

2021-2022 Annual Report

Boundary Creek, Big Swamp and
surrounding environment
Remediation and Environmental
Protection Plan (REPP)

30 September 2022

Executive Summary

In June 2017, Barwon Water acknowledged that the historic management of periodic groundwater pumping activities from the Barwon Downs borefield between 1982 and 2016 had resulted in water level decline and depressurisation of the Lower Tertiary Aquifer (LTA), which in turn was the primary cause of a reduction in groundwater contribution to the lower reaches of Boundary Creek (i.e. baseflow), that helped sustain streamflows during dry periods. When combined with drought conditions and the ineffective regulation of passing flows at a private on-stream dam located on Boundary Creek, this reduction in streamflow led to a range of unintended consequences such as: the drying out of Big Swamp, the oxidation of naturally occurring acid sulfate soils and the subsequent decline in water quality within Big Swamp and the lower reaches of Boundary Creek.

To help address these impacts, Barwon Water has already implemented the following remedial actions:

- Cessation of groundwater pumping activities at the Barwon Downs borefield
- Use of supplementary flows, where required to help maintain flows in Reach 3 of Boundary Creek all year round
- Ongoing monitoring and data collection activities to monitor and assess the progress of remediation and determine the need for any contingency measures

In addition to this Barwon Water has also committed to:

1. Developing suitable contingency measures that may be required to mitigate risks until the system sufficiently recovers to a point where this can be self-managed, and
2. Preparing and implementing a decommissioning plan for the Barwon Downs borefield production bores which has been included as an action in our draft 2023-2028 price submission.

Environmental monitoring works undertaken to monitor the progress of these remedial actions to date indicate:

- The ongoing recovery and re-pressurisation of the Lower Tertiary Aquifer
- An improvement in the ecological condition of Big Swamp, with no further encroachment of dry vegetation classes since 2019
- Water levels within Boundary Creek and Big Swamp have generally been maintained above the top of non-oxidised sediments, thus minimising the risks associated with any further oxidation of the naturally occurring acid sulfate soils

- No cease to flow events have occurred within Reach 3 of Boundary Creek since April 2020, and
- Despite the ongoing periodic flushing of acidity from the upper groundwater system and soil profile leading to periods of low pH (i.e. approx. 4 pH units), the average annual pH within Reach 3 of Boundary Creek continues to improve with the annual average pH increasing by 1 pH unit compared to the 2020-2021 period.

Barwon Water are also currently working on revising the REPP and the associated success targets based on the current 'state of knowledge' and community sentiment to ensure the REPP remains fit for purpose. In addition to this, Barwon Water are also using this knowledge and understanding to develop a risk-based contingency approach that minimises the potential for further harm which could result from the implementation of heavily engineered remedial actions.

In addition to this, the surrounding environment investigation to assess potential groundwater pumping related impacts within the broader catchment has continued in 2021-2022 with a focus on the installation of the remaining monitoring assets required to inform this assessment. This remains a key focus for the coming year as we lead into the first reporting milestone for the surrounding environment investigation that is due on 31 July 2023.

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1 Introduction

In June 2017, Barwon Water acknowledged that the historic management of periodic groundwater pumping activities from the Barwon Downs borefield between 1982 and 2016 had resulted in water level decline and depressurisation of the Lower Tertiary Aquifer (LTA), which in turn was the primary cause of a reduction in groundwater contribution to the lower reaches of Boundary Creek (i.e. baseflow), that helped sustain streamflows during dry periods. When combined with drought conditions and the ineffective regulation of passing flows at a private on-stream dam located on Boundary Creek, this reduction in streamflow led to a range of unintended consequences such as: the drying out of Big Swamp, the oxidation of naturally occurring acid sulfate soils and the subsequent decline in water quality within Big Swamp and the lower reaches of Boundary Creek.

In May 2018, Barwon Water established a community and stakeholder working group to participate in the design of a remediation plan for Boundary Creek and Big Swamp. As part of this process, Barwon Water invited the working group to nominate their own technical experts to help support them in their discussions to shape the remediation plan.

In September 2018 Barwon Water's commitment to undertake remedial works was legally strengthened through the issuing of a Ministerial Notice under section 78 of the Water Act, 1989. This notice mandated the development and implementation of the Boundary Creek, Big Swamp and surrounding environment – Remediation and Environmental Protection Plan (REPP) by 1 March 2020.

The section 78 notice defined remediation to be the controls and actions that could be practicably carried out to achieve improved environmental outcomes. In order to align this with an accepted scientific definition for remediation, the REPP further expanded the definition to be "the controls and actions that could be practicably carried out to improve the ecological condition and function of areas confirmed to have been impacted by historical management of groundwater pumping at Barwon Downs, noting that this is likely to be different to the original condition due to the extent of change since European settlement."

In February 2020, Southern Rural Water accepted Barwon Water's REPP, subject to inclusion of SRW feedback, with the REPP to be delivered under two parallel work packages:

- **The Boundary Creek and Big Swamp Remediation Plan** to address remediation of confirmed impact in the Boundary Creek catchment resulting from historical management of groundwater extraction.
- **The Surrounding Environment Investigation** to investigate whether other areas within the regional groundwater system have been impacted by historical management of groundwater extraction.

A key requirement of the section 78 notice and the REPP is the provision of quarterly updates to Southern Rural Water to report on progress with implementation of the plan, as well as an Annual Report. In line with the section 78 notice and the approved governance framework, the Annual Report is required to be submitted to Southern Rural Water for review and comment before being made publicly available by 30 September each year.

The 2021-2022 Annual Report is the third Annual Report issued following acceptance of the REPP in February 2020. This annual report provides an overview of the progress against the actions and timeframes outlined in the REPP, with progress presented in a similar format to that of the quarterly updates. The Annual Report also provides more detail on technical investigations, monitoring, data collected, and tracking against the REPP success targets.

2 Implementation of the REPP

In accordance with the REPP, Barwon Water have adopted an adaptive management approach, whereby the REPP can be adapted in response to the current 'state of knowledge'. This approach allows Barwon Water to evaluate how the confirmed areas of impact and the surrounding environment are responding to the adopted remediation actions and take further action, such as implementation of contingency measures, if and when required. This approach also ensures that the adopted remedial actions meet the vision, objectives and targets as informed by the community and stakeholder Remediation Reference Group (RRG) and their nominated experts.

To help address the requirements of the section 78 notice and ensure momentum was maintained, a number of key milestones and actions were established. However, as reported in the 1 October to 31 December Quarterly Update, this roadmap continues to be updated in accordance with the adaptive management approach to account for the current 'state of knowledge' and to capture any additional actions.

Following the completion of the Upstream Treatment Investigation in June 2022 (Barwon Water, 2022a), the submission of Barwon Water's high-level approach to the Surrounding Environment Investigation (Barwon Water, 2022b) and delays in installing the additional monitoring assets, this roadmap has again been updated to reflect the current approach (refer Figure 1). In accordance with the high-level approach submitted to Southern Rural Water on 30 June 2022, the Surrounding Environment Investigation will focus on reviewing the additional monitoring data and developing the conceptual understanding of the further investigation areas before any further modelling work is undertaken. The outcomes of this review will be submitted to Southern Rural Water in July 2023 in accordance with the next formal milestone. The findings of this work will be used to inform further modelling, as appropriate, to better ascertain groundwater pumping related impacts and track the recovery of the system following the cessation of groundwater pumping activities and determine how the system may respond under future climate scenarios.

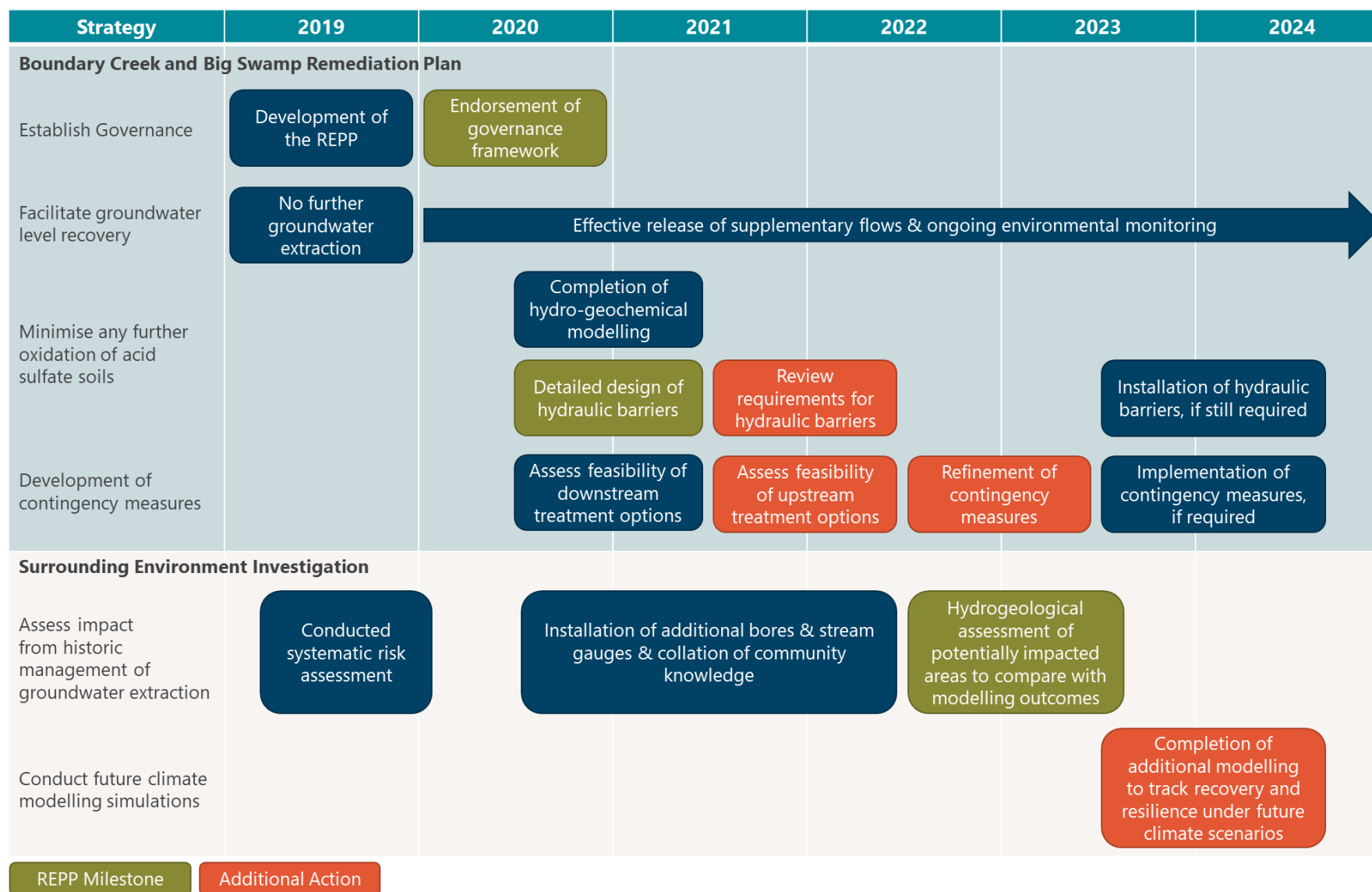


Figure 1: Timeframes for implementation of the REPP

3 Barwon Downs Borefield

In response to ongoing water shortages and challenges in meeting demand using conventional water supplies, the Geelong Waterworks and Sewage Trust (now Barwon Water) established the Barwon Downs borefield to access groundwater supplies contained within the Lower Tertiary Aquifer – a predominantly confined aquifer system that is recharged primarily by rainfall infiltration within the Barongarook High recharge zone. The Barwon Downs borefield was used intermittently to supplement conventional water supplies during dry periods between 1982 and 2016 in accordance with the groundwater extraction licence(s), with pumping primarily occurring during dry periods between 1988-1989, 1997-2001, 2005-2010 and 2016.

3.1 Metering

As Barwon Water no longer hold a groundwater extraction licence, no groundwater extraction activities can occur at the Barwon Downs borefield.

In Barwon Water's draft 2023-2028 price submission we have also committed to prepare and implement a decommissioning plan for the Barwon Downs borefield production bores. This is reflective of Barwon Water ruling out the use of the Barwon Downs borefield as a source of urban water supply in our draft Water for our Future Strategy – our next Urban Water Strategy.

3.2 Supplementary Flows

Following the identification of potential streamflow losses in the lower reaches of Boundary Creek during the 2002 licence renewal process, environmental provisions, such as the release of 2 ML/day of supplementary flows, were included in the 2004 licence to offset the potential impacts to Boundary Creek during pumping periods.

While there are currently no obligations to release these supplementary flows via the now expired groundwater licence, the use of supplementary flows continues to be an action as part of the Boundary Creek and Big Swamp Remediation Plan to assist with maintaining flow in Boundary Creek and aid in re-wetting Big Swamp. Further information regarding the supplementary flows is provided in Section 4.5.4.

3.3 Land Subsidence Monitoring

Land subsidence monitoring has occurred in the Barwon Downs region since 2003 in accordance with the now expired groundwater extraction licence to monitor any changes in ground levels that may occur due to the groundwater extraction activities. As per previous monitoring events, land subsidence monitoring was conducted by Barwon Water's spatial services team with the results presented in Table 1. Positive values indicate an increase in

ground levels compared to the readings taken in 2003, while negative values represent subsidence.

The results indicate that ground levels at most observation points have shown a small recovery since worst case conditions where ground levels indicated up to 89 mm of subsidence. Noting that this was well below the 200 mm subsidence trigger stipulated in the groundwater licence(s). Since the cessation of groundwater pumping activities the majority of monitoring stations have reported a small recovery, with the data indicating a reduction in subsidence over time. It is also noted that ground levels can also vary based on the moisture content of the soil and any associated swelling or contraction that may occur in response to seasonal fluctuation, particularly in the upper soil profile.

Table 1 Ellipsoid height differences for each observation ear compared to original 2003 data (mm)

Station ID	Ellipsoid Height Differences																			
	2004 Jun	2005 May	2006 May	2007 Jun	2007 Dec	2008 Jun	2009 Jul	2010 May	2011 Jul	2012 Jun	2013 Jun	2014 Jun	2015 Jun	2016 Jun	2017 Jun	2018 Jun	2019 Jul	2020 Jul	2021 Jul	2022 Jun
Primary Control																				
20790040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20880024	-8	-2	-8	-18	-16	-8	-21	-25	-25	-12	-23	-20	-21	-11	-19	-19	-19	-15	-19	-13
20590052	-6	0	6	-3	-12	7	8	8	15	8	14	1	3	13	27	11	-1	-26	-6	1
39780106	-1	0	3	-27	-9	-15	-16	-30	-14	-16	-30	-24	-25	-11	-19	-15	-17	-20	-23	-26
Monitoring Station																				
32390045	-6	1	-11	-42	-42	-36	-66	-75	-47	-42	-54	-42	-42	-47	-35	-39	-30	-15	-25**	-29
32390046	3	1	-8	-20	-19	-20	-47	-50	-32	-25	-46	-32	-28	-37	-25	-27	-10	-3	-16	-23
26470027	-6	2	-2	6	-11	-22	-37	-45	-36	-39	-43	-42	-35	-32	-37	-36	-21	-23	-28	-27
26470032	-5	5	-1	-43	-30	-36	-63	-63	-35	-40	-45	-42	-37	-42	-39	-40	-15	-17	-23	-31
26470033	-8	3	-13	-40	-35	-36	-65	-76	-38	-39	-44	-38	-35	-46	-39	-36	-21	-22	-19	-26
26470036	5	10	1	-32	-23	-30	-48	-63	-42	-38	-39	-33	-23	-33	-33	-24	-12	-11	-18	-20
39870025	-1	-4	-5	-15	-11	-17	-23	-34	-37	-31	-25	-29	-33	-27	-27	-21	-17	-27	-17	-25
39870026	-3	0	2	-9	-6	-15	-22	-38	-37	-33	-31	-31	-35	-21	-28	-23	-10	-5	-17	-23
38090024	-4	-3	12	8	NA	0	-26	-25	-18	-30	-15	-36	-36	-81	-74	-89	-65	-85	-64	-53
38090025	-5	-5	9	-12	NA	-5	-30	-33	-28	-48	-23	-33	-35	-27	-27	-34	-18	-31	-15	-9
38090026	-5	0	6	-15	NA	-6	-33	-31	-30	-41	-30	-33	-28	-31	-31	-33	-19	-31	-23	-23

Note:

*An additional partial survey was undertaken in December 2007 in response to changes detected in control and monitoring stations

**In 2021, reductions for monitoring station 32390045 used an incorrect antenna type (LEISR399_INT) resulting in -43mm error to the result. This has been recomputed and corrected in the above table

3.4 Recovery of the Lower Tertiary Aquifer

The groundwater pumping activities undertaken at the Barwon Downs borefield in conjunction with drought conditions resulted in the water level decline and de-pressurisation of the Lower Tertiary Aquifer. It is noted that despite this, positive pressures were maintained within the confined portions of the aquifer (refer Table 2), thus preventing drying/dewatering of the Lower Tertiary Aquifer. In contrast, the water level decline within the outcropping unconfined portions of the Lower Tertiary Aquifer may have led to a reduction in groundwater contribution to surface water systems (i.e. baseflow) and in turn resulted in environmentally significant adverse impacts. This has been shown to be the case within select reaches of Boundary Creek, where water level decline, primarily from groundwater pumping activities, resulted in a significant reduction in baseflow into Boundary Creek, thus contributing to the drying out of Big Swamp and the oxidation of the naturally occurring acid sulfate soils. Further works are currently underway as part of the Surrounding Environment Investigation to assess groundwater pumping related impacts and identify if groundwater pumping activities have led to environmentally significant adverse impacts to other surface water features and/or groundwater dependant ecosystems within the broader catchment.

In accordance with the conditions outlined in the groundwater extraction licence(s), Barwon Water have undertaken routine groundwater level monitoring since the 1980's to monitor against the groundwater level triggers stipulated in the groundwater licence(s). These monitoring activities continued following the cessation of groundwater pumping activities in 2016 and as part of the Boundary Creek, Big Swamp and surrounding environment Remediation and Environmental Protection Plan (REPP). Today these monitoring activities are used to monitor the recovery of the Lower Tertiary Aquifer. A map outlining the location of the regional groundwater observation bores is provided in Figure 2.

As outlined in the hydrographs presented in Appendix A, the groundwater levels/pressure within the Lower Tertiary Aquifer continue to display a recovering trend in the majority of observation bores since the cessation of groundwater pumping activities in 2016. In comparing the maximum recorded groundwater elevation and lowest recorded groundwater elevation with the 2021-2022 data we can see that significant recovery has occurred to date (refer Table 2 and Figure 2). As outlined in Figure 2, groundwater observation bores located within the central confined portion of the graben show 50 to 80% recovery since worst case conditions, while groundwater observation bores located in unconfined portions of the graben show an average recovery of ~40% (refer Table 2), noting that some bores primarily located along the Bamba Fault or within or adjacent to the Barongarook High recharge area continue to report recoveries <25%. It is noted that these are also generally located in elevated portions of the catchment. However, it is noted that given G28 is located within the yeo dome, G11 is located to the south of the yeo dome near a groundwater divide, and BA56, YYG217 and YYG218 are located adjacent to the Bamba Fault (refer Figure 2), groundwater levels at these bores may not be entirely representative of the broader groundwater recovery due to the

localised flow patterns around these hydrogeological features. Similarly, the presence of other licenced groundwater users within the region may impact the recovery of the Lower Tertiary Aquifer if these are installed within the Lower Tertiary Aquifer depending on their location, extraction volume and pumping regime. Noting that the Permissible Consumptive Volume (PCV) for the Gerangamete Groundwater Management Area (GMA) is currently set at 239 ML.

This is also supported by the residual drawdown contours (Appendix B) that have historically been used to monitor recovery at a sub-aquifer scale. Noting that both the residual drawdown and % recovery figures incorporate any climate related groundwater impacts which would have occurred due to reduced recharge during drought conditions and as such, while these are primarily related to pumping may never reach zero residual drawdown or 100% recovery. It is also noted that the residual drawdown contours provided in Appendix B are generated based on the recorded groundwater levels and have not been modified to account for localised flow patterns that may occur around the identified hydrogeological structures or surrounding extractive groundwater users that in reality also play a key role in the drawdown and recovery processes.

Table 2 Summary of groundwater levels recovery within the Lower Tertiary Aquifer

Bore ID	Nature of aquifer at this location	Ground Elevation (mAHD)	Approx. Surface Elevation of the Lower Tertiary Aquifer (mAHD)	Maximum Recorded Groundwater Elevation (mAHD)	Maximum Recorded Pressure Head (m)	Lowest Recorded Groundwater Elevation (mAHD)	Lowest Recorded Pressure Head (m)	Maximum 2021/2022 Groundwater Elevation (mAHD)	Maximum 2021/2022 Pressure Head (m)	Maximum Drawdown (m)	Water Level Recovery (m)	Residual Drawdown (m)	Recovery
G11	Confined	156.5	-191.1	115.7	306.7	109.9	301.0	110.5	301.6	5.8	0.6	5.1	11%
G12	Confined	158.0	-192.0	115.3	307.3	111.2	303.2	-	-	-		-	-
BK69	Unconfined	248.2	248.1	227.7	N/A	222.8	N/A	223.2	N/A	4.9	0.4	4.5	7%
G13	Confined	140.8	-231.1	161.0	392.2	114.1	345.2	141.4	372.6	46.9	27.3	19.6	58%
G14	Confined	140.3	-290.7	158.8	449.5	100.7	391.3	147.2	437.9	58.1	46.5	11.6	80%
G17	Confined	172.3	25.3	159.5	134.2	126.3	100.9	152.1	126.7	33.2	25.8	7.4	78%
G20	Confined	164.2	-114.7	157.9	272.5	104.7	219.3	146.6	261.2	53.2	41.9	11.3	79%
G21	Confined	137.3	-246.0	153.8	399.8	100.8	346.8	137.8	383.8	53.0	37.0	16.0	70%
G22	Unconfined	232.8	232.8	108.5	N/A	92.6	N/A	94.0	N/A	15.9	1.4	14.5	9%
G23	Unconfined	233.1	232.0	171.9	N/A	161.6	N/A	162.7	N/A	10.3	1.1	9.2	11%
G24	Confined	172.9	22.3	160.8	138.5	127.7	105.4	148.2	126.0	33.1	20.6	12.5	62%
G25	Confined	176.5	175.7	150.6	N/A	141.2	N/A	143.7	N/A	9.4	2.5	6.9	27%
G28	Confined	127.0	10.0	98.3	88.3	89.6	79.6	89.7	79.7	8.7	0.2	8.6	2%
Y40	Confined	156.1	35.7	126.5	90.8	120.6	84.9	121.3	85.6	5.9	0.7	5.2	12%
Y41	Unconfined	142.6	139.9	129.5	N/A	126.2	N/A	127.4	N/A	3.3	1.2	2.1	37%
M24	Confined	156.0	-317.5	161.3	478.8	112.8	430.2	149.5	466.9	48.6	36.7	11.9	76%
M25	Confined	158.4	-323.8	158.6	482.4	119.7	443.5	149.0	472.8	38.9	29.3	9.6	75%
M27	Confined	141.7	-226.5	159.5	386.0	133.0	359.5	149.2	375.7	26.6	16.3	10.3	61%
M28	Confined	127.6	-8.8	153.0	161.8	127.0	135.7	146.7	155.5	26.1	19.7	6.3	76%
M29	Confined	177.7	115.7	163.1	47.4	147.6	31.9	153.5	37.8	15.5	5.9	9.6	38%
M30	Unconfined	202.7	201.9	176.7	N/A	173.0	N/A	174.8	N/A	3.7	1.8	1.9	49%
M31	Unconfined	174.0	171.0	160.2	N/A	151.1	N/A	152.6	N/A	9.2	1.5	7.6	17%
YEO19	Unconfined	176.6	176.6	162.8	N/A	120.1	N/A	151.5	N/A	42.7	31.4	11.3	74%
YEO20R	Unconfined	174.5	173.9	163.4	N/A	148.9	N/A	153.4	N/A	14.4	4.5	10.0	31%
YEO21	Confined	138.0	92.5	156.5	64.0	128.8	36.2	146.0	53.5	27.7	17.3	10.5	62%
YEO22	Confined	179.6	112.7	163.0	50.4	128.7	16.0	150.4	37.8	34.3	21.7	12.6	63%
YEO23	Confined	163.5	4.9	160.5	155.6	139.8	134.9	151.8	146.9	20.7	12.0	8.7	58%
YEO37	Unconfined	160.4	155.7	161.0	5.3	147.6	N/A	154.0	N/A	13.4	6.3	7.0	47%
YEO38	Unconfined	164.7	156.4	159.3	2.9	153.8	N/A	154.0	N/A	5.5	0.1	5.3	3%
YEO39	Unconfined	163.8	159.0	165.2	6.1	150.5	N/A	159.2	0.1	14.7	8.7	6.0	59%
YEO40R	Unconfined	167.1	167.1	160.2	N/A	146.8	N/A	150.9	N/A	13.4	4.0	9.4	30%
YEO41	Unconfined	208.1	205.9	164.8	N/A	129.1	N/A	150.1	N/A	35.8	21.0	14.7	59%
YEO42	Confined	210.8	198.9	163.3	N/A	148.2	N/A	151.5	N/A	15.2	3.3	11.9	22%
YEO44	Confined	135.2	-21.6	115.3	136.9	92.3	113.9	107.1	128.7	22.9	14.8	8.2	64%
YYG217	Unconfined	190.9	105.1	140.6	35.5	138.7	33.7	140.5	35.4	1.9	1.8	0.1	96%
YYG218	Unconfined	190.5	105.1	161.0	56.0	157.3	52.2	158.2	53.1	3.7	0.9	2.9	24%
YYG221	Unconfined	132.7	51.5	147.1	95.5	133.2	81.7	142.6	91.1	13.8	9.3	4.5	68%

Bore ID	Nature of aquifer at this location	Ground Elevation (mAHD)	Approx. Surface Elevation of the Lower Tertiary Aquifer (mAHD)	Maximum Recorded Groundwater Elevation (mAHD)	Maximum Recorded Pressure Head (m)	Lowest Recorded Groundwater Elevation (mAHD)	Lowest Recorded Pressure Head (m)	Maximum 2021/2022 Groundwater Elevation (mAHD)	Maximum 2021/2022 Pressure Head (m)	Maximum Drawdown (m)	Water Level Recovery (m)	Residual Drawdown (m)	Recovery
W4	Confined	120.0	-137.0	120.2	257.3	119.4	256.4	-	-	-		-	-
W7	Confined	120.8	-178.3	166.0	344.3	142.4	320.7	155.2	333.5	23.6	12.8	10.8	54%
W9	Confined	143.8	-266.4	154.1	420.5	136.1	402.5	144.5	410.9	17.9	8.3	9.6	46%
BA54	Confined	157.3	-26.2	153.2	179.4	143.6	169.8	147.4	173.6	9.6	3.8	5.8	40%
BA56	Confined	167.5	49.9	147.9	98.0	140.6	90.7	142.8	92.9	7.3	2.1	5.1	29%
BA57	Confined	155.3	83.3	152.3	68.9	138.7	55.4	142.2	58.9	13.5	3.5	10.1	26%
BA58	Unconfined	157.0	-80.6	151.9	232.4	139.5	220.0	146.6	227.2	12.4	7.2	5.2	58%
E68	Confined	228.2	207.5	206.6	N/A	202.4	N/A	204.5	N/A	4.2	2.1	2.1	50%
BD3	Confined	180.3	151.6	150.9	N/A	144.0	N/A	146.2	N/A	6.9	2.2	4.7	31%
BSTB1C	Confined	144.1	116.6	-	-	141.67	25.1	147.7	31.1	-	6.0	-	-
BSBH13	Confined	147.4	132.4	-	-	-	-	147.6	15.2	-	-	-	-

Note:

Maximum recorded groundwater elevation is the maximum groundwater elevation recorded between 1986 and 2000. Noting that the date this occurred varies for each bore due to pumping that occurred prior to 1986.

Lowest recorded groundwater elevation is the lowest groundwater elevation recorded between 1986 and 2022. This is reflective of worst case conditions rather than a particular time/date

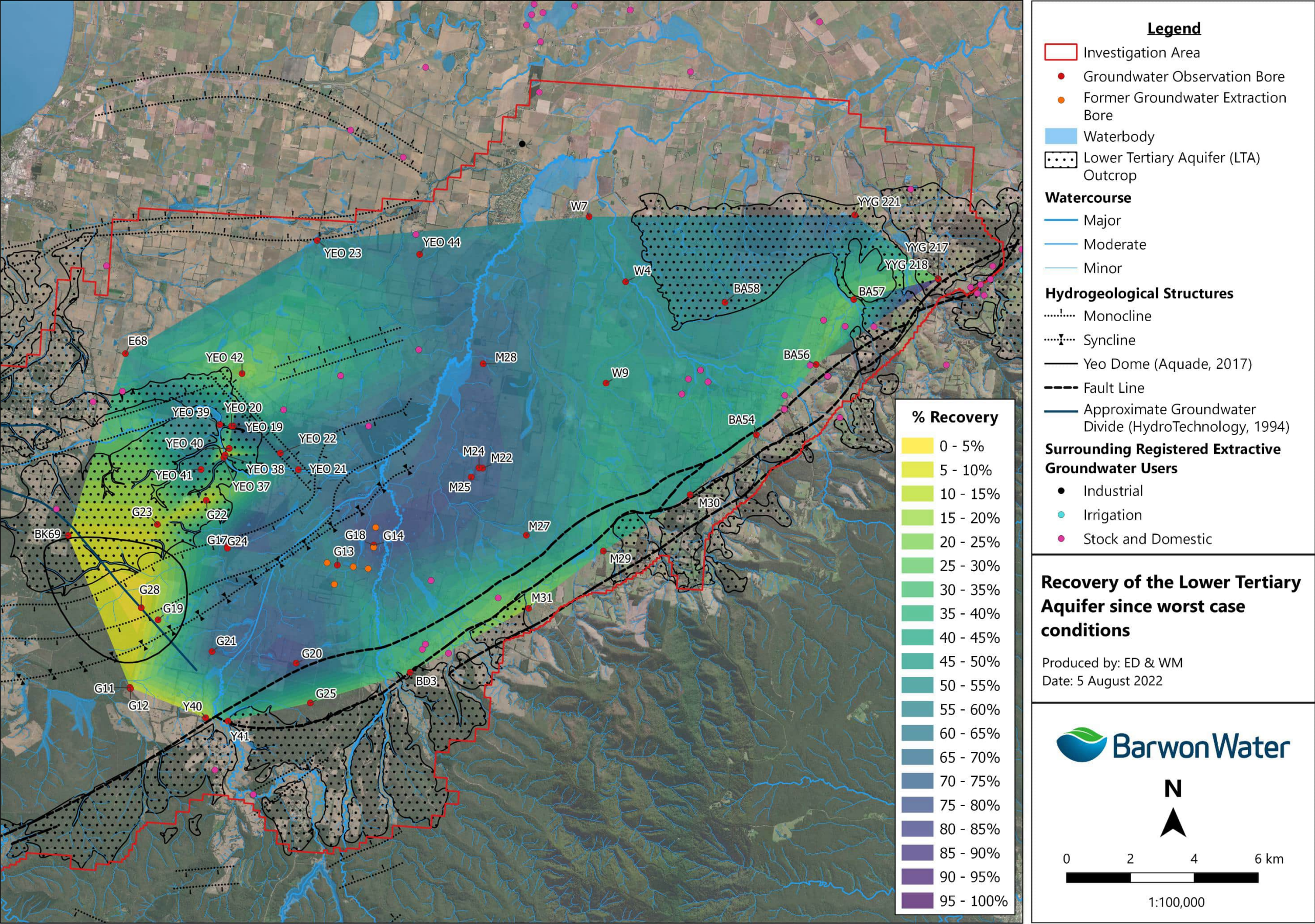


Figure 2 Recovery of the Lower Tertiary Aquifer since worst case conditions

4 Boundary Creek and Big Swamp Remediation Plan

4.1 Boundary Creek and Big Swamp Status Update

As reported in the Quarterly Updates, the conditions within Boundary Creek and Big Swamp have improved since the implementation of the REPP commenced. This is due to the cessation of pumping activities at the Barwon Downs borefield in 2016, the continued release of supplementary flows to Boundary Creek as required, and recent climatic conditions involving high rainfall. This has led to the recovery and re-pressurisation of the Lower Tertiary Aquifer system, the re-saturation of naturally occurring acid sulfate soils and a decreased occurrence of wet-dry cycling within Boundary Creek and Big Swamp. This continues to be evidenced by both the groundwater level (refer Figure 3 and Figure 4) and surface water monitoring data (refer Figure 5 and Figure 6). Noting that the water quality in Boundary Creek downstream of Big Swamp as monitored at stream gauge 233228 continues to fluctuate between seasons.

As forecast in the hydrogeochemical modelling report (Barwon Water, 2021), a slight decline in water quality was recorded at stream gauge 233276 between May and June 2022 as groundwater levels and streamflow increased following the drier and warmer summer period. This is reflective of the flushing of acidity from unsaturated acid sulfate soils that occur within the alluvial deposits and is consistent with the natural seasonal variation in soil moisture.

In addition to this, as outlined in the Outcomes and Implications of the Upstream Treatment Investigation report (Barwon Water, 2022), Barwon Water have since ruled out the use of the proposed semi-passive caustic magnesite treatment system. This decision was supported by Southern Rural Water and the Independent Technical Review Panel (ITRP) in their response received on 29 August 2022 and accounts for a range of technical, social, environmental and economic factors including:

- The inability of the proposed system to meet the intended objectives
- The potential for further harm to the environment and ecological values
- The novelty and untested nature of such a system in a similar environment
- The cost and time that would be required to conduct sufficient laboratory testing and trials to identify and validate a suitable reagent and design
- The improvements in conditions (e.g. water levels, quality and ecological condition)
- The communities preference to minimise engineering interventions, facilitate natural recovery and prevent any further harm

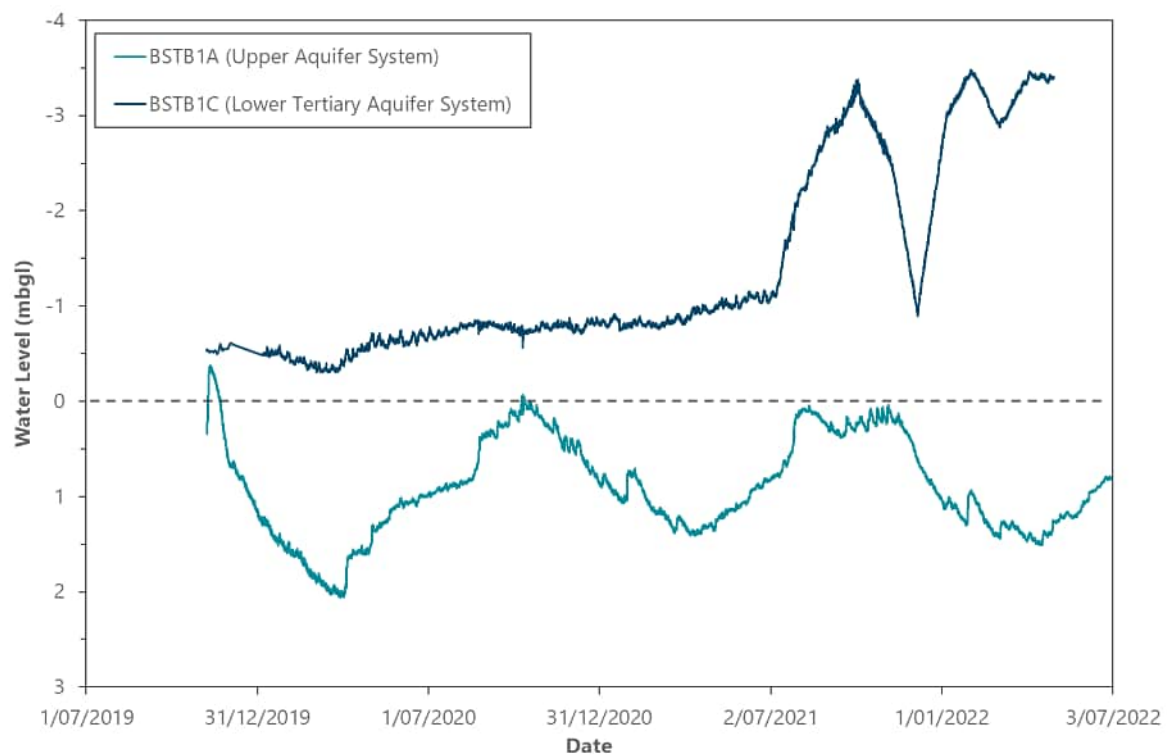


Figure 3 Groundwater levels in the eastern portion of the swamp. Note that the absence of data for BSTB1C after April 2022 is due to the logger being removed due to leakage associated with re-pressurisation of the LTA and headwork's modifications undertaken in April 2022

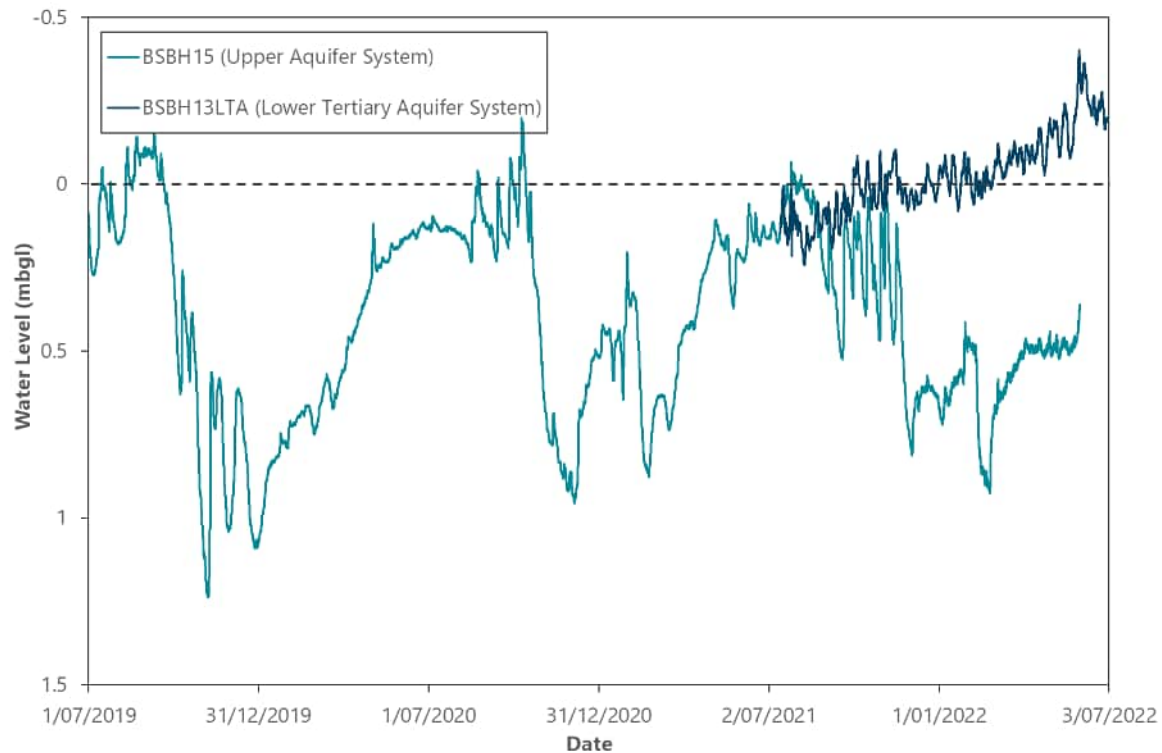


Figure 4 Groundwater levels in the western portion of the swamp. Note that the logger from BSBH15 was found to be missing on 14 July 2022 and was replaced on 15 August 2022

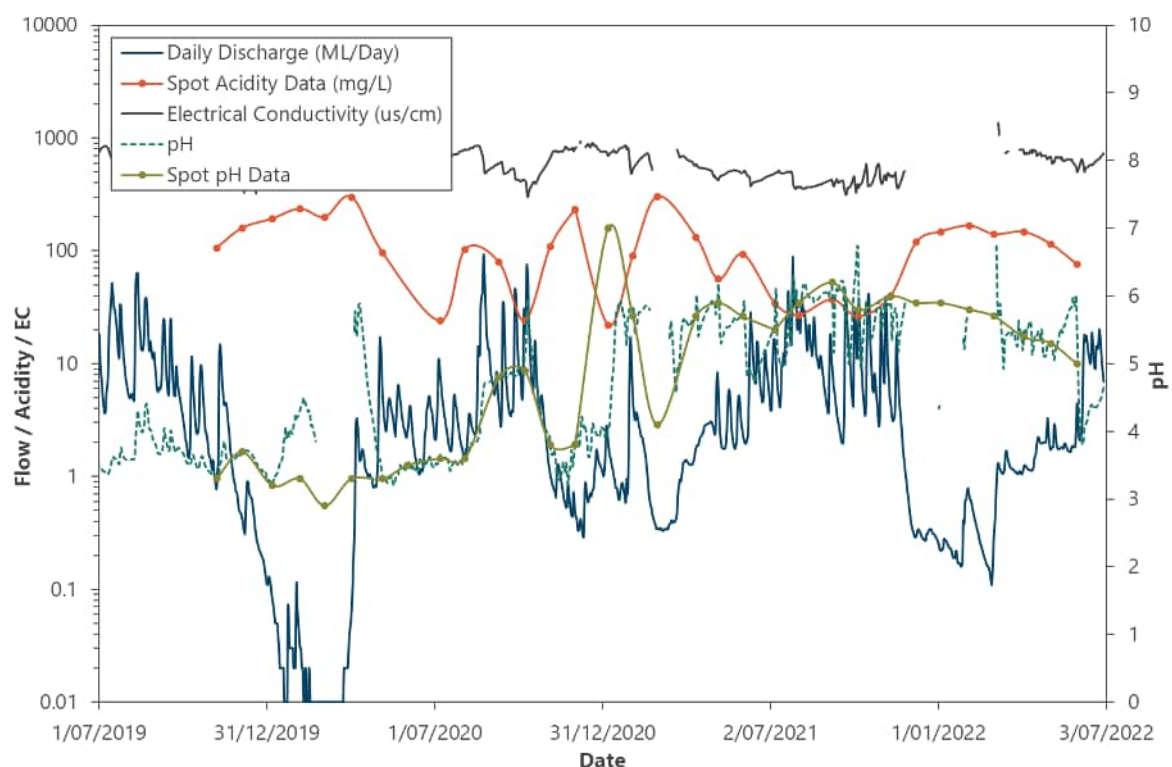


Figure 5 Streamflow, pH, EC and acidity readings in Boundary Creek – downstream of Big Swamp as recorded at stream gauge 233276 and during routine spot sampling

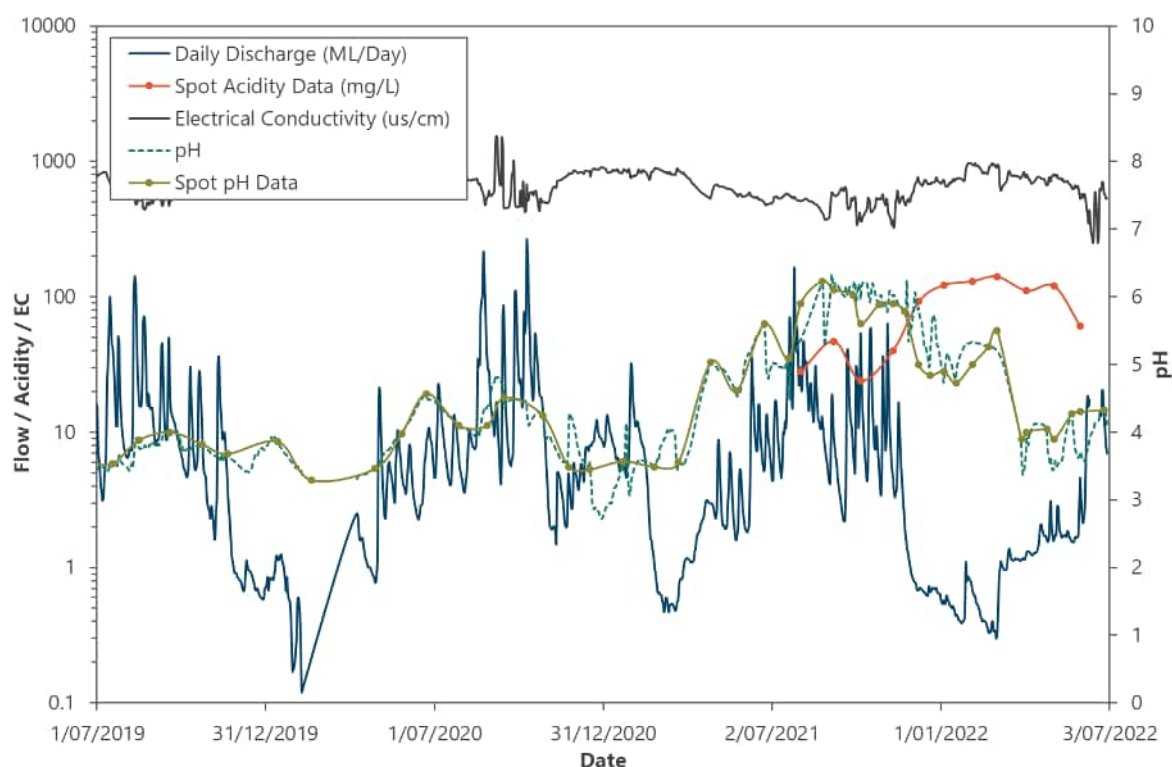


Figure 6 Streamflow, pH and acidity readings in Boundary Creek at Yeodene as recorded at stream gauge 233228 and during routine spot sampling

4.2 Actions Completed on the Boundary Creek and Big Swamp Remediation Plan During 2021-2022

Table 3 outlines the actions completed for the Boundary Creek and Big Swamp Remediation Plan between 1 July 2021 and 30 June 2022.

Table 3 Boundary Creek and Big Swamp - Actions completed in 2021-2022 (1 July 2021 – 30 June 2022)

Action Items	Comment / Link
REPP Specific Items	
Completion of quarterly Remediation Reference Group meetings	Completed on: 8 September 2021 9 December 2021 21 March 2022 8 June 2022
Hosted in-person community information sessions at Winchelsea and Colac for members of the community to receive an update on the project and engage with the project team (sessions were promoted through local newsletters, newspapers, social media and to community networks)	Completed on 10 May (Winchelsea) Completed on 17 May (Colac)
Submission of Quarterly and Annual Reports	Complete. Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Continue to collect data from new and existing monitoring assets	Complete and ongoing
Continue to release supplementary flows, where required, to try to maintain a flow of at least 0.5 ML/day at the Yeodene stream gauge #233228	Complete and ongoing Refer to Section 4.5.4 for further information.
Detailed design of the hydraulic barriers	The detailed design of the hydraulic barriers was submitted to Southern Rural Water on 1 July 2021. Barwon Water have since reviewed the viability of this remedial action as part of the Outcomes and Implications of the Upstream Treatment Investigation (Barwon Water, 2022) and no longer consider hydraulic barriers, at least in their current form, as a potential remedial action due to the unintended impacts that would result from implementing this approach. Refer to Section 4.4 for further information.

Action Items	Comment / Link
	Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Review and development of success targets for remediation of Boundary Creek and Big Swamp, including possible groundwater recovery targets for the Lower Tertiary Aquifer.	This was submitted to Southern Rural Water on 1 July 2021 as part of the detailed design of hydraulic barriers submission. It is noted that these have not formally been adopted as part of the REPP and require further assessment before these can be formally adopted. Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Hydrogeochemical modelling and design of contingency measures for active treatment of acidity loads	This was submitted to Southern Rural Water on 31 July 2021 as part of the hydraulic barrier detailed design and published to the Your Say website. Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek Refer to Section 0 for further information regarding the status of active treatment options.
Finalise remaining REPP amendments to address Southern Rural Water feedback.	Barwon Water and Southern Rural Water are in ongoing discussions regarding the proposed amendments to address any outstanding feedback prior to making any formal updates to the REPP. This will include additional revisions to account for the current 'state of knowledge' and community sentiment to ensure the REPP remains fit for purpose. Refer to Section 8 for further information.
Undertake spring macro-invertebrate and water quality sampling in the Barwon River and Boundary Creek	Sampling undertaken in November 2021 and May 2022. The findings of this are provided in the Upper Barwon River Macroinvertebrate Sampling Report 2019-2022. Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Undertake Upstream Treatment Trial Investigation to assess the feasibility of implementing a potential caustic magnesia based treatment system in treating the acidity at the source	In November 2021 Barwon Water engaged Earth Systems to conduct a desktop treatment options assessment and concept design focused on the proposed caustic magnesia based upstream treatment system. This included the completion of a workshop with Barwon Water, the appointed consultants and the Remediation Reference Group's nominated experts on 24 November 2021. The findings from this work were used to

Action Items	Comment / Link
	<p>develop a Treatment Trial Plan that was subsequently submitted to Southern Rural Water on 14 January 2022 in conjunction with the Ecological Risk Assessment.</p> <p>On 10 March 2022 a field visit was conducted with members of Barwon Water's Remediation Reference Group, Southern Rural Water and members of the ITRP and Southern Rural Water's Community Leaders Group. This visit was completed in response to feedback received during the December 2021 RRG meeting and was a great opportunity for key stakeholders to see the swamp in real life and contextualise what a small-scale field trial of the proposed caustic magnesia based treatment system would look like.</p> <p>Following feedback on the Trial Plan, Barwon Water engaged Earth System to conduct the laboratory trials required to better inform the feasibility assessment. The findings of this work were discussed during a workshop with Barwon Water, the RRG nominated experts, Southern Rural Water and the ITRP members on 31 May 2022.</p> <p>Based on the outcomes of this work that were submitted to Southern Rural Water on 30 June 2022, Barwon Water have since ruled out the use of the proposed semi-passive caustic magnesia treatment system. This decision was supported by Southern Rural Water and the Independent Technical Review Panel (ITRP) in their response received on 29 August 2022.</p> <p>Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek</p>
Additional Items	
Attended and presented at the Southern Rural Water Community Leaders Group meeting on 17 August 2021	
Attended and presented at the Southern Rural Water Community Leaders Group meeting on 16 December 2021	
Submission of an EPA Permission Pathways Form to assess the relevant permissions required to conduct a small-scale field trial of the proposed upstream treatment system	Based on the response received from EPA Victoria on 1 March 2022, 'this activity is not a prescribed permission activity as per Schedule 1 of the Environment Protection Regulations 2021

Action Items	Comment / Link
	<p>– so no permission is required from EPA to undertake the activity’.</p> <p>However, in undertaking this activity Barwon Water would need to meet the General Environmental Duty, which requires us to minimise the risk to human health and the environment from our activities, so far as reasonably practicable and consider any waste duties should any waste be generated as part of the trial.</p>
Submission of an EPA Permission Pathways Form to assess if any permissions are required from EPA to facilitate the use of supplementary flows as documented in the REPP	<p>Based on the response received from EPA Victoria on 30 March 2022, ‘this activity is not a prescribed permission activity as per Schedule 1 of the Environment Protection Regulations 2021 – so no permission is required from EPA to undertake the activity’.</p> <p>However, in undertaking this activity Barwon Water would need to meet the General Environmental Duty, which requires us to minimise the risk to human health and the environment from our activities, so far as reasonably practicable.</p>

4.3 Upcoming Actions Associated with the Boundary Creek & Big Swamp Remediation Plan

Table 4 outlines the upcoming actions associated with the Boundary Creek and Big Swamp Remediation Plan between 1 July 2022 and 30 June 2023.

Table 4 Boundary Creek and Big Swamp - Upcoming actions / milestones for 2022-2023 (1 July 2022 – 30 June 2022)

Action Items	Due
Completion of quarterly Remediation Reference Group meetings	Due in September, December, March and June each year. Noting that timing can change to account for RRG member availability or technical works.
Completion of ongoing community engagement to share updates on the project	Specific dates to be defined, but expected to be within the first 6 months of the 2023 calendar year
Submission of Quarterly and Annual Reports	<p>Quarterly reporting will occur in September, December, March and June each year and will be submitted to Southern Rural Water by the last day of the month.</p> <p>In addition to this, a draft annual report will be submitted to Southern Rural Water for review</p>

Action Items	Due
	and approval at least 14 days prior to the September submission date (being 30 September each year).
Continue to collect data from new and existing monitoring assets	Ongoing
Continue to release supplementary flows, where required, to try to maintain a flow of at least 0.5 ML/day at the Yeodene stream gauge #233228	Ongoing
Inclusion of decommissioning of the Barwon Downs production bores in the 2023-2028 price submission	The draft price submission was posted for community feedback in July 2022. The final price submission is due to be submitted to the Essential Services Commission in September 2022.
Progress amendment of the REPP based on the current 'state of knowledge' and the adaptive management approach. This will include a review of the adopted remedial actions and the development of a risk-based remedial strategy that accounts for recent community and stakeholder feedback to help facilitate natural recovery processes.	Barwon Water aim to submit a revised REPP that accounts for the current 'state of knowledge' to Southern Rural Water by the end of December 2022. It is noted that this requires review and approval by Southern Rural Water before this can be adopted. Once adopted this will supersede the current REPP that was approved in February 2020.
Development of contingency measures	Following completion of the Upstream Treatment Investigation in June 2022, Barwon Water have committed to: <ol style="list-style-type: none"> 1. Reviewing the existing design of the downstream treatment system to address the community and stakeholder feedback received on the proposed design, with the aim to get an approved design so that this can be implemented, should this be required in 2023-2024 2. Reviewing the potential use of permeable reactive barriers, or similar, that were initially included in the Remedial Options Assessment (ROA) (CDM Smith, 2019), to neutralise the acidity within the swamp. Noting that unintended impacts would also need to be minimised to achieve community and stakeholder support; and 3. Developing a risk-based contingency approach that minimises the potential for further harm which could result from the implementation of heavily engineered remedial actions.

Action Items	Due
Completion of a Level 3 Ecological Risk Assessment to quantify the risks of the existing metal and acidity loads on Boundary Creek, Big Swamp and the Barwon River and to help inform the development of suitable triggers for the implementation of relevant contingency measures, if required	This work commenced in September 2022 and is forecast to be completed by the end of June 2023
Completion of a paleoecology study of Big Swamp	In September 2022 Barwon Water engaged a consultant to undertake these works, with work forecast to commence in October 2022. It is anticipated these works will be completed by the end of June 2023.

4.4 Status of Remedial Actions

The status of the remedial actions outlined in the REPP is provided in Table 5 below.

Table 5 Status of remediation actions

Description	Purpose	Priority	Progress
Cessation of groundwater pumping activities at the Barwon Downs borefield	Allow groundwater levels in the Lower Tertiary Aquifer (LTA) to recover and enable baseflow to return	Short term	Complete and ongoing
Use of supplementary flows, where required, to maintain flows in Reach 3 of Boundary Creek all year round	Minimise wet-dry cycling, maintain saturation of acid sulfate soils and provide suitable conditions for wetland species to recolonise impacted areas	Short term	Complete and ongoing
Construction of hydraulic barriers	Effectively distribute flows across the swamp to minimise wet-dry cycling, maintain saturation of acid sulfate soils and prevent water table decline in the watertable aquifer system	Mid-longer term	Initial design completed and submitted to Southern Rural Water in July 2021. However, given the current and continued recovery of groundwater levels and the potential to increase secondary acidification, at least in the short-term and consideration of the 'do not harm' principle, Barwon Water no longer considers hydraulic barriers, at least in their current form as a

			potential remedial action (Barwon Water, 2022). Rather the use of more targeted and less intrusive water diversion barriers will be considered as part of the tiered risk-based contingency approach.
Infilling of the existing fire trenches and agricultural drain	Allow the swamp to retain more water over the winter months	Mid-longer term	Following completion of the upstream treatment investigation the applicability of hydraulic barriers has been reviewed. Given this is unlikely to assist with maintaining moisture within the swamp and lead to ecological impacts related to soil disturbance and removal of vegetation, this will need to be modified as part of the proposed risk-based contingency approach (Barwon Water, 2022)
Prevent the encroachment of dry vegetation classes	Provide suitable conditions for wetland species to recolonise disturbed areas.	Mid-longer term	Ongoing
Development of contingency measures	Reduce the metal and acidity loads and improve pH to reduce risks to downstream aquatic ecosystems	Mid-longer term	In progress, refer Section 0

4.5 Review of Success Targets

Table 6 below summarises the interim success targets that were outlined in the REPP, as well as performance to date against those targets. In order for successful remediation to be demonstrated, all success targets need to be achieved concurrently, while some targets such as flows in Boundary Creek need to also be achieved for a minimum period of two consecutive years to confirm sustainability.

It is also important to note that a review of these success targets and some revised success targets were also submitted to Southern Rural Water on 1 July 2021. The draft updated success targets have not yet been reflected in the REPP and will be reviewed in preparation of the revised REPP, which is expected to be submitted to Southern Rural Water by the end of

December 2022. As such the interim success targets continue to be used for reporting purposes in this report.

The following sections provide an overview of progress against these targets, and the draft revised targets where appropriate to help inform the remedial status to date.

Table 6 Boundary Creek and Big Swamp Remediation Success Targets

Success target	Measurement	Section Reference
Recovery trend for groundwater levels in the LTA (subject to median climate and no additional groundwater extraction above the current PCV limit)	Monitoring of groundwater levels in observation bores 64229 (G13), 64236 (G20), 82844 (M28R) and 109131 (YEO40R) to develop hydrographs to confirm a recovery trend line in LTA groundwater levels	Refer Section 4.5.1
No further encroachment of terrestrial woodland into the swamp plain	Independent monitoring of established transects to map changes in distribution and area, with current vegetation mapping to form the baseline for assessment of change along with condition scores.	Refer Section 4.5.2
No encroachment of Lowland Forest dominant species into areas of Damp Forest	Independent monitoring of established transects to map changes in distribution and area, with current vegetation mapping to form the baseline for assessment of change along with condition scores.	
No loss of structural or floristic diversity along the main channel and western end of the swamp.	Independent regular monitoring of quadrats to assess changes in species diversity over time, with a baseline assessment undertaken to form the basis for measuring changes in structural or floristic diversity along with condition scores.	
Increase diversity of understorey species within the swamp plain, with a focus on ferns and sedges	Independent monitoring of established transects to map changes in distribution and area, with current vegetation mapping to form the baseline for assessment of change along with condition scores.	
Big Swamp BH01 water table level less than 1.0 m below ground level* maintained for a period of 2 years	Water table levels	
Big Swamp BH06 water table level less than 1.5 m below ground level* maintained for a period of 2 years	Water table levels	Refer Section 4.5.3

Success target	Measurement	Section Reference
Big Swamp BH09 water table level less than 1.8 m below ground level* maintained for a period of 2 years	Water table levels	
Big Swamp BH12 water table level less than 1.9 m below ground level* maintained for a period of 2 years	Water table levels	
Big Swamp BH15 water table level less than 1.0 m below ground level* maintained for a period of 2 years	Water table levels	
At least 0.5 ML/day flow maintained at site 233228 Boundary Creek @ Yeodene stream gauge maintained for a period of 2 years (Subject to passing flow conditions being enforced at 'McDonald's Dam' in accordance with its licence conditions - dam licence no. WLE043336)	Flow ML/day	Refer Section 4.5.4
Annual median pH equal to or greater than 6.5* at site 233228 Boundary Creek @ Yeodene stream gauge maintained for a period of 2 years To be refined pending completion of geochemical modelling (Dec 2020).	pH equal to or greater than 6.5* (annual median)	Refer Section 4.5.5

4.5.1 Recovery Trend for Groundwater Levels in the Lower Tertiary Aquifer

As outlined in Section 3, water level data continues to indicate the recovery and re-pressurisation of the Lower Tertiary Aquifer following the cessation of groundwater pumping activities in 2016. This is supported by hydrographs from the critical monitoring bores outlined in the REPP (Figure 7) and the draft revised regional water level targets (Figure 8). It is noted that water level targets for BSTB1C and BSBH13 that are installed within the Lower Tertiary Aquifer will be revised as part of the revised REPP.

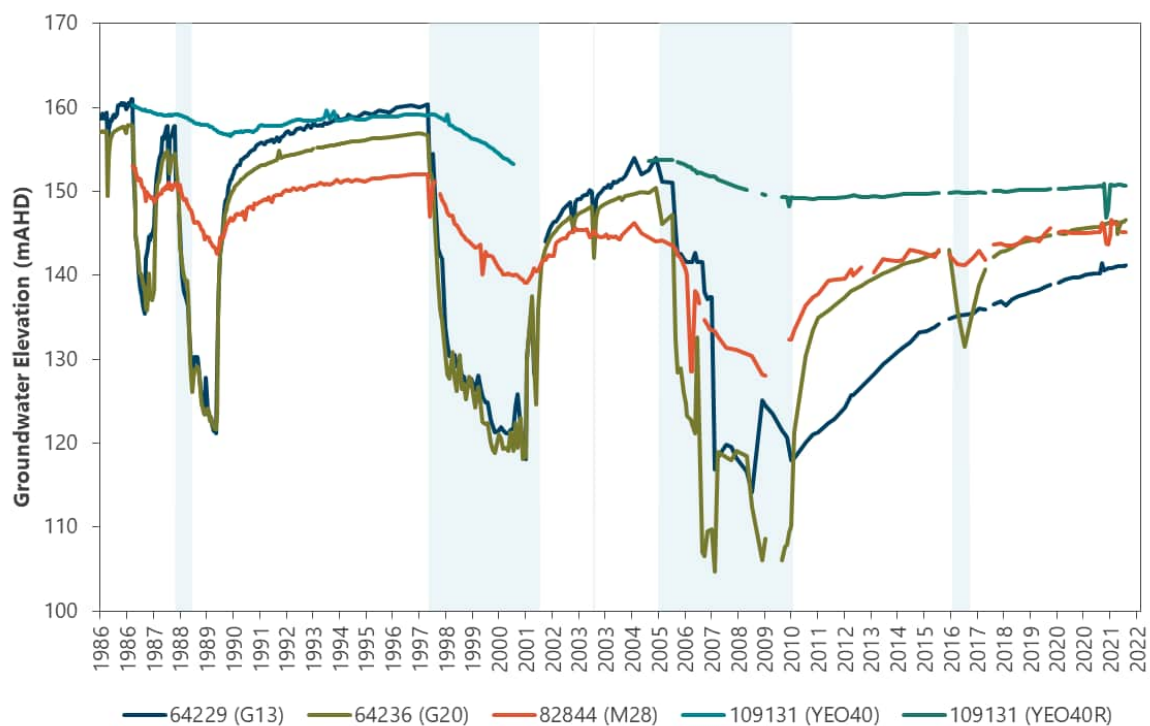


Figure 7 Hydrographs from the LTA monitoring bores outlined in the REPP

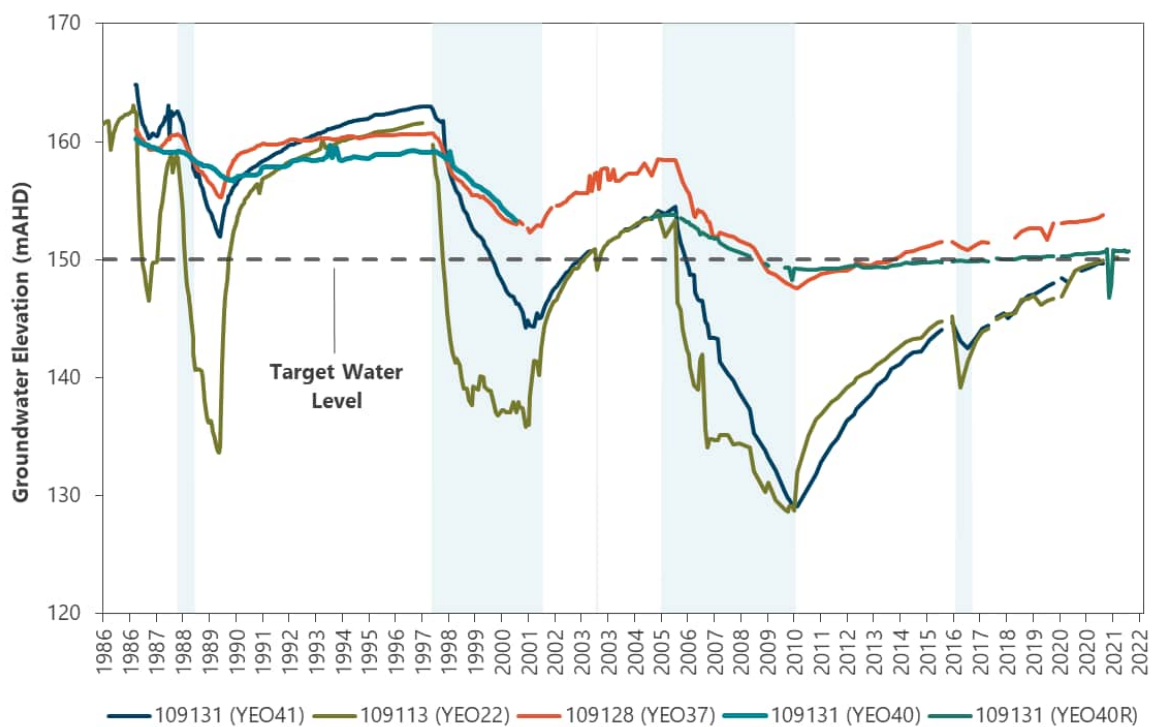


Figure 8 Hydrographs and targets from specific bores identified in the draft revised success targets

4.5.2 Big Swamp Vegetation

Ongoing biennial vegetation monitoring within Big Swamp was established during 2020/21. While the next monitoring event is due to occur in November 2022, the vegetation monitoring report from November 2020 is available in the document library on the Boundary Creek Remediation web page: <https://www.yoursay.barwonwater.vic.gov.au/boundary-creek>

The findings from the November 2020 monitoring event reported the following outcomes when compared to the initial ecohydrological assessment that was conducted in 2019:

- A decrease in Lowland Forest dominant species at the majority of monitoring locations
- No marked change in terrestrial woodland species
- No substantial decreases in structural or floristic diversity within the main channel and western end of the swamp, and
- An increased in diversity in the swamp plain

Longer term improvements are also evidenced from the site photos that were included in the Outcomes and Implications of the Upstream Treatment Investigation report (Barwon Water, 2022), which show that vegetation condition within some areas of the swamp have shown significant recovery.



2010



2019



2021

The findings of the next routine vegetation monitoring event will be summarised as part of the 2022-2023 Annual Report. The 2022 vegetation monitoring report will be made available in the document library on the Boundary Creek Remediation web page once finalised:

<https://www.yoursay.barwonwater.vic.gov.au/boundary-creek>

4.5.3 Big Swamp Groundwater Levels

All hydrographs for the monitoring bores located within in Big Swamp have been provided in Appendix C, with a summary of the groundwater levels compared to the interim and revised interim targets provided in Table 7 below.

Based on this assessment, revised interim water level targets have already consistently been achieved at 8 of the 15 monitoring bores, with the water levels at an additional 5 bores achieving the revised interim water level targets at least some of the time. It is noted that the water levels at BSBH14 and BSBH18 remain below the revised interim water level targets of 0.15 and 0.2 mbgl respectively. This indicates that the targets set for these bores may not be achievable and may need to be revised as required, as part of the revised REPP.

Table 7 Big Swamp water level target assessment

Site Code	Reporting Period	Lowest Water Level (mbgl)	Highest Water Level (mbgl)	Average Water Level (mbgl)	Interim Water Level Target (mbgl)	Status of Interim Water Level Target	Revised Interim Water Level Target (mbgl)	Status of Revised Interim Water Level Target
BSBH01	2019-2020	0.4	-0.4	0.1	1	Achieved	0.7	Achieved
	2020-2021	0.3	-0.5	0.0				
	2021-2022	0.4	-0.4	0.0				
BSBH02	2019-2020	0.3	-0.5	-0.1	N/A	N/A	1.2	Achieved
	2020-2021	0.0	-0.7	-0.2				
	2021-2022	0.1	-0.5	-0.2				
BSBH03	2019-2020	0.2	-0.5	-0.1	N/A	N/A	1.6	Achieved
	2020-2021	0.0	-0.6	-0.2				
	2021-2022	0.0	-0.6	-0.3				
BSBH04	2019-2020	0.3	0.0	0.2	N/A	N/A	0.6	Achieved
	2020-2021	0.1	-0.3	-0.1				
	2021-2022	0.0	-0.4	-0.2				
BSBH05	2019-2020	1.0	0.0	0.5	N/A	N/A	1	Achieved
	2020-2021	0.4	-0.1	0.2				
	2021-2022	0.8	-0.1	0.3				
BSBH06	2019-2020	1.5	0.3	0.9	1.5	Achieved	1	Partially Achieved
	2020-2021	1.1	0.1	0.7				
	2021-2022	1.4	0.2	0.7				
BSBH07	2019-2020	0.3	-0.6	-0.2	N/A	N/A	0.4	Achieved
	2020-2021	-0.1	-0.6	-0.4				
	2021-2022	0.1	-0.6	-0.3				
BSBH08	2019-2020	1.1	0.5	0.8	N/A	N/A	0.4	Partially Achieved
	2020-2021	0.8	0.4	0.6				
	2021-2022	0.7	0.2	0.5				
BSBH09	2019-2020	1.5	0.6	1.2	1.8	Achieved	1.5	Achieved
	2020-2021	1.2	0.7	1.0				
	2021-2022	1.2	0.7	1.0				

Site Code	Reporting Period	Lowest Water Level (mbgl)	Highest Water Level (mbgl)	Average Water Level (mbgl)	Interim Water Level Target (mbgl)	Status of Interim Water Level Target	Revised Interim Water Level Target (mbgl)	Status of Revised Interim Water Level Target
BSBH10	2019-2020	1.7	0.4	1.1	N/A	N/A	2	Achieved
	2020-2021	1.0	0.3	0.6				
	2021-2022	1.2	0.4	0.7				
BSBH11	2019-2020	2.1	0.7	1.3	N/A	N/A	1.5	Partially Achieved
	2020-2021	1.5	0.5	1.2				
	2021-2022	1.6	0.5	1.0				
BSBH12	2019-2020	1.6	0.8	1.2	1.9	Achieved	1.2	Partially Achieved
	2020-2021	1.3	0.7	1.2				
	2021-2022	1.3	0.7	1.0				
BSBH14	2019-2020	1.6	0.8	1.2	N/A	N/A	0.15	Not yet achieved
	2020-2021	1.2	0.5	0.9				
	2021-2022	0.8	0.2	0.6				
BSBH15	2019-2020	1.2	-0.2	0.4	1	Achieved	0.2	Partially Achieved
	2020-2021	1.0	-0.2	0.4				
	2021-2022	0.9	-0.1	0.4				
BSBH18	2019-2020	1.5	0.5	0.8	N/A	N/A	0.2	Not yet achieved
	2020-2021	1.0	0.2	0.6				
	2021-2022	1.3	0.3	0.6				

4.5.4 Surface Water Flow in Boundary Creek

Approximately 376 ML of supplementary flows were released into Reach 1 of Boundary Creek during the 2021-2022 period (refer Appendix D) in line with the remediation actions outlined in the REPP to:

1. Maintain saturation of the naturally occurring acid sulfate soils, and
2. Maintain flows in the lower reaches of Boundary Creek

As can be seen from Figure 9, the supplementary flows continue to assist in maintaining flows in the lower reaches of Boundary Creek during the drier months (i.e. between December and April) when streamflows are at their lowest. Noting that the effectiveness of these supplementary flows is reliant on Barwon Water manually adjusting the release valve of the private on-stream dam.

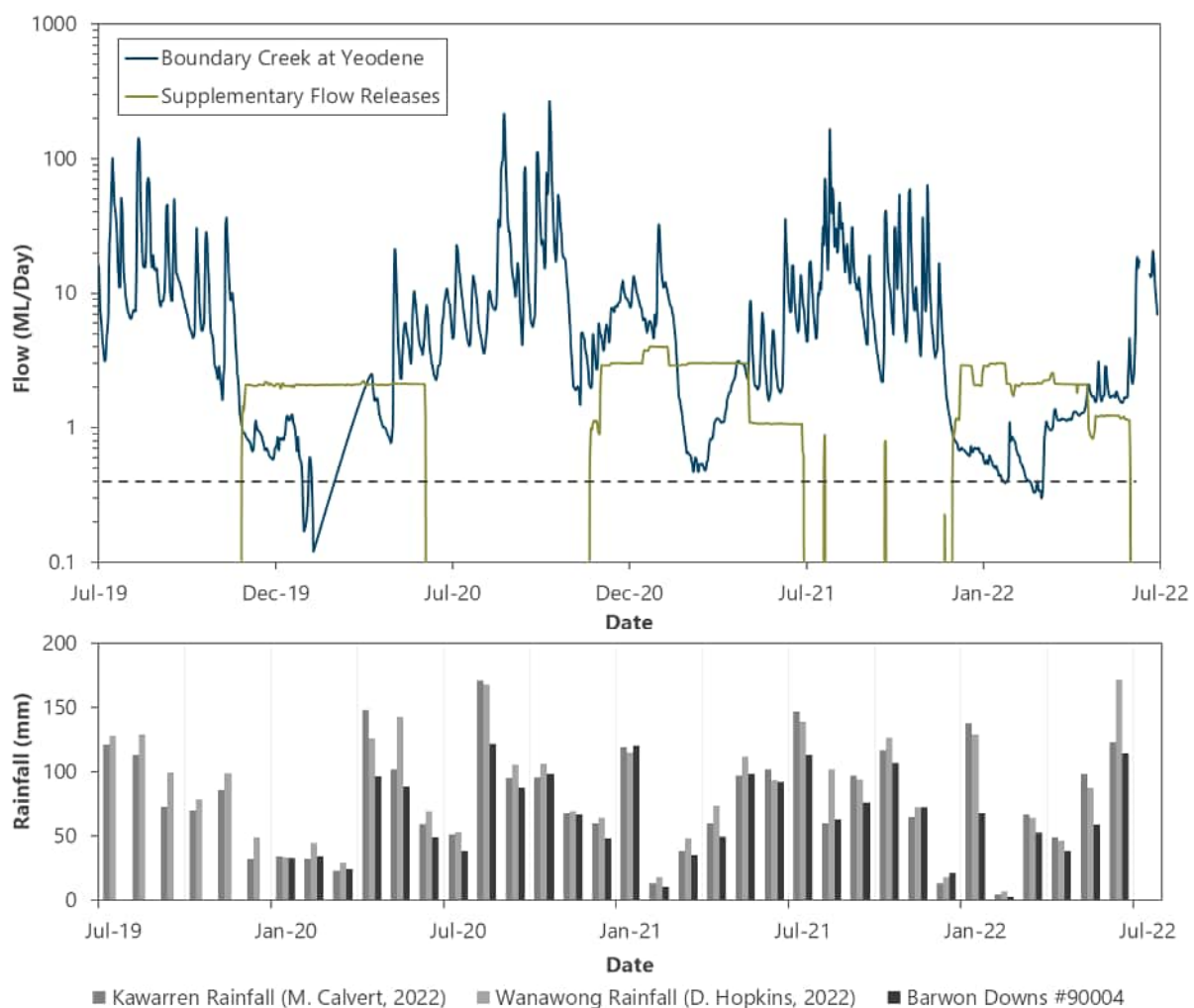


Figure 9 Surface water flows at the Yeodene stream gauge (station #233228)

Based on the telemetered data obtained from the Department of Environment, Land, Water & Planning's Water Measurement Information System (WMIS) (<https://data.water.vic.gov.au/>), streamflows recorded at Boundary Creek at Yeodene (station #233228), indicate that a minimum flow of 0.3 ML/day was maintained during the 2021-2022 period (Table 8). While this does not meet the intended target of 0.5 ML/day, this should not be considered a failure given this indicates no cease to flow events occurred during the 2021-2022 period.

Table 8 Summary flow statistics for Boundary Creek at Yeodene

Data Source	Measure	2019-2020	2020-2021	2021-2022
Telemetered Data (WMIS)	Min	0.0	0.5	0.3
	10th Percentile	0.0	1.1	0.5
	25th Percentile	0.7	2.4	0.8
	50th Percentile	3.0	6.0	1.9
	75th Percentile	8.8	11.0	10.1
	90th Percentile	20.3	26.2	22.5
	Max	141.9	258.6	161.8
	Average	8.4	13.1	8.0

4.5.5 Boundary Creek pH

Based on the telemetered and spot sampling data obtained from the Department of Environment, Land, Water & Planning's Water Measurement Information System (WMIS) (<https://data.water.vic.gov.au/>) and the analytical results from Barwon Water's routine water quality monitoring program, the average annual pH recorded at Boundary Creek at Yeodene (Station #233228) during the 2021-2022 period was 5.1 pH units (Table 9). As outlined in Table 9 this is one pH unit higher than the previous reporting period that recorded an average annual pH of 4.1 pH units. While this remains below the interim target of 6.5 pH units, it is currently unclear if a target of 6.5 is practicable due the presence of naturally occurring acid sulfate soils, low buffering capacity of the system and seasonal flushing of acidity that may continue, at least to some degree, under natural conditions.

Further work is currently underway to better inform the potential risks associated with the discharge of metal and acidity loads to the lower reaches of Boundary Creek and the Barwon River as part of the Level 3 Ecological Risk Assessment. The findings from this work will be used to inform the development of suitable triggers for the implementation of relevant contingency measures, if required.

Table 9 Summary pH statistics for Boundary Creek at Yeodene

Data Source	Measure	Reporting Period		
		2019-2020	2020-2021	2021-2022
Telemetered Data (WMIS)	Min	3.3	2.7	3.4
	10th Percentile	3.4	3.4	3.8
	25th Percentile	3.5	3.6	4.3
	50th Percentile	3.7	4.1	5.2
	75th Percentile	3.8	4.5	5.9
	90th Percentile	4.1	4.9	6.1
	Max	4.5	5.6	6.3
	Average	3.7	4.1	5.1
Spot Sampling Data (WMIS & Barwon Water)	Min	3.3	3.5	3.9
	Max	4.6	5.6	6.2
	Median	3.8	4.1	5.0
	Average	3.8	4.1	5.1

4.6 Contingency Measures

Table 10 outlines the contingency measures identified during the design and implementation of the REPP. It is noted that no contingency measures have been implemented to date.

Table 10 Contingency Measures Identified

Contingency Measure	Status
Downstream treatment – preferred method being a sodium hydroxide (NaOH) dosing plant	<p>The design of the downstream contingency measure was submitted to Southern Rural Water on 30 July 2021. Following submission Barwon Water received feedback from Southern Rural Water and the ITRP requiring further information before this could be progressed any further and requested investigation of a novel upstream treatment systems. Given the commencement of the upstream treatment investigation, the downstream treatment option was put on hold until the feasibility of the upstream treatment system could be ascertained.</p> <p>Following completion of the Upstream Treatment Investigation in June 2022, Barwon Water will progress responding to Southern Rural Water and ITRP feedback on the downstream treatment option with the aim to get a downstream treatment option approved by Southern Rural Water so that this can be implemented, should this be required in 2023-2024.</p>
Upstream treatment – using caustic magnesia (MgO)	<p>Barwon Water have since ruled out the use of the proposed semi-passive caustic magnesia treatment system. This decision was supported by Southern Rural Water and the Independent Technical Review Panel (ITRP) in their response received on 29 August 2022 and is based</p>

Contingency Measure	Status
	<p>on a range of technical, social, environmental and economic factors including:</p> <ul style="list-style-type: none"> • The inability of the proposed system to meet the intended objectives • The potential for further harm to the environment and ecological values to occur • The novelty and untested nature of such a system in a similar environment • The cost and time that would be required to conduct sufficient laboratory testing and trials to identify and validate a suitable reagent and design • The improvements in conditions (e.g. water levels, quality and ecological condition) • Significant stakeholder feedback and concern relating to: <ul style="list-style-type: none"> • Potential risks • The inclusion of the 'do no harm' principle • Minimising engineering interventions, and • Preference to facilitate natural recovery processes

Following completion of the Upstream Treatment Investigation in June 2022, Barwon Water have committed to:

1. Reviewing the existing design of the downstream treatment system to address the community and stakeholder feedback received on the proposed design, with the aim to get an approved design so that this can be implemented, should this be required in 2023-2024
2. Reviewing the potential use of permeable reactive barriers, or similar, that were initially included in the Remedial Options Assessment (ROA) (CDM Smith, 2019), to neutralise the acidity within the swamp. Noting that unintended impacts would also need to be minimised to achieve community and stakeholder support, and
3. Developing a risk-based contingency approach that minimises the potential for further harm which could result from the implementation of heavily engineered remedial actions.

4.7 Boundary Creek and Big Swamp Water Quality

Analytical data for key analytes of interest obtained as part of Barwon Water's routine groundwater and surface water monitoring program are shown in Figure 10, with summary data provided in Appendix D. For the purposes of understanding the broad acidification/neutralisation processes at play this figure displays both the individual

concentrations from surface water monitoring stations and the average groundwater concentrations within the western and eastern portions of the swamp.



Figure 10 Concentrations of key analytes over time (Note that 233228 was only added to the routine water quality monitoring program in August 2021)

Based on the data presented in Figure 10, the following observations can be made:

- The remedial activities undertaken to date have been successful in minimising any further oxidation of the naturally occurring acid sulfate soils. This is evidenced by the slight long-term decrease in acidity concentrations reported in shallow groundwater bores located within the eastern and western portions of the swamp. Noting that the upper aquifer system remains a significant source of acidity and metals
- Groundwater samples obtained from bores installed within the upper aquifer system within the eastern and western portions of the swamp continue to exhibit substantially different chemical characteristics with the western bores reported a reduced pH and elevated electrical conductivity, acidity, sulfate, iron and aluminium concentrations compared to the eastern bores
- In general, the pH within Boundary Creek as measured at stream gauges 233276, located downstream of Big Swamp, and 233228, located on Boundary Creek at Yeodene indicates a long-term increasing trend. However, as anticipated in the Hydro-Geochemical Modelling report (Barwon Water, 2021), surface water quality continues to be impacted by seasonal flushing and acidification processes. Noting that the data also suggests a decrease in the magnitude of fluctuation in pH as measured at gauge 233276, which shows a variance of up to 0.4 pH units during 2021-2022 when compared to the previous reporting period that showed a variance of up to 3.2 pH units. This is likely due to both the recent wet conditions and the increased soil moisture as a result of the water level recovery within the upper aquifer system.
- Groundwater discharge from the upper aquifer system to surface water appears to have increased during the 2021-2022 reporting period. This is evidenced by the observed decrease in pH and corresponding increases in key analytes in routine water quality samples taken at stream gauges 233276 and 233228 since November 2021 which corresponds to when rainfall and streamflows started to decline (Figure 9). While anticipated, this pattern is slightly different to previous reporting periods and outlines the importance of groundwater-surface water interaction in maintaining surface water flows and quality
- While there has been a slight long-term improvement in groundwater and surface water quality, the acidity and metal loads within the Western portion of the swamp remain elevated when compared to both the eastern portion of the swamp and the surface water monitoring locations. This is likely due to the reduced water level recovery in this portion of the swamp and the drying of surficial soils which was observed in the western end of the swamp between January and May 2022.

Further to this, the ferric and ferrous iron monitoring data (Figure 11) continues to indicate that ferrous iron is generally the predominant iron species. However, as reported in the Outcomes and Implications of the Upstream Treatment Investigation report (Barwon Water, 2022), periodic decreases in ferric iron concentrations that correspond with increases in ferrous iron

suggest that iron reduction processes may be occurring when conditions are suitable, as forecast by Cook and Wong in 2020.

Despite this, as reported in the 2019-2022 Macroinvertebrate Sampling Report (Austral Research and Consulting, 2022), the continued mobilisation of acidity and metals from Boundary Creek to the Barwon River are of very limited downstream effect.

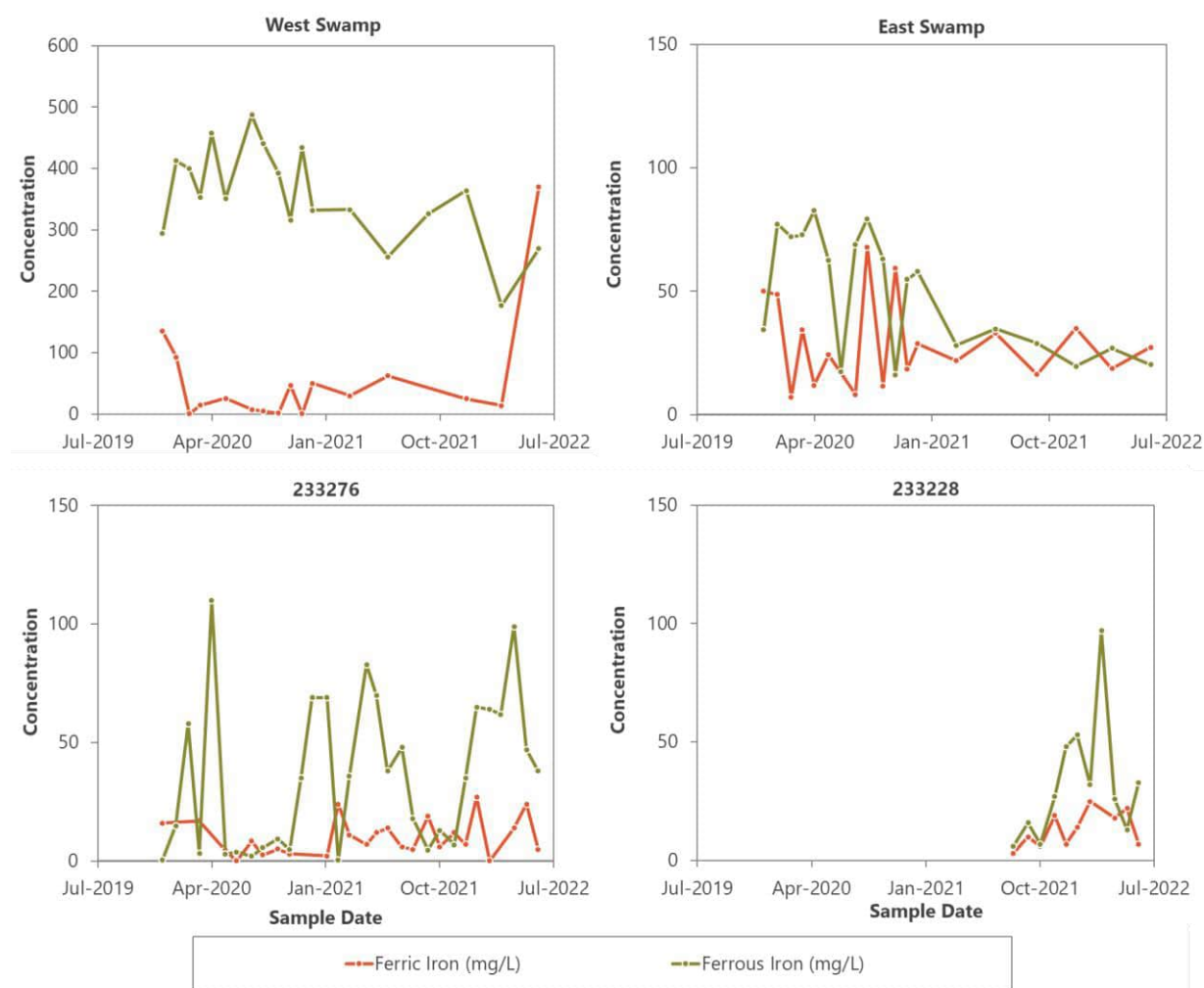


Figure 11 Ferric and ferrous iron concentrations over time (Note that site 233228 was only added to the routine water quality monitoring program in August 2021)

4.8 Macroinvertebrate Sampling

Ongoing biannual macroinvertebrate monitoring within Boundary Creek and the Barwon River was established in 2019/20. The monitoring reports from this work which were completed by Austral Research and Consulting are available in the document library on the Boundary Creek Remediation web page: <https://www.yoursay.barwonwater.vic.gov.au/boundary-creek>

The results from this work suggest that despite the poor ecological health in Boundary Creek downstream of Big Swamp, as indicated by the macroinvertebrate community, the condition of this reach is generally improving over time and despite the marginal water quality impacts to

the Barwon River, the macroinvertebrate community composition remains in a good condition downstream of the confluence.

Additional monitoring locations sampled during the autumn 2022 monitoring event also indicate that the two locations sampled upstream of Big Swamp are in very good condition and have comparable numbers of families present to sites along the Barwon River. The outcomes from this work also indicate that Boundary Creek upstream of Big Swamp appears to be in a good position to provide recolonization via drift or aerial dispersal to Big Swamp and the downstream portions of Boundary Creek provided water quality can be improved (Austral Research and Consulting, 2022).

5 Surrounding Environment Investigation

5.1 Surrounding Environment Investigation status update

The Surrounding Environment Investigation considers eight potentially impacted areas that were identified using the regional groundwater model and include the following areas:

- Barwon River (East branch)
- Barwon River (West branch)
- Barwon River (downstream of the confluence of the east and west branches)
- Gellibrand River and associated groundwater dependent ecosystems
- Ten Mile Creek
- Yahoo Creek
- Groundwater dependent ecosystems near Yeodene, and
- Groundwater dependent ecosystems near Deans Marsh

As reported in the Quarterly Updates, Barwon Water continues to progress with the surrounding environment investigation in line with the process outlined in

Figure 12.

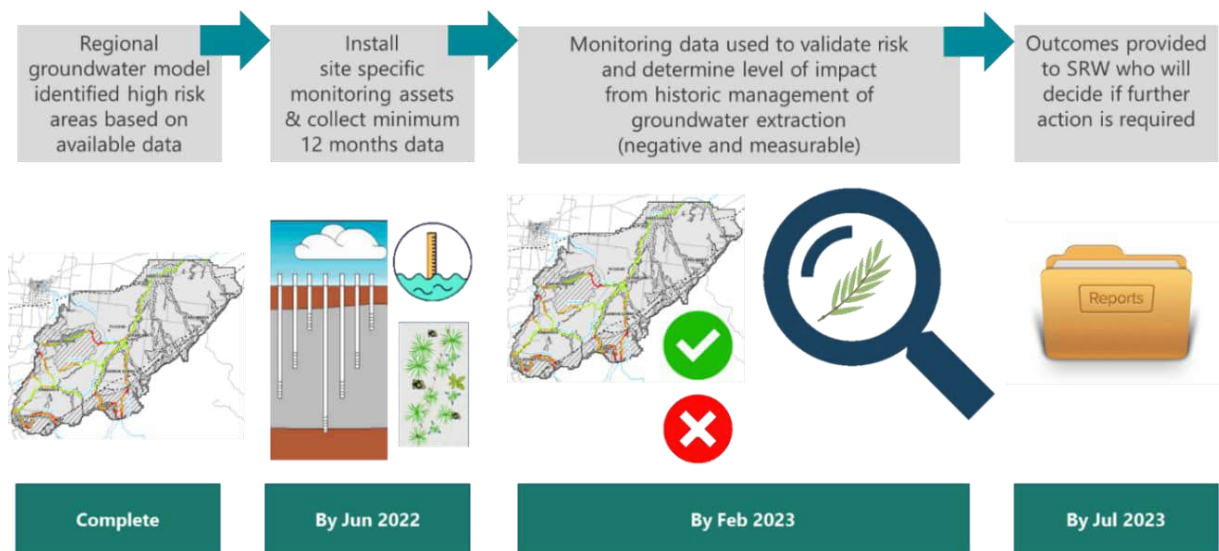


Figure 12 Process overview for the surrounding environment investigation

Due to delays in installations of site-specific monitoring assets as a result of unsafe site conditions, the focus for the 2021-2022 period was to complete installation of the remaining assets to enable data collection activities to commence. While the majority of these assets have now been installed, the Barongarook Creek stream gauge and the reinstatement of the East Barwon stream gauge remain outstanding as we continue to negotiate relevant approvals and access.

In June 2022 Barwon Water also submitted our high-level approach to conducting the surrounding environment investigation that will guide the next stage of this investigation. The phased approach adopted for this investigation will be broken down by sub-catchment and work through the following items:

- **Phase 1** – Completion of a hydrogeological assessment
- **Phase 2** – Completion of targeted investigations, as required, and
- **Phase 3** – Completion of additional modelling, as appropriate, to suitably ascertain the potential groundwater pumping related impacts

It is noted that works have currently commenced on the Loves Creek catchment due to the presence of a comprehensive dataset while we continue to collect data from the recently installed monitoring assets.

Once the above phases are complete, as relevant, Barwon Water will look to either update the regional groundwater model or create a purpose built model to track recovery and test what may happen under future climate scenarios. This will be used to:

1. Determine if recovery is enough to prevent any further degradation under future drought conditions, or
2. Determine what impacts we can expect to see under future drought conditions even in the absence of groundwater pumping activities

5.2 Actions Completed on the Surrounding Environment Investigation

Table 11 outlines the actions completed for the Surrounding Environment Investigation between 1 July 2021 and 30 June 2022.

Table 11 Surrounding Environment Investigation - Actions completed in 2021-2022 (1 July 2021 – 30 June 2022)

Action Items	Comment / Link
Completion of quarterly Remediation Reference Group meetings	Completed on: 8 September 2021 9 December 2021 21 March 2022 8 June 2022
Hosted in-person community information sessions at Winchelsea and Colac for members of the community to receive an update on the project and engage with the project team (sessions were promoted through local newsletters, newspapers, social media and to community networks)	Completed on 10 May (Winchelsea) Completed on 17 May (Colac)
Submission of Quarterly and Annual Reports	Complete

Action Items	Comment / Link
	Refer to the Your Say website located here: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Continue collection of data from new monitoring assets for the surrounding environment investigation	Ongoing
Subject to streamflows and site conditions, complete stream gauge installations for the Gellibrand River, Barongarook Creek and Barwon River downstream of the confluence with Boundary Creek	The Gellibrand River and Barwon River stream gauges have since been completed. Barwon Water continues to explore options for access to enable installation of the Barongarook stream gauge. The Barongarook Creek stream gauge and the reinstatement of the East Barwon stream gauge remain outstanding as we continue to negotiate relevant approvals and access.
Subject to safe site conditions install 4 remaining surrounding environment monitoring bores	Three former SOBN bores located along the Gellibrand River have been developed and reinstated as an alternative to installing two new bores due to site access constraints. The two East Barwon bores were completed on 6 June 2022.
Develop approach to the broader Surrounding Environment Investigation and engage a suitably qualified consultant(s)	Barwon Water's high-level approach to the broader Surrounding Environment Investigation was submitted to Southern Rural Water on 30 June 2022.

5.3 Upcoming Actions Associated with the Surrounding Environment Investigation

Table 12 outlines the upcoming actions associated with the Surrounding Environment Investigation between 1 July 2022 and 30 June 2023

Table 12 Surrounding Environment Investigation - Upcoming actions / milestones for 2022-2023 (1 July 2022 – 30 June 2022)

Action Items	Due
Completion of quarterly Remediation Reference Group meetings	Due in September, December, March and June each year. Noting that timing can change to account for RRG member availability or technical works.
Completion of ongoing community engagement to share updates on the project	Specific dates to be defined, but expected to be within the first 6 months of the 2023 calendar year
Submission of Quarterly and Annual Reports	Quarterly reporting will occur in September, December, March and June each year and will be submitted to Southern Rural Water by the last day of the month.

Action Items	Due
	In addition to this, a draft annual report will be submitted to Southern Rural Water for review and approval at least 14 days prior to the September submission date (being 30 September each year).
Continue collection of data from new monitoring assets for the surrounding environment investigation	Ongoing
Completion of remaining monitoring assets	Installation of Barongarook Creek stream gauge will be completed once relevant approvals and access has been obtained
Commence the assessment phase of the surrounding environment investigation	<p>A suitably qualified consultant was appointed to conduct the Loves Creek Hydrogeological Assessment in September 2022. This work is forecast to be completed by the end of March 2023.</p> <p>This will be used to frame the remaining Phase 1 investigations which will also commence in 2022-2023 with the aim of submitting the phase 1 works to Southern Rural Water in July 2023 in line with the next formal milestone.</p> <p>The outcomes of this work will be used to inform further technical and modelling work that will be conducted in 2023-2024. This will include the modelling of future climate scenarios.</p>

6 Issues Register

Table 13 below outlines any issues that have been identified during implementation of the REPP that may impact future implementation activities.

Table 13 Issues register

Issue	Likelihood	Consequence	Comments
Coronavirus (COVID-19) pandemic limits/delays engagement with stakeholders and the community	Medium	Low	Remediation Reference Group meetings continue to be held online in lieu of face-to-face meetings, with e-mail updates and notes also provided In general, these meetings have been well attended with most members being able to attend online. Wherever health advice permits, we will attempt to engage in a face to face setting also.
Coronavirus (COVID-19) pandemic impacts availability of appropriate consultants or contractors to undertake required work for implementation of the REPP	Medium	Low	Barwon Water have experienced delays regarding the availability of consultants, contractors and materials to complete work for this project during the coronavirus (COVID-19) pandemic. With consultants continuing to be close to capacity this remains an ongoing risk and may lead to unexpected delays.
Community concerns regarding the potential impacts of stream gauge infrastructure on the Platypi	Low	Medium	The re-instatement of the East Barwon stream gauge remains on hold as we continue to negotiate relevant approvals and access due to concerns regarding potential impacts on the Platypi. Review of these concerns by Platypi experts suggest the likelihood of this occurring is extremely low. However, Barwon Water are looking to investigate this further.
Extended remediation timeframes	Medium	Low	While water level and quality improvements are evident, the hydro-geochemical modelling report indicated that even with active intervention, the timeframe for the removal of existing acidity loads could still be in the order of 35 years. Further work is currently being undertaken to determine the risks based on the current conditions. This will inform the revised remedial strategy for inclusion in the revised REPP.

7 Community Engagement

Barwon Water is committed to continuing an open and transparent relationship with the community and key stakeholders during the implementation of the Boundary Creek, Big Swamp and surrounding environment Remediation and Environment Protection Plan.

The ongoing coronavirus (COVID-19) pandemic has presented challenges in meeting with its community and stakeholder working groups in face to face settings however, throughout 2021-2022 the Remediation Reference Group (RRG) continued to meet virtually as was done in 2020-2021. The Remediation Reference Group continues to be supported by their own nominated independent technical experts Dr Vanessa Wong (Monash University), Professor Richard Bush (Monash University) and Dr Darren Baldwin (Charles Sturt University), who provide specialist advice and support prior to and during the Remediation Reference Group meetings. Where relevant, Southern Rural Water's Community Leaders Group (CLG) were also invited to attend these meetings to discuss any upcoming submissions.

Detailed feedback received during the quarterly Remediation Reference Group meetings are provided in the Quarterly updates that can be accessed via the Your Say website located here: <https://www.yoursay.barwonwater.vic.gov.au/boundary-creek>.

During the 2021-2022 period, Barwon Water also:

- Attended Southern Rural Water's Community Leaders Group meetings when requested to present and field questions
- Conducted a field visit to Big Swamp in March 2022 with representatives from Barwon Water, the Remediation Reference Group, Southern Rural Water and Southern Rural Water's Independent Technical Review Panel to get a better understanding of the swamp conditions and various limitations
- Held two face-to-face community information sessions (one being held in Winchelsea on 10 May 2022 and the other being held in Colac on 17 May 2022), and
- Conducted a workshop with the Remediation Reference Group and Community Leaders Group to check-in on the Remediation Plan's vision, objectives and actions to ensure we are on the right track

In addition to this Barwon Water continue to share regular updates via the Your Say website located here: <https://www.yoursay.barwonwater.vic.gov.au/boundary-creek> and other media such as local newspapers, newsletters and social media.

8 REPP Amendments

Table 14 outlines any recent and upcoming REPP amendments current as of the time of this report.

Table 14 Required Amendments to the REPP

No.	REPP Amendments	Status
1	Feedback received from SRW and the ITRP on the proposed amendments	<p>Barwon Water submitted changes to Southern Rural Water on 30 September 2020. Southern Rural Water has provided feedback, which was discussed on 10 March 2021.</p> <p>Barwon Water subsequently submitted the revised updates including any which were contingent on detailed design on 31 July 2021. Barwon Water and Southern Rural Water are in ongoing discussions regarding the proposed amendments to address any outstanding feedback prior to making any formal updates. This will include additional revisions to account for the current 'state of knowledge' and community sentiment to ensure the REPP remains fit for purpose.</p>
2	Implementation of revised success targets	ITRP feedback has been received on the revised success targets. Barwon Water will consider this feedback in finalising the updated success targets as part of the REPP amendments.
3	Revision and integration of remediation actions based on feedback received from the RRG	Following receipt of Southern Rural Water's feedback on the Outcomes and Implications of the Upstream Treatment Investigation report (Barwon Water, 2022), Barwon Water will be revising the REPP to ensure clarity moving forward.

9 Progress Report

Table 15 outlines the actions that have been completed, are currently in progress, or are yet to commence as part of implementation of the REPP during 2021-2022.

Table 15 Action Register

#	Activity	Due Date	Status	Health Indicator	Comments
1.0	Meeting with SRW to be held at the Barwon Water office to develop work plan towards confirming priority actions relating to feedback provided.	30-Apr-20	Complete	Complete	Complete
2.0	Complete autumn macro-invertebrates survey:	30-Jun-20	Complete	Complete	Report now complete and is now uploaded on website
3.0	Complete soil incubation testing	31-May-20	Complete	Complete	Report has been finalised and is now uploaded on website
4.0	Submit Quarterly Update to SRW and publish to website	30-Jun-20	Complete	Complete	Southern Rural Water review of template complete. Quarterly Update uploaded to website on 30th June.
5.0	Scoping of SW-GW technical work packages required to inform detailed design and address feedback register	30-Nov-20	Complete	Complete	Complete

#	Activity	Due Date	Status	Health Indicator	Comments
6.0	Complete installation of additional monitoring assets for the following sites identified as 'high risk' in the Surrounding Environment Investigation	30-Jun-22	In progress	At Risk	All additional groundwater monitoring locations have now been completed. 3 former SOBN bores were adopted along the Gellibrand River instead of the 2 new bores due to site access issues. 4 of 5 Stream Gauges have now been installed. The Barongarook Creek stream gauge and the reinstatement of the East Barwon stream gauge remain outstanding as we continue to negotiate relevant approvals and access.
7.0	Conclusion of monitoring period enabling the capture of a full seasonal cycle of data to inform updates to the groundwater-surface water model and geochemical model.	31-Jul-20	Complete	Complete	1 year of monitoring completed. Monitoring of groundwater levels, stream flows and water quality continues in Big Swamp and Boundary Creek.
8.0	REPP Feedback Work plan - Submission and Acceptance	31-Jul-20	Complete	Complete	Completed
9.0	Governance Framework - Submission and Acceptance	31-Jul-20	Complete	Complete	Completed
10.0	Barwon Water Communications and Engagement Plan	Ongoing	In progress	On track	Remediation Reference Group meetings continue to be held quarterly. Two community information session were also held in May 2022. Plan continues to be adapted based on outcomes and outputs of project.
11.0	Submit updated REPP to capture the work plan for addressing the feedback register. SRW to accept the updated REPP.	TBA	In progress	On track	Barwon Water submitted changes to Southern Rural Water on 30 September 2020. Southern Rural Water has provided

#	Activity	Due Date	Status	Health Indicator	Comments
					<p>feedback, which was discussed on 10 March 2021.</p> <p>Barwon Water subsequently submitted the revised updates including any which were contingent on detailed design on 31 July 2021. Barwon Water and Southern Rural Water are in ongoing discussions regarding the proposed amendments to address any outstanding feedback prior to making any formal updates. This will include additional revisions to account for the current 'state of knowledge' and community sentiment to ensure the REPP remains fit for purpose.</p>
12.0	Submit annual report to SRW and publish to Your Say website	30-Sep-20	Complete	Complete	Completed
13.0	Remediation Reference Group Meeting	2-Dec-20	Complete	Complete	Completed
14.0	Establish vegetation monitoring for Boundary Creek and Big Swamp Remediation Plan	31-Dec-20	Complete	Complete	Completed
15.0	Update groundwater-surface water model	31-Dec-20	Complete	Complete	Final report uploaded to website
16.0	Submit quarterly report to SRW and publish to Your Say website	31-Dec-20	Complete	Complete	Completed
17.0	Remediation Reference Group Meeting	17-Mar-21	Complete	Complete	Completed
18.0	Submit quarterly report to SRW and publish to Your Say website	31-Mar-21	Complete	Complete	Completed
19.0	Remediation Reference Group Meeting	23-Jun-21	Complete	Complete	Completed

#	Activity	Due Date	Status	Health Indicator	Comments
20.0	Submit quarterly report to SRW and publish to Your Say website	30-Jun-21	Complete	Complete	Completed and uploaded to website
21.0	Submission of detailed design of the hydraulic barriers outlining proposed controls or actions and any revisions to success measures/targets.	1-Jul-21	Complete	Complete	Complete. Submitted to Southern Rural Water on 1 July 2021
22.0	Update Hydro geochemical model	31-Jul-21	Complete	Complete	Completed and uploaded to website
23.0	Complete detailed design of contingency measure and feasibility assessment for up-stream for new upstream treatment method	31-Jul-21	Complete	Complete	Barwon Water have since ruled out the use of the proposed semi-passive caustic magnesia treatment system. This decision was supported by Southern Rural Water and the Independent Technical Review Panel (ITRP) in their response received on 29 August 2022. Following completion of the Upstream Treatment Investigation in June 2022, Barwon Water will progress responding to Southern Rural Water and ITRP feedback on the downstream treatment option that was submitted to Southern Rural Water on 30 July 2021, with the aim to get a downstream treatment option approved by Southern Rural Water so that this can be implemented, should this be required in 2023-2024.
24.0	Remediation Reference Group Meeting	8-Sep-21	Complete	Complete	Completed
25.0	Submit annual report to SRW and publish to Your Say website	30-Sep-21	Complete	Complete	Completed and uploaded to website

#	Activity	Due Date	Status	Health Indicator	Comments
26.0	Remediation Reference Group Meeting	9-Dec-21	Complete	Complete	Completed
27.0	Submit quarterly report to SRW and publish to Your Say website	31-Dec-21	Complete	Complete	Completed and uploaded to website
28.0	Completion of upstream treatment investigation and development of Trial Plan	14-Jan-22	Complete	Complete	Complete. Submitted to SRW on 14 Jan 2022. This will also be provided to the RRG for input based on feedback from the RRG meeting which was held on 9 December 2021. Barwon Water have since ruled out the use of the proposed semi-passive caustic magnesia treatment system. This decision was supported by Southern Rural Water and the Independent Technical Review Panel (ITRP) in their response received on 29 August 2022.
29.0	Remediation Reference Group Meeting	21-Mar-21	Complete	Complete	Completed
30.0	Submit quarterly report to SRW and publish to Your Say website	31-Mar-22	Complete	Complete	Completed and uploaded to website
31.0	Hosted community information session in Winchelsea	10-May-22	Complete	Complete	Completed
32.0	Hosted community information session in Colac	17-May-22	Complete	Complete	Completed
33.0	Remediation Reference Group Meeting	8-Jun-22	Complete	Complete	Completed
34.0	If trial plan is approved undertake upstream treatment trial	30-Jun-22	In progress	Complete	Barwon Water have since ruled out the use of the proposed semi-passive caustic

#	Activity	Due Date	Status	Health Indicator	Comments
35.0	Decision on implementation of full scale upstream treatment, hydraulic barriers and downstream treatment	30-Jun-22	In progress	Complete	magnesia treatment system. This decision was supported by Southern Rural Water and the Independent Technical Review Panel (ITRP) in their response received on 29 August 2022.
36.0	Submit quarterly report to SRW and publish to Your Say website	30-Jun-22	Complete	Complete	Completed and uploaded to website

10 References

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Barwon Water (2022b), Barwon Water’s high-level approach to the surrounding environment investigation

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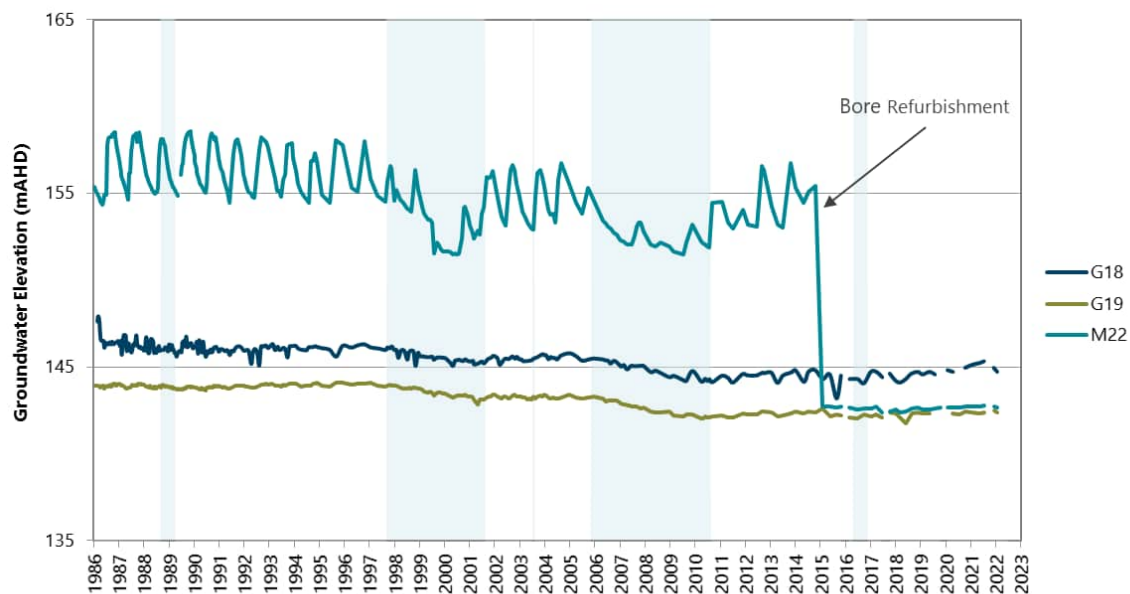
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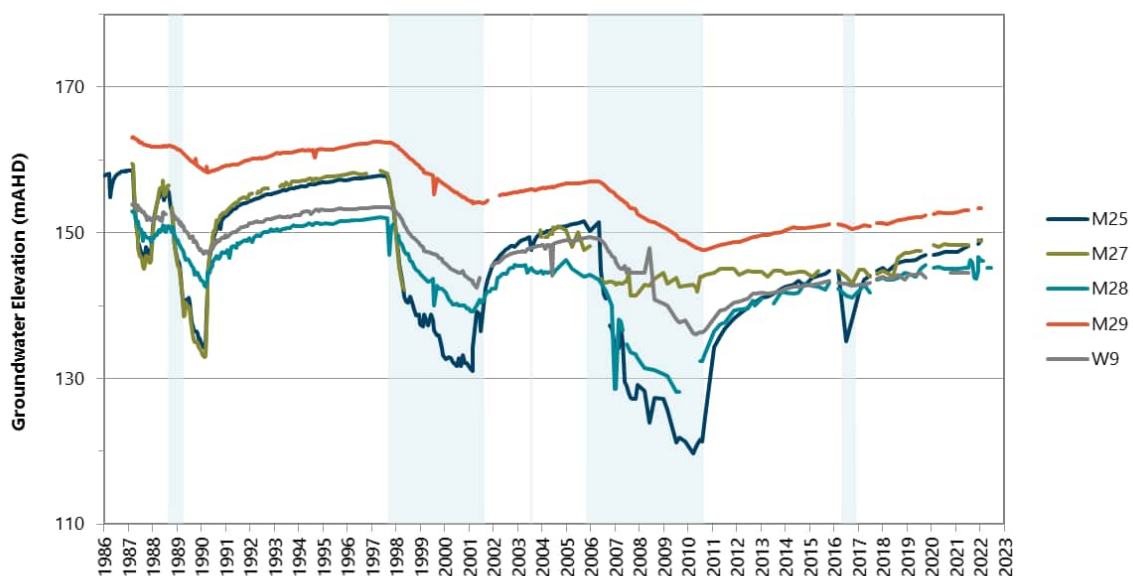
Appendix A – Hydrographs from Regional Groundwater Monitoring Bores

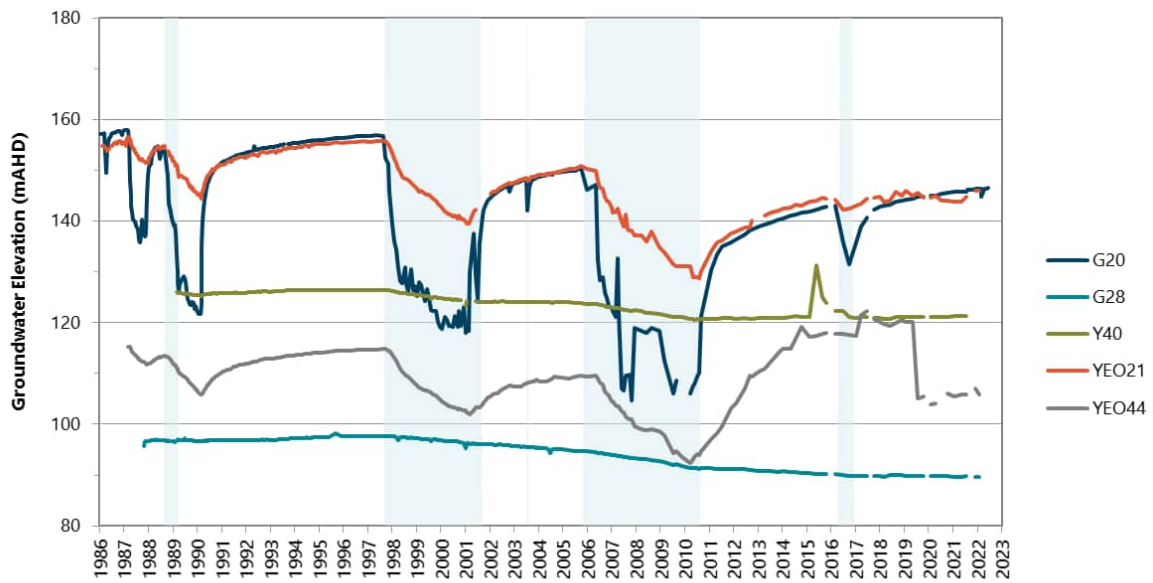
Note: Light blue shading denotes periods of groundwater extraction

Clifton Formation

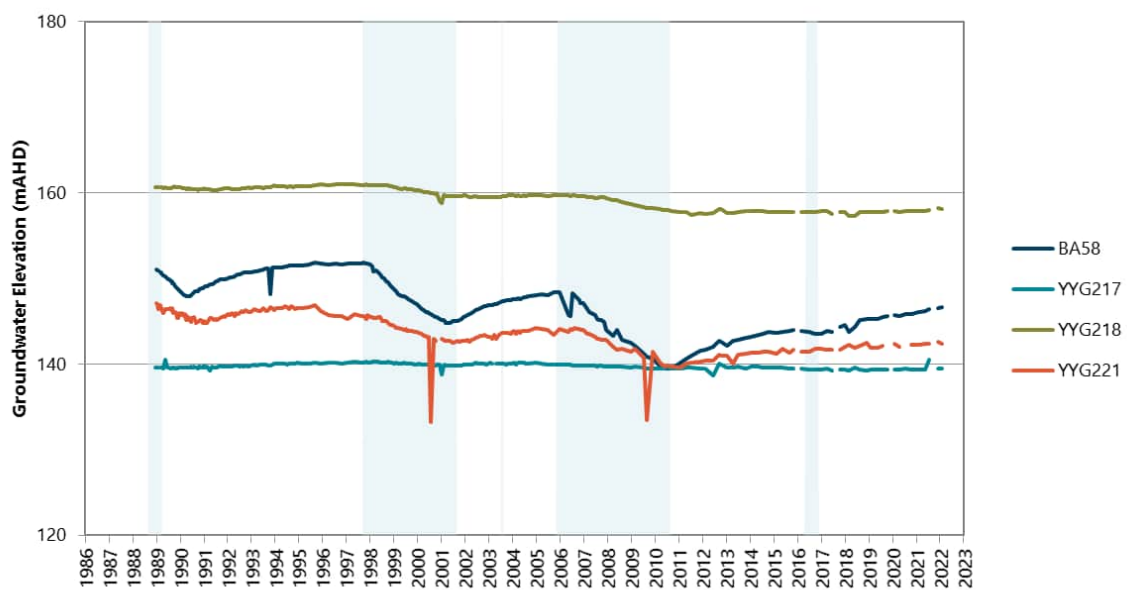


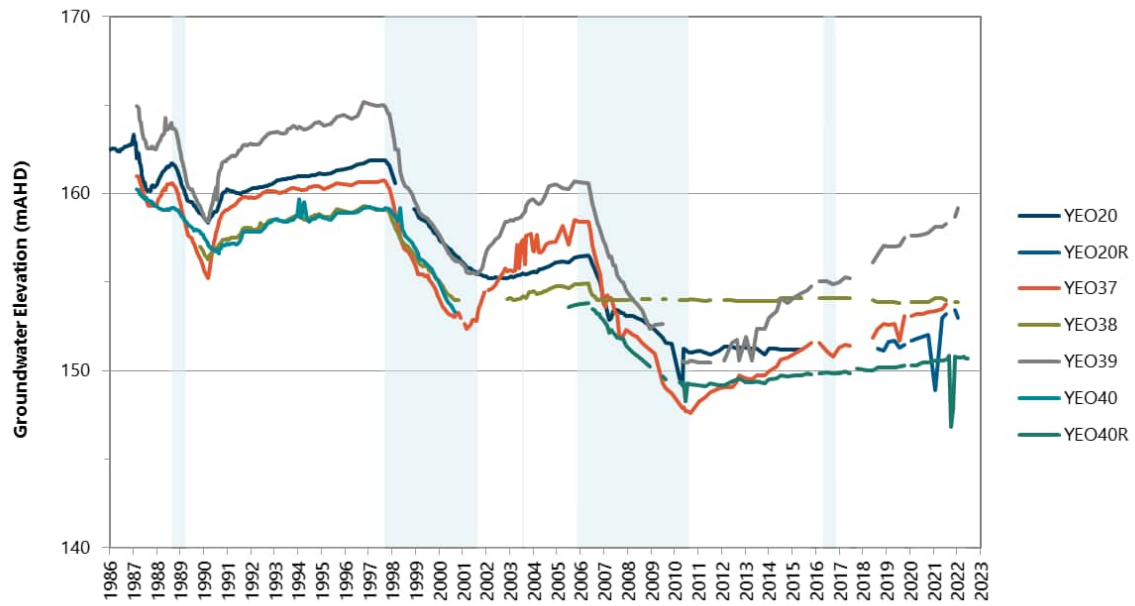
Mepunga Formation



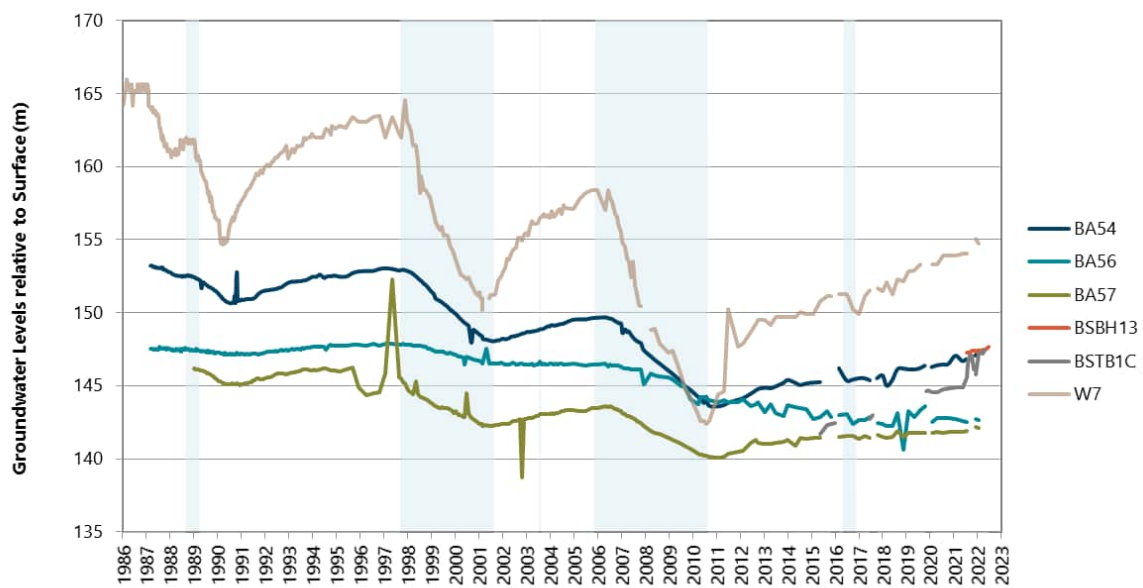


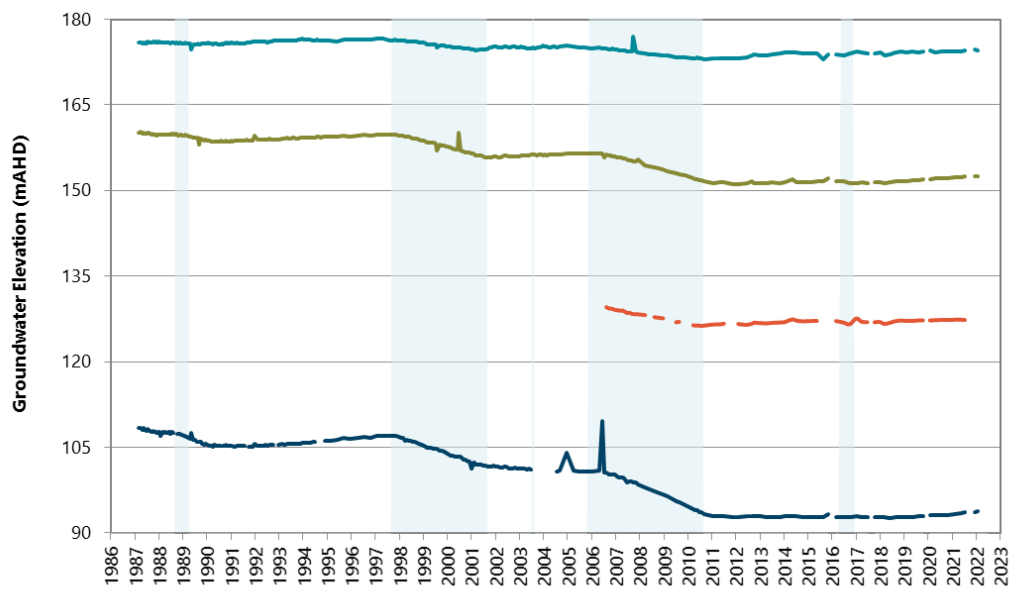
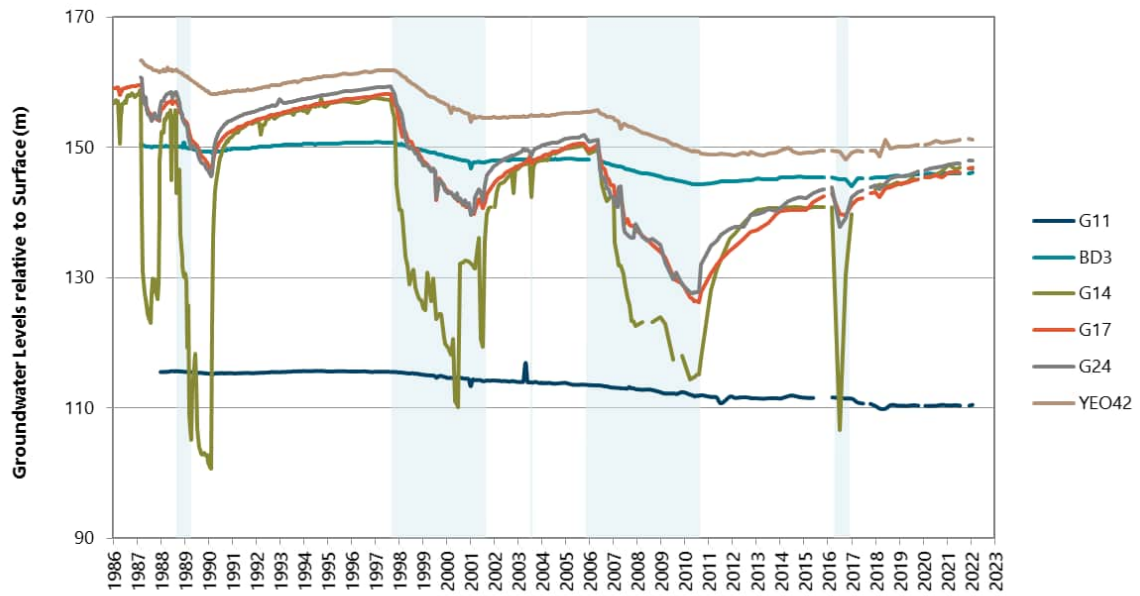
Dilwyn Formation – Unconfined Areas



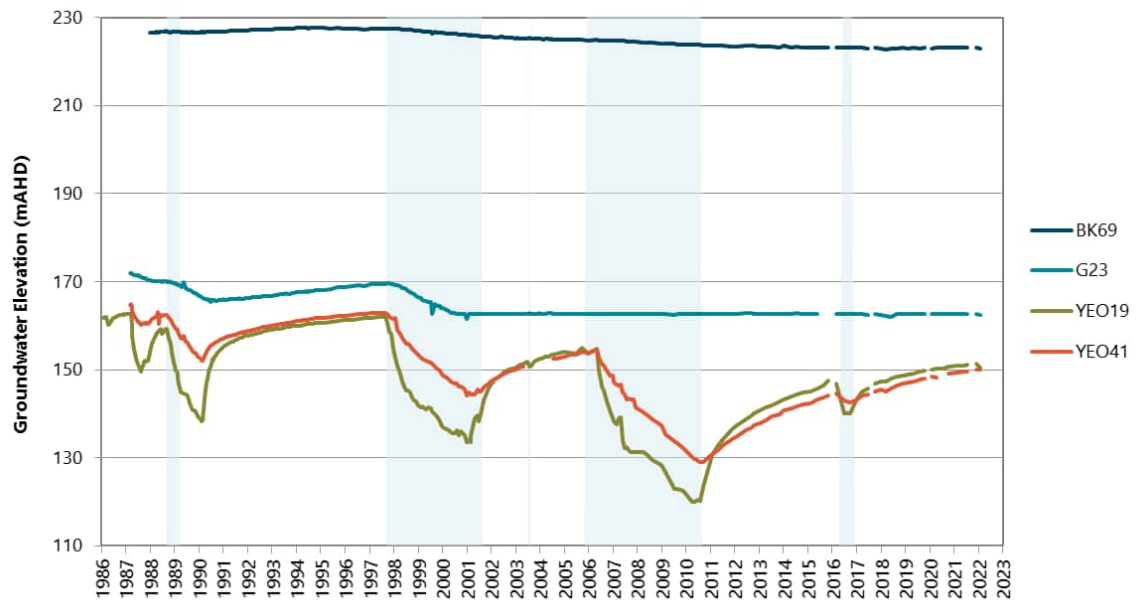


Dilwyn Formation – Confined Areas

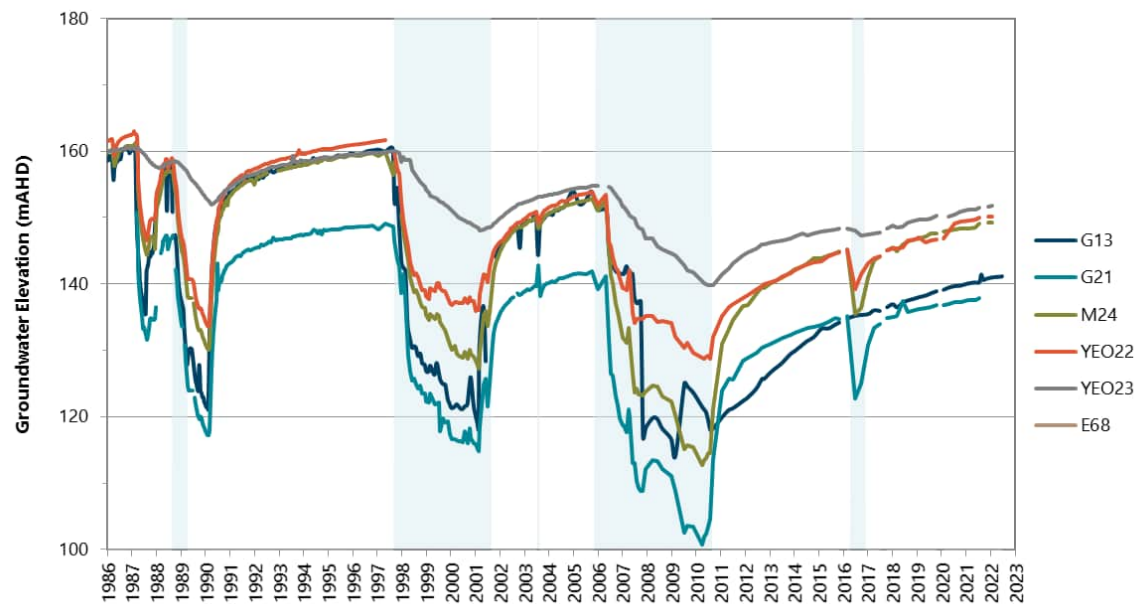




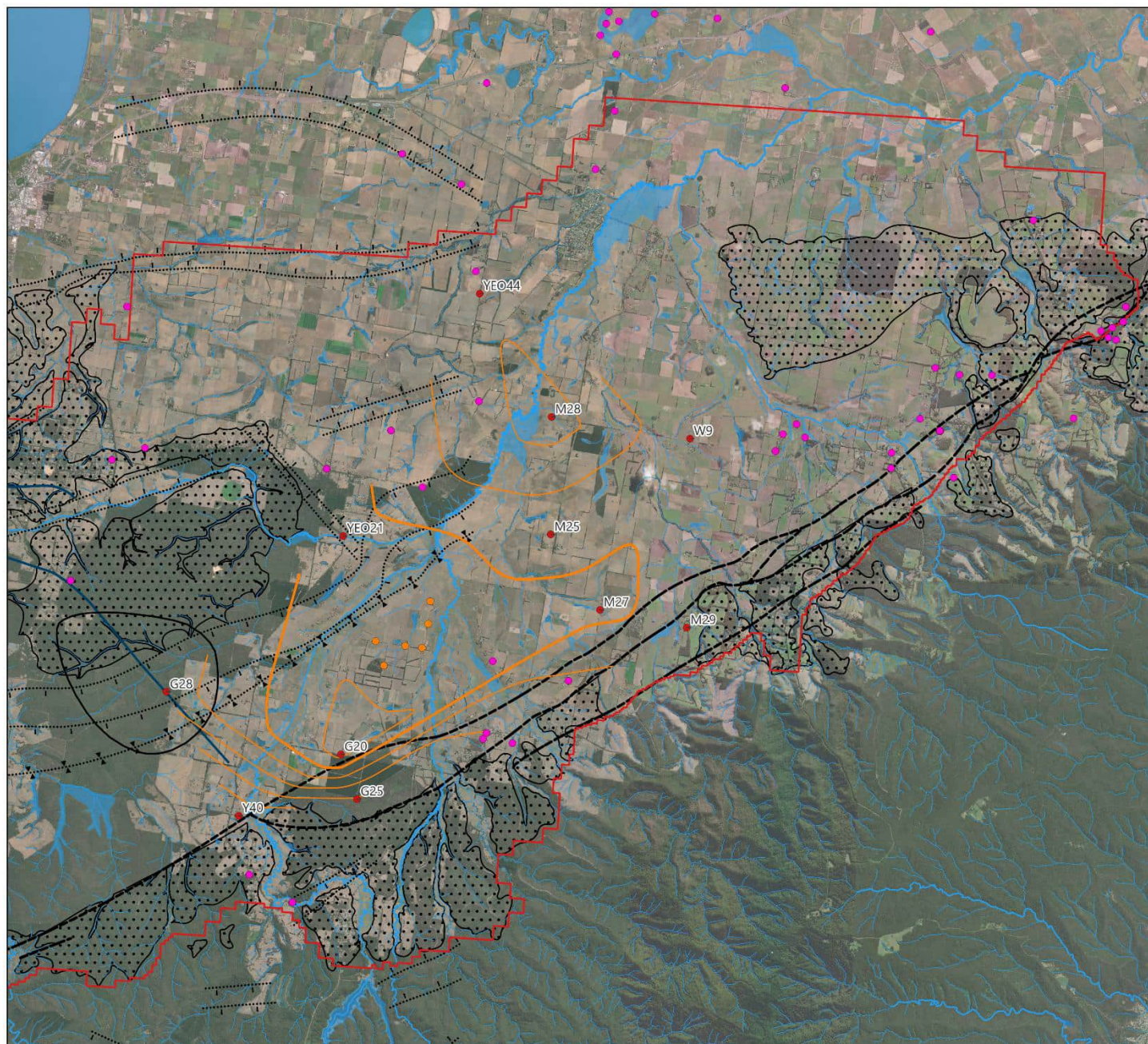
Pebble Point Formation – Unconfined Areas



Pebble Point Formation – Confined Areas



Appendix B – Residual Drawdown Contours



Legend

- Investigation Area
- Mepunga Monitoring Bores
- Former Groundwater Extraction Bore
- Surrounding Registered Extractive Groundwater Users
- Waterbody
- Lower Tertiary Aquifer (LTA) Outcrop

Residual Drawdown Contours

- Mepunga Major - 5m intervals
- Mepunga Minor - 1m intervals

Watercourse

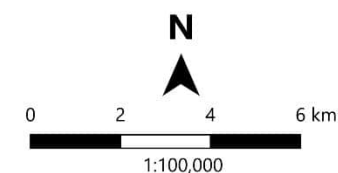
- Major
- Moderate
- Minor

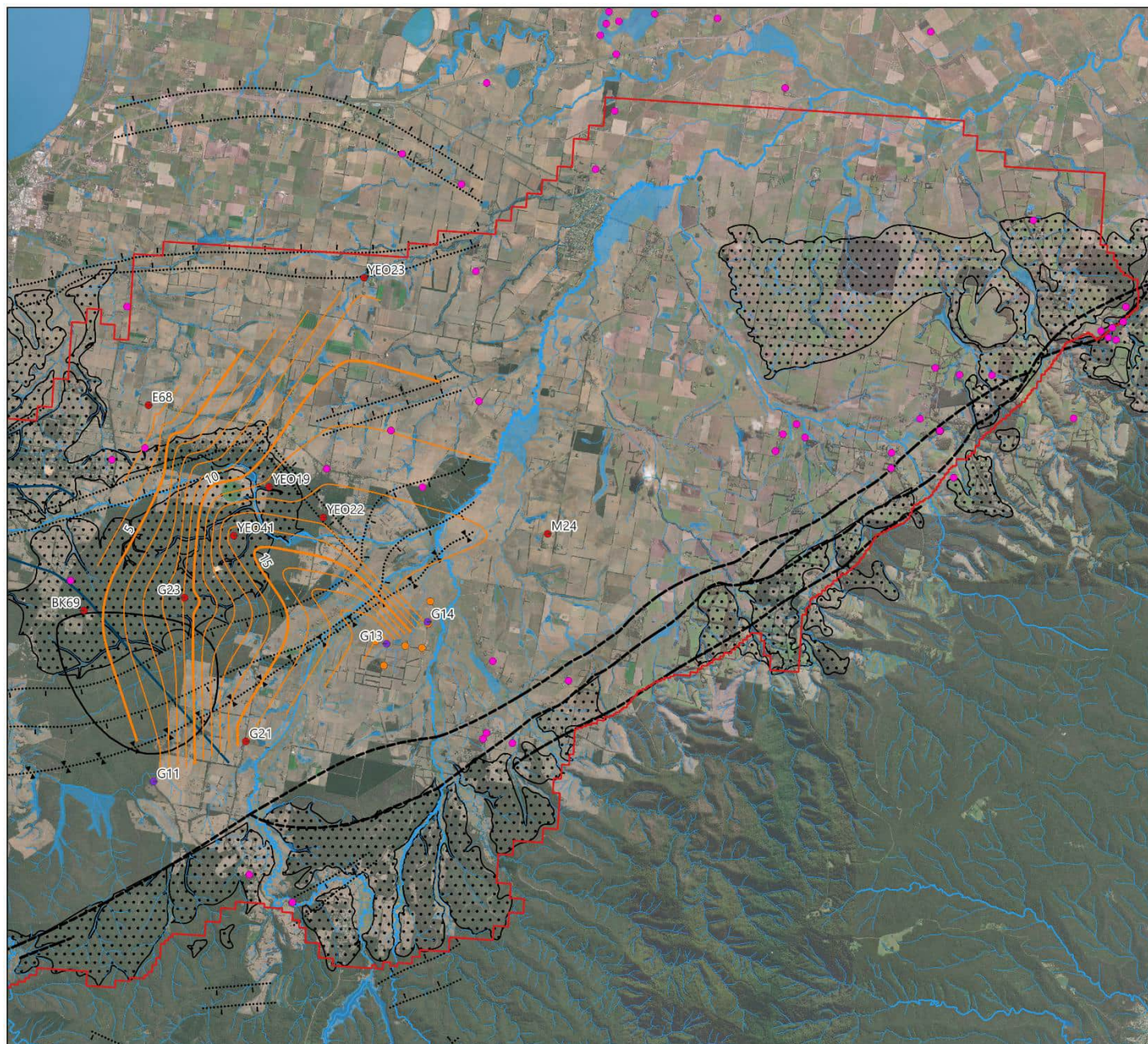
Hydrogeological Structures

- Monocline
- Syncline
- Yeo Dome (Aquade, 2017)
- Fault Line
- Approximate Groundwater Divide (HydroTechnology, 1994)

Residual Drawdown Relative to Worst Case Conditions - Mepunga Formation

Produced by: ED & WM
Date: 12 August 2022



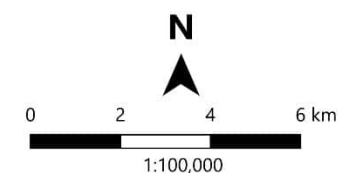


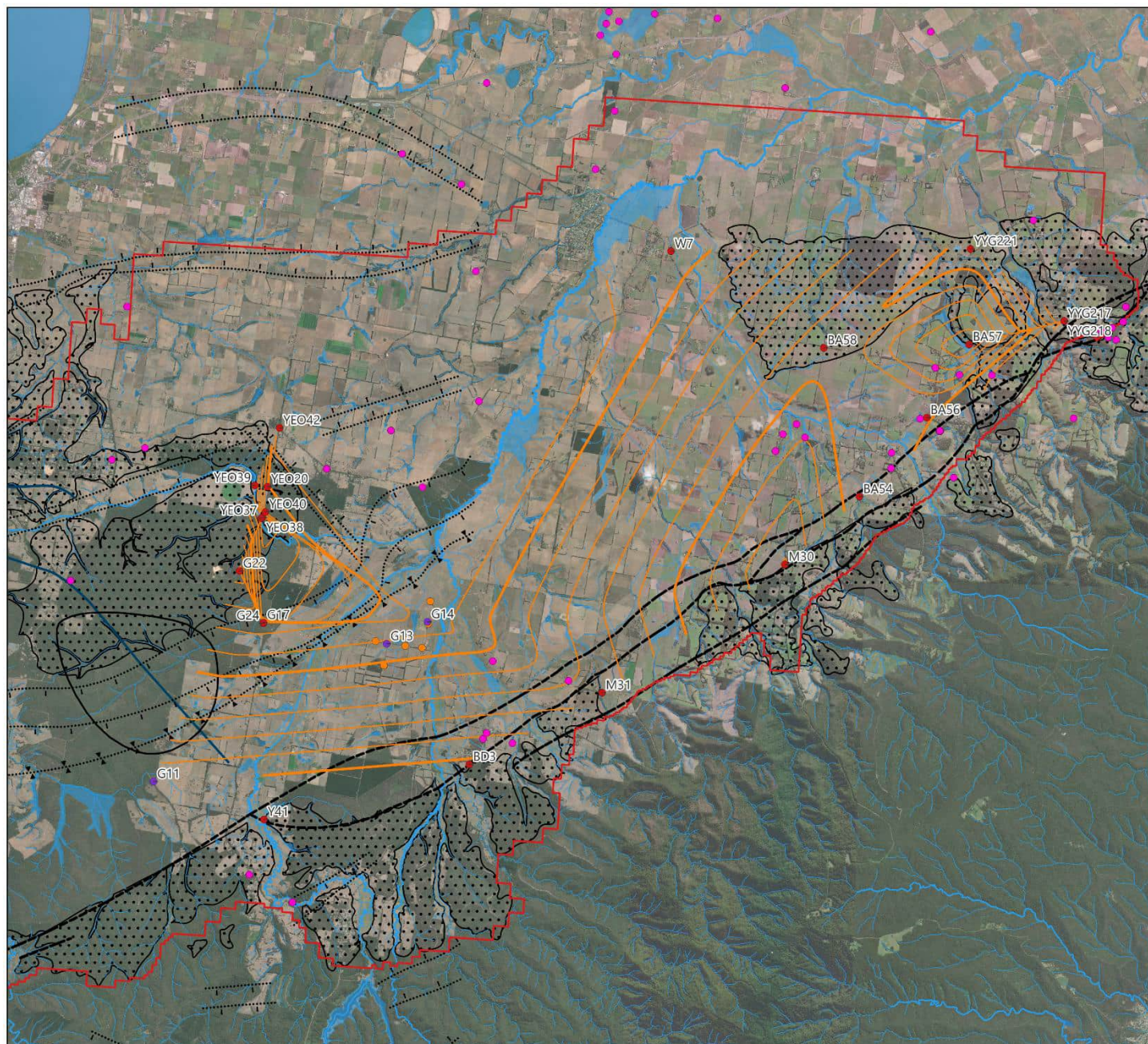
Legend

- Investigation Area
- Dilwyn and Pebble Point Monitoring Bores
- Pebble Point Monitoring Bores
- Former Groundwater Extraction Bore
- Surrounding Registered Extractive Groundwater Users
- Waterbody
- Lower Tertiary Aquifer (LTA) Outcrop
- Residual Drawdown Contours**
 - Major - 5m intervals
 - Minor - 1m intervals
- Watercourse**
 - Major
 - Moderate
 - Minor
- Hydrogeological Structures**
 - - - - - Monocline
 - · - · - Syncline
 - Yeo Dome (Aquad, 2017)
 - - - - - Fault Line
 - Approximate Groundwater Divide (HydroTechnology, 1994)

Residual Drawdown Relative to Worst Case Conditions - Pebble Point Formation

Produced by: ED & WM
Date: 12 August 2022





Legend

- Investigation Area
- Dilwyn Monitoring Bores
- Dilwyn and Pebble Point Monitoring Bores
- Former Groundwater Extraction Bore
- Surrounding Registered Extractive Groundwater Users
- Waterbody
- Lower Tertiary Aquifer (LTA) Outcrop

Residual Drawdown Contours

- Major - 5m intervals
- Minor - 1m intervals

Watercourse

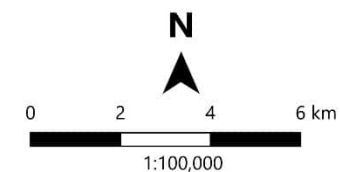
- Major
- Moderate
- Minor

Hydrogeological Structures

- - - - - Monocline
- - - - - Syncline
- Yeo Dome (Aquad, 2017)
- - - - - Fault Line
- Approximate Groundwater Divide (HydroTechnology, 1994)

Residual Drawdown Relative to Worst Case Conditions - Dilwyn Formation

Produced by: ED & WM
Date: 12 August 2022



Appendix C – Hydrographs from Big Swamp Monitoring Bores



Legend

- Existing Fire Trench
- Big Swamp Monitoring Transects
- Big Swamp Inundation Area

Groundwater Monitoring Bores

- Upper Aquifer System
- Confining Layer
- Lower Tertiary Aquifer

Watercourse

- Moderate
- Minor

Big Swamp - Groundwater Monitoring Locations

Produced by: WM
Date: 12 August 2022



N

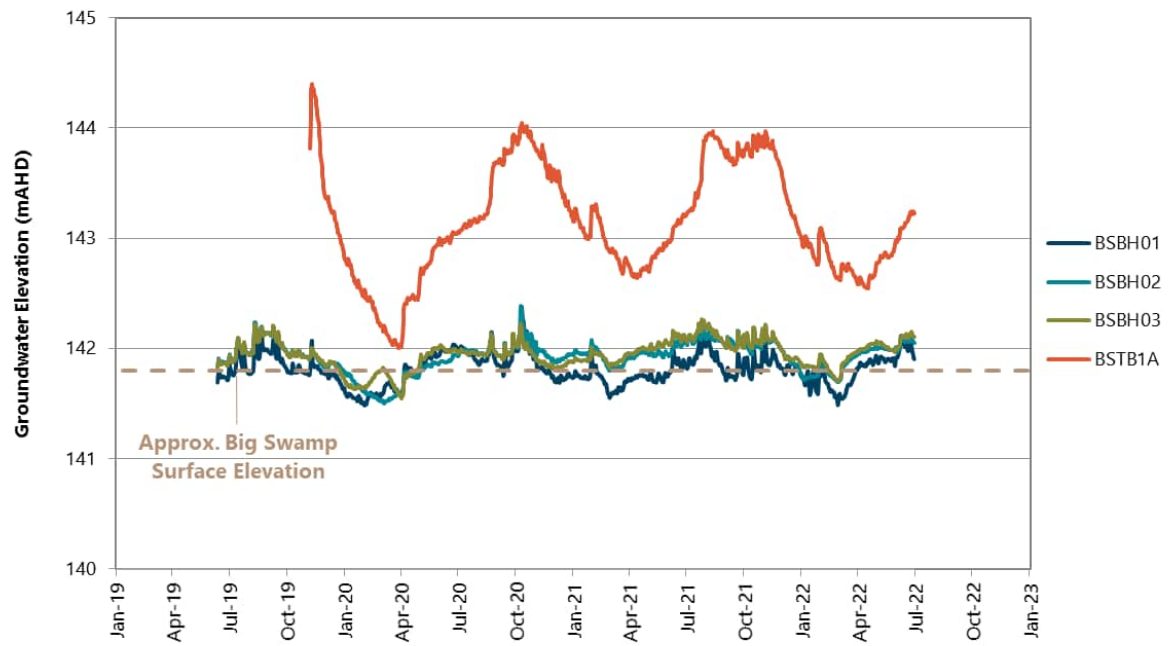


0 50 100 150 200 m

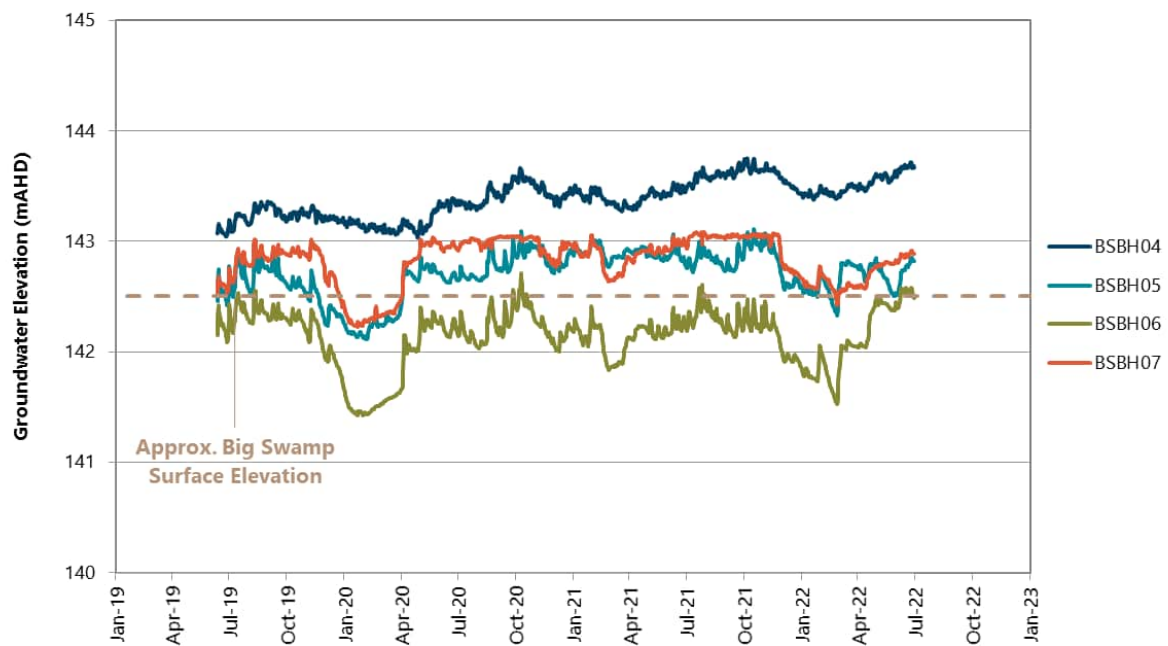


1:3,000

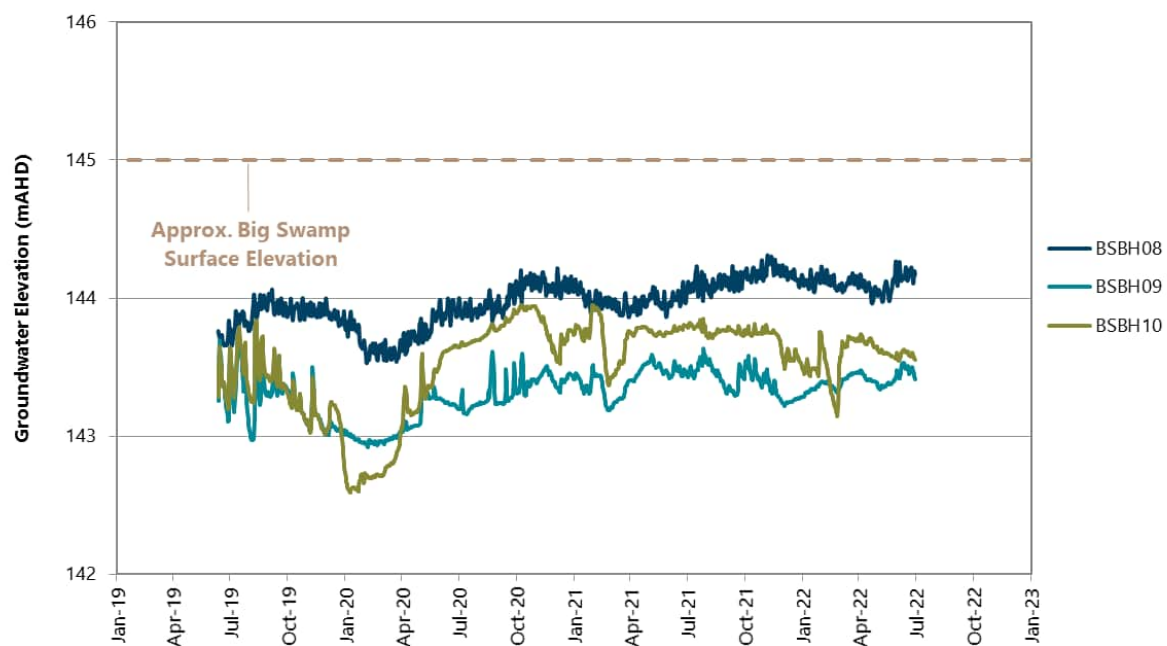
Transect 1



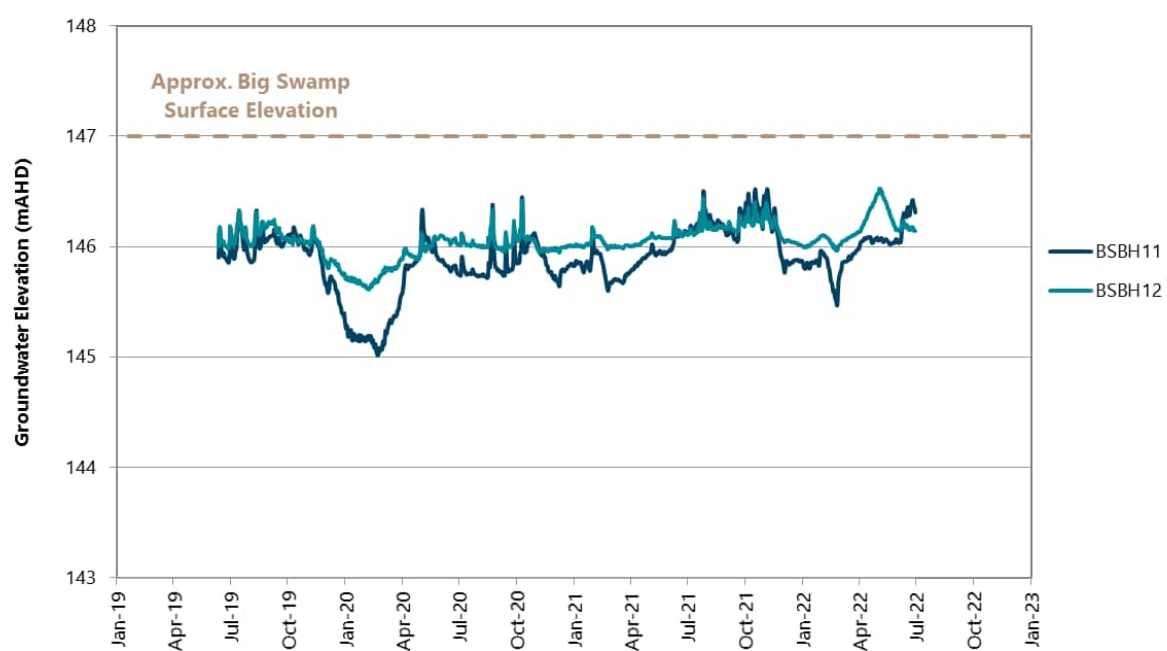
Transect 2



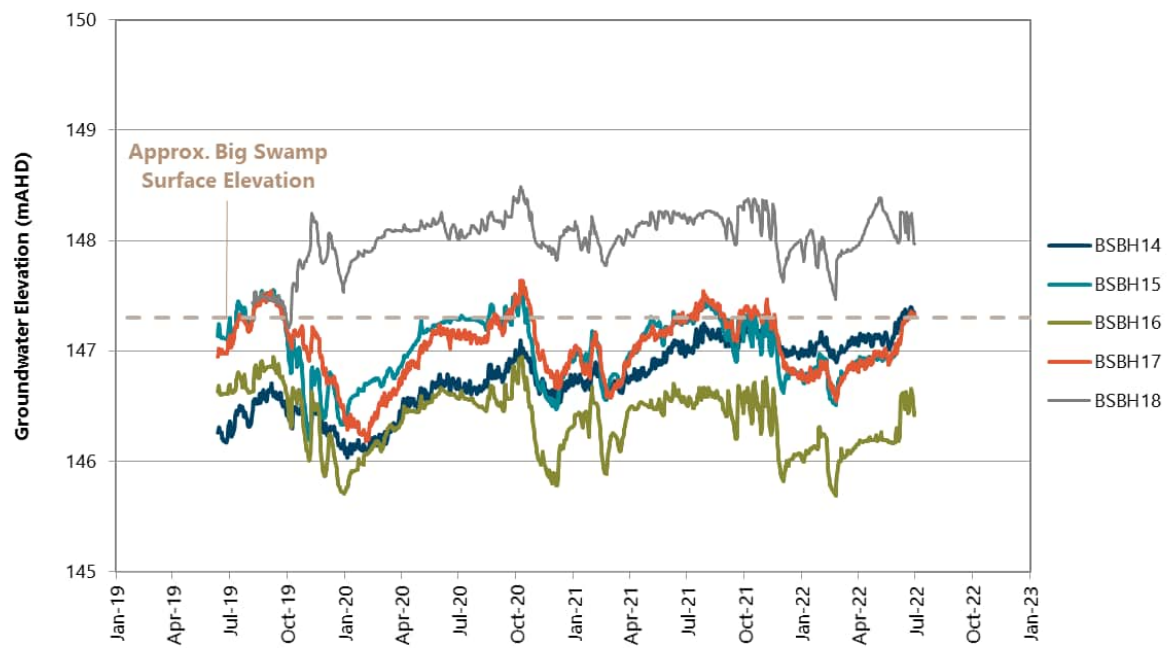
Transect 3



Transect 4



Transect 5



Appendix D – Supplementary Flow Data

Table 16 Supplementary Flow Releases 2021-2022

Date	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022
1	0.00	0.00	0.00	0.00	0.00	0.96	2.89	1.73	2.16	2.11	1.23	1.15
2	0.00	0.00	0.00	0.00	0.00	0.90	2.89	1.91	2.14	2.12	1.24	0.36
3	0.00	0.00	0.00	0.00	0.00	1.12	2.88	2.08	2.17	2.12	1.24	0.00
4	0.00	0.00	0.00	0.00	0.00	1.18	2.88	2.08	2.24	2.11	1.21	0.00
5	0.00	0.00	0.00	0.00	0.00	1.16	2.88	2.07	2.26	2.10	1.22	0.00
6	0.00	0.00	0.00	0.00	0.00	1.17	2.88	2.05	2.25	2.11	1.24	0.00
7	0.00	0.00	0.00	0.00	0.00	1.15	2.98	2.04	2.26	2.10	1.24	0.00
8	0.00	0.00	0.00	0.00	0.00	2.34	3.01	2.09	2.26	1.82	1.25	0.00
9	0.00	0.00	0.00	0.00	0.00	2.93	3.01	2.12	2.28	2.11	1.23	0.00
10	0.00	0.00	0.00	0.00	0.00	2.92	3.01	2.16	2.29	2.11	1.24	0.00
11	0.00	0.00	0.00	0.00	0.00	2.93	3.01	2.15	2.36	2.11	1.25	0.00
12	0.00	0.00	0.00	0.00	0.00	2.92	3.00	2.13	2.51	2.09	1.24	0.00
13	0.00	0.00	0.00	0.00	0.00	2.92	2.99	2.12	2.57	2.09	1.24	0.00
14	0.00	0.00	0.00	0.00	0.00	2.92	2.99	2.12	2.57	2.10	1.24	0.00
15	0.00	0.00	0.00	0.00	0.00	2.92	3.02	2.13	2.27	2.11	1.24	0.00
16	0.00	0.00	0.00	0.00	0.00	2.92	3.05	2.14	2.14	2.10	1.24	0.00
17	0.00	0.00	0.00	0.00	0.00	2.92	3.05	2.15	2.14	2.11	1.24	0.00
18	0.00	0.00	0.00	0.00	0.00	2.91	3.05	2.12	2.14	2.10	1.23	0.00
19	0.00	0.00	0.00	0.00	0.00	2.85	3.03	2.11	2.13	1.62	1.23	0.00
20	0.49	0.00	0.00	0.00	0.00	2.86	3.04	2.13	2.13	0.96	1.24	0.00
21	0.83	0.00	0.77	0.00	0.00	2.37	3.02	2.15	2.13	0.94	1.23	0.00
22	0.00	0.00	0.80	0.00	0.23	2.14	3.00	2.16	2.13	0.86	1.19	0.00
23	0.00	0.00	0.00	0.00	0.00	2.08	3.00	2.13	2.12	0.86	1.17	0.00
24	0.00	0.00	0.00	0.00	0.00	2.08	2.72	2.13	2.12	0.83	1.19	0.00
25	0.00	0.00	0.00	0.00	0.00	2.08	2.13	2.15	2.12	0.87	1.20	0.00
26	0.00	0.00	0.00	0.00	0.00	2.09	2.13	2.17	2.11	0.97	1.22	0.00
27	0.00	0.00	0.00	0.00	0.00	2.09	2.14	2.15	2.11	1.23	1.17	0.00
28	0.00	0.00	0.00	0.00	0.00	2.07	2.14	2.15	2.13	1.22	1.16	0.00
29	0.00	0.00	0.00	0.00	0.00	2.06	2.06		2.13	1.22	1.17	0.00
30	0.00	0.00	0.00	0.00	0.40	2.06	1.87		2.12	1.21	1.16	0.00
31	0.00	0.00		0.00		2.54	1.78		2.11	1.22	1.13	
Total	1.32	0.00	1.57	0.00	0.63	68.57	85.51	58.79	68.58	51.64	37.71	1.51

Appendix E – Spot Sampling Water Quality Data

Table 17 Spot sampling water quality data from Boundary Creek downstream of Big Swamp (Station #233276)

Sampled Date	PH (Field)	Electrical Conductivity (EC)	Acidity as CaCO ₃	Sulfate as SO ₄	Total Iron	Ferric Iron	Ferrous Iron	Soluble Aluminium
	pH Units	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/l	mg/L
6/11/2019	3.3	800	106	130	18			10
4/12/2019	3.7	890	159	160	16	16	0.5	13
6/01/2020	3.2	1000	193	200	3.2		15	0.04
5/02/2020	3.3	1100	236	220	30		58	9.4
3/03/2020	2.9	1300	199	28	20	17	3.3	12
1/04/2020	3.3	1200	300	290	91		110	10
5/05/2020	3.3	670	96	96	7.5	4.6	2.9	6.3
1/06/2020	3.5	700		88	9	0.2	3.9	8.2
7/07/2020	3.6	600	24	46	5.5	8.4	2.1	3.9
3/08/2020	3.6	790	103	85	14	2.6	5.6	11
9/09/2020	4.8	600	79	61	12	5.1	9.4	5.3
7/10/2020	4.9	410	24	24	9.9	3	4.8	1.2
4/11/2020	3.8	670	109	130	38		35	10
1/12/2020	3.8	820	233	200	67		69	11
6/01/2021	7	390	22	8	2.6	2.2	69	0.02
2/02/2021	5.7	530	90	74	60	24	0.4	2.5
1/03/2021	4.1	830	303	210	94	11	36	9.1
12/04/2021	5.7	590	132	100	77	7	83	2.4
6/05/2021	5.9	410	56	46	50	12	70	1
2/06/2021	5.7	490	93	65	62	14	38	1.2
7/07/2021	5.5	480	34	23	24	6	48	0.71

2/08/2021	5.9	360	27	15	9.7	5	18	0.5
7/09/2021	6.2	440	37	23	32	19	4.7	0.76
6/10/2021	5.8	390	26	10	13	6.1	13	0.24
10/11/2021	6	470	40	35	47	12	6.9	0.86
8/12/2021	5.9	720	119	92	72	7	35	2.3
4/01/2022	5.9	690	148	100	91	27	65	1.4
4/02/2022	5.8	740	167	150	61	0.2	64	3
3/03/2022	5.7	760	140	130	67		62	2.8
4/04/2022	5.4	730	147	130	61	14	99	2.5
4/05/2022	5.3	620	114	83	43	24	47	2.1
1/06/2022	5	540	76	75	43	5	38	1.9

Table 18 Spot sampling water quality data from Boundary Creek at Yeodene (Station #233228)

Sampled Date	PH (Field)	Electrical Conductivity (EC)	Acidity as CaCO ₃	Sulfate as SO ₄	Total Iron	Ferric Iron	Ferrous Iron	Soluble Aluminium
	pH Units	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/l	mg/L
6/11/2019	3.68	-	-	-	-	-	-	-
4/12/2019	-	-	-	-	-	-	-	-
6/01/2020	3.86	-	-	-	-	-	-	-
5/02/2020	3.29	-	-	-	-	-	-	-
3/03/2020	-	-	-	-	-	-	-	-
1/04/2020	3.46	-	-	-	-	-	-	-
5/05/2020	3.98	-	-	-	-	-	-	-
1/06/2020	4.57	-	-	-	-	-	-	-
7/07/2020	4.1	-	-	-	-	-	-	-

3/08/2020	4.1	-	-	-	-	-	-	-
9/09/2020	4.51	-	-	-	-	-	-	-
7/10/2020	4.25	-	-	-	-	-	-	-
4/11/2020	3.49	-	-	-	-	-	-	-
1/12/2020	3.45	-	-	-	-	-	-	-
6/01/2021	3.57	-	-	-	-	-	-	-
2/02/2021	3.49	-	-	-	-	-	-	-
1/03/2021	3.55	-	-	-	-	-	-	-
12/04/2021	5.03	-	-	-	-	-	-	-
6/05/2021	4.61	-	-	-	-	-	-	-
2/06/2021	5.6	-	-	-	-	-	-	-
7/07/2021	5.09	-	-	-	-	-	-	-
2/08/2021	5.9	420	28	23	9.2	3.1	6.1	0.57
7/09/2021	6.1	460	47	32	26	10	16	0.95
6/10/2021	5.6	410	24	15	13	6	7	0.31
10/11/2021	5.9	550	40	44	46	19	27	1.1
8/12/2021	5	680	92	89	55	7	48	2
4/01/2022	4.9	700	122	110	67	14	53	1.4
4/02/2022	5	720	130	140	57	25	32	2
3/03/2022	5.5	860	141	130	85		97	0.15
4/04/2022	4	770	111	120	44	18	26	1.7
4/05/2022	3.9	620	120	87	35	22	13	1.8
1/06/2022	4.3	750	61	89	40	7	33	2

Table 19 Spot sampling water quality statistics from bores installed in the western portion of the swamp (i.e. BSBH14-BSBH18)

Sampled Date	Average no. of data points	PH (Field)			Electrical Conductivity (EC)			Acidity as CaCO3			Sulfate as SO4			Total Iron			Ferric Iron			Ferrous Iron			Soluble Aluminium		
		Min pH	Max pH	Average pH	Min EC	Max EC	Average EC	Min Acidity	Max Acidity	Average Acidity	Min Sulfate	Max Sulfate	Average Sulfate	Min Fe	Max Fe	Average Fe	Min Fe ³⁺	Max Fe ³⁺	Average Fe ³⁺	Min Fe ²⁺	Max Fe ²⁺	Average Fe ²⁺	Min Al	Max Al	Average Al
		pH Units			uS/cm			mg/L			mg/L			mg/l			mg/L			mg/L			mg/L		
7/08/2019	5	2.9	3.8	3.3	750	4800	2110	141	2750	886	130	3400	1068										13	120	45
8/11/2019	5	2.8	3.8	3.4	680	4100	2236	113	2130	897	120	2500	1114	20	1100	518							11	98	46
4/12/2019	5	3.1	4.2	3.7	740	4200	2288	210	1968	961	140	3000	1280	25	1100	427	0.2	390	135	0.3	880	294	10	80	40
6/01/2020	5	3.2	5.1	4.2	800	7800	3140	206	2690	972	190	3300	1202	82	1200	436	3	230	93	54	1300	413	8	110	37
7/02/2020	5	2.5	3.9	3.3	290	4000	1762	145	2630	981	140	3100	1198	16	990	337	0.2	0.2	0.2	20	1200	400	10	150	49
4/03/2020	5	2.8	4.0	3.4	980	4200	2256	117	2460	809	160	3500	1202	24	1100	365	0.2	70	14	23	1100	353	5	160	44
1/04/2020	5	3.0	3.8	3.4	820	4000	2002	149	2600	806	150	3400	1122	5	970	303				7	1600	457	4	170	46
5/05/2020	5	3.0	3.8	3.4	810	4600	2064	152	3090	952	150	3900	1256	13	1100	357	2	49	26	15	1200	351	7	170	48
3/06/2020	5	3.0	3.8	3.4	680	5200	2146				140	4400	1368	17	410	151									
7/07/2020	5	3.2	4.0	3.7	770	5200	2204	149	3140	922	150	4200	1342	16	1400	388	0.2	12	7	16	1900	487	6	170	48
4/08/2020	5	3.4	4.3	3.8	740	5000	2136	185	2810	888	130	4000	1290	22	1500	413	0.2	10	5	18	1500	440	7	120	38
10/09/2020	5	3.3	4.1	3.7	520	4500	2048	143	2580	827	54	3300	854	19	1300	369	0.2	3	2	16	1300	393	7	120	37
9/10/2020	5	3.2	3.9	3.6	630	4300	1970	110	2490	796	90	3000	1044	17	1200	351	0.2	160	47	0.2	1200	316	9	120	37
6/11/2020	5	3.1	4.0	3.6	630	4100	1986	144	2710	868	130	3500	1182	29	1300	368	0.2	0.2	0.2	29	1500	434	8	97	32
1/12/2020	5	3.0	4.1	3.7	700	4200	1960	152	2870	907	150	3500	1176	50	1100	350	20	80	50	30	1100	332	8	130	39
2/03/2021	5	2.9	4.0	3.5	670	3900	1934	127	2420	864	150	3400	1216	22	1000	312	30	30	30	25	1100	333	6	160	47
2/06/2021	5	3.1	4.0	3.6	670	4100	1980	116	2410	783	140	3200	1112	32	1000	313	0.2	180	63	0.1	910	256	5	170	51
7/09/2021	5	3.4	4.1	3.8	630	4000	1980	147	2450	866	130	3300	1212	22	1000	320				26	1000	326	6	140	47
8/12/2021	5	3.2	3.9	3.7	1100	3600	2020	274	2310	923	330	3000	1164	71	760	308	0.2	50	25	81	990	364	10	140	50
3/03/2022	5	2.9	6.1	4.1	260	2300	1432	1	1390	591	49	1200	680	18	330	160	14	14	14	4	510	177	0.01	84	28
2/06/2022	5	2.8	4.0	3.4	1400	3500	2240	291	2080	998	440	2400	1169	41	460	244	370	370	370	74	750	270	9	150	61

Table 20 Spot sampling water quality statistics from bores installed in the eastern portion of the swamp (i.e. BSBH01-BSBH07)

Sampled Date	Average no. of data points	PH (Field)			Electrical Conductivity (EC)			Acidity as CaCO3			Sulfate as SO4			Total Iron			Ferric Iron			Ferrous Iron			Soluble Aluminium		
		Min pH	Max pH	Average pH	Min EC	Max EC	Average EC	Min Acidity	Max Acidity	Average Acidity	Min Sulfate	Max Sulfate	Average Sulfate	Min Fe	Max Fe	Average Fe	Min Fe ³⁺	Max Fe ³⁺	Average Fe ³⁺	Min Fe ²⁺	Max Fe ²⁺	Average Fe ²⁺	Min Al	Max Al	Average Al
		pH Units			uS/cm			mg/L			mg/L			mg/l			mg/L			mg/L			mg/L		
7/08/2019	7	4.6	7.0	6.1	510	2800	893	83	857	204	1	1500	250										0.01	17	2
8/11/2019	7	4.4	7.1	5.9	550	2700	940	38	700	146	1	1400	232	62	380	178							0.01	12	2
4/12/2019	7	4.7	6.6	6.0	510	2600	861	34	686	138	1	1400	231	17	330	84	17	90	50	0.1	240	34	0.01	11	2
6/01/2020	7	5.1	6.5	5.8	360	2500	813	100	703	207	3	1300	213	35	340	103	22	110	49	7	440	77	0.01	10	1
7/02/2020	7	3.9	6.7	6.0	240	4900	1137	27	652	130	2	1300	214	5	310	66	2	17	7	17	360	72	0.01	23	4
4/03/2020	7	4.5	7.3	6.2	480	2500	839	20	475	89	1	1300	214	33	300	93	4	120	34	19	360	73	0.01	9	1
1/04/2020	7	3.5	7.2	6.1	480	2300	789	11	532	103	1	1300	203	7	260	52	7	17	12	0.1	470	83	0.01	10	1
5/05/2020	7	4.4	6.7	6.0	520	2200	800	37	591	131	1	1200	194	28	330	86	5	66	24	12	320	63	0.01	6	1
3/06/2020	5	4.6	6.6	6.0	510	2200	814				1	1200	190	29	310	104				15	20	18	0.01	0.01	0.01
7/07/2020	7	4.8	6.6	6.1	510	2200	791	34	502	112	1	1200	191	25	240	63	0.2	20	8	17	330	69	0.01	7	1
4/08/2020	7	5.5	7.3	6.5	510	2200	801	81	520	165	1	1100	178	32	300	122	8	140	68	16	410	79	0.01	8	1
10/09/2020	7	4.6	6.7	6.1	470	2000	753	60	488	133	1	1000	161	26	220	60	4	24	12	13	310	63	0.01	6	0.8
9/10/2020	7	4.7	6.7	6.0	460	1900	730	39	439	109	1	890	144	22	200	75	2	190	59	0.1	28	16	0.01	4	0.7
6/11/2020	7	4.5	6.4	5.8	470	1900	724	64	459	145	1	930	148	22	180	58	0.2	42	18	16	250	55	0.01	5	0.7
1/12/2020	7	4.5	6.7	6.1	460	1800	697	117	424	247	2	860	136	27	200	74	8	91	29	17	270	58	0.01	4	0.6
2/03/2021	7	4.4	7.0	6.1	460	1500	649	75	359	137	2	710	113	24	150	51	0.2	44	22	2	150	28	0.01	4	0.5
2/06/2021	7	4.7	6.7	6.1	460	1400	643	26	232	78	1	500	81	25	120	57	5	91	33	0.5	140	35	0.01	3	0.4
7/09/2021	7	4.7	6.7	6.1	480	1200	626	78	298	142	1	440	73	16	97	45	0.2	31	16	10	98	29	0.01	2	0.3
8/12/2021	7	3.6	6.5	5.8	440	1100	610	45	205	77	1	280	49	19	120	54	0.2	110	35	0.8	64	20	0.01	1	0.2
3/03/2022	7	3.7	6.4	5.9	460	1000	563	8	143	55	1	230	43	21	85	46	0.2	41	19	13	71	27	0.01	1	0.2
2/06/2022	7	3.7	7.0	6.0	470	930	587	70	182	112	1	220	50	9	67	38	5	54	27	0.1	47	20	0.01	0.8	0.2