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Boundary Creek and Upper Barwon River Macroinvertebrate Sampling Report Spring 2023

- Final
- January 2024

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Contents

1. Introduction

Austral Research and Consulting (Austral) were contracted by Barwon Water in Spring 2019 to undertake an investigation into the ecological condition of the upper Barwon River with regard to the extent of impact of low pH inflows from Boundary Creek.

The initial surveys determined a baseline for ongoing monitoring of the Barwon River as part of a remediation plan required by a section 78 Ministerial Notice and twice yearly monitoring is now carried out on sites along both the Boundary Creek including Big Swamp and the Upper Barwon River.

1.1. Background

Studies have confirmed that historic groundwater extraction from the Barwon Downs borefield to boost Geelong's water supply in conjunction with a dry climate led to reductions in flows in lower Boundary Creek (Jacobs, 2017), an increased occurrence of wet-dry cycling and a decrease in groundwater levels. These factors led to the oxidation of naturally occurring acid sulfate soils in Big Swamp, thus releasing acid into the system and lowering the pH. This process has led to the discharge of acidity into the lower reaches of Boundary Creek, which flows into the Barwon River approximately 3.7 km downstream of Big Swamp.

A community and stakeholder working group was established in 2018 to develop a remediation plan for Big Swamp and Boundary Creek and the Boundary Creek, Big Swamp and Surrounding Environment - Remediation and Environmental Protection Plan (REPP) (Barwon Water, 2020) was released in December 2019 and updated in February 2020. An Ecological Risk Assessment conducted in 2022/23 (Nation Partners, 2023) identified further investigation of the health of Boundary Creek should be considered to better understand the system.

1.2. Objectives

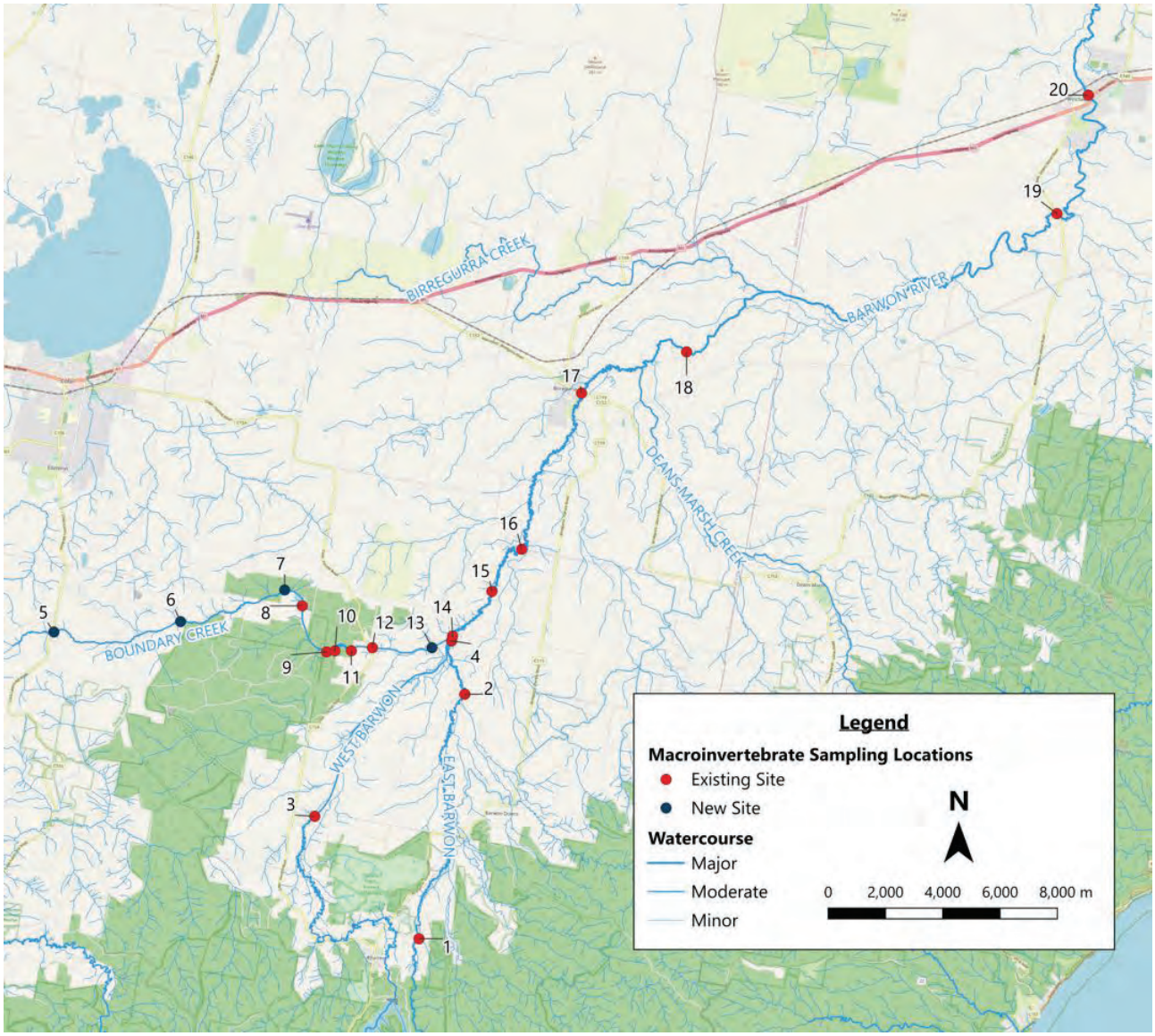
The objective of this report is to provide an overview of the ecological condition of Boundary Creek (including where it flows through Big Swamp). The condition of the upper Barwon River will also continue to be monitored.

1.3. Summary

As part of the REPP, Barwon Water has committed to continuing water quality and macroinvertebrate sampling along the Barwon River and has added a number of sites along Boundary Creek to monitor environmental health along the entire waterway. The latest results indicate that whilst Boundary Creek is still being impacted by water quality from Big Swamp, metal concentrations and pH levels are improving and that there may be wider catchment impacts to Boundary Creek including on stream dams and background metal concentrations.

2. Methods

A total of twenty sites were surveyed along the East Barwon, West Barwon, and Barwon Rivers in addition to Boundary Creek and Big Swamp (Figure 1). Twelve of these sites were sampled between Spring 2019 and Autumn 2022. A further four sites were surveyed on Boundary Creek and in Big Swamp along with the original twelve in Spring 2022 and Autumn 2023. Four more sites along Boundary Creek were added to the survey in Spring 2023 and the site numbers changed to reflect the addition of new sites over the years. The old and new site numbers along with their locations and descriptions are in Table 1.



- **Figure 1: Barwon River and Boundary Creek (base map from Open Street Map). Red markers are existing sites, blue are new sites added in Spring 2023. New numbering as per Table 1 below has been used.**

2.1. Site Selection

Sites were selected in consultation with Barwon Water to best give an indication of the impact of water coming from Big Swamp on Boundary Creek and particularly the Barwon River. Two sites are on the East Barwon River, one site is on the West Barwon River, six sites on Boundary Creek are upstream of Big Swamp, two sites are within Big Swamp, two sites are below Big Swamp and eight sites are on the mainstem Barwon River.

- **Table 1: Old and revised site numbers, site locations and descriptions.**

Revised site no.	Old site no.	Site description	Latitude	Longitude
1	1	East Barwon River @ Kents Road	-38.512196	143.732530
2	2	East Barwon River @ Dewings Bridge Road	-38.434878	143.747933
3	3	West Barwon River @ 7 Bridges Road	-38.474669	143.689396
4	4	Barwon River 100m u/s of Boundary Ck conf.	-38.418236	143.742025
5	-	Boundary Creek @Colac-Lavers Hill Road	-38.4191	143.583
6	-	Boundary Creek @Baongarook	-38.4147	143.6335
7	-	Boundary Creek @upstream McDonalds Dam	-38.4038	143.6747
8	5.1	Boundary Creek @ d/s McDonalds Dam	-38.408599	143.681938
9	5.2	Boundary Creek @ u/s Big Swamp	-38.422875	143.692198
10	BS2	Big Swamp @ western end	-38.423042	143.695382
11	BS1	Big Swamp @ eastern end	-38.422270	143.702076
12	5	Boundary Creek @ Colac-Forrest Road	-38.421122	143.710475
13	-	Boundary Creek @upstream of Barwon conf.	-38.4206	143.7343
14	6	Barwon River 100m d/s of Boundary conf.	-38.416717	143.742383
15	7	Barwon River @ north boundary of plantation	-38.402291	143.757554
16	8	Barwon River @ Colac-Lorne Road	-38.388771	143.768956
17	9	Barwon River @ Birregurra	-38.339105	143.790971
18	10	Barwon River @ Conns Lane	-38.325134	143.832385
19	11	Barwon River @ Winchelsea- Deans Marsh Rd	-38.278018	143.978382
20	12	Barwon River @ Princes Hwy bridge, Winchelsea	-38.240445	143.989326

2.2. Sampling methodology

Macroinvertebrates and *in situ* water quality, vegetation, site descriptions and photos were collected with specific sampling methods detailed below.

2.2.1. In-situ water quality

In-situ water quality parameters were measured at each site including dissolved oxygen (mg/L), temperature (ºC), specific conductivity (µS/cm) and pH using a YSI ProPlus water quality meter. Turbidity (NTU) and alkalinity (mg/L) were measured using HACH meters and test kits respectively.

2.2.2. Metals in water

Water samples were collected for metals analysis, field filtered using 0.45µm membrane filter, using bottles containing Nitric Acid (HNO_3) preservative and kept refrigerated prior to delivery to the NATA accredited ALS Laboratory.

2.2.3. Macroinvertebrates

Macroinvertebrates were collected at each site and photos and site assessment sheets were completed as per Victorian EPA guidelines (EPA Victoria, 2021). In the absence of riffle habitats, two edge samples (labelled A and B) were collected (EPA Victoria, 2021) using a 250µm mesh dip net to sample ten metres of representative habitat at two locations at each site on the 16th, 17th and 18th of October, 2023. The contents of the net were placed into a white tray to be picked through for 30 minutes with the aim of picking over 100 animals into 70% ethanol for later identification to family level following the Rapid Bioassessment Methodology for Rivers and Streams (EPA Victoria, 2021). Macroinvertebrates were identified in the laboratory in accordance with the guidelines; to class for Oligochaeta and Mites, chironomids to sub-family and all other taxa to family except those that are not included in EPA Victoria biotic calculations (EPA Victoria, 2021).

2.2.4. Site descriptions

EPA Victoria field sampling and habitat assessment sheets were filled out at each site and site photos taken (EPA Victoria, 2021). This information has been summarised in Appendix 1. The reported habitat parameter score is not expected to change over the short term unless works have been undertaken at the site such as riparian revegetation or fencing or large woody debris introduction or the site is experiencing changes in flow such as drought conditions.

3. Results

3.1. Water Quality

The *in situ* water quality information in Table 4 below give an indication of the conditions at the time of sampling. The minimum and maximum values are displayed along with the values for Spring 2023. The full data table can be found in Appendix 3. Note that new site numbers have been applied.

- **Table 2: In-situ water quality data- minimum, maximum (from Spring 2019) and current Spring 2023.**

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
Site 5 Boundary Creek @ Colac-Lavers Hill Road	Spring 23	12.2	6.97	311.4	412.6	5.79	55.5	25	14.5
Site 6 Boundary Creek @ Barongarook	Spring 23	10.4	6.67	295.0	409.4	6.04	55.2	25	45.5
Site 7 Boundary Creek upstream of McDonalds Dam	Spring 23	11.6	6.99	357.6	480.8	6.98	65.2	25	14.2
Site 8 Boundary Creek downstream of McDonalds Dam	Minimum	13.2	6.69	290.9	361.8	3.27	32.2	20	3.29
	Maximum	14.6	7.35	461	694	6.23	59.5	40	14.2
	Spring 23	15.3	7.26	362.8	445.2	4.48	45.0	25	7.20
Site 9 Boundary Creek upstream of Big Swamp	Minimum	8.9	6.63	280.8	355.8	3.68	35.8	20	5.07
	Maximum	14.0	7.14	410	592	10.18	87.2	40	13.8
	Spring 23	11.2	6.95	324.2	440.7	7.29	67.0	30	7.28
Site 10 Big Swamp western end	Minimum	11.2	3.86	272.2	338.4	1.74	16.4	0	2.55
	Maximum	14.7	5.87	360.9	489.7	3.24	31.2	20	9.64
	Spring 23	11.2	3.86	360.9	489.7	1.74	16.4	0	2.55
Site 11 Big Swamp eastern end	Minimum	8.8	5.48	306.4	384.5	2.2	22.5	10	14.2
	Maximum	13.7	6.30	656	929	5.29	46.6	30	26.9
	Spring 23	8.8	5.88	339.1	491.2	5.29	46.6	20	14.2
Site 12 Boundary Creek@ Colac-	Minimum	10.0	3.1	286.6	401.2	2.05	18.5	0	2.92
	Maximum	14.6	6.05	830	1152	8.76	87.7	20	260

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
Forrest Road	Spring 23	11.4	5.81	374.4	506.5	4.51	41.8	15	92.9
Site 13 Boundary Creek upstream of Barwon River confluence	Spring 23	12.2	4.45	552	730	5.16	48.6	10	101
Site 1 East Barwon River@ Kents Road	Minimum	12.0	6.2	93.5	129.0	3.64	35.7	5	2.6
	Maximum	16.0	8.67	209.7	279.3	9.92	123	35	26.2
	Spring 23	14.7	7.22	135.9	168.9	5.08	51.0	25	12.3
Site 2 East Barwon River @ Dewings Bridge Road	Minimum	13.4	6.3	180.7	218.2	3.30	31.8	10	8.2
	Maximum	17.2	7.71	544	664	12.54	120.9	55	18.3
	Spring 23	16.6	7.31	358.7	427.4	4.77	48.6	50	12.8
Site 3 West Barwon River@ Seven Bridges Road	Minimum	9.7	5.26	165.1	221.1	4.45	28.3	10	3.28
	Maximum	14.8	8.23	473.4	590.6	7.49	73.5	50	16.3
	Spring 23	12.0	6.69	201.9	268.7	4.79	44.9	30	7.91
Site 4 Barwon River 50-100m upstream of Boundary Creek confluence	Minimum	10	6.60	224.3	248.4	4.91	50	10	8.01
	Maximum	17.9	7.4	575	664	9.73	96.4	55	41.5
	Spring 23	12.9	6.92	277.1	360.3	6.38	60.3	50	34.6
Site 14 Barwon River 100m downstream of Boundary Creek confluence	Minimum	10.9	6.20	207.7	250.6	4.15	35.9	10	9.43
	Maximum	16.8	7.48	608	756	9.38	88.1	50	31.7
	Spring 23	12.5	6.83	324.2	426.2	6.17	53.7	35	19.8
Site 15 Barwon River @ north boundary of plantation	Minimum	10.7	6.46	510	256.2	3.67	35.3	5	10
	Maximum	16.5	7.95	599	770	9.09	91.7	45	21.8
	Spring 23	15.2	6.88	360.6	443.9	5.27	52.6	40	14.1
Site 16 Barwon River @ Colac-Lorne Road	Minimum	11.02	6.74	234.8	255.7	3.22	32	10	4.04
	Maximum	16.9	7.80	660	795	8.8	87.9	50	20.9
	Spring 23	14.8	6.91	342.2	425.2	4.55	45.0	40	12.6
Site 17 Barwon River @ Birregurra	Minimum	10.0	6.63	366.0	437.5	3.92	39.1	15	9.25
	Maximum	16.8	7.8	1115	1412	9.88	98.0	55	65.9
	Spring 23	12.8	7.58	499.4	651.2	6.94	65.8	45	29.4
Site 18	Minimum	11.1	5.56	511	461.3	3.80	37.7	15	18

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
Barwon River @Conns Lane	Maximum	16.8	7.9	1399	1561	9.03	86.1	75	58.5
	Spring 23	13.0	7.73	703	912	7.65	72.1	50	30.5
Site 19 Barwon River @Winchelsea-Deans Marsh Road	Minimum	11	6.26	733	548.8	3.62	35.2	15	13.3
	Maximum	16.5	8.25	1707	2227	9.23	87	85	81.0
	Spring 23	13.4	7.79	1156	1486	6.94	66.6	85	37.3
Site 20 Barwon River@ Princes Hwy bridge, Winchelsea	Minimum	10.8	6.69	733	622	3.66	36.9	15	9.71
	Maximum	17.1	8.06	1788	2364	8.18	82.1	100	85.5
	Spring 23	15.0	7.6	847	1048	6.25	62.8	85	17.1

Site 10 at the western (upstream) end of Big Swamp was the only site where pH was outside the range of previous samples but has only been sampled on three occasions. Overall, pH levels remain typically low within the swamp and at downstream sites but pH levels at Site 12 (Colac-Forrest Road) have not returned to the low levels recorded in Autumn 2021 and prior. Conductivity concentrations, dissolved oxygen and turbidity levels in Spring 2023 were within the range of previous sampling events.

- **Table 3: Metal results (0.45µm filtered) for freshwater samples (mg/L) and Australian & New Zealand Guidelines for Fresh & Marine Water Quality (2019). In all but two instances the 95% level of species protection is applied as is recommended for slightly to moderately disturbed ecosystems. Shaded cells indicate exceedance of guideline values.**

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Toxicant default guideline values		0.055 (>6.5pH) 0.8# (<6.5pH)	0.009#	AsIII 0.024 AsV 0.013	0.0002	CrIII 0.0003 CrVI 0.001	0.0014	-	0.0034	1.9	0.00006^	0.005^	0.00005	0.008
Site 5 Boundary Creek @ Colac-Lavers Hill Road	Spring 23	0.05	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1.2	< 0.001	0.081	< 0.0001	< 0.001	< 0.001	0.015
Site 6 Boundary Creek @ Barongarook	Spring 23	0.11	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1.4	< 0.001	0.1	< 0.0001	< 0.001	< 0.001	0.009
Site 7 Boundary Creek upstream of McDonalds Dam	Spring 23	0.06	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.85	< 0.001	0.059	< 0.0001	< 0.001	< 0.001	0.011
Site 8 Boundary Creek downstream of McDonalds Dam	Minimum	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.37	<0.001	0.015	<0.0001	<0.001	<0.001	0.004
	Maximum	0.19	0.002	0.001	<0.0002	<0.001	<0.001	2.8	0.001	0.25	<0.0001	<0.001	<0.001	0.012
	Spring 23	0.04	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1.2	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.012
Site 9 Boundary Creek upstream of Big Swamp	Minimum	0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.43	<0.001	0.019	<0.0001	<0.001	<0.001	0.004
	Maximum	0.20	0.002	0.001	<0.0002	<0.001	<0.001	2.4	<0.001	0.046	<0.0001	<0.001	<0.001	0.017
	Spring 23	0.04	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1	< 0.001	0.035	< 0.0001	< 0.001	< 0.001	0.017
Site 10 Big Swamp western end	Minimum	0.09*	<0.001	< 0.001	<0.0002	<0.001	<0.001	2.0	<0.001	0.014	<0.0001	<0.001	<0.001	0.016
	Maximum	0.12*	< 0.001	0.002	< 0.0002	< 0.001	< 0.001	2.1	< 0.001	0.019	< 0.0001	0.005	< 0.001	0.034
	Spring 23	0.12*	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	2.1	< 0.001	0.014	< 0.0001	0.005	< 0.001	0.034
Site 11 Big Swamp eastern end	Minimum	0.23*	<0.001	<0.001	<0.0002	<0.001	< 0.001	48	<0.001	0.024	<0.0001	<0.001	<0.001	0.016
	Maximum	0.31*	<0.001	0.003	<0.0002	0.001	0.002	31	<0.001	0.018	<0.0001	<0.001	<0.001	0.024
	Spring 23	0.23*	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	20	< 0.001	0.021	< 0.0001	0.002	< 0.001	0.024
Site 12 Boundary Creek@ Colac-Forrest Road	Minimum	< 0.05*	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	1.3	< 0.001	0.024	< 0.0001	< 0.001	< 0.005	0.015
	Maximum	10*	< 0.005	< 0.001	0.0002	< 0.001	< 0.001	51	< 0.001	0.18	< 0.0001	< 0.001	< 0.005	0.34
	Spring 23	0.33*	< 0.001	0.002	< 0.0002	< 0.001	< 0.001	19	< 0.001	0.029	< 0.0001	< 0.001	< 0.001	0.042

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L) Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Site 13 Boundary Creek u/s confluence with Barwon River	Spring 23	0.39*	< 0.001	0.002	< 0.0002	< 0.001	< 0.001	15	< 0.001	0.062	< 0.0001	< 0.001	< 0.001	0.064
Site 1 East Barwon River@ Kents Road	Minimum	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.21	< 0.001	< 0.005	< 0.0001	< 0.001	<0.001	<0.001
	Maximum	0.06	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.68	< 0.001	0.31	< 0.0001	< 0.001	<0.001	0.032
	Spring 23	0.02	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.47	< 0.001	0.091	0.0002	0.004	< 0.001	0.007
Site 2 East Barwon River@ Dewings Bridge Road	Minimum	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.08	< 0.001	0.006	< 0.0001	< 0.001	< 0.001	<0.005
	Maximum	0.02	0.006	< 0.001	< 0.0002	< 0.001	< 0.001	0.51	< 0.001	0.15	0.0001	0.004	< 0.001	0.008
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.14	< 0.001	0.079	0.0001	0.004	< 0.001	0.008
Site 3 West Barwon River@ Seven Bridges Road	Minimum	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	<0.05	< 0.001	0.005	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.06	0.004	< 0.001	< 0.0002	< 0.001	0.003	1.1	0.010	0.34	< 0.0001	0.003	< 0.001	0.051
	Spring 23	0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.32	< 0.001	0.079	< 0.0001	0.003	< 0.001	0.011
Site 4 Barwon River 100m upstream of Boundary Creek confluence	Minimum	<0.01	<0.001	< 0.001	< 0.0002	< 0.001	<0.001	0.05	< 0.001	0.008	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.03	0.003	< 0.001	< 0.0002	< 0.001	0.001	0.33	< 0.001	0.35	< 0.0001	< 0.001	< 0.001	0.021
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.21	< 0.001	0.096	< 0.0001	< 0.001	< 0.001	0.021
Site 14 Barwon River 100m downstream of Boundary Creek confluence	Minimum	< 0.05	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.13	< 0.001	0.010	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.11	0.002	< 0.001	< 0.0002	< 0.001	0.001	2.0	< 0.001	0.29	< 0.0001	< 0.001	< 0.001	0.057
	Spring 23	0.03	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.66	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.01
Site 15 Barwon River @ north boundary of plantation	Minimum	< 0.05*	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.05	< 0.001	0.005	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.10	0.002	0.001	< 0.0002	< 0.001	0.002	1.9	< 0.001	0.14	< 0.0001	< 0.001	< 0.001	0.040
	Spring 23	0.02	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.31	< 0.001	0.096	< 0.0001	< 0.001	< 0.001	0.007
Site 16 Barwon River @ Colac-Lorne Road	Minimum	< 0.05	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.1	0.001	< 0.001	< 0.0002	< 0.001	0.001	1.8	< 0.001	0.13	< 0.0001	0.001	< 0.001	0.015
	Spring 23	0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.23	< 0.001	0.073	< 0.0001	0.001	< 0.001	0.007
Site 17 Barwon River @ Birregurra	Minimum	< 0.05	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.011	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.05	< 0.001	0.001	< 0.0002	< 0.001	0.001	1.4	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.013
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.15	< 0.001	0.12	< 0.0001	< 0.001	< 0.001	0.01

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Site 18 Barwon River @ Conns Lane	Minimum	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.012	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.09	0.003	0.001	< 0.0002	< 0.001	0.001	1.3	< 0.001	0.13	< 0.0001	< 0.001	0.003	0.012
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.15	< 0.001	0.12	< 0.0001	< 0.001	< 0.001	0.007
Site 19 Barwon River @ Winchelsea- Deans Marsh Road	Minimum	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.025	< 0.0001	< 0.001	< 0.001	< 0.005
	Maximum	0.16	0.001	0.002	< 0.0002	< 0.001	0.002	1.4	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.010
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.12	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.008
Site 20 Barwon River @ Princes Hwy bridge, Winchelsea	Minimum	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.03	< 0.0001	< 0.001	< 0.001	< 0.001
	Maximum	0.27	< 0.001	0.002	< 0.0002	< 0.001	0.007	1.7	< 0.001	0.17	< 0.0001	< 0.001	< 0.001	0.018
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.12	< 0.001	0.17	< 0.0001	< 0.001	< 0.001	0.018

 # level of species protection unknown
** Aluminium results where pH is <6.5*
^ 99% species protection level to account for the bioaccumulating nature of this toxicant
Shaded exceeds guideline values

Zinc concentrations exceed ANZECC guidelines in Spring 2023 at every site monitored on Boundary Creek in addition to some sites on the Barwon River, both up and downstream of the confluence with Boundary Creek. Aluminium concentrations only exceeded guidelines at Sites 6 and 7, (Barongarook and upstream of McDonalds Dam) on Boundary Creek in Spring 2023. Iron levels are higher at Site 11 at the eastern end of the swamp than upstream sites and whilst they remain elevated at Sites 12 and 13 downstream of the swamp they are within the range of concentrations previously recorded.

3.1.1. Macroinvertebrates

Biotic indices such as AusRivAS, SIGNAL2, EPT (Ephemoptera, Plecoptera, Trichoptera) and taxa richness (number of families) scores were calculated in accordance with EPA Victoria biological indicators (EPA Victoria, 2004).

A list of macroinvertebrate families found at each site in Spring 2023 is in Appendix 2.

AusRivAS scores and bands (Table 3) are considered to give the most accurate assessment of the health of a site as the program compares the test site to a number of reference sites that have similar physical and chemical characteristics but are relatively free of environmental impacts. The score indicates how many macroinvertebrate families were found compared to those found at reference sites. The statewide model for edge habitat for each season was applied to these samples.

- **Table 4: AusRivAS Bands, Observed/Expected scores and descriptions for edge models (AusRivAS Macroinvertebrate Predictive Modelling Version 3.2.2)**

Band	OE 50 score Spring	Description
X	1.20+	More biologically diverse than reference sites
A	0.81-1.19	Reference condition
B	0.43-0.80	Significantly impaired
C	0.05-0.42	Severely impaired
D	0-0.04	Extremely impaired

SIGNAL2 is a biotic index based on the tolerance or intolerance of biota (macroinvertebrates) to water pollution. Sites with high scores are likely to have low nutrient, salinity and turbidity levels and high oxygen levels but its accuracy in identifying toxicants is less certain (EPA Victoria, 2021). The EPT score indicates the number of families that are sensitive to pollution that are present at the site with a low score usually indicating that there has been some type of disturbance. Together, these scores give a good picture of the health of the waterway at a site and potentially what is causing any disturbance. Taxa richness, measured by the number of macroinvertebrate families collected, can give a good overview of the health of a waterway. High numbers are associated with diverse habitats present at the site but can also be influenced by mild nutrient enrichment which can increase the food supply. The score can be combined with SIGNAL2 scores as in Figure 4 to help interpret results.

The upper Boundary Creek sites are close to the border between two biological regions. Uplands B; characterised by upland reaches in the Otway Ranges where there is some clearing for forestry, grazing and some intensive agriculture and Central Foothills and Coastal Plains; incorporating the lower reaches of the Barwon River where the region has been substantially cleared for intensive agriculture (EPA Victoria, 2004). For ease of comparison along the waterway the Central Foothills and Coastal Plains objectives have been applied. The Barwon River sites are in two biological regions with Site 1 (East Barwon River at Yaugher) in Uplands B and all other sites in Central Foothills and Coastal Plains.

- **Table 5: Environmental Quality Objectives for Biological Indicators, edge habitat (VGG, 2021).**

Objective	Season	Number of Families	SIGNAL2 Index score	EPT Index score	AusRivAS Band
Uplands B	Spring	17	4.2	6	A
Central Foothills & Coastal Plains	Spring	20	3.4	N/A	A

- **Table 6: Biotic indices in Spring 2023.**

Waterway	Site	Number of Families	SIGNAL2 Index score	EPT Index score	O/E score	AusRivAS Band
Boundary Creek	5	12	3.74	1	0.56	B
Boundary Creek	6	16	4.66	3	0.85	A
Boundary Creek	7	15	5.37	4	0.67	B
Boundary Creek	8	15	3.77	2	0.77	B
Boundary Creek	9	16	4.85	3	0.84	A
Big Swamp	10	6	3.18	0	0.27	C
Big Swamp	11	4	3.00	0	0.13	C
Boundary Creek	12	6	3.27	0	0.16	C
Boundary Creek	13	6	3.88	0	0.24	C
East Barwon River	1	11	3.47	3	0.47	B
East Barwon River	2	16	3.06	4	0.32	C
West Barwon River	3	15	4.46	5	0.76	B
Barwon River	4	16	3.42	4	0.82	A
Barwon River	14	16	3.60	4	0.64	B
Barwon River	15	17	3.35	3	0.78	B
Barwon River	16	17	3.76	5	0.90	A
Barwon River	17	19	3.59	4	0.85	A
Barwon River	18	12	3.24	2	0.56	B
Barwon River	19	16	3.87	3	0.72	B
Barwon River	20	19	4.25	3	0.89	A

Shaded values indicate compliance with Environmental Quality Objectives.

Table 6 shows that none of the sites meet all of the ecological objectives but that Site 6 at Barongarook and Site 9 upstream of Big Swamp on Boundary Creek meet two of the three objectives. Sites within Big Swamp (Sites 10 and 11) were poor but beginning to improve by the new site (Site 13) upstream of the confluence with the Barwon River. Full analysis and reporting on macroinvertebrate community compositions will occur following the Autumn survey which will incorporate temporal trends and allow comparisons with environmental objectives.

4. Conclusions

The addition of sites along Boundary Creek upstream and downstream of Big Swamp will fill a data gap regarding other impacts on the creek and any ecological recovery before it joins with the Barwon River. Recent water quality data indicates that metals such as Aluminium and Zinc exceed ANZECC guidelines in the catchment above Big Swamp but most parameters were within the previously sampled range along both Boundary Creek and the Barwon River. Waterway health as measured by aquatic macroinvertebrates was very good above both McDonalds Dam and Big Swamp but in poorer condition below each wetland/ dam including the one immediately above Site 5 at Colac-Lavers Hill Road. The most healthy sites on the Barwon River were downstream of the confluence with Boundary Creek at the Colac-Lorne Road (Site 16), Birregurra (Site 17), and Winchelsea (Site 20). Further comment and comparisons with previous results will be made following the Autumn 2023 sampling event.

5. References

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2019) *Toxicant default guideline values*. Viewed 7th February 2021. <https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants>.

Barwon Water (2020) *Boundary Creek, Big Swamp and Surrounding Environment – Remediation and Environmental Protection Plan*.

Barwon Water (2022) *East Barwon Willow Removal and Restoration Project*. Viewed 2nd June 2022. https://www.yoursay.barwonwater.vic.gov.au/east-barwon-transfer

Chessman (2003) SIGNAL 2 – A Scoring System for Macro-invertebrate('Water Bugs') in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra.

EnviroDNA (2019) *Determining the distribution of platypuses in the upper Barwon region using environmental DNA* Prepared for Upper Barwon Landcare Network.

EPA Victoria (2004) *Biological Objectives for Rivers and Streams – Ecosystem Protection*. Publication No. 793.2

EPA Victoria (2021) *Guideline for environmental management (GEM)- Rapid bioassessment methodology for rivers and streams.* Publication No. 604.2

Jacobs (2017) *Yeodene Swamp Study*, Final Draft Report for Barwon Water.

Nation Partners (2023) *Ecological Risk Assessment: Boundary Creek, Big Swamp and the Barwon River*, Final Draft Report for Barwon Water.

Victorian Government Gazette (VGG) (2021) *Environment Reference Standard, Environment Protection Act 2017* No. S 245 Wednesday 26 May 2021.

Appendix 1:

5.1. Site 1- East Barwon River@ Kents Road

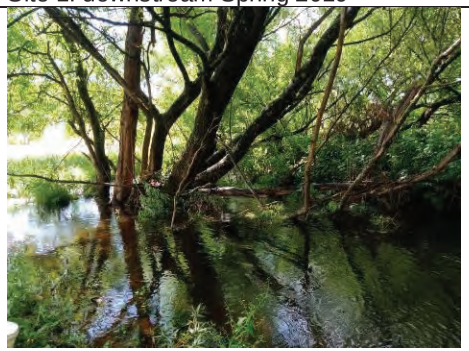

Site 1: upstream Spring 2019


Site 1: downstream Spring 2019


Site 1: upstream Autumn 2020

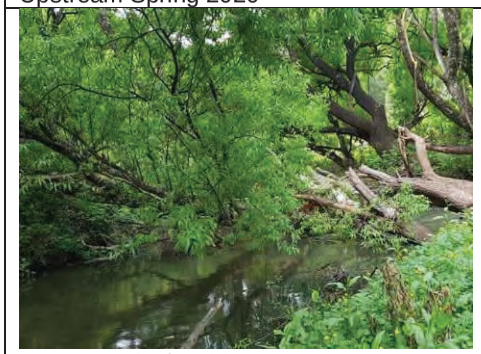

Site 1: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021


Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022


Downstream Autumn 2022


Upstream Spring 2022


Downstream Spring 2022


Upstream Autumn 2023


Downstream Autumn 2023


Upstream Spring 2023


Downstream Spring 2023

Prior to the willow removal and river realignment in early 2022, the East Barwon River at Kents Road had diverse habitat with large deep pools and some riffle/ run areas. These runs had dried to trickles in Autumn 2020 but were flowing well in Spring and Autumn 2021. The average stream width was eight meters and bank full but had contracted to five meters in Autumn 2020. Willows dominated the riparian zone and were growing within the stream channel prior to removal. The substrate was a mix of clay and silt with a number of aquatic macrophytes growing in the margins and shallow pool areas. The majority of the riparian zone was exotic vegetation, dominated by blackberries (possibly poisoned in Summer 20/21), willows and pasture grass. One larval fish has been collected as bycatch during macroinvertebrate sampling. A concurrent snapshot study by EnviroDNA (2019) found evidence of platypus at this site.

Following the works in January to April 2022 (Barwon Water, 2022), the East Barwon River at Kents Road was a homogenous channel with very little riparian zone and submerged macrophytes. The banks had healed in areas in Spring 2022 from the disturbed bare earth or rip rap that was evident in Autumn 2022. Stock now appear excluded from the waterway and all woody weeds have been removed within the vicinity of the site. Most of the

banks were vegetated in Autumn 2023 and aquatic vegetation was beginning to be established although there appeared to be a highly mobile silty substrate that may easily smother submerged macrophytes. Filamentous algae was abundant in Autumn 2023 but absent in Spring 2023.

Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 74 out of 140 in 2019 and a downgraded score of 57 out of 140 in 2022 due to the recent works. It is expected that this score will improve following the establishment of the revegetation works and ongoing stock exclusion.

5.2. Site 2- East Barwon River@ Dewings Bridge Road


Site 2: upstream Spring 2019


Site 2: downstream Spring 2019


Site 2: upstream Autumn 2020


Site 2: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021

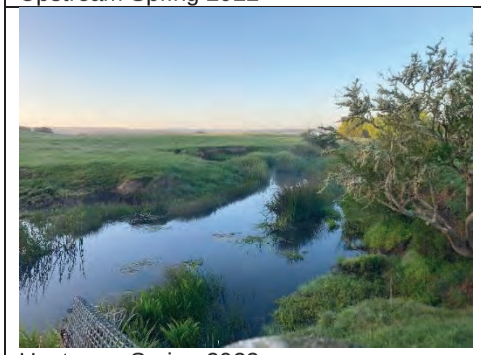
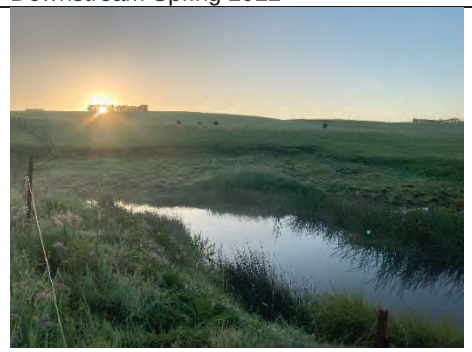

Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022


Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 Upstream Spring 2023	 Downstream Spring 2023		

The East Barwon at Dewings Bridge Road consists of a slow flowing channel with extensive backwaters. There is very little riparian zone present but a number of submerged and emergent macrophytes provide good habitat for macroinvertebrates and fish. One larval fish was found in the sample net in Autumn 2020, three pygmy perch in Spring 2020 and a pygmy perch in Spring 2021. The substrate is a mix of clay and silt with some sand. The average stream width at this site was seven meters and was bank full during both Spring and Autumn sampling. The majority of the riparian zone is pasture grass with stock access on both sides. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 59 out of 140 and increased to 70 out of 140, primarily due to the gradual reduction in erosional scars and the increase in submerged and emergent macrophyte beds, despite the constant stock access. Removing stock access and establishing riparian vegetation will improve the health of this site significantly.

5.3. Site 3- West Barwon River@ Seven Bridges Road


Site 3: upstream Spring 2019


Site 3: downstream Spring 2019


Site 3: upstream Autumn 2020


Site 3: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021


Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022


Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 upstream Spring 2023	 downstream Spring 2023		

The West Barwon River at Seven Bridges Road has large deep pools with a number of backwaters. The average stream width at this site is seven meters, narrow at the top of the surveyed reach and widening into a large pool near the bridge. The substrate is clay and silt mixed with 20% sand. There are some macrophytes present along with trailing bank vegetation, roots and instream large woody debris (primarily willow branches). Willows dominate the riparian zone a mix of shrubs and native and pasture grasses in the understory. Usual access to the river was blocked in Autumn 2023 by a ground nest European Wasps, one of a number of sites that had nests. Four larval fish were collected as bycatch during macroinvertebrate sampling in Spring 2019. One mountain galaxias, one common galaxias, one pygmy perch and a laval galaxias were collected in Spring 2020 and another galaxias in Spring 2021. A number of pygmy perch were collected in Autumn 2022. A concurrent snapshot study by EnviroDNA (2019) found evidence of platypus at this site in Spring 2019. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 85 out of 140 in 2019 and this has remained steady over the three years of the study.

5.4. Site 4- Barwon River 100m upstream of Boundary Creek confluence

 Site 4: upstream Spring 2019	 Site 4: downstream Spring 2019	 Site 4: upstream Autumn 2020	 Site 4: downstream Autumn 2020
 Upstream Spring 2020	 Downstream Spring 2020	 Upstream Autumn 2021	 Downstream Autumn 2021
 Upstream Spring 2021	 Downstream Spring 2021	 Upstream Autumn 2022	 Downstream Autumn 2022

Not sampled		 Site 4: Upstream Autumn 2023, new site	 Site 4: downstream Autumn 2023, new site
 Site 4: upstream Spring 2023, new site	 Site 4: downstream Spring 2023, new site		

Site 4 was moved in Autumn 2023 from 100 meters upstream of the confluence with Boundary Creek to 50 meters upstream of the confluence and sampled from the opposite site. The primary difference is that the Barwon River is narrower at this point and has larger beds of *Juncus*. The Barwon River 50-100 meters upstream of the Boundary Creek confluence is a large slow flowing channel with shallow side sections that support a number of macrophyte beds. The average stream width at this site is nine meters. The substrate is clay and black silt with some large woody debris and filamentous algae present in addition to the macrophytes. *Juncus, Typha, Triglochin* and *Polygonum* species are all present instream though riparian vegetation is limited to some isolated trees, a narrow native plantation and pasture grass with stock access. The introduced Gambusia (mosquito fish) were collected as bycatch during macroinvertebrate sampling in Spring 2019, Autumn 2021 and Autumn 2022 and a pygmy perch sampled in Spring 2021. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 79 out of 140 in 2019 and an increased score of 99 due to the establishment of more aquatic macrophytes and healed erosion. Fencing and revegetation of the left side of the river to a similar standard as the right side would see further improvements to the health of the river.

5.5. Site 5 – Boundary Creek @ Colac-Lavers Hill Road

Site 5: upstream Spring 2023

Site 5: downstream Spring 2023

Site 5 on Boundary Creek at Colac-Lavers Hill Road is immediately downstream of an onstream dam and is the most upstream site for this project on Boundary Creek, added in Spring 2023. The creek is only one to two meters wide and has a mix of artificial riffle areas, runs over hard clay substrate and pools. The riparian zone consists of native trees but the understory is dominated by blackberries.

5.6. Site 6 – Boundary Creek @ Barongarook

Site 6: upstream Spring 2023

Site 6: downstream Spring 2023

Site 6 was added to the sampling program in Spring 2023, having previously been sampled in 2015/2016 as part of an earlier study of the area (SKM, 2017). The site is within a dairy farm but does not appear to have stock access. Boundary Creek is between one and five meters wide with some runs but the majority of the waterway is slow flowing. The riparian zone is primarily native trees, shrubs and grasses with large sections of pasture grass. The trailing bank and emergent vegetation along with some macrophytes and sticks and logs provides good habitat for macroinvertebrates and aquatic fauna.

5.7. Site 7 – Boundary Creek upstream of McDonalds Dam


Site 7: upstream Spring 2023


Site 7: downstream Spring 2023

Site 7 on Boundary Creek is approximately 300meters above McDonalds Dam. It was previously surveyed in 2015/16 as part of an earlier study of the area (SKM, 2017). Boundary Creek is between 4 and 5 meters wide and is generally slow flowing except for the weir section. There is a good mix of undercut banks, trailing bank vegetation and macrophytes present and the riparian zone consists of native trees and shrubs but the ground cover is dominated by blackberries.

5.8. Site 8 (ex site 5.1)- Boundary Creek downstream of McDonalds Dam


Site 8: upstream Autumn 2022


Site 8: downstream Autumn 2022

			
Upstream Spring 2022	Downstream Spring 2022	Upstream Autumn 2023	Downstream Autumn 2023
			
Upstream Spring 23	Downstream Spring 23		

Site 8 on Boundary Creek was added to the current sampling regime to replicate the site sampled by Austral in 2014/2015 for Jacobs (2017). Boundary Creek below McDonalds Dam is between 3 and 4 meters wide with a mix of deep pools, shallower pools and artificial riffle areas from the culvert/ bridge. There were isolated patches of aquatic macrophytes in 2014 but non were present in 2022. Whilst large trees are a feature of the riparian zone, live blackberries and bare ground where they have been poisoned, dominate. Intensive agriculture exists outside of the riparian zone. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 87 out of 140 in 2014 and a similar score of 91 in 2022.

5.9. Site 9 (ex site 5.2)- Boundary Creek upstream of Big Swamp

Site 9: upstream Autumn 2022

Site 9: downstream Autumn 2022

Upstream Spring 2022

Downstream Spring 2022

Upstream Autumn 2023

Downstream Autumn 2023

Upstream Spring 2023

Downstream Spring 2023

Site 9 on Boundary Creek was added to the current sampling regime to give additional information on the biological health of Boundary Creek upstream of Big Swamp. Boundary Creek is between 1 and 2 meters wide either side of the vehicle crossing and is very different to all other sites sampled with a mix of large and small, deep and shallow pools and runs. There are extensive areas of macrophytes including Triglochin, Ranunculus and Cyperus beds and isolated patches of Alisma and Juncus. The riparian zone is extensive consisting of predominantly, if not totally, native species. Pool deepening works close to the gauge were in progress at the time of sampling in Autumn 2023 but this does not appear to have adversely affected instream habitat. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 130 out of 140, the highest of any in this study.

5.10. Site 10 (ex site BS2)- Big Swamp western end


Site 10: upstream Spring 2022


Site 10: downstream Spring 2022


Site 10: upstream Autumn 2023


Site 10: downstream Autumn 2023


Upstream Spring 2023


Downstream Spring 2023

Site 10 in Big Swamp has been renumbered due to the addition of sites to the program. The site was dry in Autumn 2022 and whilst was holding water in Spring 2022 and Autumn and Spring 2023, water at this site is primarily standing rather than flowing as it is at Site 11. Vegetation appears to be all native with an excellent riparian zone. Vegetation is similar to Site 11 with beds of Giant Rush and scattered sedges and rushes such as Gahnia and Cyperus but without the extensive large woody debris. This site also has floating mats and submerged decaying mats of algae amongst the vegetation.

5.11. Site 11 (ex site BS1)- Big Swamp eastern end

Site 11: upstream Autumn 2022

Site 11: downstream Autumn 2022

Upstream Spring 2022

Downstream Spring 2022

Upstream Autumn 2023

Downstream Autumn 2023

Upstream Spring 2023

Downstream Spring 2023

Site 11 in Big Swamp has been renumbered due to sites being added to the program. The water level is shallow with deep silt and slowly flows around the extensive amount of large woody debris, beds of Giant Rush and scattered sedges and rushes such as Gahnia and Cyperus. There is a high amount of iron floc present on the substrate.

5.12. Site 12 (ex site 5)- Boundary Creek @ Colac- Forrest Road


Site 12: upstream Spring 2019


Site 12: downstream Spring 2019


Site 12: upstream Autumn 2020


Site 12: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021


Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022


Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 Upstream Spring 2023	 Downstream Spring 2023		

Boundary Creek at Colac- Forrest Road was called Site 5 until a number of sites were added to the program. It has a mix of large deep pools, a large shallow pool at the bridge and shallow runs. It has been bank full with an average stream width of four meters, narrow at the top of the surveyed reach and widening into a large pool upstream of the bridge during each sampling event excepting during Autumn 2020 sampling when the creek had contracted to a pool approximately 4 meters long by 2.5 meters wide. During this time the pooled water was stagnant, with low oxygen concentrations and very high turbidity. The substrate is a mix of cobble, pebble, gravel, sand, clay and silt. There are no macrophytes but there was some filamentous algae in Spring 2019, (absent since) and trailing bank vegetation present. Foam was present at the top of the reach during most sampling events. The riparian zone is wide and a mix of native and exotic vegetation except the ground cover which is dominated by *Convolvulus* sp. and blackberries have started to establish on the right bank. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams has remained steady at 81 out of 140 between 2019 and 2022 and is likely to remain so until conditions allow aquatic vegetation to establish and the riparian vegetation is improved.

5.13. Site 13 – Boundary Creek @ upstream of confluence with Barwon River

 Site 13: upstream Spring 2023	 Site 13: downstream Spring 2023		

Site 13 was added to the sampling program in Spring 2023 to provide more information regarding the condition of Boundary Creek downstream of Big Swamp. The site is within a dairy farm but does not appear to have stock access. Boundary Creek is between three and four meters wide with some runs and there is an even mix of slow and moderately flowing section. The riparian zone is primarily native trees and shrubs with pasture grass. The trailing bank vegetation, macrophytes and roots should provide goo habitat for macroinvertebrates and aquatic fauna although the site has a silty substrate contributing to high turbidity levels.

5.14. Site 14 (ex site 6)- Barwon River 100m downstream of Boundary Creek confluence

 Site 14: upstream Spring 2019	 Site 14: downstream Spring 2019	 Site 14: upstream Autumn 2020	 Site 14: downstream Autumn 2020
 Upstream Spring 2020	 Downstream Spring 2020	 Upstream Autumn 2021	 Downstream Autumn 2021
 Upstream Spring 2021	 Downstream Spring 2021	 Upstream Autumn 2022	 Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 Upstream Spring 2023	 Downstream Spring 2023		

The Barwon River 100 meters downstream of the Boundary Creek confluence was called site 6 until a number of sites were added to the program. It is a narrow deep channel with wide shallow edges dominated by grasses and aquatic macrophytes. The average stream width at this site is five meters and was bank full in Spring 2019, Spring 2020, Autumn 2021 and Spring 2021 and had contracted to a narrow (1-2 meter) channel in Autumn 2020 and Autumn 2022. There is a narrow channel at the top of the surveyed reach, narrowing to a confined channel downstream. The river had contracted to the main channel but remained flowing, leaving the fringes to dry out in Autumn 2020 and Autumn 2022. The substrate consists of clay and silt usually with filamentous algae tangled through the macrophyte beds but in Autumn 2021 and Spring 2021 the macrophyte beds were covered in a smothering floc that was easily disturbed, forming a thick plume. This plume appeared to be absent in Autumn 2022 but this could have been due to the absence of slow flowing areas where floc would be able to settle. The iron floc was back in Autumn 2023, smothering most of the instream habitat but was again reduced in Spring 2023.

Macrophyte species are varied with Triglochin, Polygonum, Phragmites, and Juncus species all present in addition to trailing grasses. Four different fish species have been collected at this site as bycatch; southern pygmy perch, smelt and a galaxid in Autumn 2020, gambusia and southern pygmy perch in Spring 2020. The riparian zone is limited to grasses and scattered native trees and shrubs with stock access to the site. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 70 out of 140 in 2019 and a very similar

score of 71 in 2022. As with all sites that have unrestricted stock access, the health of this site would be improved by fencing and revegetating the river on both sides.

5.15. Site 15 (ex site 7)- Barwon River @ north boundary of plantation


Site 15: upstream Spring 2019


Site 15: downstream Spring 2019


Site 15: upstream Autumn 2020


Site 15: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021


Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022


Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 Upstream Spring 2023	 Downstream Spring 2023		

The Barwon River adjacent to the northern boundary of the pine plantation was called site 7 until a number of sites were added to the program. It has a large deep channel with any shallow areas dominated by beds of Phragmites. The average stream width at this site is seven meters. The substrate is clay and silt. In addition to the Phragmites beds there are beds of Triglochin, and scattered Polygonum, Juncus and other grasses. The riparian zone has a good mix of trees, shrubs and understory with a majority of native trees and shrubs. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 90 out of 140 in 2019 and increased to 104 in 2022 primarily due to continued improvements in riparian and instream macrophyte condition.

5.16. Site 16 (ex site 8)- Barwon River @ Colac- Lorne Road

 Site 16: upstream Spring 2019	 Site 16: downstream Spring 2019	 Site 16: upstream Autumn 2020	 Site 16: downstream Autumn 2020
 Upstream Spring 2020	 Downstream Spring 2020	 Upstream Autumn 2021	 Downstream Autumn 2021
 Upstream Spring 2021	 Downstream Spring 2021	 Upstream Autumn 2022	 Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 Upstream Spring 2023	 Downstream Spring 2023		

The Barwon River at Colac- Lorne Road was called site 8 until a number of sites were added to the program. It has large deep pools with a shallow areas at the sides and willow trees growing in the channel with some substrate exposed when the river level is low. The average stream width at this site is eight meters with a predominantly clay and silt substrate mixed with some sand. There are beds of *Triglochin* and *Phragmites* in addition to trailing grasses and large willows. The riparian zone consists of willow trees, pasture grasses and blackberries and allows stock access. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 69 out of 140 in 2019 and a similar score of 73 in 2022.

5.17. Site 17 (ex site 9)- Barwon River @ Birregurra


Site 17: upstream Spring 2019


Site 17: downstream Spring 2019


Site 17: upstream Autumn 2020


Site 17: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021


Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022


Downstream Autumn 2022

 Upstream Spring 2022	 Downstream Spring 2022	 Upstream Autumn 2023	 Downstream Autumn 2023
 Upstream Spring 2023	 Downstream Spring 2023		

The Barwon River at Birregurra was called site 9 until a number of sites were added to the program. The average stream width at this site is five meters with steep clay banks. The substrate is clay and silt with willow roots, some snags and Triglochin beds scattered along the edges of the channel and establishing well over time. There were willow removal works and replanting of the riparian zone in Spring 2019 in amongst the pasture grass and blackberry groundcover. The riparian zone is established and growing well although follow up ground cover weed management may be required with blackberries becoming established in Autumn 2023. Rakali footprints were evident in the soft sediment edge during many of the sampling events in 2019 and 2020. Introduced mosquitofish (Gambusia sp.) were bycatch in Autumn 2022. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 67 out of 140 in 2019 but has increased to 98 in 2022, primarily due to the successful reintroduction of the riparian zone following large scale willow removal.

5.18. Site 18 (ex site 10)- Barwon River @ Conns Lane


Site 18: upstream Spring 2019


Site 18: downstream Spring 2019


Site 18: upstream Autumn 2020


Site 18: downstream Autumn 2020


Upstream Spring 2020


Downstream Spring 2020


Upstream Autumn 2021


Downstream Autumn 2021


Upstream Spring 2021


Downstream Spring 2021


Upstream Autumn 2022

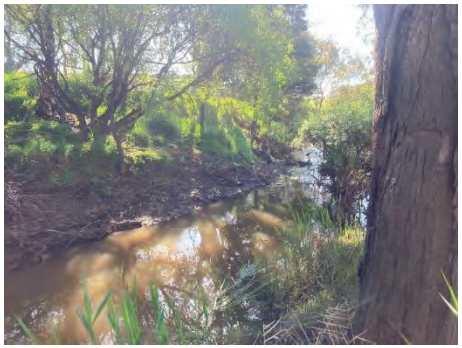

Downstream Autumn 2022

			
Upstream Spring 2022	Downstream Spring 2022	Upstream Autumn 2023	Downstream Autumn 2023
			
Upstream Spring 2023	Downstream Spring 2023		

The Barwon River at Conns Lane was called site 10 until a number of sites were added to the program It has large deep pools with some small deep backwaters and a narrow deep run at the top of the reach. The average stream width at this site is six meters. The substrate is clay and silt mixed with some sand and gravel. Phragmites beds line the channel and there are isolated patches of Triglochin in addition to Polygonum and trailing grasses along the waters edge. The trailing and shallow vegetation contained filamentous algae in Autumn 2021, 2022 and 2023. Larval fish and gambusia were collected in the macroinvertebrate net in Spring 2020 and gambusia were plentiful in Autumn 2021 though not in Spring 2021. The riparian zone consists of a native revegetation project that is more successful on the right side than the left. Exotic trees are re-establishing on the left side and pasture grass dominates. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 98 out of 140 in 2019 and a similar score of 101 in 2022.

5.19. Site 19 (ex site11) - Barwon River@ Winchelsea- Deans Marsh Road

 Site 19: upstream Spring 2019	 Site 19: downstream Spring 2019	 Site 19: upstream Autumn 2020	 Site 19: downstream Autumn 2020
 Upstream Spring 2020	 Downstream Spring 2020	 Upstream Autumn 2021	 Downstream Autumn 2021
 Site 19: upstream Spring 2021	 Site 19: downstream Spring 2021	 Upstream Autumn 2022	 Downstream Autumn 2022

			
Upstream Spring 2022	Downstream Spring 2022	Upstream Autumn 2023	Downstream Autumn 2023
			
Upstream Spring 2023	Downstream Spring 2023		

The Barwon River at Winchelsea- Deans Marsh Road was called site 11 until extra sites were added to the program. It has large deep pools with a shallow run at the top of the reach. The average stream width at this site is five meters and the substrate is clay and silt mixed with some sand and gravel. Triglochin is growing in the shallow areas of the channel and there are roots, large woody debris and trailing grasses. The riparian zone is predominately native trees and understory with a mix of grasses as groundcover. Rakali footprints were spotted at the waters edge in Spring 2019. The height and force of a flood between Autumn 2021 and Spring 2021 sampling can be seen in the upstream Spring 2021 photo of the log wedged in the forked tree in the left foreground. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 90 out of 140 in 2019 and the similar but slightly higher score of 98 in 2022 with the introduction of more woody debris into the channel following the 2021 floods and the continuing growth of riparian vegetation.

5.20. Site 20 (ex site 12)- Barwon River @ Princes Hwy bridge, Winchelsea

 Site 20: upstream Spring 2019	 Site 20: downstream Spring 2019	 Site 20: upstream Autumn 2020	 Site 20: downstream Autumn 2020
 Upstream Spring 2020	 Downstream Spring 2020	 Upstream Autumn 2021	 Downstream Autumn 2021
 Upstream Spring 2021	 Downstream Spring 2021	 Upstream Autumn 2022	 Downstream Autumn 2022

			
Upstream Spring 2022	Downstream Spring 2022	Upstream Autumn 2023	Downstream Autumn 2023
			
Upstream Spring 2023	Downstream Spring 2023		

The Barwon River at Winchelsea has large deep pools with a large shallow pool at the top of the reach. The average stream width at this site is twelve meters. The substrate is clay and silt mixed with sand and some gravel. In addition to the Phragmites beds at the top of the reach and along some edges there are also patches of *Triglochin*. Large woody debris, trailing grasses and emergent vegetation such as *Polygonum* are also present. Riparian vegetation is predominantly native with many established eucalypts and groundcover is pasture grass. A concurrent snapshot study by EnviroDNA (2019) in Spring found evidence of platypus at this site. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gave this site a score of 88 out of 140 in 2019 and a similar score of 91 in 2022.

Appendix 2

- **Table 7 Spring 2023 macroinvertebrate families Sites 1-10**

	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	9A	9B	10A	10B
Ancylidae							2	4					1	1		1				
Atriplectididae					3	1														
Atyidae	6		1	2			4	3	2			1								
Baetidae			4	3			4	1												
Caenidae			2	1		1														
Calamoceratidae																	1	2		
Ceinidae	3		21	25			15	14	1						16	8	3	3		
Ceratopogonidae					6		2									2				
Chironominae	1					1	12	12	3	9	4	4	2	1	5	13	14	16	2	1
Coenagrionidae			10	9			6	7	1						3					
Corixidae		1	21	19	9	7	5	3							1					
Crambidae			2	1																
Culicidae																	1			
Dixidae											4	2	12	4		2	6	5		
Dugesiidae	6	8				3				1						2				
Dytiscidae	1	1	2	1		2			1	1	1	1					1		2	2
Ecnomidae							1													
Elmidae											1			1						
Ephydridae											2									
Gripopterygidae	7	1				3					2	2	12	20	2		7	11		
Gyrinidae																				
Hydraenidae													2							
Hydrobiidae	4	7			1	2					3	1	1	7	12	1	5	8		
Hydrobiosidae														1				1		
Hydrochidae																				
Hydrophilidae			1	11							1	1					1	1	6	2
Hydroptilidae	1		1	1		1		2					1			1				

	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	9A	9B	10A	10B
Janiridae																				
Koonungidae																			1	
Leptoceridae	2	3		5	7	21	5	6			17	5	10	3	6	1	28	14		
Leptophlebiidae			1		3	10	1			1	13	22	8	20				14		
Lestidae																				
Lymnaeidae	1						1													
Mites	1		2	3	4	6	2	3	3		3	2	1	5	1	1	2	2		
Naucoridae			1				1	1												
Notonectidae							2				1				1					
Notonemouridae																	3			
Oligochaeta	23	21			2				2	10					2	4		2		3
Orthocladiinae	40	17				2	5	2	2	1	18	8	4	3	1	7	9	4		
Paramelitidae						3			7	2					1			3		
Parastacidae												1								
Perthiidae																				
Physidae	3	4	1	2		2	1	1							9	2				
Planorbidae			5	1		1		2	2				6	4						
Pleidae																				
Psychodidae																				
Sciomyzidae				1																
Scirtidae sp.						1			1		1							1	1	3
Simuliidae					1				9		6	2		2						
Sphaeriidae									10	1					10					
Stratiomyidae			1	1																
Tanyderidae sp.															4					
Tanypodinae					11	3		1	7	12	1	1	2				2		1	
Telephlebiidae													2	1				2		
Tipulidae					2															
Veliidae					10	8	2		1		3	5	5	3	1	1	2	1		

Table 8 Spring 2023 macroinvertebrate families Sites 11-20

	11A	11B	12A	12B	13A	13B	14A	14B	15A	15B	16A	16B	17A	17B	18A	18B	19A	19B	20A	20B
Ancylidae																			1	
Atriplectididae																				
Atyidae							1		3	8	3		9	2	3					1
Baetidae							7		1		35	4		1			12	16		6
Caenidae																				
Calamoceratidae										1		3		1					3	8
Ceinidae							1		3	2	1	4	7	6	2	4			2	4
Ceratopogonidae					1		1		2	1	1	3		1				1		
Chironominae		1		5		2	7	15	9	13	7	18	15	11	4	2	27	9	22	8
Coenagrionidae							1		10	6	1	9	12	8	1	1		1	3	3
Corixidae									12	10	10	18	3	1	1		2	6	2	1
Crambidae																	1			
Culicidae																				
Dixidae																				
Dugesiidae	2	3	1	1			1		12	13		7	14	6	1		1		1	
Dytiscidae			1		2	2	1	1	2		1		3	5						
Ecnomidae																				
Elmidae																				1
Ephydridae								1												
Gripopterygidae							13	11		1	2		1	5	2	2	12	10	1	14
Gyrinidae																			1	2
Hydraenidae																	2	1		
Hydrobiidae																				
Hydrobiosidae							1													
Hydrochidae							1							1			1		1	
Hydrophilidae							5	3		1				1	1		2			1
Hydroptilidae							2		2	2	1	3		1	2	1				

	11A	11B	12A	12B	13A	13B	14A	14B	15A	15B	16A	16B	17A	17B	18A	18B	19A	19B	20A	20B
Janiridae				1		2										1				
Koonungidae	10	5		1																
Leptoceridae							8	1		1	3	3					2	2		4
Leptophlebiidae											2			5						
Lestidae										1										
Lymnaeidae							1		1	1	1			1	1					
Mites									1	4	2	4		3			3	8	2	9
Naucoridae													1							
Notonectidae										1								1		
Notonemouridae													1							
Oligochaeta				1	1		2	5										2		
Orthocladiinae							9	2	6	5	32	19	10	16	26	13	7	4	24	16
Paramelitidae							7	5				1	2	1	3	9			2	
Parastacidae																				
Perthiidae						1														
Physidae							2				10	7	13	5	25	9	9	10	5	9
Planorbidae							9	3												
Pleidae													1							
Psychodidae							1													
Sciomyzidae																				
Scirtidae sp.	1		1	2	3	2								1			1		1	1
Simuliidae																	7	9	1	2
Sphaeriidae																				
Stratiomyidae											1				1					
Tanyderidae sp.						1														
Tanypodinae	1	1			1				2	1		2							1	1
Telephlebiidae														1						1
Tipulidae				1				1												
Veliidae			3						1		2		4	1	3		1	2	9	5

Appendix 3

- **Table 9: In-situ water quality data in Boundary Creek and the Barwon River- Spring 2019 to Spring 2023.**

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
Site 5 Boundary Creek @ Colac-Lavers Hill Road	Spring 23	12.2	6.97	311.4	412.6	5.79	55.5	25	14.5
Site 6 Boundary Creek @ Barongarook	Spring 23	10.4	6.67	295.0	409.4	6.04	55.2	25	45.5
Site 7 Boundary Creek upstream of McDonalds Dam	Spring 23	11.6	6.99	357.6	480.8	6.98	65.2	25	14.2
Site 8 Boundary Creek downstream of McDonalds Dam	Autumn 22	13.2	6.81	461	694	6.23	59.5	35	3.29
	Spring 22	14.6	7.35	290.9	361.8	3.27	32.2	40	14.2
	Autumn 23	14.4	6.69	369.6	463.6	5.53	54.2	20	12.5
	Spring 23	15.3	7.26	362.8	445.2	4.48	45.0	25	7.20
Site 9 Boundary Creek upstream of Big Swamp	Autumn 22	8.9	6.72	410	592	10.18	87.2	30	5.07
	Spring 22	14.0	6.63	280.8	355.8	3.68	35.8	40	13.8
	Autumn 23	13.3	7.14	354.8	457.3	5.26	50.4	20	10.1
	Spring 23	11.2	6.95	324.2	440.7	7.29	67.0	30	7.28
Site 10 Big Swamp western end	Spring 22	14.7	5.87	272.2	338.4	2.06	20.6	20	9.64
	Autumn 23	13.9	5.38	334.1	424.2	3.24	31.2	10	3.97
	Spring 23	11.2	3.86	360.9	489.7	1.74	16.4	0	2.55
Site 11 Big Swamp eastern end	Autumn 22	9.6	5.48	656	929	2.2	22.5	10	20.1
	Spring 22	13.7	6.30	306.4	390.3	2.90	28.0	30	26.9
	Autumn 23	13.6	5.87	384.5	491.6	3.13	30.2	20	17.4
	Spring 23	8.8	5.88	339.1	491.2	5.29	46.6	20	14.2
Site 12 Boundary Creek@ Colac-Forrest Road	Spring 19	12.1	3.94	777	1030	7.43	67.6	0	2.92
	Autumn 20	10.4	4.05	680	944	2.05	18.5	0	260
	Spring 20	12.9	3.1	614	798	5.31	50.6	0	6.82

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
	Autumn 21	10.0	4.0	286.6	401.2	8.76	76.8	20	35.7
	Spring 21	14.6	6.05	364.5	453.7	8.10	87.7	20	75.3
	Autumn 22	10.4	4.75	830	1152	7.37	66.2	0	22.3
	Spring 22	13.9	6.02	328.4	416.5	3.69	35.2	20	36.9
	Autumn 23	13.3	5.49	386	497.1	4.14	39.2	10	42.0
	Spring 23	11.4	5.81	374.4	506.5	4.51	41.8	15	92.9
Site 13 Boundary Creek upstream of Barwon River confluence	Spring 23	12.2	4.45	552	730	5.16	48.6	10	101
	Spring 19	13.2	6.2	186.7	240	13.07	123	5	9.09
	Autumn 20	14	8.67	161.8	210.2	4.42	47.5	5	2.6
	Spring 20	16.0	7.2	123.7	149.5	7.79	80.1	35	2.88
Site 1 East Barwon River@ Kents Road	Autumn 21	10.6	6.5	93.5	129.0	7.59	68.7	25	8.5
	Spring 21	12.2	6.59	120.5	159.7	9.92	94.2	30	5.86
	Autumn 22	12.0	6.96	209.7	279.3	8.40	77.7	30	26.2
	Spring 22	14.5	7.62	178.5	223.4	3.64	35.7	25	6.97
	Autumn 23	13.6	7.23	150.5	193.0	5.56	54.1	35	4.68
	Spring 23	14.7	7.22	135.9	168.9	5.08	51.0	25	12.3
	Spring 19	15.5	6.3	544	664	6.8	66.8	10	9.97
	Autumn 20	16	7.71	180.7	218.2	5.85	59.9	10	9.49
	Spring 20	16.2	7.6	272.0	327.3	10.86	110.4	55	9.35
Site 2 East Barwon River @ Dewings Bridge Road	Autumn 21	11.2	6.58	228.9	311.8	8.21	74.2	35	8.2
	Spring 21	16.6	6.65	220.1	245.4	9.02	94.5	40	7.88
	Autumn 22	14.5	6.53	387.7	484.1	12.54	120.9	45	12.9
	Spring 22	13.4	7.63	250.4	321.7	3.30	31.8	35	18.3
	Autumn 23	17.2	7.35	276.6	326.2	4.47	47.1	45	10.2
	Spring 23	16.6	7.31	358.7	427.4	4.77	48.6	50	12.8
	Spring 19	14.7	5.26	473.4	590.6	7.3	73.5	10	16.3
Site 3 West Barwon River@	Autumn 20	14.4	8.23	179.6	224.0	4.45	42.9	10	3.28

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
Seven Bridges Road	Spring 20	12.7	7.1	195.2	255.0	6.12	56.3	50	5.58
	Autumn 21	9.7	7.3	165.1	233.4	7.21	63.9	30	3.65
	Spring 21	14.7	6.73	179.1	221.1	6.63	66.4	35	3.54
	Autumn 22	10.6	7.02	240.7	331.5	7.49	67.5	30	3.43
	Spring 22	12.5	7.51	256.6	336.7	3.01	28.3	40	12.7
	Autumn 23	14.8	6.56	196.7	245.0	4.80	47.4	35	4.29
	Spring 23	12.0	6.69	201.9	268.7	4.79	44.9	30	7.91
Site 4 Barwon River 50-100m upstream of Boundary Creek confluence	Spring 19	17.9	7.4	575	664	9.15	96.4	10	8.01
	Autumn 20	17	6.60	211.2	248.4	6.08	64.3	10	41.5
	Spring 20	14.1	7.4	248.1	326.1	8.25	80.5	55	17.7
	Autumn 21	10.8	7.03	224.3	308.7	7.96	71.2	35	14.2
	Spring 21	17.3	6.88	242.3	277.4	8.06	83.5	45	12.6
	Autumn 22	13.6	7.31	423.4	541.6	9.73	93.5	45	30.5
	Spring 22	Site not accessible due to high water							
	Autumn 23	16.2	6.91	370	444.7	4.91	50	40	12.6
	Spring 23	12.9	6.92	277.1	360.3	6.38	60.3	50	34.6
Site 14 Barwon River 100m downstream of Boundary Creek confluence	Spring 19	14.4	7.34	608	756	7.3	71.3	10	9.43
	Autumn 20	15.8	6.88	207.7	250.6	6.58	66.1	10	31.7
	Spring 20	13.9	7.0	298.5	378.8	6.88	67.1	50	12.2
	Autumn 21	10.9	7.19	254.2	347.7	7.03	62.9	25	20.6
	Spring 21	16.7	7.48	262.2	310.8	6.20	66.3	30	18.5
	Autumn 22	12.4	7.25	477	628	9.38	88.1	35	12.5
	Spring 22	15.2	6.20	304.8	374.6	3.67	35.9	30	18.1
	Autumn 23	16.8	6.90	398	472	4.15	43.0	35	11.8
	Spring 23	12.5	6.83	324.2	426.2	6.17	53.7	35	19.8
Site 15 Barwon River @ north boundary of plantation	Spring 19	13.4	7.9	599	770	7.2	71.7	5	10
	Autumn 20	15.4	6.46	207.9	256.2	7.46	75.6	5	21.8
	Spring 20	14.2	7.1	276.6	348.2	7.15	69.7	45	13.6
	Autumn 21	10.7	7.14	258.1	354.6	6.78	61.9	20	17.9

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
	Spring 21	15.7	7.62	254.2	309.0	6.72	68.5	45	12.87
	Autumn 22	14.5	7.04	510	637	9.09	91.7	35	12.9
	Spring 22	13.3	7.95	304.7	392.6	3.67	35.3	35	21.7
	Autumn 23	16.5	6.92	386	459	3.68	45.9	30	19.7
	Spring 23	15.2	6.88	360.6	443.9	5.27	52.6	40	14.1
Site 16 Barwon River @ Colac-Lorne Road	Spring 19	16.2	7.8	660	795	8.8	87.9	10	13.5
	Autumn 20	15.9	6.79	234.8	284.8	3.22	32	10	5.13
	Spring 20	16.3	7.3	286.3	344.2	6.55	67.7	50	5.61
	Autumn 21	11.0	6.74	255.8	350.3	7.10	64.2	25	12.4
	Spring 21	16.9	7.35	244.3	255.7	6.75	70.4	35	13.0
	Autumn 22	13.7	7.21	552	701	6.14	59.1	35	4.04
	Spring 22	14.0	7.69	322.1	407.4	3.33	32.6	40	20.9
	Autumn 23	15.5	6.89	449	368	3.58	36.0	35	15.1
	Spring 23	14.8	6.91	342.2	425.2	4.55	45.0	40	12.6
Site 17 Barwon River @ Birregurra	Spring 19	15.4	7.8	1049	1288	9.7	98	15	16.6
	Autumn 20	16.2	6.79	494.4	600.6	6.65	69.8	15	11.1
	Spring 20	16.7	7.5	477.8	568.1	8.28	86.6	25	16.2
	Autumn 21	10.0	7.62	372.9	523.3	7.69	67.0	40	23.7
	Spring 21	16.8	7.15	366.0	437.5	7.61	77.5	45	32.4
	Autumn 22	14.1	7.56	1115	1412	9.88	92.7	55	9.25
	Spring 22	16.0	6.63	574	694	4.24	43.0	45	65.9
	Autumn 23	15.2	7.28	810	996	3.92	39.1	40	19.0
	Spring 23	12.8	7.58	499.4	651.2	6.94	65.8	45	29.4
Site 18 Barwon River @Conns Lane	Spring 19	14.6	7.9	1252	1561	8.1	86.1	15	18
	Autumn 20	16.2	5.56	511	613	3.96	40.2	15	19.2
	Spring 20	15.6	7.5	756	920	7.45	76.2	75	22.2
	Autumn 21	11.1	7.14	372.5	506.5	9.03	81.5	40	33.7
	Spring 21	16.8	7.29	276.3	461.3	8.05	84.7	45	19.9
	Autumn 22	14.5	7.44	1119	1399	7.09	67.5	60	19.5

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (DO) (mg/L)	DO %	Alkalinity (mg/L)	Turbidity (NTU)
	Spring 22	15.6	6.78	643	783	3.80	37.7	50	58.5
	Autumn 23	14.9	7.39	901	1117	4.85	47.8	60	29.1
	Spring 23	13.0	7.73	703	912	7.65	72.1	50	30.5
Site 19 Barwon River @Winchelsea- Deans Marsh Road	Spring 19	13	7.9	1707	2227	9.23	87	15	26.1
	Autumn 20	15.6	6.26	762	929	3.62	35.2	15	13.3
	Spring 20	15.5	7.6	863	1054	6.28	64.7	75	13.7
	Autumn 21	11.0	6.82	401.9	548.8	8.35	74.1	40	31.5
	Spring 21	16.5	7.39	444.1	589.3	7.34	75.6	45	21.1
	Autumn 22	12.4	7.46	1369	1805	7.02	65.3	70	16.2
	Spring 22	14.6	8.25	1563	1950	5.02	49.7	85	81.0
	Autumn 23	14.5	7.42	733	919	4.92	48.1	55	33.7
	Spring 23	13.4	7.79	1156	1486	6.94	66.6	85	37.3
Site 20 Barwon River@ Princes Hwy bridge, Winchelsea	Spring 19	12.4	8	1788	2364	8.4	82.1	15	19.9
	Autumn 20	15.9	6.69	924	1117	5.25	54.5	15	20.7
	Spring 20	15.0	7.6	1048	847	6.25	62.8	85	17.1
	Autumn 21	10.8	6.93	466.1	639.8	8.18	72.7	40	31.2
	Spring 21	17.1	7.61	622	733	7.06	79.3	50	19.6
	Autumn 22	13.8	7.48	1737	2209	6.54	63.2	80	9.71
	Spring 22	15.5	8.06	1528	1868	3.66	36.9	85	85.5
	Autumn 23	14.5	7.37	797	997	7.85	76.5	75	24.9
	Spring 23	13.5	7.87	1297	1664	7.01	67.0	100	22.8

- **Table 10: Metal results (0.45µm filtered) from Boundary Creek and Barwon River for freshwater samples (mg/L) and Australian & New Zealand Guidelines for Fresh & Marine Water Quality (2019). In all but two instances the 95% level of species protection is applied as is recommended for slightly to moderately disturbed ecosystems. Shaded cells indicate exceedance of guideline values.**

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Toxicant default guideline values		0.055 (>6.5pH) 0.8# (<6.5pH)	0.009#	AsIII 0.024 AsV 0.013	0.0002	CrIII 0.0003 CrVI 0.001	0.0014	-	0.0034	1.9	0.00006^	0.005^	0.00005	0.008
Site 5 Boundary Creek @ Colac-Lavers Hill Road	Spring 23	0.05	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1.2	< 0.001	0.081	< 0.0001	< 0.001	< 0.001	0.015
Site 6 Boundary Creek @ Barongarook	Spring 23	0.11	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1.4	< 0.001	0.1	< 0.0001	< 0.001	< 0.001	0.009
Site 7 Boundary Creek upstream of McDonalds Dam	Spring 23	0.06	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.85	< 0.001	0.059	< 0.0001	< 0.001	< 0.001	0.011
Site 8 Boundary Creek downstream of McDonalds Dam	Autumn 22	<0.01	0.002	<0.001	<0.0002	<0.001	<0.001	0.39	<0.001	0.015	<0.0001	<0.001	<0.001	0.007
	Spring 22	0.19	<0.001	0.001	<0.0002	<0.001	<0.001	2.8	0.001	0.25	<0.0001	<0.001	<0.001	0.004
	Autumn 23	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.37	<0.001	0.070	<0.0001	<0.001	<0.001	0.006
	Spring 23	0.04	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1.2	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.012
Site 9 Boundary Creek upstream of Big Swamp	Autumn 22	0.01	0.002	0.001	<0.0002	<0.001	<0.001	0.59	<0.001	0.019	<0.0001	<0.001	<0.001	0.007
	Spring 22	0.20	<0.001	0.001	<0.0002	<0.001	<0.001	2.4	<0.001	0.046	<0.0001	<0.001	<0.001	0.004
	Autumn 23	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.43	<0.001	0.030	<0.0001	<0.001	<0.001	0.004
	Spring 23	0.04	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	1	< 0.001	0.035	< 0.0001	< 0.001	< 0.001	0.017
Site 10 Big Swamp western end	Autumn 23	0.09*	<0.001	0.002	<0.0002	<0.001	<0.001	2.0	<0.001	0.019	<0.0001	<0.001	<0.001	0.016
	Spring 23	0.12*	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	2.1	< 0.001	0.014	< 0.0001	0.005	< 0.001	0.034
Site 11 Big Swamp eastern end	Autumn 22	0.26*	<0.001	0.003	<0.0002	0.001	0.002	48	<0.001	0.024	<0.0001	<0.001	<0.001	0.023
	Autumn 23	0.31*	<0.001	0.003	<0.0002	0.001	<0.001	31	<0.001	0.018	<0.0001	<0.001	<0.001	0.016
	Spring 23	0.23*	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	20	< 0.001	0.021	< 0.0001	0.002	< 0.001	0.024
Site 12 Boundary Creek@	Spring 19	10*	< 0.005	< 0.001	0.0002	< 0.001	< 0.001	5.4	< 0.001	0.06	< 0.0001	< 0.001	< 0.005	0.34
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	17	< 0.001	0.18	< 0.0001	< 0.001	< 0.005	0.015

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Colac-Forrest Road	Summer21	7.2*	< 0.005	0.001	<0.0002	0.001	< 0.001	40	< 0.001	0.061	< 0.0001	0.001	< 0.005	0.23
	Autumn21	1.6*	<0.001	0.004	<0.0002	<0.001	0.005	50	<0.001	0.024	<0.0001	0.003	<0.001	0.08
	Spring 21	1.2*	<0.001	<0.0002	<0.0002	<0.001	<0.001	1.3	<0.001	0.034	<0.0001	<0.001	<0.001	0.11
	Autumn 22	1.2*	0.003	0.006	<0.0002	<0.001	<0.001	51	0.003	0.042	<0.0001	0.001	<0.001	0.10
	Spring 22	1.2*	<0.001	0.004	<0.0002	0.002	<0.001	20	<0.001	0.030	<0.0001	0.001	<0.001	0.052
	Autumn 23	0.40*	<0.001	0.003	<0.002	0.002	<0.001	29	<0.001	0.027	<0.0001	<0.001	<0.001	0.059
	Spring 23	0.33*	< 0.001	0.002	< 0.0002	< 0.001	< 0.001	19	< 0.001	0.029	< 0.0001	< 0.001	< 0.001	0.042
Site 13 Boundary Creek u/s confluence with Barwon River	Spring 23	0.39*	< 0.001	0.002	< 0.0002	< 0.001	< 0.001	15	< 0.001	0.062	< 0.0001	< 0.001	< 0.001	0.064
Site 1 East Barwon River@ Kents Road	Spring 19	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	< 0.001	0.04	< 0.0001	< 0.001	< 0.005	0.032
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.21	< 0.001	0.007	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	0.06	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.68	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.04	<0.001	<0.001	<0.0002	<0.001	<0.001	0.35	<0.001	0.046	<0.0001	<0.001	<0.001	0.002
	Spring 21	0.03	<0.001	<0.001	<0.0002	<0.001	<0.001	0.21	<0.001	0.015	<0.0001	<0.001	<0.001	<0.001
	Autumn 22	0.02	0.008	<0.001	<0.0002	<0.001	<0.001	0.42	<0.001	0.31	<0.0001	<0.001	<0.001	0.009
	Spring 22	0.03	<0.001	<0.001	<0.0002	<0.001	<0.001	0.34	<0.001	0.031	<0.0001	<0.001	<0.001	0.005
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.24	<0.001	0.052	<0.0001	<0.001	<0.001	0.004
	Spring 23	0.02	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.47	< 0.001	0.091	0.0002	0.004	< 0.001	0.007
Site 2 East Barwon River@ Dewings Bridge Road	Spring 19	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.4	< 0.001	0.15	< 0.0001	< 0.001	< 0.005	0.008
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.08	< 0.001	0.037	< 0.0001	0.001	< 0.005	< 0.005
	Summer21	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.006	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.19	<0.001	0.057	<0.0001	<0.001	<0.001	0.005
	Spring 21	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.30	<0.001	0.010	<0.0001	<0.001	<0.001	0.004
	Autumn 22	<0.01	0.006	<0.001	<0.0002	<0.001	<0.001	0.10	<0.001	0.028	<0.0001	<0.001	<0.001	0.006
	Spring 22	0.02	<0.001	<0.001	<0.0002	<0.0001	<0.001	0.51	<0.001	0.063	<0.0001	<0.001	<0.001	0.004
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.11	<0.001	0.040	<0.0001	<0.001	<0.001	0.005
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.14	< 0.001	0.079	0.0001	0.004	< 0.001	0.008

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Site 3 West Barwon River@ Seven Bridges Road	Spring 19	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.31	< 0.001	0.31	< 0.0001	< 0.001	< 0.005	0.051
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	0.004	0.015	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.09	< 0.001	0.12	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.21	<0.001	0.035	<0.0001	<0.001	<0.001	0.006
	Spring 21	0.03	<0.001	<0.001	<0.0002	<0.001	<0.001	0.65	<0.001	0.005	<0.0001	<0.001	<0.001	0.007
	Autumn 22	<0.01	0.004	<0.001	<0.0002	<0.001	<0.001	0.13	<0.001	0.081	<0.0001	<0.001	<0.001	0.014
	Spring 22	0.06	<0.001	<0.001	<0.0002	<0.001	0.003	1.1	<0.001	0.34	<0.0001	<0.001	<0.001	0.015
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	0.001	0.12	0.010	0.067	<0.0001	<0.001	<0.001	0.014
	Spring 23	0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.32	< 0.001	0.079	< 0.0001	0.003	< 0.001	0.011
Site 4 Barwon River 100m upstream of Boundary Creek confluence	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	< 0.001	0.15	< 0.0001	< 0.001	< 0.005	0.017
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.14	< 0.001	0.35	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.33	< 0.001	0.019	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.19	<0.001	0.06	<0.0001	<0.001	<0.001	0.002
	Spring 21	0.03	<0.001	<0.001	<0.0002	<0.001	<0.001	0.71	<0.001	0.008	<0.0001	<0.001	<0.001	0.011
	Autumn 22	<0.01	0.003	<0.001	<0.0002	<0.00	0.001	0.05	<0.001	0.095	<0.0001	<0.001	<0.001	0.014
	Spring 22	Site not accessible due to high water												
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.10	<0.001	0.13	<0.0001	<0.001	<0.001	0.006
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.21	< 0.001	0.096	< 0.0001	< 0.001	< 0.001	0.021
Site 14 Barwon River 100m downstream of Boundary Creek confluence	Spring 19	0.09	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.13	< 0.001	0.17	< 0.0001	< 0.001	< 0.005	0.057
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.17	< 0.001	0.16	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.69	< 0.001	0.29	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.07	<0.001	<0.001	<0.0002	<0.001	<0.001	2	<0.001	0.069	<0.0001	<0.001	<0.001	0.012
	Spring 21	0.06	<0.001	<0.001	<0.0002	<0.001	0.001	1.3	<0.001	0.010	<0.0001	<0.0001	<0.001	0.016
	Autumn 22	0.02	0.002	<0.001	<0.0002	<0.001	<0.001	0.19	<0.001	0.11	<0.0001	<0.001	<0.001	0.014
	Spring 22	0.11	<0.001	<0.001	<0.0002	<0.001	<0.001	1.8	<0.001	0.13	<0.0001	<0.001	<0.001	0.006
	Autumn 23	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.27	<0.001	0.13	<0.0001	<0.001	<0.001	0.009
	Spring 23	0.03	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.66	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.01
Site 15	Spring 19	0.07	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.15	< 0.001	0.08	< 0.0001	< 0.001	< 0.005	0.013

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Barwon River @ north boundary of plantation	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	0.001	0.09	< 0.001	0.01	< 0.0001	< 0.001	< 0.005	0.006
	Summer21	0.06	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.37	< 0.001	0.023	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.07	<0.001	<0.001	<0.0002	<0.001	<0.001	0.61	<0.001	0.072	<0.0001	<0.001	<0.001	0.009
	Spring 21	0.05	<0.001	<0.001	<0.0002	<0.001	0.002	1.2	<0.001	0.005	<0.0001	<0.001	<0.001	0.040
	Autumn 22	0.01	0.002	<0.001	<0.0002	<0.001	<0.001	0.05	<0.001	0.14	<0.0001	<0.001	<0.001	0.008
	Spring 22	0.10	<0.001	0.001	<0.0002	<0.001	<0.001	1.9	<0.001	0.086	<0.0001	<0.001	<0.001	0.006
	Autumn 23	0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.17	<0.001	0.14	<0.0001	<0.001	<0.001	0.007
	Spring 23	0.02	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.31	< 0.001	0.096	< 0.0001	< 0.001	< 0.001	0.007
Site 16 Barwon River @ Colac- Lorne Road	Spring 19	0.1	< 0.005	< 0.001	< 0.0002	< 0.001	0.001	0.23	< 0.001	0.066	< 0.0001	< 0.001	< 0.005	0.015
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	<0.001	0.24	< 0.001	<0.005	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.04	<0.001	<0.001	<0.0002	<0.001	<0.001	0.33	<0.001	0.031	<0.0001	<0.001	<0.001	0.005
	Spring 21	0.05	<0.001	<0.001	<0.0002	<0.001	<0.001	1.2	<0.001	0.021	<0.0001	<0.001	<0.001	0.012
	Autumn 22	<0.01	0.001	<0.001	<0.0002	<0.001	<0.001	0.04	<0.001	0.052	<0.0001	<0.001	<0.001	0.012
	Spring 22	0.09	<0.001	<0.001	<0.0002	<0.001	<0.001	1.8	<0.001	0.13	<0.0001	<0.001	<0.001	0.006
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.07	<0.001	0.12	<0.0001	<0.001	<0.001	0.005
	Spring 23	0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.23	< 0.001	0.073	< 0.0001	0.001	< 0.001	0.007
Site 17 Barwon River @ Birregurra	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.098	< 0.0001	< 0.001	< 0.005	0.01
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.016	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.37	< 0.001	0.037	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.24	<0.001	0.038	<0.0001	<0.001	<0.001	0.004
	Spring 21	0.04	<0.001	<0.001	<0.0002	<0.001	<0.001	0.99	<0.001	0.011	<0.0001	<0.001	<0.001	0.006
	Autumn 22	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.02	<0.001	0.10	<0.0001	<0.001	<0.001	0.013
	Spring 22	0.05	<0.001	0.001	<0.0002	<0.001	0.001	1.4	<0.001	0.13	<0.0001	<0.001	<0.001	0.004
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.02	<0.001	0.13	<0.0001	<0.001	<0.001	0.004
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.15	< 0.001	0.12	< 0.0001	< 0.001	< 0.001	0.01
Site 18 Barwon River @	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.09	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.027	< 0.0001	< 0.001	< 0.005	0.008

Site Waterway	Sampling event	Filtered Metal Concentration (mg/L)												
		Aluminium	Antimony	Arsenic (total)	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Conns Lane	Summer21	0.09	< 0.005	< 0.001	<0.0002	< 0.001	<0.001	0.6	< 0.001	0.045	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.25	<0.001	0.025	<0.0001	<0.001	<0.001	0.005
	Spring 21	0.04	<0.001	<0.001	<0.0002	<0.001	<0.001	1.2	<0.001	0.012	<0.0001	<0.001	<0.001	0.004
	Autumn 22	<0.01	0.003	<0.001	<0.0002	<0.001	<0.001	0.03	<0.001	0.12	<0.0001	<0.001	0.003	0.012
	Spring 22	0.06	<0.001	0.001	<0.0002	<0.001	0.001	1.3	<0.001	0.096	<0.0001	<0.001	<0.001	0.004
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.02	<0.001	0.13	<0.0001	<0.001	<0.001	0.005
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.15	< 0.001	0.12	< 0.0001	< 0.001	< 0.001	0.007
Site 19 Barwon River @ Winchelsea- Deans Marsh Road	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.42	< 0.001	0.1	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.082	< 0.0001	< 0.001	< 0.005	< 0.005
	Summer21	0.16	< 0.005	<0.001	<0.0002	< 0.001	<0.001	1.4	< 0.001	0.028	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.03	<0.001	<0.001	<0.0002	<0.001	<0.001	0.18	<0.001	0.032	<0.0001	<0.001	<0.001	0.003
	Spring 21	0.04	<0.001	0.001	<0.0002	<0.001	0.001	1.1	<0.001	0.025	<0.0001	<0.001	<0.001	0.003
	Autumn 22	<0.01	0.001	<0.001	<0.0002	<0.001	<0.001	0.03	<0.001	0.12	<0.0001	<0.001	<0.001	0.010
	Spring 22	0.03	<0.001	0.002	<0.0002	<0.001	0.002	1.0	<0.001	0.11	<0.0001	<0.001	<0.001	0.003
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.02	<0.001	0.11	<0.0001	<0.001	<0.001	0.004
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.12	< 0.001	0.13	< 0.0001	< 0.001	< 0.001	0.008
Site 20 Barwon River @ Princes Hwy bridge, Winchelsea	Spring 19	0.07	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.56	< 0.001	0.1	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.044	< 0.0001	< 0.001	< 0.005	0.015
	Summer21	0.27	< 0.005	0.001	<0.0002	< 0.001	0.001	1.7	< 0.001	0.049	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn21	0.02	<0.001	<0.001	<0.0002	<0.001	<0.001	0.19	<0.001	0.03	<0.0001	<0.001	<0.001	<0.001
	Spring 21	0.04	<0.001	0.001	<0.0002	<0.001	0.001	1.0	<0.001	0.021	<0.0001	<0.001	<0.001	0.003
	Autumn 22	<0.01	<0.001	<0.001	<0.0002	<0.001	0.007	0.04	<0.001	0.11	<0.0001	<0.001	<0.001	0.013
	Spring 22	0.03	<0.001	0.002	<0.0002	<0.001	0.001	1.0	<0.001	0.10	<0.0001	<0.001	<0.001	0.003
	Autumn 23	<0.01	<0.001	<0.001	<0.0002	<0.001	<0.001	0.03	<0.001	0.12	<0.0001	<0.001	<0.001	0.006
	Spring 23	< 0.01	< 0.001	< 0.001	< 0.0002	< 0.001	< 0.001	0.12	< 0.001	0.17	< 0.0001	< 0.001	< 0.001	0.018

 # level of species protection unknown
** Aluminium results where pH is <6.5*
^ 99% species protection level to account for the bioaccumulating nature of this toxicant
Shaded exceeds guideline values