

Annual Bulk Entitlement Report

**Anglesea groundwater
2021-2022**

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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. A total of 1,405.7 ML was extracted during the 2021-2022 reporting period covered by this annual report.

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 2021 to 30 June 2022:

- 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 1405.7 ML during 2021-2022 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 2021-2022. 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. As part of informing the community about the groundwater pumping test and upcoming bulk entitlement review, we hosted information sessions in January and April 2022 – and at the time of this report, planning for sessions in September 2022.

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 2021-2022

Date	Groundwater extraction rates (ML)											
	Jul 2021	Aug 2021	Sept 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	April 2022	May 2022	June 2022
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	0.0	12.1	4.4	14.7
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	0.0	12.0	4.4	17.2
3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	11.2	0.0	12.0	4.4	18.9
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	13.6	4.4	18.4
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	0.0	17.0	4.4	18.1
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.0	17.7	4.4	17.9
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6	0.0	17.5	4.4	17.7
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	17.6	4.3	17.5
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3	0.1	17.4	4.3	18.4
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	3.0	15.8	4.3	18.7
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.1	4.8	17.1	4.3	18.6
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.1	5.1	18.1	4.3	18.4
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	5.1	17.4	4.3	18.3
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	5.1	16.9	4.3	17.8
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	5.0	17.6	4.3	16.2
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	11.4	17.4	4.3	16.2
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	16.0	17.3	3.3	16.6
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	16.1	17.2	3.0	14.9
19	0.0	0.0	0.0	0.0	0.1	0.0	0.0	5.6	14.5	9.1	4.4	12.8
20	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	14.3	4.4	4.3	14.1
21	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.3	14.1	4.4	2.2	14.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9	4.4	0.0	14.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.7	4.4	2.8	9.9
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	4.4	4.5	8.1
25	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	13.5	4.4	4.5	10.9
26	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	13.4	4.4	4.5	10.8
27	0.0	0.0	0.0	0.2	0.0	0.0	3.3	0.0	13.2	4.4	4.5	10.8
28	0.0	0.0	0.8	0.0	0.0	0.0	6.8	0.0	13.1	4.4	4.5	12.5
29	0.0	0.0	3.7	0.0	0.0	0.0	8.4	0.0	11.9	4.4	4.5	13.1
30	0.0	0.0	1.2	0.0	0.0	0.0	0.0		12.2	4.4	10.1	13.9
31	0.0	0.0		0.0		0.0	6.6		12.1		15.2	
Total	0.1	0.0	5.7	0.3	0.3	0.0	28.7	175.3	245.2	349.0	141.9	459.2
Prog. Total	0.1	0.1	5.8	6.1	6.4	6.4	35.1	210.4	455.6	804.6	946.5	1405.7
Max. Flow	0.0	0.0	3.7	0.2	0.1	0.0	8.4	12.8	16.1	18.1	15.2	18.9
Min. Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	8.1
Ave. Flow	0.0	0.0	0.2	0.0	0.0	0.0	0.9	6.0	7.9	11.6	4.6	15.3

Table 2: Annual groundwater extraction by bore 2021-2022

Production bores		Groundwater Extraction (ML)
MAP. ID	BE. ID	
GW1	(SPB1)	155.8
GW2	N/A	132.8
GW3	(SPB3)	197.0
GW4	(SPB4)	209.5
GW5	N/A	198.4
GW6	(NPB6)	303.3
GW7	(NPB7)	208.8
Annual total		1405.7

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. DELWP has advised that Coastal Bore 119349 is in poor condition and is scheduled for decommissioning. Given this during the 2021-2022 reporting period Barwon Water constructed a replacement Coastal Bore P21 in the UEVF. Given the timing of the construction no water quality results are available for 2021-2022 from the P21 Coastal Bore in the UEVF.

The objective of this groundwater sampling is to detect any potential change in groundwater quality in the aquifers as a result of groundwater extraction and in particular any changes associated with potential inter-aquifer flow and saline intrusion.

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 2021-2022. 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.

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-GW5 as a result of the short operation time since operation of the borefield moved to standby mode in July 2020. From January 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.

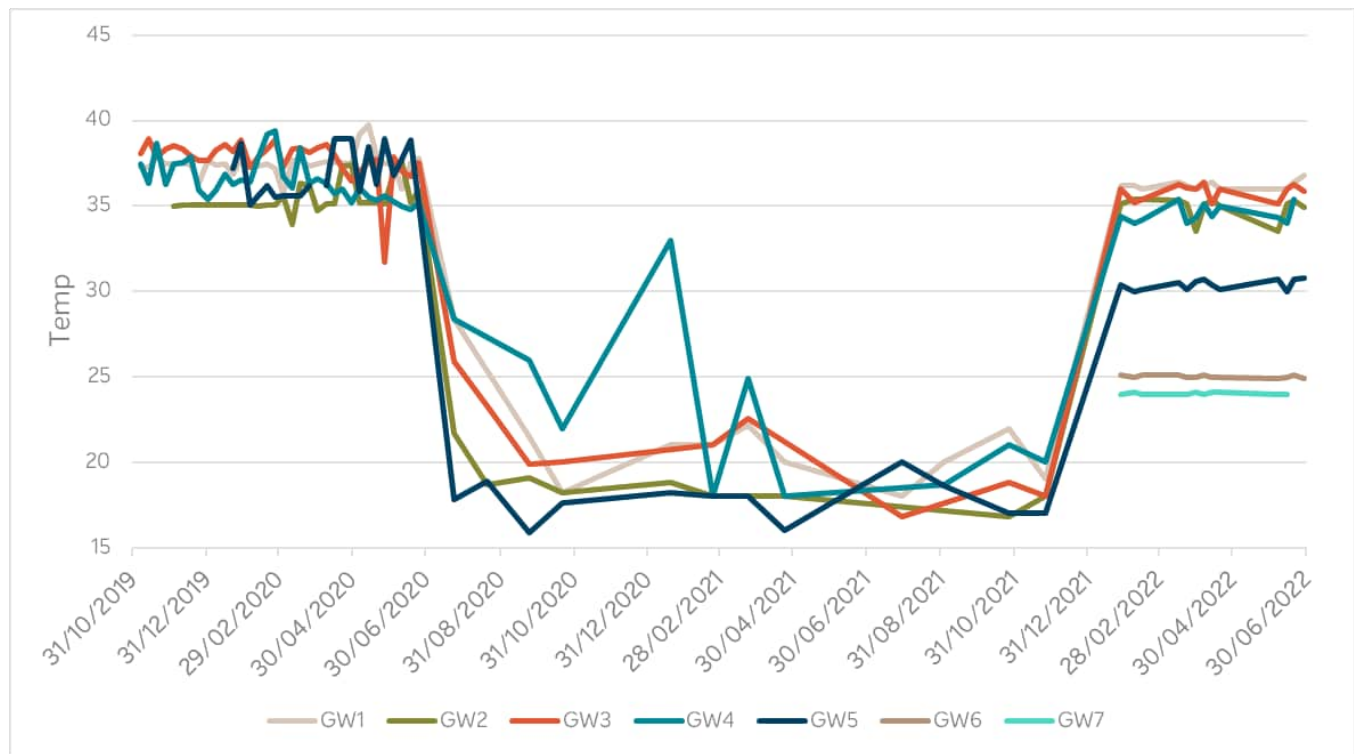


Figure 1: Groundwater quality results for temperature – production bores

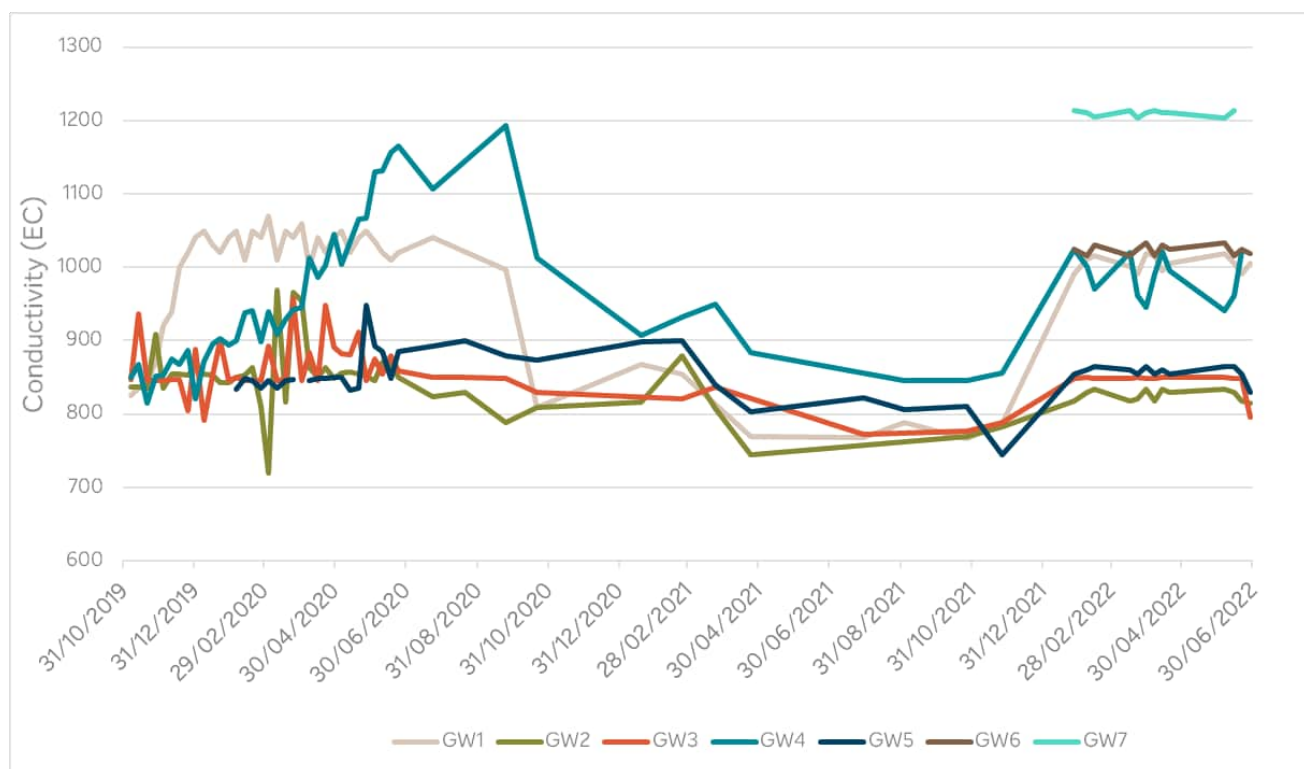


Figure 2: Groundwater quality results for salinity (EC) – production bores

Deep observation bores

The 2021-2022 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. State observation bore 119348 was not able to be sampled due to a water quality sampling pump being stuck in the well. Ventia are currently working with DELWP to rectify this issue.

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 – 21	Not sampled – Sampling pump stuck in well				
			Jan – 22	Not sampled – Sampling pump stuck in well				
NB2	UEVF	165	Jul – 21	15.6	5.83	2356	2600	1340
			Jan – 22	20.3	5.67	2460	2570	1630
SB2	UEVF	229	Jul – 21	15.6	5.66	2375	2530	1310
			Jan – 22	18.7	5.54	3255	3390	1870
P14	LEVF	504	Jul – 21	17	6.1	1006	1240	615
			Jan – 22	21.9	6.12	1023	1050	586
P15	LEVF	466	Jul – 21	13.8	5.04	880	1070	518
			Jan – 22	20.4	4.89	941	952	1010

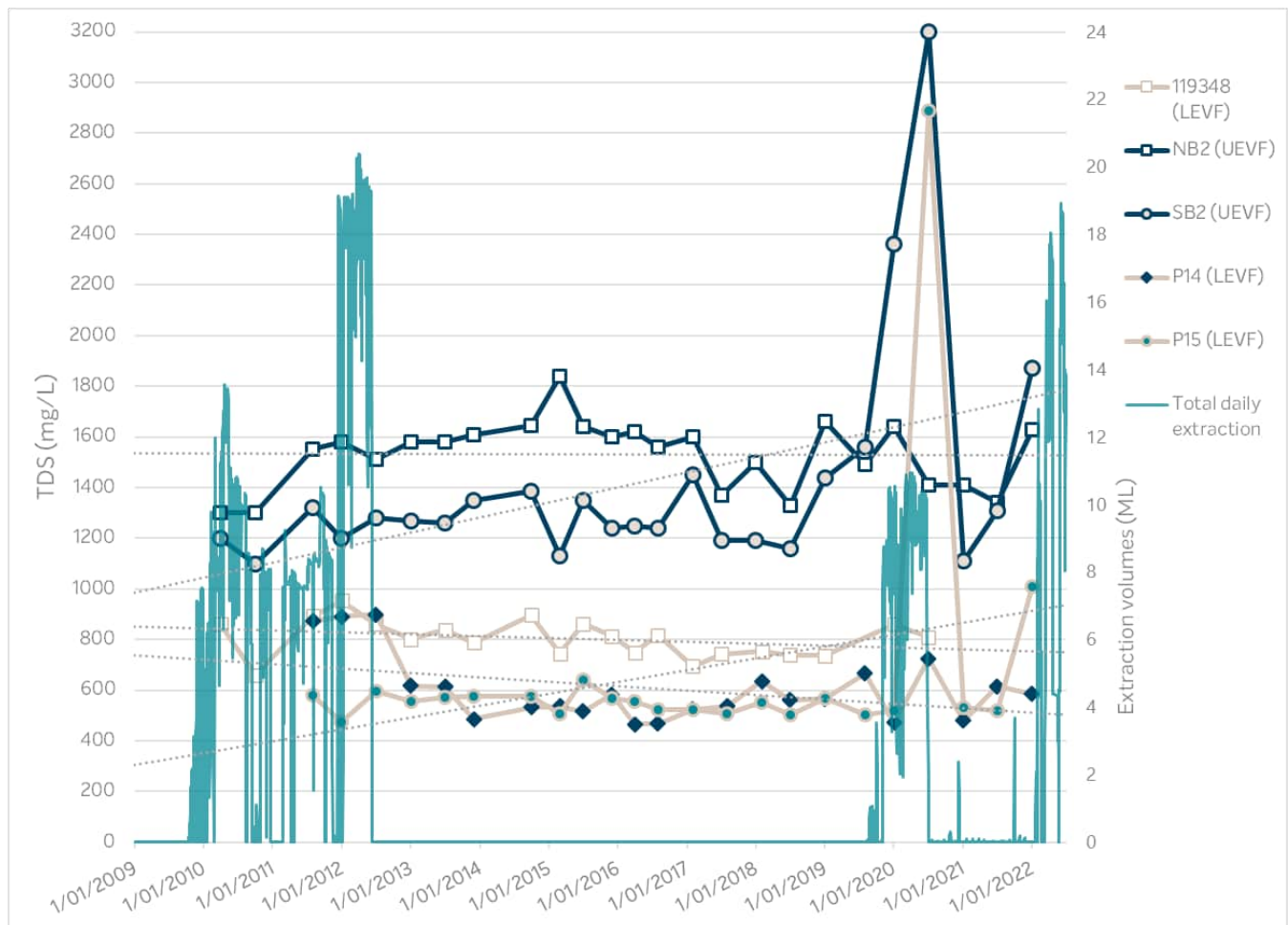


Figure 3: Groundwater quality results – deep observation bores

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.

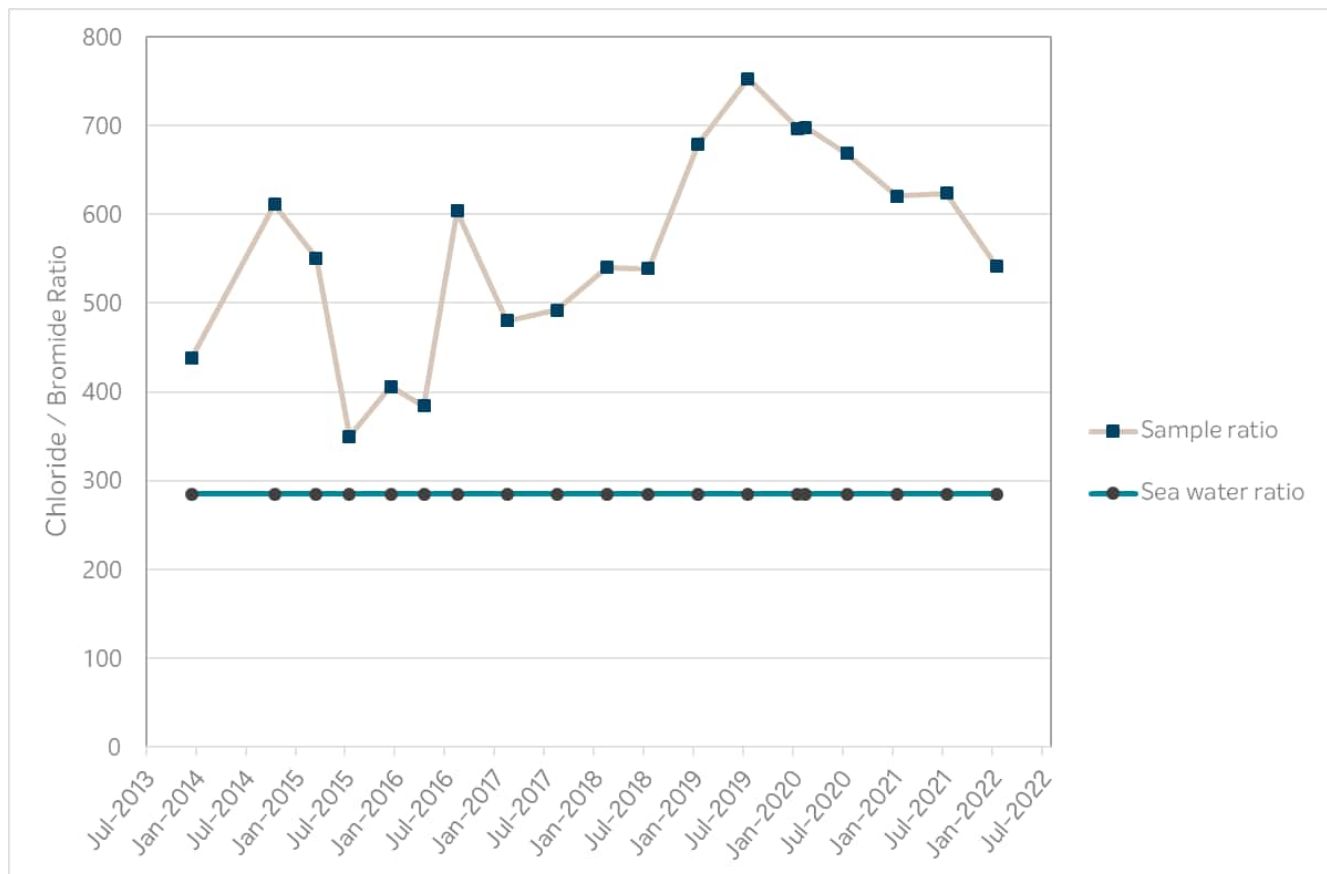


Figure 4 illustrates the chloride/bromide ratios overtime. The trend remains above the 285:1 ratio associated with seawater. Hence there continues to be no indication of saline intrusion at P14 to date.

Shallow observation bores

The 2021-2022 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.

As observed in Table 4 and Figure 5, a higher than expected result for TDS was observed at bore P1 in the perched water table. This unusual result was confirmed with the laboratory. The lab team believes the high result may be a result of the sample requiring a lower volume to be used during analysis due to the sample matrix (sample turbidity). For TDS analysis, the lab uses a 2.0um filter so if particles smaller than 2.0 um are present, these will pass through the filter and could potentially bias results high. The consistent EC reading supports this theory from the laboratory and suggests the high TDS reading is not an accurate reflection of the salinity in this bore at the time of sampling.

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-21	14.4	5.49	1540	1530	922
		Jan-22	14.7	5.31	1586	1620	886
P7B	PWT	Jul-21	12.6	3.89	858	834	586
		Jan-22	14.8	3.84	864	880	790
P8	PWT	Jul-21	11	4.93	2344	2410	1120
		Jan-22	15	5.09	2186	2345	1640
P19	UEVF	Jul-21	14.95	5.85	1155	1140	673
		Jan-22	16.3	5.77	1202	1230	733
P12	LEVF	Jul-21	18.6	5.91	1144	1100	580
		Jan-22	19.1	5.83	1165	1180	674
WTOB2	PWT	Jul-21	10.3	4.15	3399	3660	2770
		Jan-22	14.1	3.97	3119	3340	1930
Salt Creek Catchment							
P16	LEVF	Jul-21	12	4.45	543	556	664
		Jan-22	14.7	4.58	605	651	604
P17	PWT	Jul-21	13.6	6.85	1530	1650	906
		Jan-22	14.9	6.50	1280	1280	1050
P1	PWT	Jul-21	12.7	6.15	480	441	780
		Jan-22	15	6.16	403	340	3600
WTOB1	PWT	Jul-21	15.1	5.16	680	685	718
		Jan-22	15.3	5.05	1212	1290	1010

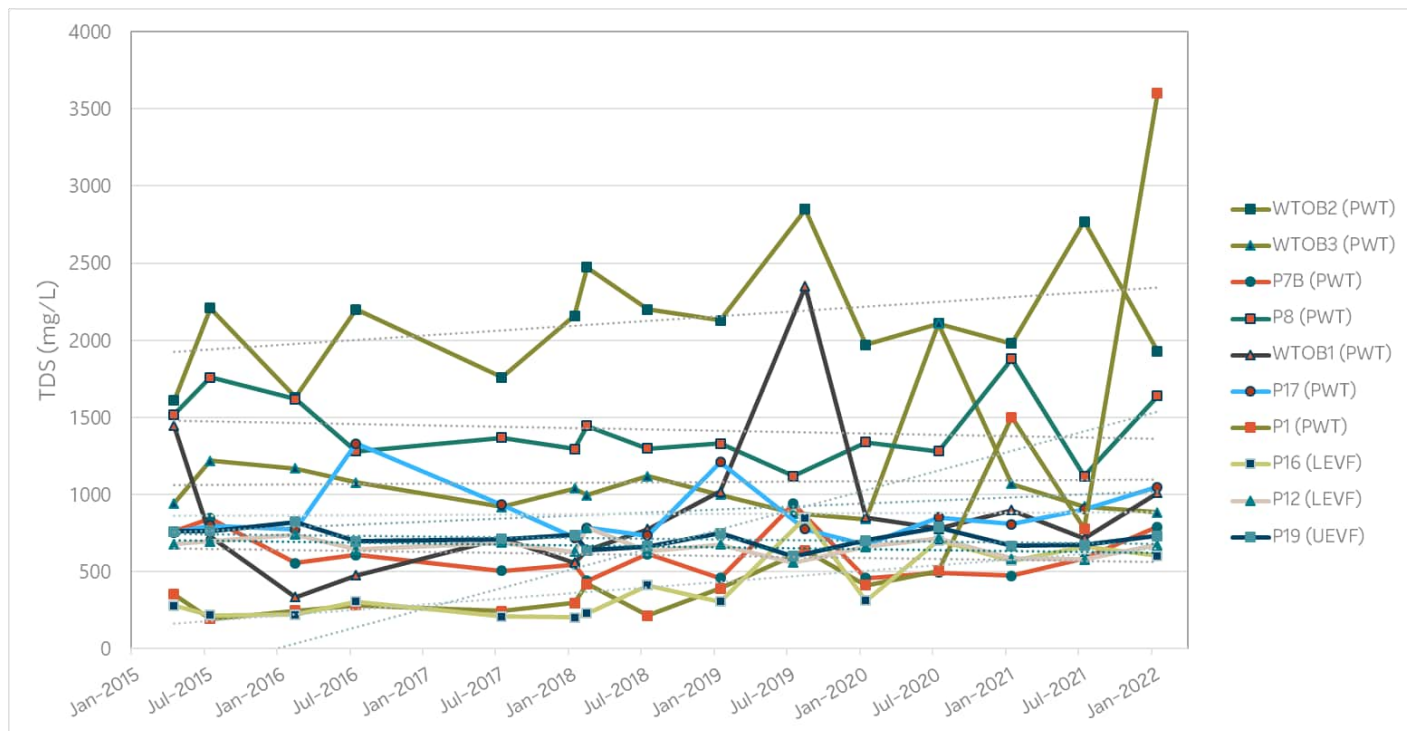


Figure 5: Groundwater quality results – shallow observation bores

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 (2021-22), 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
07-2021	318	538	337	288	728	1003	4290
08-2021	718	404	301	1468	595	310	3970
09-2021	267	380	281	1469	680	Dry	3920
10-2021	262	367	296	1241	629	901	3890
11-2021	225	381	249	1173	382	860	3640
12-2021	311	290	264	910	484	568	3180
01-2022	264	283	250	1192	822	Dry	3290
02-2022	230	262	270	854	580	701	3470
03-2022	251	335	231	949	665	Dry	3610
04-2022	338	360	302	1010	211	Dry	3650
05-2022	283	272	260	1103	707	Dry	3720
06-2022	263	444	228	771	768	Dry	3840

- 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
07-2020	5.0	Dry	6.5	4.2	7.5	Dry	2.8
08-2020	5.4	5.1	5.7	4.5	6.2	Dry	2.8
09-2020	4.9	5.2	7.6	4.7	6.3	Dry	2.8
10-2020	7.2	7.3	6.9	6.1	6.9	5.4	2.9
11-2020	6.2	5.6	6.9	4.1	6.2	Dry	3.0
12-2020	6.0	6.1	6.2	4.4	Dry	Dry	3.8
01-2021	6.3	6.8	6.6	3.3	Dry	5.3	3.2
02-2021	6.3	5.9	6.0	5.1	Dry	Dry	3.0
03-2021	Dry	Dry	6.1	4.1	5.7	Dry	2.9
04-2021	Dry	Dry	6.1	Dry	7.5	Dry	3.2
05-2021	6.2	Dry	6.2	4.9	6.2	Dry	3.7
06-2021	6.2	5.9	6.5	4.4	6.3	Dry	2.8
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

- 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 next 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 2021-2022 the groundwater levels were above the required trigger levels.

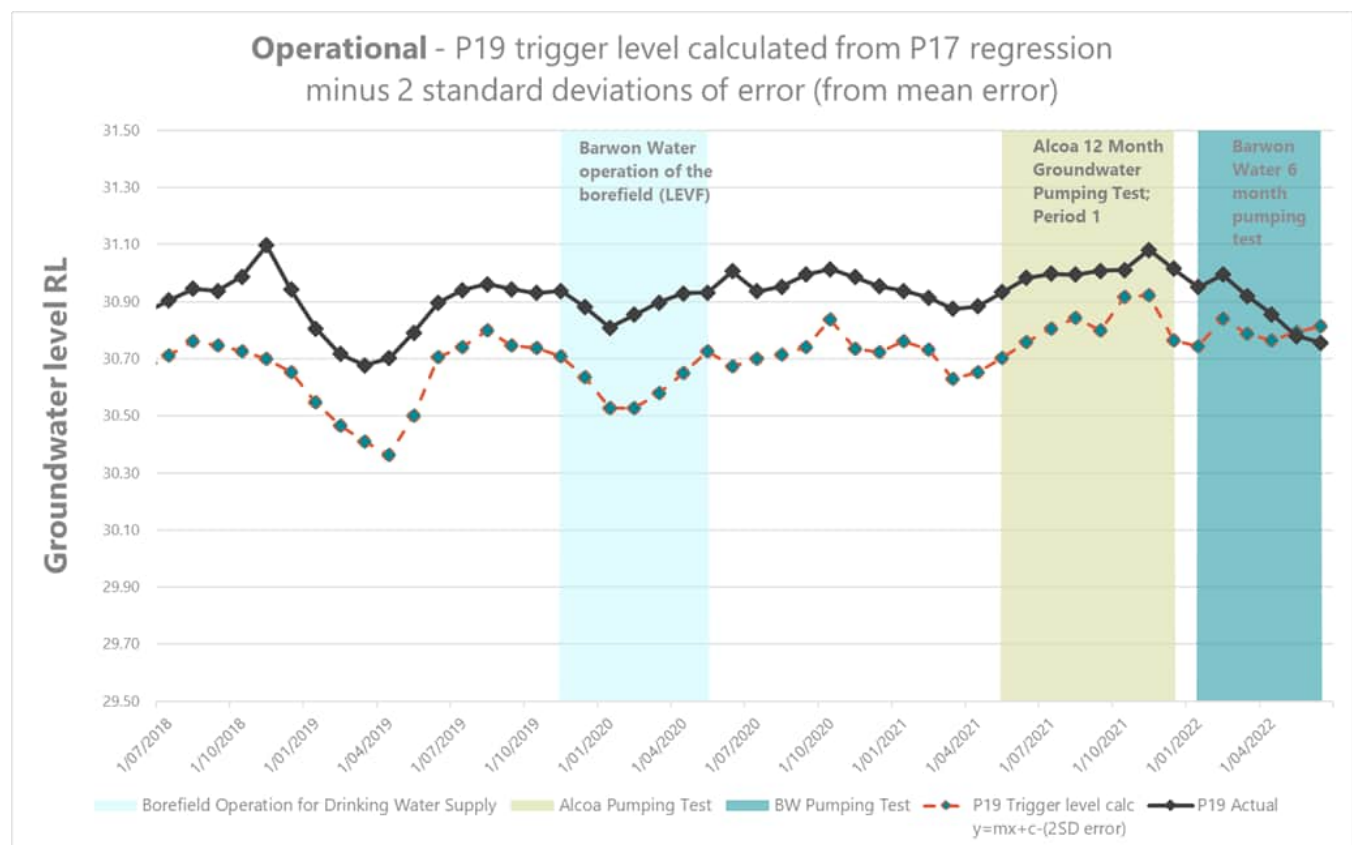


Figure 7: Groundwater level and the trigger level for P19 in the upper eastern view formation.

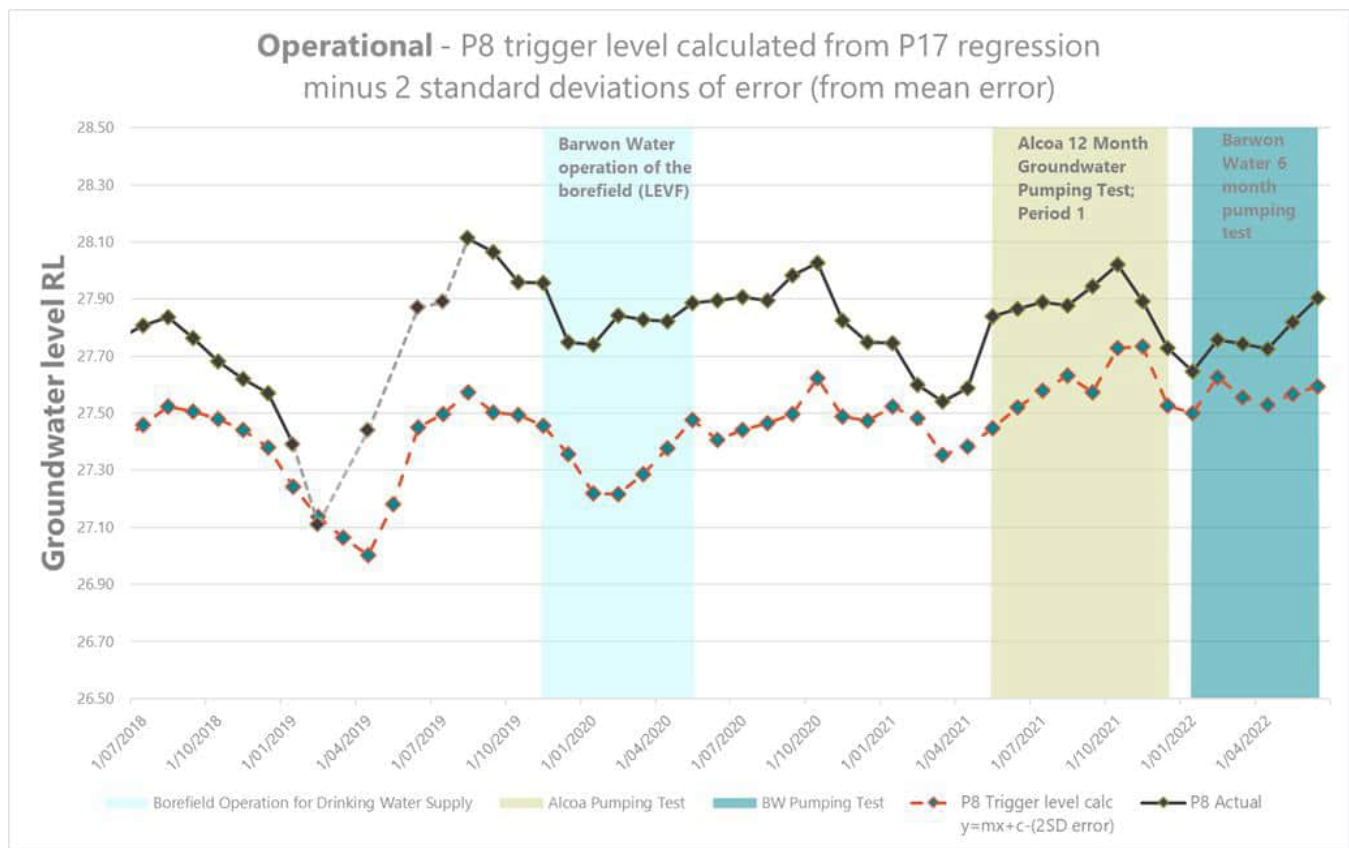


Figure 8: Groundwater level and the trigger level for P8 in the perched water table.

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 May and June 2022, 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 the groundwater levels in the PWT (P8) increasing at the same time and, therefore, there was no drawdown in the PWT.

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 DELWP 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.

This request for a minor amendment to the Bulk Entitlement (Anglesea Groundwater) Order 2009 has been provided to DELWP for consideration.

5.3 Amendment to the Monitoring and Assessment Program (MAP)

There have been no amendments to the MAP in 2021-2022 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

Observations bores still planned for decommissioning by Alcoa include:

- WB5
- WB12

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

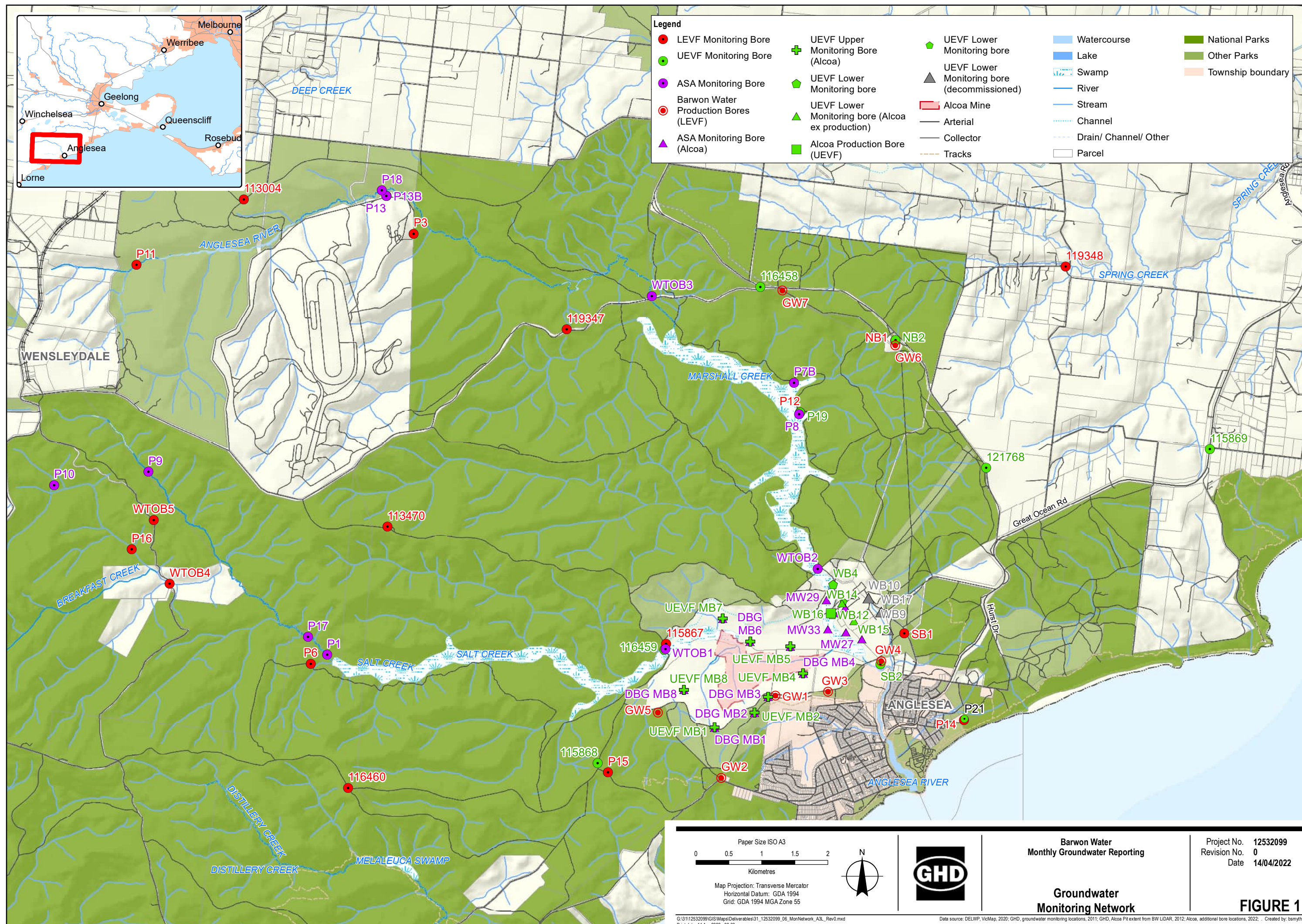
Barwon Water's consultants. The recommendation was that both bores are beyond refurbishment and should be decommissioned and replaced to improve our understanding of the Anglesea borefield

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.

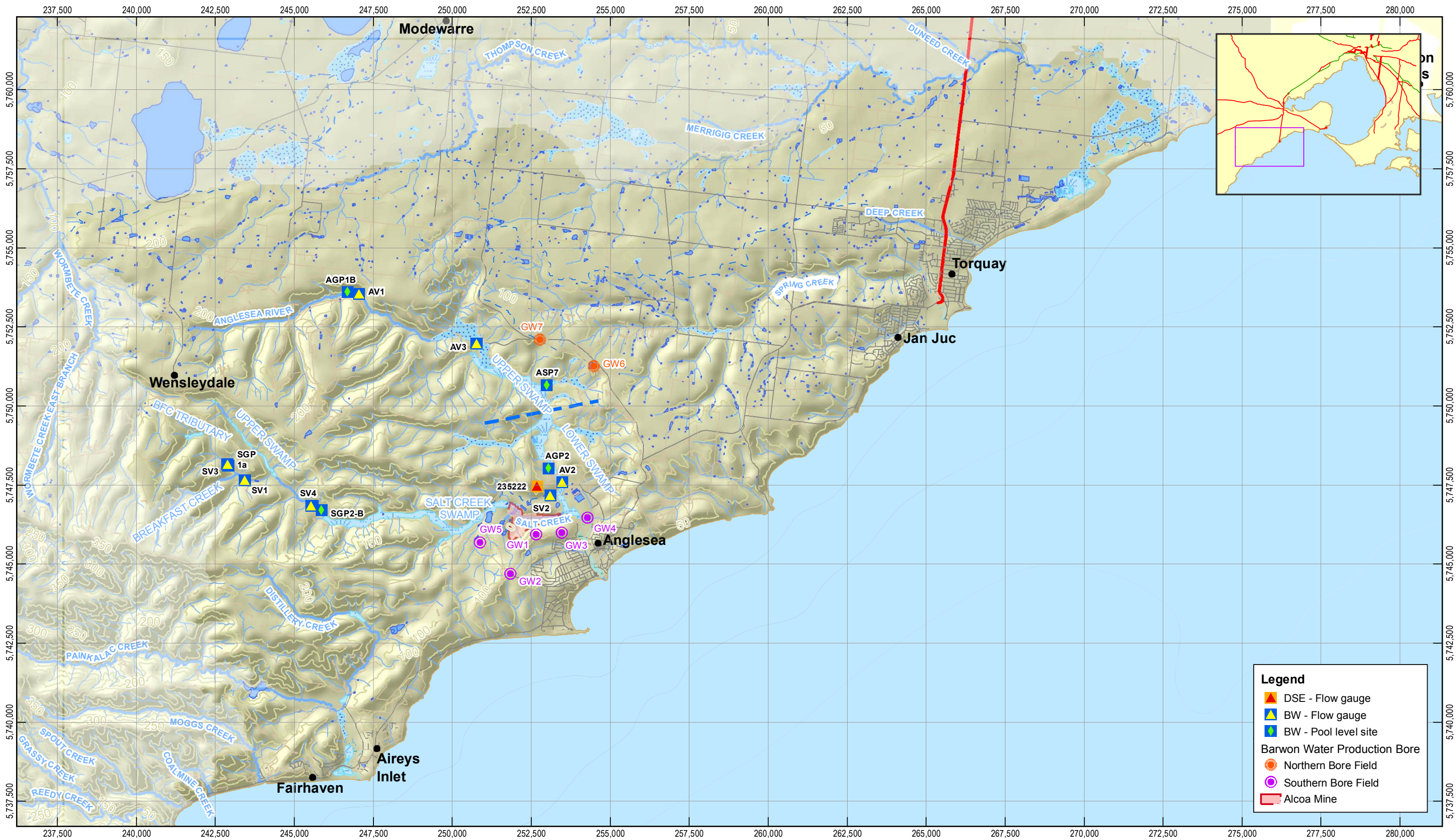
Appendix A

Observation bore locations



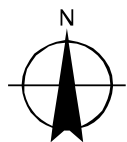
Appendix B

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: jearmonth

Appendix C

Surface water quality results - field testing

Name Breakfast Creek Tributary @ V notch
GHD/BW ID SV3
SINo. 235274A
BE Map ID GS7

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Flow at V notch	General weather conditions	Comments
14/07/2021	12:20	0.115	318	197.16	9.18	9.18	4.92	9.7	0.06	Cloudy	Air temp 9.9 Water clear, Photo and Sample.
10/08/2021	9:30	0.14	718	445.16	11.63	11.63	5.4	8.5	0.9	Cloudy	Air temp 9.5 Water clear
8/09/2021	12:50	0.102	267	165.54	9.01	9.01	4.95	9.7	0.03	Sunny	Air temp 16.8 Water clear
12/10/2021	10:45	0.157	262	162.44	9.47	9.47	4.5	12.5	2.03	Sunny	Air temp 14.5 Water clear
4/11/2021	10:00	0.322	225	139.5	10.02	10.02	5.3	13.5	7.91	Sunny	Air temp 15.6 Water clear
1/12/2021	11:00	0.128	311	192.82	8.21	8.21	5.74	12.4	0.07	Sunny	Air temp 28.0 Water clear
6/01/2022	11:50	0.15	264	163.68	6.98	6.98	6.4	13.6	1.98	Cloudy	Air temp 24.0
7/02/2022	11:55	0.133	230	142.6	7.08	7.08	6.32	17.5	0.4107	Sunny	Air Temp = 27.1.
8/03/2022	8:15	0.128	251	155.62	9.51	9.51	6.47	14.9	0.39	Cloudy	Air temp 13.5
27/04/2022	10:35	0.119	338	209.56	8.11	8.11	5.83	15.5	0.05	Cloudy	Air temp 16.9
11/05/2022	11:50	0.128	283	175.46	9.5	9.5	4.47	11.8	0.39	Cloudy	Air temp 13.5
8/06/2022	12:00	0.188	263	163.06	8.33	8.33	4.92	9.7	4.52	Cloudy	Air temp 8.8

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

Date	Time (EST)	Gauge Height	EC (μS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
14/07/2021	11:25	0.196	538	333.6	10.16	10.16	5.44	9	9.7	Low Flow	Cloudy	Water clear, Photo, Sample
10/08/2021	10:20	0.208	404	250.5	10.49	10.49	6.3	8.2	10.2	Flowing	Cloudy	Water clear
8/09/2021	11:35	0.161	380	235.6	7.45	7.45	5.93	10	14.7	Low Flow	Cloudy	Water clear
12/10/2021	11:15	0.2	367	227.5	9.51	9.51	5.4	10.3	15.5	Low Flow	Cloudy	Water clear
4/11/2021	9:15	0.513	381	236.2	10.42	10.42	6.2	12.9	12.5	Flowing	Cloudy	Water clear
1/12/2021	10:00	0.158	290	179.8	7.29	7.29	5.91	15.3	26.5	Flowing	Sunny	Water clear
6/01/2022	11:15	0.176	283	175.5	7.83	7.83	6.5	16.8	22.8	Flowing	Sunny	Water clear
7/02/2022	12:30	0.164	262	162.4	6.59	6.59	6.2	17.8	25.5	Flowing	Sunny	Water clear
8/03/2022	8:45	0.158	335	207.7	7.1	7.1	6.4	15.3	15.1	Flowing	Cloudy	Water clear
27/04/2022	10:00	0.171	360	223.2	7.66	7.66	6.44	13.2	16.2	Flowing	Cloudy	Water clear
11/05/2022	11:15	0.178	272	168.6	8.05	8.05	6.6	10.2	13.5	Flowing	Cloudy	Water clear
8/06/2022	11:15	0.236	444	275.3	8.91	8.91	5.8	9.3	8	Flowing	Cloudy	Water clear

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

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
12/07/2021	11:50	0.17	337	208.9	9.32	9.32	5.81	6.5	8.6	Flowing	Cloudy	Flowing
10/08/2021	12:15	0.212	301	186.6	10.22	10.22	6.38	8.5	11.9	Flowing	Cloudy	Flowing
8/09/2021	14:30	0.163	281	174.2	9.31	9.31	5.91	9.5	16.3	Flowing	Sunny	Flowing
12/10/2021	9:30	0.212	296	183.5	10.15	10.15	5.41	8	14	Flowing	Sunny	Flowing
4/11/2021	11:15	0.796	249	154.4	9.53	9.53	5.3	12.4	17.3	Flowing	Sunny	Flowing
1/12/2021	12:15	0.152	264	163.7	8.76	8.76	5.78	13.2	29.9	Flowing	Sunny	Flowing
6/01/2022	12:45	0.22	250	155	6.21	6.21	6.03	14.5	24.5	Flowing	Sunny	Flowing
8/02/2022	11:05	0.152	270	167.4	7.6	7.6	6.47	18.7	26	Flowing	Sunny	Flowing
8/03/2022	12:30	0.17	231	143.2	7.71	7.71	6.2	15.1	15.2	Flowing	Sunny	Flowing
27/04/2022	11:35	0.146	302	187.2	8.5	8.5	6.27	11.5	17.2	Flowing	Sunny	Flowing
17/05/2022	10:00	0.14	260	161.2	8.01	8.01	6.61	10.5	12.9	Flowing	Cloudy	Flowing
8/06/2022	10:00	0.3	228	141.4	9.98	9.98	6.2	7.8	7.6	Flowing	Cloudy	Flowing

Name

GHD/BW ID

SINo.

BE Map ID

Salt Creek (Encoder) @ Alcoa

SV2

235222A

GS3

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
13/07/2021	13:25	BELOW	288	178.6	7.4	7.4	2.99	9.4	12.9	No Flow	Cloudy	Water clear, Sample and photo taken.
11/08/2021	10:30	0.067	1468	910.2	10.51	10.51	3.72	5.8	11.3	Flowing	Cloudy	Water clear
9/09/2021	10:25	0.016	1469	910.8	9.9	9.9	3.78	14.6	16.8	Trickle flow	Cloudy	Water clear
11/10/2021	12:00	0.091	1241	769.4	10.79	10.79	3.72	8.4	13	Flowing	Cloudy	Water clear
3/11/2021	11:30	0.05	1173	727.3	9.1	9.1	3.6	13.1	19.1	Flowing	Cloudy	Water clear
2/12/2021	8:45	0.056	910	564.2	9.07	9.07	3.74	17.7	20.6	Flowing	Cloudy	Water clear
6/01/2021	14:00	BELOW	1192	739	8.29	8.29	3.51	26.5	24.7	Flowing	Cloudy	Water clear
8/02/2022	12:45	0.079	854	529.5	7.01	7.01	3.56	24.3	27.1	Flowing	Cloudy	Water clear
9/03/2022	10:00	0.014	949	588.4	8.93	8.93	3.79	18.8	17	Flowing	Cloudy	Water clear
26/04/2022	10:45	BELOW	1010	626.2	8.88	8.88	3.96	16	17.1	Flowing	Cloudy	Water clear
12/05/2022	10:30	BELOW	1103	683.9	10.69	10.69	3.79	14.4	13.5	Flowing	Cloudy	Water clear
9/06/2022	11:30	BELOW	771	478	10.12	10.12	3.8	10.5	8.1	Flowing	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	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Pool conditions	General weather conditions	Comments
12/07/2021	11:30	2.014	342	212.04	8.68	4.22	5.49	6.8	Flowing	Cloudy	Air temp 8.5 Dark tannin stain.
10/08/2021	12:05	2.033	351	217.62	8.71	3.11	5.97	8.8	Flowing	Cloudy	Air temp 10.5 Dark tannin stain.
8/09/2021	14:05	1.993	279	172.98	6.05	6.05	5.93	9.7	Flowing	Cloudy	Air temp 16.0 Dark tannin stain.
12/10/2021	9:20	2.042	610	378.2	9.65	3.21	4.8	10.2	Flowing	Cloudy	Air temp 14.5 Dark tannin stain.
4/11/2021	11:05	2.853	249	154.38	9.71	2.11	6	11.2	Flowing	Cloudy	Air temp 17.2 Dark tannin stain.
1/12/2021	12:00	1.974	273	169.26	8.2	2.1	5.82	13.5	Flowing	Sunny	Air temp 29.2 Dark tannin stain.
6/01/2021	12:30	2.04	265	164.3	7.69	2.11	6.21	12.5	Flowing	Cloudy	Air temp 24.0 Dark tannin stain.
8/02/2022	9:45	1.964	257	159.34	8.06	8.06	6.1	15.1	Flowing	Cloudy	Air temp 24.5 Dark tannin stain.
8/03/2022	12:10	1.99	285	176.7	6.68	6.68	6.73	15.1	Flowing	Cloudy	Air temp 14.8 Dark tannin stain.
27/04/2022	11:30	1.971	298	184.76	8.49	8.49	6.39	12.8	Flowing	Cloudy	Air temp 17.1 Dark tannin stain.
17/05/2022	9:50	1.967	302	187.24	8.11	3.21	6.52	11	Flowing	Cloudy	Air temp 13.0 Dark tannin stain.
8/06/2022	9:35	2.132	241	149.42	11.03	2.31	6.65	7.6	Flowing	Cloudy	Air temp 7.7 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	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Pool conditions	General weather conditions	Comments
12/07/2021	10:05	2.438	1312	813.44	6.77	2.33	5.48	7.2	Stagnant	Cloudy	Air temp 6.9 Water tannin stained. Photo taken.
9/08/2021	11:50	2.482	417	258.54	8.49	2.11	6.01	9.4	Stagnant	Cloudy	Air temp 11.0 Water tannin stained.
8/09/2021	10:25	2.362	645	399.9	7.39	7.39	5.95	10	Stagnant	Cloudy	Air temp 14.4 Water tannin stained.
12/10/2021	12:20	2.479	757	469.34	6.82	2.11	5.26	16.2	Stagnant	Cloudy	Air temp 17.5 Water tannin stained.
4/11/2021	8:30	2.742	408	252.96	9.42	2.7	5.6	13.6	Stagnant	Cloudy	Air temp 12.1 Water tannin stained.
1/12/2021	7:50	2.424	484	300.08	7.02	2.11	5.94	11.5	Stagnant	Cloudy	Air temp 20.9 Water tannin stained.
6/01/2021	10:50	2.242	703	435.86	6.62	2.35	6.5	16.8	Stagnant	Cloudy	Air temp 24.0 Water tannin stained.
7/02/2022	10:30	2.49	346	214.52	6.51	2.66	6.26	19.1	Stagnant	Cloudy	Air temp 24.2 Water tannin stained.
8/03/2022	10:00	2.356	692	429.04	8.1	8.1	6.4	15.1	Stagnant	Cloudy	Air temp 15.1 Water tannin stained.
27/04/2022	9:30	2.316	627	388.74	7.28	7.28	6.21	15.1	Stagnant	Cloudy	Air temp 17.1 Water tannin stained.
11/05/2022	10:10	2.355	734	455.08	7.71	3.11	5.88	10.3	Stagnant	Cloudy	Air temp 12.8 Water tannin stained.
8/06/2022	13:30	2.412	774	479.88	9.21	9.21	5.8	8.5	Stagnant	Cloudy	Air temp 8.5 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	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
12/07/2021	10:05	0.13	728	451.36	6.64	6.64	5.27	7.3	6.7	Flowing	Cloudy	Water Milky clear. Sample. Photo
9/08/2021	11:15	0.141	595	368.9	8.59	8.59	6.02	8.3	9.2	Flowing	Cloudy	Water Milky clear.
8/09/2021	9:55	0.13	680	421.6	3.25	3.25	5.47	9.3	10.1	Flowing	Cloudy	Water Milky clear.
12/10/2021	12:05	0.124	629	389.98	6.88	6.88	4.89	13	17.2	Flowing	Cloudy	Water Milky clear.
4/11/2021	8:15	0.564	382	236.84	9.1	9.1	5.59	13.4	11.2	Flowing	Cloudy	Water Milky clear.
1/12/2021	7:30	0.111	484	300.08	7.65	7.65	5.6	13.1	20.9	Flowing	Cloudy	Water Milky clear.
6/01/2022	10:35	BELOW	822	509.64	6.75	6.75	5.6	18.4	23.4	Flowing	Cloudy	Water Milky clear.
7/02/2022	10:50	0.101	580	359.6	5.87	5.8	5.91	18	26.6	Flowing	Cloudy	Water Milky clear.
8/03/2022	9:45	0.098	665	412.3	6.97	6.7	5.6	15.5	15	Flowing	Cloudy	Water Milky clear.
27/04/2022	9:15	0.058	211	130.82	9.21	9.21	6.21	12.5	13	Flowing	Cloudy	Water Milky clear.
11/05/2022	9:55	0.102	707	438.34	6.82	6.82	6.84	10.7	12.5	Flowing	Cloudy	Water Milky clear.
8/06/2022	13:00	0.28	768	476.16	9.21	9.21	5.8	8.5	8.2	Flowing	Cloudy	Water Milky clear.

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

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
12/07/2021	7:50	0.103	1003	621.9	9.51	9.51	4.35	7	6.4	Stagnant	Cloudy	Samples and Photo, Water clear.
9/08/2021	8:40	0.12	310	192.2	10.53	10.53	4.24	7	6.5	Flowing	Cloudy	Water clear
8/09/2021	8:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	11.1	Dry	Sunny	No Sampling as pool dry.
11/10/2021	8:00	0.121	901	558.6	8.63	8.63	3.95	9.8	8.5	Trickle flow	Cloudy	Water clear
3/11/2021	8:40	0.152	860	533.2	7.34	7.34	3	20.8	25.2	Flowing	Cloudy	Water clear
1/12/2021	6:30	0.12	568	352.2	7.36	7.36	4.17	15.6	22.6	Trickle flow	Sunny	Water clear
6/01/2022	10:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	20.1	Dry	Cloudy	No Sampling as pool dry.
7/02/2022	8:30	0.119	701	418	5.55	5.55	4.06	16.8	21.9	Trickle flow	Sunny	Samples taken.
8/03/2022	10:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	20.1	Dry	Cloudy	No Sampling as pool dry.
26/04/2022	13:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	17	Dry	Cloudy	No Sampling as pool dry.
11/05/2022	8:55	DRY	n/a	n/a	n/a	n/a	n/a	n/a	12.3	Dry	Cloudy	No Sampling as pool dry.
9/06/2022	9:10	DRY	n/a	n/a	n/a	n/a	n/a	n/a	7.1	Dry	Cloudy	No Sampling as pool dry.

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

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
14/07/2021	9:05	0.048	2362	1464.4	9.86	9.86	3.04	8.9	7.5	Stagnant	Cloudy	Water clear.
9/08/2021	10:10	0.132	2130	1320.6	10.72	10.72	3.12	8.1	7.9	Stagnant	Cloudy	Water clear.
9/09/2021	8:50	0.059	2220	1376.4	7.6	7.6	3.02	12	13.2	Stagnant	Cloudy	Water clear.
11/10/2021	8:50	0.058	2150	1333	9.92	9.92	2.58	11.1	9	Stagnant	Cloudy	Water clear.
3/11/2021	9:20	0.152	2035	1261.7	7.34	7.34	3.98	20.8	25.2	Stagnant	Cloudy	Water clear.
1/12/2021	8:45	0.11	2000	1240	5.9	5.9	3.16	24.7	25.6	Stagnant	Cloudy	Water clear.
13/01/2022	10:35	BELOW	2123	1316.26	4.31	4.31	3.05	28.6	31.1	Stagnant	Sunny	Water clear
8/02/2022	7:40	0.136	2160	1301	8.94	8.94	3.17	19.6	18.4	Stagnant	Sunny	Water clear.
9/03/2022	8:30	0.028	2640	1636.8	8.91	8.91	3.23	16.6	15.1	Stagnant	Cloudy	Water clear.
26/04/2022	12:35	BELOW	3180	1971.6	3.81	3.81	4.96	17.5	17	Stagnant	Cloudy	Water clear.
12/05/2022	12:00	BELOW	2860	1773.2	6.92	6.92	2.9	15	14.4	Stagnant	Cloudy	Water clear.
9/06/2022	9:50	0.06	2360	1463.2	11.2	11.2	3.01	8.8	7.5	Stagnant	Cloudy	Water clear.

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

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
13/07/2021	14:15	0.353	3941	2443.42	9.11	9.11	3.01	8.8	9	Flowing	Cloudy	Water clear, Photo taken
11/08/2021	9:00	0.374	3010	1866.2	9.77	9.77	2.9	9.6	9.9	Flowing	Cloudy	Water clear
9/09/2021	11:25	0.335	3180	1971.6	8.85	8.85	2.89	12.9	23.4	Flowing	Cloudy	Water clear
11/10/2021	10:00	0.33	2870	1779.4	8.73	8.73	2.75	14.2	9.5	Flowing	Cloudy	Water clear
3/11/2021	10:20	0.377	2560	1587.2	6.92	6.92	2.9	14.2	21.7	Flowing	Cloudy	Water clear
2/12/2021	7:30	0.358	2410	1494.2	5.03	5.03	3.02	17	20.7	Flowing	Cloudy	Water clear
6/01/2022	14:30	0.198	2750	1705	8.42	8.42	3.01	28.2	24.2	Flowing	Cloudy	Water clear
8/02/2022	13:30	0.355	2840	1760.8	6.42	6.42	2.72	27.8	25.8	Flowing	Cloudy	Water clear
9/03/2022	10:35	0.288	3110	1928.2	8.23	8.23	3.1	19.7	17.6	Flowing	Cloudy	Water clear
26/04/2022	11:35	0.202	2950	1829	6.81	6.81	2.91	12.2	17.5	Flowing	Cloudy	Water clear
12/05/2022	9:30	0.252	2950	1829	8.95	8.95	2.98	13.7	13	Flowing	Cloudy	Water clear
9/06/2022	12:15	0.319	2880	1785.6	10.56	10.56	2.96	8.5	8.2	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	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
13/07/2021	12:45	0.11	4290	2659.8	7.4	7.4	2.99	9.4	12.9	Flowing	Cloudy	Water very clear
11/08/2021	11:15	0.141	3970	2461.4	8.3	8.3	2.8	9.8	10.2	Flowing	Cloudy	Water very clear
9/09/2021	10:05	0.1	3920	2430.4	7.22	7.22	2.9	10.9	17	Flowing	Cloudy	Water very clear
11/10/2021	11:15	0.078	3890	2411.8	6.64	6.64	2.67	12	12.7	Flowing	Cloudy	Water very clear
3/11/2021	10:45	0.121	3640	2256.8	5.48	5.48	2.7	14.3	20.8	Flowing	Cloudy	Water very clear
2/12/2021	8:00	0.104	3180	1971.6	4.65	4.65	2.86	15.3	20.6	Flowing	Cloudy	Water very clear
6/01/2022	13:45	0.008	3290	2039.8	5.75	5.75	2.83	24.6	24.1	Flowing	Cloudy	Water very clear
8/02/2022	12:20	0.077	3470	2151.4	3.74	3.74	2.73	23.4	27	Flowing	Sunny	Water very clear
9/03/2022	9:15	0.03	3610	2238.2	4.06	4.06	3.05	17.8	15.3	Flowing	Cloudy	Water very clear
26/04/2022	10:30	0.006	3650	2263	8.4	8.4	3.65	17.1	17	Flowing	Cloudy	Water very clear
12/05/2022	10:00	0.011	3720	2306.4	8.95	8.95	2.91	12.1	13.5	Flowing	Cloudy	Water very clear
9/06/2022	11:00	0.033	3840	2380.8	11.2	11.2	3	13.2	8	Flowing	Cloudy	Water very clear

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	Not sampled - Pump stuck in bore.																
NB2	21/07/2021	6.33	1340	2600	118,000	<1	74	<1	74	74	711	52	21	273	20.4	24	8.13
	19/01/2022	6.04	1630	2570	126,000	<1	77	<1	77	67	736	54	20	280	20.5	24.9	9.79
SB2	21/07/2021	6	1310	2530	148,000	<1	49	<1	49	22	708	55	38	276	18.6	24	12.7
	19/01/2022	5.9	1870	3390	205,000	<1	58	<1	58	27	959	73	39	408	26.1	32.5	10.9
P15	22/07/2021	5.76	518	1070	64,000	<1	11	<1	11	4	258	18	14	118	7.17	8.83	10.4
	24/01/2022	5.47	1010	952	61,000	<1	6	<1	6	4	261	18	15	126	7.54	8.75	7.41
Saline Intrusion Monitoring																	
P14	17/08/2021	6.72	615	1240	2000	<1	143	<1	143	14	279	10	36	123	7.79	10.8	16
	27/01/2022	6.96	586	1050	2000	<1	121	<1	121	12	252	8	36	138	8.18	9.57	7.82
Swamp GDE																	
WTOB3	14/07/2021	5.98	922	1530	61,000	<1	27	<1	27	5	485	27	3	232	12.6	15.5	10.1
	18/01/2022	5.91	886	1620	58,000	<1	15	<1	15	5	472	28	3	242	13.2	14.8	5.95
P7B	14/07/2021	4.26	586	834	51,000	<1	<1	<1	<1	6	240	14	3	115	6.53	7.83	9.06
	17/01/2022	4.2	790	880	49,000	<1	<1	<1	<1	6	246	15	3	116	6.66	7.96	8.92
P8	14/07/2021	4.82	1120	2410	137,000	<1	<1	<1	<1	44	701	54	16	290	19.7	22.6	7.01
	17/01/2022	5.33	1640	2345	126,000	<1	6	<1	6	42	646	50	16	274	18.5	-	-
WTOB2	22/07/2021	3.9	2700	3660	533,000	<1	<1	<1	<1	62	902	74	30	428	28.6	36.5	12.2
	17/01/2022	4.11	1930	3340	431,000	<1	<1	<1	<1	55	800	67	30	388	25.9	31.5	9.81
P17	15/07/2021	6.65	906	1650	30000	<1	167	<1	167	34	414	30	4	187	12.4	15.6	11.5
	17/01/2022	6.76	1050	1280	3000	<1	162	<1	162	25	316	20	4	159	9.91	12.2	10.4
P1	15/07/2021	5.4	780	441	20000	<1	7	<1	7	2	130	5	2	70	3.61	4.22	7.87
	17/01/2022	5.59	3600	340	<1000	<1	25	<1	25	1	87	2	2	63	3	2.95	0.88
WTOB1	15/07/2021	5.46	718	685	53,000	<1	23	<1	23	3	195	10	2	101	5.42	7.06	13.2
	18/01/2022	5.81	1010	1290	53,000	<1	14	<1	14	5	371	19	2	191	10.2	11.8	7.61
Upper Anglesea Swamp and Trigger Level Site																	
P8	14/07/2021	4.82	1120	2410	137,000	<1	<1	<1	<1	44	701	54	16	290	19.7	22.6	7.01
	17/01/2022	5.33	1640	2345	126,000	<1	6	<1	6	42	646	50	16	274	18.5	-	-
P19	14/07/2021	6.34	673	1140	19,000	<1	69	<1	69	11	381	16	26	157	9.36	12.5	14.4
	17/01/2022	6.23	733	1230	14,000	<1	58	<1	58	10	371	16	25	160	9.41	11.9	11.7
P12	14/07/2021	6.53	580	1100	8000	<1	82	<1	82	11	343	14	27	153	9.05	11.5	11.8
	17/01/2022	6.32	674	1180	8000	<1	68	<1	68	10	353	14	26	156	9.1	11.5	11.6
Breakfast Creek Tributary																	
P16	15/07/2021	4.6	664	556	53,000	<1	<1	<1	<1	3	139	15	2	75	4.7	5.02	3.36
	18/01/2022	4.37	604	651	51,000	<1	<1	<1	<1	2	155	18	3	82	5.22	5.43	1.96

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 2021-2022 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 2021–2022.

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 2020 -2021.

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 2021.

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 2021 – 2022.

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 2021.

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 2021.

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 2021-2022 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

