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DEPARTMENT OF PLANNING,
INDUSTRY AND ENVIRONMENT

GROUNDWATER DESKTOP STUDY

SPECIAL ACTIVATION PRECINCT, PARKES

wsp

JULY 2019

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Groundwater Desktop Study
Special Activation Precinct, Parkes

Department of Planning, Industry and Environment

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GLOSSARY

Alluvial	Sediments deposited by flowing water.
Alluvium	General term for unconsolidated deposits of inorganic materials (clay, silt, sand, gravel, boulders) deposited by flowing water.
Aquifer	Rock or sediment in a formation, group of formations or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.
Aquitard	Saturated geological unit with a relatively low permeability that can store large volumes of water but does not readily transmit or yield significant quantities of water to bores or springs. An aquitard can sometimes, if completely impermeable, be called an aquiclude.
Australian Height Datum (AHD)	A level datum, uniform throughout Australia, that generally approximates mean sea level.
Bore	Artificially constructed or improved groundwater cavity used for the purpose of accessing or recharging water from an aquifer. Interchangeable with borehole, piezometer.
Borehole	Includes a well, excavation, or other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer. Interchangeable with bores, wells, piezometers.
Clay	Deposit of particles with a diameter less than 0.002 mm, typically contain variable amounts of water within the mineral structure, and exhibit high plasticity.
Confined aquifer	An aquifer bounded above and below by impervious (confining) layers. In a confined aquifer, the water is under sufficient pressure so that when wells are drilled into the aquifer, measured water levels rise above the top of the aquifer.
Drawdown	The change in groundwater level in a bore, or the change in water table elevation in an unconfined groundwater system, due to the extraction of groundwater.
Fault	Zone of displacement in rock formations resulting from forces of tension or compression in the earth's crust.
Formation	General term used to describe a sequence of rock layers.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Groundwater flow	The movement of water through openings and pore spaces in rocks below the water table i.e. in the saturated zone.
Groundwater resource	Groundwater available for beneficial use, including human usage, aquatic ecosystems and the greater environment.
Hydraulic conductivity	Measure of the ease with which water will pass through earth material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (metres per day).
Hydraulic gradient	Change in the hydraulic head over a certain distance.

(Hydraulic) head	Elevation to which water will rise in a borehole connected to a point in an aquifer.
Hydrogeology	The study of the interrelationships of geological materials and processes with water, especially groundwater.
Impact	An event that disrupts ecosystem, community, or population structure and alters the physical environment, directly or indirectly.
Infiltration	The downward movement of water from the atmosphere into the ground; not to be confused with percolation.
Investigation area	The area of land encompassed by the Parkes SAP.
Investigation buffer	The area of land encompassed within a 2-km zone adjacent to the Parkes SAP boundaries.
Lithology	The physical character of rocks.
Modelling	The creation of a computerised model that simulates natural environment, allows simulations to project future outcomes.
Monitoring bore	A bore used to monitor groundwater levels or quality.
Permeability	The ease with which a fluid can pass through a porous medium and is defined as the volume of fluid discharged from a unit area of an aquifer under unit hydraulic gradient in unit time (metres per day).
Recharge	Recharge is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation.
Runoff	All surface and subsurface flow from a catchment, but in practice refers to the flow in a river i.e. excludes groundwater not discharged into a river.
Semi-confined aquifer	An aquifer that is partly confined by layers of lower permeability material through which recharge and discharge may occur, also referred to as a leaky aquifer.
Stratigraphy	Branch of geology dealing with the classification, nomenclature, correlation, and interpretation of stratified rocks.
Water table	The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric; it can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.
Watercourse	A river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events: — in a natural channel, whether artificially modified or not — in an artificial channel that has changed the course of the stream It also includes weirs, lakes and dams.
Yield	The quantity of water removed from a water resource e.g. yield of a borehole.

ABBREVIATIONS

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
mBGL	Metres Below ground level
BoM	Bureau of Meteorology
CDFM	Cumulative departure from mean
DOI-W	Department of Primary Industries – Water
EPA	Environment Protection Authority
ET	Evapotranspiration
GDE	Groundwater dependent ecosystem
GMA	Groundwater management area
MBGL	Metres below ground level
SAP	Special Activation Precinct

1 INTRODUCTION

1.1 BACKGROUND

The Parkes Special Activation Precinct (the SAP) is a joint Government Agency initiative, announced by the Deputy Premier, the Hon John Barilaro MP, to create a 20-year vision for job creation and regional development. The Department of Premier and Cabinet and the Department of Planning, Industry and Environment are leading the creation of the Parkes SAP.

Parkes is a location of State and regional significance and the SAP is an economic enabler that will address market failures and leverage catalyst opportunities. The SAPs are a place-based approach to 'activate' this strategic location.

The Parkes SAP was selected because of the economic opportunities associated with the construction of an Inland Rail from Brisbane to Melbourne and the existing east-west Sydney to Perth/Adelaide Rail corridor which cross at Parkes creating an opportunity for an Inland Port.

The Parkes SAP will lead to investment in common-use infrastructure, including roads infrastructure, water, electricity, telecommunication, gas systems and services, high speed internet and data connections and facilities, and other possible infrastructure or services.

A SAP contains five core components and this plan (government led studies) will inform fast track planning for the Precinct and potential future infrastructure investment and government led development:

1.1.1 REGIONAL AND LOCAL CONTEXT

Parkes local government area (LGA) is located approximately 350 kilometres west of Sydney, in the Central West and Orana Region. The main townships and settlements in the LGA include Alectown, Bogan Gate, Cookamidgera, Parkes, Peak Hill, Trundle and Tullamore. Other major centres in the region include Condobolin, Cowra, Dubbo, Forbes and Orange.

The Parkes township has a stable population of approximately 11,500 people (ABS, 2016), with around 5,000 dwellings. An industrial estate (zoned IN1 – General Industrial) is located south of the town, adjoining the Newell Highway. The town is serviced by an existing local centre, mixed use areas that contain both commercial, business and retail use. A new hospital and associated health Precinct is located towards the southern end of the town. The Parkes Regional Airport is located east of town, with the Parkes National Logistics Hub located to the west.

The Central West and Orana Regional Plan 2036 identifies the following key features about Parkes:

- development and settlement is clustered around key corridors, including the twin centres of Parkes and Forbes
- Parkes, along with Dubbo, is a major freight hub particularly in the selling, processing, manufacturing and transporting of livestock and agricultural produce
- TransGrid's NSW Connection Opportunities identifies Parkes as having capacity for renewable energy generation; and
- existing regional mining operations (North Parkes Mines and Tomingley) near Parkes.

The establishment of a Parkes SAP is consistent with Parkes Shire Council's vision and strategic planning for the locality.

1.1.2 PARKES SPECIAL ACTIVATION PRECINCT

The Parkes SAP is located to the west of the Parkes township (see Figure 1.1). The Parkes SAP is strategically located at the intersection of:

- the Brisbane to Melbourne Inland Rail
- the Sydney to Perth/Adelaide Rail corridor; and
- is in close proximity to the junction of the Henry Parkes Way and Newell Highway.

The Inland Rail project has received $9.3 billion in funding from the Commonwealth Government to support the upgrade to the freight network from Brisbane the Melbourne. It is projected that the first train will run between the two capital cities in 2025. Parkes is an important connection for the Inland Rail project, as it is the epicentre of inland freight.

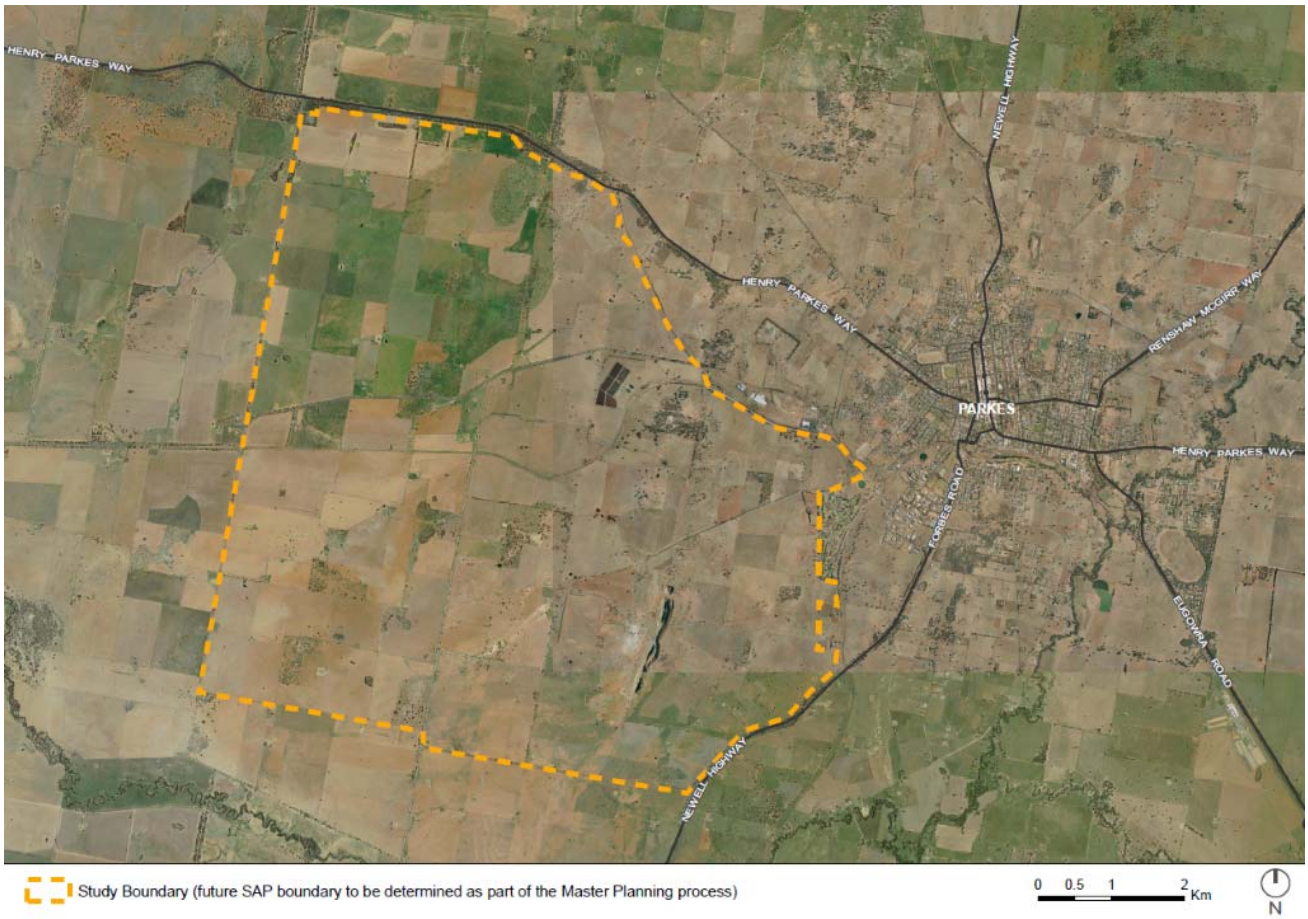

Figure 1.1 Indicative location of Parkes SAP

The Parkes SAP area is predominantly occupied by agricultural land, with a solar energy facility located in the north-western corner and an existing quarry operation located in the south-eastern area of the Precinct.

The existing primary industries in Parkes are focused around freight and logistics, agribusiness and mining. Parkes strategic location within Regional NSW provides the opportunity to capitalise on these industries, along with the potential to expand into warehousing, advanced food manufacturing and renewable energy uses.

1.1.3 PLANNING FRAMEWORK

Currently under the Parkes Local Environmental Plan (LEP) 2013, the Parkes SAP area is zoned:

- RU1 – Primary Production
- SP1 – Special Activities; and
- SP2 – Infrastructure.

The land zoned SP1 – Special Activities has been identified as the Parkes National Logistics Hub. The Logistics Hub covers approximately 600 hectares. The land includes the Pacific National and SCT Logistics sites among other landholdings. The locality provides the opportunity to create an intermodal site serviced by rail and road connections.

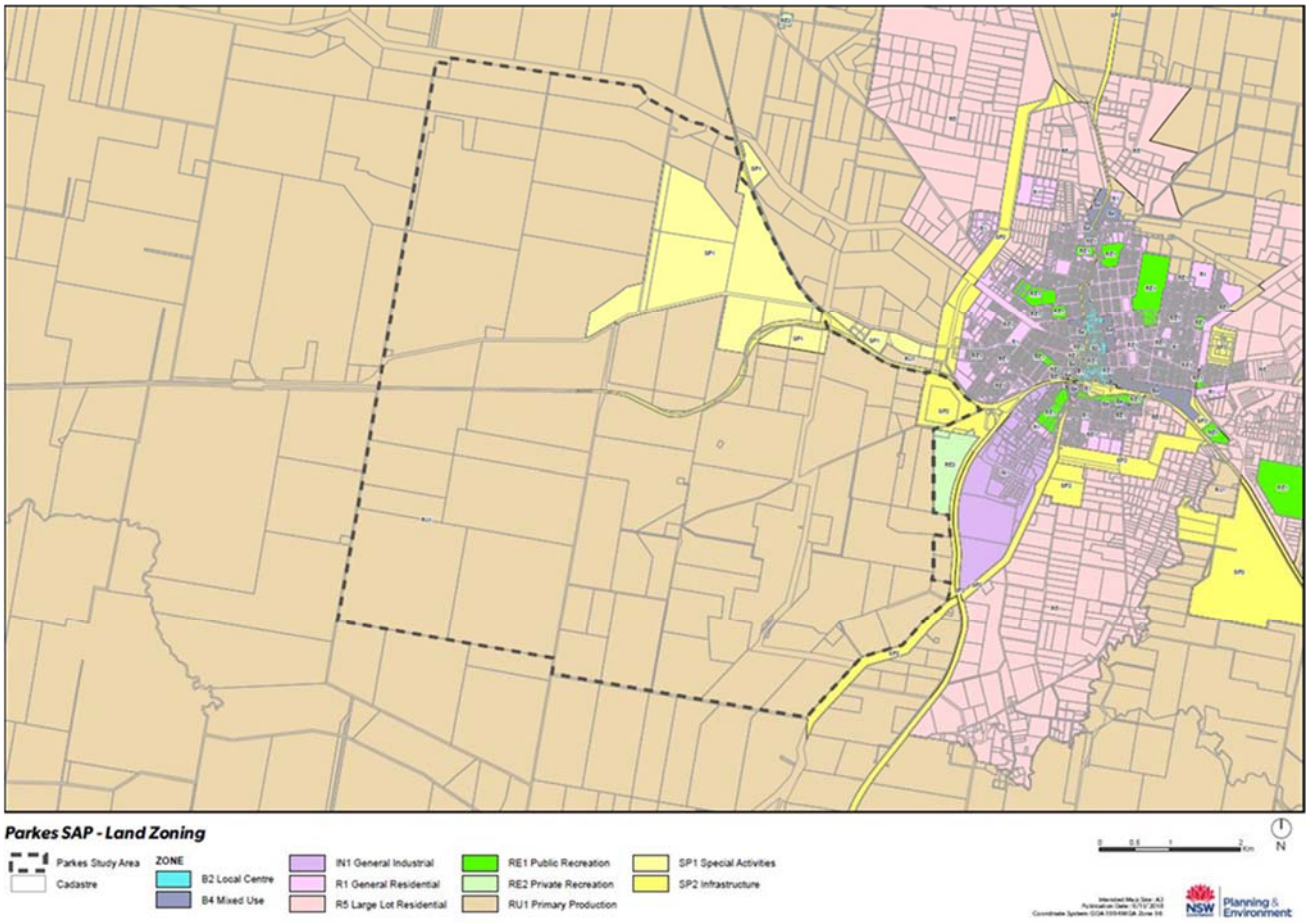

Figure 1.2 Existing zoning map

1.2 SCOPE OF WORKS

The scope of works for this groundwater assessment includes the following:

- a summary of relevant legislation
- insight into groundwater availability and licensing within the investigation area
- a description of the existing subsurface and groundwater environment within the investigation area
- identification of groundwater related environmental values (registered bore users and groundwater dependent ecosystems) with a two kilometre buffer around the investigation area (hereafter, referred to as the 'investigation buffer') through a review of the following:
  - geological maps, Bureau of Meteorology's (BoM) Groundwater Dependent Ecosystem (GDE) Atlas and National Groundwater Information System (NGIS) database search for registered bores
  - groundwater level and groundwater quality related to the investigation area and project buffer
  - climatic data (rainfall and evapotranspiration) from the nearest available source to the investigation area
- identification of possible groundwater systems to be utilised as future resources

Refer to Figure 1.3 for the Parkes SAP location (investigation area) and investigation buffer.

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Date: 4/04/2019	Approved by: Ellen.Kwantes		Coordinate system: GDA 1994 MGA Zone 55 Scale is correct when printed at A3

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Parkes SAP

Figure 1.3
Site Location Map

2 REGULATORY CONTEXT

The following sections outline the Commonwealth and State legislation are relevant to the management of groundwater and water resources within the investigation area.

2.1 COMMONWEALTH

Commonwealth guidelines relevant to the management of groundwater include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC/ ARMCANZ, 2000).* These guidelines provide for the sustainable use of Australia's water resources by protecting and enhancing quality, while maintaining economic and social development.
- *Australian Drinking Water Guidelines (NHMRC, 2011).* These guidelines provide guidance to the Australian community and the water supply industry on what constitutes good quality drinking water.
- *The Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act*)* prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas and species, population and communities and heritage items.

Approval from the Commonwealth Minister for the Environment is required for:

- an action which has, would have, or is likely to have a significant impact on 'matters of National Environmental Significance' (NES matters). The current NES matters include:
  - World Heritage properties
  - National Heritage places
  - wetlands of international importance
  - listed threatened species and ecological communities
  - migratory species protected under international agreements
  - Commonwealth marine areas
  - the Great Barrier Reef Marine Park
  - nuclear actions (including uranium mines)
  - a water resource, in relation to coal seam gas development and large coal mining development
- an action by the Commonwealth or a Commonwealth agency which has, would have, or is likely to have a significant impact on the environment
- an action on Commonwealth land which has, would have, or is likely to have a significant impact on the environment
- an action which has, would have, or is likely to have a significant impact on the environment of Commonwealth land, no matter where it is to be carried out.

Impacts on NES matters are assessed through a referral process to the Commonwealth Department of Environment and Energy. If the Commonwealth Minister for the Environment determines that a project is likely to have a significant impact on a NES matter, then the project becomes a controlled action and approval of the Commonwealth Minister for the Environment would be required before construction works can commence.

2.2 STATE LEGISLATION

2.2.1 WATER ACT 1912 AND WATER MANAGEMENT ACT 2000

Water resources are administered under the *Water Act 1912* and the *Water Management Act 2000* by the NSW Department of Industries – Water (DoI-W). The *Water Management Act 2000* governs the issue of water access licences and approvals for those water sources (rivers, lakes, estuaries and groundwater) in New South Wales where Water Sharing Plans have commenced. Water sharing plans establish rules for sharing water between the environmental needs of the river or aquifer and water users, and also between different types of water use such as town supply, rural domestic supply, stock watering, industry and irrigation. The Water Act 1912 governs the issue of water licences for water sources in other areas. There are Water Sharing Plans for regulated and unregulated river catchments and groundwater sources in water management areas.

The *Water Management Act 2000* requires approvals for activities that impact the aquifer(s) present. The approval is for activities that intersect groundwater other than water supply bores and may be issued for up to ten years. Part 2 of the *Water Management Act 2000* establishes access licences for the take of water within a particular water management area.

Part 3 of the *Water Management Act 2000* establishes three types of approvals that a proponent may be required to obtain. These are:

- water use approvals
- water management work approvals (including water supply work approvals)
- activity approvals (including controlled activity approvals and aquifer interference approvals).

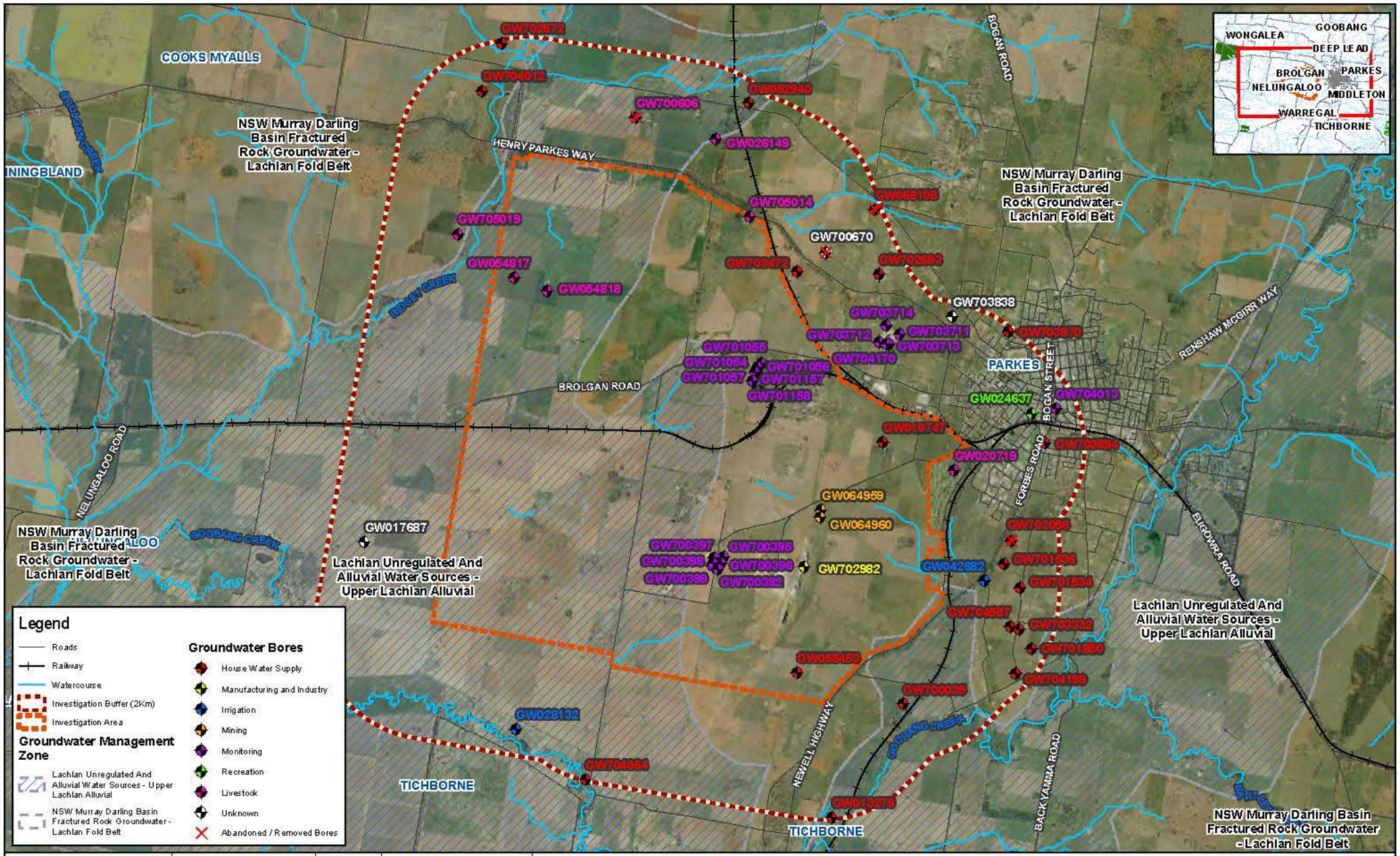
To construct a test or monitoring bore a ‘Water Supply Work Approval’ form, which can be downloaded from the DoI – W website, is required to be completed and submitted to the nearest DoI – W office. To construct a production bore the same form must be filled out together with a ‘Water Use Approval’ form.

2.2.2 WATER SHARING PLANS

The Water Sharing Plans describe the annual groundwater recharge volumes for each identified groundwater source and also the volumes of water that are available for sharing (the Long Term Average Annual Extraction Limit (LTAAEL)). Provisions are made for environmental water allocations, basic landholder rights, domestic and stock rights and native title rights. Water Sharing Plans are typically in place for 10 years, however they may be suspended in times of severe water shortages.

Two Water Sharing Plans are currently operating within the investigation area (Figure 2.1):

- NSW Murray-Darling Basin Fractured Rock, commenced 16 January 2012
- Lachlan Unregulated and Alluvial, commenced 14 September 2012.



Map: PS112886_GIS_004_A5	Author: David.Naiken
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Parkes SAP

Figure 2.1

Registered Groundwater Users and Groundwater Management Areas within investigation area and within 2 km buffer

Department of Planning and Environment

2.2.3 NSW MURRAY-DARLING BASIN FRACTURED ROCK WATER SHARING PLAN

The NSW Murray-Darling Basin (MDB) Fractured Rock Groundwater Sources are located within the NSW portion of the MDB, approximately between Broken Hill to the west, Lithgow to the east and extending to the northern and southern borders of NSW-QLD and NSW-VIC, respectively. The Water Sharing Plans comprises 10 zones covering 244,040 km^2 and includes all fractured rock groundwater sources that are not included in Water Sharing Plans, as well as miscellaneous, unmapped alluvial sediments that overly outcropping fractured rock groundwater sources and porous rock sediments within predominately fractured rock groundwater sources.

The NSW MDB Fractured Rock Water Sharing Plan establishes a LTAAEL for each groundwater source that is the allowable limit of extraction for that water source. The LTAAEL is equal to the average annual recharge less the volume set aside for the environment. Each year a provision is made for basic rights to ensure the total extraction from the water source is within the LTAAEL. Applications can be made for local water utilities under an exemption (NSW Department of Infrastructure, Planning and Natural Resources, 2005).

The Project is situated within The Lachlan Fold Belt groundwater source zone (Zone 4) of the Water Sharing Plan that encompasses 16,722 km^2 and carries an LTAAEL limit of 821,250 ML/yr. Town water supply and stock and domestic users have a higher priority for access to groundwater than other groundwater users. In 2017 (DoI-W) total requirements for basic landholder rights (domestic and stock) was 75,464 ML/yr and an additional 5,380 ML/yr was allocated to local water utilities.

The Lachlan Fold Belt groundwater source has further been separated into two water management zones:

- *Lachlan Fold Belt MDB (Mudgee)*
- *Lachlan Fold Belt (Other).*

Trading is allowed within a groundwater source. However, licenses cannot be traded into or out of the groundwater source or management zones. Currently the Lachlan Fractured Rock Water Sharing Plan is completely allocated, however there is a provision for the generation of new licenses in the future (Pers. comm. S. Hamilton, DoI-W, 19 March 2019).

2.2.4 LACHLAN UNREGULATED AND ALLUVIAL WATER SHARING PLAN

The Lachlan Unregulated and Alluvial Water Sharing Plan provides a legislative framework for water resources for all unregulated streams and alluvial aquifers within the Lachlan Water Management Area. The Water Sharing Plan covers an approximate area of 90,000 km^2 located between the Murrumbidgee Catchment to the south, Murray catchment to the west, the slopes of the Great Dividing Range to the east and the Macquarie and Barwon-Darling to the north and northwest, respectively. The Water Sharing Plan can be separated into 10 management zones that cover two principal water resources:

- *Unregulated Rivers*: All the unregulated rivers in the Lachlan River catchment excluding Mandagery Creek and its tributaries.
- *Upper Lachlan and Belubula Valley Alluvial Groundwater Sources*: Provides legislative framework for major alluvial aquifers not already covered by a Water Sharing Plan.

There are a total of 24 management zones (distinct groundwater sources) across both of these water resources that have been subdivided into 22 zones within the Unregulated Rivers Management Area and 2 zones within the Upper Lachlan and Belubula Valley Groundwater Sources Management Area. However, the Water Sharing Plan is currently completely allocated and licenses can only be traded through the market with current licensee holders (Pers. comm. S. Hamilton, DoI-W, 19 March 2019). There is currently no provision for the generation of new licenses within the Lachlan Unregulated and Alluvial Water Sharing Plan.

The Lachlan Unregulated and Alluvial Water Sharing Plan establishes a LTAAEL for each groundwater source that is the allowable limit of extraction for that water source. The LTAAEL is equal to the average annual recharge less the volume

set aside for the environment. Each year a provision is made for basic rights to ensure the total extraction from the water source is within the LTAAEL. Applications can be made for local water utilities under an exemption (NSW Department of Infrastructure, Planning and Natural Resources, 2005).

2.2.5 WATER LICENSES

The NSW Water Register maintained by the NSW Land Registry Services provides detailed information about water access licences (WALs) within NSW. WALs can typically be obtained (subject to restrictions outlined within the relevant Water Sharing Plans) through purchasing or trading of an existing WAL. Table 2.1 lists the total number of WALs per license category within the corresponding Water Sharing Plan.

Table 2.1 Total number of WALs per Water Sharing Plan for the 2018 to 2019 Financial Year (WaterNSW, 2019a)

WATER SHARING PLAN	ACCESS LICENCE CATEGORY	NO. WAL(S)	AVAILABLE WATER (ML)	USAGE YTD (ML)
NSW MDB Fractured Rock Water Sharing Plan – Lachlan Fold Belt	Aquifer	1024	66,926.7	703.8
	Aquifer (Town Water Supply)	6	467.4	1.7
	Local Water Utility	35	2,370.5	0.1
	Local Water Utility (Domestic and Commercial)	1	50	0
	Salinity and Water Table Management	1	236	0
Lachlan Unregulated and Alluvial Sources Water Sharing Plan – Upper Lachlan Alluvial Groundwater Source	Aquifer	375	166,518.5	50,188.2
	Local Water Utility	9	7,848	181.1

2.2.6 AQUIFER INTERFERENCE POLICY

The *Aquifer Interference Policy* (AIP) is a component of the NSW 'Strategic Regional Land Use Policy' and was introduced in September 2012. The AIP defines the regime for protecting and managing impacts of aquifer interference activities on NSW's water resources and strikes a balance between the water needs of towns, farmers, industry and the environment. It clarifies the requirements for obtaining extraction groundwater licences and assessment process under the *Water Management Act 2000*.

The AIP will assist proponents of aquifer interference activities in preparing the necessary information and studies to be used by the NSW Department of Primary Industries in the assessment of project proposals that have some level of aquifer interference. Furthermore, this Policy will form the basis of assessment and subsequent advice provided by the NSW Office of Water under the *Environmental Planning and Assessment Act 1979* to other planning bodies such as the Planning Assessment Commission, depending on the phase or location of the project.

One of the policy principles is that activities with the potential to contaminate groundwater are considered to be an aquifer interference activity. Approvals under the AIP will be granted as long as no more than minimal harm will be imposed on any water source or its dependent ecosystems. In summary, the minimal impact criteria in relation to the project are as follows:

- Impacts to the water table are considered to be minimal where the water table change is less than ten percent of the cumulative seasonal variation, 40 metres from any high priority GDE. If the impact is greater it must be demonstrated that the variation will not prevent the long-term viability of a GDE.
- Impacts to the water table are considered minimal if the cumulative decline in any registered water supply work is less than two metres. If the impact is greater make good provisions apply.
- Impacts to water pressure are considered minimal if the cumulative decline in any registered water supply work is less than two metres. If the impact is greater make good provisions apply.

Impacts to water quality are considered minimal if the change in groundwater quality remains within the current beneficial use category of the groundwater source beyond 40 metres from the activity. If this cannot be achieved studies are required to demonstrate that the change will not prevent the long-term viability of the dependent ecosystem or affected water supply works.

3 PHYSICAL SETTING

3.1 TOPOGRAPHY AND LANDUSE

The project is located approximately 2.2 km southeast of Parkes, NSW and is bounded by Henry Parkes Way to the north, Newell Highway (A39), the Parkes to Narromine rail corridor and Parkes Golf Club to the east and agricultural lots to the south and west, respectively.

The investigation area (5,600 hectares) encompasses gentle undulating, rural landscapes primarily used for agricultural purposes (including vacant lots with some detached residential dwellings), with site elevation ranging from approximately 263 metres Australian Height Datum (mAHD) to 351 mAHD. In addition to the agricultural lots, the Main West Line rail corridor bisects the central portion of the investigation area, which services transport from Sydney to Perth via Broken Hill and an SCT logistics train yard and Pacific National Logistics terminal (currently nearing construction completion). An active resource extraction with processing plant, owned and operated by Westlime Pty Ltd, extracts from the workings of a previous gold mine, and processes fine lime, agricultural lime, dolomite, construction materials and roadbase (Westlime, 2019) within the south-eastern portion of the investigation area. There is also an existing and approved solar farm in the north-west corner of the investigation area.

The investigation area contains south to south westerly aspects across the eastern and southern portions, and westerly to north westerly across the western and northern portions of the investigation area, respectively. Topographic grades of < 2% to 5% are anticipated across the project, with the higher grades situated around slopes and crests associated with the North Parkes volcanics. The total hydrogeological catchment area for the Lachlan region is 85,532 km^2 (CSIRO, 2008).

3.2 CLIMATE

Meteorological data obtained from the closest Bureau of Meteorology (BoM) weather station (Parkes Airport, BoM station 65068, BoM, 2019a) located approximately 8 km north east of the investigation area (Refer Figure 1.3, in Chapter 1) are summarised in Table 3.1.

Table 3.1 Historic climate data obtained from BoM station 65068 (BoM 2019a)

CLIMATE DATA	RECORD	COMMENT
Mean monthly rainfall (1998–2018)	29.5 mm – 72.0 mm	Lowest rainfall occurs in April and May. Highest rainfall occurs in February, November and December.
Historic rainfall range (1998–2018)	248.2 mm – 1087.8 mm	Historic low occurred in 2006. Historic high occurred in 2010.
Combined yearly rainfall mean (1998–2018)	603.1 mm	–
Monthly mean evapotranspiration (2009–2018)	42 mm – 245 mm	Lowest evapotranspiration occurs from May to July. Highest evapotranspiration occurs from December to February.
Combined yearly evapotranspiration mean (2009–2018)	1,620 mm	Rainfall marginally exceeds evapotranspiration in June and July. Evapotranspiration greatly exceeds rainfall in remaining months.

Historic monthly average rainfall and evapotranspiration are depicted in Figure 3.1.

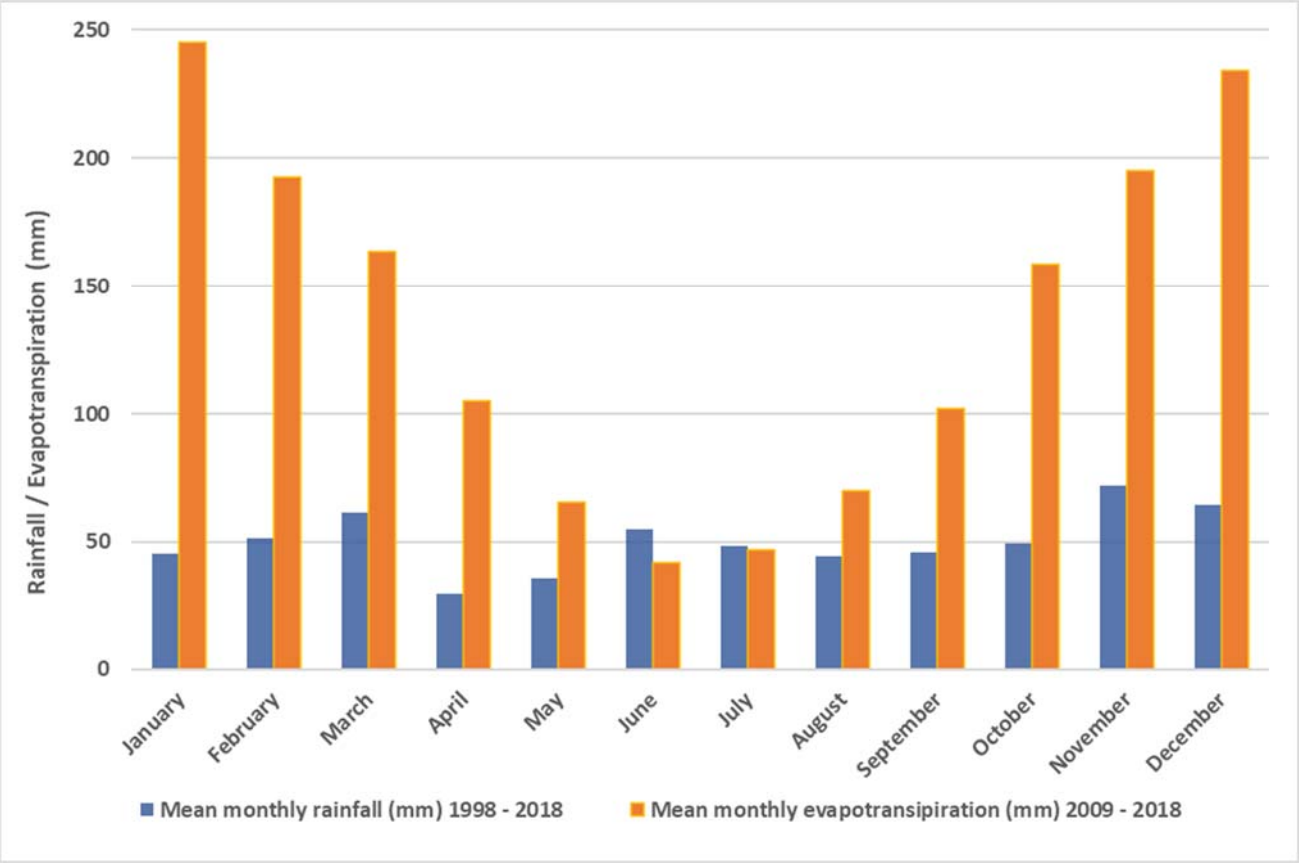


Figure 3.1 Mean monthly rainfall and evapotranspiration recorded at Parkes airport (BoM: #065068)

Long-term cumulative rainfall residual plots provide an indication of the broad scale trends in rainfall pattern behaviour, and are formulated by subtracting the average annual rainfall for the recorded period from the actual annual rainfall and then accumulating these residuals over the assessment period. The long-term annual cumulative deviation from mean (CDFM) rainfall is a simplistic statistical technique that can identify potential changes in groundwater levels of unconfined aquifers that receive direct recharge through rainfall (CSIRO, 2010). Periods of below average rainfall are represented as downward trending slopes, while periods of above average rainfall are represented as upwards trending slopes. The long-term annual CDFM rainfall with total annual rainfall for 1998–2018 is plotted in Figure 3.2.

The CDFM plot illustrates that deviation over the past two decades of climate data for the investigation area comprises two distinct trends. Dry periods (reduced rainfall) were experienced predominately within the first decade across years 2000–2003, 2005–2009 and 2017–2018, represented by negative CDFM values. The overall 'drying' trend from 2000 to 2009 corresponds to the nationwide Millennium drought and an extreme dry heatwave that impacted the Murray Darling Basin. The change to wetter, La Niña, conditions can be witnessed within the latter decade from 2010, with sharp positive gradient slopes and a shift towards above average rainfall from 2011 to 2017.

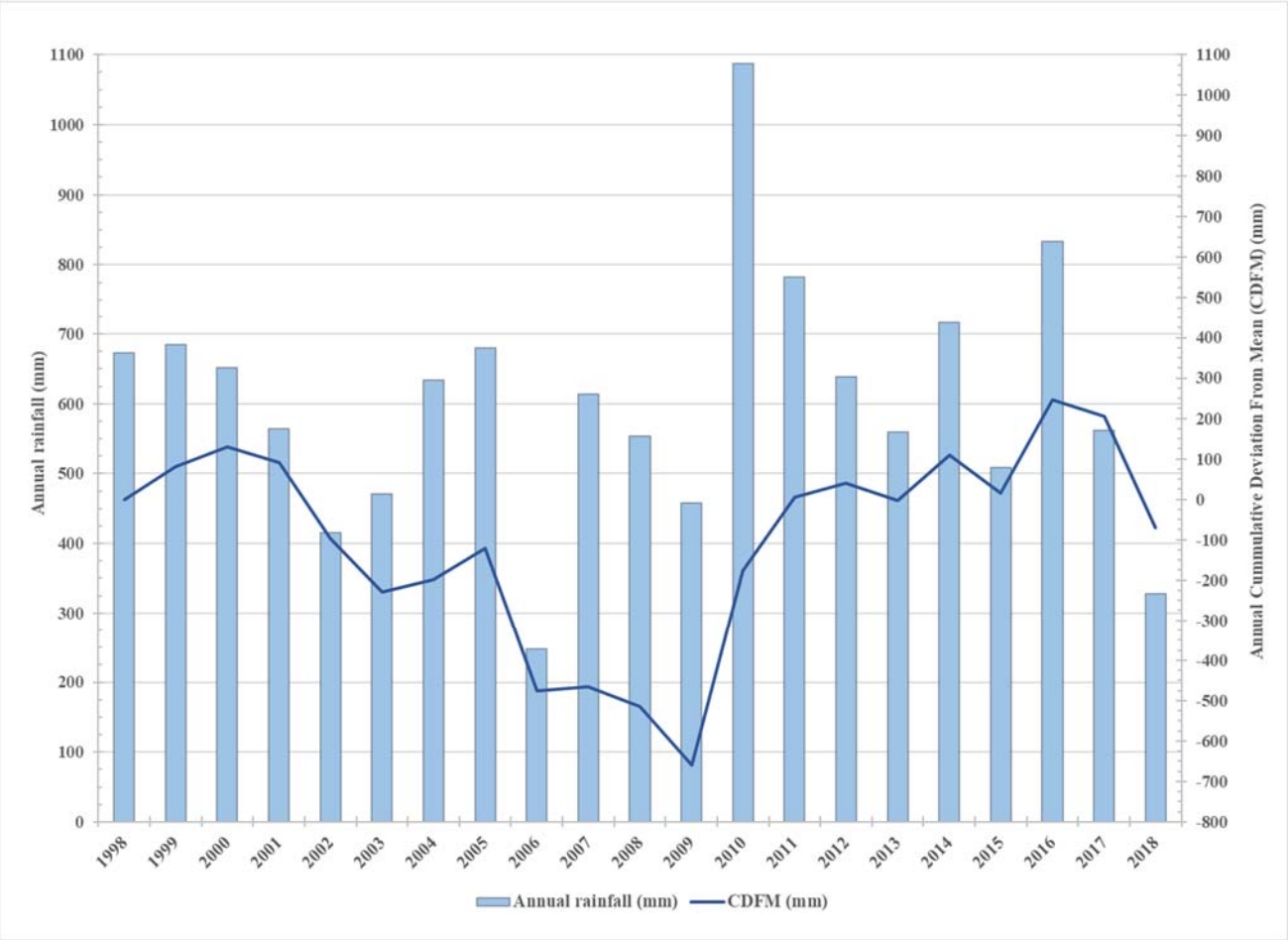


Figure 3.2 CDFM and historic annual rainfall recorded at Parkes airport (BoM station 65068)

The above figures (Figure 3.1 and Figure 3.2) illustrate that the climate at Parkes is characterised by low annual precipitation, dominated by periods of dry months, with primary rainfall distribution typically occurring through the summer half of the year. The climate at Parkes is heavily influenced by the El Niño and La Niña cycles, that may last for up to eight years.

3.3 DRAINAGE AND SURFACE WATERS

Drainage from the investigation area is separated by a thrusted NE-SW trending geological ridge (North Parkes Volcanic Group) through the central portion of the Investigation area. Drainage from topography situated east and south of this ridge is by overland flow towards the south and southwest into Goobang Creek. Drainage from topography situated to the west and north west is by overland flow towards the north west and west into Ridgey Creek. Both creeks converge approximately 5.5 km to the west of the Investigation area and continue to flow generally west into the Lachlan River at Condobolin, NSW (approximately 85 km).

The investigation area is likely to receive urban runoff, dependent upon infiltration rates, from the Parkes Golf Club, rail corridor, Brolgan Road, Henry Parkes Way and Newell Highway.

3.4 SOILS

The investigation area covers a range of soil types that reflect the topography and the underlying geology of the region. In the east of the site (topographically up gradient) the dominant soil landscape is the **Parkes Soil Landscape** which comprises soils developed on the foot slopes and side slopes of Ordovician (485 to 41 million years old) metasediments. The following soils and their locations within the investigation area are summarised as:

- The soils formed on the upper slopes of the Parks Soil Landscape are typically shallow to moderately deep (<60 cm) moderately well drained red earths (otherwise known as red kandosols) which are soils with a gradual textural change from the surface to depth and are not calcareous.
- Mid-slope soils are typically red podzolic soils (otherwise known as Red Chromosols) which are characterised by a brown friable loamy topsoil overlying a contrasting red clay dominated subsoil that are not acidic. Lower slopes typically have a moderately deep (>80 cm) profile with similar red podzolic soils, with minor levels of carbonates being expressed in the subsoil.
- The narrow drainage lines tend to be dominated by brown solodic soils (brown Sodosols) which, as the name suggests, are high in sodium, poorly drained and have a high erosion risk.
- The western half of the project site (topographically lower) is dominated by the **Brolgan Plain Soil Landscape** which is a level to gently undulating plan formed on Quaternary (up to 2.5 million years old) sediments nearer to the Goobang Creek.
- The dominant soils are deep (>100 cm), imperfectly drained carbonate rich Red Brown Earths (Red and Brown Kandosols, Chromosols and Brown Sodosols) and Non-calcic Brown Soils (Red Chromosols). Deep (>100 cm), moderately well-drained Red Podzolic Soils (Red Chromosols) and Red Earths (Red Kandosols) also occur on some plains.
- Deep (>100 cm), poorly drained Yellow Solodic Soils (Yellow Sodosols) occupy small drainage lines and drainage depressions with rare very deep (>150 cm), poorly drained Brown Clays (Brown Vertosols) occur on some lower lying areas.
- In the north of the study area is an isolated Ordovician Goonumbla volcanic rise. The soils associated with these volcanic are known as the **Goonumbla Soil Landscape** with generally shallow lithosols (otherwise known as rudosols and tenosols) on upper slopes and crests, and red podzolic soils (red and brown chromosols) on mid to lower slopes. These soils laterally grade into the surrounding alluvial soils.

  In the far west of the site are isolated instances of **Daroobalgie Soil Landscape**. These appear to be associated with possible depressions or drainage lines. This landscape is a Gilgai landscape with micro relief resulting in small rises and small depressions. The rises typically are very deep (>150 cm), moderately well-drained carbonate rich Red Brown Earths (Calcarosols and Brown Chromosols), while the depressions are typically Very deep (>150 cm), very poorly drained Grey Clays (otherwise known as Grey Vertosols).

  In addition to these soil types the area also includes, in the south east, a portion of disturbed terrain associated with the Westlime quarry lease.

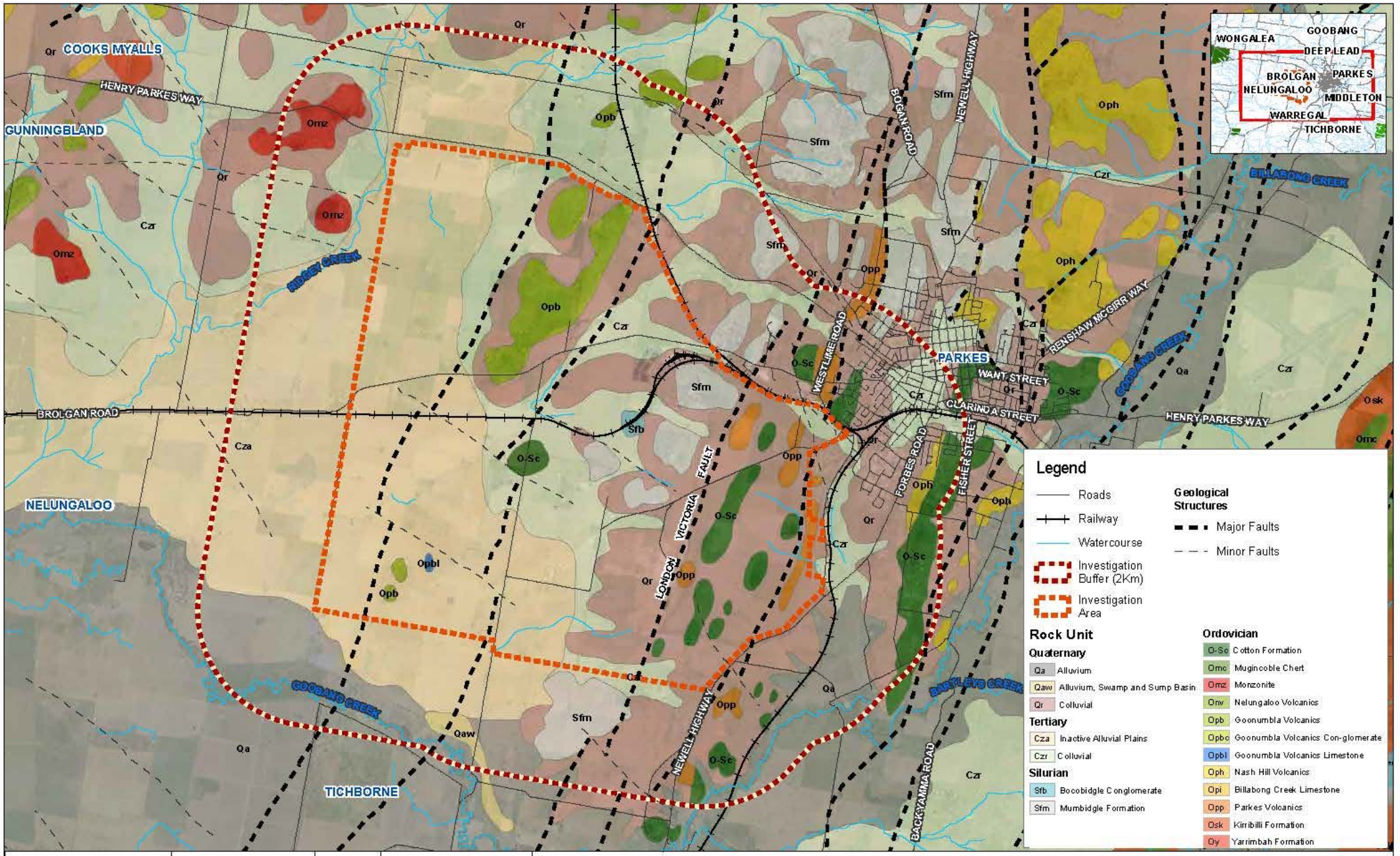
Source: Soil Landscapes, NSW Office of Environment and Heritage, 2018 (Brolgan Plain, Parkes Plain) http://www.environment.nsw.gov.au/eSpade2WebApp - Accessed on 27 February 2019.

3.5 GEOLOGY

Mapped geology (Parkes 1:100 000 Geological Sheet 8531, 1st Edition, 2000) includes:

- Tertiary inactive alluvial plains and shallow colluvial plains (western portion) and Quaternary sediments derived from colluvial sheetwash (central and eastern portions).
- Andesitic lavas and breccia's, volcanoclastic sandstone and conglomerates from the Ordovician Northparkes Volcanic Group (Goonumbla Volcanics).
- Altered and sheared andesitic lavas and breccia's, volcanoclastic sandstone and conglomerates from the Ordovician Northparkes Volcanic Group (Parkes Volcanics).
- Mudstones, lithic sandstone, polymitic conglomerate, sandstone and limestone lenses (Mumbidgle Formation)
- Siltstone, chert, sandstone, marl, minor limestone and conglomerate from the Ungrouped Ordovician Units (Cotton Formation).

The investigation area is located within the Parkes Fault Zone, a zone comprising multiple NE – SW trending regional thrusts, including the London – Victoria Fault. These regional faults are cross cut by localised discontinuous NW-SE trending faults. Refer to Figure 3.3, for investigation area geology.



Map: PS112886_GIS_003_A4	Author: David.Naiken		1:50,000
Date: 4/04/2019	Approved by: Ellen.Kwantes		Coordinate system: GDA 1994 MGA Zone 55 Scale ratio correct when printed at A3

Data Source: Imagery © Department of Finance, Services & Innovation 2018

Parkes SAP

Figure 3.3
Geology Map

4 HYDROGEOLOGY

4.1 INVESTIGATION BUFFER

To adequately characterise the hydrogeological conditions, a regional scale understanding is required. Groundwater regimes are complex and can be influenced by broad geographical scales. The investigation buffer incorporates the investigation area, and includes the broader areas with a 2 km buffer radius extending approximately to Parkes city centre to the east, Goobang Creek to the south, and agricultural lots to the north and west. It has also been selected to incorporate the environmental receptors of Goobang Creek and Ridgey Creek as well as Parkes city centre.

4.2 REGISTERED GROUNDWATER BORES

A search of the BoM's NGIS database registered groundwater bore database (BoM, 2019b) identified 19 registered bores within the investigation area and an additional 35 bores within the investigation buffer. The list of the search results for bores identified within the investigation area and is presented in Table 4.1. Bores identified within the investigation buffer are listed in Table A.1, Appendix A. The location of all registered bores identified in Table 4.1 and Table A.1, Appendix A are plotted on Figure 2.1, in Chapter 2.

The majority of the bores within the investigation area and the investigation buffer are used for monitoring purposes and household water supply, respectively. The remaining bores are used for household water supply, stock, manufacturing and industry, recreation and culture and mining. The status of the identified bores within the investigation area is predominantly unknown with four bores listed as proposed. The status of bores identified within the investigation buffer are predominantly functioning and functional with 2 bores listed as abandoned, 2 bores as removed and 10 as unknown. No data was available for the purpose of the monitoring bores.

Data obtained from WaterNSW (2019b and 2019c) identified six bores within the investigation buffer that contained pertinent groundwater information not listed in the NGIS database. The following registered bores contained groundwater yield information relating to the fractured rock hydrogeological unit (refer Section 4.3.2): GW010747 (0.15-1.26 l/s), GW054818 (1.13 l/s), GW058453 (2.00 l/s), GW064960 (4.00), GW705014 (0.18 l/s) and GW705019 (0.95 l/s).

Table 4.1 List of registered groundwater bores within the investigation area (BoM, 2019b)

BORE NUMBER	EASTING	NORTHING	CONSTRUCTED DEPTH (mBGL)	PURPOSE	STATUS	SALINITY (µS/cm) [1]	SCREENED INTERVAL [2]	INFERRED LITHOLOGY
GW010747	606486	6332046	55	Household water supply / Stock	Unknown	640-1920	ND	Fractured rock
GW054817	600192	6334854	91	Stock	Unknown	ND	64 m – 91 m	Fractured rock
GW054818	600760	6334632	84	Stock	Unknown	ND	73 m – 76 m	Fractured rock
GW058453	605018	6328119	61	Household water supply / Stock	Unknown	1,800	51 m – 61 m	Fractured rock
GW064959	605437	6330887	65	Mining	Unknown	ND	ND	ND
GW064960	605409	6330764	60	Mining	Unknown	ND	ND	ND
GW700382	603669	6329884	ND	Monitoring	Unknown	ND	ND	ND
GW700395	603769	6330084	17	Monitoring	Unknown	ND	ND	ND
GW700396	603719	6329984	18	Monitoring	Unknown	ND	ND	ND
GW700397	603609	6330084	41	Monitoring	Unknown	ND	ND	ND
GW700398	603589	6329984	20	Monitoring	Unknown	ND	ND	ND
GW700399	603569	6329934	52	Monitoring	Unknown	ND	ND	ND
GW701054	604348	6333330	40	Monitoring	Proposed	ND	40 m – 41 m	Fractured rock (regolith)
GW701055	604407	6333387	3	Monitoring	Proposed	ND	2 m – 3 m	Fractured rock (regolith)
GW701056	604359	6333321	3	Monitoring	Proposed	ND	2 m – 3 m	Fractured rock (regolith)

BORE NUMBER	EASTING	NORTHING	CONSTRUCTED DEPTH (mBGL)	PURPOSE	STATUS	SALINITY (µS/cm) [1]	SCREENED INTERVAL [2]	INFERRED LITHOLOGY
GW701057	604301	6333244	3	Monitoring	Proposed	ND	2 m – 3 m	Fractured rock (regolith)
GW701157	604268	6333089	5	Monitoring	Unknown	ND	4 m – 5 m	Alluvial
GW701158	604263	6333084	15	Monitoring	Unknown	ND	6 m – 15 m	Alluvial / Fractured rock (regolith)
GW702982	605139	6329933	ND	Manufacturing and Industry [3]	Unknown	ND	ND	ND

Notes

(1) A x0.64 factor applied to salinity values recorded in ppm (WaterNSW 2019b)

(2) Inferred from lithological log. No or incomplete construction logs provided.

(3) Likely not a bore, license involved in the de-watering of an open pit quarry.

4.3 HYDROGEOLOGICAL UNITS

Based on background information obtained from the Parkes 1: 100,000 geological map, along with NSW Governmental studies (CSIRO, 2008 & NSW DoI-W, 2012), it can be inferred that the investigation area contributes groundwater recharge into the Lachlan Fractured Rock groundwater source within the eastern portion and the Lachlan Unregulated and Alluvial Water Sources in the western portion of the investigation area, respectively.

4.3.1 LACHLAN UNREGULATED AND ALLUVIAL

The Lachlan Unregulated and Alluvial groundwater source is anticipated to contain a shallow (Cowra Formation) and a deep aquifer (Lachlan Formation). Expected aquifer characteristics are provided in Table 4.2. The Lachlan unregulated and alluvial groundwater resource within the Project n area is likely to represent the Lachlan Formation (deep alluvial).

Table 4.2 Lachlan Unregulated and Alluvial Groundwater Sources (adopted from Carrara et al, 2004 and O'Rouke & Kolstad, 2011)

DESCRIPTION	SHALLOW (COWRA FORMATION)	DEEP (LACHLAN FORMATION)
Unit thickness	< 40 m	~ 60 m
Aquifer confinement	Unconfined to semi-confined	Semi-confined to confined
Hydraulic conductivity (m/d)	0.01 – 40	1 – 100
Specific yield	0.1 – 1 x 10^{-5}	0.001 – 1 x 10^{-5}
Hydraulic gradient and flow	Low gradient Lateral flow with possible seepage to underlying aquifer	Low gradient Lateral flow
Yields (l/s)	Variable, typically 0.1 – 40	Variable, typically 5 – 150
Water quality (TDS)	< 1,500 mg/L (fresh – slightly saline)	< 1,500 mg/L (fresh – slightly saline)

4.3.2 LACHLAN FRACTURED ROCK

The Lachlan Fractured Rock groundwater source is anticipated to contain a shallow (weathered regolith) and a deep aquifer (bedrock). Expected aquifer characteristics are provided in Table 4.3. It is expected that both the shallow and deep Lachlan Fractured Rock groundwater source are present in the investigation area.

Table 4.3 Lachlan Fractured Rock aquifer characteristics (DoI-W, 2017 & GA, 2018)

DESCRIPTION	SHALLOW (WEATHERED REGOLITH)	DEEP (SILURIAN / ORDOVICIAN BEDROCK)
Unit thickness	2 m – 60 m	2500 – 4000 m
Aquifer confinement	Unconfined to semi-confined	Semi-confined - confined
Hydraulic conductivity (m/d)	0.01 – 40	Variable; dependent on connectedness and aperture of fracture and joint systems.
Yield (l/s) [1]	Low	Typically < 3
Hydraulic gradient and flow	Low – moderate gradient Vertical and lateral flow	Variable gradient Flow confined to secondary flow conduits facilitated by fracture and joint systems
Water quality (TDS)	< 1,500 mg/L (fresh – slightly saline)	< 3,000 mg/L (fresh – slightly saline)

Notes

(1) Source: DoI-W (2017b).

4.4 GROUNDWATER LEVELS AND FLOW DIRECTION

There is limited available groundwater level information within the investigation area and its buffer zone. Four bores (GW013279, GW705014 and GW705019) were identified within the investigation buffer that contained static water level (SWL). Bore GW013279 reported a SWL in 1998 of 3.72 metres below ground level (mBGL). The bore is located at the southern boundary of the Project buffer zone, adjacent to Goobang Creek, within the Lachlan Unregulated and Alluvial groundwater source. The remaining three bores (GW064959, GW705014 and GW705019), located proximal to the eastern, northern and north western boundary of the investigation area, within the Lachlan Fractured Rock groundwater source, reported SWL's of 5 mBGL (measured 1988), 30 mBGL (measured 2011) and 61 mBGL (measured 2017), respectively. Additional information obtained from WaterNSW (2019c) identified in the bores containing groundwater yield data (refer to Section 4.2) that water bearing zones were generally intersected between 46 mBGL to 80 mBGL. This illustrates that once the groundwater source within the Lachlan Fracture Rock is intersected, the groundwater level may rise within the bore (or opening), if unrestricted, to a higher elevation (potentiometric surface).

In addition to the data obtained from the NGIS and WaterNSW search, WSP (2017) conducted a factual geotechnical report for the proposed Parkes Intermodal Terminal located within the central portion of the investigation area. The geotechnical investigation covered an alignment that crossed both the Lachlan Unregulated and Alluvial groundwater source and Lachlan Fractured Rock groundwater source sediments. The subsurface test-pit investigation was conducted by excavator to a maximum depth of 3.4 mBGL. No groundwater was intersected during the investigation.

It can be inferred from the available information that regional groundwater flow is generally towards the west. Locally, groundwater flow will generally follow the topography. Influences on flow within the water bearing zones of the Lachlan Unregulated and Alluvial will be related to the presence of bands (or lenses) of coarser sediments derived from alluvial

sources. Paleochannels are present within the Lachlan alluvium and are typically associated with the Lachlan River further south within the Bland Catchment.

Local flow paths within the Lachlan Fractured Rock groundwater source will likely be controlled by the degree of connectedness through secondary porosity controlled by the extent and aperture of joints and fractures. Considering the Project location within the Parkes Fault Zone, groundwater flow paths and hydraulic connectivity are likely to be further influenced by the presence of faults that may act as hydraulic barriers or conduits. Groundwater flow is likely anisotropic (different horizontal and vertical flow rates), with vertical preferential flow paths aligned to the orientation of joints, faults and fractures.

Groundwater exchange between the alluvium and the underlying fractured rock is expected to be insignificant in the context of a groundwater resource as the systems are not considered hydraulically connected (DoI-W, 2018).

Groundwater recharge is primarily from rainfall and infiltration, particularly, Goobang Creek and Ridgey Creek, which are likely ephemeral (groundwater recharge zones). Preliminary assessment from available data suggests that the groundwater level within the investigation area, is likely to be at depths below creek water levels (when present). It is anticipated that groundwater levels will be below 3.5 mBGL for regions close to Goobang Creek within the Lachlan Unregulated and Alluvial groundwater source, with groundwater depths likely increasing towards the north and northeast across the investigation area. Groundwater levels within the Lachlan Fractured Rock groundwater source are expected to be at greater depths, between 40 mBGL – 80 mBGL. However once the groundwater source is intersected, groundwater levels may rise within the bore to shallower elevations.

4.5 SENSITIVE RECEPTORS

4.5.1 GROUNDWATER USERS

Based on the NGIS bore database search, seven (7) registered bores within the investigation area and an additional 295within the investigation buffer can be classified as sensitive receptors. The remaining bores identified within the investigation area and buffer are licensed as ‘monitoring’ or are listed as abandoned or removed, and are therefore not classified as a sensitive receptor. The bores identified as sensitive receptors currently hold licenses for household water supply, stock, irrigation, mining and manufacturing and industry, with six of these bores within the investigation buffer classified as unknown.

4.5.2 GROUNDWATER DEPENDENT ECOSYSTEMS

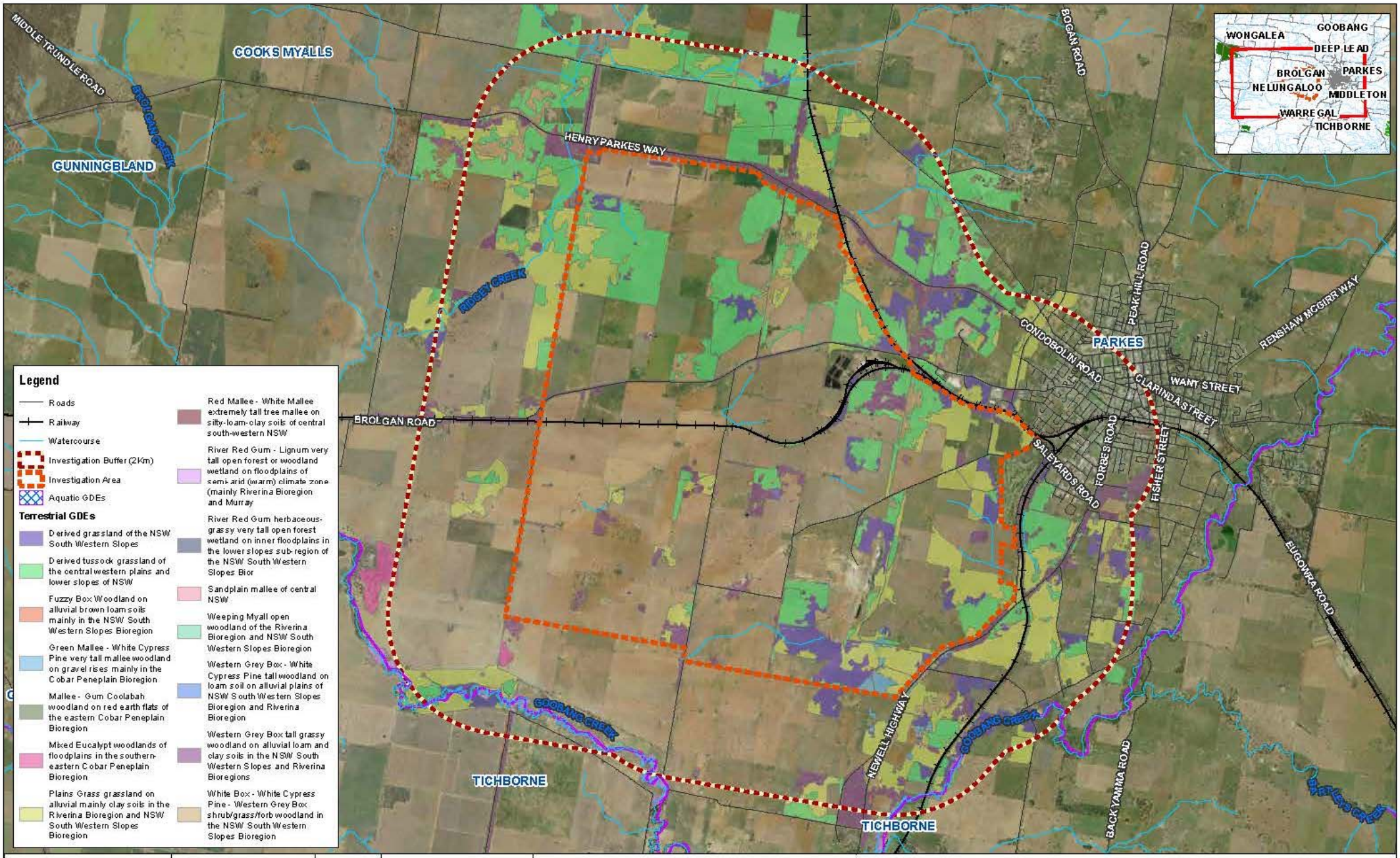
Groundwater dependent ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater. When considering GDEs, sustaining groundwater is predominantly defined as being active within the saturated zone of the regolith and its associated capillary fringe (but not soil pore water content in the unsaturated zone).

These ecosystems range from those entirely dependent on groundwater to those that may use groundwater while not having a dependency on it for survival (i.e. ecosystems or organisms that use groundwater opportunistically or as a supplementary source of water).

Identified GDE’s found within the investigation area and buffer from the BoM GDE Atlas (BoM 2019c) are listed below (refer Figure 4.1):

- no *aquatic* GDE within the Project boundary
- 1 *aquatic* GDE (Goobang Creek watercourse) within the investigation buffer
- 9 distinct *Terrestrial* vegetation GDE’s within the investigation area
- 14 distinct *Terrestrial* vegetation GDE’s within the investigation buffer.

All identified terrestrial GDE’s are labelled as low potential (for groundwater interaction), based on regional studies. The identified aquatic GDE is labelled as moderate potential (for groundwater interaction), based on the National assessment.



Map: PS112886_GIS_006_A3	Author: David.Naiken
Date: 4/04/2019	Approved by: Ellen.Kwantes

Data Source: Imagery © Department of Finance, Services & Innovation 2018

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Coordinate system: GDA 1994 MGA Zone 55
Scale: ratio correct when printed at A3

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Parkes SAP

Figure 4.1
Aquatic and Terrestrial GDEs in the investigation area and 2 km buffer

4.6 NEIGHBOURING BOREWATER OPERATIONS

Borewater (groundwater) is currently utilised as a resource by Parkes Shire Council as part of the updated Parkes-Peak Hill Water Supply Scheme (Cardno, 2015). The updated scheme aims to deliver "high quality water and reliably supply service" through an upgrade to the water treatment plant (WTP) capacity (from 16 ML/d to 24 ML/d), where water is sourced from the Beargamil and Lake Endeavour Dams (~21 km and ~25 km east-northeast of the investigation area, respectively), the Lachlan River and adjacent Lachlan alluvium borefield (~27 km south of the investigation area, near Forbes). At the time of the Cardno (2015) report, WALs for the eight bores (six owned by Parkes Shire Council, two owned by North Parkes Mine) that comprised the Lachlan alluvium borefield totalled 28,750 ML/year and were designed to extract groundwater with maximum pumping rates between 20 L/s to 80 L/s (median extraction rate of 40 L/s). The borefield was also recommended as the priority water 'take' in scenarios where demand is less than maximum available supply.

The Cardno (2015) report identified the following water quality issues related to the WTP since its commission in 1958:

- removal of iron/manganese sludge balls from the filter beds (built up over time)
- town supply issues (unable to meet peak demands of up to 17 ML/d)
- presence of CO_2 identified in the borefield groundwater at levels up to 100 mg/L. This was noted to have potential negative impacts (increased corrosion) on the longevity of the pipeline infrastructure
- significant decline in borefield groundwater levels during the 2002–2010 drought period (almost leading to bores becoming inoperable)
- sustainable yield of the bores is unknown.

Considering the distance of the borefield to investigation area and unknown bore construction details, extraction rates within the Lachlan Unregulated and Alluvial Water Sharing Plan groundwater source within the investigation area may differ to the extraction values utilised by the borefield. However, the listed yield values fall within the regional background ranges provided in Table 4.2.

5 POTENTIAL IMPACTS TO GROUNDWATER RECEPTORS AND GROUNDWATER SOURCE(S)

5.1 SAP SUB PRECINCT DEVELOPMENT

All the proposed sub-precinct land uses (JensenPlus, 2019) have the potential to impact groundwater receptors and the groundwater source through a decline in groundwater levels, quality and/or quantity. This may occur during both construction and operational phases of a project. Examples of how future projects within the Masterplan may impact groundwater receptors and the groundwater source(s) include, but are not limited to:

- the compaction of the alluvial aquifer due to development
- possible contamination from the various industrial use, particularly heavy agricultural and waste storage or treatment
- storage of chemicals within the sub-precincts
- groundwater decline through possible excavation or ongoing extraction of the groundwater source(s).

The degree of impact and level of severity to a groundwater receptor and the groundwater source(s) should be assessed during completion of the Masterplan and mitigation measures, if required, incorporated within a groundwater management strategy. Typically, impacts can be successfully managed in accordance to a groundwater management strategy. However, if groundwater users experience a decline in groundwater levels within their existing bores (commonly defined as greater than 2 m), provisions would be implemented to 'make good' the supply by restoring the water supply to pre-development levels. The measures taken would be site specific, but could include installation of a new bore, deepening of the bore, provision of a new water supply or monetary compensation.

5.2 GROUNDWATER RECEPTORS

5.2.1 REGISTERED BORES

Registered bores may be impacted by changes in groundwater use and supply with the implementation of using the groundwater source as a resource. Considering the Project encompasses multiple hydrogeological units across two Water Sharing Plans, the beneficial use of the local groundwater resource may be tailored and any future changes in its usage is unlikely to affect all users within the investigation area and buffer. The degree of impact to registered bores will be subject to the following:

- whether the bores within the investigation area continue to operate or are decommissioned
- the degree of connectivity between bores identified within the investigation buffer, particularly within the Lachlan Fractured Rock Water Sharing Plan, due to the presence of faults within this region
- the volume and length of time of the groundwater resource extraction.

Bores located across Water Sharing Plans are not expected to be impacted by changes to groundwater use within the other Water Sharing Plan.

5.2.2 GROUNDWATER DEPENDENT ECOSYSTEMS

Confirm potential impacts with ecological report.

5.3 GROUNDWATER RESOURCE SUSTAINABILITY RISK

Table 5.1 summaries the risk assessment undertaken by DoI-W (2018) for the Lachlan water resource plan area GW10 (Lachlan alluvium). The risk assessment for the Lachlan Fractured Rock water resource plan area has not yet been completed (DoI-W, 2017b). This risk assessment incorporated historical and predictive data and outcomes may differ from actual year to year usage of the system(s). The following table is intended to provide a guide to the severity of potential risks associated with change in influencing factors of the groundwater system(s).

Table 5.1 Summary of risks for the Lachlan water resource plan area GW10: Lachlan alluvium (DoI-W, 2017a & 2018)

RISK ASSESSMENT	LACHLAN ALLUVIUM (SHALLOW)	LACHLAN ALLUVIUM (DEEP)
Local drawdown reducing groundwater access by consumptive users	High	High
Structural integrity of the groundwater system	Medium	Medium
Groundwater extraction inducing connection with poor quality aquifers	High	High
Climate change reducing recharge and groundwater availability	Low	Medium
Growth in local water utilities reducing groundwater availability	Medium	Medium
Growth in basic landholder rights reducing groundwater availability	Medium	High

6 CONCLUSION

The preliminary desktop assessment indicates that multiple groundwater sources, legislated under two separate Water Sharing Plans, were identified within the investigation area. Both groundwater sources are likely to contain fresh – slightly saline quality water that is suitable for multiple beneficial uses including drinking water supply, irrigation and stock water supply, and represent extensive groundwater systems. Within the Lachlan alluvium, the water resource is utilised across irrigation and industry as well as water supply for stock and domestic use and local water utilities. This contrasts with the Lachlan fractured rock water source where the resource use is dominated by stock and domestic uses.

The total available water for aquifer use (through WALs) is considerably greater in the Lachlan Unregulated and Alluvial Water Sharing Plan, where usage volumes from 2012 to 2016 have extracted approximately 37% – 52% of the Water Sharing Plan yearly extraction limit (DoI-W, 2017a). However, the Water Sharing Plan is currently completely allocated with no provision for the generation of new licenses. In contrast, the Lachlan Fractured Rock Water Sharing Plan, whilst also completely allocated, does contain a provision for the generation of new licenses in the future (DoI-W, 2019).

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8 REPORT LIMITATIONS

8.1 SCOPE OF SERVICES

This environmental site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

8.2 RELIANCE ON DATA

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP

8.3 ENVIRONMENTAL CONCLUSIONS

In accordance with the scope of services, WSP has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Also, it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

8.4 REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

8.5 OTHER LIMITATIONS

WSP will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

APPENDIX A

DETAILS OF REGISTERED BORES WITHIN THE PROJECT BUFFER

Table A.1 List of registered groundwater bores within the investigation buffer (BoM, 2019b)

BORE NUMBER	EASTING	NORTHING	CONSTRUCTED DEPTH (mBGL)	PURPOSE	STATUS	SALINITY (µS/CM)	SCREENED INTERVAL	LITHOLOGY
GW013279	605613	6325649	8	Household water supply	Functioning	ND	ND	ND
GW017687	597633	6330352	91	Unknown	Unknown	ND	ND	ND
GW020719	607698	6331571	85	Livestock	Unknown	4820	ND	ND
GW024637	609030	6332542	43	Recreation and culture	Unknown	ND	ND	ND
GW026149	603638	6337220	20	Livestock	Unknown	ND	ND	ND
GW028132	600217	6327153	48	Irrigation	Unknown	ND	ND	ND
GW042682	608221	6329686	61	Irrigation	Unknown	ND	ND	ND
GW052940	604189	6337831	84	Household water supply	Unknown	2080	8 m – 84 m 1	Fractured rock
GW068108	606347	6336021	52	Household water supply	Abandoned	ND	ND	ND
GW700035	606825	6327576	55	Household water supply	Unknown	ND	ND	ND
GW700606	602263	6337584	64	Livestock	Removed	ND	ND	ND
GW700670	605513	6335284	60	Unknown	Abandoned	ND	ND	ND
GW701534	608821	6329566	66	Household water supply	Functioning	ND	16 m – 66 m	Fractured rock
GW701536	608554	6329971	72	Household water supply	Functioning	ND	60 m – 72 m	Fractured rock

BORE NUMBER	EASTING	NORTHING	CONSTRUCTED DEPTH (mBGL)	PURPOSE	STATUS	SALINITY (µS/CM)	SCREENED INTERVAL	LITHOLOGY
GW701850	609018	6328524	53	Household water supply	Functioning	ND	ND	ND
GW702056	608682	6330365	108	Household water supply	Removed	ND	ND	ND
GW702672	599972	6338857	60	Household water supply	Functioning	ND	ND	ND
GW702693	606419	6334913	84	Household water supply	Functioning	ND	ND	ND
GW703332	608806	6328846	78	Household water supply	Functioning	ND	ND	ND
GW703472	605020	6334960	30	Household water supply	Functioning	ND	ND	ND
GW703694	609254	6332037	21	Household water supply	Unknown	ND	ND	ND
GW703711	606588	6333725	40	Monitoring	Functional	ND	ND	ND
GW703712	606417	6333760	40	Monitoring	Functional	ND	ND	ND
GW703713	606773	6333898	40	Monitoring	Functional	ND	ND	ND
GW703714	606539	6334043	40	Monitoring	Functional	ND	ND	ND
GW703838	607668	6334191	40	Unknown	Unknown	ND	ND	ND
GW703970	608627	6333926	72	Household water supply	Functioning	ND	ND	ND
GW704012	599647	6338044	42	Household water supply	Functioning	ND	18 m – 42 m	Fractured rock

BORE NUMBER	EASTING	NORTHING	CONSTRUCTED DEPTH (mBGL)	PURPOSE	STATUS	SALINITY (µS/CM)	SCREENED INTERVAL	LITHOLOGY
GW704013	609427	6332617	60	Monitoring	Proposed	ND	48 m – 60 m	Fractured rock
GW704064	601401	6326292	85	Household water supply	Functioning	ND	ND	ND
GW704170	606542	6333724	46	Monitoring	Functional	ND	ND	ND
GW704199	608750	6328097	60	Household water supply	Functioning	ND	ND	ND
GW704587	608658	6328903	73	Household water supply	Functioning	ND	ND	ND
GW705014	604205	6335888	66	Stock, domestic	Functioning	ND	ND	Fractured rock
GW705019	599228	6335594	78	Stock, domestic	Functioning	ND	ND	Fractured rock

ABOUT US

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals. We design lasting Property & Buildings, Transportation & Infrastructure, Resources (including Mining and Industry), Water, Power and Environmental solutions, as well as provide project delivery and strategic consulting services. With approximately 48,000 talented people globally, we engineer projects that will help societies grow for lifetimes to come.