3	63	38	82			123										
G9075018	17/05/1966	116502	500	7.7	62	38	84			123										
G9075018	18/05/1966	116503	500	7.7	62	38	82			122										

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075018	18/05/1966	116504	500	7.6	63	38	81			125										
G9075018	18/05/1966	116505	590	7.9	81	49	103			124										
G9075018	19/05/1966	116506	550	7.8	68	41	101			122										
G9075018	19/05/1966	116507	500	7.6	62	38	82			123										
G9075018	19/05/1966	116508	550	7.5	62	38	82			123										
G9075018	19/05/1966	116509	500	7.6	66	40	85			124										
G9075018	20/05/1966	116510	550	7.8	62	38	84			123										
G9075018	20/05/1966	116511	500	7.6	63	38	86			118										
G9075018	20/05/1966	116512	500	7.7	69	42	78			124										
G9075018	20/05/1966	116513	550	7.6	62	38	78			139										
G9075018	21/05/1966	116514	550	7.5	64	39	82			126										
G9075018	21/05/1966	116515	550	7.5	63	38	86			127										
G9075018	21/05/1966	116516	550	7.7	63	38	88			129										
G9075018	21/05/1966	116517	550	7.7	66	40	89			129										
G9075018	20/08/1981	116518	2950	8.1	222	271	492	1850	59	800	1320	84	1	22	442	123	0.4	0.3	19	
G9075019	24/08/1981	116519	680	8.2	308	375	321	420	48	38	60	49	1	5	22	26	0.3	0.5	24	
G9075020	22/08/1981	116520	540	8	249	304	273	350	37	30	50	44	1	5	16	19	0.2	0.8	19	
G9075020	10/12/1992	116521		6.8																
G9075020	10/12/1992	116522	95	6.8	31	38	30	64	7	7	12	3	1	4	5	10	0.1	34	8	
G9075020	10/12/1992	116523		6.5																
G9075020	10/12/1992	116524		6.5																
G9075020	10/12/1992	116525		6.4																

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075020	10/12/1992	116526																			
G9075020	10/12/1992	116527		6.4																	
G9075020	10/12/1992	116528		6.4																	
G9075020	10/12/1992	116529		6.3																	
G9075020	10/12/1992	116530		6.3																	
G9075020	10/12/1992	116531		6.3																	
G9075020	10/12/1992	116532		6.3																	
G9075020	12/08/1993	116533																0.004			Heavy Metals
G9075021	27/08/1981	116534	480	8.1	255	311	358	270	36	6	10	41	1	2	5	13	0.2	0.1	19		
G9075022	27/08/1981	116535	440	8	259	316	257	270	37	10	16	40	1	2	4	13	0.2	0.1	18		
G9075023	26/08/1981	116536	500	7.9	281	342	284	290	38	12	18	46	1	3	6	13	0.3	0.6	17		
G9075023	11/08/1993	116537	478	8.3	269	328	278	257	37	12	19	45	1	3	5	12	0.1	0.07	13		
G9075023	12/08/1993	116538																0.007			Heavy Metals
G9075024	26/08/1981	116539	550	8	278	339	301	310	35	28	44	52	1	4	12	21	0.3	0.1	18		
G9075025	25/08/1981	116540	650	7.9	315	384	338	390	43	32	54	56	1	5	16	29	0.3	0.2	21		
G9075026	26/08/1981	116541	480	8.2	264	322	269	280	32	12	20	46	1	3	6	13	0.2	0.1	16		
G9075026	13/12/1992	116542																0.07			Heavy Metals
G9075026	14/12/1992	116543	123	6.9	56	68	53	90	13	3	5	5	1	3	6	11	0.2	122	13		
G9075026	14/12/1992	116544		7.3																	
G9075026	12/08/1993	116545	476	8.3	260	317	272	252	33	12	19	46	1	3	5	11	0.1	0.1	16		

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075026	12/08/1993	116546	475	8.3	260	317	268	251	33	11	17	45	1	3	5	12	0.1	0.06	16	
G9075026	12/08/1993	116547																0.003		Heavy Metals
G9075026	12/08/1993	116548																0.005		Heavy Metals
G9075027	22/08/1981	116549	540	7.9	260	317	278	320	44	28	44	41	1	5	14	9	0.2	0.2	22	
G9075028	25/08/1981	116550	580	7.8	300	366	313	350	43	30	48	50	1	5	14	24	0.3	0.1	21	
G9075029	29/10/1979	116551		8.8	10	6	43		4	103	170	8		3	55			1.8		
G9075030	29/10/1979	116552		5.9	2	3	17		2	43	71	3		1	2			2.6		
G9075031	1/11/1979	116553		8.3	170	207	718		64	2079	3426	136		50	1175			9.2		
G9075033	14/07/1992	116555																		Micro-organisms
G9075034	31/10/1991	116556																		Micro-organisms
G9075034	14/07/1992	116557																		Micro-organisms
G9075034	19/11/1992	116558																		Micro-organisms
G9075035	31/10/1991	116559																		Micro-organisms
G9075035	14/07/1992	116560																		Micro-organisms
G9075035	19/11/1992	116561																		Micro-organisms

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075036	10/12/1992	116562	130	6.7																	
G9075036	10/12/1992	116563	133	6.5																	
G9075036	10/12/1992	116564	175	6.4																	
G9075036	10/12/1992	116565	550	6.3																	
G9075036	10/12/1992	116566	25200	6.7																	
G9075036	10/12/1992	116567	124	6.6	31	38	36	84	8	17	28	4	1	4	9	10	0.1	29	7		
G9075036	10/12/1992	116568	129	6.6																	
G9075036	10/12/1992	116569	155	6.4																	
G9075036	10/12/1992	116570																			Total Susp. Solids
G9075036	10/12/1992	116571	212	6.3																	
G9075036	10/12/1992	116572	4500	6.3																	
G9075036	10/12/1992	116573	25300	6.7																	
G9075036	12/08/1993	116574	1241	8	236	288	343	678	60	247	407	47	1	6	128	36	0.2	0.19	21		
G9075037	11/12/1992	116575	195	6.6																	
G9075037	11/12/1992	116576		6.5																	
G9075037	11/12/1992	116577		6.5																	
G9075037	11/12/1992	116578		6.4																	
G9075037	11/12/1992	116579		6.4																	
G9075037	11/12/1992	116580		6.4																	
G9075037	11/12/1992	116581		6.4																	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075037	4/08/1995	146890																			Trace Metals
G9075037	4/08/1995	146891	873	8.1	412	502							0.014								Heavy Metals
G9075038	11/12/1992	116582	418	6.7																	
G9075038	11/12/1992	116583	893	6.6																	
G9075038	11/12/1992	116584	15300	6.7																	
G9075038	11/12/1992	116585	24900	6.8																	
G9075038	11/12/1992	116586	32300	6.8																	
G9075038	11/12/1992	116587	35100	6.9																	
G9075038	11/12/1992	116588	35200	6.8																	
G9075038	11/12/1992	116589	386	6.6	31	38	51	218	9	88	145	7	1	5	49	19	0.1	31	7		
G9075038	11/12/1992	116590																			Total Susp. Solids
G9075038	11/08/1993	116591	6750	7.4	192	235	1185	3945	214	1843	3038	158	1	23	951	388	0.2	0.71	26		
G9075039	14/12/1992	116592		7.1																	
G9075039	14/12/1992	116593	134	6.8	62	75	58	84	15	2	3	5	1	5	2	9	0.1	13	9		
G9075039	14/12/1992	116594		7																	
G9075039	14/12/1992	116595		7																	
G9075039	14/12/1992	116596		6.9																	
G9075039	14/12/1992	116597																			Total Susp. Solids
G9075039	14/12/1992	116598		6.9																	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075039	14/12/1992	116599		6.9																	
G9075039	12/08/1993	116600	527	8.3	279	340	292	281	41	15	25	46	1	4	6	15	0.1	0.11	20		
G9075039	12/08/1993	116601																0.002			Heavy Metals
G9075039	4/08/1995	146887	244	7.8	129	157							0.016								
G9075039	4/08/1995	146889																			Heavy Metals
G9075039	4/08/1995	152964	244	7.8	129	157							0.016								Heavy Metals
G9075039	23/11/1995	153743	319	7.2	156	190							0.006								Heavy Metals
G9075039	19/10/2008		520	8																	
G9075040	11/12/1992	116602	21000	7	71	87	2280	13300	156	7060	11630	460	1	1410	3950	1030	0.2	0.5	6		
G9075040	11/12/1992	116603	9980	7																	
G9075040	11/12/1992	116604	10000	7																	
G9075040	11/12/1992	116605	10900	7																	
G9075040	11/12/1992	116606	17000	7.1																	
G9075040	11/12/1992	116607																			Total Susp. Solids
G9075040	11/12/1992	116608	27800	7.3																	
G9075040	11/12/1992	116609	28800	7.3																	
G9075040	11/12/1992	116610	29100	7.3																	
G9075040	13/12/1992	116611																0.08			Heavy Metals
G9075041	11/12/1992	116612	21200	7.4																	

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075041	11/12/1992	116613	26900	7.5																	
G9075041	11/12/1992	116614	37600	7.6																	
G9075041	11/12/1992	116615	38600	7.6																	
G9075041	11/12/1992	116616	39100	7.5																	
G9075041	11/12/1992	116617																			Total Susp. Solids
G9075041	11/12/1992	116618	9830	6.8	49	60	1030	5790	76	3040	5010	205	1	62	1690	422	0.2	2.7	6		
G9075042	13/12/1992	116619	147	6.9	63	77	62	96	15	4	7	6	1	5	3	9	0.1	16	10		
G9075042	13/12/1992	116620																			Total Susp. Solids
G9075042	13/12/1992	116621																0.16			Heavy Metals
G9075042	10/08/1993	116622	1063	7.7	484	590	553	608	96	65	107	76	1	6	34	58	0.3	1.04	27		
G9075042	11/08/1993	116623		7.5																	Heavy Metals
G9075042	11/08/1993	116624										61						0.18			Heavy Metals
G9075042	11/08/1993	116625		8														0.018			Heavy Metals
G9075042	11/08/1993	116626		8.3														0.006			Heavy Metals
G9075042	4/08/1995	152965	873	8.1	412	502							0.014								Heavy Metals
G9075042	23/11/1995	153744	1150	8.1	444	541							0.006								
G9075043	14/12/1992	116627	86	6.7	39	47	39	53	9	6	10	4	1	4	2	8	0.1	28	8		

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075043	14/12/1992	116628																			Total Susp. Solids
G9075043	14/12/1992	116629																			Turbidity
G9075043	10/08/1993	116630	555	7.8	307	374	323	292	55	12	19	45	1	3	5	11	0.1	0.11	19		
G9075044	14/12/1992	116631	76	6.6	33	40	30	58	7	1	2	3	1	3	3	8	0.1	27	7		
G9075044	14/12/1992	116632																			Turbidity
G9075044	14/12/1992	116633																			Total Susp. Solids
G9075045	9/12/1992	116634	114	6.7	48	58	48	72	11	2	3	5	1	6	2	10	0.1	22	9		
G9075045	9/12/1992	116635																			Total Susp. Solids
G9075046	9/12/1992	116636	103	7.1	43	52	41	61	10	2	3	4	1	4	3	10	0.1	36	9		
G9075046	9/12/1992	116637																			Total Susp. Solids
G9075046	9/12/1992	116638																			Turbidity
G9075046	10/08/1993	116639	700	8.2	305	371	339	387	45	47	78	55	1	4	26	34	0.2	0.06	21		
G9075047	9/12/1992	116640	37	5.6	3	4	7	32	1	1	2	1	2	3	3	6	0.1	2.7	7		
G9075047	9/12/1992	116641																			Total Susp. Solids
G9075047	9/12/1992	116642																			Turbidity
G9075047	11/08/1993	116643	588	8.1	284	346	305	314	48	28	46	45	1	4	14	24	0.2	0.23	19		
G9075047	11/08/1993	116644																0.003			Heavy Metals

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075047	11/08/1993	116645																0.003		Heavy Metals
G9075049	12/12/1992	116650		7.8																
G9075049	12/12/1992	116651		7.8																
G9075049	12/12/1992	116652		7.8																
G9075049	12/12/1992	116653		7.8																
G9075049	12/12/1992	116654		7.8																
G9075049	12/12/1992	116655		7.8																
G9075049	12/12/1992	116656		7.8																
G9075049	12/12/1992	116657		7.8																
G9075049	12/12/1992	116658	43400	7.6	108	132	5260	30600	316	16170	22650	1090	2	333	9190	2820	0.3	0.4	2	
G9075049	12/12/1992	116659																		Total Susp. Solids
G9075049	12/08/1993	116660	838	7.8	247	301	316	471	59	118	195	41	1	5	59	26	0.2	1.17	22	
G9075050	9/12/1992	116661	103	7.1	43	52	41	69	10	3	5	4	1	4	3	11	0.1	37	9	
G9075050	9/12/1992	116662																		Total Susp. Solids
G9075050	9/12/1992	116663																		Turbidity
G9075050	10/08/1993	116664	896	8	386	471	431	500	67	62	103	64	1	5	35	44	0.2	0.36	20	
G9075051	15/09/1989	116665	870	8.3	438	534	445	510	35	37	61	87	1	11	33	29	0.3	0.1	36	
G9075051	28/07/1993	116666	1660	7.2	420	512	811	1190	150	101	166	106	1	11	78	425	0.5	2	26	
G9075051	28/07/1993	116667																		Trace Metals

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075051	28/07/1993	116668																			Micro-organisms
G9075051	28/07/1993	116669																			Micro-organisms
G9075051	18/08/1993	116670	1670	7	428	522	841	1210	152	108	178	112	2	11	82	461	0.6	0.1	27		
G9075051	18/08/1993	116671																			Micro-organisms
G9075051	19/08/1993	116672																			Trace Metals
G9075051	21/10/1993	116673																			Micro-organisms
G9075051	7/12/1993	116674	1440	7.6	433	528	653	922	113	95	157	90	1	12	81	264	0.5	0.1	27		
G9075051	7/12/1993	116675																			Heavy Metals
G9075051	23/08/1995	1086																			Micro-organisms
G9075052	13/01/1995	151057	27.5	6.3	6.4	7.8							0.01								
G9075052	2/08/1995	152966	220	7	81	99							0.013								Heavy Metals
G9075052	21/11/1995	153741	410	7.3	172	210															Heavy Metals
G9075053	4/08/1995	152967	158	7.1	72.5	88.4							0.01								Heavy Metals
G9075053	23/11/1995	153745	225	6.8	103	126							0.019								Heavy Metals
G9075054	13/05/1996	154760	15800	7.4	258	315	2020	10400	183	5340	8800	382	1	102	3010	980	0.2	0.1	16		Heavy Metals

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9075054	13/05/1996	154761	13800	7.3	247	301	1930	8850	221	4620	7610	335	1	77	2570	870	0.1	0.1	12	
G9075055	8/10/1996	154830	62	5.7	11	14	21	49	5	13	21	2	2	2	7	1	0.1	0.5	2	
G9075055	11/10/2008		200	7																
G9075056	11/08/2008		114	6.8																
G9075057	11/08/2008		280																	
G9075059	12/08/2008		13																	
G9075060	12/08/2008		17																	
G9075061	13/08/2008		213	7																
G9075061	13/08/2008	EL1259 4	219	7.7	101	101	86.6	130	16.8	7.5		10.8	0.01	11.1	6.2	1.4	0.2	0.06	24.4	Heavy Metals
G9075062	13/08/2008		33																	
G9075063	13/08/2008		19																	
G9075064	8/10/2008		102	6																
G9075064	8/10/2008	EL1259 4	83	6.6	9	9	9.3	80	1.2	18.2		1.5	0.005	1.2	11.2	0.5	0.1	0.46	12.8	Heavy Metals
G9075065	9/10/2008		350	6																
G9075065	9/10/2008	EL1259 4	363	7.7	185	185	181	220	68.9	8.2		2.2	0.01	0.5	6.3	3.3	0.1	0.6	11.8	Heavy Metals
G9075066	9/10/2008		160	6																
G9075066	9/10/2008	EL1259 4	162	6.1	4	4	16.9	130	1.9	37		2.9	0.015	0.8	23.3	3.8	0.01	0.58	30.4	Heavy Metals
G9075067	9/10/2008		1210	7																
G9075068	11/10/2008		55	5.5																
G9075069	11/10/2008		333	7.5																

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9075070	11/10/2008		409	8																	
G9075071	11/10/2008		518	8																	
G9075072	11/10/2008		33	5																	
G9075073	11/10/2008		136	6																	
G9075074	11/10/2008		25	5																	
G9075075	12/10/2008		120	6																	
G9075076	12/10/2008		181	6																	
G9075077	12/10/2008		1886	9																	
G9075078	18/10/2008		532	7.5																	
G9075078	18/10/2008	EL1259 4	443	7.2	191	191	202	310	48.7	6.1		19.5	0.06	15.8	5.4	34.9	0.3	0.02	56	Heavy Metals	
G9075079	18/10/2008		527	7.5																	
G9075081	18/10/2008		788	8																	
G9075081	18/10/2008	EL1259 4	737	8	422	422	407	430	94.3	7.9		41.6	0.3	2.4	4.4	2	0.2	0.02	24	Heavy Metals	
G9075082	18/10/2008		667																		
G9075083	19/10/2008		918	8.5																	
G9075083	19/10/2008	EL1259 4	891	8.1	516	516	507	530	84.6	13.3		71.7	0.005	4.9	7.7	0.8	0.2	0.02	29.8	Heavy Metals	
G9075084	19/10/2008		911	8.5																	
G9075085	10/07/2008		61	6.6																	
G9080133	30/09/1968	116693	3000	7.3	130	79	425	1650	55	855		67	1	20	465	122	0.7	0.1	11		
G9080133	30/09/1968	116694	230	6.5	98	60	122	160	18	16		13	1	3	9	6	0.1	0.1	11		

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis
G9080133	30/04/1976	116695	218	7.2	105	128	98			7	12									
G9080133	13/01/1978	116696	220	7.2	110	134	106			8	13									
G9080133	3/08/1984	116697	380	8.5	199	233	194	200	35	10	16	26	1	2	7	6	0.1	0.3	21	
G9080133	21/08/2006		540	8.3																Temp=3 2
G9080133	14/12/2006		680																	Temp=3 1
G9080133	14/06/2007		366	>7. 6																
G9080133	17/07/2007		466																	
G9080133	25/09/2007		546																	
G9080133	27/10/2007		558																	
G9080133	24/11/2007		582																	
G9085010	15/07/1965	116710	4680	5.6	10	6	980	23626	60	1711				51	96	200				
G9085010	15/07/1965	116711	704	6.5	70	43	112	470	8	267		22		14	5	60				
G9085013	14/07/1965	116715	80	6.7	29	18	18	100	4	18		2		9	10					
G9085014	14/07/1965	116716	135	7.3	40	24	24	172	4	31		3		5	15					
G9085084	22/09/2008		40	5																
G9085085	10/07/2008		480	7.8																
G9085086	10/07/2008		253	7.5																
G9085087	10/07/2008		91	7.1																
G9085088	10/07/2008		44	6.6																
G9085089	12/07/2008		111	7.4																

Surface Water Site	Sample Date	Sample No:	Specific Conduct (uS/cm)	pH	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Calcium (mg/L)	Chloride (mg/L)	NaCl (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Fluoride (mg/L)	Iron (mg/L)	Silica (mg/L)	Other Analysis	
G9085090	12/07/2008		512	8.2																	
G9085091	12/07/2008		49	7.1																	
G9085092	12/07/2008		694	7.6																	
G9085099	21/06/2007		384																		

APPENDIX G: RAINFALL RECORDER SITES

LIMMEN BIGHT RIVER REGION

Station Number	Site	Easting	Northing	Commence	Cease	Recommence	Status
DR014621	NUTWOOD DOWNS	409098.7	8251320	31/08/1935	31/03/2003		open
DR014628	TANUMBIRINI	462581.3	8181254	31/12/1969	28/02/2003		open
DR014645	Limmen River	553750.8	8312092	31/05/1995	31/03/2003		open
DR014701	BAUHINIA DOWNS	551782.8	8207198	31/12/1973	31/12/1999		closed
DR014712	Hodgson River	402817.2	8277703	31/07/1974	31/03/2003		open
DR014716	BROADMERE STATION	521478	8183281	30/11/1971	29/02/1992	31/01/2003	open
DR014719	NATHAN RIVER	544797.7	8277270	31/05/1979	31/10/1992	31/03/2003	open
DR014621	NUTWOOD DOWNS	409098.7	8251320	31/08/1935	31/03/2003		open
DR014628	TANUMBIRINI	462581.3	8290187	31/12/1969	28/02/2003		open

Sites are all located in zone 53, Datum MGA94.

MACARTHUR RIVER REGION

Station Number	Site	Easting	Northing	Commence	Cease	Recommence	Status
DE014703	CENTRE ISLAND [GULF CARPENTARIA]	692974.8	8258056	1/08/1975	31/03/1984	30/04/1994	closed
DE014704	McARTHUR RIVER [MIMETS]	614654.5	8182097	1/11/1974	31/05/1993	30/04/1994	closed
DE014711	VANDERLIN ISLAND @ MET STATION	719697.3	8250434	1/01/1967	30/11/1970	31/05/1999	
DR014700	BALBIRINI (CAPE CRAWFORD)	578295.8	8149961	30/04/1968	31/05/1992	31/05/1999	
DR014703	CENTRE ISLAND	694776.8	8259886	29/02/1968	31/03/2003		open
DR014704	McARTHUR RIVER (MIMETS)	615786.5	8182982	31/12/1967	31/03/2003		open
DR014708	BING BONG	644836.1	8271323	31/12/1964	31/01/2002		open
DR014710	BORROLOOLA	639179.2	8223415	31/08/1889	31/08/1978		closed
DR014711	VANDERLIN IS MISMETS	719679.7	8248589	30/11/1964	31/12/1977		closed
DR014714	BORROLOOLA WELFARE	639179.2	8223415	30/09/1970	31/12/1974		closed
DR014715	McARTHUR RIVER STATION	590763.7	8157287	30/04/1970	31/07/2001		open
DR014722	Cape Crawford	577386.7	8155085	31/08/1986	30/11/1999		
DR014723	BORROLOOLA AWS	639528.2	8222214	31/12/1986	28/02/1987	31/03/2003	open
DR014724	McCants Spring	607453.3	8108738	30/11/1988	31/05/1991		closed
DR014725	BILLENGARAH	577465.7	8199102	31/05/1991	30/06/1991	31/01/2002	open
DR014726	BORROLOOLA POLICE STATION	639187.2	8224705	31/05/1991	30/11/1991	31/01/2002	open
DR014727	DOOLGARINA	688773	8204879	31/05/1991	30/04/1994		closed
DR014729	Bing Bong Port	648765.5	8271474	31/12/1995	31/03/2003		open
G9070121	McArthur River At Borroloola Crossing	640990.2	8221723	1/04/1965	28/03/2006		open
G9070132	McArthur River At M. I. M. Pump	615852.1	8180684	7/10/1969	29/03/2006		open
R9070135	McArthur River At At Favenc Range	518454.1	8149672	14/10/1975	14/09/2005		open
R9070142	McArthur River Upstream Baileys Grave	577964	8133751	3/12/1974	4/08/2005		open
R9070146	Looking Glass Creek At Skipping Stones	602125.5	8203167	20/10/1975	13/05/1993		closed

Sites are all located in zone 53, Datum MGA94.

Back Cover: Indigenous wooden food and water carrier – Coolamon or *Lujuluju* -purchased from Waralungku Arts, Borroloola



Daphne Mawson

Daphne Mawson, a Garrwa woman, related the following story about a coolamon of water. She lives in Borroloola and works at the Borroloola primary school teaching indigenous culture in Garrwa.

Story about the frog and the Pee Wee

Every night when I was little, my grandmother told me a story about the frog and the Pee Wee. It is a story of how the rivers came to be and not to be greedy. She said that a long, long time ago in the dreamtime there was a Pee Wee and a frog. The Pee Wee was the owner of a coolamon of water. He used to carry it around.

One day the Pee Wee camped under a tree and hid the Coolamon of water. The frog came to the Pee Wee to ask where he got water from. The Pee Wee said go north and the frog went north. In the evening he came back tired and weary and said there was no water there. 'Where did you get the water from' he asked? The Pee Wee replied 'ah I forgot, I got the water from the east'. So the frog went to the east and as he traveled he was getting very tired but he made it back to the Pee Wee. Once again he asked 'where did you get the water from'? The Pee Wee said 'Oh silly me, that's right I got it from the south'. Off he slowly went, he was getting very tired and very thirsty. But the frog still didn't find the water and went back to the Pee Wee. He asked the Pee Wee again, his lips were dry and parched, his voice was croaky 'Where did you get the water from'? The Pee Wee said 'I'm getting old, I keep forgetting, that's right, I got it from the west'. So off went the frog, he was very tired and dehydrated. By this time the Pee Wee was getting tired because he hadn't slept for days as he was guarding his coolamon from the frog. He fell asleep. Poor old frog slowly dragged himself back after not finding any water. He saw the Pee Wee had fallen asleep and grabbed a rock and smashed the coolamon. Water gushed everywhere and that's how the rivers were created. The Pee Wee woke up with a start and found his water gushing everywhere, he ran and grabbed the stick and bashed himself over the head crying for his water. Blood streamed all over his body and that's why today the black marks you see on the Pee Wee are the blood stains for when he cried for his water. Today when you hear the first storms you hear the frogs in the lagoons, that's the frogs teasing the greedy Pee Wee who wouldn't share his water.

This was the story my grandmother told to teach us to share everything, especially water which is needed for everyone's survival.

