Cockburn River Groundwater and Surface Water Connectivity Study

Assessing the connectivity between groundwater and river pools to identify the potential implications for groundwater use.

December 2021

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Acknowledgment of Country

The NSW Government acknowledges Aboriginal people as Australia's first people practicing the oldest living culture on earth and as the Traditional Owners and Custodians of the lands and waters. We recognise the intrinsic connection of Traditional Owners to Country and acknowledge their contribution to the management of landscapes, water and other natural resources across NSW.

NSW Department of Planning, Industry and Environment understands the need for consultation and inclusion of Traditional Owner knowledge, values and uses in water planning to ensure we are working towards equality in objectives and outcomes. The department is committed to continuing future relationships and building strong partnerships with Aboriginal people.

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1. Summary

This project investigates the interaction between surface water and groundwater in the Peel Alluvium Groundwater Source - Cockburn River Alluvium Management Zone. It compares the water depth and water quality of four pools in the Cockburn River with local groundwater levels and rainfall.

The main aim of the project is to determine how groundwater extraction influences surface water volumes/levels. Key findings of this study, in conjunction with numerical modelling, will assist in the development of options for groundwater access rules in the Cockburn River Alluvium Management Zone.

This study concludes that:

- Surface water and groundwater were always connected within the Cockburn River Alluvium Management Zone during the study period, fluctuating between throughflow connectivity, to losing connected, depending on the location and hydrological conditions such as rainfall, stream flow and potentially extraction. No part of the stream system was disconnected from groundwater.
- The pools were maintained by groundwater during the zero-flow period in 2019/2020. However, it could not be determined from the available information if groundwater extraction over this period significantly impacted on water levels in the pools.

  During the period of very low water levels (in 2019/2020), the pools had poor water quality with high water temperatures and very low dissolved oxygen levels, hence biota would have been under stress. The pools were also very small (in size and depth) and inflows from groundwater were likely important for biota during dry times, as there had been zero surface water flows for the previous ten months.
- Following the resumption of surface water flow in mid-January 2020, after which the main monitoring period commenced, it could not be determined if groundwater extraction significantly impacted on pool heights as there was substantial rainfall in the area and constant river flows during the data collection period. The direct analysis methods applied in this project were not able to distinguish the individual contribution of rainfall, surface water flows and groundwater discharge to river/extraction and how they directly impact on or contribute to the pool levels.
- Pumping groundwater from the alluvium will likely have an impact on surface water especially during low/no surface water flow periods. However, the specific contribution and timing of impact from groundwater extraction on surface water cannot be determined directly from the information and analysis undertaken in this study.
- Numerical modelling is required to analyse the direct impact of groundwater extraction on the stream/pool levels.

2. Project purpose

The aim of this project is to assess how groundwater extraction influences water levels in the river and river pools of the Cockburn River.

The scope of this project is limited to understanding the effect of groundwater pumping on river pool water levels and the hydraulics of these effects.

This project aims to answer the following research questions:

1. How does groundwater extraction influence surface water pool volumes/levels?
2. How does this affect the water quality in the river pools of the Cockburn River?

The Department of Planning, Industry and Environment is developing a numerical model for the Peel Alluvium that includes the Cockburn River Alluvium Management Zone.

The model will allow the department to further investigate surface water/groundwater interactions in the Peel Alluvium and assess the effect of different access rules in the Cockburn River Alluvium Management Zone.

The information collected in this project will be considered in the modelling and assist in identifying options for groundwater daily access rules for further consideration.

3. Introduction

The groundwater in the Cockburn River Alluvium is highly connected to the Cockburn River, hence groundwater extraction has the potential to impact surface water flows and river pool depth (Cook et al., 2006; Welch et al., 2013; DoI, 2019).

Pools in river systems provide valuable ecological services including providing refugia for aquatic biota during low and zero flow conditions that are frequently experienced during drought.

The Cockburn River supports several high ecological value assets that are dependent on the sustainability of river pools, including endangered populations of Eel-tailed catfish and Murray cod, which are listed as vulnerable. A key threatening process (listed in the *Threatened Species Conservation Act 1995*) for these fish communities is the alteration to natural flow regimes of rivers and streams.

The pools and groundwater system associated with the Cockburn River are also an important source of water for licence holders, domestic and stock users and communities, providing for basic landholder rights and other productive uses like commercial irrigation.

Extraction from the unregulated Cockburn River Water Source - Cockburn River Management Zone is managed under the *Water Sharing Plan for the Namoi and Peel Unregulated River Water Sources 2012*. This plan defines low flow cease to pump rules that are linked to the Cockburn River Kootingal gauge that apply to unregulated surface water users.

The Peel Alluvium Groundwater Source - Cockburn River Alluvium Management Zone is managed under the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020.* While there are currently no cease to pump rules for groundwater licences, access rules can be included after 1 July 2022.

This study will help us understand the hydrological conditions in the surface water pools and their connection to the underlying alluvial aquifer which will be considered in determining if daily access rules for groundwater extraction are appropriate.

4. Study area

Cockburn River Alluvium Management Zone is associated with the Cockburn River in the Cockburn River Catchment, a sub-catchment of the Namoi River Catchment (Figure 1 - page 7), located near the city of Tamworth in the North-West Slopes region of New South Wales and is part of the Murray-Darling Basin.

The Cockburn River is located in the upper catchment of the Peel River. The river is 33.6 km in length and drains a sub-catchment of approximately 1,130 km^2 (Boys et al., 2011). The Cockburn River begins at the confluence of Swamp Oak Creek and Jamiesons Creek, it then flows in a south-westerly direction joining the Peel River (Boys et al., 2011).

Cockburn River Alluvium Management Zone (Figure 2) extends from the village of Nemingha in the south-west approximately 9 km to Kootingal, then another 5.5 km to the north-east past Kootingal (total length approximately 15 km). The width of the system varies along its length but is generally less than 1 km wide.

4.1. Climate

Climate data is available the from Kootingal (Gate Street) Station 55148 and Tamworth Airport Station 055325, from the Bureau of Meteorology (BOM) and augmented by patch point data from the SILO database (Queensland Department of Environment and Science/BOM).

The climate in the Cockburn catchment is temperate, the temperature extremes range from -5 °Celsius (C) in the winter to 40+°C in the summer. Average rainfall is approximately 660 mm/year (2010 to 2020), rainfall is generally summer dominant from November to February. Summer rainfall is typically 70 - 95 mm per month at Kootingal. During the recent drought in 2018/2019 rainfall was well below the 10-year average monthly rainfall (Figure 3).

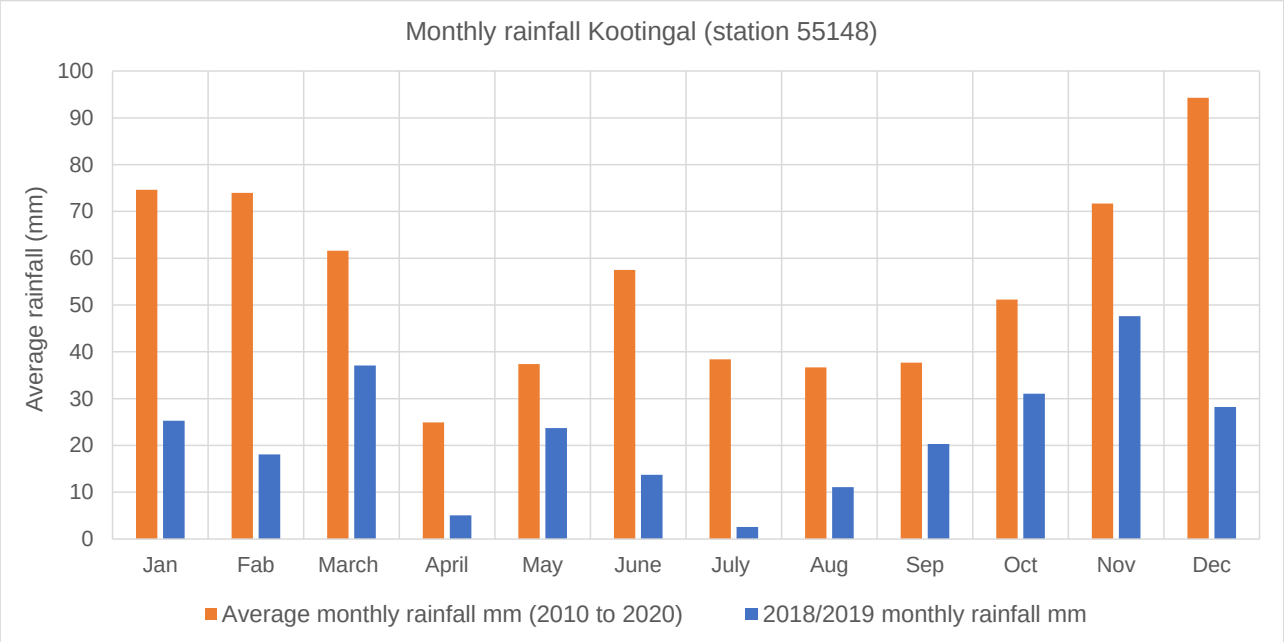

Figure 3. Average monthly and 2018/2019 rainfall at Kootingal (BOM station 55148)

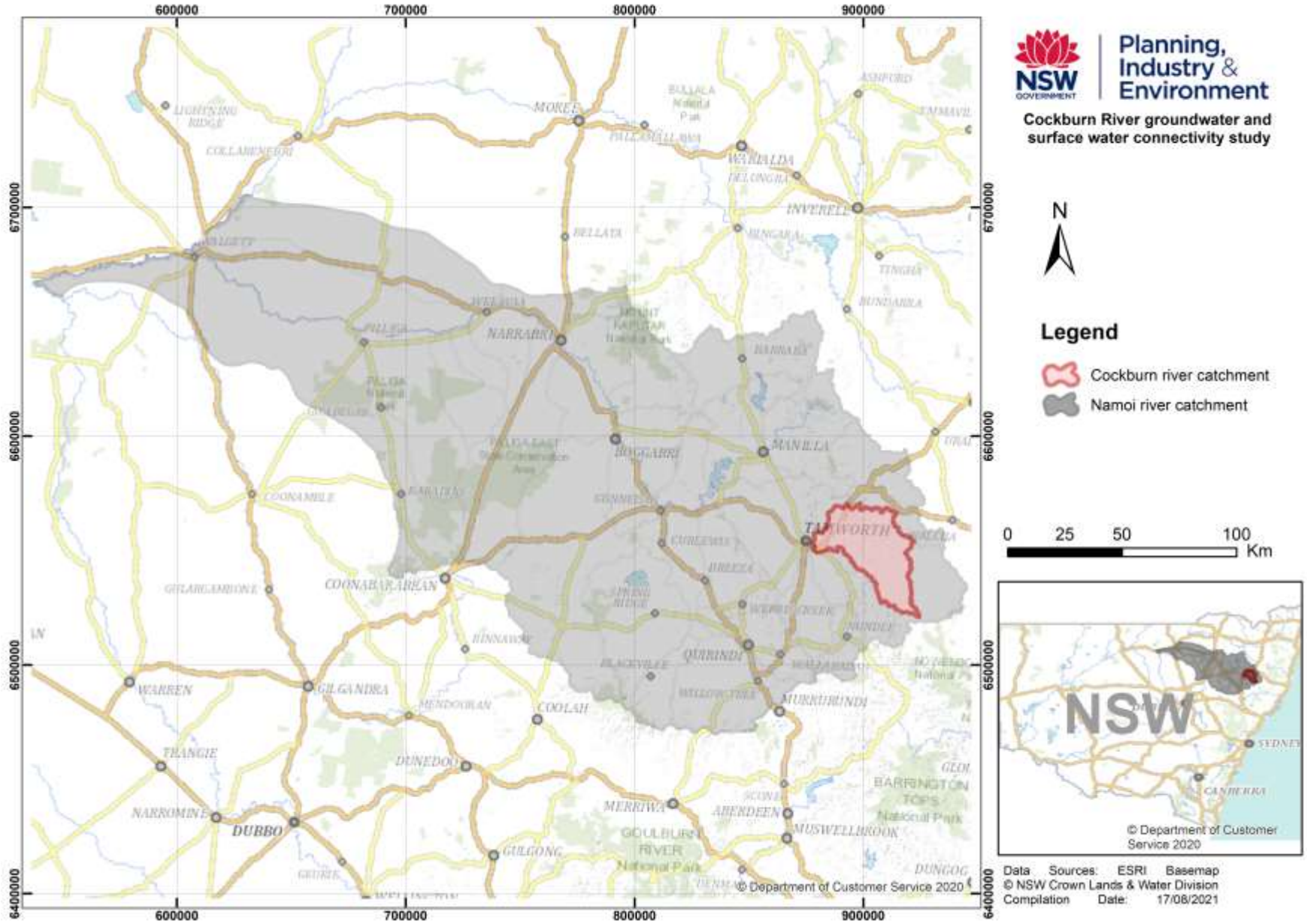

Figure 1. Cockburn River water source in the Namoi River catchment.

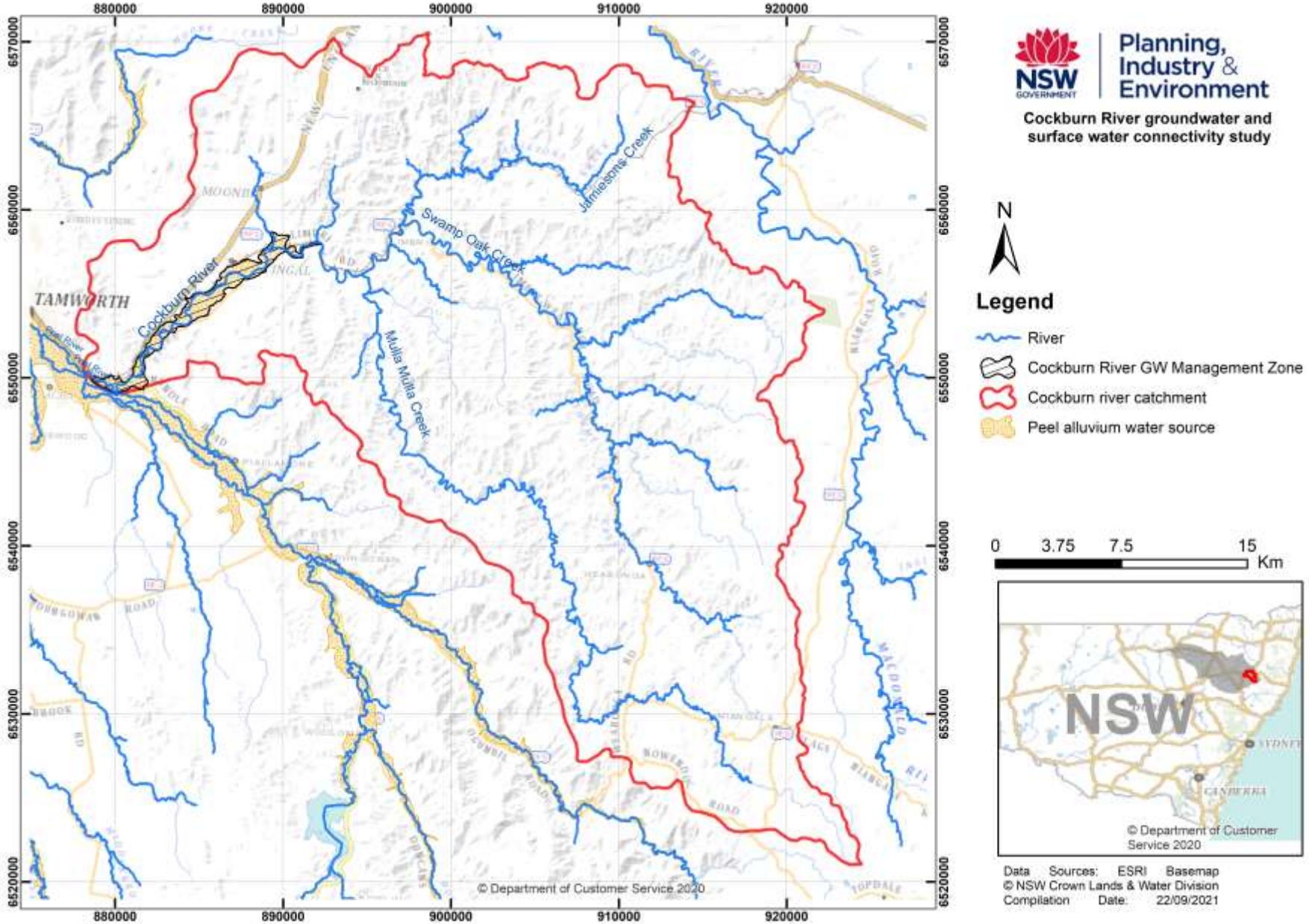

Figure 2. Study pools location in Peel Alluvium Water Source located in the Namoi Valley.

The cumulative deviation from mean rainfall (2010 to 2020) for Kootingal is shown in Figure 4. This graph shows the cumulative difference from the monthly average rainfall and provides a visual representation of the rainfall history in an area.

The y-axis is unimportant in Figure 4, the rising and falling trends in the data are the focus of the graph. The falling trend indicates a period of lower-than-average rainfall, a rising trend showing periods of above average rainfall. The 2018/2019 drought period shows a pronounced decreasing trend representing the period of very low rainfall.

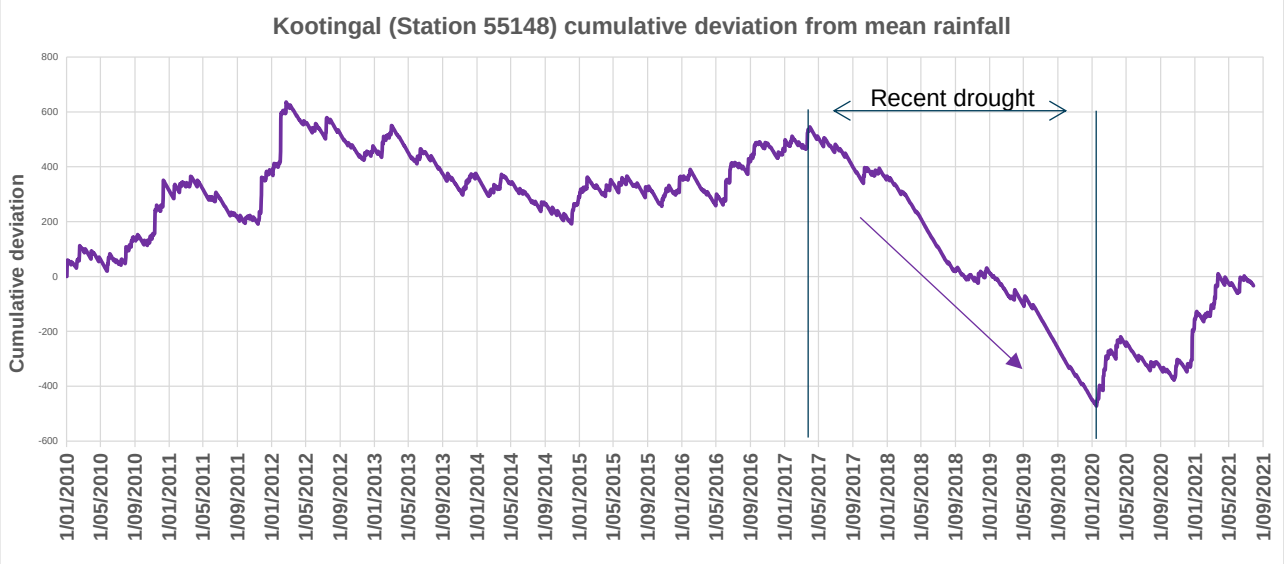

Figure 4. Cumulative deviation from mean rainfall graph – Kootingal 2010 to 2020

4.2. Hydrology

There are three current gauging stations in the Cockburn River; two at the Kootingal Bridge (419099 and 419114) and one at Mulla Crossing (419016). The Kootingal Bridge gauging station (419114) has been recently installed and became operational on 1 July 2020.

The new Kootingal gauge (419114) replaces the existing gauge (419099). The existing gauge is still active as it was designed to detect flood events and act as a warning system for Tamworth Regional Council. The new gauge is designed to accurately record daily flows at levels required to trigger the cease-to-pump rules in the water sharing plan.

The flow duration curve shows that the river often ceases to flow at the Kootingal gauge (419099), about 25% of the time (Figure 5). However, the river does not dry completely with some surface water pools being maintained by groundwater discharge throughout the system. The new gauge at Kootingal (419114) does not have a history of data to show an updated duration curve.

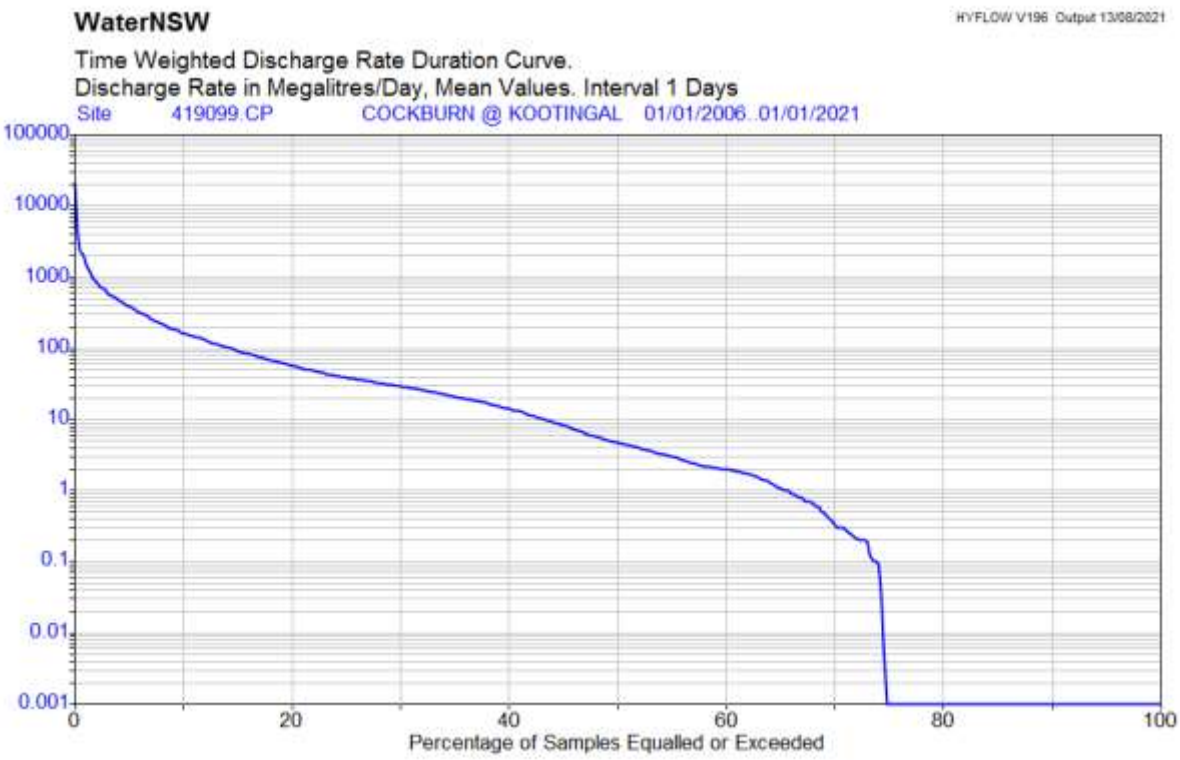

Figure 5. Flow duration curve for the Cockburn River at Kootingal 419099.

4.3. Hydrogeology

The Cockburn River alluvium forms a shallow unconfined aquifer associated with the Cockburn River. The alluvium generally consists of sands, clays, gravels, cobbles and boulders. The thickness of Cockburn River Alluvium can be up to 25 m, but is generally less than 15 metres.

The depth to the water table varies from 4 m to 7 m below the ground surface. The saturated thickness of this unconfined aquifer varies from 4 m to 12 metres. The top 3 m to 5 m of the alluvium is generally loam or clay rich soils.

4.4.1 Surface water/groundwater interaction theory

Surface water can interact with groundwater in all types of landscapes. There are four basic ways surface water and groundwater interact:

a) Gaining stream (Figure 6a) - streams gain water from inflow of groundwater through the streambed.

b) Losing stream (Figure 6b) - streams lose water to groundwater by outflow through the streambed. Streams can be both, gaining in some reaches and losing in other reaches.

c) Disconnected stream (Figure 6c) - the stream is disconnected from groundwater as the water table is below the bottom of a stream.

d) Through-flow stream (Figure 6d) - where groundwater passes across the stream and can be gaining and losing at the same time.

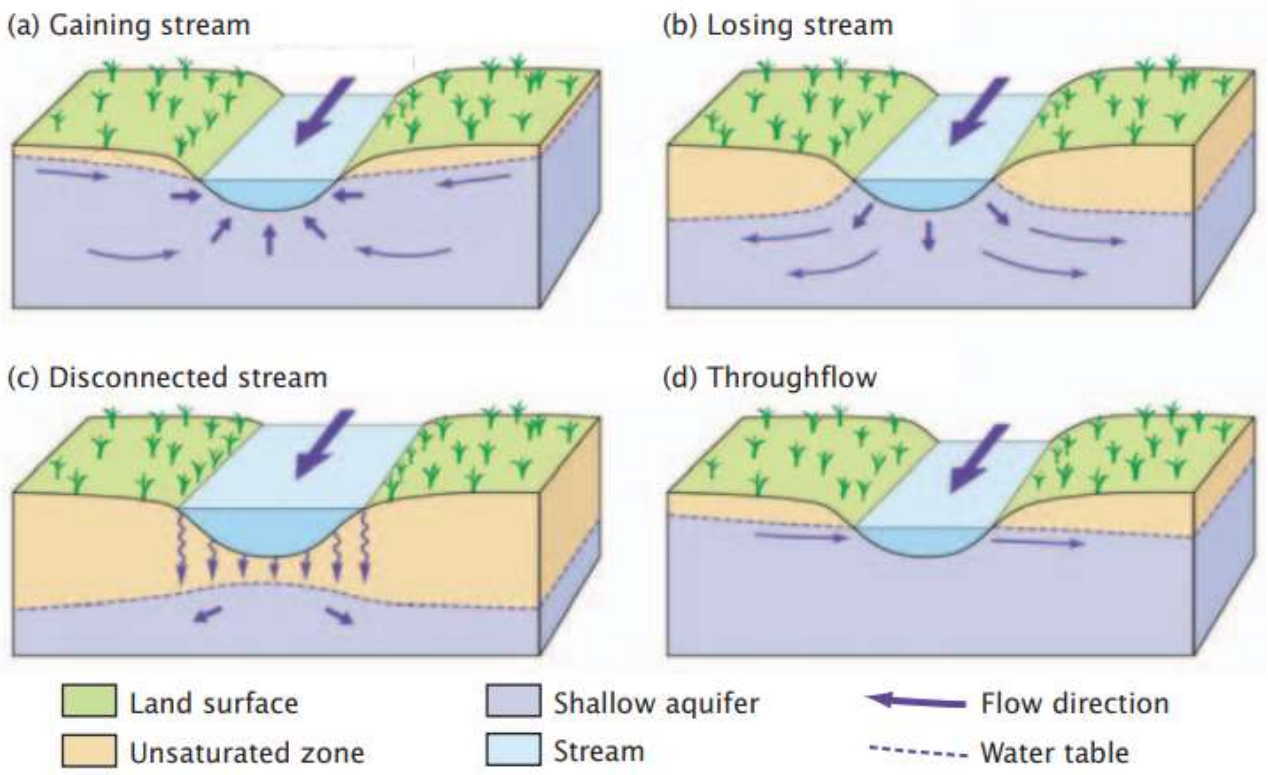

Figure 6. Surface water/groundwater interaction types (Winter et al, 1999)

For groundwater to discharge into a stream channel, the water table in the vicinity of the stream must be higher than the stream water level. For surface water to seep into groundwater, the water table in the vicinity of the stream must be lower than the stream level.

In connected systems including gaining, losing and throughflow streams, pumping groundwater can impact on the stream. Whereas disconnected systems, pumping of shallow groundwater near the stream does not affect the flow of the stream near the pumped wells/bores. This is because there is an unsaturated zone between the groundwater table and river where a system is disconnected, meaning that the surface water and groundwater are not hydraulically connected, so pumping groundwater, no matter how much or how close the bore is to the stream, will not induce additional leakage from a stream.

4.4.1 Groundwater monitoring network

Long term groundwater level data is available from the existing government monitoring bore sites at Nemingha and Kootingal (Figure 7).

The hydrographs for the government monitoring bores at Kootingal and Nemingha are shown in Figure 8 (Kootingal), with Cockburn River height data from Kootingal gauge (419099) and Figure 9 (Nemingha), there is no surface water gauge with long term data close to the Nemingha monitoring bore sites. The water levels are plotted in metres above the Australian Height Data (mAHD), meaning the heights are relative regardless of ground level variations.

The groundwater level shows correlation to surface water events over time, confirmed in Figure 8, as the groundwater levels mimic the surface water peaks.

The available water level data has been contoured (in mAHD) as shown in Figure 7, the predominant groundwater flow direction within the Cockburn River alluvium is downstream from north east to south west.

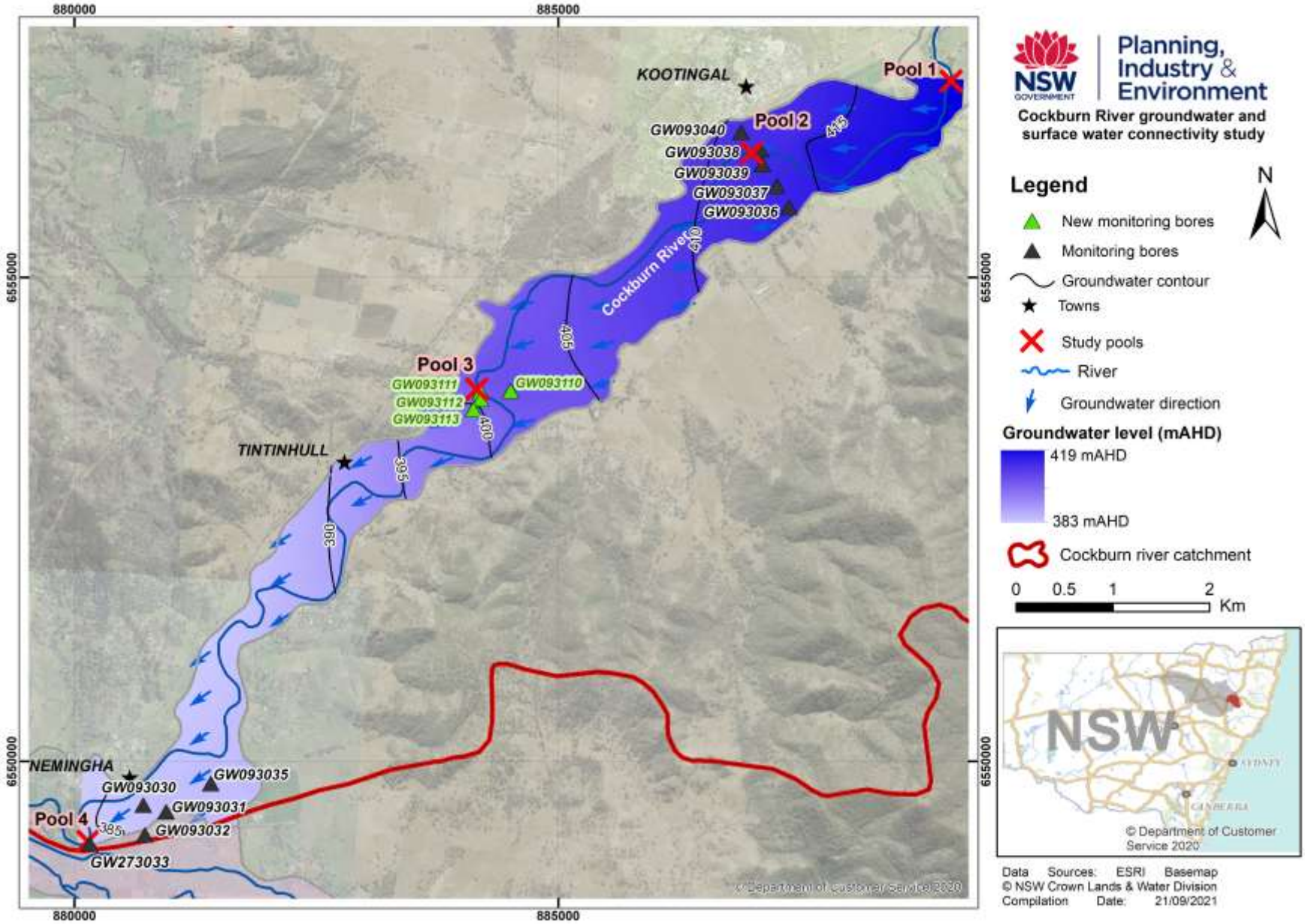

Figure 7. Groundwater flow direction in the Cockburn River Alluvium Groundwater Management Zone

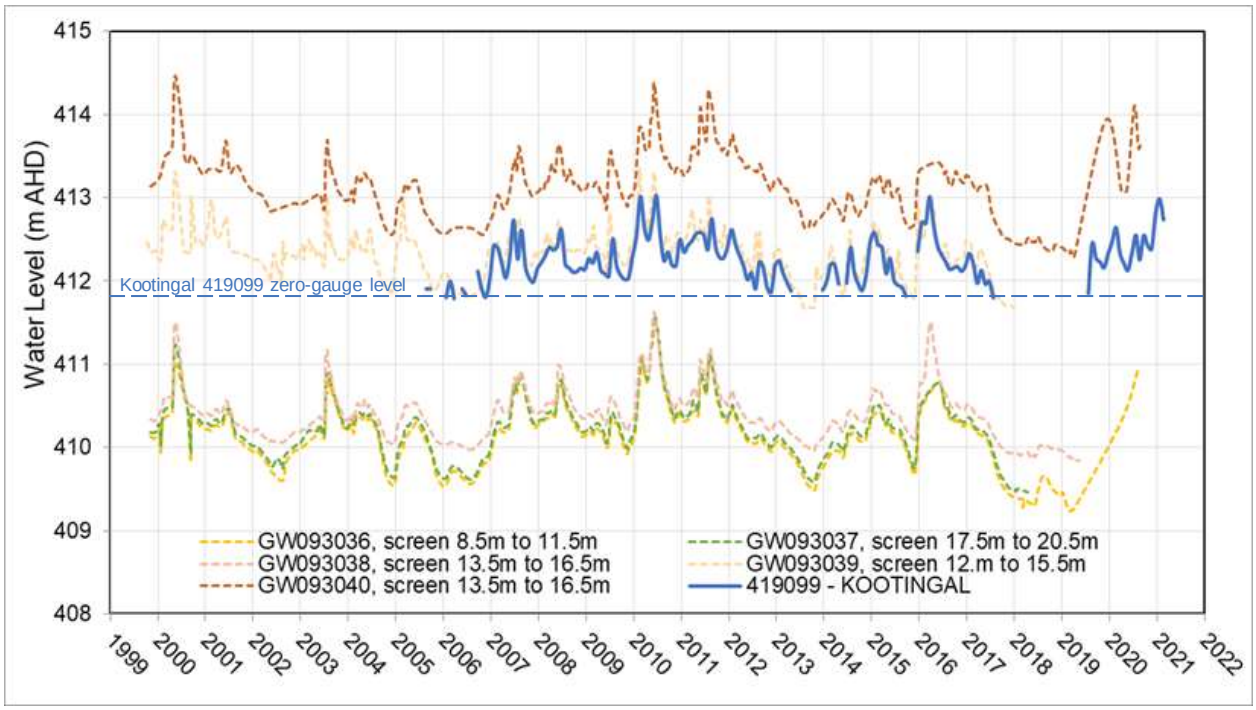

Figure 8. Kootingal groundwater monitoring bore hydrographs with monthly river height (blue line)

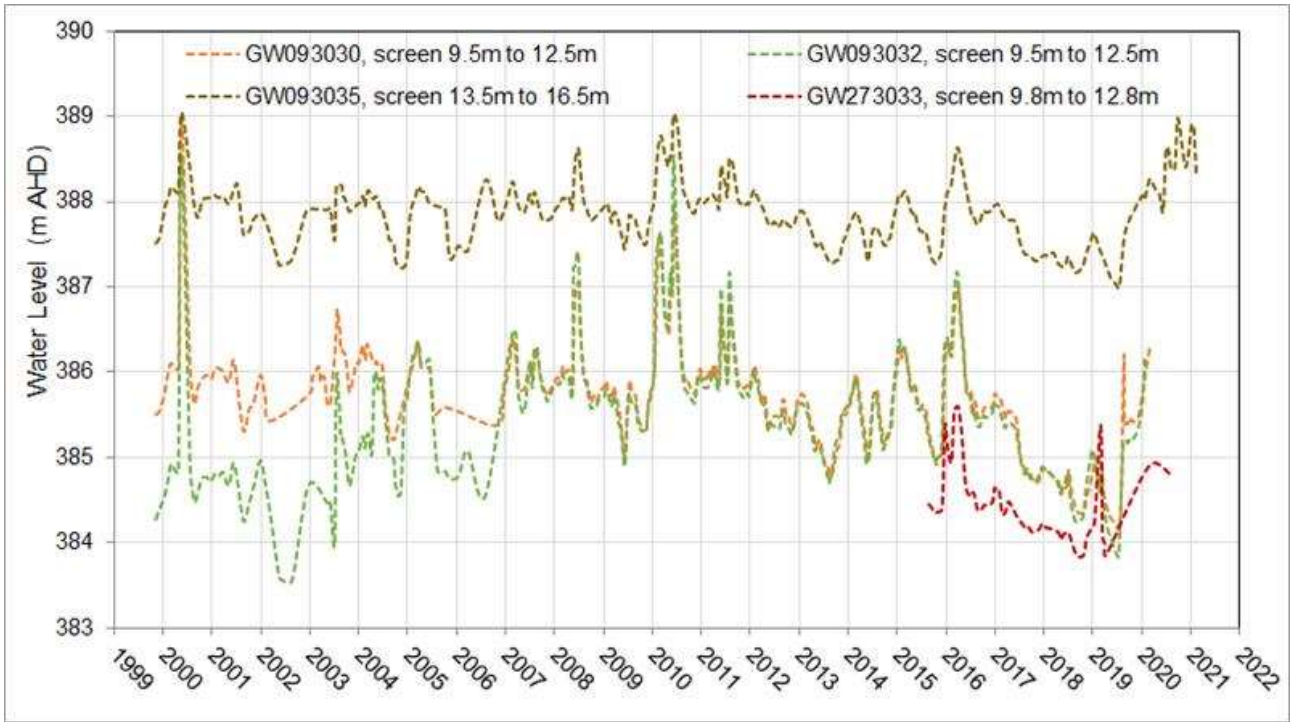

Figure 9. Nemingha groundwater monitoring bore hydrographs

4.4. Extraction

The number of extraction sites and shares held in the Cockburn River Management Zones, alluvial and unregulated river are listed in Table 1. The location of all bores and surface water extraction sites is shown in Figure 10.

Table 1. Extraction information for groundwater and surface water licences

	Access Licences			Basic Landholder Rights	
Cockburn River Management Zones	Number of extraction points	Number of Water Access Licences	Total Shares Held (equivalent to ML/year)	Number of extraction points	Volume allocated in the water sharing plan (ML/year)
Alluvium (groundwater)	57	37	4720	44	240*
Unregulated River	58	87	3075	~	219

* Volume allocated for the whole Peel Alluvium Groundwater Source.

~ Information on the number of Basic Landholder Rights extraction points is unavailable.

Groundwater extraction in the alluvium is monitored and recorded for Water Access Licences holders, the usage for the last 10 years from 2011 to 2021 is shown in Figure 11. The highest groundwater usage year was 2013/2014 with approximately 1300 ML/year. Average usage over this period is 800 ML. The recorded usage was relatively low in 2019/2020 (approximately 200 ML recorded) and in 2020/2021 (approximately 330 ML recorded), these low usage years is likely a result of both very low rainfall/recharge in 2019 that could have impacted on bore yields and potentially planting, this was then followed by resumption of surface water flow and higher rainfall fall in 2020 to present.

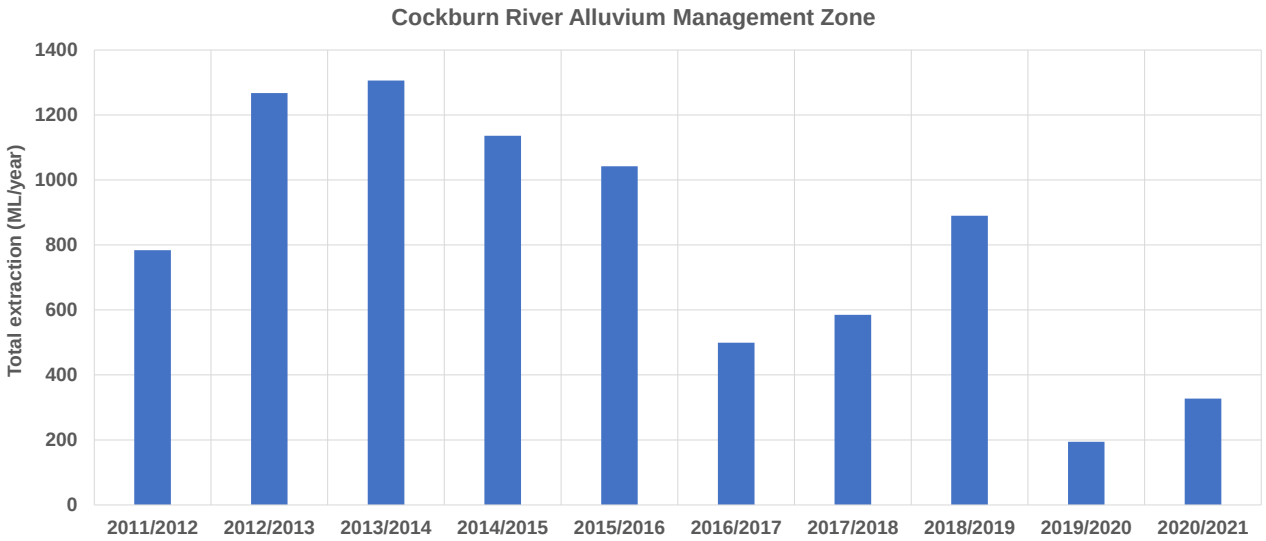

Figure 11. Total groundwater extraction (2011/12 to 2020/21) from production bores in Cockburn River Alluvium Management Zone

Extraction from basic landholder rights bores is not monitored and is unknown. Unregulated surface water extraction is not currently metered, there is no surface water extraction data available from the Cockburn River Management Zone.

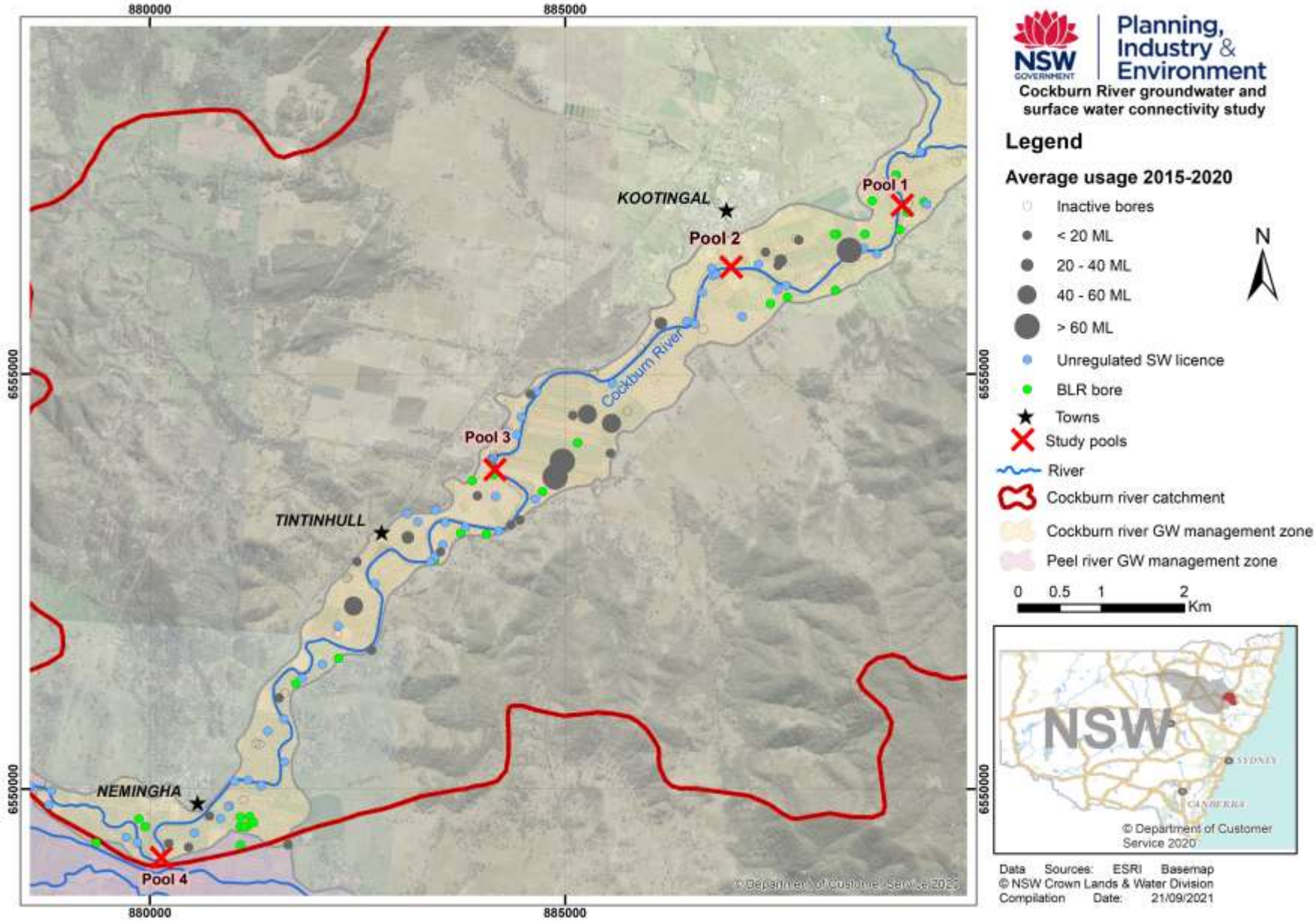

Figure 10. Location of active and inactive production bore in Cockburn River Alluvium Management Zone (in map: SW = surface water).

5. Methodology

5.1. Site selection

Four pools on the Cockburn River and 23 nearby groundwater bores were selected to study how much groundwater extraction influences water levels in the river and river pools.

The four pools were selected based on:

- ease of access
- healthy riparian vegetation (riparian vegetation provides bank stability, habitat, shade and food for native fish)
- depth and size sufficient to determine pool persistence during drought conditions

Pools 2, 3 and 4 were initially inspected in October 2019. Temporary gauging posts were installed at pools 3 and 4 to give an estimate of any changes in pool depth; the original gauge post downstream of Kootingal Bridge was used for Pool 2 (Appendix A, Figure 32 to 35). Pool water level changes, daily flow, rainfall and evaporation data was monitored for the period December 2019 to April 2021.

The 23 groundwater bores were selected for this investigation based on their proximity to the pools and ease of access. These included 8 existing monitoring bores, 11 private bores and 4 newly drilled monitoring bores.

The private and new monitoring bores included in the study, as well as the pools, were surveyed by a registered surveyor in 2020, this information is included in Appendix B. The location of the pool and bores considered in this study are identified in Figure 12. Further information on the sites is provided in Appendix C and bore logs for each bore considered in the study are included in Appendix D, E and F.

5.2. Surface water monitoring

The dimensions of the four pools were measured using a variety of techniques. Pool length and width were measured using a laser rangefinder. Pool depths were measured using a Deeper Pro sonar. Multiple transects were taken longitudinally and laterally along the pools to establish pool dimensions during different flow conditions.

During zero flow river conditions, the depths of individual pools were shallow, with most pools having an average depth of 1 to 1.5 metres. Pool length ranged from approximately 23 m to 240 m, and pool width ranged from 10 to 25 metres. When the pools resumed flowing in early 2021, pool depths increased with average depths ranging from 1.5 to 3 metres during flowing conditions

Diver dataloggers (pressure probes) were installed in the four pools to measure water levels and conductivity. Pressure probes were installed during a dry period in December 2019 and measurements were recorded every 15 minutes. Pressure probes were attached to Besser blocks so their relative height did not change as water levels fluctuate. A barometric pressure probe was also installed in a nearby location. The Barometric pressure probe provided a reference for air pressure in the local area.

The pressure probes measure water level with a highly accurate pressure sensor that measures absolute pressure. The pressure is equal to the weight of the water column above the measuring instrument plus the prevailing air pressure. Accuracy of probes are +-0.5cm (VanEssen Instruments, *Product Manual, 2018)*.

Water quality loggers were also installed in all four pools to analyse changes in temperature, dissolved oxygen and salinity. One dissolved oxygen/temperature logger was placed approximately

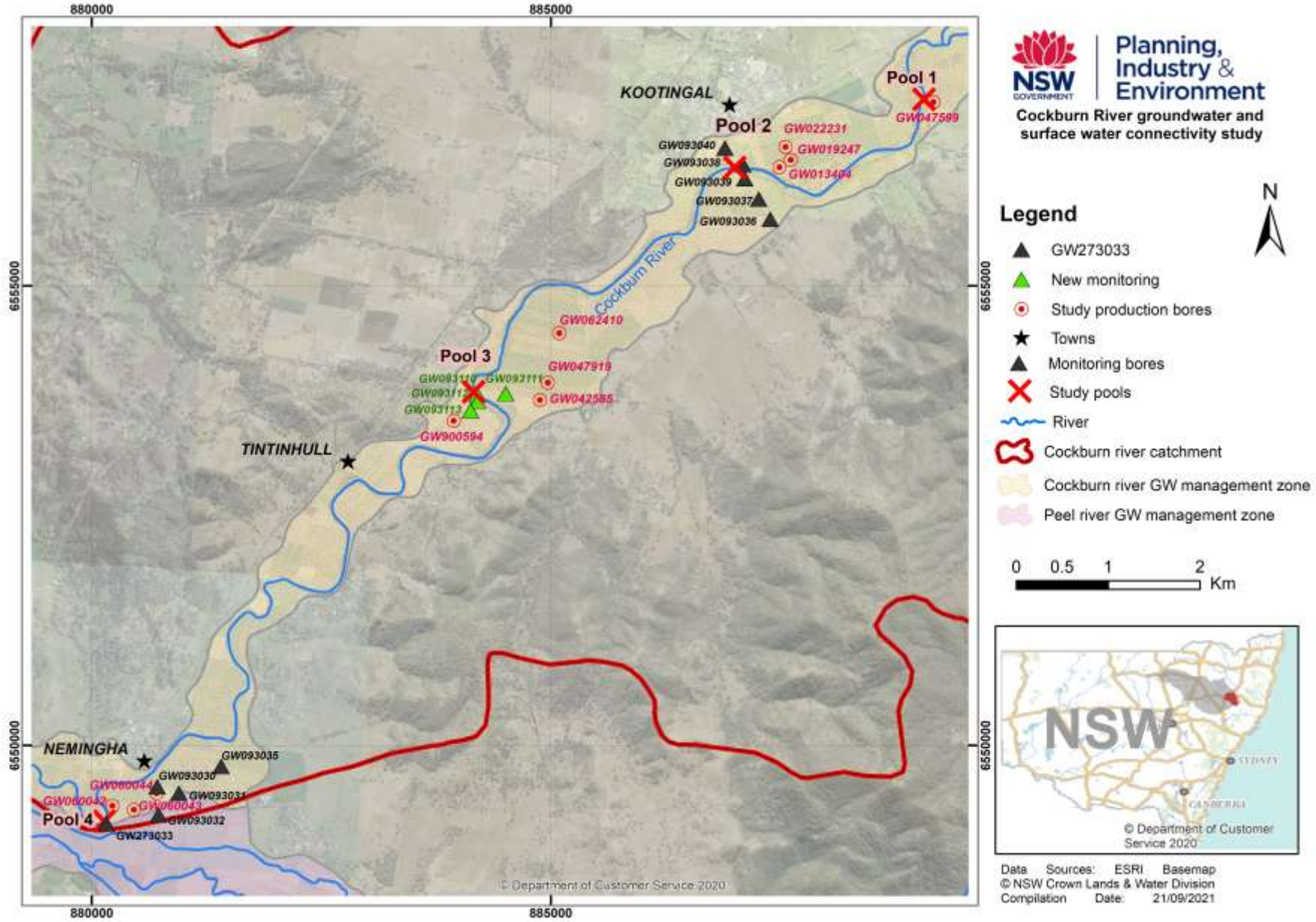

Figure 12. Pools and bores examined in the study.

25 cm below the water surface, the other was placed just above the riverbed. These probes were fixed in-situ as outlined for pressure probes. Measurements were taken automatically and logged every 30 minutes (day and night) to determine if dissolved oxygen stratification occurred within each pool and if dissolved oxygen concentrations were influenced by flow, particularly in zero flow periods.

5.3. Groundwater monitoring

Groundwater level and temperature data was collected from 23 bores included in the study; this information is summarised in Table 2.

Note: Monitoring bore GW093031 (shown on the maps) was not included in the study, as there is limited information available from this site. This bore is situated on a bedrock high (6 m deep) and is often dry. Also, GW093035 was not included, as it is at distance from Pool 2 and there are other closer sites available.

Table 2. Groundwater monitoring information

Site	Location	Bore Type	Instrumentation type	Date instrument installed
GW047599	Pool 1	Private production	Diver datalogger	June 2020
GW013404	Pool 2	Private production	Diver datalogger	February 2020
GW019247	Pool 2	Private production	Diver datalogger	February 2020
GW022231	Pool 2	Private production	Diver datalogger	February 2020[1]
GW093036	Pool 2	Existing monitoring	WaterNSW probe & telemetry	February 2005
GW093037	Pool 2	Existing monitoring	WaterNSW probe & telemetry	February 2005
GW093038	Pool 2	Existing monitoring	WaterNSW probe & telemetry	June 2020
GW093039	Pool 2	Existing monitoring	WaterNSW probe & telemetry	June 2020
GW093040	Pool 2	Existing monitoring	WaterNSW probe & telemetry	December 2002
GW042585	Pool 3	Private production	Diver datalogger	February 2020
GW047919	Pool 3	Private production	Diver datalogger	February 2020
GW062410	Pool 3	Private production	Diver datalogger	February 2020
GW900594	Pool 3	Private production	Diver datalogger	February 2020[2]
GW093110	Pool 3	New monitoring	Diver datalogger	May 2020
GW093111	Pool 3	New monitoring	Diver datalogger	May 2020
GW093112	Pool 3	New monitoring	Diver datalogger	May 2020
GW093113	Pool 3	New monitoring	Diver datalogger	May 2020
GW060042	Pool 4	Private production	Diver datalogger	February 2020
GW060043	Pool 4	Private production	Diver datalogger	February 2020
GW060044	Pool 4	Private production	Diver datalogger	February 2020
GW093030	Pool 4	Existing monitoring	WaterNSW probe & telemetry	June 2020
GW093032	Pool 4	Existing monitoring	WaterNSW datalogger	August 2020
GW273033	Pool 4	Existing monitoring	WaterNSW probe & telemetry	July 2020

[1]GW022231 only has data from the 24 February 2020 to the 9 September 2020. The logger was accidently turned off on the 9 September 2020 and it wasn't discovered until the next download of data on the 16 April 2021.

[2]GW900594 collapsed at some point between 2 April 2020 and 9 September 2020 and the logger has been stuck in the hole since this time. Data is only available forGW900594 from the 24 February to the 2 April 2020.

The Diver dataloggers (pressure probes) are similar to those installed in the pools. Diver datalogger data for groundwater included in this report was downloaded in April 2021. The main data considered in this report if for the period February 2020 to April 2021 except GW022231, which has data available to September 2020.

The instrumentation installed by WaterNSW is consistent with their existing protocol for groundwater datalogger and telemetry installation, for more information including water level data available for download see the WaterNSW website.

6. Analysis and results

6.1. Study pools

6.1.1. Flow condition effects on dissolved oxygen and temperature

The hydrographic data was categorised into flow classes (Appendix A) and compared with the dissolved oxygen and temperature data for Pool 2 (Figure 13). Pool 2 has been selected as representative of the pools because it was the deepest pool and is located where the new river gauge exists (419114).

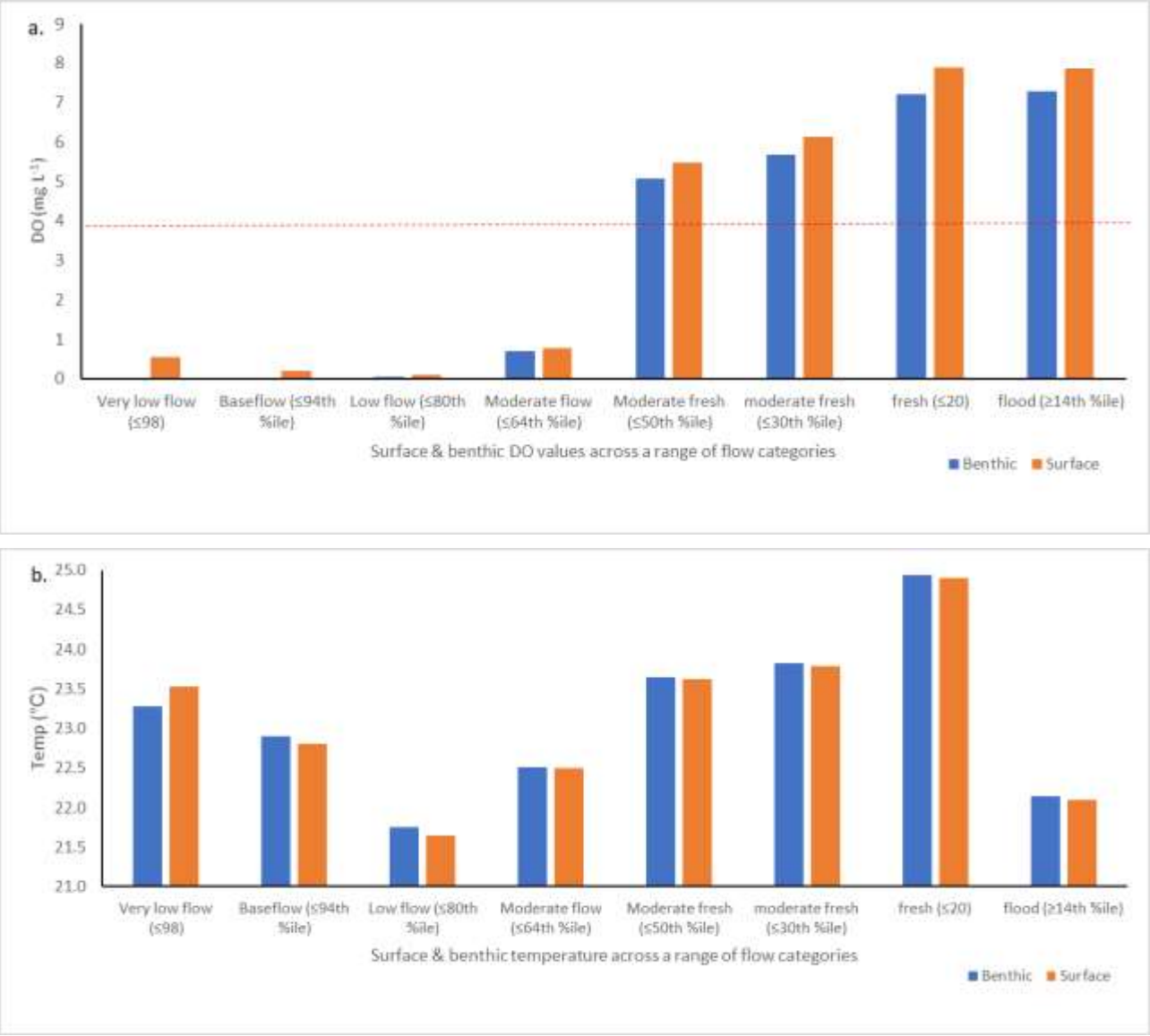

Figure 13. Pool 2 during the summer of 2020-21 with mean surface and benthic probe data: (a.) dissolved oxygen concentrations; and (b.) temperature values, per flow category during the summer of 2020-21. The red dashed line (a) represents the dissolved oxygen concentration (4mg/L) required to support aquatic organisms. Concentrations less than 2mg/L can result in death.

During summer when water levels were low (up to a moderate flow of 20 ML/d), dissolved oxygen concentrations were extremely low, potentially resulting in conditions that are lethal for aquatic organisms (anoxic conditions, i.e., <2 mg/L). However, when the river was flowing (e.g., a 50th

percentile: ≥29 ML/d) the pool was well oxygenated, reducing stress on aquatic organisms such as fish.

When dissolved oxygen concentrations remain below 4 mg/L, as highlighted by the red dashed line in Figure 5a, fish and other biota are placed under increasing stress. Dissolved oxygen concentrations below 2 mg/L can be lethal. The water temperature was consistently above 21°C, irrespective of river discharge during the summer months (Figure 5b).

Pool electrical conductivity levels generally increased with distance downstream, although values are not likely to be a concern for biota or irrigation (values ranged between 0.1 to 0.79 millisiemens per centimetre).

Lastly, no groundwater water quality samples were collected during the study period.

6.1.2. Native biota

It was not within the scope of this study to undertake native biota sampling in the surface water pools. A previous study by Boys et al., (2011) surveyed a range of native fish species in these pools.

However, during site visits by staff in December 2019, fish were observed to be under stress in some pools. Our observations can be summarised as:

1. fish have lost condition (i.e. had visual loss of weight)
2. fish were observed to float to the top of the water column often on their side and then slowly swim back down to the bottom of the pool
3. some fish had perished

Additionally, during the drought conditions as pools were drying up, a community member provided a photo of seven adult native Eel-tailed catfish that were collected and moved from a drying pool into a larger and deeper pool.

6.2. Surface water / groundwater interaction

6.2.1 Zero flow period

As outlined in section 5.1, visual estimates to determine changes in pool depth prior to the installation of pressure probes was achieved using existing or temporary gauging plates (Appendix B: Figure 23 to Figure 26). From late October 2019 to mid-December 2019 pool depths dropped by 6 cm in Pool 2; 30 cm in Pool 3; and 20 cm in Pool 4 during the zero flow period (Appendix B: Figure 22).

Upon installation of pressure probes in all four pools, changes in water levels for individual pools were compared against river flow, rainfall and evapotranspiration data to establish potential influences on pool heights. A linear regression was undertaken to establish the rate at which pools were changing height.

During the December 2019 to January 2020 zero flow period, when pressure probes were installed, overall the pool water level did not change substantially, but there were some differences in how they responded. It was expected that high evapotranspiration rates in summer (rates of 0.87 cm/day - daily evapotranspiration data, Tamworth Airport, BOM) would result in clear decreases in water levels for the zero flow period. However, this was not the case with some pool water levels increasing, some decreasing and some barely changing (Figure 14).

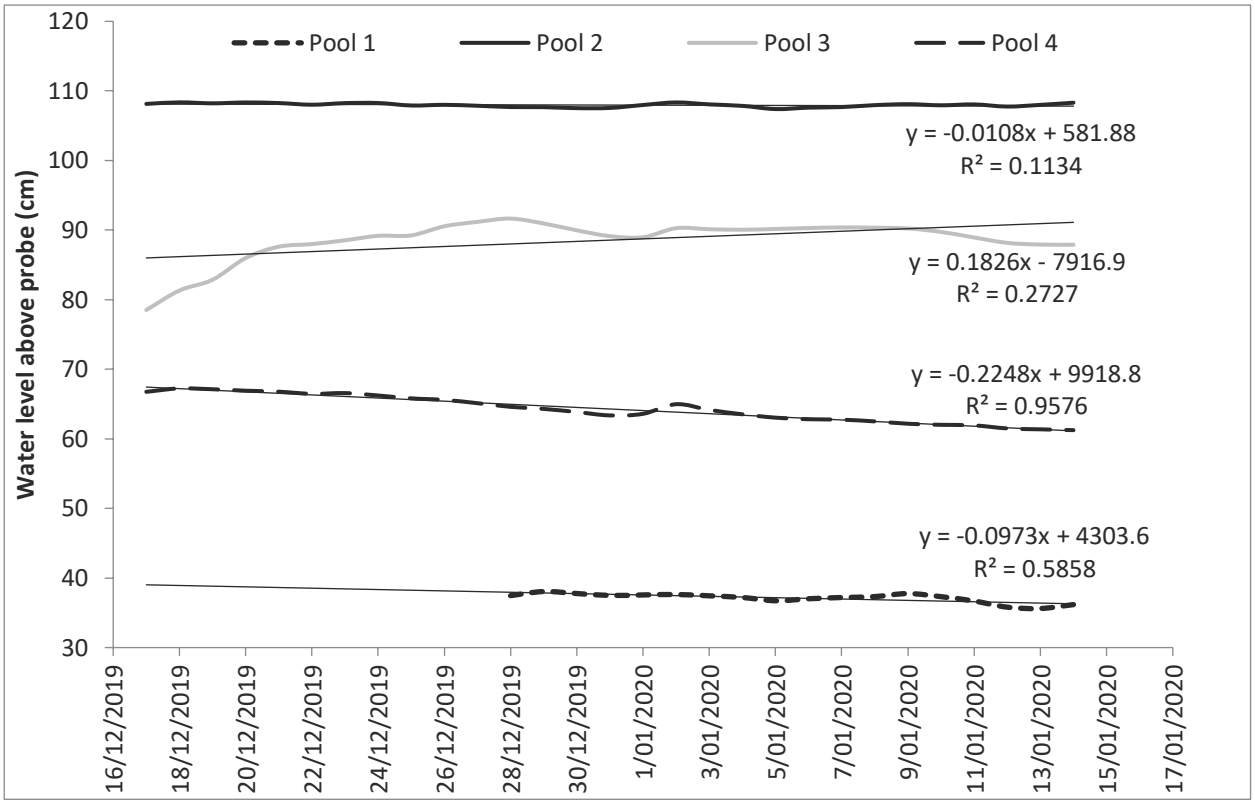

Figure 14. Water levels above pressure probes for the four surface water pool sites during the cease to flow conditions (17/12/2019 until 14/01/2020). There was very little rainfall in this period (approximately 7 mm recorded at Kootingal station 55148 between 17/12/2019 and 14/01/2020).

Pool 1 had water levels dropping in depth by approximately 2 cm over the 18 days (between 28/12/2019 and 14/01/2020). The slope of linear regression indicates there is a decrease in depth of 0.1 cm each day on average for the pool (Figure 14). A smaller set of data was used for this analysis, as there was are some unexplained changes in water depth in the first 10 days.

Pool 2 had very little change in water depth (<1 cm) over the 29 days of zero flow (between 17/12/2019 and 14/01/2020). The slope of the linear regressions shows the small decrease in depth 0.01 cm each day on average for the pool (Figure 14).

Pool 3 has more variability of depth but an overall increase over the 29 days of zero flows. The probe shows an initial increase in water depth of 13 cm for the initial 12 days (17/12/2020 until 28/12/2020). There are some time periods where water level decreases. The slope of the linear regressions shows the small increase in depth 0.18 cm each day on average for the pool (Figure 14).

Pool 4 had overall decreases in water levels over the 29 days of zero flows. The pool dropped in depth by approximately 5 cm (between 17/12/2019 and 14/01/2020). The slope of linear regression indicates there is a decrease in depth of 0.2 cm each day on average for the pool (Figure 14).

There were no other zero flow periods during the study.

6.2.2 Resumption of flow period

Following the resumption of flow in mid-January 2020, changes in pool heights were compared to groundwater levels to determine the relationship between surface water and groundwater. As an example, data over a 3-month period (October 2020 to December 2020) is displayed for Pool 3, with private bore GW047919 (Figure 15) located approximately 1 km east of the pool. These three months were chosen to coincide with the main pumping period of the bore. A shorter period has been displayed than the complete record of data so more detail can be seen from this example.

The downward spikes in the data of up to nearly 2 m, represent drawdown in response to pumping from that bore, the level that groundwater returns to when the pump is turned off is called the recovered water level. This bore extracted 74 ML over the 2019/2020 water year and 36 ML over the 2020/2021 water year. The exact volume pumped in October 2020 (2019/2020 water year) and November/December 2020 (2020/2021 water year), cannot be determined with the available information.

There was a pronounced declining trend in the recovered groundwater level (orange line) over the groundwater pumping period in the first half of October, this declining trend is replicated, but more subdued in the river height data (grey dashed line) over the same period, however; did not show a perceptible corresponding decline in the pool data (blue line).

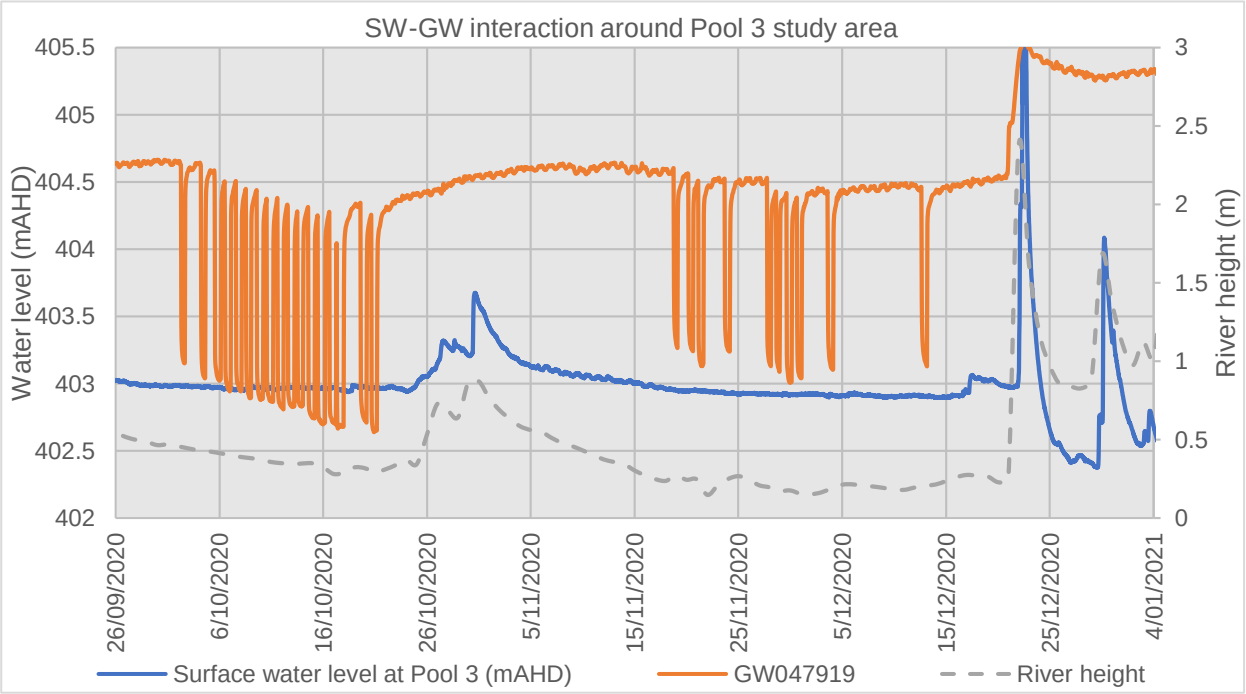

Figure 15. Surface water (SW) and groundwater (GW) fluctuations around Pool 3. River height was measured at Kootingal bridge (419099).

The river was flowing over this period hence the pool level is dominated by river flow. The pool data (blue line) shows minor fluctuations just prior to and following the river event in October 2020, these are most obvious in the data between the 5/11/2020 and 15/11/2020. As the river was flowing over this period, there is the possibility these fluctuations are due to surface water extraction.

The groundwater data shows a significant water level increase in response to the main river peak event in December 2020, but not to the smaller event in late October/early November.

The direct impact of groundwater pumping on the pool over this period cannot be determined from review of this information, as the river was flowing over this period masking any evidence of direct impact from groundwater extraction.

Hydrographs of all available water level data (pools and study bores) collected to date is provided in Appendix G. The data from the other pools and bores show similar trends.

6.2.3 Cross-sections

Cross sections have been developed to visualise and determine the nature of the surface water and groundwater connectivity near each of the four study pools. The cross sections are based on surface elevation, aquifer depth (where it could be determined from the bore logs) and groundwater level data plotted with riverbed elevation and pool water levels (all in mAHD). Where the total depth of the alluvium is unknown, the average depth was considered as an approximate depth of bedrock.

The cross sections were plotted with water levels from two periods; July 2020 to represent winter conditions and January 2021 to represent summer. Rainfall is summer dominant in this area and this is reflected in the water levels, which are generally higher over the summer period.

Pools 1 and 2

Pools 1 and 2 have been represented by two cross sections (Figure 16).

Section AB runs approximately east to west, parallel along the alluvium and intercepting the river at two locations near Pool 1 and Pool 2 (Figure 17).

Section CD runs north-west to south-east, perpendicular to the river, intercepting the river near Pool 2 (Figure 18).

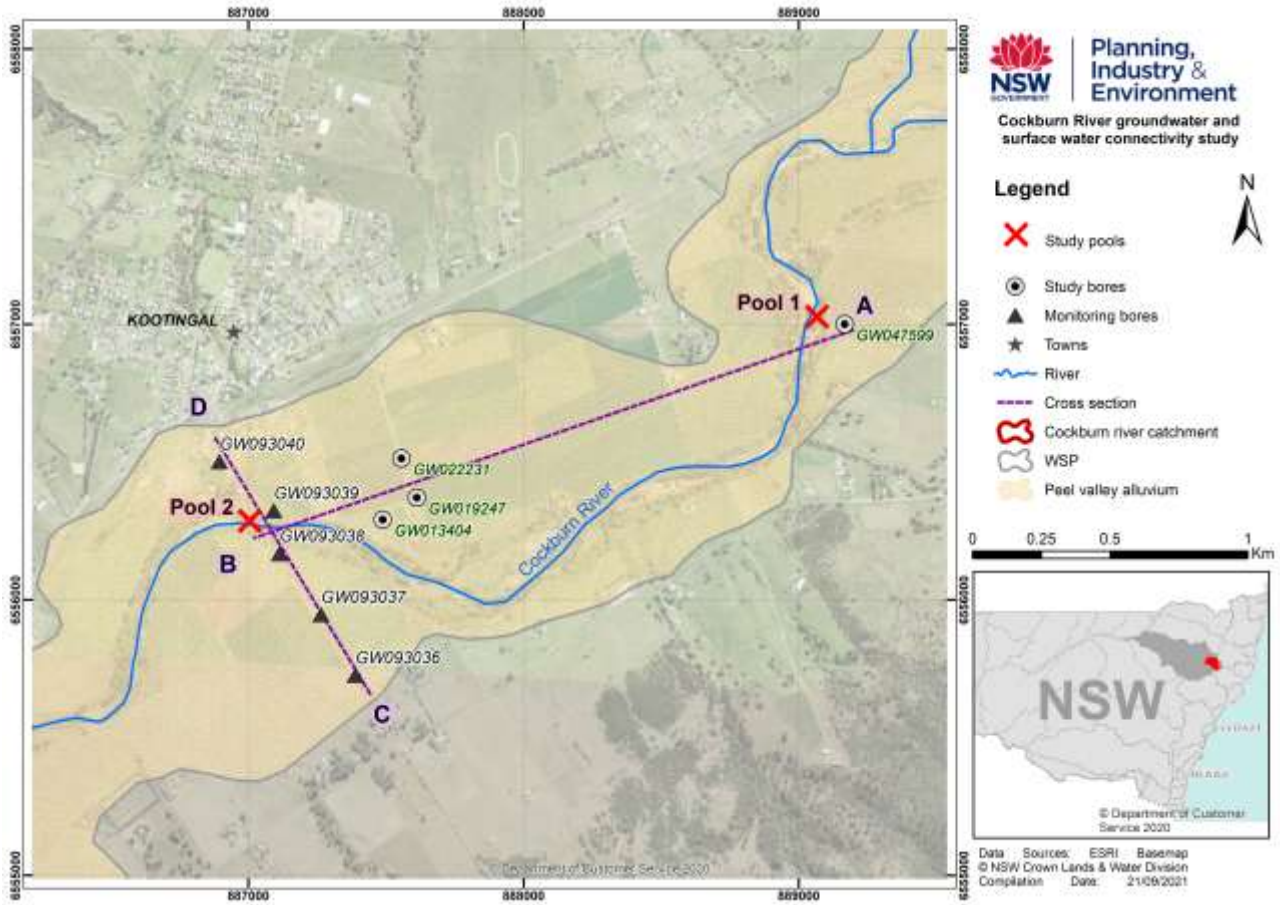

Figure 16. Cross section locations - Pools 1 and 2 (GW = groundwater).

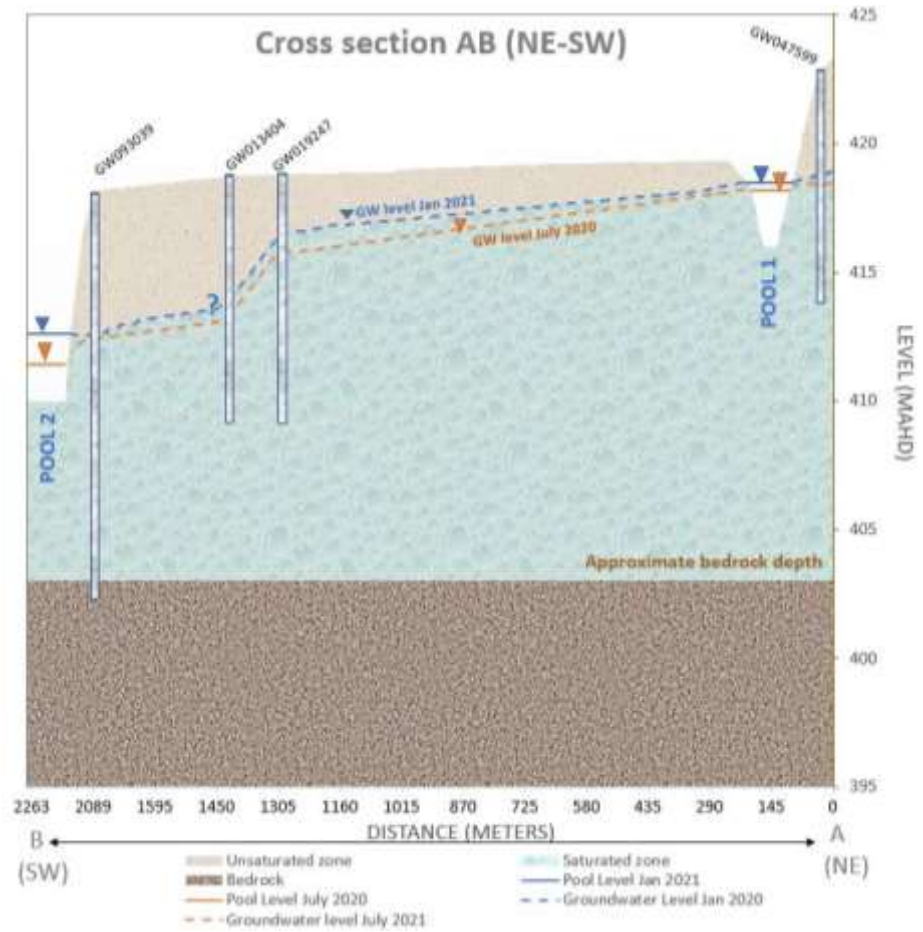

Figure 17. Cross section AB.

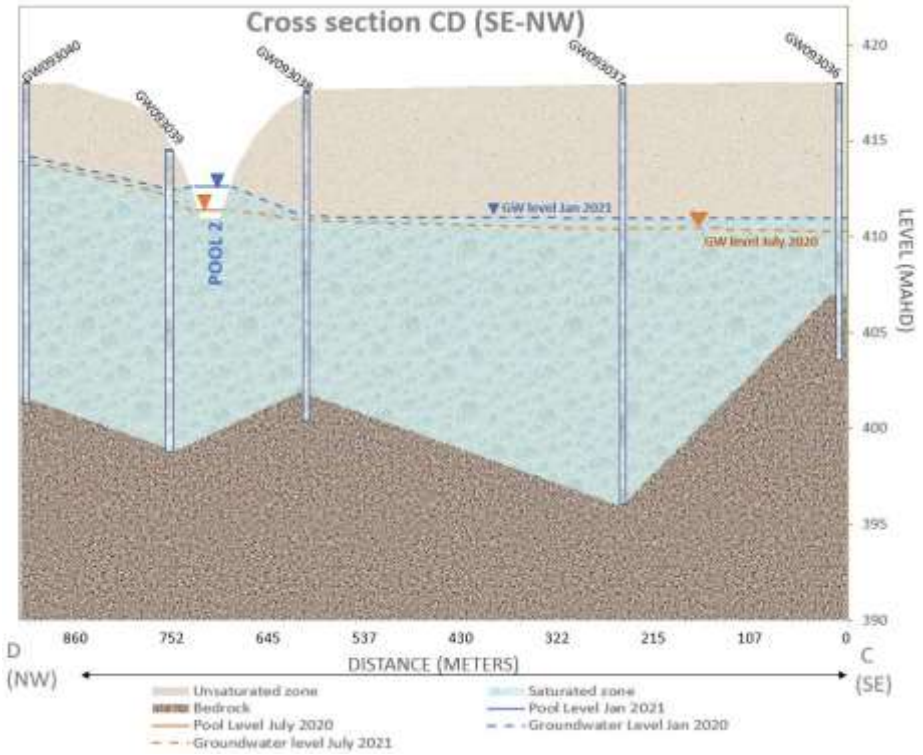

Figure 18. Cross section CD (GW = groundwater).

Cross section AB (Figure 17) shows the groundwater hydraulic head decreases from point A to point B, that is, water is flowing downstream (approximately) from north to south, which is confirmed in the hydrograph shown in Figure 8.

Based on these water level readings, Pool 1 (Figure 17) appears to be a through-flow system, as the groundwater level to the north-east of the pool is higher than the groundwater level to the south-west of the pool. The groundwater levels near Pool 1 are relatively similar to the pool levels, meaning that the system is likely to be transitional, changing form gaining or throughflow to losing depending on the conditions in this area.

Cross sections AB (Figure 17), and CD (Figure 18) show that groundwater levels to the north-east side of Pool 2 are higher than the groundwater levels on the south-west side, indicating the groundwater is flowing (generally) across the river. During summer 2021 (January) the pool level is higher than the groundwater levels, indicating losing conditions. In winter (July) the groundwater level is higher than Pool 2 to the north-east and slightly lower on the south-west side, making it a throughflow system over winter. This again shows the transitional nature of the connectivity between the surface water and groundwater.

Pool 3

Pool 3 is represented by two cross sections (Figure 19).

Section EF runs north-east to south-west, parallel along the alluvium and intercepting the river near Pool 3 (Figure 20).

Section GH runs east to west, perpendicular to the river, intercepting the river near Pool 3 (Figure 21).

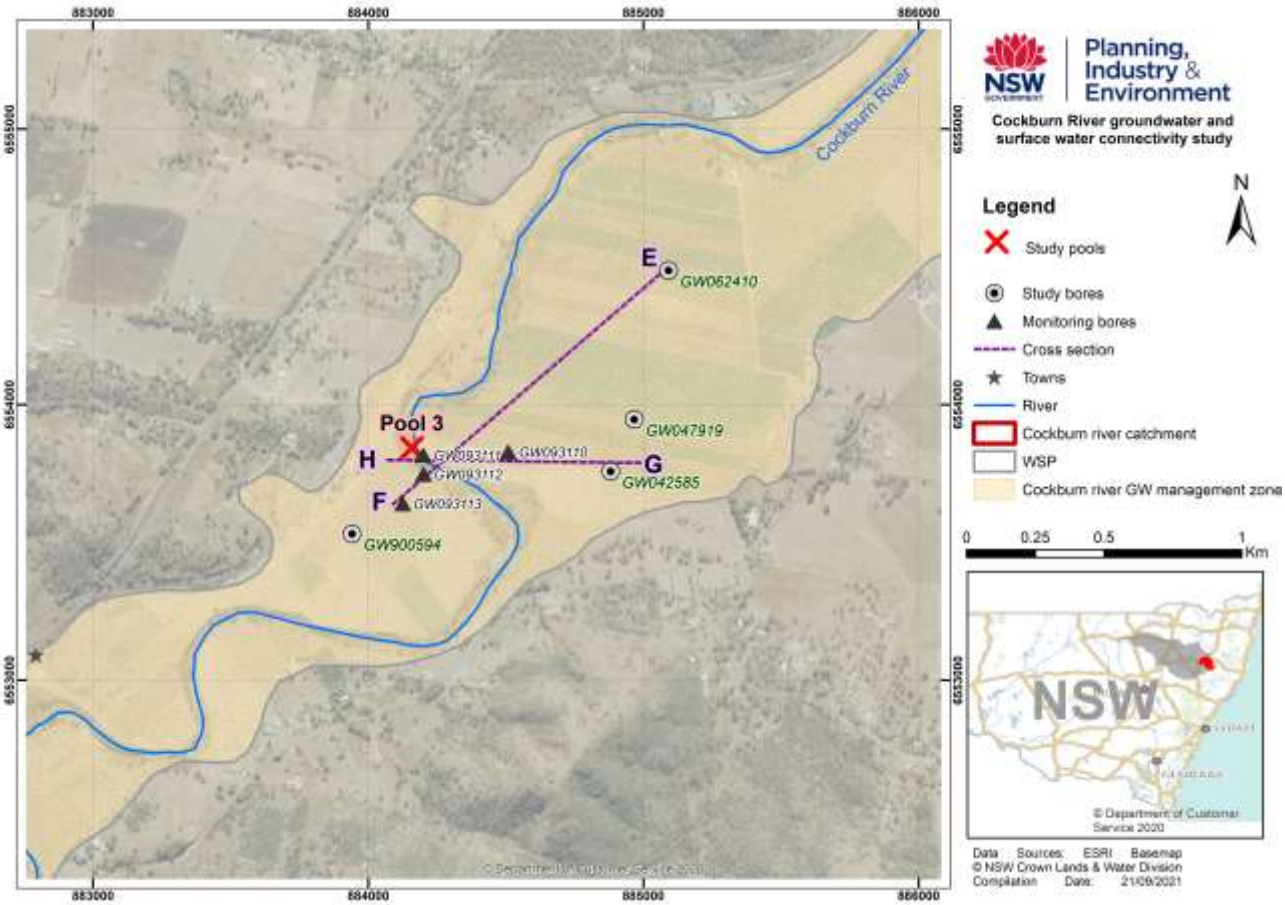

Figure 19. Cross section locations – Pool 3 (GW = groundwater).

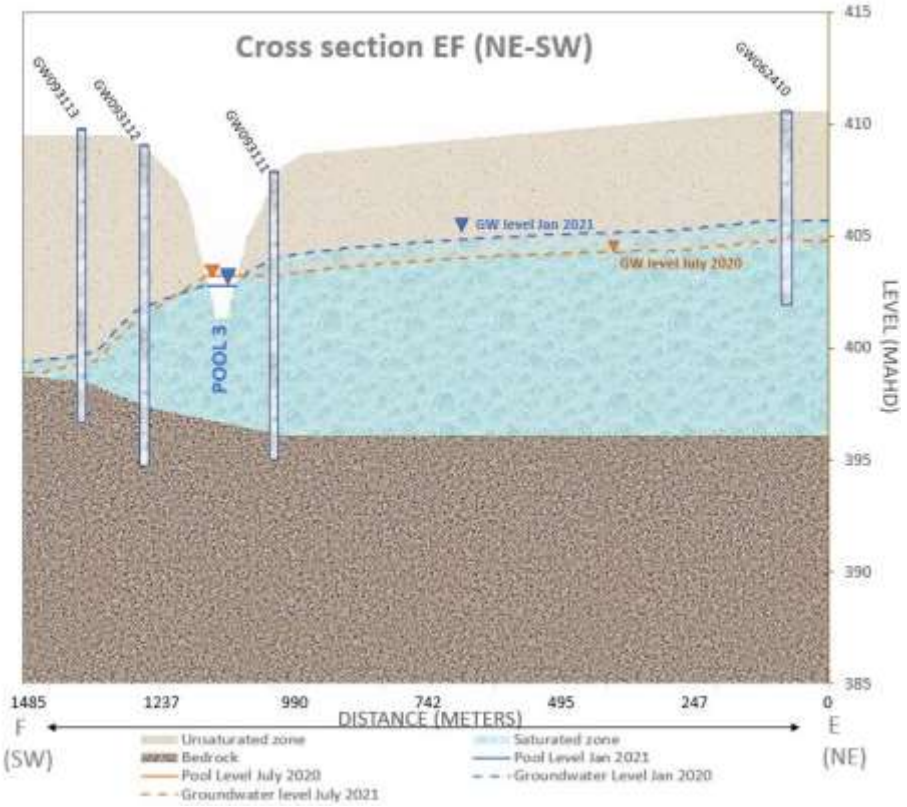

Figure 20. Cross section EF

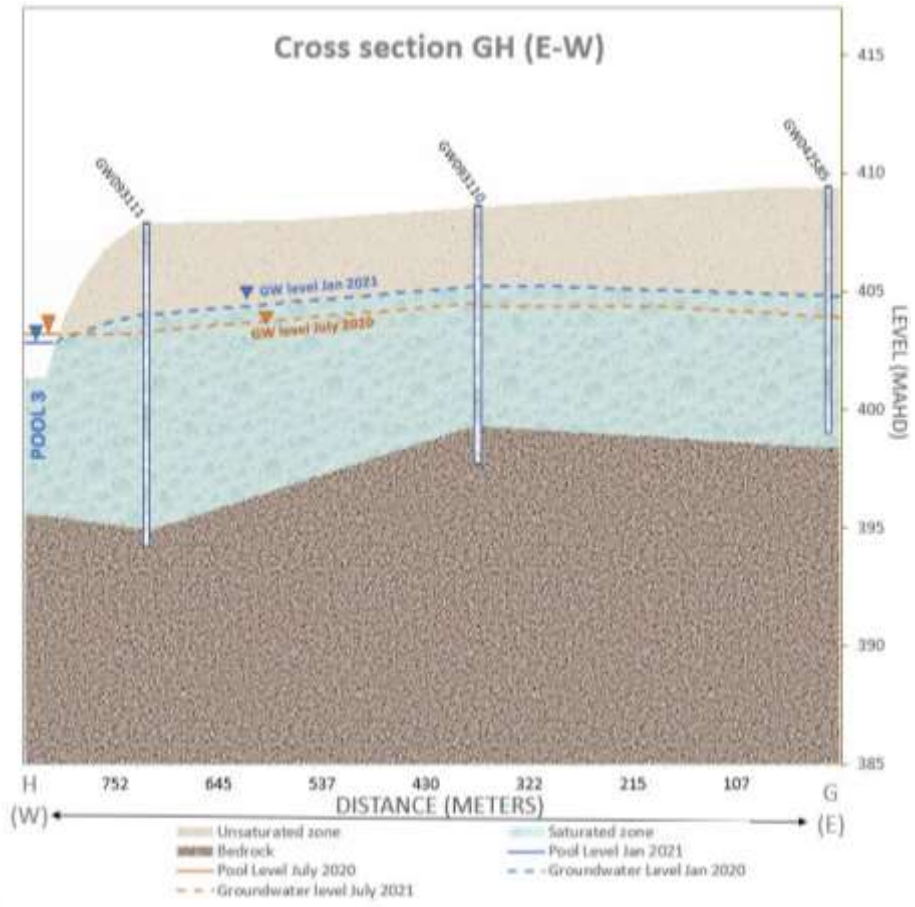

Figure 21. Cross section GH.

Pool 3 shows the pool level is lower in summer compared to winter, which is opposite to what is expected given summer dominate rainfall in this area. The other three pools all show the pool height is higher in summer (January) compared to July (winter).

The reason for this unexpected trend in Pool 3 is potentially due to surface water extraction dropping the pool level, there is a surface water extraction point close to Pool 3, this cannot be verified as there is currently no metering of unregulated extraction. This could also be due to probes shifting during flows, but this is also unable to be verified.

Cross sections EF (Figure 20) shows that groundwater levels to the north-east of Pool 3 is higher than the groundwater level on the south-west side, again indicating the groundwater is flowing (generally) across the river from north-east towards the south-west.

Cross section EF, the groundwater level is similar, but slightly lower than the pool level to the north-east during winter (July) and the groundwater level lower than the pool to the south-west, making the connectivity losing at this time. Over summer the groundwater level is higher than the pool to the north-east and the groundwater level lower than the pool level to the south-west, making the connectivity throughflow from at this time.

Section GH (Figure 21) only shows trends on the eastern side of Pool 3. The water level during both summer and winter are higher than the pool level, although during winter (July) the groundwater level is only marginally higher than the pool level. This indicates the gaining connectivity on the eastern side of the river. It is expected from the EF section that the groundwater level would be lower on the western side of the pool, making it through-flow connectivity. The connectivity near Pool 3 is transitional, changing form gaining/throughflow (flow from north-east to south-west) to losing depending on the conditions in this area.

Cross section EF (Figure 20) shows very low groundwater levels on the left-hand side (south-west) edge of the section, the reason for this is not fully understood and should be investigated. There is limited available information on bore GW900594, located to the south east of the section, to inform on water levels in this section. An investigation into the reason for the unexpected low water level monitoring bore GW093113 is required.

Pool 4

Pool 4 is represented by one cross section (Figure 22).

Section IJ runs north-east to south-west, approximately parallel along the alluvium and terminating adjacent to Pool 4 (Figure 23). There is no data south-west of the pool.

In July 2020 the groundwater level was slightly higher than the pool level, making it a gaining system at this time, the groundwater level is below the pool height in January 2021, meaning that at this time the river was a losing system.

During summer 2021 (January) the pool level is higher than the groundwater levels, indicating losing connectivity. In winter (July) the groundwater level is higher than Pool 4 indicating gaining connectivity. The flow is towards the pool, demonstrated by the groundwater level being higher in GW060044 compared to GW273033. The connectivity is likely to be transitional, changing throughflow (flow from north-east to south-west) to losing depending on the conditions in this area.

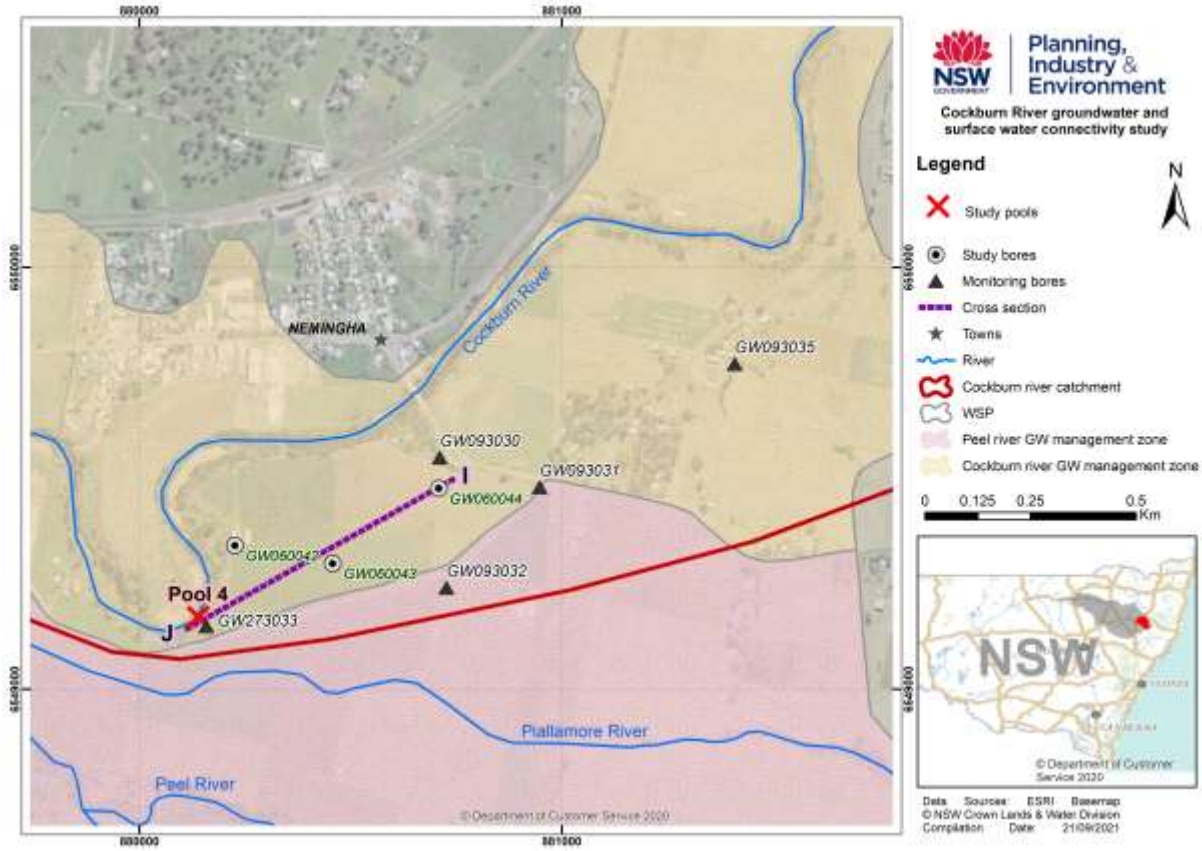

Figure 22. Cross section location – Pool 4 (GW = groundwater).

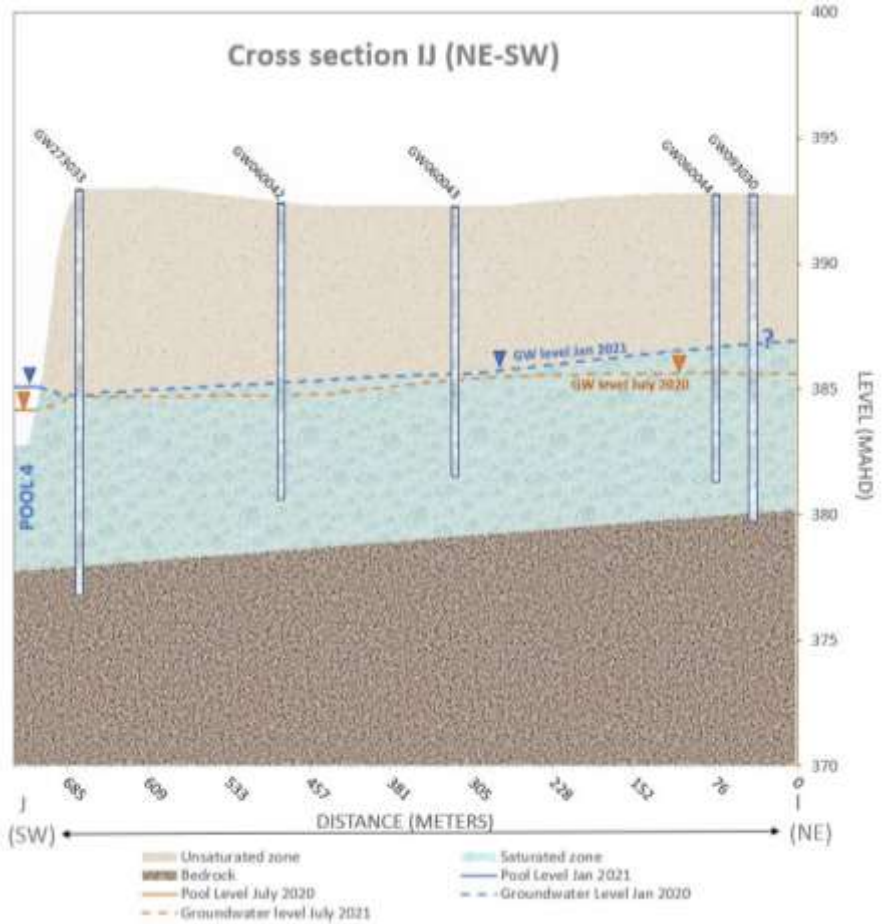

Figure 23. Cross section IJ.

7. Conclusions

7.1 Pool levels during no river flow

During the zero flow events within the monitoring period (December 2019 to January 2020), the pool water levels were relatively stable, despite high evaporation rates under drought conditions.

The river had been in zero river flow conditions for ten months prior to the pressure probes being installed in the pools. Between initial site visits in late October 2019 and when the pressure probes were installed in December 2019, study pools were observed to contract in size, relative to gauge plates. Pool height data obtained from temporary height gauge plates shows that by the end of the extended drought (December 2019), the pools monitored showed a drop in water level, with Pool 3 by as much as 30 cm. It is likely that over the ten months of zero flow the pools contracted in size until they reached a level where pool height was maintained by groundwater.

Thus, a form of equilibrium (or pressure balance) between the pools and the groundwater source appears to be reached and pool water levels stabilised.

7.2 Water quality during the no river flow

Dissolved oxygen in the pools deteriorated under zero flow conditions, putting aquatic biota under stress when dissolved oxygen was less than 4 mg/L. This was apparent with observations of some native fish under visible stress (December 2019).

When river flows were in the low flow category (below the 80th percentile), dissolved oxygen concentration was lower. This is in spring and autumn and during moderate flows (64th percentile) conditions. Reduced flow can result in low dissolved oxygen concentrations and low flow supports algal blooms. Both these conditions can increase the stress on native fish and other river biota.

These water quality patterns were not as apparent during winter periods and as flows returned the water column was well mixed and oxygen levels remained above sub-lethal levels.

In Australian inland rivers dissolved oxygen concentrations can vary considerably. Dissolved oxygen is driven by a combination of factors including: temperature, the presence of phytoplankton, organic matter and aquatic plants (Sheldon & Walker, 1997).

An increase in water temperature results in a reduction in the dissolved oxygen carrying capacity of the water. In Australian inland river pools reduced dissolved oxygen concentrations generally occur during the summer months and when river flows are minimal. Stratification will occur with a layer of warmer water on the surface, above a cooler layer of water (Boulton & Brock, 1999) below.

The conceptual model below helps to summarise these relationships and identifies ecosystem responses to water extraction in river pool under no-flow conditions and can be applied to the Cockburn River (Figure 24).

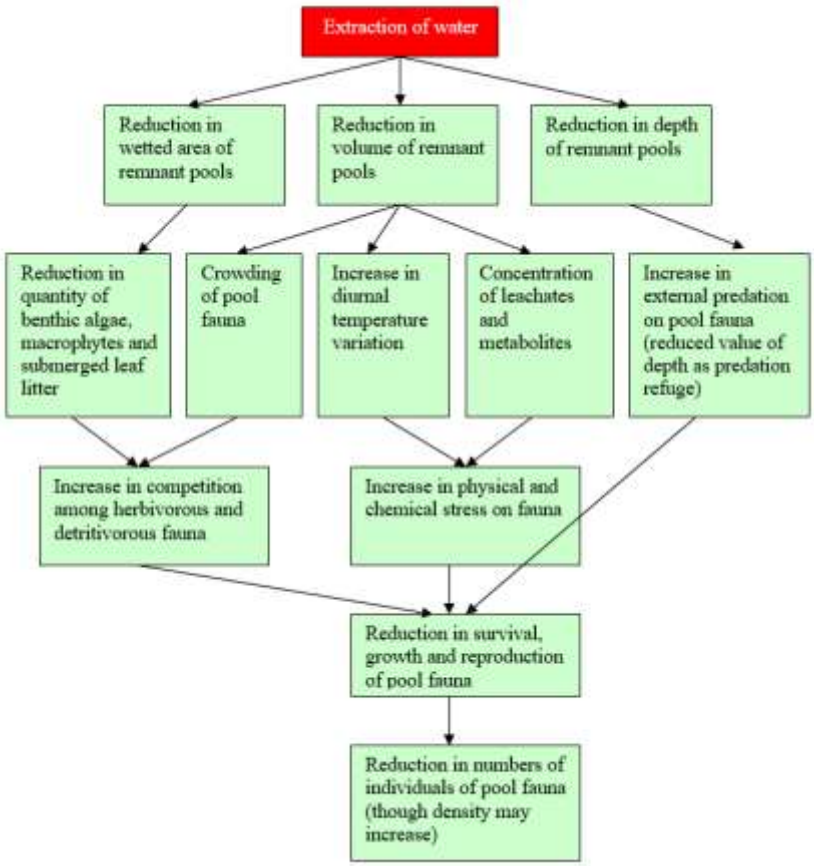

Figure 24. Aquatic ecosystem responses to water extraction in river pools under no-flow conditions. Responses will vary according to natural patterns of water loss and timing, frequency and magnitude of extraction.

7.3 Connectivity

In this study, water levels in the river pools and groundwater were compared over the period February 2020 to April 2021. The Cockburn River was low/zero flow conditions prior to the commencement of the study, flow resumed in January 2021 following a significant rainfall event. Surface water flow continued over the main study period.

The data shows that all four pools transition from throughflow connected systems (groundwater is flowing through to or from the river) to losing systems (the river is losing to groundwater). Hence, the pools and groundwater are connected, the type of connection dependent on the location and hydrological conditions such as rainfall, stream flow and potentially surface water or groundwater pumping.

Over the study period (from February 2020 to April 2021) the groundwater level always remained above the base of the pools even during periods where the river was losing to the groundwater. At these times, the river/pool water level was above the groundwater level, making the hydraulic gradient from the river/pool towards the groundwater, however; the groundwater level never dropped lower than the deepest point of the pools.

It can be inferred from the available pool data collected in December 2019 during no surface water flow conditions (this is before the main study period commenced), that the pools were gaining/throughflow connected, that is, the groundwater level was above the base of the pools and the pools were being maintained by groundwater in December 2019 as there was no flow in the river to maintain the pools.

The Cockburn River Alluvium Management Zone is a relatively small alluvial system, being mostly less than 1.5 km wide and less than 15 m deep. Given the small size of the system, groundwater extraction will most likely impact on surface water. However, the direct relationship of groundwater pumping and the degree of impact on surface water at a specific location depends on surface water flows, aquifer properties, volume pumped and proximity of pumping bores to surface water.

During no surface water flow periods, where the groundwater is maintaining the pools, surface water will likely be most sensitive to groundwater extraction.

7.4 Management considerations

A risk assesment, undertaken by the department for the Namoi catchment, identified a high risk to ecological values in the Cockburn River during zero flows and base/low flows from both surface and groundwater extraction. The risk assessment considered the current strategies and rules in place under the NSW *Water Management Act 2000* and the water sharing plan rules.

Daily access (cease-to-pump) rules are established for surface water users in the Cockburn River Management Zone in the Cockburn River Water Source under the *Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012*. A summary of these access rules are listed in Figure 25.

Access Rules

Cockburn River Management Zone

Management zone	Cockburn River (Cockburn River from its intersection with Mulla Mulla Creek downstream to where it enters the Peel Regulated River water source)	Cockburn River Tributaries (All other surface waters of the Cockburn River water source area excluding the Cockburn River management zone)
Cease to pump (CtP)	Very Low Flow Class	Less than or equal to 2.5 ML/day on a rising river and less than or equal to 0.3 ML/day on a falling river
	A Class	Greater than 2.5 ML/day on a rising river and greater than 0.3 ML/day on a falling river
Reference point	Cockburn River at Kootingal Gauge (419099)	

Note: water must not be taken under an access licence with an extraction component that specifies the Cockburn River Management Zone in the Cockburn River Water Source in the following circumstances when flows are between 2.5 ML/day and 0.3 ML/day at the Cockburn River at Kootingal gauge (419099) on a falling river:

(a) between 7 am and 7 pm from 1 September to 31 May,

(b) between 7 pm and 7 am from 1 June to 31 August

Figure 25. Access rules for the Cockburn River Management Zone as summarised in the Rules Summary Sheet for the Cockburn River Water Source

There are no daily access rules for groundwater licences in the Cockburn River Alluvium Management Zone in the Peel Alluvium Groundwater Source under the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020*. However, the water sharing plan includes an amendment provision (clause 68) that allows for the plan to be amended after 1 July 2022 to establish access rules in the Cockburn River Alluvium Management Zone.

Extraction from groundwater will likely have some degree of impact on surface water, however; the specific contribution and timing of impact from groundwater extraction on surface water cannot be determined directly from the information and analysis from this study.

Key findings of this study, in conjunction with other information and numerical modelling if available, will help inform options to manage the impact of groundwater extraction on surface water in the Cockburn River Alluvium Management Zone.

8. References

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Appendix A – Additional study pool data

Hydrographic data (from gauging stations 419099 and 419114 at Kootingal Bridge and Pool 2) were used to determine the variability in river discharge during the study. Water quality data, including temperature and dissolved oxygen from each pool, was compared against discharge and pool heights. The data was compared hourly as a basis for determining daily pattern in rivers (increased temperatures occurring in the evening and reduced temperatures in the morning).

Flow categories used to estimate dissolved oxygen and temperature variability against discharge, across seasons, is presented below. The discharge categories reflect the range of flows that can occur within the Cockburn River. For example, the 80th percentile is the value below which 80% of observations may be found.

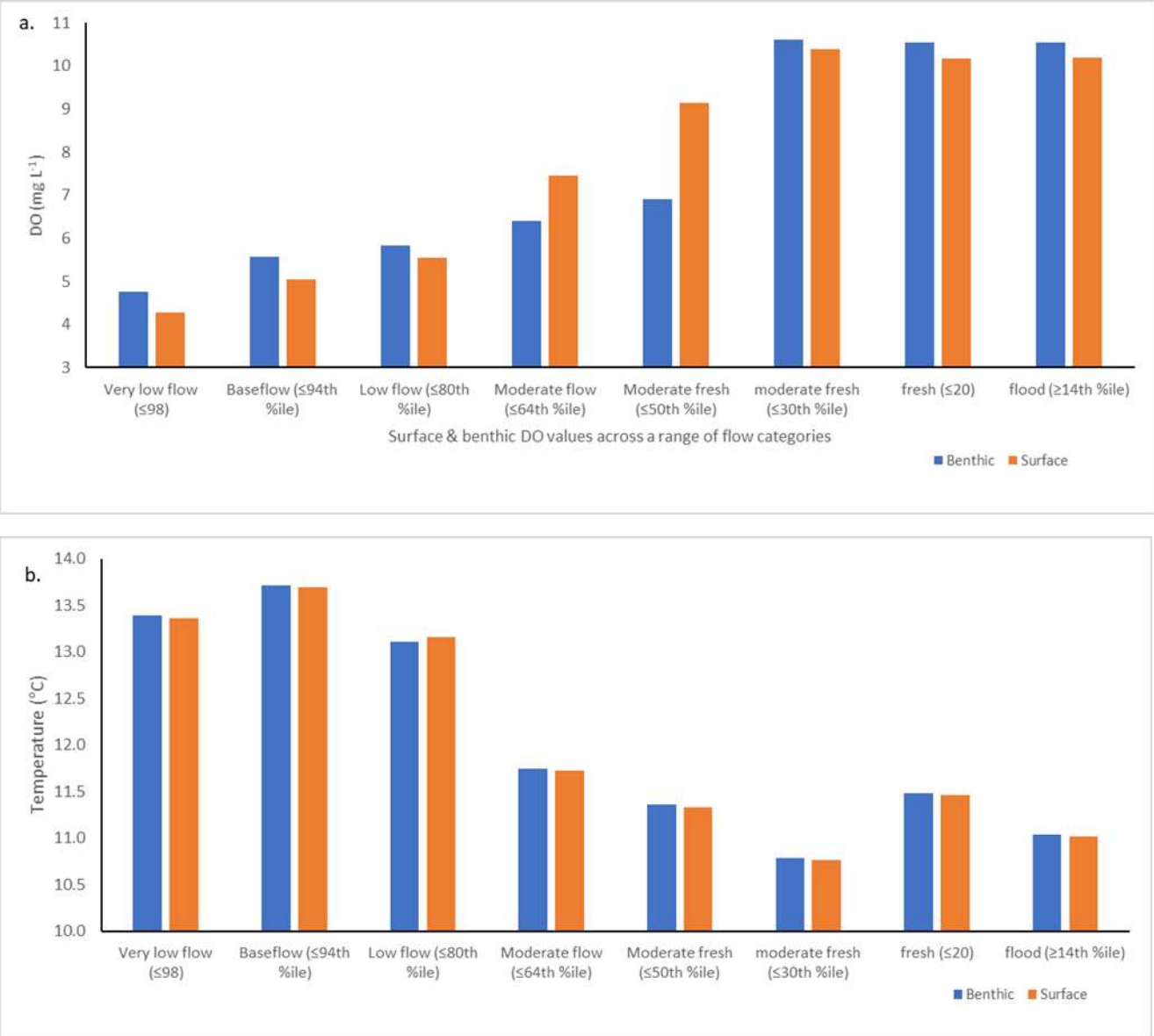


Figure 26. Pool 2 during the winter of 2020, showing mean surface and benthic probe data: (a.) dissolved oxygen concentrations; and (b.) temperature values, per flow category.

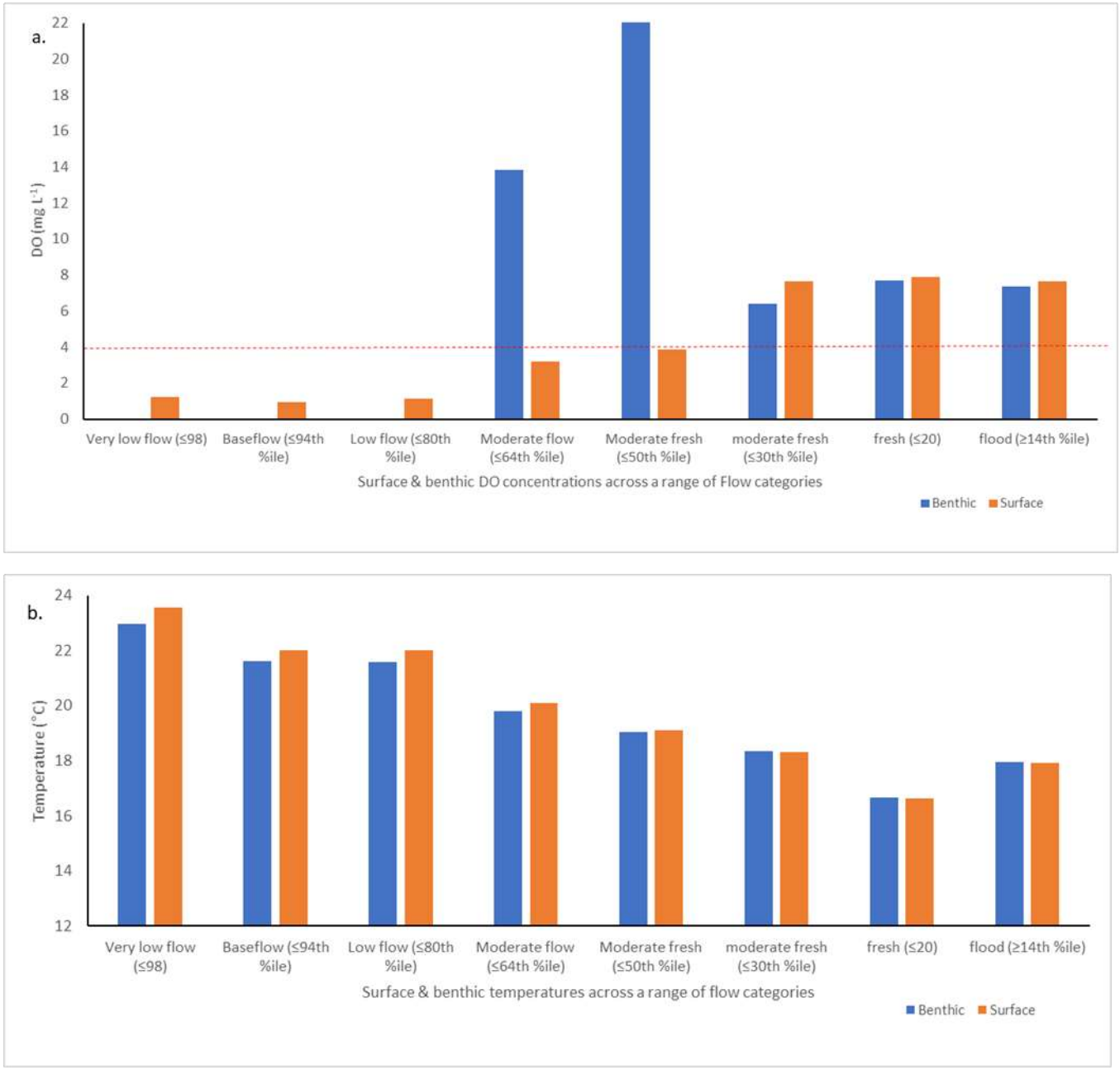


Figure 27. Pool 2 during the spring of 2020, showing mean surface and benthic probe data: (a.) dissolved oxygen concentrations; and (b.) temperature values, per flow category. The red dashed line (a) represents the dissolved oxygen concentration (4mg/L) required to support aquatic organisms. Concentrations less than 2mg/L can result in death. There was an anomaly during the moderate flow categories in spring where benthic concentrations exceeded surface values.

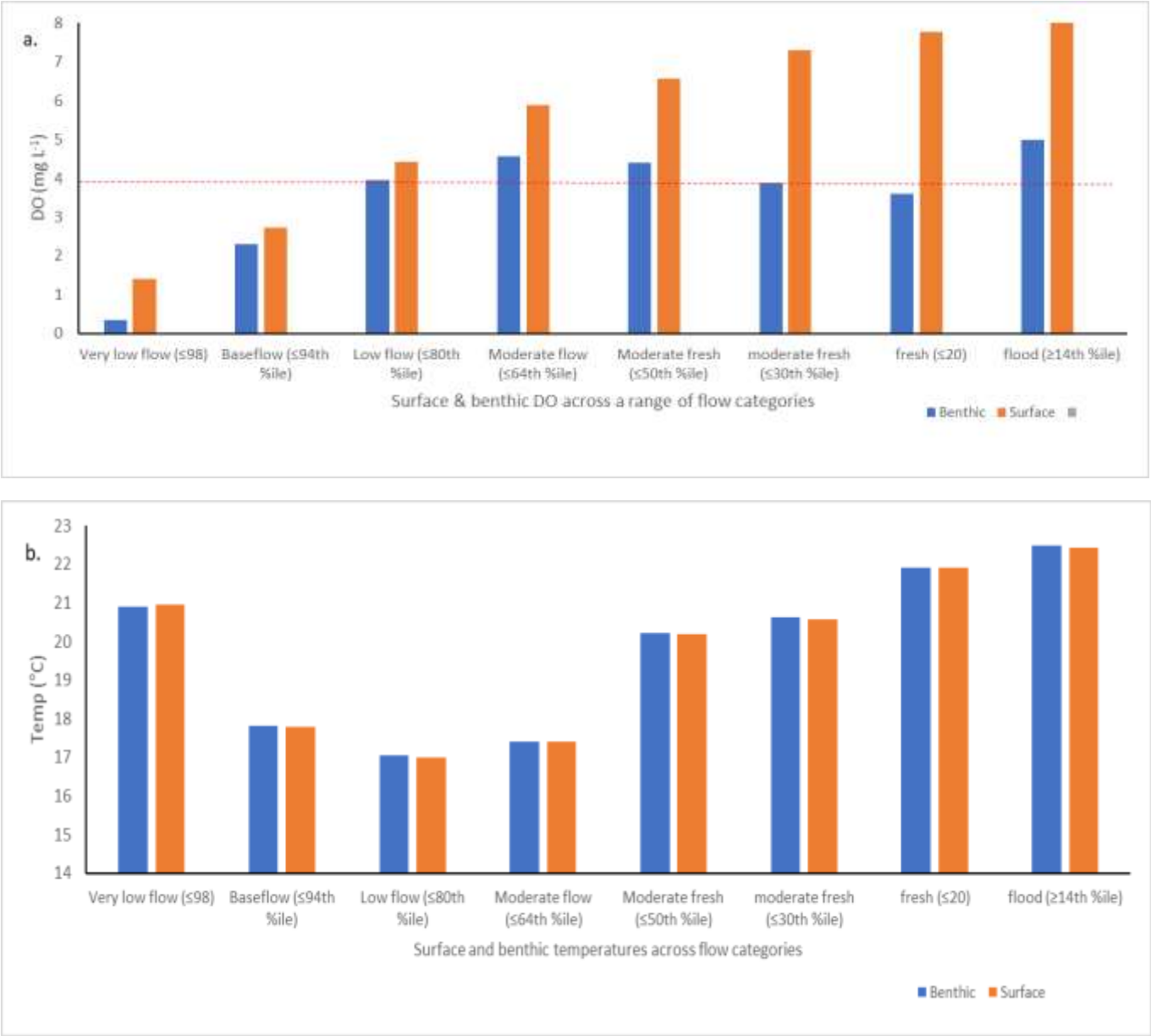


Figure 28. Pool 2 during the autumn of 2020, showing mean surface and benthic probe data: (a.) dissolved oxygen concentrations; and (b.) temperature values, per flow category. The red dashed line (a) represents the dissolved oxygen concentration (4mg/L) required to support aquatic organisms. Concentrations less than 2mg/L can result in death.

Table 2. Seasons flow duration table from the Cockburn River gauge (419114) used to determine flow categories that influence dissolved oxygen and temperature pool data. Percentiles selected are based on the generic flow duration curve or unregulated rivers (Figure 20).

WaterNSW HYFLOW V196 13:11_21/09/2021

Site 419114 — Cockburn River at D/S Kootingal Bridge Weir — Site 419114
Variable 141.00 — Discharge Rate in Megalitres/Day
Percentage of Time that Parameter was Equalled or Exceeded.
Period of Record 13/06/2019 to 30/06/2021

%	Total	AUTUMN	SPRING	SUMMER	WINTER	%
00	1.131	7.082	1.966	1.131	16.010	100
98	3.601	8.847	2.332	2.583	17.006	98
96	4.151	9.912	4.255	3.499	17.657	96
94	4.262	10.990	4.910	3.601	18.563	94
92	5.552	13.613	5.768	3.972	18.922	92
90	6.551	14.213	6.300	4.078	19.272	90
88	7.751	16.220	6.551	4.151	19.775	88
86	9.508	17.100	6.755	4.151	20.225	86
84	12.848	18.390	7.198	4.219	21.270	84
82	15.350	19.961	7.712	4.262	22.640	82
80	16.913	21.996	7.896	4.356	23.328	80
78	18.313	23.537	8.112	4.749	24.921	78
76	19.126	25.153	9.952	5.471	25.897	76
74	20.266	26.252	11.194	5.590	26.610	74
72	21.434	27.979	13.580	5.660	28.530	72
70	22.917	29.981	16.020	7.098	30.295	70
68	24.066	31.718	17.532	11.659	32.543	68
66	25.723	32.661	18.181	13.973	36.565	66
64	26.610	34.753	19.114	19.704	39.942	64
62	28.828	35.734	19.887	21.146	43.759	62
60	30.295	37.543	20.483	22.947	45.611	60
58	31.923	38.390	21.743	23.918	55.726	58
56	33.772	40.122	22.652	25.322	74.712	56
54	35.668	41.903	24.060	27.280	84.218	54
52	36.719	43.622	25.671	28.838	95.830	52
50	38.455	45.981	25.671	29.837	111.998	50
48	40.232	47.399	29.145	31.118	123.335	48
46	43.645	49.229	30.079	34.062	136.914	46
44	45.737	50.319	31.172	35.930	151.981	44
42	48.434	53.175	32.046	38.257	160.882	42
40	52.440	56.672	33.325	40.240	180.374	40
38	58.958	60.912	34.543	46.885	190.390	38
36	62.504	63.759	35.232	56.075	228.360	36
34	68.662	67.448	35.744	68.915	240.604	34
32	75.331	69.306	36.666	80.964	281.475	32
30	83.593	70.835	37.485	99.012	299.624	30
28	94.604	76.784	38.839	118.354	312.684	28
26	107.313	82.152	39.725	131.773	330.393	26
24	127.314	89.083	41.291	172.911	395.527	24
22	149.739	95.546	44.068	209.882	409.563	22
20	174.774	103.176	45.033	291.106	457.727	20
18	193.032	119.688	47.056	425.150	511.621	18
16	242.061	132.575	49.524	480.185	582.694	16
14	302.302	150.943	53.902	543.757	650.324	14
12	403.940	176.368	60.005	652.595	776.619	12
10	474.903	193.032	60.933	864.451	910.395	10
8	594.809	237.035	62.523	1142.294	1111.717	8
6	870.307	302.587	65.147	1238.198	1590.713	6
4	1240.890	450.245	78.275	1482.226	1797.296	4
2	1776.013	706.249	105.017	1826.256	4035.657	2
0	17110.32	17110.32	225.481	2698.565	11686.20	0

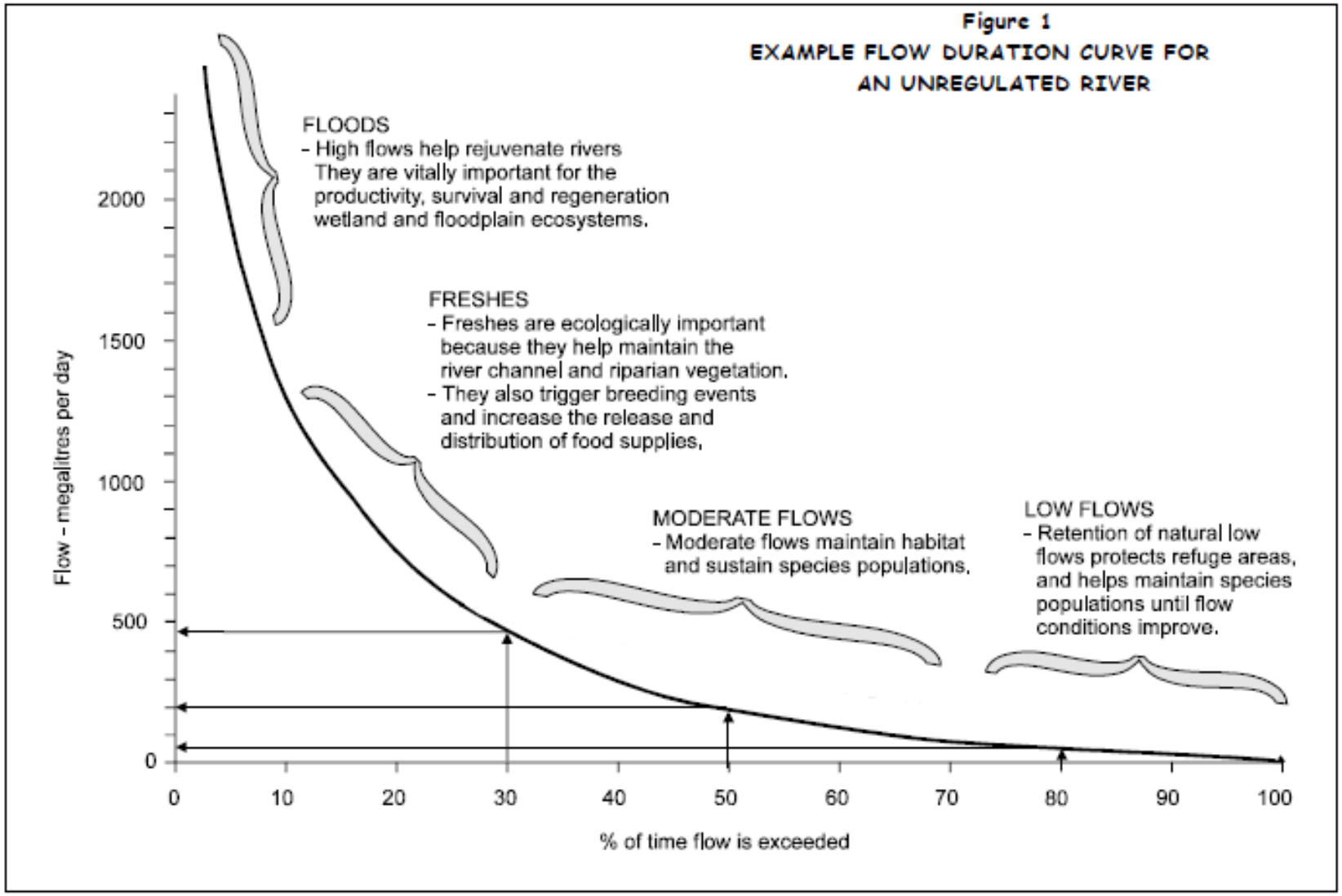


Figure 29. Flow duration curve estimating the percentage of time a flow category is equalled or exceeded in an unregulated river in NSW

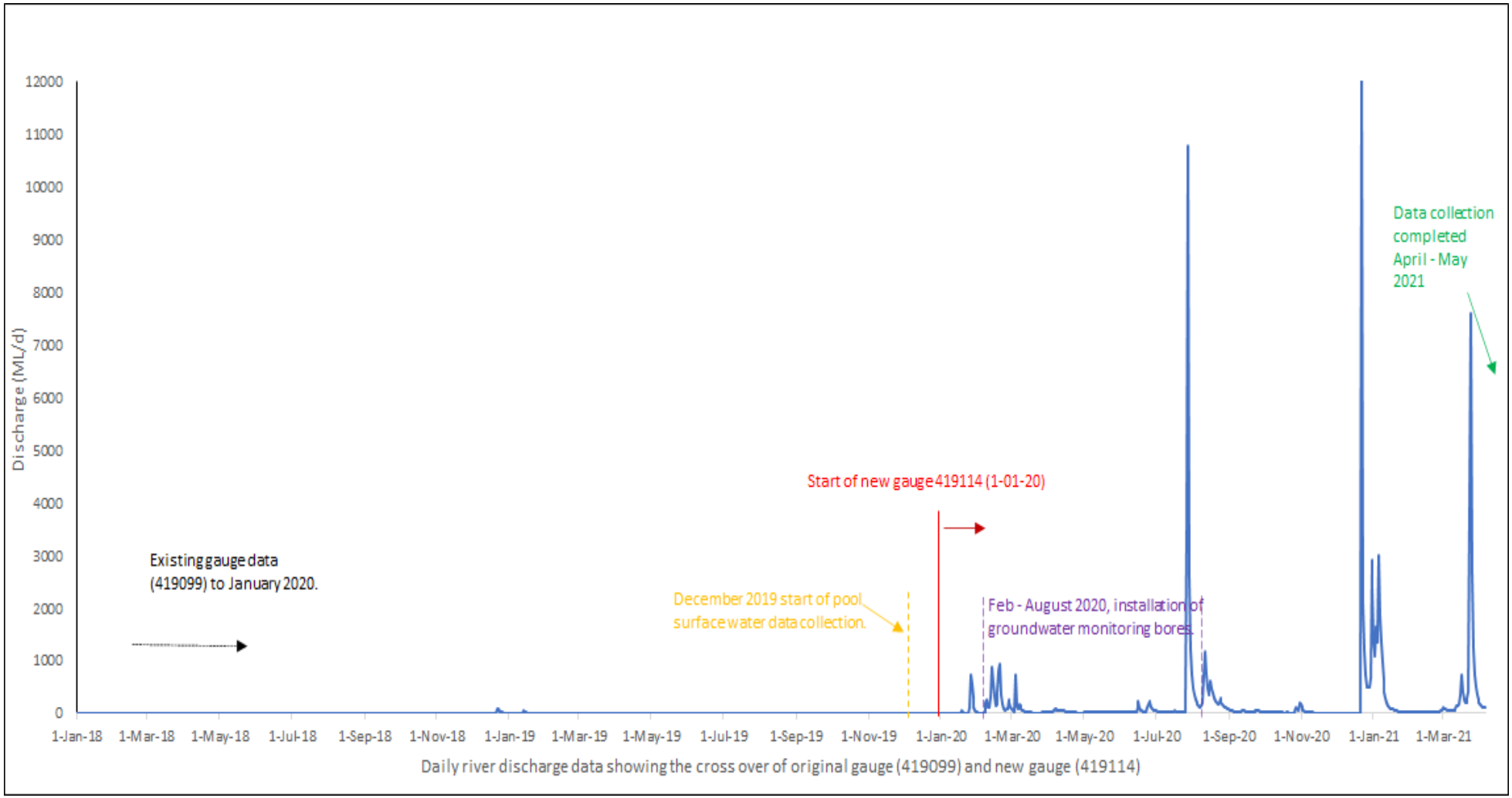


Figure 30. Hydrograph leading up to and during the study period with details of when the project started and activation of the new surface water gauge.

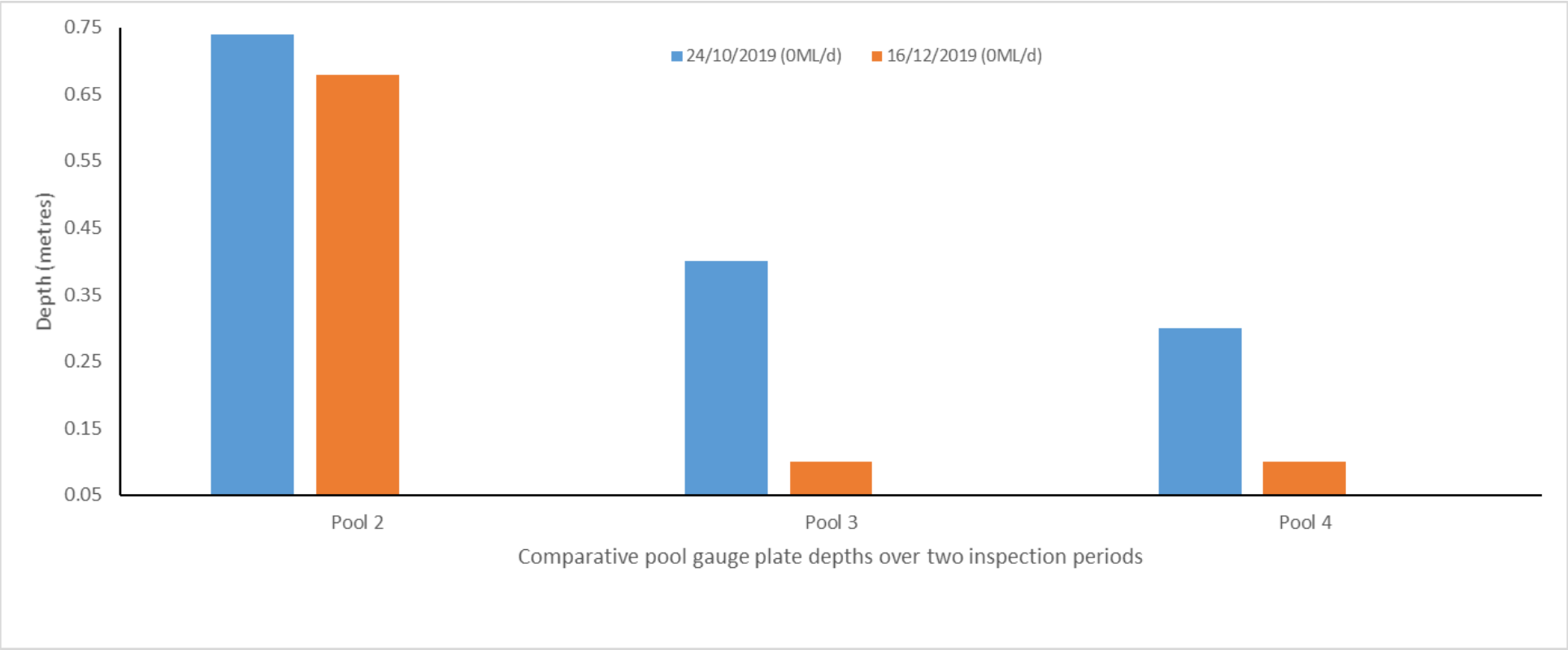


Figure 31. Histogram showing relative changes in pool height (depth) based on gauge post readings across two site visits. 0 ML/d flows were recorded during both the October and December 2019 visits. Pool 1 was not located until the site visit in December 2019.

Figure 32. Gauging post in Pool 2 (23-Oct-2019) used to estimate changes in pool depth prior to installation of pressure probes in mid-December 2019.

Figure 33. Gauging post in Pool 2 (16-Dec-2019) comparative depth change with Figure .

Figure 34. Temporary gauging post in Pool 4 (24-Oct-2019) used to estimate changes in pool depth prior to installation of pressure probes in mid-December 2019.

Figure 35. Temporary gauging post in Pool-4 (16-Dec-2019) showing drop in pool depth compared to Figure 34 above.

Appendix B – Survey data

It is noted that the pool names changed in reporting, so they are labelled in order down the system.

Monitoring Bore and Well Survey - Kootingal and Nemingha NSW

Area A & B - Kootingal MGA 94 MGA 94
Survey Date: 22/07/2020 Surveyor: Leigh Barry - Registered Surveyor - Bath Stewart Associates
Survey Reference: 20198

						All Elevations to AHD							
Updated Pool Numbering 2021	Site	Lat (Dec.)	Long (Dec.)	Zone	Easting	Northing	Water Level	Bench Mark	Data Logger RL	Ground Level	Top Protective Casing	Top PVC	Remarks
	GW022231	-31.061277	151.060629	56	314958	7E+06			421	419.85			
	GW019247	-31.062534	151.061271	56	315021	7E+06			422.71	420.32			
	GW013404	-31.063294	151.060005	56	314902	7E+06			420.01	419.68			
	GW047599	-31.056358	151.07728	56	316537	7E+06			423.64	423.51			
	GW062410	-31.08033	151.035627	56	312609	7E+06			410.73	410.59			
	GW047919	-31.085239	151.034524	56	312514	7E+06			410	409.42			
	GW042585	-31.086964	151.033701	56	312438	7E+06			409.83	409.45			
	GW093110 -	-31.086447	151.029785	56	312064	7E+06				407.85	409.09	408.63	
	GW093111 -	-31.08665	151.026553	56	311756	7E+06				408.77	409.86	409.69	
	GW900594	-31.089308	151.023965	56	311514	7E+06			407.48	407.37			
	GW093112 -	-31.087276	151.02659	56	311761	7E+06				409.49	410.82	410.35	
	GW093113 -	-31.088266	151.025847	56	311692	7E+06				408.27	409.46	409.08	
Reported as Pool 2	Pool 1	-31.063458	151.054917	56	314417	7E+06	411.29						22/7/20 - 10.50am
Reported as Pool 2	Pool 1 BM	-31.063456	151.054917	56	314417	7E+06		411.47					Bench Mark - Top Post
Reported as Pool 3	Pool 2	-31.086102	151.025747	56	311678	7E+06	403.13						22/07/20 - 1.15pm
Reported as Pool 1	Pool 4	-31.056071	151.076282	56	316441	7E+06	418.14						22/07/20 - 9.30am

Area A & B Datum
Base Point: PM36079 - RL: 424.996 (Gate Street and Denman Avenue Kootingal)
Site Datum: MGA 94 Zone 56 and AHD from PM36079 Revision B Sheet 1 of 2

Monitoring Bore and Well Survey - Kootingal and Nemingha NSW

Area C - Nemingha MGA 94 MGA 94
Survey Date: 3/08/2020 Surveyor: Leigh Barry - Registered Surveyor - Bath Stewart Associates
Survey Reference: 20198

						All Elevations to AHD							
	Site	Lat (Dec.)	Long (Dec.)	Zone	Easting	Northing	Water Level	Bench Mark	Data Logger RL	Ground Level	Top Protective Casing	Top PVC	Remarks
	GW060042	-31.128235	150.986677	56	308035	7E+06			392.36	392.29			
	GW060043	-31.128544	150.989119	56	308269	7E+06			392.33	391.8			
	GW060044	-31.126862	150.991678	56	308509	7E+06			392.83	392.73			
Reported as Pool 4	Pool 3	-31.130126	150.985007	56	307880	7E+06	384.51						3/08/2020 - 11am

Area C Datum
Base Point: PM334 - RL:397.408 (New England Hwy and Nundle Street Nemingha)
Site Datum: MGA 94 Zone 56 and AHD from PM334

Appendix C – Bore details

These tables should be used with reference to Figure 12 for locations.

Table 3. Groundwater bores monitoring activity near Pools 1 and 2.

Site	Bore Type	Depth (mbgl)	Latitude	Longitude	Date surveyed	Date instrumentation installed	Instrumentation installed by	Instrumentation type
GW047599	Active Production	7.3	-31.0559	151.077	22 July 2020	5 June 2020.	DPIE Water	Diver datalogger
GW013404	Active Production	9.8	-31.0618	151.0592	22 July 2020	24 February 2020.	DPIE Water	Diver datalogger
GW019247	Inactive Production	9.4	-31.0626	151.0611	22 July 2020	24 February 2020.	DPIE Water	Diver datalogger
GW022231	Inactive Production	9.4	-31.0631	151.0608	22 July 2020	24 February 2020.	DPIE Water	Diver datalogger
GW093036	Monitoring	12	-31.0684	151.0593		18 February 2005	WaterNSW	Data logger and telemetry
GW093037	Monitoring	21	-31.0665	151.0577		18 February 2005	WaterNSW	Data logger and telemetry
GW093038	Monitoring	17	-31.0646	151.0561		29 June 2020	WaterNSW	Data logger and telemetry
GW093039	Monitoring	16	-31.0631	151.0558		29 June 2020	WaterNSW	Data logger and telemetry
GW093040	Monitoring	17	-31.0616	151.0537		11 December 2002	WaterNSW	Data logger and telemetry

Table 4. Groundwater bore monitoring activity near Pool 3.

Site	Bore Type	Depth (mbgl)	Latitude	Longitude	Date surveyed	Date instrumentation installed	Instrumentation installed by	Instrumentation type
GW042585	Active Production	10.6	-31.087	151.0337	22 July 2020	27 February 2020	DPIE Water	Diver datalogger
GW047919	Active Production	8.7	-31.0852	151.0345	22 July 2020	27 February 2020.	DPIE Water	Diver datalogger
GW062410	Inactive Production	8.6	-31.0802	151.0357	22 July 2020	27 February 2020.	DPIE Water	Diver datalogger
GW900594	Active Production	9.5	-31.0893	151.024	22 July 2020	24 February 2020.	DPIE Water	Diver datalogger
GW930110	New Monitoring - Drilled 30 April to 1 May 2020	9.2	-31.0864	151.029785	22 July 2020	14 May 2020.	DPIE Water	Diver datalogger
GW930111	New Monitoring - Drilled 28 April 2020	13.5	-31.0866	151.026553	22 July 2020	14 May 2020	DPIE Water	Diver datalogger
GW930112	New Monitoring - Drilled 5 May 2020	14	-31.0872	151.02659	22 July 2020	14 May 2020	DPIE Water	Diver datalogger

Site	Bore Type	Depth (mbgl)	Latitude	Longitude	Date surveyed	Date instrumentation installed	Instrumentation installed by	Instrumentation type
GW930113	New Monitoring - Drilled 6 to 7 May 2020	13.2	-31.0882	151.025847	22 July 2020	14 May 2020	DPIE Water	Diver datalogger

Table 5. Groundwater bore monitoring activity near Pool 4.

Site	Bore Type	Depth (mbgl)	Latitude	Longitude	Date surveyed	Date instrumentation installed	Instrumentation installed by	Instrumentation type
GW060042	Active Production	11.6	-31.1282	150.9867	3 August 2020	24 February 2020.	DPIE Water	Diver datalogger
GW060043	Inactive Production	10.7	-31.1285	150.9892	3 August 2020	24 February 2020.	DPIE Water	Diver datalogger
GW060044	Inactive Production	10.7	-31.1687	150.9917	3 August 2020	24 February 2020.	DPIE Water	Diver datalogger
GW093030	Monitoring borehole	13	-31.1262	150.9917		29 June 2020	WaterNSW	Diver datalogger
GW093031	Monitoring borehole	6	-31.1268	150.9942				
GW093032	Monitoring borehole	13	-31.1289	150.9919		18 August 2020	WaterNSW	Data logger and telemetry
GW273033	Monitoring borehole	17	-31.124	150.999		10 July 2020	WaterNSW	Data logger and telemetry

Appendix D – Bore log data, new bores

Form A Particulars of completed work

WaterNSW

Driller's Licence No:	DL2392
Class of Licence:	Class 4
Driller's Name:	Jeremy Whyte
Assistant Driller:	Richard bullock
Contractor:	Mannion Drilling

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	
Final Depth	X	m 7.4	

Work Licence No:	GW093110
Name of Licensee:	DPIE MB1
Intended Use:	Monitoring
Completion Date:	05 /05 / 20

DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method
0	12	185	7

WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
4	8	4	8.4								

CASING / LINER DETAILS

Material	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing
6	114.3	6.3	-1.	4.3	1 & 5
6	114.3	6.3	7.	7.4	1 & 5

Casing Support Method	3						
Type of casing Bottom	2						
Centralisers installed (Yes/No)	No	Indicate on sketch					
Sump installed (Yes/No)	Yes	From	7.	m to	7.4	m	
Pressure cemented (Yes/No)	Yes	From		m to		m	
Casing Protector cemented in place							

WATER ENTRY DESIGN

General							Screen	Slot Details		
Material	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening Type	Fixing	Aperture (mm)	Length (mm)	Width (mm)	Alignment
6	114.3	6.3	4.3	7.	5	1 & 5	1			H

GRAVEL PACK

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m3
Rounded	X	Graded	X	3	5	3.3	7.4		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)		Yes				0	3.3		
Method of placement of Gravel Pack				1					

For Departmental use only: G W

Form A Particulars of completed work

WaterNSW

Work Licence No:	GW093110

BORE DEVELOPMENT

Chemical used for breaking down drilling mud	(Yes/No)	Yes	Name:	Asca-200

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	8	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION

Test Type		Date	Pum intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1	/ /								
	Stage 2	/ /								
	Stage 3	/ /								
	Stage 4	/ /								
Single stage (constant rate)		/ /								

Height of measuring point above ground level		m	Test Method	

WORK PARTLY BACKFILLED OR ABANDONED

Original depth of work		m		Is work partly backfilled	(Yes/No)	
Is work abandoned:	(Yes/No)		Method of abandonment:	Backfilled	Plugged	Capped
Has any casing been left in the work	(Yes/No)		From		m To	m

Sealing / fill type	From depth m	To depth m	Sealing / fill type	From depth m	To depth

Site chosen by:	Hydrogeologist		Geologist		Driller		Diviner		Client		Other	

Lot No			DP No		Northing	6559143.3	Zone	56J
Work Location Co-ordinates			Easting	312064.3	or	MGA/GDA		(See explanation)
GPS:	(Yes/No)		>>	AMG/AGD				
			Longitude		Latitude			

Please mark the work site with "X" on the CLID provided map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

		Signatures:	
Driller:		Licensee:	
Date:	06 / 05 / 20	Date:	/ /

Form A Particulars of completed work

Work Licence No:	GW093110

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)			WORK CONSTRUCTION SKETCH
Depth		Description	
From (m)	To (m		
0	1	Silty clay, trace sand, fine to medium, black to grey	
1	3	Sandy clay	
3	4	Sandy clayey gravel, gravel fine to coarse,	
4	6	Sandy gravel, fine to coarse	
6	8	Gravel some sand	
8	9.2	Sandy gravel	
9.2	12	Granite hard	

WORK NOT CONSTRUCTED BY DRILLING RIG													
Method of excavation:	Hand dug		Back hoe		Dragline		Dozer		Other				
Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)						

Please attach copies of the following if available								
Geologist log	(Yes/No)		Laboratory analysis of water Sample	(Yes/No)		Pumping test(s	(Yes/No)	
Geophysical log	(Yes/No)		Sieve analysis of aquifer material	(Yes/No)		Installed Pump details	(Yes/No)	

DRAFT / FINAL

Planning, Industry & Environment

BORE CONSTRUCTION LOG

SITE :MB1
GW NO : GW093110

PROJECT : Cockburn Pool Study	MULTI PIPE NO	NO. OF PIPES : 1
LOCATION :	NORTHING :	EASTING :
START DATE : 30/04/2020	ELEVATION :	
COMPLETION DATE :1/05/2020	LOGGED BY : Martin O'Rourke	
DRILL TYPE : BOURNE 1500	CHECKED BY :	
DRILLING METHOD : Mud Rotary 185 mm diameter hole	CUTTINGS	

DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION -1.12 to 2.12 protective casing	COMMENTS
1	Silty CLAY; trace sand, fine to medium, black to grey		0 to 2.3 grout	Top of protective casing 1.12 m above ground
2	Sandy CLAY; sand 30% fine to coarse, rounded to sub-angular, 80% lithic fragments 20% quartz; trace gravel <1% fine to medium, mainly fine, rounded to sub-angular; grey brown			
3			2.3 to 3.1 bentonite seal	
4	Sandy Clayey GRAVEL; gravel fine to coarse, mainly fine to medium, 2-15mm, coarse trace 20-35 mm, mainly lithic fragments; sand fine to coarse trace mica, 80% lithic fragments 20% quarts, founded to sub-angular; brown		3.1 to 7.4 gravel pack	
5	Sandy GRAVEL; gravel 80% fine to coarse, coarse 20% to 45mm, rounded to sub-rounded, 80% lithic fragments, 20 % quartz; sand 12% fine to coarse, well rounded to sub-rounded quarts 50% lithic fragments 50%; some clay 8%; brown		4.3 to 7.0 screen	
6				
7	GRAVEL some sand 8%, trace clay; gravel fine to coarse, 30% coarse lithic fragments to 50mm, 50% medium lithic fragments founded to sub-rounded, fine 30%, 50% quartz, 50 % lithic fragments rounded to sub-rounded; sand fine to coarse, 50% quartz, 50 % lithic fragments well rounded to sub-angular: brown		7 to 7.4 m sump	
8			At 7.4 end cap	
9.2	Sandy GRAVEL; gravel 90%, fine to coarse, coarse 20%, medium 40%, fine 40% rounded to sub-rounded; sand 10% fine to coarse, coarse 60% sub-rounded to sub-angular; brown		7.4 to 9.2 hole collapse	
	At 9.2m Granite, hard drilling TOTAL DEPTH 9.2m			

COMMENTS: Hole collapsed in from 7.4 to 9.2 m

PAGE 1 OF 1

Form A Particulars of completed work

WaterNSW

Driller's Licence No:	DL2392
Class of Licence:	4
Driller's Name:	Jeremy Whyte
Assistant Driller:	Richard bullock
Contractor:	Mannion Drilling

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	
Final Depth	X	m 10.9	

Work Licence No:	GW093111
Name of Licensee:	DPIE MB2
Intended Use:	Monitoring
Completion Date:	08 /05 / 20

DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method
0	13.5	185	7

WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method	D D L at end of test (m)	Duration	Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative			Hrs min	Cond (µS/cm)	TDS (mg/L)
7	10	3	8.5							

CASING / LINER DETAILS

Material	OD (mm)	Wall Thicknes (mm)	From (m)	To (m)	Method Fixing
6	114.3	6.3	-1	7.6	1 & 5

Casing Support Method	3					
Type of casing Bottom	2					
Centralisers installed (Yes/No)	No	Indicate on sketch				
Sump installed (Yes/No)	Yes	From	10.6	m to	10.9	m
Pressure cemented (Yes/No)	Yes	From	0	m to	6	m
Casing Protector cemented in place						

WATER ENTRY DESIGN

General							Screen	Slot Details		
Material	OD (mm)	Wall Thicknes (mm)	From (m)	To (m)	Opening Type	Fixing	Aperture (mm)	Length (mm)	Width (mm)	Alignment
6	114.3	6.3	7.6	10.6	5	1 & 5	1			H

GRAVEL PACK

Type		Grade		Grain size (mm)		Depth (m)		Quantity	
				From	To	From	To	Litres	m3
Rounded	X	Graded	X	3	5	7.6	10.9		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)		Yes				6	7.6		
Method of placement of Gravel Pack		1							

For Departmental use only: G W

Form A Particulars of completed work

WaterNSW

Work Licence No:	GW093111

BORE DEVELOPMENT

Chemical used for breaking down drilling mud	(Yes/No)	Yes	Name:	Asca-200

Method	Balling/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs		hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION

Test Type		Date	Pum intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1	/ /								
	Stage 2	/ /								
	Stage 3	/ /								
	Stage 4	/ /								
Single stage (constant rate)		/ /								

Height of measuring point above ground level		m	Test Method	

WORK PARTLY BACKFILLED OR ABANDONED

Original depth of work		m		Is work partly backfilled	(Yes/No)	
Is work abandoned:	(Yes/No)		Method of abandonment:	Backfilled	Plugged	Capped
Has any casing been left in the work	(Yes/No)		From	m	To	m

Sealing / fill type	From depth m	To depth m	Sealing / fill type	From depth m	To depth

Site chosen by:	Hydrogeologist	X	Geologist		Driller		Diviner		Client		Other	

Lot No			DP No		Northing	6559122.5	Zone	56J
Work Location Co-ordinates			Easting	311763.5	or	MGA/GDA		(See explanation)
GPS:	(Yes/No)		>>	AMG/AGD				
			Longitude		Latitude			

Please mark the work site with "X" on the CLID provided map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

		Signatures:	
Driller:		Licensee:	
Date:	13 / 05 / 20	Date:	/ /

Form A Particulars of completed work

Work Licence No:	GW093111

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)			WORK CONSTRUCTION SKETCH
Depth		Description	
From (m)	To (m		
0	1	Clayey sand	
1	2.5	Sandy clay	
2.5	4	Sandy clay	
4	5	Gravel sand	
5	7	Gravel clay	
7	8	Sandy gravel	
8	11	Gravelly sand	
11	12	Clayey sand	
12	13	Sandy clay gravel	
13	13.5	Bedrock	

WORK NOT CONSTRUCTED BY DRILLING RIG													
Method of excavation:	Hand dug		Back hoe		Dragline		Dozer		Other				
Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)						

Please attach copies of the following if available								
Geologist log	(Yes/No)		Laboratory analysis of water Sample	(Yes/No)		Pumping test(s	(Yes/No)	
Geophysical log	(Yes/No)		Sieve analysis of aquifer material	(Yes/No)		Installed Pump details	(Yes/No)	

Planning, Industry & Environment

BORE CONSTRUCTION LOG

DRAFT / FINAL

SITE : MB2

GW NO : GW093111

PROJECT : Cockburn Pool Study	MULTI PIPE : ☐ YES ☒NO	NO. OF PIPES : 1
LOCATION : Cockburn R. : Back Kootingal Rd, Kootingal NSW 2352	NORTHING :	EASTING :
START DATE : 28/04/2020	ELEVATION :	
COMPLETION DATE : 28/04/2020	LOGGED BY : Patrick Wilcox and Martin O'Rourke	
DRILL TYPE : BOURNE 1500	CHECKED BY : Martin O'Rourke	
DRILLING METHOD : Mud Rotary 185 mm diameter	☐ CORE ✔ CUTTINGS	

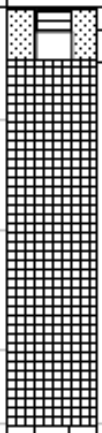
DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION	COMMENTS
1	Clayey SAND; sand 60%, fine to medium, sub-rounded to sub-angular, 20% quartz, 80% lithic fragments; clay 30%; some silt 10%. Grey brown.		-1.09 to 2.09 Protective casing; 0 to 5.0 grout	
2	Sandy silty CLAY; 50% clay; 40% Sand, fine to medium sub-rounded to sub-angular grains with 20% quartz fragments; silt 10%; brown to 2.5			
2.5				
3	Sandy clayey GRAVEL; gravel 70%, fine to medium gravels, sub-rounded to sub-angular; sand 20%, fine to medium grains, 90% lithic fragments, 10% quartz; clay 10%; grey			
4				
5	Sandy clayey GRAVEL; gravel 50% fine to medium gravels, sub-rounded to sub-angular; sand 30%, fine to coarse grains, 80% lithic fragments and 20% quartz; clay 20%; grey brown			
6	Gravelly clayey SAND; sand 60%, medium to coarse grains, sub-rounded to sub-angular, 70% lithic fragments, 30% quartz; gravel 20%, fine to medium gravels, sub-rounded; clay 20%; grey brown		5.0 to 6.0 bentonite seal	
7	Gravelly clayey SAND; sand 50%, medium to coarse, sub-rounded to sub-angular, 60% lithic fragments, 40% quartz; gravel 30%, fine to medium, sub-rounded to sub-angular, 20% quartz fragments; clay 20%; grey brown		6.0 to 10.5 gravel pack	
8	Sandy GRAVEL : gravel 55%, fine to medium gravels, rounded to sub-angular, 40% quartz fragments; sand 45% with medium to coarse grains, sub-rounded to angular; grey brown		7.2 to 10.2 screen	
9	Gravelly SAND; sand 60% with medium to coarse grains, sub-rounded to sub-angular, 60% lithic fragments, 40% quartz; gravel 40%, fine to medium, sub-rounded to angular, 60% quartz fragments; Trace clays; grey brown			
10				

COMMENTS:	PAGE 1 OF 2

DRAFT / FINAL

BORE CONSTRUCTION LOG

SITE : MB2
GW NO : GW093111

DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION	COMMENTS
11	As above		 10.2 to 10.5 sump; 10.5 to 13.5 hole collapse	
12	Clayey Sandy GRAVEL; gravel 50%, fine to medium, sub-rounded to sub-angular, 20% quartz fragments. sand 30% with medium to coarse grains, sub-rounded to sub-angular, 60% lithic, 40% quartz; clay 20%; brown grey			
13	Sandy Clayey GRAVEL; gravel 70%, medium to coarse gravels, sub-rounded to angular, 60% quartz fragments; sand 10%, medium to coarse, sub-rounded to sub-angular, 70% lithic fragments, 30% quartz; clay 20%; brown grey			
13.5	GRAVEL; gravel 95%, fine to coarse gravels, 80% coarse, sub-rounded to angular, 10% quartz fragments; trace sand and trace clays; grey with browns streaks			
	At 13.5m Rock, hard drilling. TOTAL DEPTH 13.5 m			

COMMENTS:	PAGE 2 OF 2

Form A Particulars of completed work

WaterNSW

Driller's Licence No:	2392
Class of Licence:	4
Driller's Name:	Jeremy Whyte
Assistant Driller:	Richard Bullock
Contractor:	Mannion Drilling

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	
Final Depth	X	m 11.6	

Work Licence No:	GW093112
Name of Licensee:	DPIE MB3
Intended Use:	Monitoring
Completion Date:	13 /05 / 20

DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method
0	14	185	7

WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method	D D L at end of test (m)	Duration	Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative			Hrs min	Cond (µS/cm)	TDS (mg/L)
8	11.5	3.5	8.5							

CASING / LINER DETAILS

Material	OD (mm)	Wall Thicknes (mm)	From (m)	To (m)	Method Fixing
6	114.3	6.3	-1	8.1	1 & 5

Casing Support Method	3						
Type of casing Bottom	2						
Centralisers installed (Yes/No)	No	Indicate on sketch					
Sump installed (Yes/No)	Yes	From	11.1	m to	11.6	m	
Pressure cemented (Yes/No)	Yes	From	0	m to	6	m	
Casing Protector cemented in place							

WATER ENTRY DESIGN

General							Screen	Slot Details		
Material	OD (mm)	Wall Thicknes (mm)	From (m)	To (m)	Opening Type	Fixing	Aperture (mm)	Length (mm)	Width (mm)	Alignment
6	114.3	6.3	8.1	11.1	5	1 & 5	1			H

GRAVEL PACK

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m3
Rounded	X	Graded	X	3	5	7	14		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)		Yes				6	7		
Method of placement of Gravel Pack				1					

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Form A Particulars of completed work

WaterNSW

Work Licence No:	GW093112

BORE DEVELOPMENT

Chemical used for breaking down drilling mud	(Yes/No)	Yes	Name:	Asca-200

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	14	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION

Test Type		Date	Pum intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1	/ /								
	Stage 2	/ /								
	Stage 3	/ /								
	Stage 4	/ /								
Single stage (constant rate)		/ /								

Height of measuring point above ground level		m	Test Method	

WORK PARTLY BACKFILLED OR ABANDONED

Original depth of work		m		Is work partly backfilled	(Yes/No)	
Is work abandoned:	(Yes/No)		Method of abandonment:	Backfilled	Plugged	Capped
Has any casing been left in the work	(Yes/No)		From		m To	m

Sealing / fill type	From depth m	To depth m	Sealing / fill type	From depth m	To depth

Site chosen by:	Hydrogeologist	X	Geologist		Driller		Diviner		Client		Other	

Lot No			DP No	
Work Location Co-ordinates			Easting	311760
GPS:	(Yes/No)		>>	AMG/AGD
			Longitude	

Northing	6559056.6	Zone	56J
or	MGA/GDA		(See explanation)
Latitude			

Please mark the work site with "X" on the CLID provided map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

		Signatures:	
Driller:		Licensee:	
Date:	13 / 05 / 20	Date:	/ /

Form A Particulars of completed work

Work Licence No:	GW093112

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)			WORK CONSTRUCTION SKETCH
Depth		Description	
From (m)	To (m		
0	3	Sandy clay silt	
3	5	Clay and silt	
5	7	Sandy silty clay	
7	9	Gravel sandy clay	
9	11.5	Sandy clay gravel	
11.5	14	Weathered granite	

WORK NOT CONSTRUCTED BY DRILLING RIG							
Method of excavation:	Hand dug		Back hoe		Dragline		Dozer		Other	
Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available								
Geologist log	(Yes/No)		Laboratory analysis of water Sample	(Yes/No)		Pumping test(s	(Yes/No)	
Geophysical log	(Yes/No)		Sieve analysis of aquifer material	(Yes/No)		Installed Pump details	(Yes/No)	

Planning, Industry & Environment

BORE CONSTRUCTION LOG

DRAFT / FINAL

SITE :MB3

GW NO :GW093112

PROJECT : Cockburn Pool Study	MULTI PIPE : NO	NO. OF PIPES : 1
LOCATION :	NORTHING :	EASTING :
START DATE : 5/05/2020	ELEVATION :	
COMPLETION DATE :5/05/2020	LOGGED BY :	
DRILL TYPE : BOURNE 1500	CHECKED BY :	
DRILLING METHOD : Mud Rotary 185 mm diameter hole	CUTTINGS	

DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION -1.2 to 2.0 protective casing	COMMENTS
1	Sandy Clayey SILT; sand 25%, fine to coarse to 2mm, angular to rounded, lithic fragments 75% quartz 25%; dark brown; trace gravel fine to 6mm, mainly quartz		0 to 6.0 grout	
2	Sandy Clayey SILT; sand 30%, fine to coarse to 2mm, angular to rounded, lithic fragments 75% quartz 25%; dark brown; trace gravel < 1% fine to 6mm, mainly quartz			
3	Sandy Clayey SILT; sand 20%, fine to coarse to 2mm, angular to rounded, lithic fragments 75% quartz 25%; dark brown; trace gravel fine to 6mm, mainly quartz			
4	Clayey SILT / Silty CLAY; brown; some sand 6%, fine to coarse to 2 mmm mainly fine to medium < 0.6 mm, sub-angular to rounded, , lithic fragments 80% quartz 20%; trace gravel <1% fine to 6mm, lithic fragments 50% quartz 50%, sub-angular to rounded			
5	Silty CLAY; brown; some sand 9%, fine to coarse to 2 mm mainly fine to medium < 0.6 mm, sub-angular to rounded, , lithic fragments 80% quartz 20%; trace gravel <1% fine to 6mm, lithic fragments 50% quartz 50%, sub-angular to rounded			
6	Sandy Silty CLAY; sand 20% fine to coarse, mainly fine to medium 0.6 mm, sub-angular to sub-rounded, lithic fragments 80% quartz 20%; brown to grey to black probably mottled in situ; trace gravel fine to 6mm sub-angular quarts 80% lithic fragments 10%			
7	Sandy Silty CLAY; sand 15% fine to coarse, mainly fine to medium 0.6 mm, sub-angular to sub-rounded, lithic fragments 80% quartz 20%; grey; trace gravel fine to 6mm sub-angular quarts 50% lithic fragments 50%		6.0 to 7.0 bentonite seal	
8	Gravelly Sandy CLAY; gravel 20-30% fine to coarse to 40 mm, mainly fine to medium to 15 mm, sub-angular to sub-rounded, lithic fragments 80% quartz 20%; sand 15% fine to coarse to 2 mm, sub-angular to rounded, lithic fragments 80% quartz 20 %; grey brown		7.0 to 11.1 gravel pack	
9			8.0 to 11.0 screen	
10	Clayey Sandy GRAVEL; gravel 70% fine to coarse to 25 mm, medium 80%, sub-angular to sub-rounded, lithic fragments 80% quartz 20%; sand 12% fine to coarse to 2 mm, sub-angular to rounded, lithic fragments 70% quartz 30 %; brown			

COMMENTS:

PAGE OF

DRAFT / FINAL

Planning, Industry & Environment

BORE CONSTRUCTION LOG

SITE : MB3
GW NO :GW093112
DATE:5/05/2020

DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION	COMMENTS
10	Clayey Sandy GRAVEL; gravel 70% fine to coarse to 60 mm, medium 80%, sub-angular to sub-rounded, lithic fragments 80% quartz 20%; sand 12% fine to coarse to 2 mm, sub-angular to rounded, lithic fragments 70% quartz 30 %; brown		8.0 to 11.0 screen	
11				
11.5			11.1 to 11.6 sump	
12	Extremely weathered GRANITE to a Sandy Gravelly CLAY.		At 11.6 m End Cap	
14	At 14 m GRANITE, hard		11.6 to 14.0 hole collapsed	11.6 to 14.0 hole collapsed
	Total Depth 14.0 m			

COMMENTS:

PAGE OF

Form A Particulars of completed work

WaterNSW

Driller's Licence No:	2392
Class of Licence:	4
Driller's Name:	Jeremy Whyte
Assistant Driller:	Richard Bullock
Contractor:	Mannion Drilling

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	
Final Depth	X	m 10.3	

Work Licence No:	GW093113
Name of Licensee:	DPIEMB4
Intended Use:	Monitoring
Completion Date:	08 /05 / 20

DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method
0	13.2	185	7

WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method	D D L at end of test (m)	Duration	Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative			Hrs min	Cond (µS/cm)	TDS (mg/L)
7	10	3	8.47							

CASING / LINER DETAILS

Material	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing
6	114.3	6.3	-1	7.3	1 & 5

Casing Support Method	3						
Type of casing Bottom	2						
Centralisers installed (Yes/No)	No	Indicate on sketch					
Sump installed (Yes/No)	Yes	From	10	m to	10.3	m	
Pressure cemented (Yes/No)	Yes	From	0	m to	5	m	
Casing Protector cemented in place							

WATER ENTRY DESIGN

General							Screen	Slot Details		
Material	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening Type	Fixing	Aperture (mm)	Length (mm)	Width (mm)	Alignment
6	114.3	6.3	7.3	10	5	1 & 5	1			H

GRAVEL PACK

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m3
Rounded	X	Graded	X	3	5	6	13.2		
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)		Yes				5	6		
Method of placement of Gravel Pack				1					

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Form A Particulars of completed work

WaterNSW

Work Licence No:	GW093113

BORE DEVELOPMENT

Chemical used for breaking down drilling mud	(Yes/No)	Yes	Name:	Asco-200

Method	Bailing/Surging		Jetting		Airlifting	X	Backwashing		Pumping		Other:	
Duration		hrs		hrs	15	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION

Test Type		Date	Pum intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1	/ /								
	Stage 2	/ /								
	Stage 3	/ /								
	Stage 4	/ /								
Single stage (constant rate)		/ /								

Height of measuring point above ground level		m	Test Method	

WORK PARTLY BACKFILLED OR ABANDONED

Original depth of work		m		Is work partly backfilled	(Yes/No)	
Is work abandoned:	(Yes/No)		Method of abandonment:	Backfilled	Plugged	Capped
Has any casing been left in the work	(Yes/No)		From		m To	m

Sealing / fill type	From depth m	To depth m	Sealing / fill type	From depth m	To depth

Site chosen by:	Hydrogeologist	X	Geologist		Driller		Diviner		Client		Other	

Lot No		DP No	
Work Location Co-ordinates		Easting	311679
GPS: (Yes/No)		>>	AMG/AGD
		Longitude	

Northing	6558936.7	Zone	56J
or	MGA/GDA		(See explanation)
Latitude			

Please mark the work site with "X" on the CLID provided map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

		Signatures:	
Driller:		Licensee:	
Date:	14 / 05 / 20	Date:	/ /

Form A Particulars of completed work

Work Licence No:	GW093113

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)			WORK CONSTRUCTION SKETCH
Depth		Description	
From (m)	To (m		
0	5	Silty sandy clay	
5	8	Sandy clay	
8	9	Sandy clay gravel	
9	11	Sandy gravel	
11	13.2	Weathered granite	

WORK NOT CONSTRUCTED BY DRILLING RIG													
Method of excavation:	Hand dug		Back hoe		Dragline		Dozer		Other				
Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)						

Please attach copies of the following if available								
Geologist log	(Yes/No)		Laboratory analysis of water Sample	(Yes/No)		Pumping test(s	(Yes/No)	
Geophysical log	(Yes/No)		Sieve analysis of aquifer material	(Yes/No)		Installed Pump details	(Yes/No)	

DRAFT / FINAL

BORE CONSTRUCTION LOG

SITE : MB4
GW NO : GW093113

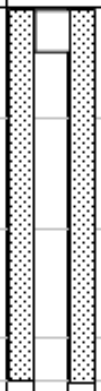
PROJECT : Cockburn Pool Study	MULTI PIPE : ☐ YES ☐ NO	NO. OF PIPES : 1
LOCATION :	NORTHING :	EASTING :
START DATE : 06/05/2020	ELEVATION :	
COMPLETION DATE : 07/05/2020	LOGGED BY : Patrick Wilcox and Martin O'Rourke	
DRILL TYPE : BOURNE 1500	CHECKED BY : Martin O'Rourke	
DRILLING METHOD : Mud Rotary 185 mm diameter	☐ CORE ✔ CUTTINGS	

DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION	COMMENTS
1	Sandy clayey SILT; silt 50%; sand 30% fine to medium up to 1mm, subrounded to subangular, 10% quartz fragments and 90% lithic; clay 20%; trace gravel up to 4mm. Dark brown		Protective casing to 1.17 to 2.0	
2	Silty sandy CLAY; clay 50%; silt 35%; sand 15% fine to medium grains, subrounded to subangular, 85% lithic fragments, 15% quartz; Trace gravels; Brown			
3	Silty sandy CLAY; clay 70%; silt 20%, sand 10% fine to medium grains, subrounded to subangular, 90% lithic fragments, 10% quartz; trace gravels up to 8mm. brown			
4				
5	Silty CLAY; clay 80%; silt 15%; sand 5%, fine to medium grains, subrounded to subangular, 90% lithic fragments; trace gravels; brown			
6	Sandy CLAY; clay 80%; sand 20%, fine to medium grains, subrounded to subangular, 80% lithic fragments, 20% quartz; trace gravels; brown			Bentonite 5 to 6m
7	Sandy CLAY; clay 70%; sand 30%, fine to course grains up to 1.5mm predominantly 0.5-1mm, subrounded to angular, 80% lithic fragments, 20% quartz; trace gravels; light brown			Gravel pack 6 to 13.2m
8	Sandy clayey GRAVEL; gravel 65%, fine to course gravels up to 35mm, subrounded to angular; clay 20%; sand 15%, fine to medium grains up to 1.5mm; gray brown			Screen from 7.3 to 10m
9	Sandy clayey GRAVEL; gravel 90%, fine to coarse gravels up to 25mm; subrounded to angular; clay 5%; sand 5% fine to medium grains, 90% lithic fragments, 10% quartz; browny grey			
10	Sandy GRAVEL; gravel 92%, fine to coarse gravels up to 40mm, coarse 15%, medium 30%, fine 55%, subrounded to angular; sand 6%, fine to course grains up to 2mm, subrounded to rounded, 60% quartz, 40% lithic. Brown			
COMMENTS:				PAGE 1 OF 2

DRAFT / FINAL

BORE CONSTRUCTION LOG

SITE : MB4
GW NO : GW093113

DEPTH (m)	GEOLOGICAL DESCRIPTION *Lithology, grain size, secondary components, colour, other*	GRAPHIC LOG	CONSTRUCTION	COMMENTS
11	Sandy GRAVEL : gravel 87%, fine to medium gravels with trace coarse, subangular to rounded; sand 12%, fine to course grains to 2mm, subrounded to rounded, 60% quartz fraction, 40% lithic; trace clays; brown.			10.0 to 10.3m sump
12	Sandy gravelly CLAY; extremely weathered granite.			
13				
13.2	Granite			Total depth bore
COMMENTS:				PAGE 2 OF 2

Appendix E – Bore log data, existing government monitoring bores

WaterNSW
Work Summary

GW093036

Licence:		**Licence Status:**	
		Authorised Purpose(s):	
		Intended Purpose(s):	MONITORING BORE
Work Type:	Bore		
Work Status:	Instrumented		
Construct.Method:	Rotary Mud		
Owner Type:	NSW Office of Water		
Commenced Date:		**Final Depth:**	12.00 m
Completion Date:	12/11/1999	**Drilled Depth:**	12.00 m
Contractor Name:	DLWC GROUNDWATER DRILLING		
Driller:	Gerard Anthony Smit		
Assistant Driller:			
Property:		**Standing Water Level (m):**	
GWMA:		**Salinity Description:**	
GW Zone:		**Yield (L/s):**	1.000

Site Details

Site Chosen By:

		County	**Parish**	**Cadastre**
Form A:		PARRY	NEMINGHA	RD ADJ 1//119395
Licensed:				
Region:	90 - Barwon	**CMA Map:**	9135-4N		
River Basin:	419 - NAMOI RIVER	**Grid Zone:**		**Scale:**	
Area/District:					
Elevation:	16.36 m (A.H.D.)	**Northing:**	6561194.800	**Latitude:**	31°04'06.2"S
Elevation Source:	Unknown	**Easting:**	314846.400	**Longitude:**	151°03'33.5"E
GS Map:	-	**MGA Zone:**	56	**Coordinate Source:**	Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	12.00	220			Rotary
1		Annulus	Waterworn/Rounded	7.50	12.00				Graded, Q:0.700m3
1	1	Casing	Steel	-1.57	0.50	100	92		Driven into Hole, Welded
1	1	Casing	P.V.C.	0.00	12.00	50	45		Seated on Bottom
1	1	Opening	Slots - Horizontal	8.50	11.50	50		0	Sawn, PVC Class 12, SL: 20.0mm, A: 1.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
8.50	11.50	3.00	Unknown			1.00	12.00	02:00:00	

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	3.00	3.00	Black Clay	Clay	Tikiri Tennakoon, 2/11/2010: Assigned code.
3.00	8.00	5.00	Brown Clay and Gravel	Clay	
8.00	11.00	3.00	Fine Gravel	Gravel	
11.00	12.00	1.00	Shale Black	Shale	

Remarks

08/03/2010: Maintenance Data: Pipe =,contractor=GDCS,maintained=,blocked=,recovered=,SWL below MP=9.89,Height of MP/Cas=1.57,Depth below MP=12.8,Bore Protector Painted=yes,New Lid on Bore Protector=,I.D. added=,Lock=,New Bore Protector Required= ,New Bore Protector Added=,Cement Around Bore Protector=,camera=,airlift=,airlift success=,logger repaired=,logger installed or replaced=,narrative=Paint, Data Logger not disturbed, ,
26/09/2012: Primary Client changed from GWB to GWA on 26/09/2012.
01/10/2013: Roadway 3m from shelter
28/01/2014: Box type shelter - no insulation
24/11/2015: Martin O'Roruke Ground Level determined from elevation Top of Protective Casing minus RL to Ground
04/03/2016: Primary Client changed from GWA to IPART on 04/03/2016.

WaterNSW
Work Summary

GW093037

Licence: **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status: Instrumented
Construct.Method: Rotary Mud
Owner Type: NSW Office of Water

Commenced Date: **Final Depth:** 21.00 m
Completion Date: 14/11/1999 **Drilled Depth:** 21.00 m

Contractor Name: DLWC GROUNDWATER DRILLING
Driller: Gerard Anthony Smit
Assistant Driller:

Property: **Standing Water Level (m):**
GWMA: **Salinity Description:**
GW Zone: **Yield (L/s):** 1.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	1//776616
Licensed:			

Region: 90 - Barwon **CMA Map:** 9135-4N
River Basin: 419 - NAMOI RIVER **Grid Zone:** **Scale:**
Area/District:

Elevation: 16.36 m (A.H.D.) **Northing:** 6561403.800 **Latitude:** 31°03'59.4"S
Elevation Source: Unknown **Easting:** 314689.400 **Longitude:** 151°03'27.7"E

GS Map: - **MGA Zone:** 56 **Coordinate Source:** Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	21.00	220			Rotary
1		Annulus	Waterworn/Rounded	16.50	21.00				Graded, Q:0.700m3
1	1	Casing	Steel	-1.62	0.50	100	92		Driven into Hole, Seated on Bottom, Welded
1	1	Casing	P.V.C.	0.00	21.00	50	45		Seated on Bottom
1	1	Opening	Slots - Horizontal	17.50	20.50	50		0	Sawn, PVC Class 12, SL: 20.0mm, A: 1.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
17.50	20.50	3.00	Unknown			1.00	21.00	02:00:00	

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.00	2.00	Brown Clay	Clay	
2.00	10.00	8.00	Brown Clay bound Gravel	Clay	
10.00	19.00	9.00	Gravel	Gravel	
19.00	21.00	2.00	Spotted Gravel	Gravel	

Remarks

08/03/2010: Maintenance Data: Pipe =,contractor=GDCS,maintained=,blocked=,recovered=,SWL below MP=9.36,Height of MP/Cas=1.5,Depth below MP=22.7,Bore Protector Painted=yes,New Lid on Bore Protector=,I.D. added=,Lock=,New Bore Protector Required= ,New Bore Protector Added=,Cement Around Bore Protector=,camera=,airlift=,airlift success=,logger repaired=,logger installed or replaced=,narrative=Paint, Data Logger not disturbed, ,
26/09/2012: Primary Client changed from GWB to GWA on 26/09/2012.
01/10/2013: Roadway 3m from shelter
28/01/2014: Box type shelter - no insulation
24/11/2015: Martin O'Roruke Ground Level determined from elevation Top of Protective Casing minus RL to Ground
04/03/2016: Primary Client changed from GWA to IPART on 04/03/2016.

WaterNSW
Work Summary

GW093038

Licence: | **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status: Manual Observations,Monthly
Construct.Method: Rotary Mud
Owner Type: NSW Office of Water

Commenced Date:
Completion Date: 17/11/1999

Final Depth: 17.00 m
Drilled Depth: 17.00 m

Contractor Name: DLWC GROUNDWATER DRILLING
Driller: Gerard Anthony Smit
Assistant Driller:

Property:
GWMA:
GW Zone:

Standing Water Level (m):
Salinity Description:
Yield (L/s): 1.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	1//776616
Licensed:			

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 16.37 m (A.H.D.)
Elevation Source: Unknown

Northing: 6561617.800
Easting: 314530.400

Latitude: 31°03'52.6"S
Longitude: 151°03'22.0"E

GS Map: -

MGA Zone: 56

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	17.00	220			Rotary
1		Annulus	Waterworn/Rounded	12.50	17.00				Graded, Q:0.700m3
1	1	Casing	Steel	-1.57	0.50	100	92		Seated on Bottom, Driven into Hole, Welded
1	1	Casing	P.V.C.	0.00	17.00	50	45		Seated on Bottom, Glued
1	1	Opening	Slots - Horizontal	13.50	16.50	50		0	Sawn, PVC Class 12, SL: 20.0mm, A: 1.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
13.50	16.50	3.00	Unknown			1.00	17.00	01:00:00	

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	6.00	6.00	Brown Clay/Gravel	Clay	
6.00	13.00	7.00	Sandy Gravel	Gravel	
13.00	16.00	3.00	Clay Sand and Gravel	Sand	
16.00	17.00	1.00	Spotted Granite	Granite	

Remarks

08/03/2010: Maintenance Data: Pipe =,contractor=GDCS,maintained=,blocked=,recovered=,SWL below MP=9.81,Height of MP/Cas=1.57,Depth below MP=18.15,Bore Protector Painted=yes,New Lid on Bore Protector=,I.D. added=,Lock=,New Bore Protector Required= ,New Bore Protector Added=,Cement Around Bore Protector=,camera=,airlift=,airlift success=,logger repaired=,logger installed or replaced=,narrative=Paint, Data Logger not disturbed, ,
26/09/2012: Primary Client changed from GWB to GWA on 26/09/2012.
24/11/2015: Martin O'Roruke Ground Level determined from elevation Top of Protective Casing minus RL to Ground
04/03/2016: Primary Client changed from GWA to IPART on 04/03/2016.

WaterNSW
Work Summary

GW093039

Licence: **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status: Manual Observations,Monthly
Construct.Method: Rotary Mud
Owner Type: NSW Office of Water

Commenced Date: **Final Depth:** 16.00 m
Completion Date: 03/12/1999 **Drilled Depth:** 16.00 m

Contractor Name: DLWC GROUNDWATER DRILLING
Driller:
Assistant Driller:

Property: **Standing Water Level (m):**
GWMA: **Salinity Description:**
GW Zone: **Yield (L/s):** 1.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	INGLIS	MOONBI	221//811260
Licensed:			

Region: 90 - Barwon **CMA Map:** 9135-4N
River Basin: 419 - NAMOI RIVER **Grid Zone:** **Scale:**
Area/District:

Elevation: 418.22 m (A.H.D.) **Northing:** 6561776.000 **Latitude:** 31°03'47.3"S
Elevation Source: Unknown **Easting:** 314505.000 **Longitude:** 151°03'21.0"E

GS Map: - **MGA Zone:** 56 **Coordinate Source:** Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	16.00	250			Rotary
1		Annulus	Waterworn/Rounded	11.50	16.00				Graded, Q:0.500m3
1	1	Casing	Steel	-1.48	0.50	100	92		Seated on Bottom, Driven into Hole, Welded
1	1	Casing	P.V.C.	0.00	16.00	50	45		Seated on Bottom, Glued
1	1	Opening	Slots - Horizontal	12.50	15.50	50		0	Sawn, PVC Class 12, SL: 20.0mm, A: 1.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
12.50	15.00	2.50	Unknown			1.00	16.00	02:00:00	

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	11.00	11.00	Brown Clay	Clay	
11.00	12.00	1.00	Sandy Clay	Sandy Clay	Tikiri Tennakoon, 2/11/2010: Assigned code.
12.00	15.50	3.50	River Gravel	Gravel	
15.50	16.00	0.50	Shale Yellow	Shale	

Remarks

08/03/2010: Maintenance Data: Pipe =,contractor=GDCS,maintained=,blocked=,recovered=,SWL below MP=7.37,Height of MP/Cas=1.46,Depth below MP=16.2,Bore Protector Painted=yes,New Lid on Bore Protector=,I.D. added=,Lock=,New Bore Protector Required= ,New Bore Protector Added=,Cement Around Bore Protector=,camera=,airlift=,airlift success=,logger repaired=,logger installed or replaced=yes,narrative=Paint, Data Logger removed & replaced, ,
24/11/2015: Martin O'Roruke Ground Level determined from elevation Top of Protective Casing minus RL to Ground

WaterNSW
Work Summary

GW093040

Licence: **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status: Instrumented
Construct.Method: Rotary Mud
Owner Type: NSW Office of Water

Commenced Date:
Completion Date: 16/12/1999

Final Depth: 17.00 m
Drilled Depth: 17.00 m

Contractor Name: DLWC GROUNDWATER DRILLING
Driller:
Assistant Driller:

Property:
GWMA:
GW Zone:

Standing Water Level (m):
Salinity Description:
Yield (L/s): 1.500

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	INGLIS	MOONBI	RD ADJ 1//600329
Licensed:			

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 16.37 m (A.H.D.)
Elevation Source: Unknown

Northing: 6561942.800
Easting: 314300.400

Latitude: 31°03'41.8"S
Longitude: 151°03'13.3"E

GS Map: -

MGA Zone: 56

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	17.00	250			Rotary
1		Annulus	Waterworn/Rounded	12.50	17.00				Graded, Q:0.700m3
1	1	Casing	P.V.C.	-0.01	17.00	50	45		Seated on Bottom, Glued
1	1	Casing	Steel	0.39	0.39	100	92		Seated on Bottom, Driven into Hole, Welded
1	1	Opening	Slots - Horizontal	13.50	16.50	50		0	Sawn, PVC Class 12, SL: 20.0mm, A: 1.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
13.00	16.00	3.00	Unknown			1.50	17.00	02:00:00	

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Sandy Top Soil	Topsoil	
1.00	12.00	11.00	Brown Clay	Clay	
12.00	13.00	1.00	Decomposed Granite and Clay	Sandy Clay with Gravel	Tikiri Tennakoon, 2/11/2010: Assigned code.
13.00	16.00	3.00	River Gravel	Gravel	
16.00	17.00	1.00	Moombi Granite	Granite	

Remarks

06/07/2009: Nat Carling, 6-July-2009: Added RL's, updated casing details (based on RL's) & coordinates. As provided in State Water's survey results.
08/03/2010: Maintenance Data: Pipe =,contractor=GDCS,maintained=,blocked=,recovered=,SWL below MP=4.88,Height of MP/Cas=0,Depth below MP=17.2,Bore Protector Painted=yes,New Lid on Bore Protector=,I.D. added=,Lock=,New Bore Protector Required= ,New Bore Protector Added=,Cement Around Bore Protector=,camera=,airlift=,airlift success=,logger repaired=,logger installed or replaced=,narrative=Paint, Data Logger not disturbed, ,
26/09/2012: Primary Client changed from GWB to GWA on 26/09/2012.
01/10/2013: Roadway 3m from shelter
28/01/2014: Box type shelter - no insulation
04/03/2016: Primary Client changed from GWA to IPART on 04/03/2016.

Appendix F – Bore log data, private bores

WaterNSW
Work Summary

GW047599

Licence: 90CA814524 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): NOT KNOWN

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date:
Final Depth: 7.30 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	42
Licensed:	PARRY	NEMINGHA	Whole Lot 42//1111229

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6562612.000
Easting: 316505.000
Latitude: 31°03'21.3"S
Longitude: 151°04'37.0"E

GS Map: -
MGA Zone: 56
Coordinate Source:

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	0.00	3.70	1200			
1	1	Casing	Timber	3.70	7.30				

WaterNSW
Work Summary

GW013404

Licence: 90CA814928 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION
Intended Purpose(s): IRRIGATION, STOCK

Work Type: Well
Work Status: Supply Obtained
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 01/01/1959
Final Depth: 9.80 m
Drilled Depth: 9.80 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A KOOTINGAL 2352 NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m): 7.300
Salinity Description:
Yield (L/s): 12.630

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	INGLIS	MOONBI	221//811260
Licensed:	INGLIS	MOONBI	Whole Lot 221//811260

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6561935.000
Easting: 314820.000
Latitude: 31°03'42.3"S
Longitude: 151°03'33.0"E

GS Map: -
MGA Zone: 56
Coordinate Source:

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	-0.80	-0.80	1372			

WaterNSW
Work Summary

GW019247

Licence: 90CA819407 **Licence Status:** CURRENT

Authorised Purpose(s): TOWN WATER SUPPLY
Intended Purpose(s): TOWN WATER SUPPL

Work Type: Well
Work Status: Supply Obtained
Construct.Method:
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/06/1962

Final Depth: 9.40 m
Drilled Depth: 9.40 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM

Standing Water Level (m): 5.800
Salinity Description: 0-500 ppm
Yield (L/s): 10.100

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	INGLIS	MOONBI	1//217900
Licensed:	INGLIS	MOONBI	Whole Lot 1//700639

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6561846.000
Easting: 315007.000

Latitude: 31°03'45.3"S
Longitude: 151°03'40.0"E

GS Map: -

MGA Zone: 56

Coordinate Source:

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	-2.40	-2.40	1219			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
5.80	9.20	3.40	Unconsolidated	5.80		10.10			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	5.18	5.18	Driller	Invalid Code	
5.18	5.79	0.61	Sand	Sand	
5.79	7.92	2.13	Gravel Fine Water Supply	Gravel	
7.92	9.45	1.53	Gravel Coarse Water Supply	Gravel	

Remarks

01/11/1985: MOONBI-KOOTINGAL TWS
17/04/2008: Nat Carling, 17-Apr-2008: Adjusted cadastre, previously entered Lot/DP was '33'.

Work Summary

GW022231

Licence: 90CA819407
Licence Status: CURRENT

Authorised Purpose(s): TOWN WATER SUPPLY
Intended Purpose(s): TOWN WATER SUPPL

Work Type: Well
Work Status: Supply Obtained
Construct.Method:
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/04/1963
Final Depth: 9.40 m
Drilled Depth: 9.40 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m): 5.800
Salinity Description: 0-500 ppm
Yield (L/s): 10.100

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	INGLIS	MOONBI	221//811260
Licensed:	INGLIS	MOONBI	Whole Lot 1//700639

Region: 90 - Barwon
CMA Map: 9135-4N
River Basin: 419 - NAMOI RIVER
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6561784.000
Easting: 314982.000
Latitude: 31°03'47.3"S
Longitude: 151°03'39.0"E

GS Map: -
MGA Zone: 56
Coordinate Source:

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	-2.10	-2.10	1219			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
5.80	9.30	3.50	(Unknown)	5.80		10.10			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	4.88	4.88	Topsoil Alluvial	Topsoil	
4.88	5.79	0.91	Sand Clay	Sand	
5.79	8.23	2.44	Gravel Medium Coarse Gravel Water Supply	Gravel	
8.23	8.84	0.61	Gravel Water Supply	Gravel	
8.84	9.45	0.61	Rock Weathered Water Supply	Rock	

WaterNSW
Work Summary

GW042585

Licence: 90CA814472 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 01/06/1975
Final Depth: 10.60 m
Drilled Depth: 10.70 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m):
Salinity Description: 501-1000 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	L3 DP561357 (87)
Licensed:	PARRY	NEMINGHA	Whole Lot 2//814381

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6559087.539
Easting: 312438.298
Latitude: 31°05'13.0"S
Longitude: 151°02'01.3"E

GS Map: -
MGA Zone: 56
Coordinate Source: GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Opening	Slots	-100.00	0.00	914		1	
1	1	Casing	Concrete Cylinder	-0.60	4.20	1219			
1	1	Casing	Steel	3.90	10.60	914			Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
4.20	10.60	6.40	Unconsolidated	4.20		15.16			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.13	2.13	Soil Black	Soil	
2.13	4.57	2.44	Clay Water Supply	Clay	
4.57	5.48	0.91	Loam Sandy Water Supply	Loam	
5.48	7.01	1.53	Loam Gravel Water Supply	Loam	
7.01	10.66	3.65	Gravel Boulder Water Supply	Gravel	

Remarks

03/12/2019: Coordinates adjusted as per request from DPIE

WaterNSW
Work Summary

GW047919

Licence: 90CA814472 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 01/11/1980
Final Depth: 8.70 m
Drilled Depth: 8.70 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	43
Licensed:	PARRY	NEMINGHA	Whole Lot 2//814381

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6559281.707
Easting: 312513.115
Latitude: 31°05'06.8"S
Longitude: 151°02'04.3"E

GS Map: -
MGA Zone: 56
Coordinate Source: GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete	0.00	5.50	3000			
1	1	Casing		5.50	14.20	3000			

WaterNSW
Work Summary

GW062410

Licence: 90CA814614 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 01/01/1972
Final Depth: 8.60 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	39
Licensed:	PARRY	NEMINGHA	Whole Lot 3//977489

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9135-4N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6559839.000
Easting: 312611.000
Latitude: 31°04'48.7"S
Longitude: 151°02'08.4"E

GS Map: -
MGA Zone: 56
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete	0.00	0.00	1500			

WaterNSW
Work Summary

GW900594

Licence: 90CA814906 **Licence Status:** CURRENT

Authorised Purpose(s): IRRIGATION,STOCK,DOMESTIC
Intended Purpose(s): DOMESTIC, STOCK, IRRIGATION

Work Type: Bore
Work Status:
Construct.Method: Hand Drilled
Owner Type:

Commenced Date:
Completion Date:
Final Depth: 9.50 m
Drilled Depth:

Contractor Name: (None)
Driller: Unknown Unknown
Assistant Driller:

Property: MERRINGAH Merringah KOOTINGAL 2352 NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m): 7.200
Salinity Description:
Yield (L/s): 12.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	INGLIS	TAMWORTH	LOT A DP 363656
Licensed:	INGLIS	TAMWORTH	Whole Lot A//363656

Region: 90 - Barwon
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6558809.236
Easting: 311516.950
Latitude: 31°05'21.5"S
Longitude: 151°01'26.4"E

GS Map: -
MGA Zone: 56
Coordinate Source: GPS - Global

Remarks

28/07/1997: Form A Remarks:
WELL WORKS

WaterNSW
Work Summary

GW060042

Licence: 90CA814582 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date:

Final Depth: 11.60 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	26
Licensed:	PARRY	NEMINGHA	Whole Lot 1//745074

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 9035-1S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)

Northing: 6554431.104
Easting: 308034.714

Latitude: 31°07'41.6"S
Longitude: 150°59'12.0"E

GS Map: -

MGA Zone: 56

Coordinate Source: GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	0.00	0.00	1219			

WaterNSW
Work Summary

GW060043

Licence: 90CA814582 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date:
Final Depth: 10.70 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	26
Licensed:	PARRY	NEMINGHA	Whole Lot 1//745074

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9035-1S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6554402.197
Easting: 308274.877
Latitude: 31°07'42.7"S
Longitude: 150°59'21.1"E

GS Map: -
MGA Zone: 56
Coordinate Source: GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	0.00	0.00	1219			

WaterNSW
Work Summary

GW060044

Licence: 90CA814582 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Well
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date:
Final Depth: 10.70 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: 005 - PEEL VALLEY
GW Zone: 001 - PEEL ALLUVIUM
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	PARRY	NEMINGHA	34
Licensed:	PARRY	NEMINGHA	Whole Lot 1//338469

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 9035-1S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6549953.038
Easting: 308593.116
Latitude: 31°10'07.3"S
Longitude: 150°59'30.1"E

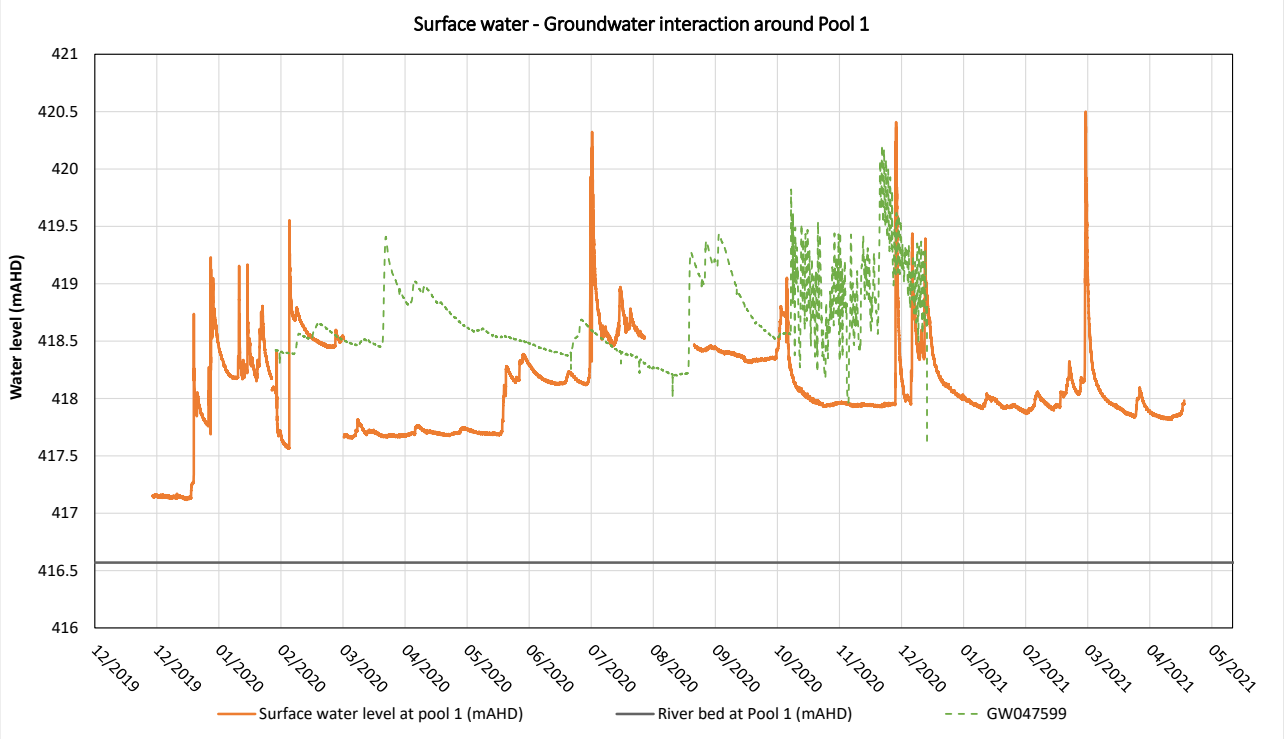
GS Map: -
MGA Zone: 56
Coordinate Source: GPS - Global

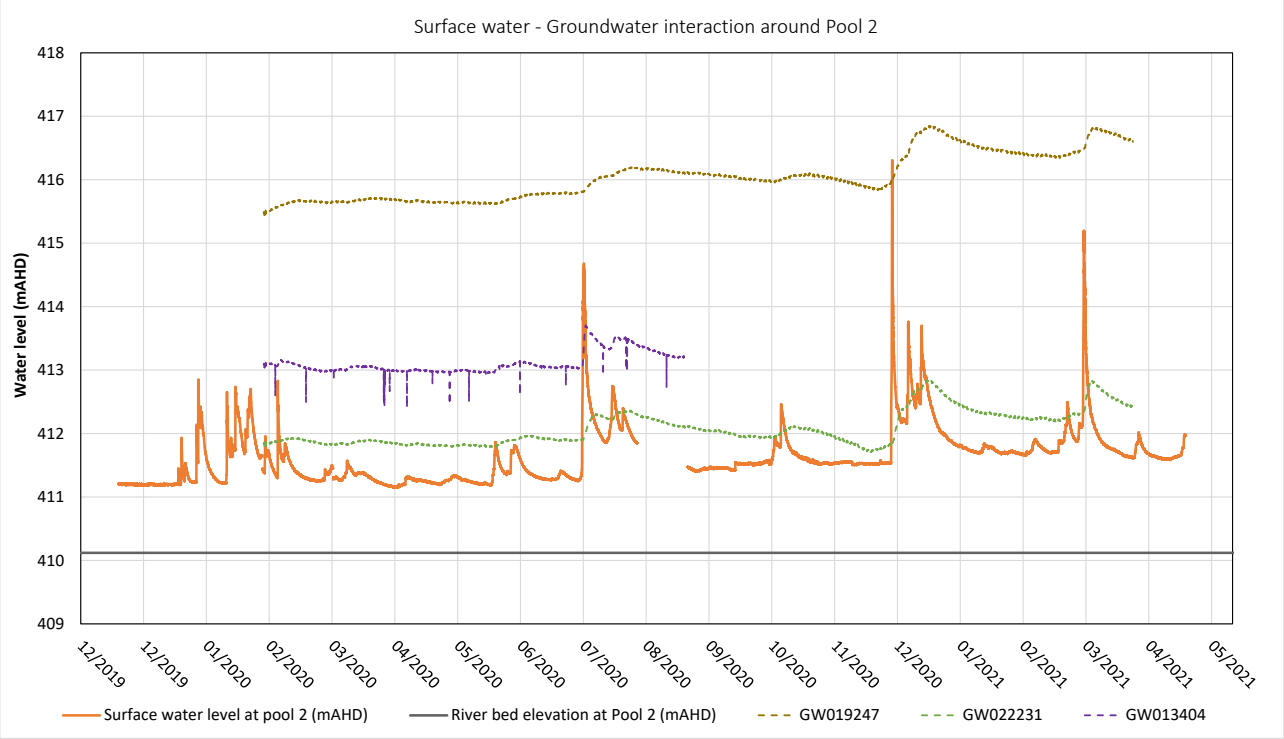
Construction

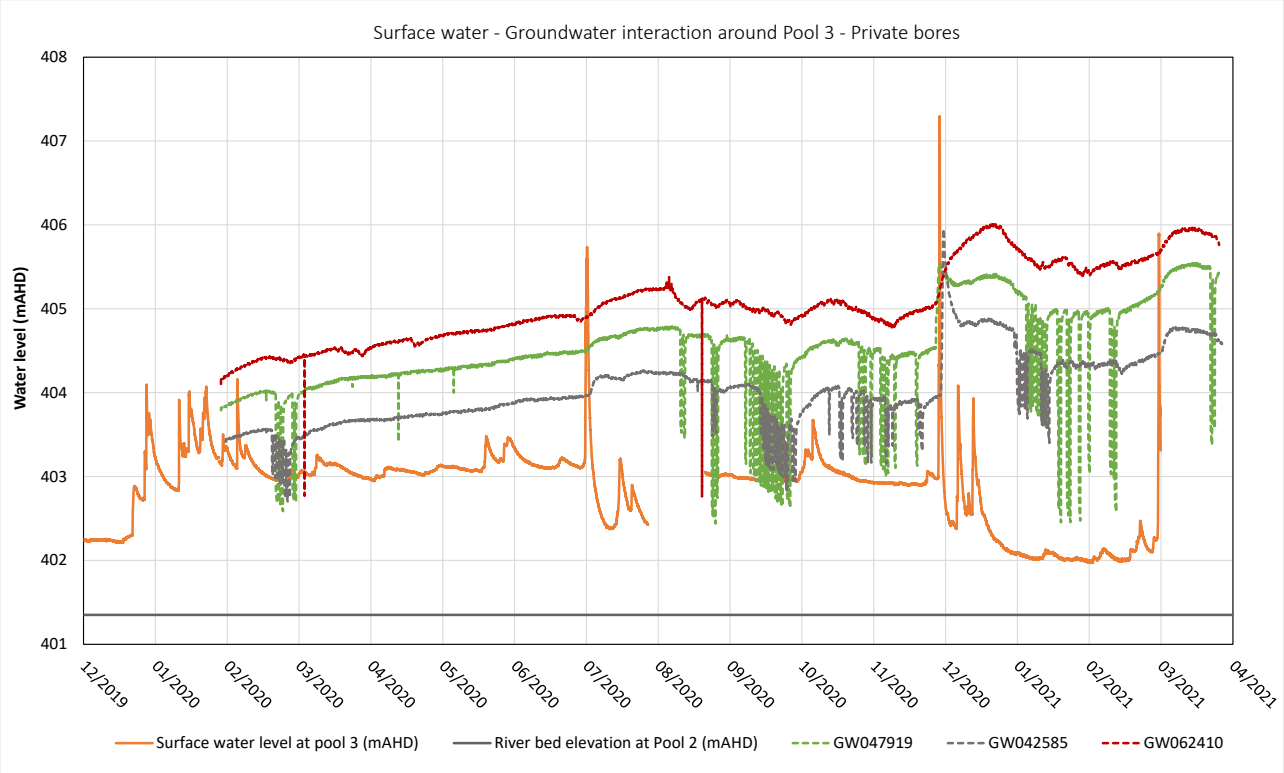
Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

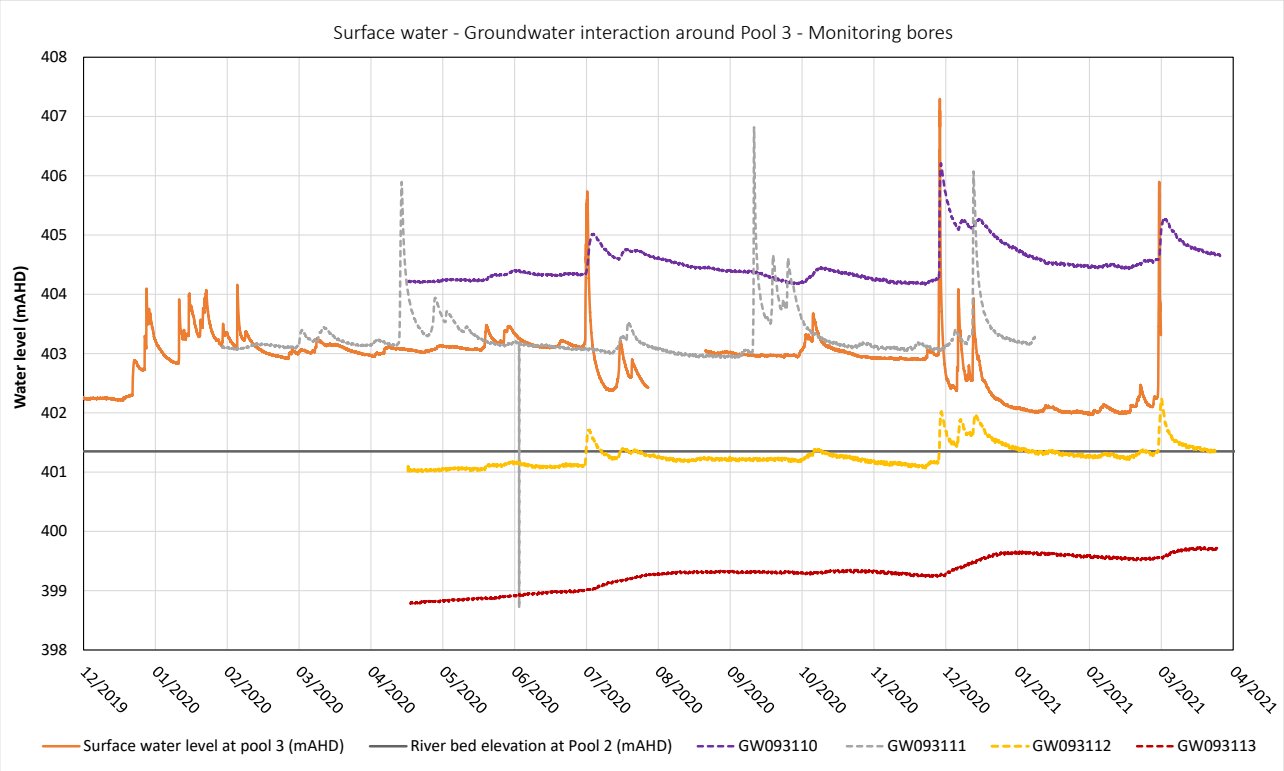
Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Concrete Cylinder	0.00	0.00	1219			

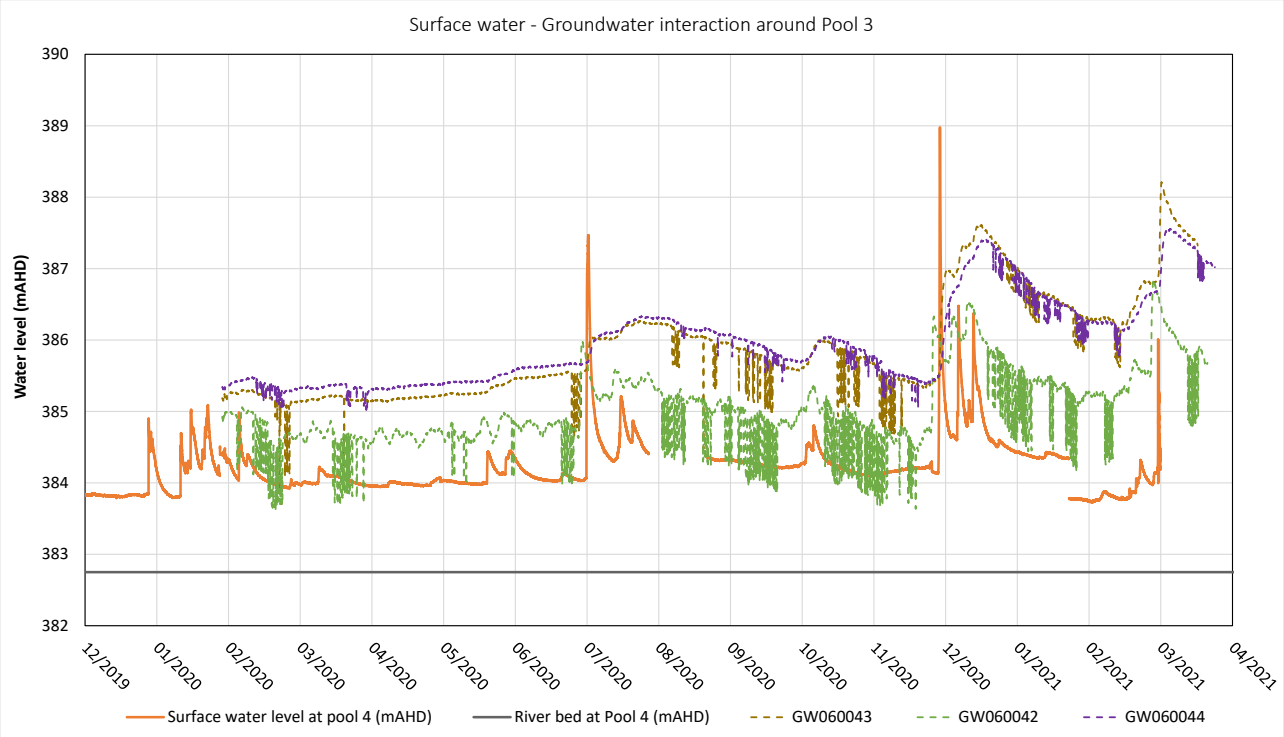
Appendix G – All available water level information from the study






Surface water - Groundwater interaction around Pool 3 - Private bores
Water level (mAHD)
408
407
406
405
404
403
402
401
12/2019
01/2020
02/2020
03/2020
04/2020
05/2020
06/2020
07/2020
08/2020
09/2020
10/2020
11/2020
12/2020
01/2021
02/2021
03/2021
04/2021
Surface water level at pool 3 (mAHD)
River bed elevation at Pool 2 (mAHD)
GW047919
GW042585
GW062410


Surface water - Groundwater interaction around Pool 3 - Monitoring bores
Water level (mAHD)
408
407
406
405
404
403
402
401
400
399
398
12/2019
01/2020
02/2020
03/2020
04/2020
05/2020
06/2020
07/2020
08/2020
09/2020
10/2020
11/2020
12/2020
01/2021
02/2021
03/2021
04/2021
Surface water level at pool 3 (mAHD)
River bed elevation at Pool 2 (mAHD)
GW093110
GW093111
GW093112
GW093113


Surface water - Groundwater interaction around Pool 3
Water level (mAHD)
390
389
388
387
386
385
384
383
382
12/2019
01/2020
02/2020
03/2020
04/2020
05/2020
06/2020
07/2020
08/2020
09/2020
10/2020
11/2020
12/2020
01/2021
02/2021
03/2021
04/2021
Surface water level at pool 4 (mAHD)
River bed at Pool 4 (mAHD)
GW060043
GW060042
GW060044