

Annual Bulk Entitlement Report

**Anglesea groundwater
2022-2023**

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1. Introduction

The Anglesea Borefield is one of a number of water sources that can supplement the existing Greater Geelong water supply system. Our diverse water supply mix is part of a balanced approach to managing the region's water resources and providing greater water security. The Anglesea Borefield is used to extract groundwater from the Lower Eastern View Formation in the Jan Juc Groundwater Management Area and contains seven production bores that are licensed to extract a maximum of 40 ML in any day, 10,000 ML in any year, and 35,000 ML in any 5-year period.

When in use, groundwater from the Anglesea Borefield is pre-treated at the Anglesea Pre-Treatment Plant before it is transferred to Wurdee Boluc Reservoir, where it is stored and eventually undergoes full treatment before being supplied to customers.

The borefield was operated intermittently between 2009 and 2012 for commissioning and testing, and then again between August 2019 and end of June 2020 to supplement the existing Greater Geelong water supply system.

On 27 January 2022, Barwon Water commenced a groundwater pumping test to inform a review of our bulk entitlement and environmental monitoring program at the Anglesea borefield. The pumping test ran for six months with strict environmental protection controls in place. The test was completed on 27 July 2022. We extracted 1,783 ML during the test, and this water was used to supplement drinking water supplies for Barwon Water customers.

During 2022-2023, which is the reporting period covered by this annual report, 388.5 ML was extracted. This included the end of the pumping test in July 2022 and a small amount of water that was extracted while the borefield was in standby maintenance mode where the pumps were turned over periodically.

Barwon Water operates the Anglesea Borefield under the Bulk Entitlement (Anglesea Groundwater) Order 2009 (the Order), which requires Barwon Water to prepare an annual report called the Annual Bulk Entitlement Report (Anglesea Groundwater). The annual report includes information on groundwater extraction rates, water quality sampling, trigger levels and any issues or difficulties in complying with the Order. This report will be available for stakeholders, agencies, our customers and community.

The Order requires Barwon Water to also establish a Monitoring and Assessment Program (MAP), which commenced in 2009. The objective of the MAP is to protect environmental values and the health of groundwater dependent ecosystems, while also continuing to collect data to build an understanding of the long-term sustainability of groundwater resources in the Anglesea area. Environmental monitoring is ongoing, even if the borefield is not in use.

Under the Order, Barwon Water is also required to undertake periodic reviews of the Bulk Entitlement (Anglesea Groundwater) Order 2009. The review conducted in 2013 identified a number of areas of the MAP that should continue to be monitored, as well as areas that are not considered to be dependent on groundwater from the Lower Eastern View Formation and, therefore, could be subject to reduced monitoring. As a result of the 2013 review, a revised MAP was established and subsequently approved by the Minister for Water in September, 2014. Barwon Water has since implemented the revised MAP 2014 and has been operating in accordance with the MAP 2014.

In accordance with the Order, Barwon Water must prepare an annual report, to be called an Annual Bulk Entitlement Report (Anglesea Groundwater) which must include the following information in respect of the 12 month period, 1 July 2022 to 30 June 2023:

- a) the daily amount of groundwater taken under the Order;
- b) the monthly amount of groundwater taken under the Order;
- c) the annual amount of groundwater taken under the Order and from each bore;
- d) the results of the water quality sampling carried out under the monitoring and assessment program;
- e) any period or periods of greater than 30 days during which the average of the daily groundwater levels in an observation bore was below a trigger level as provided for in clause 9 of the Order;
- f) any issues or difficulties experienced or anticipated by Barwon Water in implementing an approved program or restoring groundwater levels as provided for in clause 9 of the Order;
- g) any arrangements entered into with an existing groundwater user under clause 7 of the Order;
- h) the results of any independent arbitration under clause 18 of the Order to which Barwon Water is a party; and
- i) any difficulties experienced or anticipated by Barwon Water in complying with the Order and any remedial action taken or proposed by it.

2. Groundwater extraction (Clauses 16.1 A, 16.2 A, 16.2 B and 16.2 C)

Under the bulk entitlement, and subject to ongoing appropriate environmental monitoring, Barwon Water is permitted to extract a maximum of 40 ML in any one day; 10,000 ML in any one year; and 35,000 ML in any five-year period. The extracted volume of 388.5 ML during 2022-2023 is a result of a pumping test conducted to inform a review of the bulk entitlement and environmental monitoring program that is required to be completed by the end of 2024. All water extracted was used to supplement drinking water supplies for Barwon Water customers. Table 1 shows the daily extraction rates and Table 2 shows the total extraction per bore of the Anglesea Borefield during 2022-2023. Table 1 also shows the small volumes extracted leading up to the pumping test commencing. These small volumes are a result of operational maintenance being undertaken on the production bores.

Community engagement

Keeping the community and key stakeholders updated on Anglesea Borefield operations and environmental monitoring is important. Barwon Water provides regular updates via the Surf Coast Shire, Anglesea River Working Group, Friends of Anglesea River and the wider Anglesea community.

The Anglesea Borefield operates in conjunction with an extensive environmental monitoring program, which includes community oversight of the monitoring through the Anglesea River Working Group.

Table 1: Total daily/monthly groundwater extraction 2022-2023

Date	Groundwater extraction rates (ML)											
	Jul 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	April 2023	May 2023	June 2023
1	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	15.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	16.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
12	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	16.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	5.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.2	0.0	0.0	0.0	0.0		0.0	0.0	0.1	0.0
31	0.0	0.0		0.0		0.0	0.0		0.0		0.0	
Total	388.0	0.1	0.2	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Prog. Total	388.0	388.0	388.3	388.3	388.3	388.3	388.4	388.4	388.4	388.4	388.5	388.5
Max. Flow	17.1	0.0	0.2	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Min. Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ave. Flow	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2: Annual groundwater extraction by bore 2022-2023

Production bores		Groundwater Extraction (ML)
MAP. ID	BE. ID	
GW1	(SPB1)	65.9
GW2	N/A	54.6
GW3	(SPB3)	87.7
GW4	(SPB4)	0.0
GW5	N/A	75.6
GW6	(NPB6)	73.2
GW7	(NPB7)	31.6
Annual total		388.5

3. Water quality sampling (Clause 16.2 D)

3.1 Groundwater quality

The 2014 MAP stipulates that groundwater salinity is to be measured twice a year at five deep observation bores (between 165 – 490m deep) as well as 11 shallow observation bores (less than 80m deep). The deep observation bores monitor the Upper Eastern View Formation (UEVF) and the Lower Eastern View Formation (LEVF), while the shallow observation bores monitor the perched water table as well as the UEVF and LEVF. The monitoring under the MAP utilises observation bores managed by Barwon Water, the State Government and Alcoa.

There are two bores identified in the MAP that monitor for saline intrusion, bore P14 in the LEVF and Coastal Bore 119349 in the UEVF. DEECA has advised that Coastal Bore 119349 is in poor condition and is scheduled for decommissioning. In 2021-22 Coastal Bore P21 in the UEVF was constructed meaning we now have data for the UEVF coastal bore.

Production bores

The MAP requires weekly monitoring of field salinity and temperature in each production bore (GW1-GW7) that is in operation when taking groundwater. The Anglesea Borefield was operated as part of the pumping test in 2022-2023. Given this, manual readings were taken on a weekly basis from each of the production bores.

Figure 1 and 2 below show weekly results of monitoring for temperature and electrical conductivity (EC) taken from telemetry on each bore while in operation.

For a majority of the year the borefield was in standby maintenance mode. Due to the short operation time required for maintenance (<10mins) the temperature readings are not representative of the actual temperature in the LEVF due to cooling of the water as a result of the distance the water travels to the surface while in contact with the stainless steel casing of the production bore. Figure 1 shows the drop in the temperature measured for GW1-GW7 as a result of the short operation time since operation of the borefield moved to standby mode in August 2022. From January 2022 you can see the temperature increase as the duration of pumping was increased for the pumping test. These values recorded during the pumping test are considered to be the most accurate representation of the temperature of the LEVF at each production bore location.

It is understood through previous monitoring that the salinity levels in the LEVF are lower than what is expected in the UEVF. The data shows that EC remains relatively stable for all production bores,

particularly for the period of the pumping test, with the highest EC recording in production bore GW7. There was also some fluctuation in the temperature at GW7 which reflects some intermittent pumping while maintenance was undertaken on the production bore.

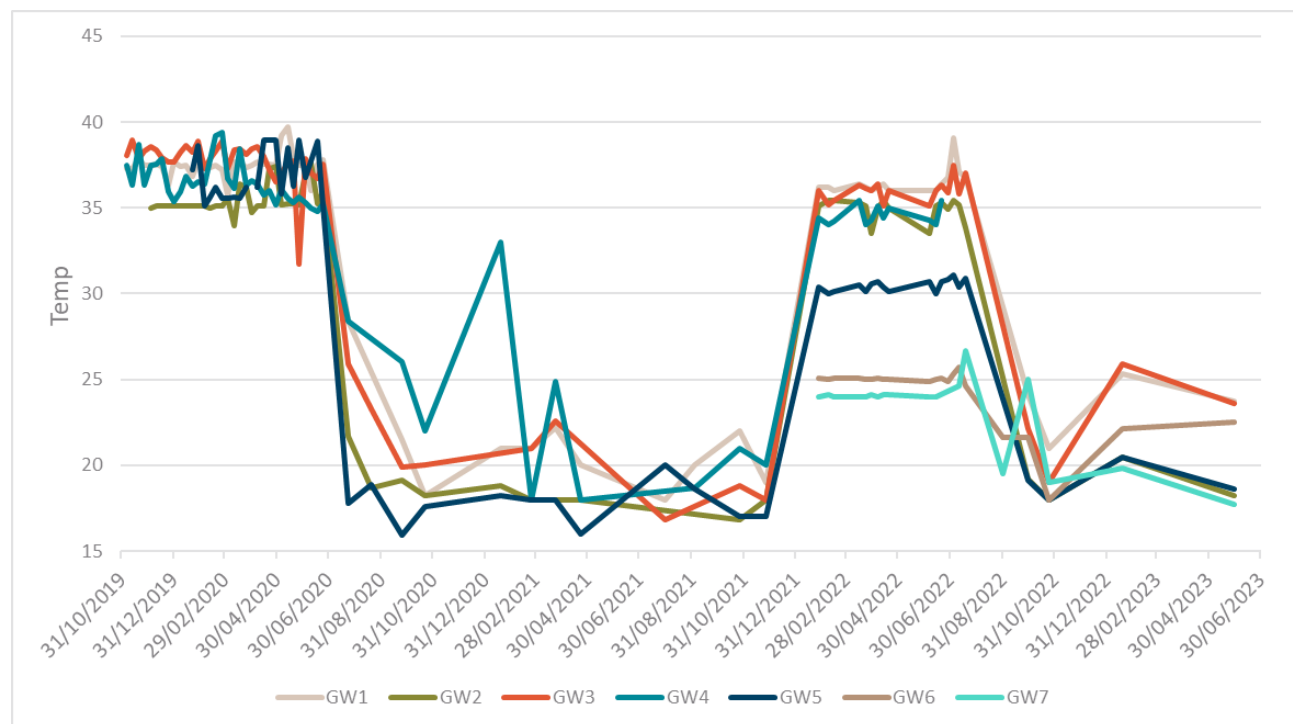


Figure 1: Groundwater quality results for temperature – production bores

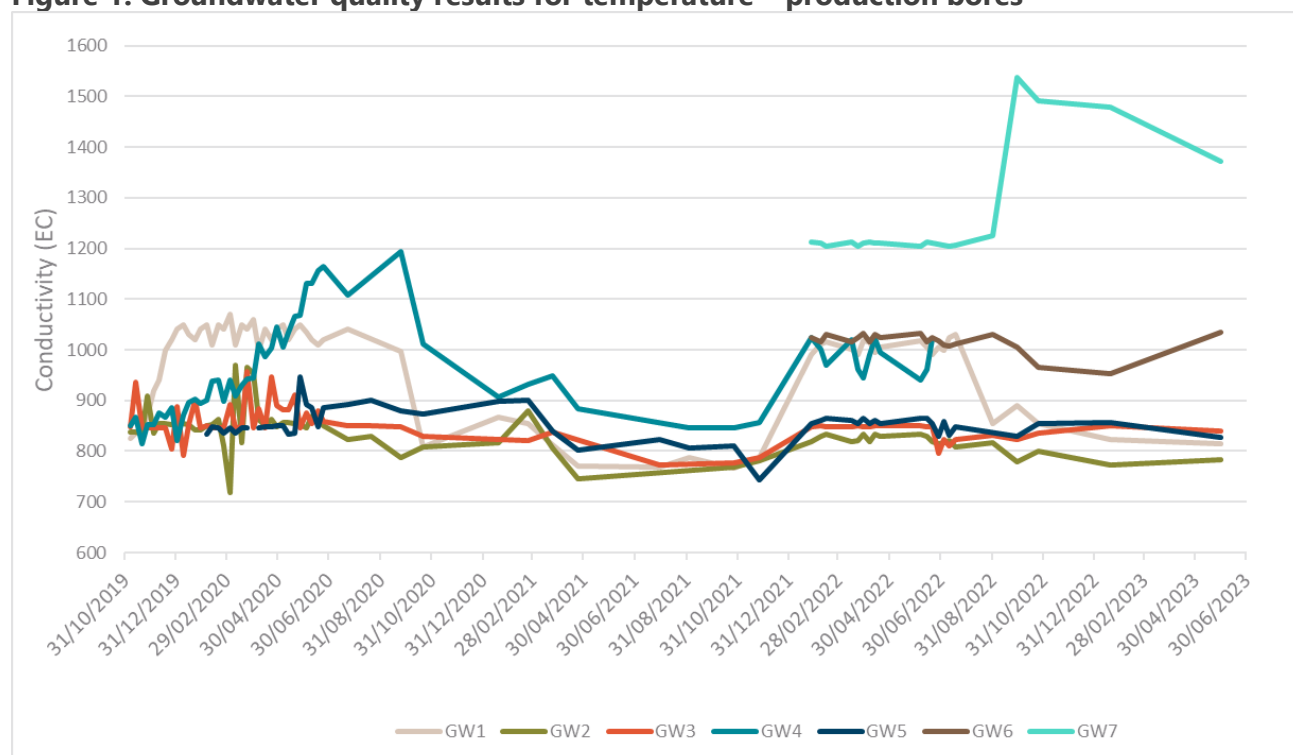


Figure 2: Groundwater quality results for salinity (EC) – production bores

Deep observation bores

The 2022-2023 groundwater salinity results from the deep observation bores are provided in Table 3, while the results over the whole monitoring period (from April 2010 onwards) have been provided

graphically in Figure 3. This figure depicts the salinity measurements against the groundwater extraction and recovery periods. A linear regression line has been developed for each site in order to compare the results over the monitoring period.

Laboratory testing of major cations and anions, salinity (TDS and EC), pH, and bromide (for bores P14) was also completed at these groundwater bores and has been provided in Appendix E.

Table 3: Groundwater Quality Results – Deep Observation bores

Bore ID	Aquifer	Depth (m)	Date	Field Parameters			Lab Result	
				Temp °C	pH	EC (µS/cm)	EC (µS/cm)	TDS (mg/L)
119348	LEVF	N/A	Jul-22	23.1	7.76	1356	1400	766
			Jan-23	23.2	7.7	1312	1430	815
SB2	UEVF	229	Jul-22	15.4	5.67	4350	3820	2390
			Jan-23	19	5.49	4301	4280	2460
NB2	UEVF	165	Jul-22	14.5	5.83	2615	2280	1620
			Jan-23	22	5.5	2488	2470	1400
P14	LEVF	504	Jul-22	1	5.96	848	859	441
			Jan-23	18.6	6.05	949	1020	646
P15	LEVF	466	Jul-22	14.5	5.09	867	853	512
			Jan-23	22.2	4.88	900	940	514

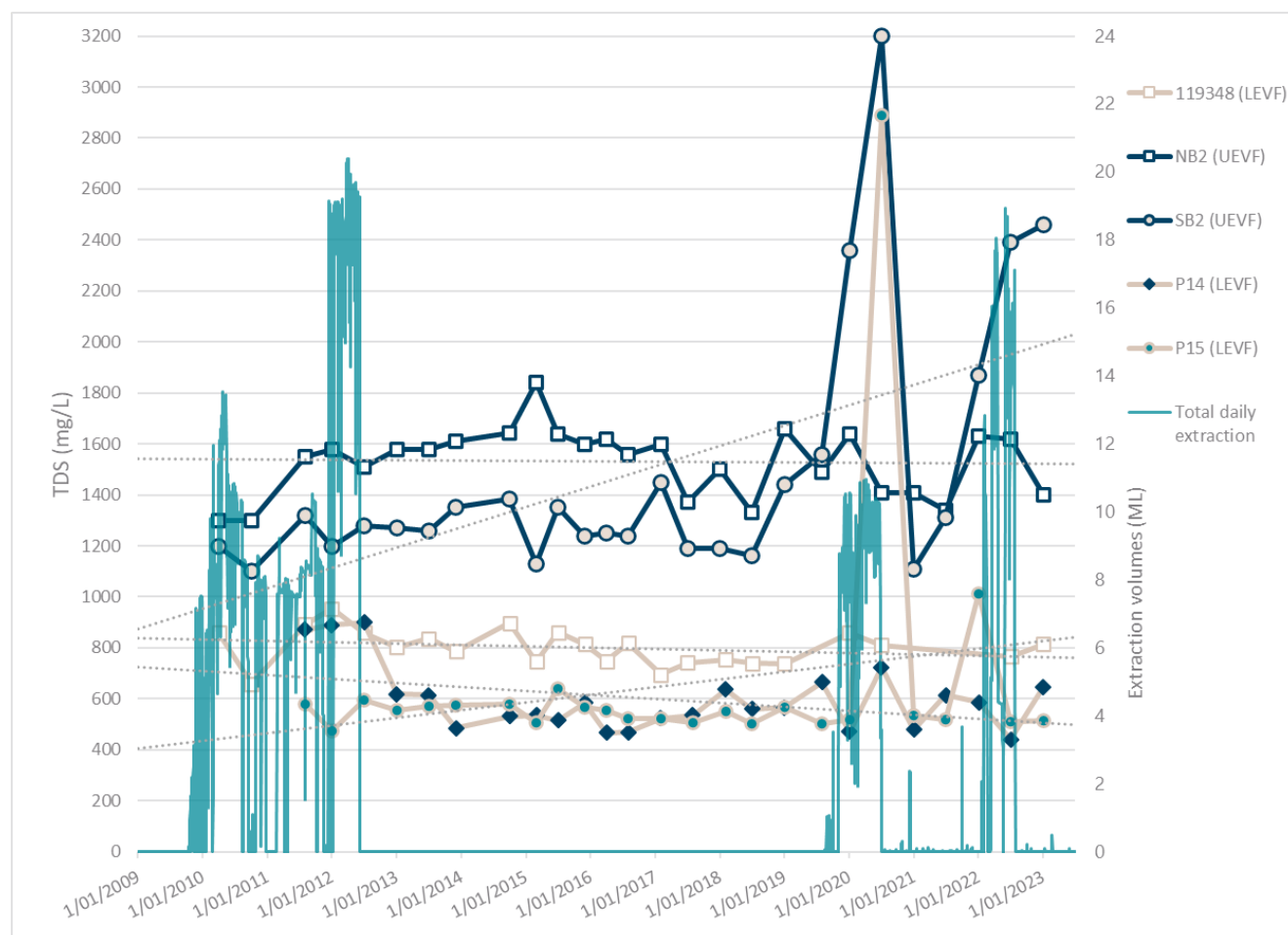


Figure 3: Groundwater quality results – deep observation bores

The field readings taken for the Electrical Conductivity (EC) are conducted during the bore purging process. Both the Total Dissolved Solids (TDS) and EC are taken to measure the salinity in groundwater samples. The TDS readings are measured in controlled laboratory conditions by weighing the residual solids that remain after the water from the sample is evaporated. This method is proven to be much more accurate than the EC readings, where an electrical current is passed through the sample and measured. Since the TDS yields more accurate results, these results have been used to analyse the trends in the groundwater salinity.

Given its proximity to the coastline, P14 is also tested for chloride and bromide to monitor for potential seawater intrusion. Seawater in an open ocean has a constant chloride/bromide ratio of approximately 285g/1g (285:1). Therefore, a decreasing chloride/bromide ratio, in conjunction with rising salinity can be indicative of saline intrusion. Results in Figure 4 show that there is no indication of saline intrusion at observation bore P14.

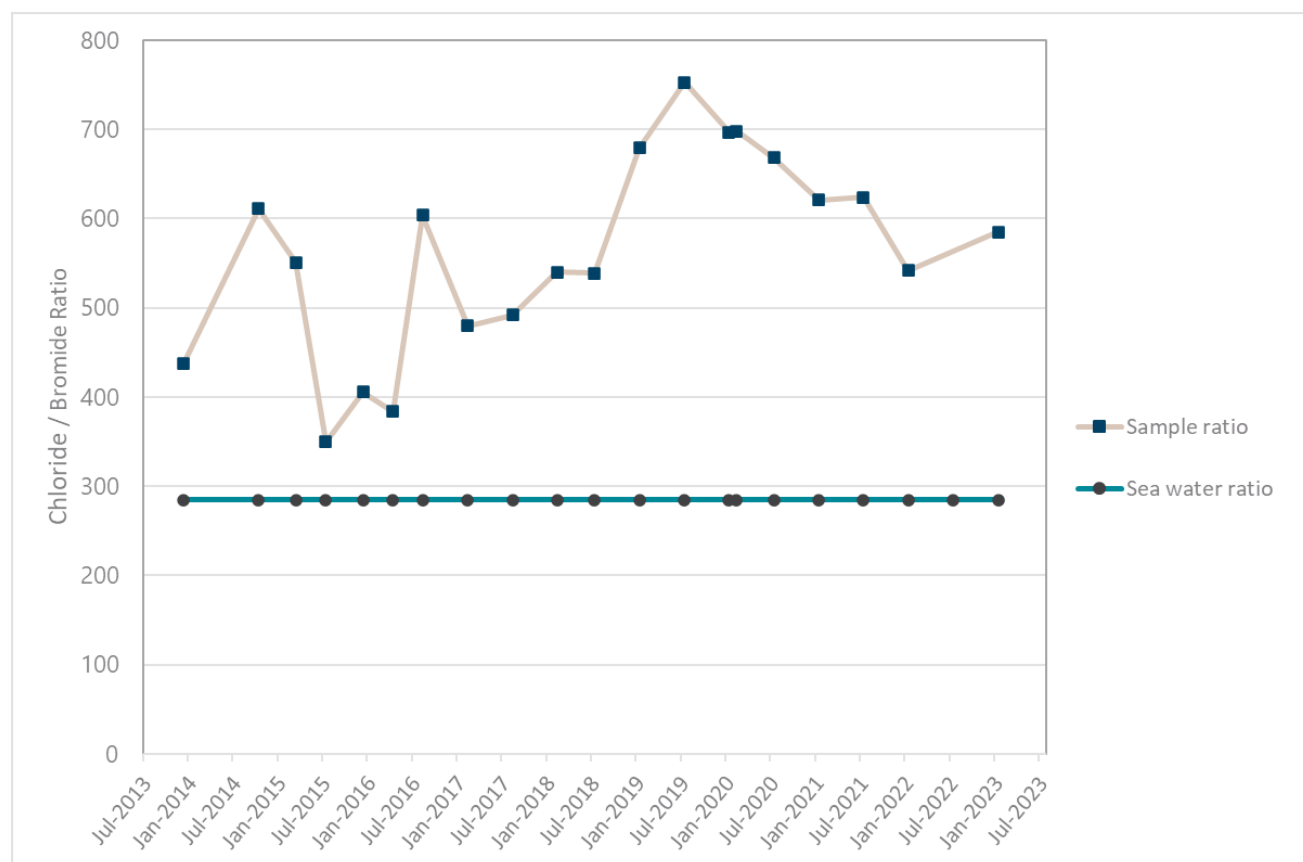


Figure 4 illustrates the chloride/bromide ratios overtime. The trend remains above the 285:1 ratio associated with seawater. Hence there continues to be no indication of saline intrusion at P14 to date.

Shallow observation bores

The 2022-2023 groundwater salinity results from the shallow observation bores are provided in Table 4. Groundwater salinity monitoring at the shallow observation bores commenced in April 2015, which provides the opportunity to look at long-term trends. Figure 5 below shows the trend of each shallow observation bore over time using the data available.

The assessment of groundwater quality is primarily focused on salinity as the main indicator of changes in the aquifer system. Salinity levels in the perched water table generally fluctuate more than in the upper or lower eastern view formations. This is potentially due to the variable nature of the water level in the perched water table as a result of climatic variation. When considering the impact of the climate

verses pumping it is important to consider P17, which is outside the area of influence from pumping. Results for shallow observation bore water level versus salinity level is provided in Appendix G.

Table 4: Groundwater Quality Results – Shallow Observation bores

			Field Parameters			Lab Result	
Bore ID	Aquifer	Date	Temp °C	pH	EC (µS/cm)	EC (µS/cm)	TDS (mg/L)
Anglesea River Catchment							
WTOB3	PWT	Jul-22	14	5.52	1581	1560	893
		Jan-23	14.9	5.32	1512	1730	995
P7B	PWT	Jul-22	12.6	3.92	878	853	476
		Jan-23	13.5	3.68	1301	1520	833
P8	PWT	Jul-22	11.1	5.27	2180	2240	4180
		Jan-23	14	4.97	2119	2240	1390
P19	UEVF	Jul-22	14.2	5.86	1336	1320	720
		Jan-23	15.7	5.62	1291	1420	800
P12	LEVF	Jul-22	16.5	6.05	1190	1160	625
		Jan-23	17.65	6.2	1095	1210	684
WTOB2	PWT	Jul-22	11.2	4.14	3211	3120	1920
		Jan-23	15.5	3.89	3053	3200	2060
Salt Creek Catchment							
P16	LEVF	Jul-22	11.3	4.58	488	454	727
		Jan-23	15	4.24	536	608	504
P17	PWT	Jul-22	12.8	6.79	1460	1420	1130
		Jan-23	16.4	6.23	1080	1080	769
P1	PWT	Jul-22	11.3	6.36	419	364	1080
		Jan-23	16.4	5.72	386	378	567
WTOB1	PWT	Jul-22	14.4	5.28	1467	1480	1390
		Jan-23	16.5	5	1153	1220	1090

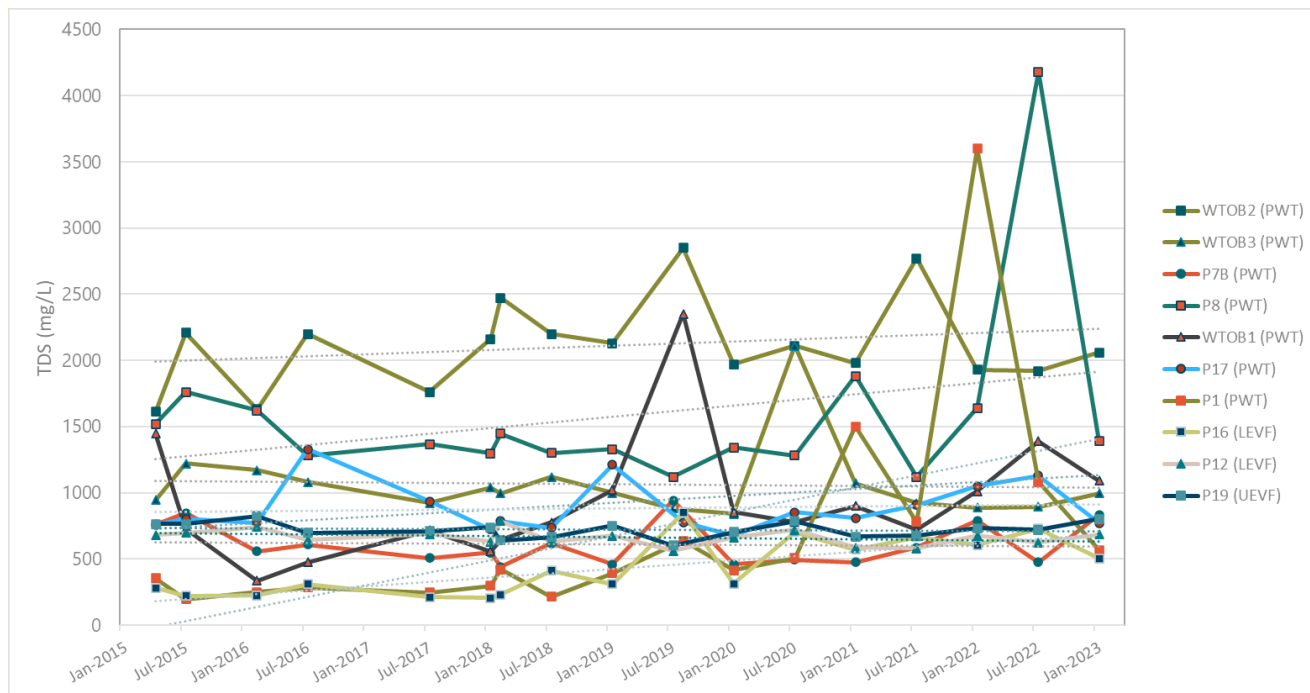


Figure 5: Groundwater quality results – shallow observation bores

3.2 Surface water quality – field testing

As outlined in the MAP 2014, Barwon Water monitors surface water quality at the sites listed in Table 5. The objective of this sampling is to;

- monitor baseline surface water quality, and monitor for any potential quality changes over time
- assist in the assessment of groundwater and surface water interactions in many areas, by reviewing the water quality data collected over time, in conjunction with groundwater and surface water level monitoring
- assist in the assessment of the process of acid generation in the catchments.

The water quality parameters tested are Electrical Conductivity (EC), Total Dissolved Solids (TDS), pH, Dissolved Oxygen (DO) and temperature. The location of the surface water sites has been provided in Appendix B and the results of the water quality testing is provided in Appendix C.

Table 5: Surface water quality sites – field testing

Catchment	BW ID	Site ID	SINo.	Site description	Monitoring frequency
Salt Creek	SV3	GS7	235274A	Breakfast Creek Tributary @ V notch	Monthly
	SV1	GS1	235273A	Breakfast Creek @ Road Bridge	Monthly
	SV4	GS2	235276A	Salt Creek @ Denhams Track	Monthly
	SV2	GS3	235222A	Salt Creek (Encoder) @ Alcoa	Monthly
	SGP2-B (pool)	N/A	235275A	Salt Creek (Pool) above swamp @ Denham Track	Monthly
Anglesea River	AGP1-B (pool)	N/A	235271A	Upper Anglesea River @ AARC	Monthly
	AV1	GS4	235270A	Upper Anglesea River @ AARC (V Notch)	Monthly
	AV3	GS6	235277A	Anglesea River @ Gumflats Road	Monthly
	ASP7 (pool)	N/A	235280A	Anglesea Swamp @ Vegetation Site P7	Monthly
	AGP2 (pool)	N/A	235272A	Anglesea Wetlands @ Allardyne Track	Monthly
	AV2	GS5	235260A	Anglesea River (Marshy Creek) @ Alcoa	Monthly

3.3 Surface water quality – laboratory testing

Barwon Water conducts laboratory sampling at all sites listed in Table 6 as outlined in the MAP 2014. This sampling is conducted biannually and the tested parameters include major cations and anions, salinity and pH. Water samples are taken by Australian Laboratory Services (ALS) to be independently tested. The full results from the laboratory testing of surface water sites are provided in Appendix D, with result for pH and EC provided below in table 7 and 8.

Table 6: Surface water quality sites – laboratory testing

Catchment	BW ID	Site ID	SINo.	Site description
Salt Creek	SV3	GS7	235274A	Breakfast Creek Tributary @ V notch
	SV1	GS1	235273A	Breakfast Creek @ Road Bridge
	SV4	GS2	235276A	Salt Creek @ Denhams Track
	SV2	GS3	235222A	Salt Creek (Encoder) @ Alcoa
Anglesea River	AV1	GS4	235270A	Upper Anglesea River @ AARC (V Notch)
	AV3	GS6	235277A	Anglesea River @ Gumflats Road
	AV2	GS5	235260A	Anglesea River (Marshy Creek) @ Alcoa

Observations

The following trends have been identified from the surface water quality results taken from the field and laboratory testing:

- As the water flows downstream through the swamp the salinity levels generally increase. The higher surface water salinities recorded at the downstream ends of both catchments reflects the storage and concentration of salts in the main swamps through evapotranspiration. The salts then remain stored in the swamps until sufficient rainfall is generated to flush the salts downstream into the Anglesea Estuary. This is supported by the results in Table 7 that shows field reading results from upstream to downstream in both the Salt Creek and Anglesea River catchment.

Table 7: Surface water results (2022-23), indicating increasing salinity (EC) from upstream to downstream through the Salt Creek and Anglesea River catchments

Date	Salt Creek				Anglesea River		
	235274A	235273A	235276A	235222A	235270A	235277A	235260A
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
7/07/2022	278	284	300	750	795	Dry	3860
2/08/2022	317	266	275	509	684	1032	3700
14/09/2022	274	386	248	948	814	851	1696
21/10/2022	251	503	264	699	652	646	1809
17/11/2022	253	417	220	604	246	647	1614
6/12/2022	310	386	273	506	489	578	1145
11/01/2023	237	280	280	717	705	Dry	1480
7/02/2023	331	388	269	557	Dry	Dry	1738
10/03/2023	262	297	269	845	Dry	Dry	Dry
12/04/2023	303	288	272	Dry	Dry	Dry	Dry
9/05/2023	255	349	262	445	Dry	Dry	Dry
20/06/2023	203	351	268	387	321	Dry	Dry

- Table 8 shows field readings with a continuing trend of pH values decreasing as water flows downstream through the swamps, with the lowest pH value generally being recorded at the downstream end of the Salt Creek and Anglesea catchments. These results are consistent with the current understanding that the source of acidity in the catchments is the presence of naturally occurring sulphides (pyrites). When the catchments are subjected to wetting and drying cycles the pyritic sediments are oxidised, which causes acid generation in the swamps. The acid is released from the swamps when a large rainfall event flushes the stored acid from the downstream end of the swamps to the estuary. The water quality results show no correlation between the values observed and groundwater extraction periods.

Table 8: Surface water results (2020-21 & 2021-22), indicating decreasing pH from upstream to downstream in the Anglesea catchment

Date	Salt Creek				Anglesea River		
	235274A	235273A	235276A	235222A	235270A	235277A	235260A
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
07-2021	4.9	5.4	5.8	3.0	5.3	4.4	3.0
08-2021	5.4	6.3	6.4	3.7	6.0	4.2	2.8
09-2021	5.0	5.9	5.9	3.8	5.5	Dry	2.9
10-2021	4.5	5.4	5.4	3.7	4.9	4.0	2.7
11-2021	5.3	6.2	5.3	3.6	5.6	3	2.7
12-2021	5.7	5.9	5.8	3.7	5.6	4.2	2.9
01-2022	6.4	6.5	6.0	3.5	5.6	Dry	2.8
02-2022	6.3	6.2	6.5	3.6	5.9	4.1	2.7
03-2022	6.5	6.4	6.2	3.8	5.6	Dry	3.1
04-2022	5.8	6.4	6.3	4.0	6.2	Dry	3.7
05-2022	4.5	6.6	6.6	3.8	6.8	Dry	2.9
06-2022	4.9	5.8	6.2	3.8	5.8	Dry	3.0
07-2022	5.7	5.8	6.2	4.2	6.6	Dry	2.9
08-2022	6.6	6.3	6.3	4.2	7.4	4.3	3.2
09-2022	6.1	7.2	6.8	3.8	7	4.5	3.2
10-2022	5.9	7	6.4	3.9	6.7	4.3	3.1
11-2022	5.8	6.5	6.1	4	5.7	5.6	3.2
12-2022	5.6	6.4	6.4	4.1	6.5	4.6	3.4
01-2023	6.6	6.1	6.5	3.8	6.4	Dry	3.3
02-2023	6	6.1	6.3	4	Dry	Dry	3.3
03-2023	5.5	6.8	6.9	3.1	Dry	Dry	Dry
04-2023	6.7	6	6.8	Dry	Dry	Dry	Dry
05-2023	6	5.6	6.1	4.6	Dry	Dry	Dry
06-2023	5.5	6	6.6	4.6	5.2	Dry	Dry

- To further understand the distribution of acid sulfate soils across the Salt Creek and Anglesea River catchment, Monash University were contracted by Barwon Water to undertake soil sampling for potential acid sulfate soils. This report was completed in December 2020. A copy of the full report and summary report can be found on the [Barwon Water website](#).
- All the data collected through the monitoring and assessment program will be pivotal in informing the current bulk entitlement review. It is through this process that more detailed analysis of the longer term data sets will be undertaken.

4. Groundwater trigger levels (Clause 16.2 E)

The groundwater trigger levels were revised in 2014 following the Bulk Entitlement review. The revised Bulk Entitlement's groundwater trigger levels were established with the objective of maintaining groundwater levels in the perched water table to within the likely range of natural variation, and ensure that there is no significant drawdown recorded in the perched water table as a result of pumping from the Anglesea Borefield. If the perched water table is maintained within these natural variations, then impacts to surface water flow, acid generation processes and, therefore, ecology should not occur as a result of groundwater extraction from the Lower Eastern View Formation. The groundwater trigger levels are set for two bores in the Anglesea Swampland:

- Bore P19: Monitoring the Upper Eastern View Formation
- Bore P8: Monitoring the Perched Water Table

The trigger mechanism accounts for the seasonal variation in the groundwater levels using groundwater levels measured at bore P17, which sits outside the area of influence for the Anglesea Borefield. These trigger levels use daily recorded values, which are converted to a monthly average and are calculated based on the following formulae:

$$P8 = 0.3131 * P17 + 9.4666 - 2 \text{ Standard Deviations of Error}$$

$$P19 = 0.2391 * P1 + 16.82 - 2 \text{ Standard Deviations of Error}$$

It should be noted that these formulae are the amended calculation as discussed in section 5.2. The trigger levels are shown in 7 and Figure 8. At all times during 2022-2023 the groundwater levels were above the required trigger levels.

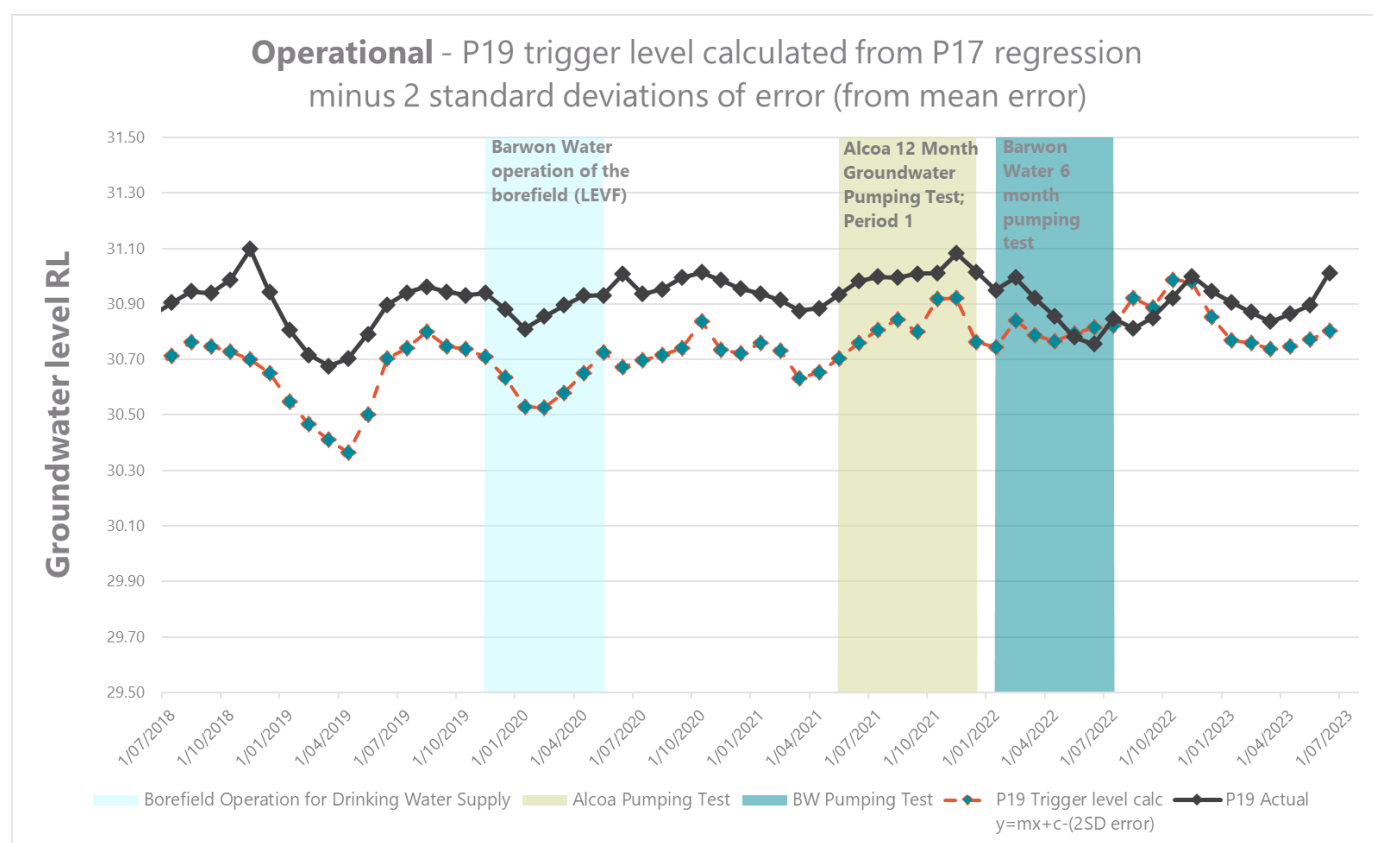


Figure 7: Groundwater level and the trigger level for P19 in the upper eastern view formation.

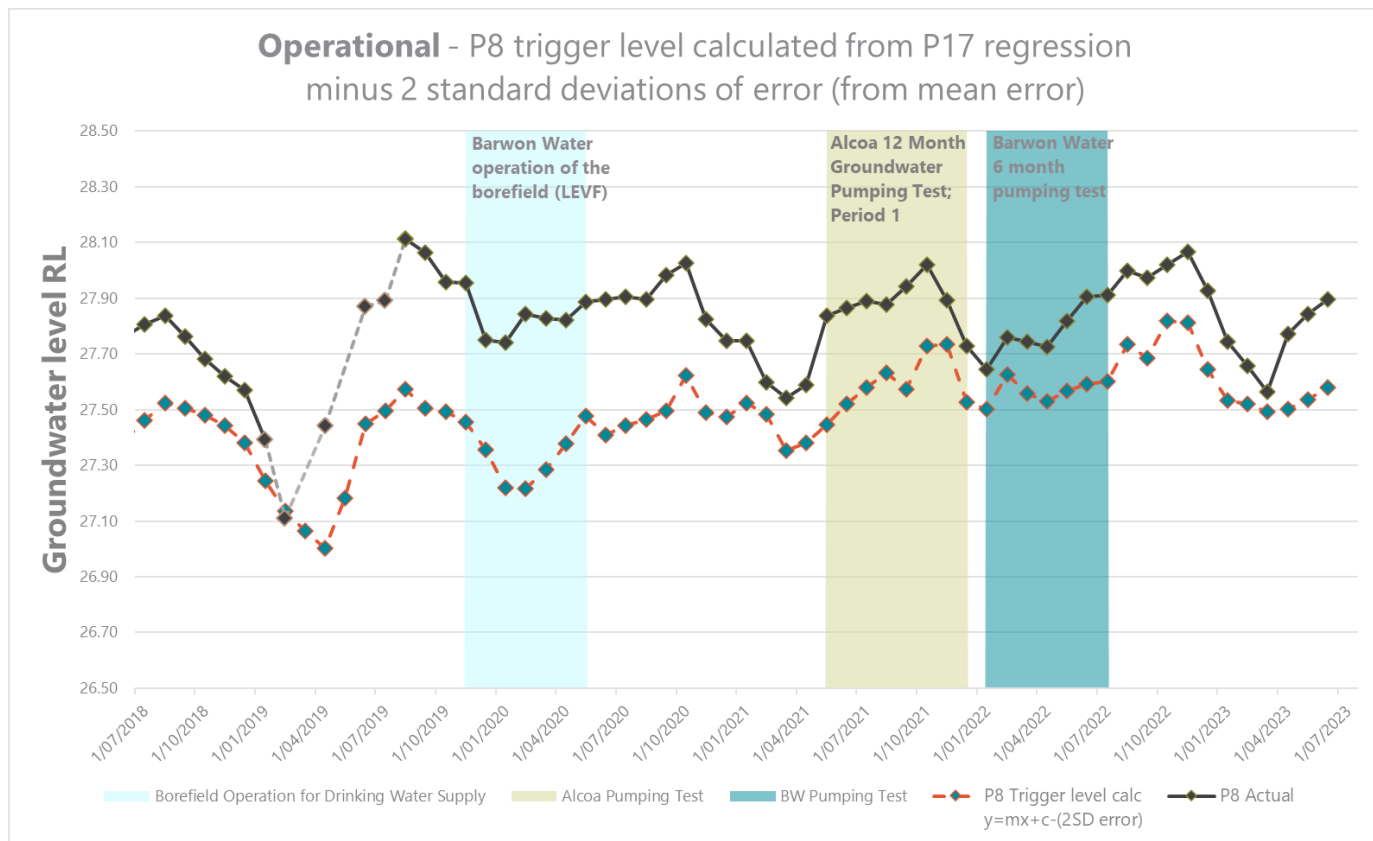


Figure 8: Groundwater level and the trigger level for P8 in the perched water table.

For the trigger to be exceeded, groundwater levels at both bores need to fall below a certain threshold level (also known as a 'trigger') for the month.

For the month of July and October 2023, the P8 component of the trigger was not exceeded (groundwater levels remained above the threshold set for the month) whereas P19 was exceeded (groundwater levels fell below the threshold).

While the groundwater levels in the UEVF (P19) declined, our investigations showed there was no correlation to the groundwater levels in the PWT (P8) and it is also worth noting there was no groundwater extraction during this time.

This means the reduced water level in the UEVF did not impact on water levels in the PWT or groundwater dependent ecosystems.

5. Issues in implementing the program or restoring groundwater levels (Clause 16.2 D, 16.2 F)

5.1 Water quality sampling

Monthly water quality sampling is conducted at eleven sites to observe pH, temperature, DO and EC. Some of the sampling sites were dry for a period of time during the past year. Water quality sampling could not be completed when a sampling site was dry.

5.2 Bulk Entitlement Minor Amendment

There is an error in the formula described in the Order that is used to calculate the trigger level in observation bore P19. This typographical error does not impact on the trigger levels; however, Barwon Water is working with DEECA on an amendment notice to reflect the original intent. Barwon Water plans to submit an application in accordance with section 45 of the *Water Act 1989*, to apply to amend

the Bulk Entitlement (Anglesea Groundwater) Order 2009 to correct this error as part of the bulk entitlement review process.

5.3 Amendment to the Monitoring and Assessment Program (MAP)

There have been no amendments to the MAP in 2022-2023 however, future amendments will be required as a result of the mine rehabilitation works being undertaken by Alcoa.

There are currently a number of observation bores that Alcoa own that are included in Barwon Water's monitoring and assessment program.

Bores that are no longer required for a specific purpose for Alcoa, are being decommissioned by Alcoa as a result. Decommissioned bores listed below are not all listed in the MAP but are provided for context in what has changed over the reporting period in the Anglesea catchment.

Decommissioned:

- WB9 Sept 2020
- WB10 Aug 2020
- WB13 Jun 2021
- WB17 May 2021
- Old MB1 June 2021

The planned review of our bulk entitlement and environmental monitoring program will make an assessment of the most appropriate observation bores to be monitored through the monitoring program. Although a number of bores have been decommissioned there has also been a number of new bores constructed by Alcoa that are also currently being monitored by Barwon Water and could be incorporated into a new MAP.

6. Arrangements with existing groundwater users (Clause 16.2 G)

There have been no arrangements entered into that would trigger this clause.

7. Independent Arbitration (Clause 16.2 H)

Independent arbitration has not been necessary.

8. Difficulties in compliance with the order (Clause 16.2 I)

8.1 Bore 115868 (UEVF) and 119349 (UEVF) replacements

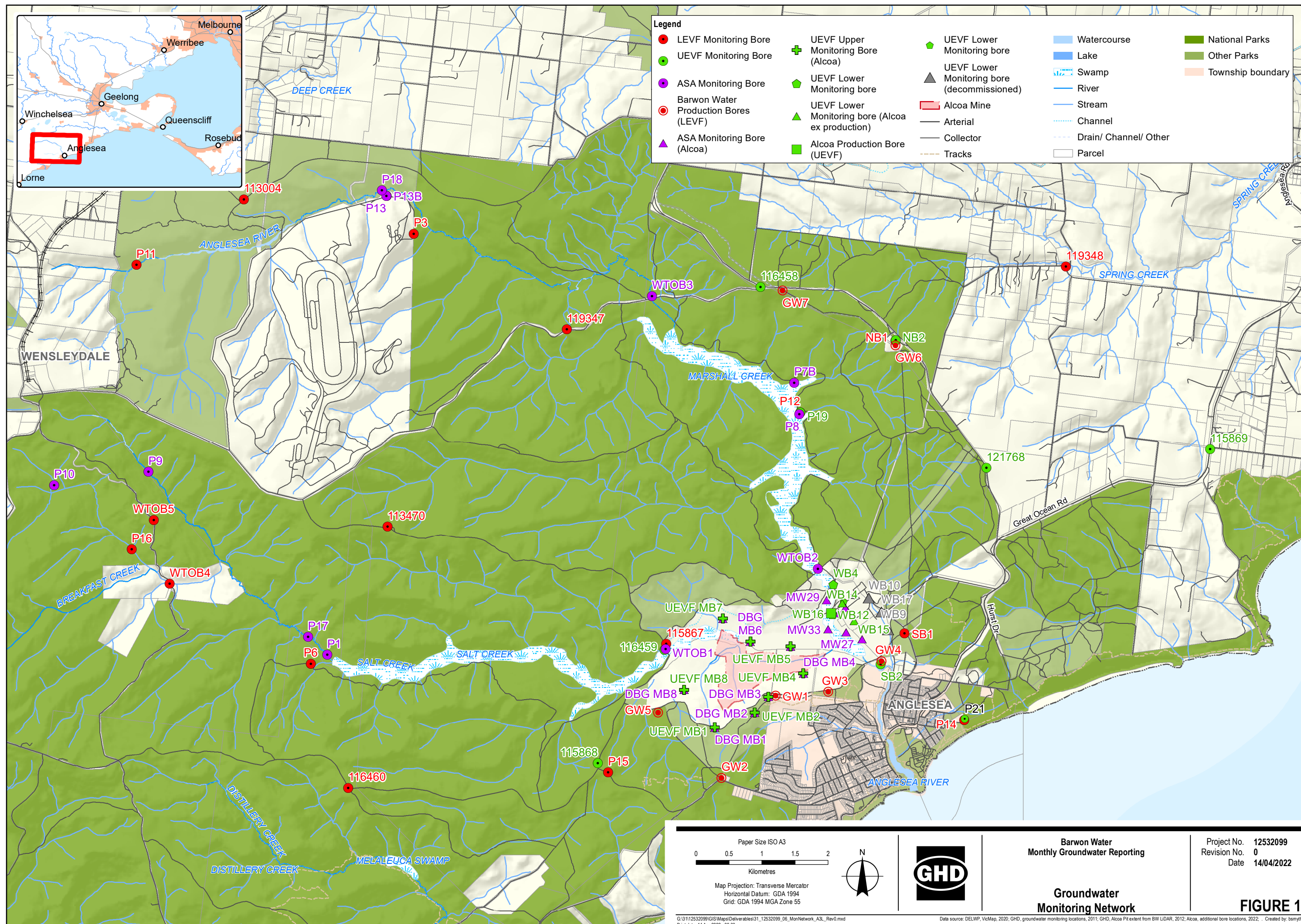
DELWP has advised that bores 115868 and coastal bore 119349 are in poor condition and are scheduled for decommissioning and replacement. Following notification of the planned decommissioning, a condition assessment was undertaken on each bore in July 2019 and independently reviewed by Barwon Water's consultants. The recommendation was that both bores are beyond refurbishment and should be decommissioned and replaced to improve our understanding of the Anglesea borefield.

Bore 119349 was decommissioned in 2019, and a replacement (P21) was constructed in 2021.

Bore 115868 is currently under request for a section 27 consent with Parks Victoria for a replacement bore to be constructed at the same site. If approved by Parks Victoria, Barwon Water will proceed with construction of the replacement bore.

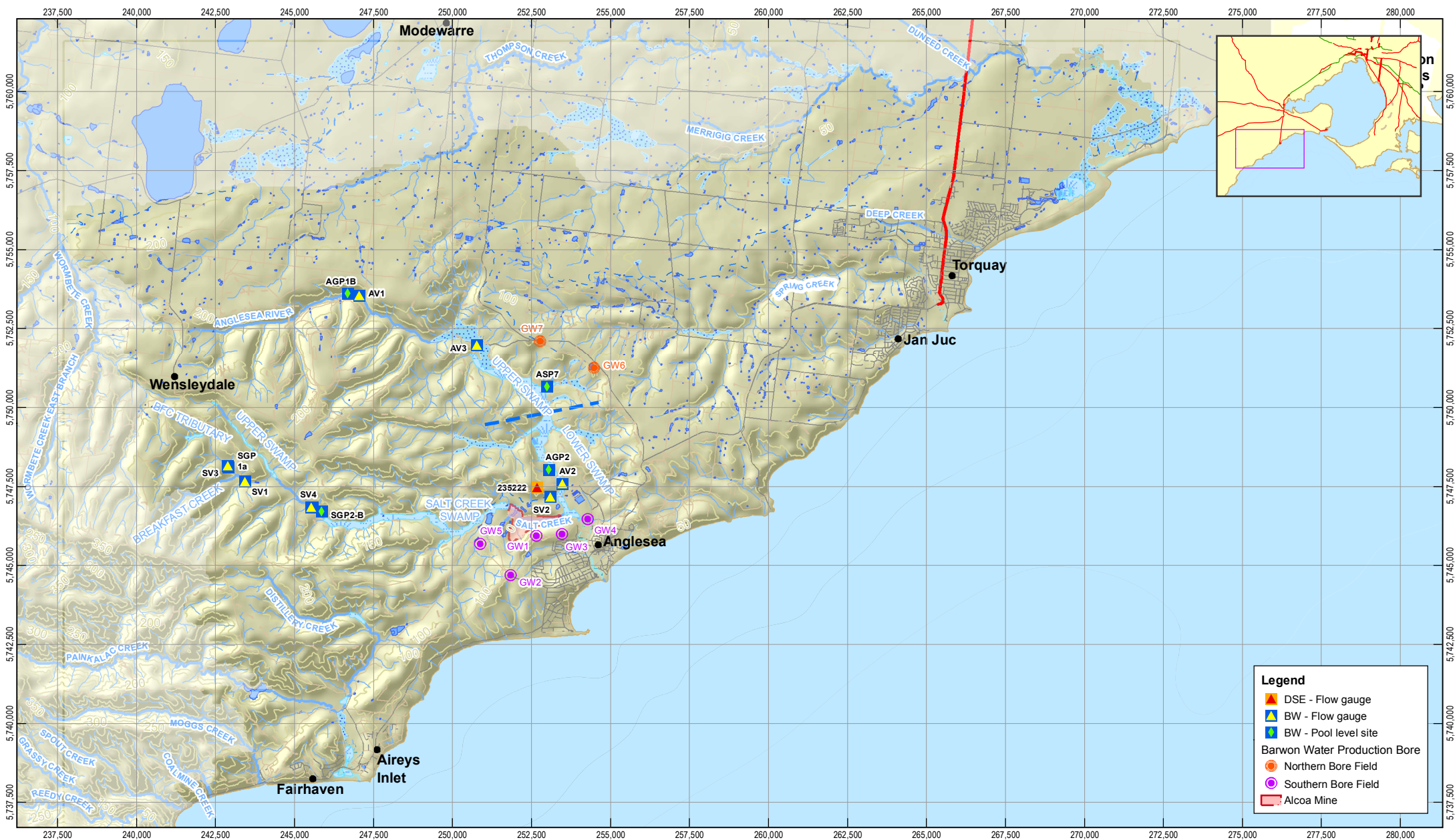
Appendix A

Observation bore locations



Appendix B

Surface water monitoring locations



1:160,000 Paper Size A4

0 0.5 1 2 3 4 5
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55



LEGEND

- Towns
- Highway
- Sealed Road (Arterial & Local)
- Unsealed Road
- Unsealed Track
- Estuary
- Lake
- Flat
- Swamp
- pondage
- River
- Stream
- Channel / Drain
- Connector
- Contours (50m)



Barwon Water
Anglesea Borefield
Numerical Modelling and Recalibration
Surface Water
Monitoring Locations

Job Number 31-32669
Revision A
Date 12 Jun 2015

Figure 2

G:\31\32669\GIS\Maps\Deliverables\0002_Anglesea_Monitoring_2014_SW_Locations.mxd

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Data source: VicMap, DSE, ABARES, Corangamite CMA, DPI, Barwon Water, BOM and SILO Created by:jeamonth

Appendix C

Surface water quality results - field testing

1.1 Appendix A - Monthly Field Observations

Name Breakfast Creek Tributary @ V notch

GHD/BW ID SV3

SINo. 235274A

BE Map ID GS7

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temp (°C)	Flow at V notch	Weather conditions	Comments
7/07/2022	10:00	0.152	278	172.4	10.02	10.02	5.7	9.8	0.62	Cloudy	Air Temp 10.1, Water clear.
2/08/2022	12:55	0.176	317	196.5	9.37	9.37	6.6	7.4	0.95	Cloudy	Air Temp 10.1, Water clear.
14/09/2022	11:40	0.184	274	169.9	8.99	8.99	6.1	8.6	1.14	Cloudy	Air Temp 14.1, Water clear.
21/10/2022	6:30	0.22	251	155.6	10.01	10.01	5.9	11.4	2.3	Cloudy	Air Temp 13.5, Water clear.
17/11/2022	8:00	0.272	253	156.9	10.51	10.51	5.8	11.4	4.72	Cloudy	Air Temp 9.9, Water clear.
6/12/2022	8:00	0.176	310	192.2	8.99	8.99	5.6	12.5	0.95	Cloudy	Air Temp 14.0, Water clear.
11/01/2023	7:00	0.134	237	146.9	8.73	8.73	6.6	14.8	0.3	Sunny	Air Temp 24.2, Water clear.
7/02/2023	7:15	0.14	331	205.2	8.82	8.82	6	13.3	0.35	Cloudy	Air Temp 15.0, Water clear.
10/03/2023	7:00	0.127	262	162.4	8.14	8.14	5.5	13.6	0.38	Cloudy	Air Temp 13.8, Water clear.
12/04/2023	8:00	0.18	303	187.9	9.97	9.97	6.7	12	1.04	Cloudy	Air Temp 11.7, Water clear.
9/05/2023	8:10	0.16	255	158.1	8.92	8.92	6	9.9	0.65	Cloudy	Air Temp 8.7, Water clear.
20/06/2023	12:15	0.283	203	125.9	10.5	10.5	5.5	9.9	4.78	Cloudy	Air Temp 9.2, Water clear.

Name Breakfast Creek @ Road bridge
GHD/BW ID SV1 - Bridge
SINo. 235273A
BE Map ID GS1

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	10:30	0.192	284	176.1	8.71	8.71	5.8	9.1	10.2	Flowing	Cloudy	Water clear
2/08/2022	11:40	0.214	266	164.9	9.87	9.87	6.3	10.6	12.1	Flowing	Cloudy	Water clear
14/09/2022	12:00	0.222	386	239.3	8.72	8.72	7.2	9	14.5	Flowing	Cloudy	Water clear
21/10/2022	7:00	0.258	503	311.9	9.85	9.85	7	11.8	13.8	Flowing	Cloudy	Water clear
17/11/2022	8:30	0.337	417	258.5	9.54	9.54	6.5	11.4	10.4	Flowing	Cloudy	Water clear
6/12/2022	8:30	0.23	386	239.3	9.44	9.44	6.4	14	15.6	Flowing	Cloudy	Water clear
11/01/2023	7:45	0.183	280	173.6	5.1	5.1	6.1	16.4	17.9	Flowing	Sunny	Water clear
7/02/2023	7:45	0.195	388	240.6	7.55	7.55	6.1	14.4	15.7	Flowing	Cloudy	Water clear
10/03/2023	7:30	0.178	297	184.1	7.45	7.45	6.8	13.9	14.7	Flowing	Cloudy	Water clear
12/04/2023	8:45	0.23	288	178.6	9.2	9.2	6	12.3	12.2	Flowing	Cloudy	Water clear
9/05/2023	8:45	0.218	349	216.4	9.2	9.2	5.6	10	8.8	Flowing	Cloudy	Water clear
20/06/2023	11:30	0.265	351	217.6	10.36	10.36	6	8.4	8.5	Flowing	Cloudy	Water clear

Name Salt Creek @ Denham's Track
GHD/BW ID SV4
SINo. 235276A
BE Map ID GS2

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	11:30	0.178	300	186	8.71	8.71	6.2	8.4	12.7	Flowing	Cloudy	Flowing
3/08/2022	13:15	0.21	275	171	8.93	8.93	6.3	8.5	13.4	Flowing	Cloudy	Flowing
14/09/2022	13:00	0.223	248	154	8.91	8.91	6.8	6.5	15	Flowing	Cloudy	Flowing
21/10/2022	9:00	0.27	264	164	9.72	9.72	6.4	10.2	15.4	Flowing	Cloudy	Flowing
21/11/2022	9:45	ABOVE	220	136	9.81	9.81	6.1	11.5	8.3	Flowing	Cloudy	Flowing
6/12/2022	10:30	0.211	273	169	8.79	8.79	6.4	13.1	17	Flowing	Cloudy	Flowing
11/01/2023	9:45	0.138	280	174	8.71	8.71	6.5	16.2	20	Flowing	Sunny	Flowing
7/02/2023	9:30	0.15	269	167	8.01	8.01	6.3	13.9	16.6	Flowing	Cloudy	Flowing
10/03/2023	9:15	0.136	269	167	8.77	8.77	6.9	14	15.8	Flowing	Cloudy	Flowing
12/04/2023	10:45	0.21	272	169	8.62	8.62	6.8	12.5	15	Flowing	Cloudy	Flowing
9/05/2023	11:00	0.188	262	162	9.11	9.11	6.1	10	9.8	Flowing	Cloudy	Flowing
20/06/2023	10:15	0.3	268	166	11.22	11.22	6.6	7.8	7.9	Flowing	Cloudy	Flowing

Name Salt Creek (Encoder) @ Alcoa
GHD/BW ID SV2
SINo. 235222A
BE Map ID GS3

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	13:00	BELOW	750	465	11.03	11.03	4.2	10.5	12.5	Flowing	Cloudy	Water clear
3/08/2022	9:30	BELOW	509	315.6	10.85	10.85	4.2	11	11.7	Flowing	Cloudy	Water clear
15/09/2022	11:30	0.057	948	587.8	10.11	10.11	3.8	13.8	11.2	Flowing	Cloudy	Water clear
21/10/2022	13:15	0.109	699	433.4	9.93	9.93	3.9	16	21.1	Flowing	Cloudy	Water clear
16/11/2022	11:45	0.19	604	374.5	9.81	9.81	4	15	13.3	Flowing	Cloudy	Water clear
5/12/2022	11:45	0.078	506	313.7	9.74	9.74	4.1	16.4	16.5	Flowing	Cloudy	Water clear
10/01/2023	12:30	-0.026	717	444.5	8.07	8.07	3.8	24.8	24.2	Flowing	Sunny	Water clear
6/02/2023	10:30	BELOW	557	345.3	8.9	8.9	4	18.4	16.5	Stagnant	Cloudy	Water clear
9/03/2023	11:30	BELOW	845	523.9	8.92	8.92	3.1	20.4	14.7	Stagnant	Cloudy	Water clear
11/04/2023	11:15	DRY	n/a	n/a	n/a	n/a	n/a	n/a	17.1	Stagnant	Cloudy	Water clear
8/05/2023	11:15	BELOW	445	275.9	10.4	10.4	4.6	11.1	13	Stagnant	Cloudy	Water clear
19/06/2023	10:45	0.043	387	239.9	9.9	9.9	4.6	10.9	7.6	Stagnant	Cloudy	Water clear

Name Salt Creek (Pool)above swamp @ Denham Track (new downstream site)
GHD/BW ID SGP2-B
SINo. 235275A
BE Map ID

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (C)	Flow State	Weather conditions	Comments
7/07/2022	11:20	2.073	298	184.8	9.25	9.25	6.3	8.4		Flowing	Cloudy	Air temp 12.5 Dark tannin stain.
2/08/2022	12:55	2.066	484	300.1	8.32	2.11	6.3	9.8		Flowing	Cloudy	Air temp 12.5 Dark tannin stain.
14/09/2022	12:40	2.05	263	163.1	8.61	2.85	6.7	10.3		Flowing	Cloudy	Air temp 15.1 Dark tannin stain.
21/10/2022	8:30	2.1	287	177.9	10.11	2.71	6.4	10.4		Flowing	Cloudy	Air temp 15.2 Dark tannin stain.
21/11/2022	9:30	ABOVE	206	127.7	9.97	9.97	6.2	11.1		Flowing	Cloudy	Air temp 8.2 Dark tannin stain.
6/12/2022	10:00	2.048	313	194.1	9.29	9.59	6.4	12.2		Flowing	Cloudy	Air temp 17.1 Dark tannin stain.
11/01/2023	9:30	1.951	311	192.8	7.52	2.11	6.9	16.5		Flowing	Sunny	Air temp 19.5 Dark tannin stain.
7/02/2023	9:10	1.991	403	249.9	8.22	2.71	5.8	14.9		Flowing	Cloudy	Air temp 16.7 Dark tannin stain.
10/03/2023	9:00	1.969	270	167.4	6.91	6.91	7	15.8		Flowing	Cloudy	Air temp 15.6 Dark tannin stain.
12/04/2023	10:20	2.057	311	192.8	8.47	3.11	6.6	15.6		Flowing	Cloudy	Air temp 14.9 Dark tannin stain.
9/05/2023	10:45	2.028	301	186.6	8.71	2.12	5.9	10.2		Flowing	Cloudy	Air temp 9.1 Dark tannin stain.

Name Upper Anglesea River (Pool) @ Australian Automotive Research Centre - (New downstream pool site)
GHD/BW ID AGP1-B
SINo. 235271A
BE Map ID

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	9:20	GH 2.431	914	566.7	10.91	10.91	6.1	7.6		Stagnant	CLOUDY	Air temp 7.6 Water tannin stained.
2/08/2022	10:00	GH 2.490	881	546.2	10.11	10.11	7.1	9.8		Stagnant	CLOUDY	Air temp 10.6 Water tannin stained.
14/09/2022	9:55	GH 2.474	1088	674.6	8.92	8.92	6.2	7.5		Stagnant	CLOUDY	Air temp 14.0 Water tannin stained.
20/10/2022	10:45	GH 2.620	395	244.9	7.17	2.11	6	10.5		Stagnant	CLOUDY	Air temp 18.5 Water tannin stained.
16/11/2022	9:35	GH 2.657	394	244.3	8.2	2.87	5.8	12.8		Stagnant	CLOUDY	Air temp 12.8 Water tannin stained.
5/12/2022	9:45	GH 2.550	330	204.6	8.57	2.82	6.9	16.7		Stagnant	CLOUDY	Air temp 17.2 Water tannin stained.
10/01/2023	8:15	GH 2.296	389	241.2	7.33	2.75	6.7	17.6		Stagnant	Sunny	Air temp 18.7 Water tannin stained.
6/02/2023	8:30	GH 2.258	863	535.1	3.66	1.22	6.2	14.4		Stagnant	CLOUDY	Air temp 15.1 Water tannin stained.
9/03/2023	8:00	GH 2.040	571	354	7.22	2.11	6.9	13.2		Stagnant	CLOUDY	Air temp 10.5 Water tannin stained.
11/04/2023	8:55	GH 1.854	793	491.7	6.61	2.32	6.6	10.8		Stagnant	CLOUDY	Air temp 10.8 Water tannin stained.
8/05/2023	8:55	GH 1.868	598	370.8	7.36	7.36	6.3	8.5		Stagnant	CLOUDY	Air temp 7.2 Water tannin stained.
19/06/2023	13:00	GH 1.918	396	245.5	5.46	5.46	5.8	9.2		Stagnant	CLOUDY	Air temp 7.8 Water tannin stained.

Name Upper Anglesea River @ AARC (V notch site)
GHD/BW ID AV1
SINo. 235270A
BE Map ID GS4

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	9:00	0.119	795	492.9	11	11.01	6.6	7.7	8	Flowing	Cloudy	Water Milky clear.
2/08/2022	9:30	0.182	684	424.08	10	9.97	7.4	8.8	10.5	Flowing	Cloudy	Water Milky clear.
14/09/2022	9:55	0.148	814	504.68	11.1	11.1	7	7.6	6	Flowing	Cloudy	Water Milky clear.
20/10/2022	10:30	0.233	652	404.24	8.9	8.91	6.7	14.9	18.6	Flowing	Cloudy	Water Milky clear.
16/11/2022	9:20	0.467	246	152.52	8.6	8.55	5.7	12.5	12.3	Flowing	Cloudy	Water Milky clear.
5/12/2022	9:20	0.151	489	303.18	8.2	8.16	6.5	16.3	17.1	Flowing	Cloudy	Water Milky clear.
10/01/2023	7:45	BELOW	705	437.1	8	7.96	6.4	15.4	17.8	Flowing	Sunny	Water Milky clear.
6/02/2023	8:15	DRY	n/a	n/a	n/a	n/a	n/a	n/a	14.6	DRY	Cloudy	Dry River
9/03/2023	8:15	DRY	n/a	n/a	n/a	n/a	n/a	n/a	10.6	DRY	Cloudy	Dry River
11/04/2023	8:40	DRY	n/a	n/a	n/a	n/a	n/a	n/a	10.8	DRY	Cloudy	Dry River
8/05/2023	8:40	DRY	n/a	n/a	n/a	n/a	n/a	n/a	6.2	DRY	Cloudy	Dry River
19/06/2023	12:30	0.072	321	199.02	7.9	7.9	5.2	9.8	7.2	STAGNANT	Cloudy	Water Milky clear.

Name Anglesea River @ Gumflats Road
GHD/BW ID AV3
SINo. 235277A
BE Map ID GS6

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	8:30	DRY	n/a	n/a	n/a	n/a	n/a	n/a	5.5	dry	Cloudy	Dry River
2/08/2022	8:40	0.12	1032	639.84	10.71	10.71	4.3	8.8	9	Flowing	Cloudy	Water clear
14/09/2022	8:45	0.118	851	527.62	12.05	12.05	4.5	6.1	4.3	Flowing	Cloudy	Water clear
20/10/2022	9:15	0.146	646	400.52	9.51	9.51	4.3	11.1	15	Flowing	Cloudy	Water clear
16/11/2022	8:00	0.248	647	401.14	10.22	10.22	5.6	10.2	9.8	Flowing	Cloudy	Water clear
5/12/2022	8:20	0.12	578	358.36	7.89	7.89	4.6	16.6	15.4	Flowing	Cloudy	Water clear
10/01/2023	6:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	16	Dry	Cloudy	Dry River
6/02/2023	7:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	14.5	Dry	Cloudy	Dry River
9/03/2023	7:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	10.8	Dry	Cloudy	Dry River
11/04/2023	7:50	DRY	n/a	n/a	n/a	n/a	n/a	n/a	10.5	Dry	Cloudy	Dry River
8/05/2023	7:50	DRY	n/a	n/a	n/a	n/a	n/a	n/a	6.1	Dry	Cloudy	Dry River
19/06/2023	13:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	8	Dry	Cloudy	Dry River

Name Anglesea Swamp @ Vegetation Site P7
GHD/BW ID ASP7
SINo. 235280A
BE Map ID

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
8/07/2022	10:00	0.06	2340	1451	11.2	11.2	3	8.4	9.1	Stagnant	CLOUDY	Water clear.
3/08/2022	12:45	0.098	1997	1238	11.7	11.7	3.1	14.9	12.1	Stagnant	CLOUDY	Water clear.
15/09/2022	9:10	0.142	1696	1052	10.11	10.11	3.2	13	14.8	Stagnant	CLOUDY	Water clear.
20/10/2022	8:30	0.198	1348	836	9.11	9.11	3.3	15.7	14.1	Stagnant	CLOUDY	Water clear.
17/11/2022	12:20	0.342	1148	712	7.43	7.43	3.9	14	11.8	Stagnant	CLOUDY	Water clear.
6/12/2022	11:45	0.188	1320	818	6.38	6.38	3.6	21.6	22	Stagnant	CLOUDY	Water clear.
11/01/2023	11:45	0.088	1818	1127	7.42	7.42	5.9	22.1	26	Stagnant	Sunny	Water clear
6/02/2023	11:30	Below	2680	1662	6.52	6.52	3.6	20.1	19.1	Stagnant	CLOUDY	Water clear.
10/03/2023	11:15	DRY	n/a	n/a	n/a	n/a	n/a	n/a	20.2	Dry	CLOUDY	Dry
11/04/2023	12:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	17.1	Dry	CLOUDY	Dry
8/05/2023	12:20	Below	2490	1544	7.92	7.92	3.4	11.7	12.7	Stagnant	CLOUDY	Pool only. Water clear.
20/06/2023	13:30	0.12	1903	1180	10.1	10.1	3.2	9.6	9.3	Stagnant	CLOUDY	Pool only. Water clear.

Name Anglesea Wetlands @ Allardyle Track
GHD/BW ID AGP2
SINo. 235272A
BE Map ID

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	12:30	0.348	2810	1742.2	8.61	8.61	2.9	7.9	12.8	Flowing	Cloudy	Water clear
3/08/2022	10:05	0.372	2820	1748.4	11.05	11.05	3	8.5	13.3	Flowing	Cloudy	Water clear
15/09/2022	13:50	0.381	2490	1543.8	11.21	11.21	3.1	10.2	16.5	Flowing	Cloudy	Water clear
21/10/2022	11:20	0.434	1359	842.6	9.81	9.81	3.3	13.2	20.6	Flowing	Cloudy	Water clear
16/11/2022	10:40	0.554	847	525.1	8.66	8.66	3.4	12.9	12.8	Flowing	Cloudy	Water clear
5/12/2022	10:35	0.389	805	499.1	6.8	6.8	3.6	16.9	17.3	Flowing	Cloudy	Water clear
10/01/2023	10:40	0.238	1489	923.2	8.71	8.71	3.8	24.3	22.3	Flowing	Sunny	Water clear
6/02/2023	9:25	DRY	n/a	n/a	n/a	n/a	n/a	n/a	16.8	Dry	CLOUDY	Dry
9/03/2023	9:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	16.8	Dry	CLOUDY	Dry
11/04/2023	9:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	10.7	Dry	CLOUDY	Dry
8/05/2023	10:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	7.4	Dry	CLOUDY	Dry
19/06/2023	11:15	0.308	1369	848.8	6.43	6.43	2.8	10.3	8.5	Flowing	Cloudy	Water clear

Name Anglesea River (Marshy Creek) @ Alcoa
GHD/BW ID AV2
SINo. 235260A
BE Map ID GS5

Date	Time (EST)	Gauge Height (m)	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Flow State	Weather conditions	Comments
7/07/2022	12:45	0.063	3860	2393.2	10.1	10.1	2.9	9.8	12.2	Flowing	Cloudy	Water very clear
3/08/2022	9:15	0.081	3700	2294	10.71	10.71	3.2	9.8	11.3	Flowing	Cloudy	Water very clear
15/09/2022	9:10	0.118	1696	1051.5	10.11	10.11	3.2	13	14.8	Flowing	Cloudy	Water very clear
21/10/2022	11:45	0.24	1809	1121.6	9.75	9.75	3.1	12.4	20.8	Flowing	Cloudy	Water very clear
16/11/2022	11:00	0.685	1614	1000.7	8.94	8.94	3.2	12.4	12.8	Flowing	Cloudy	Water very clear
5/12/2022	11:15	0.142	1145	709.9	5.55	5.55	3.4	15.6	17.5	Flowing	Cloudy	Water very clear
10/01/2023	11:00	BELOW	1480	917.6	5.47	5.47	3.3	23.8	23.4	Flowing	Sunny	Water very clear
6/02/2023	9:45	BELOW	1738	1077.6	7.87	7.87	3.3	17.6	16.2	Stagnant	Cloudy	Water very clear
9/03/2023	10:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	15.5	Dry	Cloudy	Dry
11/04/2023	10:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	17	Dry	Cloudy	Dry
8/05/2023	10:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	12.9	Dry	Cloudy	Dry
19/06/2023	9:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	8.2	Dry	Cloudy	Dry

Appendix D

Surface water quality results - laboratory testing

						Alkalinity			Anions by IC		Total Metals by ICP				pH
Catchment	Site	Date	Time (EST)	TDS (mg/L)	EC (µS/cm)	Total Alkalinity (mg CaCO ₃ / L)	Bicarbonate Alkalinity (mg CaCO ₃ / L)	Carbonate Alkalinity (mg CaCO ₃ / L)	Chloride (mg/L)	Sulphate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	pH (Lab)
Salt Creek	SV3	7/02/2022	1155	120	220	2	2	2	57	10	0.4	5.3	1.2	35	5
		7/07/2022	1000	180	230	2	2	2	62	10	0.4	5.2	0.5	30	5.1
	SV1	7/02/2022	1230	160	250	9	9	2	65	10	2	6.6	1.4	39	6
		7/07/2022	1030	200	270	3	3	2	74	10	1.9	6.5	1	35	5.8
	SV4	7/02/2022	1105	200	250	13	13	2	67	50	2	6.5	1.7	39	6.1
		7/07/2022	1130	190	250	4	4	2	75	5	1.7	5.6	1.1	34	6
	SV2	8/02/2022	1245	460	840	2	2	2	84	300	7.6	18	3.2	46	3.6
		7/07/2022	1300	350	570	2	2	2	65	230	18	14	2.5	35	4.2
Anglesea River	AV1	7/02/2022	1050	370	570	4	4	2	160	24	1.9	12	2.8	93	5.5
		7/07/2022	900	420	720	2	2	2	220	20	2.4	15	2.4	110	5.4
	AV3	7/02/2022	830	270	660	2	2	2	160	54	2.9	11	4.6	92	4
		7/07/2022	830	DRY											
	AV2	8/02/2022	1220	2100	3500	2	2	2	710	510	39	66	11	390	2.8
		7/07/2022	1245	2100	3600	2	2	2	1600	1200	43	75	9.7	380	2.8
	AGP1-B	Not required													

Appendix E

Groundwater quality results - laboratory testing

						Alkalinity				Major Ions					Ionic Balance		
Bore	Date	pH	TDS (mg/L)	EC (µS/cm)	Sulphate as SO4 (mg/L)	Carbonate as CaCO3	Bicarbonate as CaCO3 (mg/L)	Hydroxide as CaCO3	Alkalinity (total) as CaCO3	Calcium (mg/L)	Chloride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Cations (meq/l)	Total Anions (meq/L)	Ionic Balance
Inter-aquifer Flow Monitoring																	
119348	25/07/2022	8.1	766.0	1356.0	<1000	<1	120.0	<1	120.0	13.0	380.0	10.0	25.0	207.0	11.1	13.1	8.3
	25/01/2023	7.9	815.0	1312.0	2000.0	<1	125.0	<1	120.0	15.0	402.0	10.0	27.0	201.0	11.0	13.9	11.5
NB2	13/07/2022	5.8	1400.0	22615.0	139000.0	<1	71.0	<1	71.0	81.0	719.0	57.0	22.0	295.0	22.1	24.6	5.3
	24/01/2023	5.5	1620.0	2488.0	132000.0	<1	50.0	<1	50.0	78.0	761.0	55.0	21.0	282.0	21.2	25.2	8.6
SB2	13/07/2022	6.3	2390.0	4350.0	262000.0	<1	45.0	<1	45.0	44.0	1170.0	91.0	51.0	583.0	36.3	39.4	4.0
	24/01/2023	3.6	2460.0	4301.0	281000.0	<1	<1	<1	<1	45.0	1280.0	92.0	50.0	579.0	36.3	42.0	7.3
P15	19/07/2022	5.8	812.0	867.0	51000.0	<1	17.0	<1	17.0	4.0	249.0	17.0	16.0	112.0	6.9	8.4	10.1
	13/01/2023	5.5	514.0	900.0	52000.0	<1	14.0	<1	14.0	5.0	252.0	19.0	14.0	122.0	7.5	8.5	6.2
Saline Intrusion Monitoring																	
P14	18/07/2022	6.56	441	848	10000	<1	80	<1	80	8	230	10	46	99	6.7	8.29	10.6
	30/01/2023	6.83	646	949	4000	<1	124	<1	124	14	258	11	40	130	8.28	9.84	8.59
Swamp GDE																	
WTOB3	11/07/2022	5.62	893	1581	68,000	<1	14	<1	14	5	442	28	3	242	13.2	14.2	3.68
	19/01/2023	5.34	995	1512	70,000	<1	8	<1	8	5	501	26	3	225	12.2	15.7	12.5
P7B	11/07/2022	4.24	476	878	51,000	<1	<1	<1	<1	6	231	15	3	122	6.92	7.58	4.56
	19/01/2023	3.68	833	1301	89,000	<1	<1	<1	<1	15	418	24	6	159	9.79	13.6	16.4
P8	11/07/2022	5.27	4180	2180	124,000	<1	11	<1	11	43	634	52	16	282	19.1	20.7	3.98
	19/01/2023	4.97	1390	2119	127,000	<1	<1	<1	<1	41	686	49	15	266	18	22	9.9
WTOB2	11/07/2022	4.2	1920	3211	383,000	<1	<1	<1	<1	58	795	70	30	410	27.2	30.4	5.45
	19/01/2023	3.46	2060	3053	392,000	<1	<1	<1	<1	54	888	65	31	375	25.1	33.2	13.8
P17	12/07/2022	7.14	1130	1460	1000	<1	184	<1	184	37	340	26	5	178	11.8	13.3	5.69
	23/01/2023	6.99	769	1080	<1000	<1	132	<1	132	23	269	18	3	144	8.97	10.2	6.54
P1	12/07/2022	6.36	1080	419	7000	<1	15	<1	15	1	89	3	2	56	2.78	2.96	3
	23/01/2023	5.72	567	386	<1000	<1	36	<1	36	3	55	8	2	57	3.34	3.12	3.43
WTOB1	12/07/2022	5.25	1390	1467	70,000	<1	11	<1	11	7	423	22	3	211	11.4	13.6	8.77
	23/01/2023	5.69	1090	1153	53,000	<1	32	<1	32	6	336	18	2	181	9.7	11.2	7.24
Upper Anglesea Swamp and Trigger Level Site																	
P19	11/07/2022	6.09	720	1336	29,000	<1	53	<1	53	14	370	21	25	179	10.8	12.1	5.44
	19/01/2023	6.68	800	1291	30,000	<1	34	<1	34	14	406	21	26	169	10.4	12.8	9.97
P12	11/07/2022	6.21	625	1190	1100	<1	59	<1	59	12	325	15	26	165	9.68	10.6	4.44
	19/01/2023	14	684	1096	8000	<1	56	<1	56	12	359	14	27	150	8.97	11.4	12
Breakfast Creek Tributary																	
P16	12/07/2022	4.82	727	448	44,000	<1	<1	<1	<1	<1	98	9	2	63	3.53	3.68	2.06
	18/01/2023	4.59	504	536	58,000	<1	4	<1	4	2	134	16	2	72	4.6	5.07	4.84

Appendix F

Monitoring and Assessment Program Update

1. Purpose

Under the bulk entitlement for the Anglesea borefield, Barwon Water has established a comprehensive Monitoring and Assessment Program (MAP) that has been independently reviewed by independent experts and approved by the Minister for Water.

The objective of the MAP is to protect environmental values and the health of groundwater dependent ecosystems, whilst also continuing to collect data to build our understanding of the long-term sustainability of groundwater resources in the Anglesea area.

The following section provides an update on the MAP for the reporting period of the annual report.

2. Groundwater level monitoring

Groundwater level monitoring has been conducted at a daily frequency at 42 observation bores during the 2022-2023 reporting period. For the three trigger bores P8, P17 and P19 Barwon Water has maintained daily monitoring and installed telemetry for constant oversight.

3. Groundwater quality monitoring

During operation of the Anglesea Borefield, the MAP requires a minimum of weekly field salinity and temperature monitoring in each production bore (GW1-GW7) that is being pumped.

Field and laboratory water quality parameters required for both deep and shallow observation bores under the MAP were recorded during this sampling in 2022–2023.

4. Surface water flow & level monitoring

The monitoring and assessment program has seven surface water flow monitoring sites with four located in the Salt Creek catchment and three located in the Anglesea River catchment. All sites have permanent data loggers recording on a minimum daily frequency.

Surface water level is also monitored with a data logger located in a pool in Salt Creek and three sites in the Anglesea River, two of which have data loggers and one that is measured monthly during field sampling.

5. Surface water quality monitoring

The MAP has identified 11 water quality monitoring sites across the Salt Creek and Anglesea River catchments. Monitoring consists of laboratory testing twice-yearly along with monthly field sampling. The frequency of this sampling does not change in relation to activation of the bore field and has all been completed throughout 2022–2023.

6. Aquatic ecology monitoring

The aquatic ecology monitoring consists of two components and includes macroinvertebrate and Southern Pygmy Perch sampling.

Macroinvertebrate sampling is required in Spring every third year at 11 sites across the catchment. This was completed in Spring 2022.

A combination of Southern Pygmy Perch and macroinvertebrate sampling is also required to be conducted on an annual basis at a select number of sites across the catchment.

This component of the MAP does not change during operation of the borefield and all required monitoring was completed during 2022–2023.

7. Terrestrial ecology monitoring

Terrestrial ecology monitoring also comprises of two components, including monitoring of both frog assemblages and vegetation.

When taking groundwater, the MAP requires monitoring of frogs annually. Frog surveys were conducted in spring 2022.

For vegetation monitoring, when taking groundwater, Barwon Water is required to undertake vegetation assessments annually in spring at six sites in the Anglesea Swamp and four sites in the Anglesea Estuary. This was also conducted in spring 2022.

8. Acid sulfate soil investigations

To further understand the distribution of acid sulfate soils across the Salt Creek and Anglesea River catchment, Monash University were been contracted by Barwon Water to undertake soil sampling for potential acid sulfate soils. This report was completed in December 2020. A copy of the full report and summary report can be found on the Barwon Water website.

9. Land level surveying

Barwon Water has 30 survey monitoring points covering the area of likely drawdown of groundwater levels in the Lower Eastern View Formation (LEVF). This regional subsidence network is surveyed annually. If land subsidence levels are recorded outside the permitted range of 20mm for two consecutive surveys at three survey locations or more, we must investigate further and change borefield operations as required.

10. Rainfall gauging

Rainfall is recorded via rain gauges at three sites across the catchment. This data is downloaded on a monthly basis and maintained in accordance with approved Bureau of Meteorology standards.

11. Failure of monitoring infrastructure

During the 2022-2023 period, there were four failures of data loggers that were replaced with new replacement loggers.

Appendix G

Shallow observation bore water
level versus salinity level

