WALLBRIDGE GILBERT AZTEC

Barossa Infrastructure Ltd

Groundwater Resource Assessment

FINAL REPORT

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1 INTRODUCTION

Barossa Infrastructure Ltd (BIL) operates an irrigation scheme, providing water to viticultural proponents, primarily via transfer from the Warren Reservoir. Since its inception in 2001, the BIL scheme has led to reduced use of increasingly saline local groundwater, drought proofed vineyards and relieved pressure on domestic supply during periods of high demand.

BIL scheme supply water salinity is reported as averaging 246 mg/L for the Fromm Square primary supply point and 646 mg/L for the Gomersal Road secondary supply point (CWMS supply which is then diluted in the pipeline). Salinity results are collated from quarterly sampling analysis conducted by National Association of Testing Authorities (NATA) accredited laboratory Australian Water Quality Centre (AWQC).

The pre-development environmental assessment for the project[1] identified three soil classifications that were considered at risk of developing rising groundwater levels due to irrigation. As a result, fourteen shallow monitoring wells were installed (2001) within the 'at risk' soil formations.

Groundwater level, salinity and rainfall were last collated and reported for BIL in 2014[2] noting that groundwater levels "related to the long-term trends in the rainfall patterns" and that "trends in salinity are harder to define".

The climate of the Barossa Valley is characterised as Mediterranean, with hot, dry summers and cool, wet winters driving the need for irrigation. Rainfall data (2002 to 2022) was collated from the Nuriootpa PIRSA weather station (BoM station 023373) was chosen for analysis of wells within Kalimna/Ebenezer (within the Hundred of Belvedere), Marananga (Hundred of Nuriootpa) and Central Valley Floor (Hundred of Moorooroo), with Lyndoch (BoM station 023309) chosen for analysis of wells within Lyndoch (Hundred of Barossa).

Total annual rainfall for 2002-22 averaged 476 mm at Nuriootpa PIRSA, significantly below the long-term (1870-2022) annual rainfall of 544.5 mm at Tanunda (BoM station 023318) and 556.8 mm at Lyndoch (BoM station 023309).

BIL engaged WGA to prepare a groundwater monitoring report. The following report presents the data and analyses for the period 2002 until June 2022 relating to the groundwater level and salinity monitoring within the Barossa Valley, noting risk of BIL scheme irrigation to the groundwater resource.

[1] Environmental Assessment (2000). Eco Management Services Pty Ltd
[2] Groundwater (Water Table) Monitoring, 2014. Water Search Pty Ltd.

2 GROUNDWATER RESOURCES

Surface water and groundwater resources are managed under the *Landscape South Australia Act 2019* and the Barossa Water Allocation Plan (WAP). The WAP provides for sustainable management of the groundwater resources through the Barossa Prescribed Water Resource Area (PWRA).

Aquifers of the Barossa PWRA consist of two sedimentary Tertiary aquifers (upper and lower) and a fractured rock aquifer that underlies the sedimentary Tertiary aquifers. Analysis of the upper sedimentary Tertiary aquifer is detailed within this report as it is the most at risk from impacts of irrigation, and therefore enables an assessment of impact and/or risk to groundwater from irrigation by BIL customers.

The Department for Environment and Water (DEW) monitor groundwater and salinity within two networks: 1- Barossa Prescribed Water Resource Area (PWRA) and 2- Barossa irrigation wells salinity monitoring.

2.1 UPPER SEDIMENTARY AQUIFER

Geology of the upper sedimentary aquifer consists of Tertiary aged outwash gravels and clayey sands.

Groundwater levels of the upper sedimentary aquifer are directly influenced by rainfall and irrigation recharge (return irrigation flows), displaying greater temporal variability than the lower sedimentary and fractured rock aquifers.

Groundwater level of the upper sedimentary aquifer has a long record (30 years) of a declining or stable trend (mean decline 0.57 m/y[3]), with the exception of 1992 due to a wet spring period.

Salinity of the upper sedimentary aquifer is reported to range from 600 mg/L to greater than 6,000 mg/L and exhibits significant spatial variability across the region.

2.2 LOWER SEDIMENTARY AQUIFER

Geology of the lower sedimentary aquifer consist of Tertiary aged fluviatile, lacustrine, and deltaic beds, and are equivalents of the Maslin Sands Aquifer.

Groundwater level of the lower sedimentary aquifer has a long record (30 years) of a declining trend (mean decline 0.079 m/y[3]), with 1992 the exception due to a wet spring period. Since the year 2000 groundwater levels within the lower sedimentary aquifer have stabilised or risen slightly, although levels are still below monitoring levels recorded in the late 1970's.

Reported salinity of the lower sedimentary aquifer ranges from 500 mg/L to greater than 3,000 mg/L and exhibits significant variability across the region.

[3] Barossa Prescribed Water Resources Area 2019-20 Water Resources Assessment, DEW, 2021

2.3 FRACTURED ROCK AQUIFER

Geology of the fractured rock aquifer is varied, with a series of Neoproterozoic aged metasediments such as the Woolshed Flat Shale, Saddleworth Formation, and Stonyfell Quartzite[4].

The fractured rock aquifer is recharged from rainfall infiltration from the Barossa Ranges / Eden Valley.

Groundwater level of the fractured rock aquifer has long (30 year) recorded a declining or stable trend (mean decline 0.13 m/y[5]), with 1992 the exception due to a wet spring period.

Salinity of the fractured rock aquifer ranges from 500 mg/L to 3,000 mg/L and exhibits significant variability across the region.

[4] Geological Survey of South Australia 1:250,000 Map Sheet – Adelaide (SI5409)
[5] Barossa Prescribed Water Resources Area 2019-20 Water Resources Assessment, DEW, 2021

3 MONITORING NETWORK

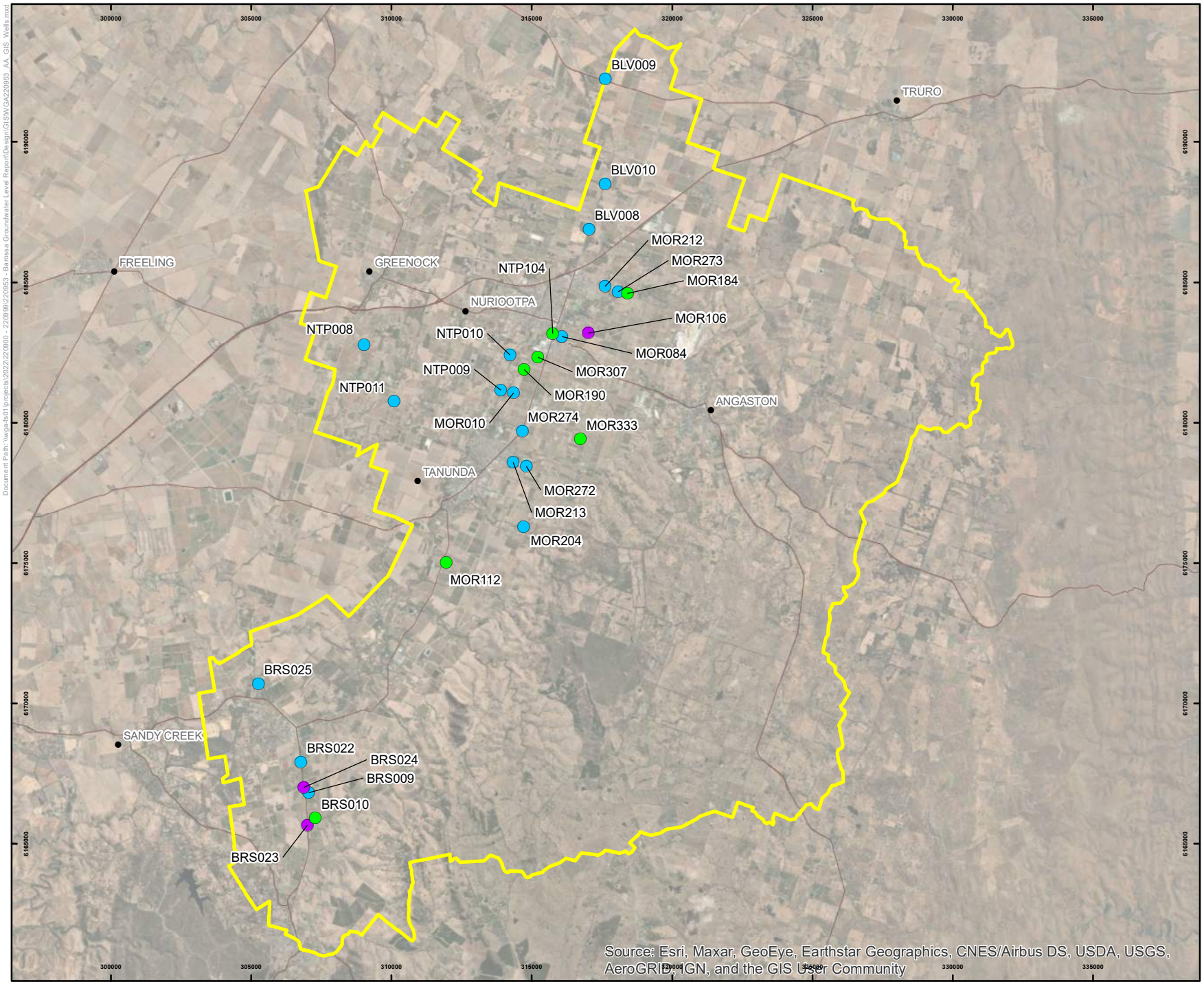
The Department for Environment and Water (DEW) monitor 107 wells for water level. There are 158 wells listed for salinity monitoring within the Barossa PWRA, however DEW does not collect samples. Groundwater levels are monitored by DEW twice yearly, whilst salinity relies on monitoring via well owner sample submission. Well owner salinity sample submission is an unreliable source of information due to being sporadic, averaging less than 30 samples per year (per comms. G Mackenzie DEW) and raise issues relating to quality control.

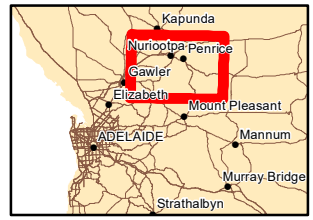
The Watersearch (2014) groundwater monitoring report identified 20 wells (Table 1) within the upper sedimentary Tertiary aquifer monitored for water level and salinity. Salinity monitoring of the wells detailed within Table 1 ceased in 2014 due to DEW removing the service from all groundwater monitoring networks.

Three wells MOR272, BRS023 and BRS024 are not suitable for analysis due to a lack of data, leaving 17 wells contributing to this analysis (Figure 1).

Table 1: Upper Sedimentary Aquifer Groundwater Wells

Obswell	Unit Number	Easting	Northing	Zone	Original Drilled Depth (m)	Original Drilled Date
BLV008	6729-1672	317035.7	6186892.5	54	12	25/10/2001
BLV009	6729-1673	317617.6	6192237.6	54	8	25/10/2001
BLV010	6729-1674	317608.7	6188505.5	54	10	25/10/2001
BRS009	6628-13342	307051.7	6166811.4	54	29.5	11/06/1985
BRS022	6628-20690	306769.7	6167917.5	54	8	23/10/2001
BRS025	6628-20694	305255.7	6170700.5	54	9	23/10/2001
MOR010	6629-4	314345.7	6181050.6	54	24.4	21/06/1939
MOR084	6629-73	316064.7	6183056.6	54	10	2/10/1974
MOR204	6628-15398	314702.7	6176273.5	54	15	27/11/1990
MOR212	6729-1448	317598.7	6184856.5	54	21	28/10/1991
MOR213	6628-16133	314327.7	6178583.5	54	29	31/10/1992
MOR273	6729-1671	318074.7	6184662.6	54	9	26/10/2001
MOR274	6628-20695	314652.7	6179690.5	54	15	24/10/2001
NTP008	6629-1811	309025.1	6182768.9	54	9	25/10/2001
NTP009	6629-1812	313897.7	6181157.5	54	10	24/10/2001
NTP010	6629-1813	314223.6	6182401.5	54	8	24/10/2001
NTP011	6629-1814	310086.7	6180766.5	54	9	25/10/2001
MOR272	6628-20692	314798.7	6178434.5	54	14	24/10/2001
BRS023	6628-20691	306997.7	6165655.5	54	15	23/10/2001
BRS024	6628-20693	306868.7	6167004.6	54	10	23/10/2001





LEGEND

- Locality
- Main Road
- Barossa PWRA

Groundwater Monitoring Well

- Salinity - Current
- Water Level - Current
- Water Level - Historical

N

0 1,000 2,000 3,000 4,000 5,000 m

Scale 1:185,000 @ A4

Coordinate System: GDA2020 MGA Zone 54

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Figure 1

Barossa Groundwater Level Report

Groundwater Monitoring Wells

Groundwater monitoring of salinity across 158 wells within the Barossa PWRA is restricted to forty-seven (47) wells within upper and lower sedimentary Tertiary aquifers. Only six (6) wells have salinity samples taken within the last 10 years from the upper sedimentary Tertiary aquifer (Table 2). An additional two groundwater monitoring wells within DEW network (BRS009 and BRS010) contain landowner submitted salinity readings.

Since 2018, groundwater users have submitted samples to DEW to be tested for salinity, however limited uptake (~30 samples per year) and sporadic submission significant limits the efficacy of the dataset.

Table 2: Salinity Monitoring Wells within Upper Sedimentary Aquifer

Obswell	Unit Number	Salinity (mg/L)	Salinity date
MOR106	6729-1496	1826	02/05/2022
MOR112	6628-4804	1127	19/04/2022
MOR184	6729-1179	1793	23/03/2022
MOR190	6629-1261	2704	17/03/2020
MOR307	6629-1284	1575	18/03/2022
MOR333	6728-2739	1132	31/03/2022
NTP104	6629-1704	1804	20/05/2021
BRS009	6628-13342	188	24/03/2022
BRS010	6628-12503	1010	20/03/2022

4 GROUNDWATER STATUS

Groundwater level and salinity status was assessed for the upper sedimentary Tertiary aquifer within four regions: Kalimna/Ebenezer (within the Hundred of Belvedere), Marananga (Hundred of Nuriootpa), Central Valley Floor (Hundred of Moorooroo) and Lyndoch (Hundred of Barossa).

Data interval was collated from 2002 until June 2022 to compliment the 2014 Watersearch Groundwater Monitoring report[6].

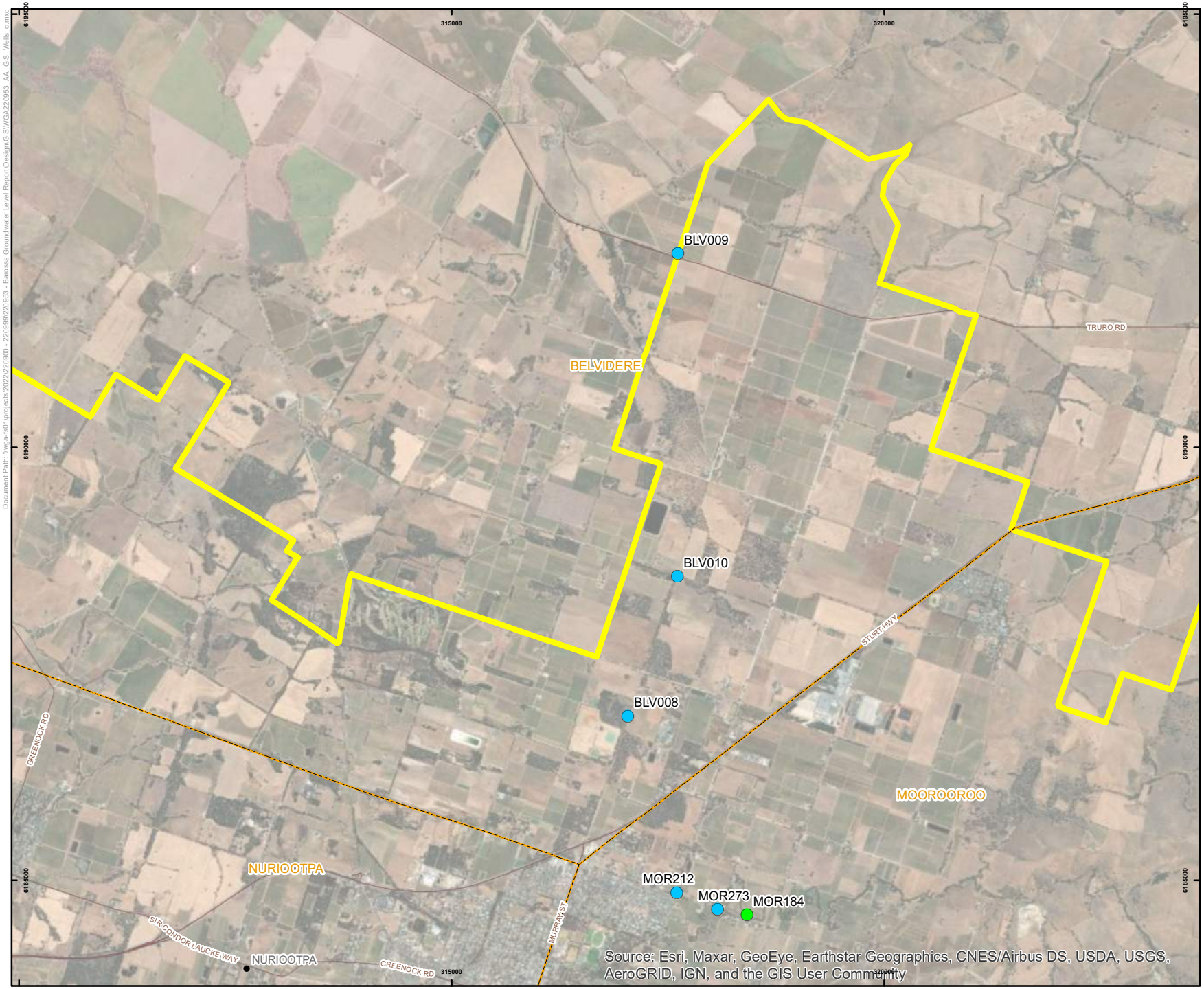
4.1 KALIMNA (HUNDRED OF BELVIDERE)

4.1.1 Groundwater Level

Groundwater level within the Kalimna area (Belvidere) monitoring wells BLV008, BLV009 and BLV010 displays a subtle (2 m decline over 20 years) declining trend (Figure 2). Seasonal fluctuation is observed within the groundwater level trends, with increased groundwater level following rainfall and decreased groundwater level during extraction for irrigation (September to February).

Rainfall exceeding the average during spring (as observed in 2005, 2011 and 2016) results in a stable or increased groundwater level as a result of rainfall recharge and reduced groundwater extraction for irrigation.

[6] Groundwater (Water Table) Monitoring, 2014. Water Search Pty Ltd.



LEGEND

- Locality
- Main Road
- Hundred
- Barossa PWRA

Groundwater Monitoring Well

- Salinity - Current
- Water Level - Current
- Water Level - Historical

N

0 250 500 750 1,000 m

Scale 1:60,000 @ A4

Coordinate System: GDA2020 MGA Zone 54

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Figure 2

Barossa Groundwater Level Report

Groundwater Monitoring Wells

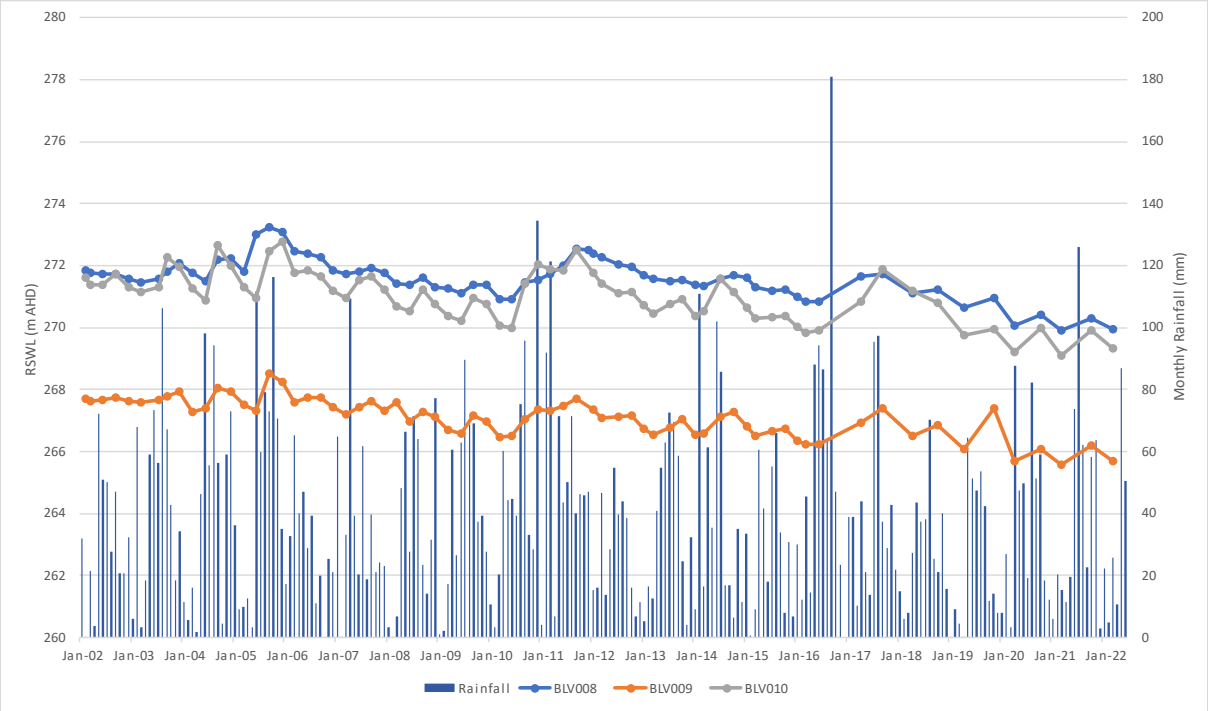
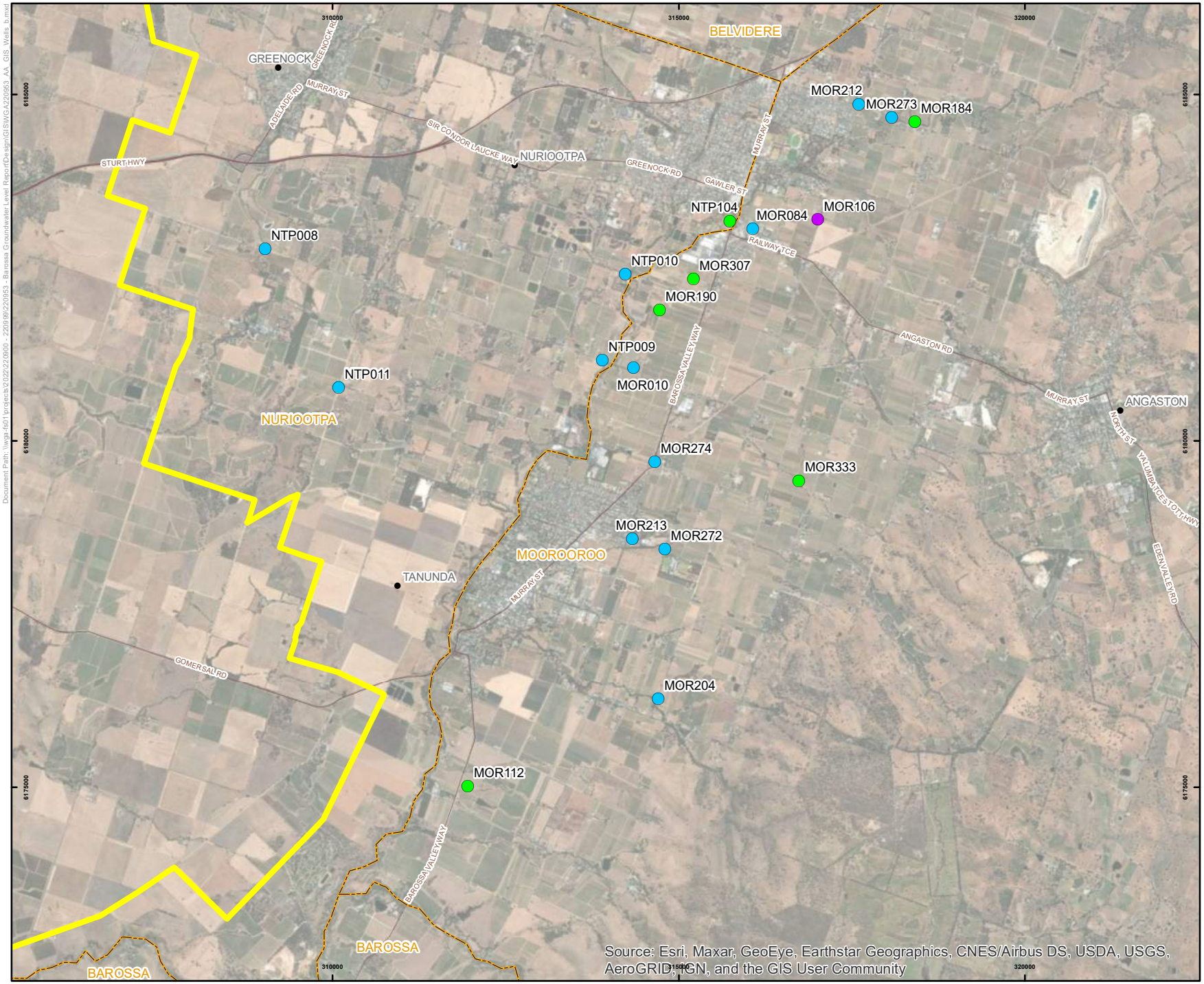


Figure 3: Kalimna Monitoring Well Hydrographs

4.2 MARANANGA (HUNDRED OF NURIOOTPA)

4.2.1 Groundwater Level

Groundwater level within the Marananga area (Hundred of Nuriootpa) monitoring wells NTP008, NTP009, NTP010 and NTP011 display stable trends (Figure 3). Seasonal fluctuation observed within the groundwater level trends are slight (<1.0m) and do not appear to fluctuate significantly in response to rainfall recharge or extraction.



LEGEND

- Locality
- Main Road
- Hundred
- Barossa PWRA

Groundwater Monitoring Well

- Salinity - Current
- Water Level - Current
- Water Level - Historical

N

0 250 500 750 1,000 m

Scale 1:75,000 @ A4

Coordinate System: GDA2020 MGA Zone 54

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Figure 4

Barossa Groundwater Level Report

Groundwater Monitoring Wells

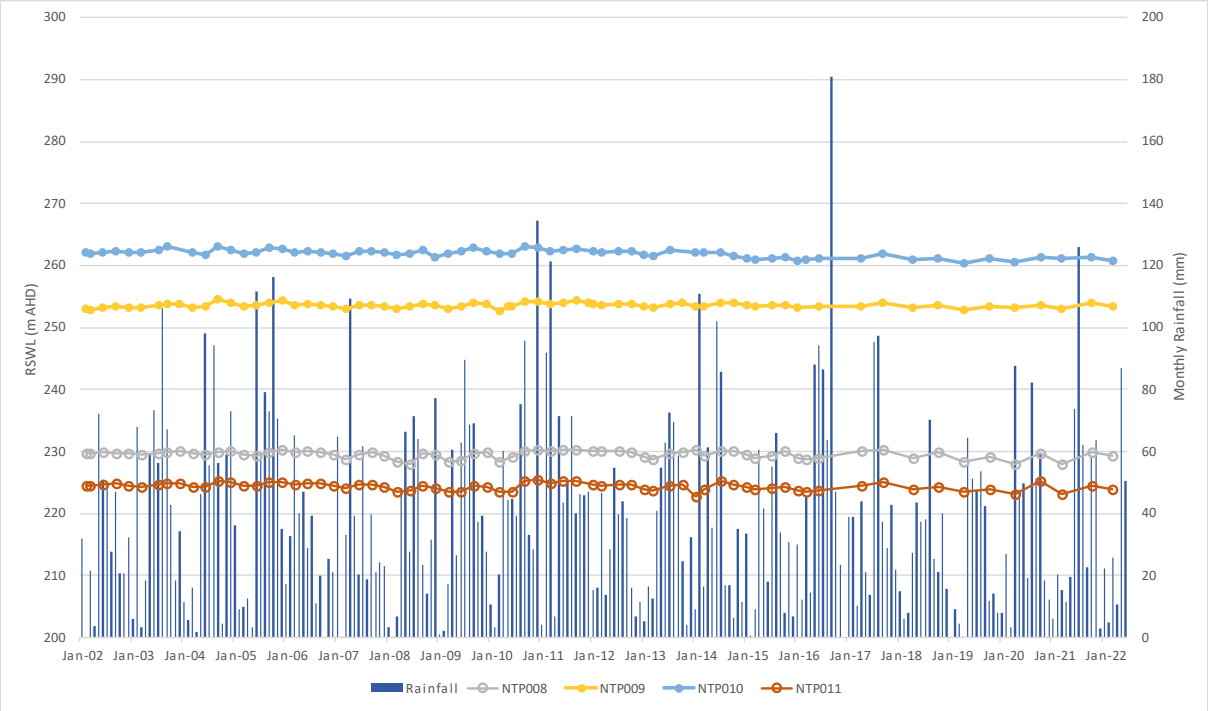


Figure 5: Marananga Monitoring Well Hydrographs

4.3 CENTRAL VALLEY FLOOR (HUNDRED OF MOOROOROO)

4.3.1 Groundwater Level

Groundwater level within the Central Valley Floor (Hundred of Moorooroo) area monitoring wells MOR010, MOR084, MOR204, MOR212, MOR213, MOR273 and MOR274 display a stable trend, with the exception of MOR213 (Figure 4). Seasonal fluctuation is observed within the groundwater level trends, with increased groundwater level following rainfall and decreased groundwater level during extraction for irrigation (September to February).

MOR213 displays a steep rising trend (3.95 m/y) between April 2018 – March 2022. The well is situated at ground level within a drainage channel near the corner or Menge and Magnolia Road. DEW monitoring notes indicate that the well has been missing the Gatic cover since 2018, it is covered with a stone and evidence of flood water draining into the well. Groundwater trends since 2018 should be considered anomalous until the Gatic cover is fixed.

MOR272 has not recorded a groundwater level depth, with comments from 2005-06 suggesting the well was dry. The well was removed from the DEW Barossa PWRA monitoring network in 2015.

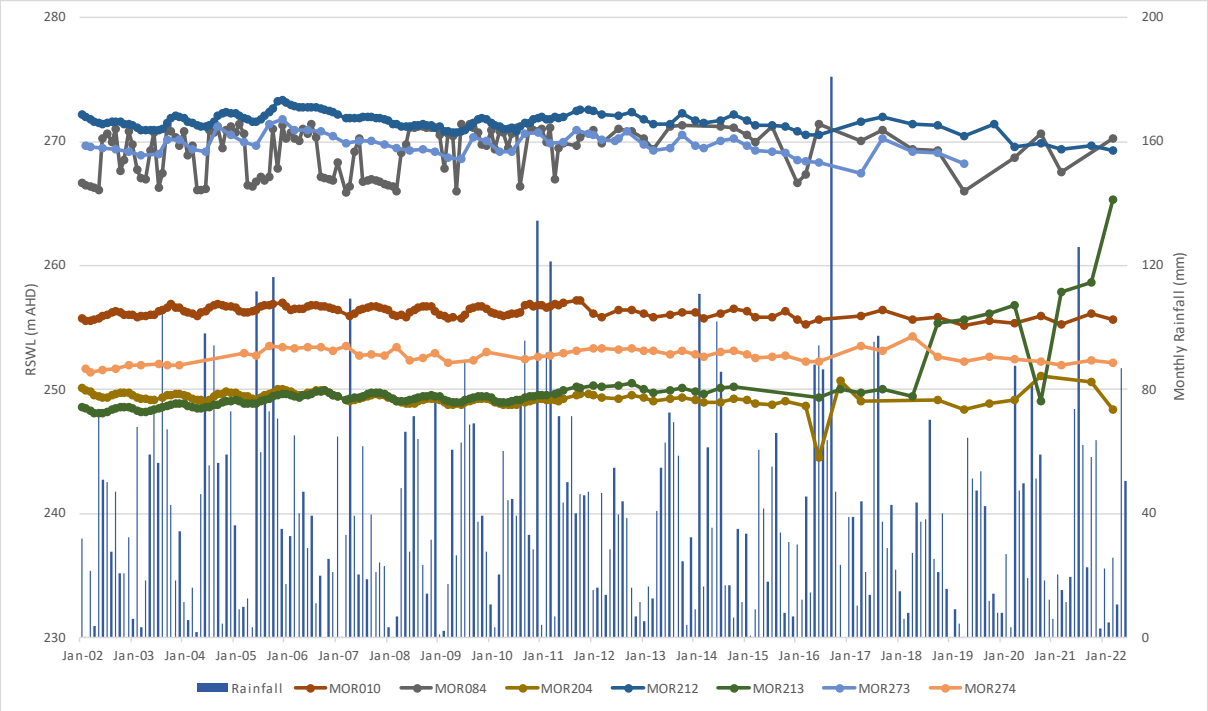


Figure 6: Central Valley Floor Monitoring Well Hydrographs

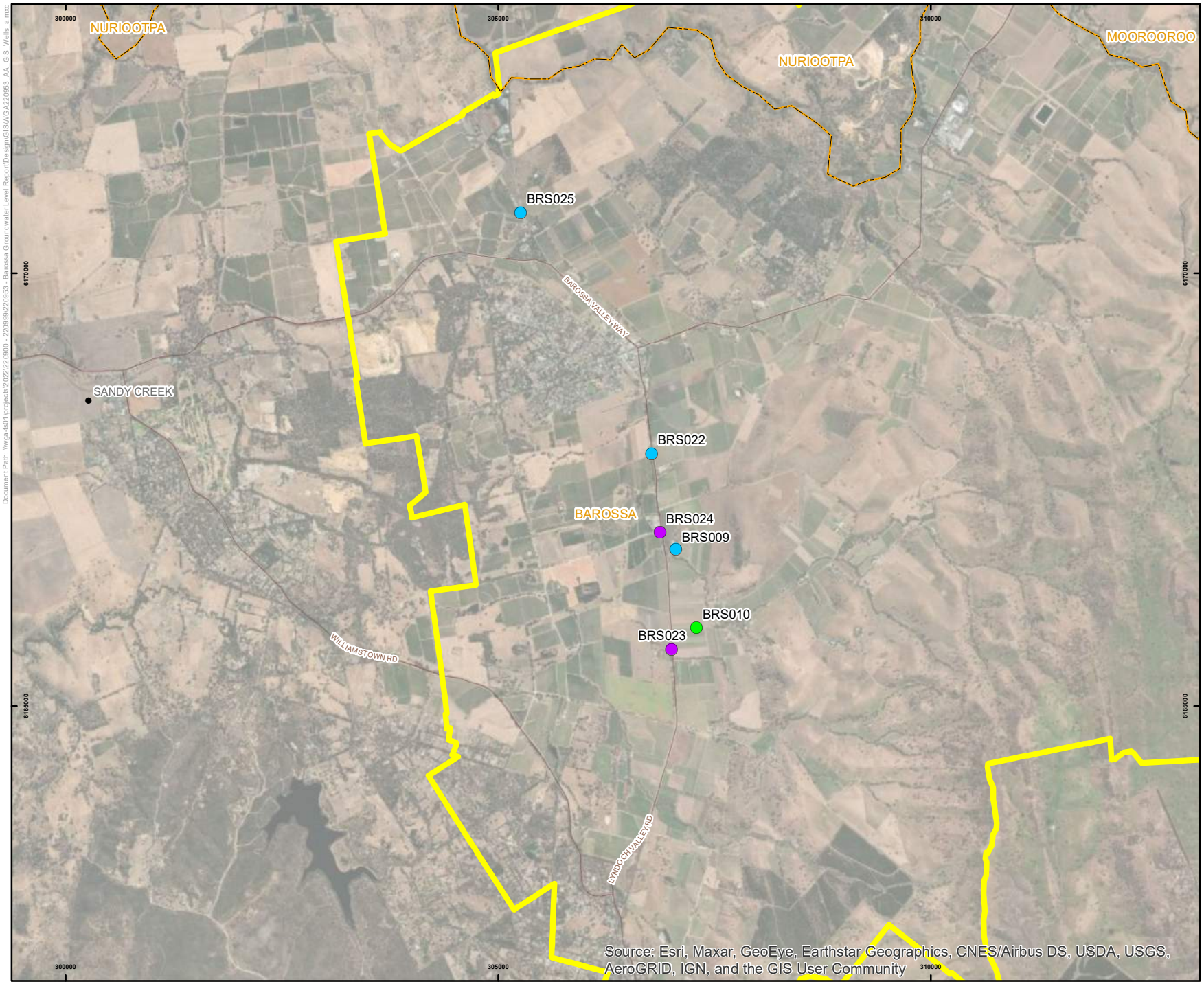
4.4 LYNDOCH (HUNDRED OF BAROSSA)

4.4.1 Groundwater Level

Groundwater level within the Lyndoch (Hundred of Barossa) area monitoring wells BRS009, BRS0022, BRS024 and BRS025 (Figure 7) displays a stable to declining trend (mean decline 0.11 m/y). Seasonal fluctuation observed within the groundwater level trends are slight (<2.0m) and do not appear to fluctuate significantly in response to rainfall recharge or extraction.

Declining groundwater levels are evident within BRS009 (5m decline over 20 years) and BRS025 (3m decline over 20 years).

Stable groundwater level is evident within BRS025.



LEGEND

- Locality
- Main Road
- Hundred
- Barossa PWRA

Groundwater Monitoring Well

- Salinity - Current
- Water Level - Current
- Water Level - Historical

N

0 250 500 750 1,000 m

Scale 1:60,000 @ A4

Coordinate System: GDA2020 MGA Zone 54

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Figure 7

Barossa Groundwater Level Report

Groundwater Monitoring Wells

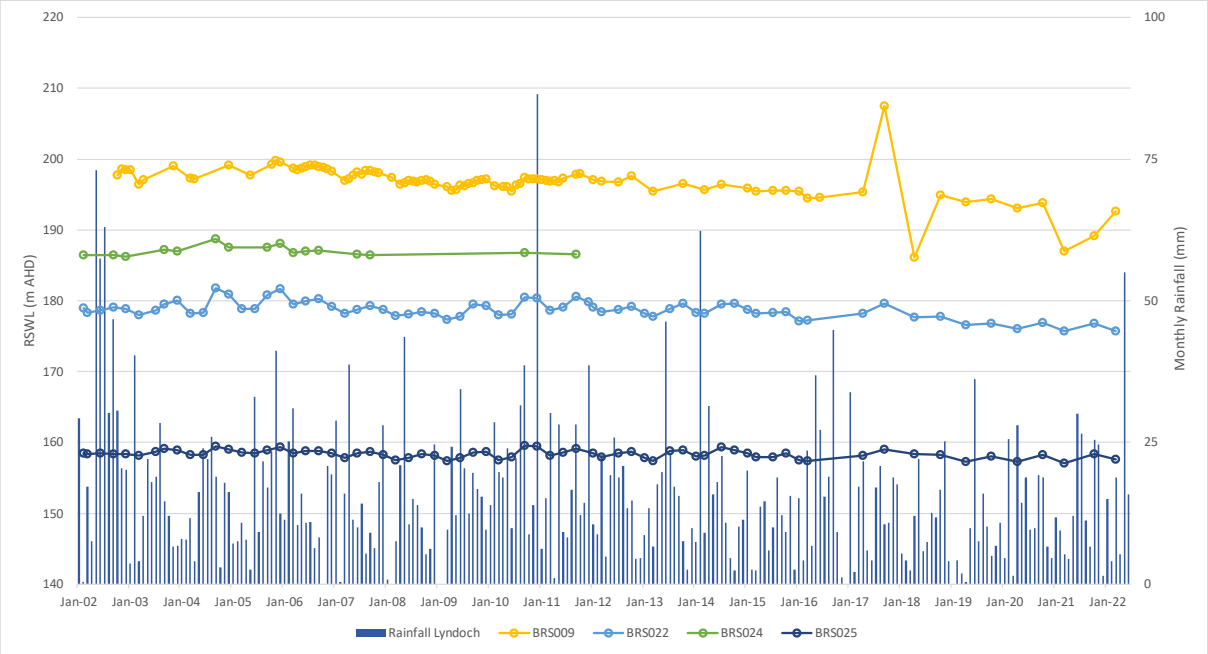

Figure 8: Lyndoch Monitoring Well Hydrographs

BRS023 has not recorded a groundwater level depth, with comments from Waterconnect monitoring from 2002 and 2006 suggesting the well was dry. The well was removed from the DEW Barossa PWRA monitoring network in 2015.

BRS024 has not recorded a groundwater level depth since 2011 or salinity since 2006. Comments from WaterConnect do not indicate why the well is no longer monitored. The well was removed from the DEW Barossa PWRA monitoring network in 2015.

4.5 GROUNDWATER SALINITY

Groundwater salinity data presented in 2014[5] coincided with the then Department of Environment, Water and Natural Resources removing groundwater salinity monitoring from service from all groundwater monitoring networks. As such, extension of observations reported within the 2014 Groundwater Monitoring report[7] is not possible.

Six DEW groundwater monitoring wells have salinity data from the last 10 years from the upper sedimentary Tertiary aquifer (Table 2). An additional three groundwater monitoring wells within DEW network (BRS009, BRS010 & MOR106) contain landowner submitted salinity readings.

Groundwater salinity data from the upper sedimentary aquifer display stable trends observed within 2018-2022 data (Figure 9). Salinity data from 2011-2018 was not collected for the wells analysed. Salinity trends prior to 2011 display increased fluctuation within some wells, however an overall stable or declining trend is noted for the 2002-2022 reporting period.

Five out of nine monitored wells have current (2022) salinity values exceeding than salt tolerance of grape vines (1,500 mg/L)[8].

[7] Groundwater (Water Table) Monitoring, 2014. Water Search Pty Ltd.
[8] Suarez, D. *et al*. Grape Rootstock Response to Salinity, Water and Combined Salinity and Water Stresses, 2019.

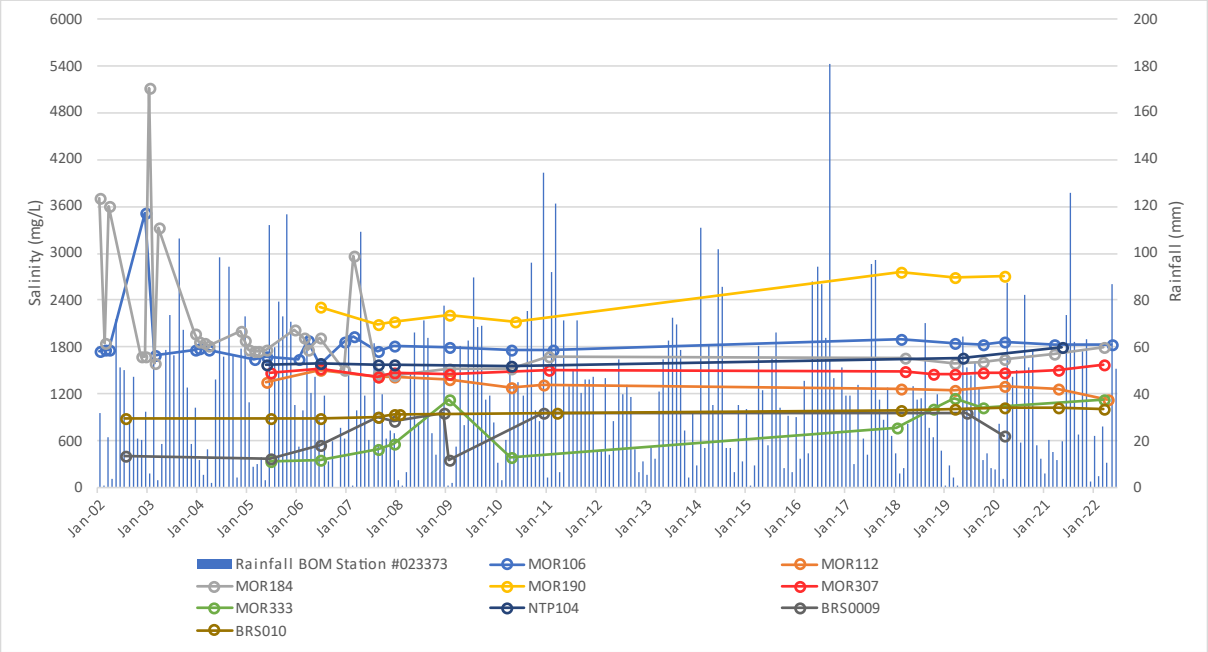

Figure 9: Upper Sedimentary Aquifer Monitoring Wells Salinity

BIL irrigation use is mixed amongst the nine upper sedimentary aquifer monitoring wells. The presence of irrigation volumes from the BIL scheme does not appear to impact groundwater salinity trend positively or negatively.

5 CONCLUSION

Groundwater monitoring for level and salinity for the upper sedimentary Tertiary aquifer has been analysed for the period extending 2002 to 2022, to assess potential risk of rising groundwater level and salinity resulting from irrigation using BIL water.

Total annual rainfall for 2002-22 averaged 476 mm at Nuriootpa PIRSA, significantly below the long-term (1870-2022) annual rainfall of 544.5 mm at Tanunda (BoM station 023318) and 556.8 mm at Lyndoch (BoM station 023309).

BIL scheme supply salinities average 246 mg/L (Fromm Square) and 646 mg/L (undiluted Gomersal CWMS), significantly below the salinity tolerance of grape vines of 1,500 mg/L.

Groundwater monitoring reported in 2014 noted that groundwater levels “related to the long-term trends in the rainfall patterns” and that “trends in salinity are harder to define”.

Groundwater level data from 2002-22 indicated varied results with stable trend in the Central Valley, stable trend in the Marananga area, stable to declining trend (mean decline 0.11 m/y) in the Lyndoch area and a subtle declining trend (mean decline 0.1 m/y) within the Kalimna area. Rising groundwater level trends are not observed in relation to BIL irrigation within monitoring wells assessed. Declining groundwater level trends observed in Lyndoch and Kalimna areas may be driven by declining rainfall over the past 20 years.

Seasonal response to rainfall recharge is evident across all monitoring sites. Above average spring rainfall leads to increased groundwater level at Kalimna. The rainfall recharge response is stronger within the Kalimna area than other monitored areas. A subtle declining groundwater level trend at Kalimna and increased spring recharge indicates lower aquifer storativity (the volume of water released from storage per unit surface area of the aquifer per unit decline in hydraulic head).

Low aquifer storativity is a natural phenomenon relating to insufficient aquifer physical properties, resulting in groundwater level decline if over extracted (as observed for the current extraction regime) and increased groundwater level observed with relation to above average spring rainfall.

DEW ceased salinity monitoring in 2014, significantly limiting groundwater salinity trend analysis. Salinity data from nine available upper sedimentary aquifer monitoring wells indicates that overall stable or declining trends for the analysed data set (2002-2022). This analysis suggests that the BIL irrigation scheme is not causing negative salinity impacts on the upper sedimentary Tertiary aquifer.

Since the inception of the BIL scheme (2001), trends associated with groundwater level and salinity of the upper sedimentary Tertiary aquifer do not indicate any negative impacts to the resource.

6 RECOMMENDATIONS

Consideration for ongoing salinity monitoring is recommended, with DEW removing the function in 2014 and current owner submission method failing to ensure consistent and reliable data. Future salinity monitoring, through re-instatement of the DEW salinity monitoring, consisting of targeted non-irrigation upper sedimentary Tertiary aquifer wells will deliver consistent and reliable data. Current analysis suggests that the BIL irrigation scheme is not causing negative salinity impacts on the upper sedimentary Tertiary aquifer. As such, ongoing DEW salinity monitoring frequency at 5-year interval is considered adequate.

Soil salinity of the profile overlying the upper sedimentary Tertiary aquifer has not been considered as part of this report. However, the pre-development environmental assessment for the project[9] identified three soil classifications that were considered at risk of developing rising groundwater levels due to irrigation. Rising groundwater levels are not evident within the available dataset and is unlikely to be a widespread issue. Soil salinity monitoring or investigation within areas of ongoing saline groundwater irrigation would provide localised insights.

[9] Environmental Assessment (2000). Eco Management Services Pty Ltd

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