Derwent Estuary Recreational Water Quality Program

Annual Report 2019-20

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Derwent Estuary Program

The Derwent Estuary Program (DEP) is a regional partnership between local governments, the Tasmanian State Government, businesses, scientists, and community-based groups to restore and promote our estuary. The DEP was established in 1999 and has been nationally recognised for excellence in coordinating initiatives to reduce water pollution, conserve habitats and species, monitor river health and promote greater use and enjoyment of the foreshore.

Our major sponsors include Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough councils, the Tasmanian State Government, TasWater, Tasmanian Ports Corporation, Norske Skog Boyer, Nyrstar Hobart Smelter and Hydro Tasmania.

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1 EXECUTIVE SUMMARY

This report presents results of the Derwent Estuary Recreational Water Quality Program (RWQ) 2019-20 season. The RWQ is a joint initiative between six local councils, the State Government of Tasmania, Environmental Protection Agency (EPA) and the Derwent Estuary Program (DEP). Water samples were collected weekly at 43 sites throughout the estuary between 1 December 2018 and 31 March 2019 and analysed for the faecal indicator bacteria, enterococci.

The water quality at Swimming Sites was significantly better than the previous season, with only five exceedances of the enterococci trigger level of 140 MPN 100 mL-1, compared to last season with its record number of 52 exceedances. At the end of this summer, when the long-term classification is updated, there were 10 Swimming Sites graded as Good, six sites graded as Fair, none as Poor, and five sites not yet rated (all sites require five years of sampling data to calculate a long-term rating).

This season saw the inclusion of four new swimming sampling sites, two completely new sites (Blackmans Bay Beach (north), Bellerive Beach (east) and two sites that had been moved from positions by stormwater outfalls (Blackmans Bay Beach (south) and Kingston Beach (south), which is consistent with Department of Health (DoH) advice of not swimming near outfalls.

The water quality at the 22 Environmental Sites (including one new site at New Norfolk) was also an improvement on the previous season. On 18 occasions results of over 140 MPN 100 mL^{-1} were recorded, compared to 51 times last season. The season results led to three sites upgrading from Fair to Good: Elwick Bay, Geilston Bay and MONA jetty, and one decline from Good to Fair for Lindisfarne Bay.

Average rainfall for the summer season (December-March) was higher than last year, and closer to the summer average for the four BOM weather stations we monitor during the RWQ season. There were four days throughout the summer with > 10 mm of rain recorded somewhere in the estuary, including some very heavy downpours. However, none of these heavy rainfall events occurred within a 24-hour period prior to sampling. On closer examination, on only four occasions did any rain fall in the 24 hours prior to sampling, and during these events the rainfall did not exceed 5 mm.

Generally good water quality was reported this season for most Swimming Sites and for many of the Environmental Sites, and some sites had an improved result from last season. This is likely due in large part to the timing of rainfall this summer, but several councils have also conducted significant works in their stormwater catchments, and we may be starting to see improvements in water quality as a result. It is recommended that councils take a proactive approach to managing stormwater infrastructure, and use the materials mentioned in the recommendations below, to continue this excellent work.

1.1 Post-season recommendations & updates

DEP recommends that councils take a proactive approach to the management of recreational water quality, by considering all Fair ratings (and results at sites not yet

rated) as a warning sign that water quality may be worsening, and therefore sanitary investigations should be initiated. Councils are also encouraged to conduct sanitary surveys at all Fair and Poor sites as a standard protocol on each sampling day.

Please see below for new materials that have been produced for councils. First up, a new Response Protocol to assist councils with how to respond to high enterococci results. Secondly, when high enterococci results are detected, a new Source Tracking Framework and Tool Kit provides guidance of how to locate the pollution source.

1.1.1 Response Protocol

A recommendation from last season, was a step-by-step guide of how to respond to high RWQ sample results. With the help from DoH and input from council partners, DEP has produced a Response Protocol, which can help guide the required response by councils to the various enterococci results of their RWQ sampling. The Protocol is a flowchart outlining what to do when the results fall within particular ranges, e.g. exceeds guideline trigger levels (Figure 1.1).

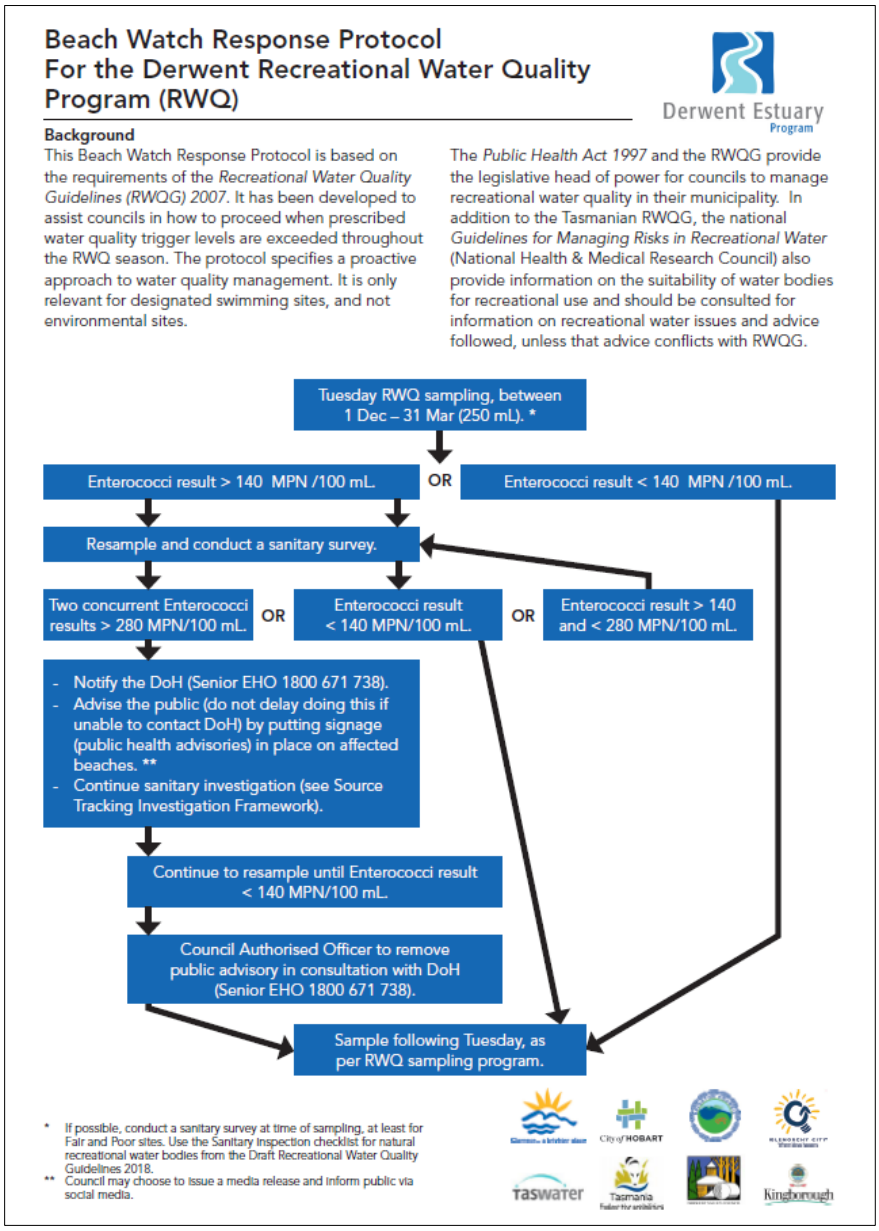

Figure 1.1. Response Protocol. Flowchart of how to respond to RWQ sample results.

1.1.2 How to locate faecal pollution sources

Also, on the back on recommendations from last year's RWQ season, the DEP is thrilled to share its new *Source Tracking Framework and Tool Kit*, which is a manual that provides practical assistance to local councils and others searching for faecal pollution sources at recreational swimming beaches and in stormwater systems. The information includes a flow chart to help investigators find the pollution source by taking them through easy-to-follow screening, tracing and remediation phases, and then provides detailed information about subsurface infrastructure investigation tools, water quality indicators, and microbial source tracking methods (Figure 1.2).

One new exciting source-tracking method is the use of an ammonia test kit, which provides quick detection of pathogens. Given its price ($30 for 130 tests, from an aquarium shop!), speed to get result (5 min.) and the amount of sample water required (5ml), the DEP now recommends that councils incorporate the ammonia test-kits into their investigations, particularly for rapid assessments of stormwater sub-catchments to pinpoint contamination hotspots. At least two councils have already had very positive results using these kits.

The information in the manual was put together with assistance from local councils, Analytic Services Tasmania, Public Health Laboratory, EPA, TasWater and Department of Health.
The Framework and Toolkit is available in hardcopy from the DEP or via the DEP website https://www.derwentestuary.org.au/publications/

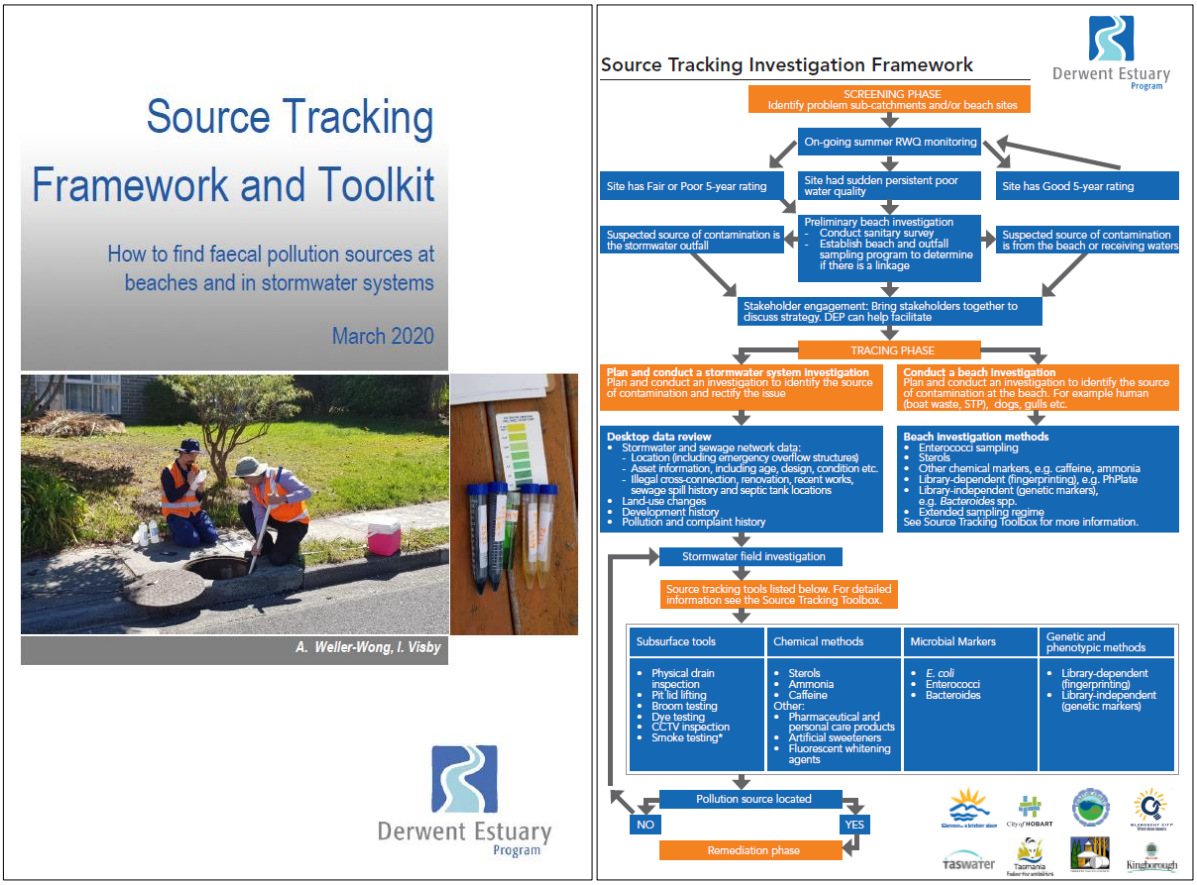

Figure 1.2. Source Tracking Framework and Tool Kit. Left: frontpage of manual. Right: framework and flowchart of how to conduct a source tracking investigation.

2 INTRODUCTION

Water quality monitoring of beaches and bays in the Derwent estuary is coordinated by the DEP in collaboration with DoH, EPA and the six councils that border the estuary (Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough). The primary objectives of the program are to coordinate monitoring, investigations and assist councils and the DoH in managing human health risks associated with poor water quality. The DEP's role in the program is to:

- Coordinate recreational water quality monitoring in the Derwent estuary;
- Compile and analyse data, including classification of beaches and bays, annual reporting and analysis of long-term trends;
- Support and facilitate site specific investigations into poor or deteriorating water quality at targeted sites.

The water quality data is made publicly available via the DEP website and Facebook page on a weekly basis throughout the summer (December-March), to allow the community to make informed decisions as to where and when to swim. This data is also used to inform decision-making processes, by identifying stormwater and wastewater assets that require investigating.

2.1 Pathogens and health risks

Water contaminated by sewage and animal faeces may contain pathogenic micro-organisms (bacteria, viruses, protozoa), which pose a health hazard when the water is used for primary contact recreation, such as swimming. Infection may occur by swallowing, inhaling or by direct contact of contaminated water with ears, nasal passages, mucous membranes and cuts in the skin, which allow the pathogens to enter the body (N.Z. Ministry for the Environment, 2002). The most common health conditions associated with primary contact recreation in contaminated water are gastrointestinal disorders, respiratory illnesses, eye, nose and throat infections and skin disorders.

Direct detection of pathogens is not a feasible option for routine assessments since they occur intermittently and are difficult to recover from water. Thus water samples are analysed for the concentration of more easily detected microorganisms, which may indicate the presence of pathogens, referred to as faecal indicator bacteria (refer to Coughanowr et al. 2015 for more information). In the Derwent estuary, enterococci is sampled as the key faecal indicator bacteria, as required by the Tasmanian Recreational Water Quality Guidelines 2007 (Dept of Health & Human Services, 2007).

2.2 Sources of contamination

Key sources of faecal contamination in coastal waters can include untreated sewage or faecal contamination from a catchment transported via the stormwater system, animal faeces or resuspension of contaminated sediments:

- Stormwater systems in urban areas are often contaminated with sewage. The source for this contamination can be caused by a failure in the wastewater (sewage) system, including overflows during high rainfall events, or direct cross-connections, leakages, or animal faeces in low rainfall (or non rainfall) events;
- Direct contamination can occur from animal faeces. High density animal aggregations, such as birds or dogs, on beaches can contribute to contamination;
- Resuspension of contaminated sediments by wind or wave action is also a possible source of contamination.

Differentiating between contaminant sources can be very difficult, however regular (and case-based) sanitary surveys, possibly combined with specialist laboratory techniques, such as sterol and DNA testing, can help advance our understanding.

2.3 Recreational water quality guidelines

Swimming and environmental sites in the Derwent estuary are graded as Good, Fair and Poor. This is in accordance with the Recreational Water Quality Guidelines for Tasmania (Dept of Health & Human Services, 2007), which were largely based on the National Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Both guidelines are currently under review. The guidelines are based on aseptic grab sample analysis for the faecal indicator microbial group enterococci, and the Tasmanian guidelines adopt a three-tiered approach to classifying the long-term (5 years of data) quality of a site based on available data. The tiers are:

- *Good*: rolling 5-year 95th Hazen percentile value of < 200 enterococci MPN (Most Probably Number) 100 mL^{-1}.
- *Fair*: rolling 5-year 95th Hazen percentile value of 200 - 500 enterococci MPN 100 mL^{-1}.
- *Poor*: rolling 5-year 95th Hazen percentile value of > 500 enterococci MPN 100 mL^{-1}. In this case, water at these sites is considered to be a threat to public health in the event of primary contact recreation and the particular local council is required to advise the general public and to erect warning signs to this effect.

In addition to long-term site classification, trigger levels have been set to manage public exposure to episodic or emerging water quality issues. If a sample exceeds 140 enterococci MPN 100 mL^{-1}, the council is required to resample, and if two consecutive samples return a result above 280 MPN 100 mL^{-1}, the public must be notified via signage on the beach in question. This signage can only be removed by Council's Authorised Officer in consultation with the Department of Health.

3 RECREATIONAL WATER QUALITY PROGRAM

3.1 Swimming and Environmental sites

Aseptic grab samples are collected each Tuesday by Council and the EPA/DEP throughout the Derwent estuary, during summer and early autumn each year (from 1 December to 31 March). Sites are categorised as either *swimming sites* or *environmental sites* as described below, and locations are shown in Figure 3.1.

- The 21 *swimming sites* monitored this season are in locations where a significant number of people swim or conduct other primary contact recreation. These sites are sampled by Council to provide a basis for public health information.

- The 22 *environmental sites* monitored this season were selected to provide a broader context for interpretation of Swimming Site results and for other purposes. These sites are sampled by either Council or EPA/DEP were selected based on the following rationale:
  - Bays and coves that are frequently used for secondary contact recreation and/or have foreshore parks;
  - Areas with identified potential sources of faecal contamination;
  - Sites with relatively low risk of contamination, sampled to contextualise Swimming Site results;
  - Sites associated with major swimming events, such as the Trans Derwent Swim.

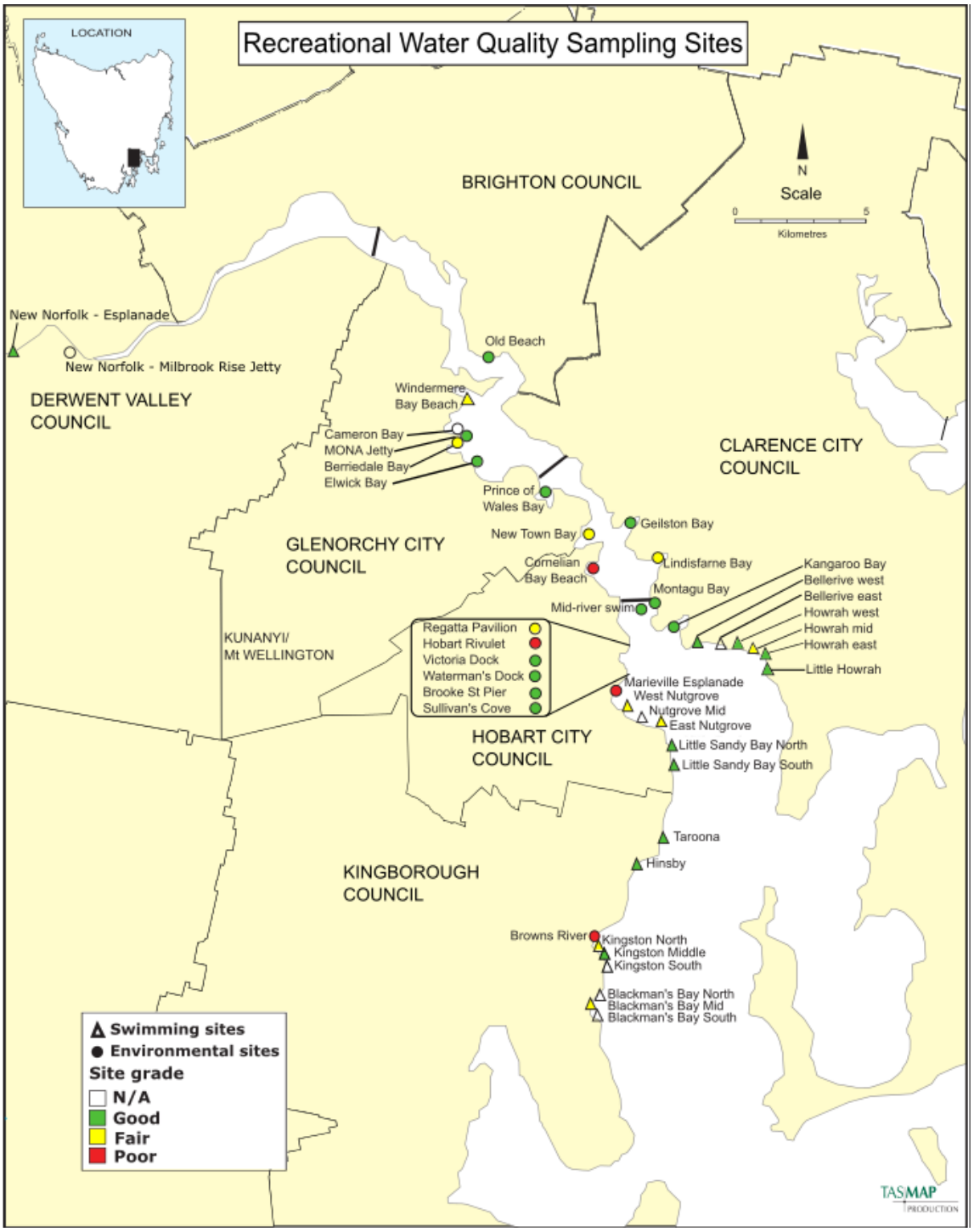

Figure 3.1 Recreational Water Quality sampling sites (Swimming and Environmental sites) with their current water quality classification based on data collected in the summer months between December 2015 and March 2020. Sites without five years of data (N/A) are depicted without a rating.

3.2 **Sample analysis**

All samples are analysed at the Public Health Laboratory (PHL) (St Johns Ave. New Town) using the Enterolert method, which provides confirmed results within 24 hours of analysis. For designated Swimming Sites, if the original sample exceeds the relevant trigger level (Dept of Health & Human Services, 2007), laboratory staff notify the councils so retesting can occur. Results are typically reported between 24 and 48 hours after sample submission to the laboratory.

Samples that exceed the prescribed DoH trigger levels will be provided with Measurement Uncertainty (MU) estimations *if* they fall within the MU range of the trigger levels. The MU ranges are currently between 99-197 for the trigger level of 140, and between 199-395 for the trigger level of 280. All other results will continue to be reported as either meeting, or not meeting, the Recreational Water Quality Guidelines 2007 (*Public Health Act 1997*).

Importantly, if a sample result exceeds a prescribed trigger level the DoH requires it to be retested, no matter whether the result falls within the MU range of that level.

3.3 Inter-calibration exercise

An inter-calibration exercise is organised by the DEP at the start of each season to ensure that all sampling officers are using the same protocols, thus minimising sampler bias. The sampling method is demonstrated, associated protocols are reviewed, and participants simultaneously sample from a designated location. Results are compared to identify any sampler bias and are also useful to better understand the degree of variability between water samples collected from a given site and/or between sites.

Wader safety is discussed, and the value of wader safety courses. The DEP encourages all EHOs to attend such a course before undertaking beach sampling, as wearing waders can be hazardous if water gets inside them, e.g. from boat wake or when bending to take water sample. As part of wader safety, it is very important to wear a tight belt, and ideally also a PFD (Figure 3.2).

Figure 3.2. EHO's showing off the gold star combination of waders, belts and PFDs at Windermere Beach 26 November 2019.

For a full report on this season's inter-calibration exercise results see Appendix 9.1. The next inter-calibration exercise will be conducted in November 2020.

4 2019-20 RWQ SEASON RESULTS

4.1 Rainfall

Rainfall is a major threat and driver of pollution at beaches and other recreational swimming areas as it generates potentially contaminated stormwater runoff and can trigger discharges and overflows from the wastewater (sewerage) system. The water quality of urban beaches and bays can therefore be strongly influenced by rainfall (NHMRC, 2008).

Rainfall data collected and reported by the Bureau of Meteorology (BOM) at four weather stations throughout the Derwent estuary catchment are used to compare rainfall throughout each RWQ season (December to March) against the long-term average rainfall for that period. Observations of daily rainfall are nominally made at 9 am and record the total for the previous 24 hours. Hobart (Ellerslie Rd.), Kingston (Greenhill Dr.), Hobart Airport and New Norfolk (west) have been selected as representative of sampling sites in the Derwent estuary. Rainfall varies across the estuary, with long-term averages for the summer months ranging between 163 mm at Hobart Airport to 202.1 mm at Kingston (Greenhill Dr.).

Whilst there is variation in amount of rain recorded at each of the BOM weather stations, the general trend has been the same at each of the four stations over the last five years. The above-average rainfall recorded in the 2017-18 predominantly fell in a heavy three-day rainfall event in early December, otherwise that season was largely dry too. Overall, summers are wetter in the Kingston catchment than anywhere else in the estuary (Figure 4.1).

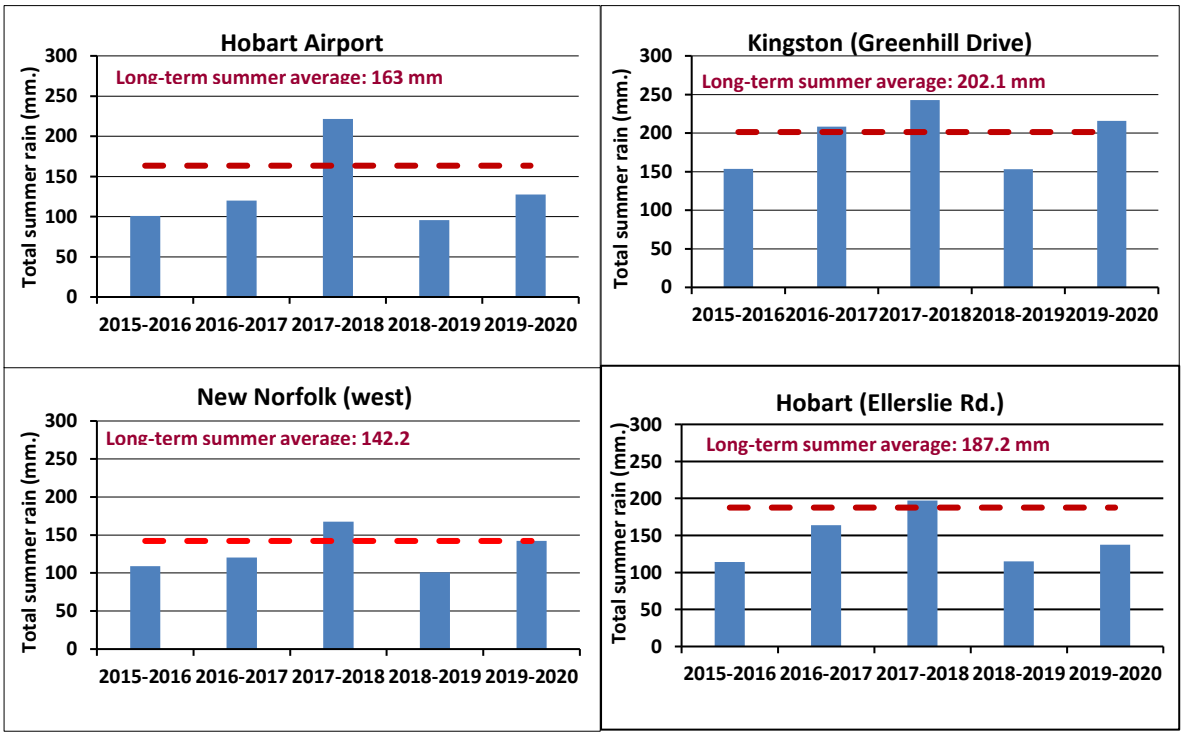

Figure 4.1 Total rainfall (in mm.) at four weather stations in the Derwent estuary catchment during the last five RWQ program seasons (between December and March), as recorded by the Bureau of Meteorology (2020). The long-term average rainfall for the period is indicated in red text and by dotted line.

During the 2019-20 season, rainfall was close to the average at all four BOM weather stations. There were four days throughout the summer with > 10 mm recorded somewhere in the estuary, including some very heavy downpours (e.g. 66 mm in Kingston on 6 March and 36 mm in New Norfolk on 23 January). None of these heavy rainfall events occurred within a 24-hour period prior to sampling.

All rainfall data for the four BOM stations that cover the Derwent estuary are listed in Appendix B 9.2.

4.1.1 Enterococci response to rainfall at swimming sites

As mentioned in the previous section (section 4.12.2), it is recognised that water quality at urban beaches can be strongly affected by stormwater runoff due to rainfall. The DEP conducted a preliminary assessment of the season's results to identify possible relationship between enterococci concentration and rainfall.

The assessment includes all enterococci samples across all Swimming Sites, a total of 373 samples, collected this season. Results were separated into two groups:

- **Group 1**. Results < 140 MPN 100 ml $^{-1}$: 368 samples.
- **Group 2**. Results > 140 MPN 100 ml $^{-1}$: 5 samples.

These two groups were separately assessed for a possible response to rainfall. Rainfall data was used from the four local BOM stations as outlined in section 4.1

Rainfall included data records for the 24 hours prior to 9 am on the day of sampling. Rainfall on the day of sampling has not been considered. This decision was made based on other reports that take the same approach (DEP, 2013; DPIE, 2019). If further analysis is conducted, this decision should be reassessed.

As noted in section 4.1, the rainfall recorded at all four BOM weather stations during the 2019-20 was close to the long-term average. However, rainfall events in the 24 hours preceding sampling this season were few. On only four days, did any rain precede sampling, and none of these events exceeded 5 mm (Appendix B, 9.2).

Group 1 (< 140 MPN):
- 368 samples.
- 81 % of the enterococci results (< 140 MPN 100 ml $^{-1}$) occurred when no rain fell in the preceding 24 hours (Figure 4.2).
- 19 % of results occurred on days when the total rainfall in the preceding 24 hours was < 5 mm.

Group 2 (> 140 MPN):
- 5 samples.
- 80 % of high enterococci values (> 140 MPN 100 ml $^{-1}$) occurred when no rain fell in the preceding 24 hours (Figure 4.2).
- 20% of high enterococci values occurred on days when the total rainfall in the preceding 24 hours was < 5 mm.

Of the 373 samples collected this summer, 99 % of enterococci results were < 140 MPN 100 ml $^{-1}$. Low rainfall (0.1 - 5 mm) did not seem to negatively influence enterococci results, with 69 of 70 low rainfall samples < 140 MPN 100 ml $^{-1}$ (Figure 4.2).

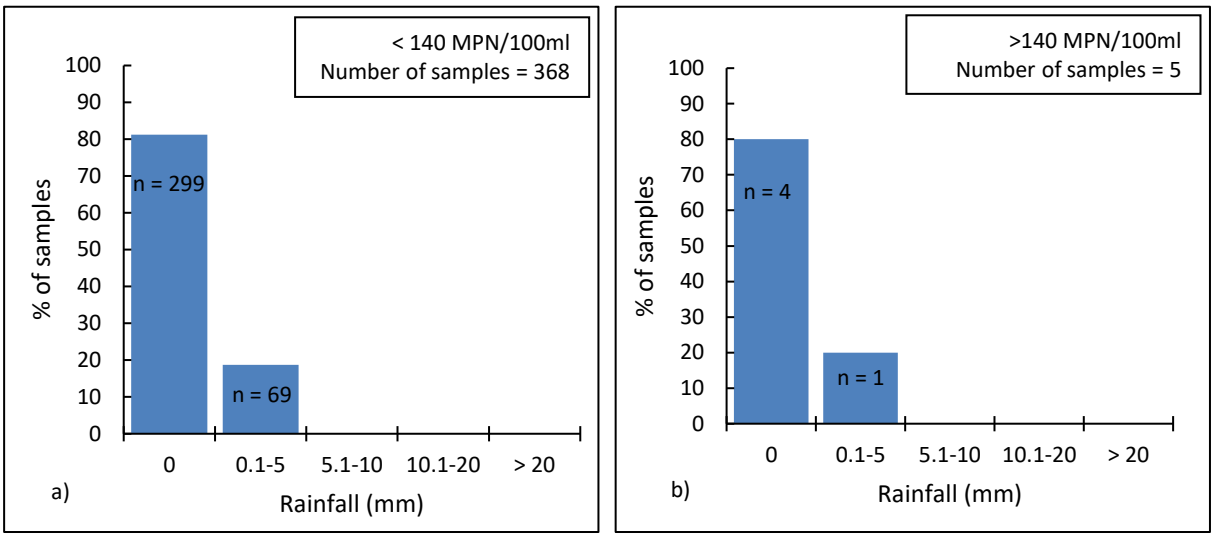

Figure 4.2 Proportion of samples < 140 MPN 100 ml $^{-1}$ (a), and > 140 MPN 100 ml $^{-1}$ (b), that respond to rainfall. Graphs include all enterococci samples collected at swimming sites during the 2019 – 20 RWQ season.

In summary, the lack of heavy rainfall before sampling is likely to have had a positive impact on results, and the above assessment suggests that the little rain that did precede sampling had a negligent influence.

It is recommended that this study be replicated with the five-year data (or the entire data-set) at the individual beach level. This would be a more robust approach and give greater confidence in observed responses. Also, it is likely that beaches respond differently depending on the proximity of sampling sites to stormwater outlets, activities in, and topography of, the catchment. Analysing the beaches individually could give an indication of which beaches respond to stormwater run-off which may assist decision-making and allocation of resources to conducting stormwater works. It is recommended that this analysis would be a beneficial inclusion in the State of the Derwent Report 2020.

4.2 **Long-term site classification**

After each RWQ season, a new long-term rating is calculated for all Swimming and Environmental sites. This calculation is based on the immediate previous five seasons of sampling data for each site. Table 1 shows the updated rating after the 2019-20 season, thus with sample results from December 2015 to March 2020. The colours refer to Tasmanian *Recreational Water Quality Guidelines* (Dept of Health & Human Services, 2007), using the rolling 5-year 95th Hazen percentile for enterococci, where green denotes Good (< 200 MPN 100 mL^{-1}), yellow denotes Fair (200 - 500 MPN 100 mL^{-1}), and red denotes Poor (> 500 MPN 100 mL^{-1}).

The number of samples with enterococci readings between 140 and 280 MPN 100 mL^{-1}, > 280 MPN 100 mL^{-1}, > 140 in 2018-19 and total number of samples, for same 5-year period are also shown.

It is important to note, that for sites where there is not yet five years of data available, there is no long-term rating. The 95th Hazen percentile listed in Table 2 only provides an indication of a future rating for these sites. It is useful for councils to take note of early water quality trends, as they may indicate there are issues that require attention and action now.

Table 1. Long-term ratings for Swimming and Environmental sites as calculated after the 2019-20 RWQ season.

		Updated long-term rating	5-year 95th Hazen percentile	Samples between 140 and 280	Samples > 280	Total number of samples
Swimming sites	**Bellerive Beach (east)*	*N/A*	*33*	*0*	*0*	*18*
	Bellerive Beach (west)	Good	180	5	1	87
	Blackmans Bay Beach (mid)	Fair	319	3	5	87
	**Blackmans Bay Beach (north)*	*N/A*	*46*	*0*	*0*	*18*
	**Blackmans Bay Beach (south)*	*N/A*	*116*	*1*	*0*	*18*
	Hinsby Beach	Good	32	2	0	87
	Howrah Beach (east)	Good	192	3	3	87
	Howrah Beach (mid)	Fair	410	3	8	87
	Howrah Beach (west)	Good	119	0	3	87
	Kingston Beach (mid)	Good	94	2	1	87
	Kingston Beach (north)	Fair	260	4	4	87
	**Kingston Beach (south)*	*N/A*	*147*	*1*	*0*	*18*
	Little Howrah Beach	Good	128	1	3	87
	Little Sandy Bay Beach (north)	Good	96	2	1	87
	Little Sandy Bay Beach (south)	Good	54	2	0	87
	New Norfolk (Esplanade)	Good	94	1	1	75
	Nutgrove Beach (east)	Fair	219	6	3	87
	**Nutgrove Beach (mid)*	*N/A*	*728*	*2*	*4*	*52*
	Nutgrove Beach (west)	Fair	259	4	4	87
	Taroona Beach	Good	137	0	4	87
	Windermere Beach	Fair	209	2	3	80
Environmental sites	Brooke St. Pier	Good	43	0	2	69
	Browns River	Poor	2297	11	30	86
	**Cornelian Bay	Poor	1809	10	16	64
	Elwick Bay	Good	180	2	3	80
	Geilston Bay	Good	158	4	1	69
	Hobart Rivulet	Poor	1080	11	24	69
	Kangaroo Bay	Good	53	1	1	69
	Lindisfarne Bay	Fair	275	2	3	69
	Marieville Esplanade	Poor	1839	13	15	86
	Mid-river swim	Good	30	2	0	68
	Berriedale Bay (MONA)	Fair	397	3	6	64
	**Cameron Bay (MONA)*	*N/A*	*347*	*2*	*3*	*64*
	MONA jetty	Good	101	0	3	77
	Montagu Bay	Good	22	1	0	68
	**New Norfolk (Millbrook Rise Jetty)*	*N/A*	*72*	*0*	*0*	*14*
	New Town Bay	Fair	304	5	4	69
	Old Beach Jetty	Good	190	3	3	81
	Prince of Wales Bay	Good	151	3	1	69
	Regatta Pavillion	Fair	457	6	6	68
	Sullivans Cove	Good	52	0	1	68
	Victoria Dock	Good	161	2	2	69
	Watermans Dock	Good	197	1	3	69

***** Indicates < 5 years of data available.
**Cornelian Bay is monitored intermittently when conditions allow, thus result is not robust.

4.3 Site results

4.3.1 Swimming Sites

This season saw four new swimming sites. Bellerive Beach (east) and Blackmans Bay Beach (north) were both added to provide additional and consistent sampling along the length of these two popular beaches. Kingston Beach (south) and Blackmans Bay Beach (south) were also new sites this season, having been moved from their previous locations by stormwater outfalls, which is consistent with DoH advice of not swimming near outfalls. All new sites require five years of sampling data to calculate a long-term rating.

The water quality at swimming sites during the 2019-20 summer was significantly better than the previous season with only five exceedances of the enterococci trigger level of 140 MPN 100 mL^{-1}, compared to last season with its record number of exceedances (52) (Appendix C 9.3.1, Weller-Wong and Visby, 2019). At the end of this season, 10 Swimming Sites were graded as Good, six sites graded as Fair, none as Poor and five sites yet to be classified due to incomplete 5-year datasets (Figure 4.3, Figure 4.4).

While no sites experienced a rating decline this year, the high number of Fair sites is a caution to local councils that there a risk of additional sites declining towards a Poor rating in coming seasons.

The two Swimming Sites with the consistently best water quality are still Hinsby Beach and Little Sandy Bay Beach (south), both having only had two exceedances above 140 MPN 100 mL^{-1} during the last five seasons (Table 1). The Swimming Site with the poorest Hazen percentile result at the moment is Howrah Beach (mid), currently Fair, with three exceedances above 140 MPN 100 mL^{-1} and eight over 280 during the last five seasons. Nutgrove Beach (mid) has only been sampled for three seasons and therefore does not have a long-term rating, but prior to this year's excellent results (only one enterococci result above 10 MPN 100 mL^{-1}) it recorded three exceedances above 280 MPN 100 mL^{-1} giving this site a preliminary Hazen percentile result of 728.

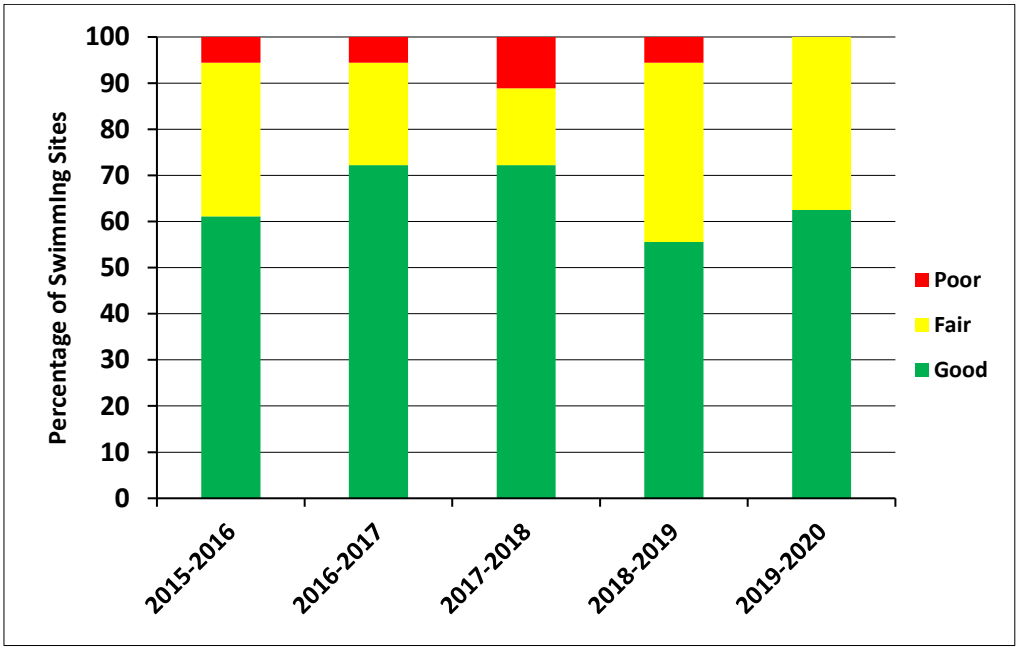

Figure 4.3 Proportion of Swimming Sites graded as Good, Fair, and Poor in the last five RWQ seasons. Proportions based on those sites with five years of data.

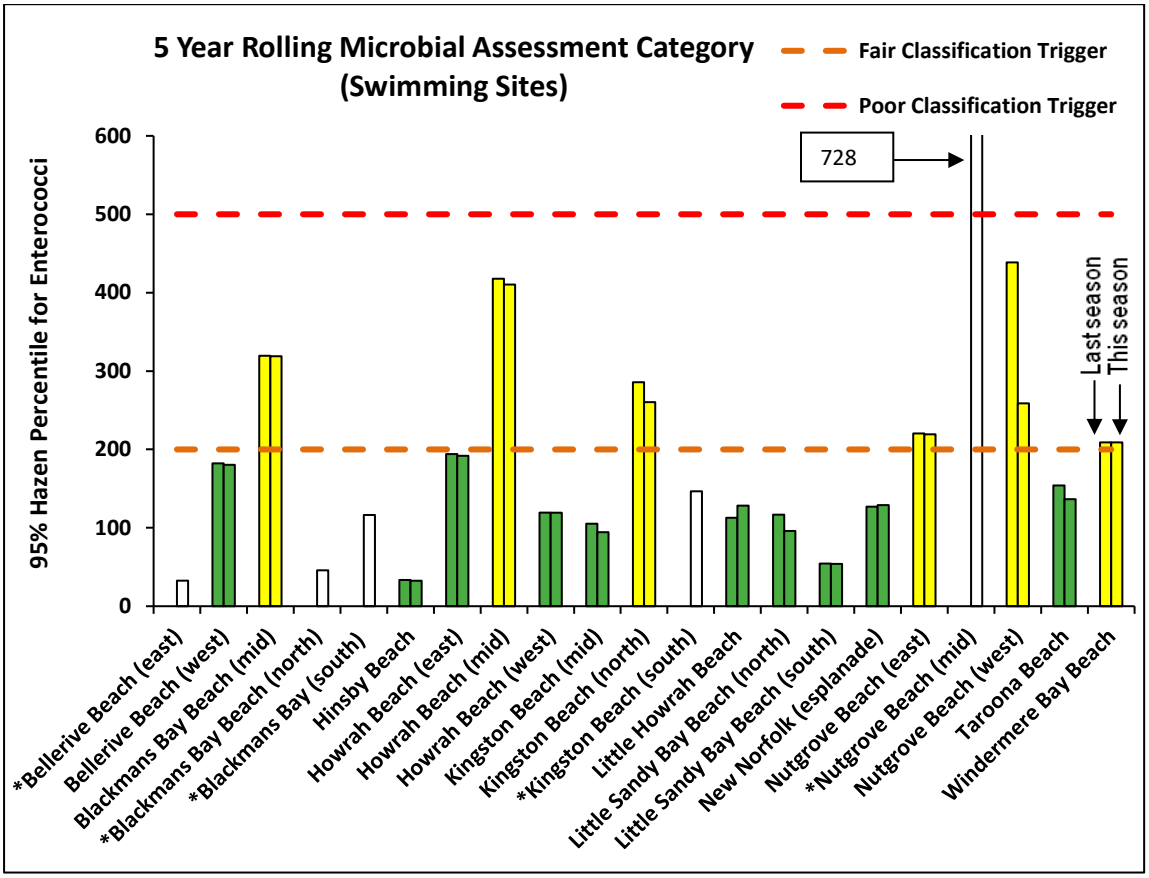

Figure 4.4: Comparison of rolling 5-year Hazen percentile enterococci result for Swimming Sites. Each site is presented as a pair of results, where the left bar represents 2018-19 RWQ season results, while the right bar represents 2019-20 season result. Green denotes Good (< 200 MPN 100 mL^{-1}), yellow denotes Fair (200 - 500 MPN 100 mL^{-1}), red denotes Poor (> 500 MPN 100 mL^{-1}), and the classification trigger lines are indicated with dotted lines. * indicates that less than five years of data is available, thus those results are less robust.

See the full list of enterococci results for all Swimming Sites in 2019-20 in Appendix C, and read more details about Specific Investigations in Section 5.

4.3.2 Environmental Sites

One new Environmental Site was added this season, in New Norfolk at the Millbrook Rise Jetty. This site was previously been sampled in the 2012/13 and 2013/14 RWQ seasons, always with good results.

The water quality at the Environmental Sites during the 2019-20 sampling season were significantly better than the previous season. However, there were still 18 occurrences where the enterococci trigger level of 140 MPN 100 mL-1 was exceeded, but this was 33 occurrences less than the previous RWQ season (Appendix 9.3.2, Weller-Wong and Visby, 2019). At the end of the season 12 sites were graded as Good, four as Fair, four as poor and two yet to be classified due to an incomplete 5-year data-set (Figure 4.5,Figure 4.6).

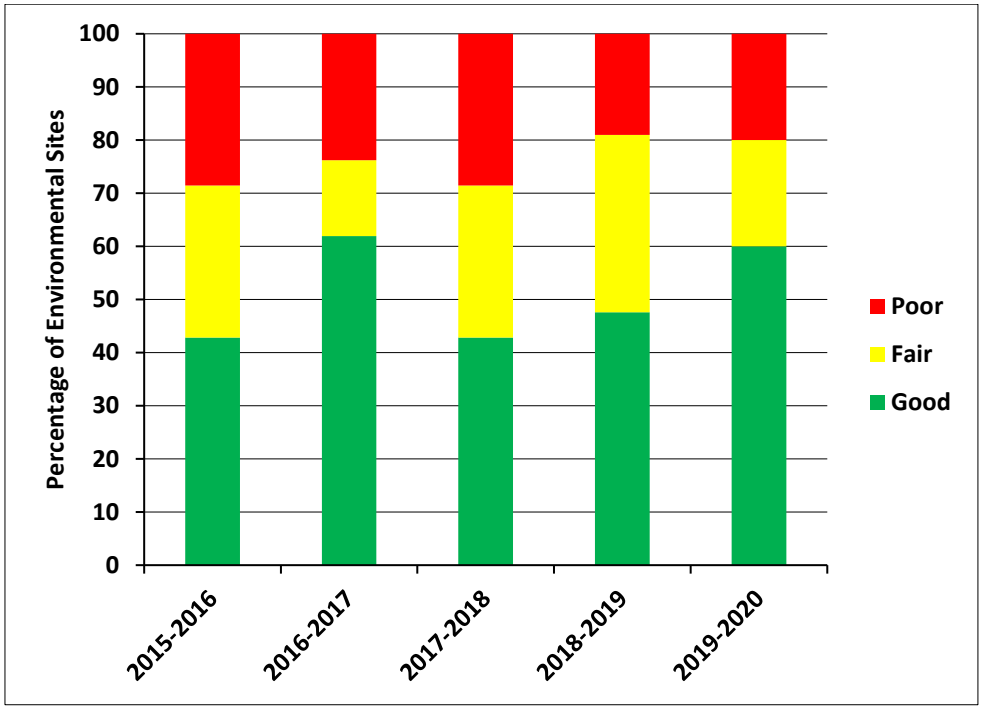

Figure 4.5 Proportion of Environmental Sites graded as Good, Fair, and Poor in the last five RWQ seasons. Proportions based on those sites with five years of data.

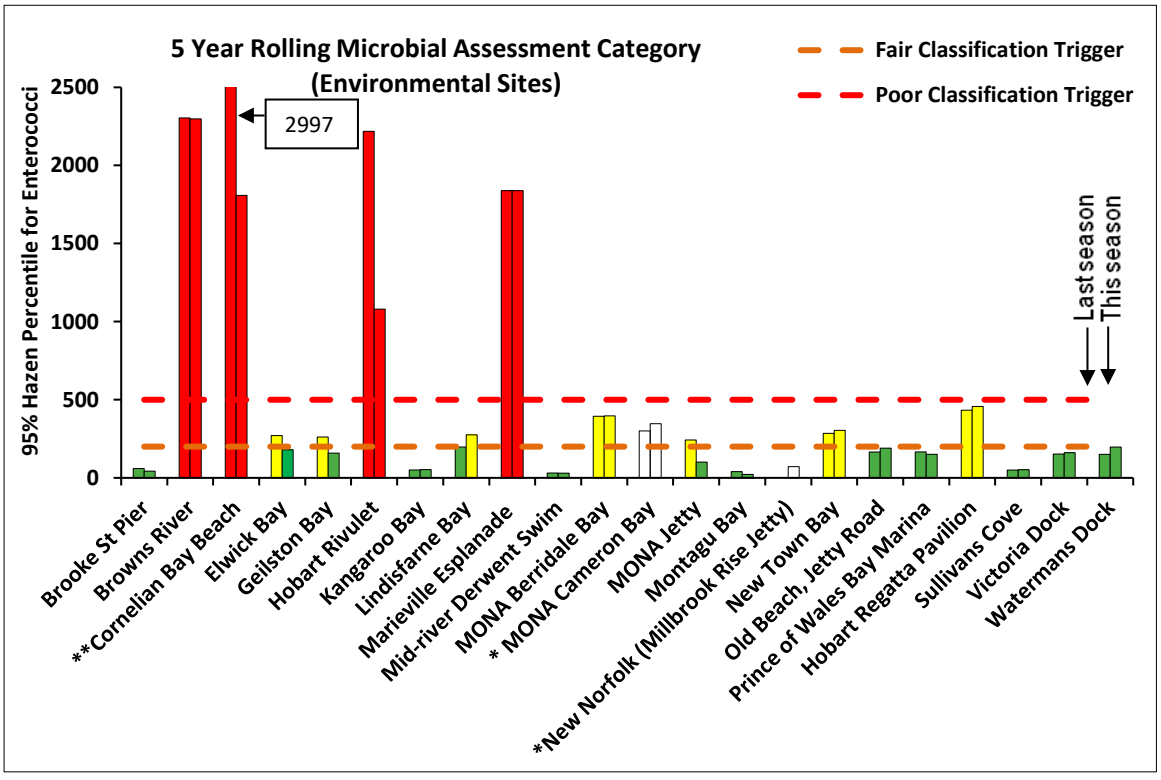

Figure 4.6 Comparison of rolling 5-year Hazen percentile enterococci result for Environmental Sites. Each site is presented as a pair of results, where the left bar represents 2018-19 RWQ season results, while the right bar represents 2019-20 season result. Green denotes Good (< 200 MPN 100 mL^{-1}), yellow denotes Fair (200 - 500 MPN 100 mL-1), red denotes Poor (> 500 MPN 100 mL^{-1}), and the classification trigger lines are indicated with dotted lines. * indicates > five years of data available. **Cornelian Bay is monitored intermittently, when conditions allow, thus those results are less robust.

This year's results led to three sites upgrading from Fair to Good: Elwick Bay, Geilston Bay and MONA jetty, but unfortunately a decline to Fair for Lindisfarne Bay (Figure 4.6), after three seasons in the Green. Other significant improvements were seen, though not leading to ratings change, at Cornelian Bay and at Hobart Rivulet. Sampling at Cornelian Bay is intermittent due to tide levels and conditions, which makes the data from the site less robust. But Hobart Rivulet is sampled weekly and experienced a change to the 95th Hazen percentile figure from 2218 to 1080, which is a substantial jump in the right direction (Table 1).

After this season, Montagu Bay has overtaken Mid-river Derwent as the Environmental Site with the best water quality. Those two sites are followed closely by Brooke St Pier and Sullivans Cove. Montagu Bay had only one enterococci sample > 140 MPN 100 mL^{-1} over the past five seasons, whilst Mid-river Derwent had two. Brooke St Pier had two samples >280 MPN 100 mL^{-1} in last five years and Sullivans Cove had one (Table 1).

See the full enterococci results for all Environmental Sites in Appendix C 9.3.2

5 SPECIFIC INVESTIGATIONS

The DEP recommends that councils view a Fair site classification as a caution of potential problems that may escalate, and therefore merits investigating. Water quality investigations are ongoing at various estuary sites, including the Howrah beaches (Clarence City Council), and the Blackmans Bay and Kingston beaches (Kingborough Council), as discussed below.

See Section 1.1.1 for details on the new *Source Tracking Framework and Tool Kit* that can assist councils in conducting investigations for the source of pollution on a beach or in a stormwater catchment.

5.1 Howrah Beach (mid)

Previous investigations have confirmed that recreational water quality at Howrah Beach (mid) is highly susceptible to stormwater contamination. At the end of the 2018-19 RWQ season, this site returned to a high Fair rating, which was a reminder, and warning, that continued catchment investigation work is required to achieve consistent good beach water quality at this beach.

Stormwater investigations are now continuing in the Howrah beach catchment. CCC have collected 83 stormwater samples from the Howrah catchment area so far during the 2019/2020 financial year.

Council are currently Investigating cross connection issues in Banjorrah Street Howrah and Merinda Street Howrah with Taswater, after sampling and dye testing of stormwater was used to locate the source of contamination. Issues in Mortyn Place appear to have been fixed, which have been confirmed with follow-up testing.

A direct connection of a house sewer to Councils stormwater main in Douglas Street was also identified by Council and NuJet CCTV crew this financial year. The problem was resolved by issuing a plumbing order to the property owner to connect to Taswater sewer. This sewer connection had most likely been flowing directly to stormwater for decades. Council are also following up cross connection issues in Victoria Esplanade in Bellerive, with CCTV and dye testing.

CCC is planning to extend funding for the Howrah Stormwater Investigation project for another 6 months to continue ongoing investigations and complete the sampling

coverage of all the identified sub-catchments. Re-sampling and testing of areas which have been fixed by TasWater is ongoing.

The new ammonia kit has been successfully used by CCC in conjunction with enterococci samples, as well as in catchments to identify contamination hot spots.

5.2 Blackmans Bay Beach and Kingston Beach

Kingborough Council in collaboration with TasWater have implemented two low-flow diversions to sewer in Blackmans Bay, which has reduced the amount of stormwater discharging to the recreational beach.

The two previous RWQ seasons at Blackmans Bay Beach (south) demonstrated poor water quality, however the 2019-20 season has seen a significant improvement. The public health advisory issued for Blackmans Bay Beach (south) at the end of the 2018/19 season received significant community and media attention.

Kingborough Council commenced an extensive sampling regime and investigation at the Blackmans Bay and Kingston beaches, taking both recreational water and stormwater outfall samples. This sampling regime has been running consistently each week since November of 2018. Kingborough Council appointed a Stormwater Investigation Officer who has been able to track sources of contamination back up the catchment to their source, using a combination of methods, including visual inspection as well as ammonia & bacterial testing. This has been successful in locating ageing sewer infrastructure impacting stormwater as well as domestic cross connection issues, which have been promptly rectified by TasWater, Kingborough Council and property owners.

Investigations in the Blackmans Bay and Kingston Beach stormwater catchments are ongoing.

6 COMMUNICATIONS

6.1 Media

This RWQ season saw significantly less media attention compared to last year. The likely reason for this is that we had such good sampling results across the estuary this past summer.

6.2 Website

Weekly RWQ results were reported via the DEP website on the *Beach Watch* page (for Swimming Sites) https://www.derwentestuary.org.au/beach-watch/ and the associated *Bay Watch* page (for Environmental Sites). These pages allow the public to locate a weekly sampling result and long-term rating for a particular beach or bay by clicking on an interactive map or looking at a table.

The Beach Watch page was viewed by approx. 3,346 people over the course of the 2019-20 RWQ season, a decrease of around 16,000 views compared to the previous season. As mentioned above, this decrease is likely due to much better water quality results than last summer.

6.3 **Facebook**

Weekly RWQ results are shared on the DEP Facebook page www.facebook.com/derwentestuary. As with the DEP website, the number of Facebook views during the 2019-20 season decreased significantly from the previous season. On average, the Facebook page was viewed by 300 people per week during the RWQ season.

All EHOs are warmly invited to share photos from their sampling days to be used on Facebook, so that we can hopefully reach more people with our messages.

6.4 **Weekend advisory**

The most important message that we need to convey to the swimming public, is to not swim after heavy rains, due to the water quality of urban beaches and bays being often strongly influenced by stormwater run-off (NHMRC, 2008). We keep an eye on the weekend forecasts and can put out an advisory on the DEP Facebook page when necessary, e.g. when recent or predicted rainfall is greater than 10 mm. This 'protocol' was conducted throughout the season (Figure 6.1).

Figure 6.1 DEP Facebook posting from 6 March 2020 referring to the weekly RWQ results during a week with poor weather forecast for the weekend.

6.5 **Signage**

The signs installed at Derwent estuary swimming sites are a useful source of information for beach users. The DEP recommends that local councils conduct an annual review of signage in their municipality to ensure that all signs are located in the most appropriate locations (i.e. visible to most visitors), are in good condition (e.g. free of graffiti), and that they are replaced with new signs as required (e.g. when the water quality category changes).

Because of no long-term ratings changes following this summer, no signage changes are required post-season. For new Swimming Sites, it is recommended that signs are only erected once a long-term rating has been established, i.e. after five seasons.

7 ACKNOWLEDGEMENTS

The DEP would like to sincerely thank all council environmental health officers and other council staff who have contributed to this RWQ season, as well as EPA staff who have assisted with boating requirements. Many thanks also go the staff at the Public Health Laboratory and the Department of Health for their ongoing participation and friendly support, and our industry partners, including TasWater.

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9 APPENDIX

9.1 Appendix A - RWQ Intercalibration report 2019-20

9.1.1 Executive Summary

Recreational Water Quality (RWQ) monitoring in the Derwent estuary is conducted and reported in accordance with the Recreational Water Quality Guidelines 2007 (*Public Health Act 1997*). In order to ensure consistency of sampling methods and to assess the degree of variability between samples and samplers, the Derwent Estuary Program (DEP) coordinates an annual inter-calibration exercise.

On a cold afternoon on 26 November 2019, environmental health officers from three council partners together with the DEP simultaneously collected a sample each at

Windermere Beach. Results were consistent between samplers. Due to there being no flow in the stormwater outfall at the southern end of the beach, no second sample site was tested this year, and thus no comparison between potentially good and poor water quality sites was conducted.

The sampling results demonstrated little variability between samplers. Samplers adopted good sampling technique, and showed satisfactory knowledge about field sheets, sample storage, wader safety, and potential sources of faecal contamination.

9.1.2 Introduction

The RWQ monitoring is conducted and reported in accordance with the Recreational Water Quality Guidelines 2007 (*Public Health Act 1997*). The guidelines recommend classifying primary contact recreation beaches using 5-year 95th Hazen percentile values for the faecal indicator bacteria enterococci:

- Good (surveillance mode) = < 200 MPN/100 mL.
- Fair (alert mode) = 200 - 500 MPN/100 mL.
- Poor (action mode) = > 500 MPN/100 mL.

The long-term beach classification guidelines do not take into account the possible influence of variability in the data due to differences in sampling techniques between samplers, or possible heterogeneity of the sampled water body. The RWQ program uses data provided by a number of different council environmental health officers, which increases the risk of variability due to sampling technique. Thus, the primary objective of the annual inter-calibration exercise is to review and practice sampling methods at the start of each season, in order to improve consistency of results. A secondary objective is to gain a better understanding of water quality at a particular site.

9.1.3 Overview

Participants

The DEP (Inger Visby) coordinated the participation of the following:

- Kingborough Council (Elzette Mustonen)
- Clarence City Council (Andrew Foreshore)
- Glenorchy City Council (Tracy Tavasz)
- DEP (Akira Weller-Wong)

There were apologies from Brighton Council, Department of Health, City of Hobart and Derwent Valley Council.

Location

Site 1 was off the beach by the Knights Point Reserve (Figure 9.1). Site 2 was going to be at the southern end of the beach by one of the stormwater outfalls, but as there was no flow this plan was abandoned on the day**.**

Figure 9.1. Location of the site sampled for the RWQ inter-calibration exercise on 26 November 2019 at Windermere Beach.

Method

Field sheets were completed by entering wind speed, wind direction, date and time of sampling. Any general observations were also noted, such as discolouration, odour, construction activity, boat presence, density of wildlife, evidence of faeces, proximity to stormwater outfalls or any other matters which might influence results. Bottles were labelled with the site, time, and the sampler's name.

All samplers concurrently collected a single sample at each site from an approximate water depth of 0.3 m. Bottles were only opened immediately prior to collecting the sample. Once the bottle cap had been removed, care was taken to ensure that this was not contaminated by fingers or by contact with surfaces. The bottle was quickly plunged to the required sampling depth, then it was tilted upward with the mouth pointed upward. The sample was brought to the surface and a portion of the sample tipped out so that the level in the sample container was at the bottle collar. The sample lid was screwed tightly shut before removing it from the sample pole and the sample was placed upright in a chilled esky ready for transport to the laboratory (Public Health Laboratory in New Town). Samples were delivered to the laboratory immediately upon completion of the inter-calibration event.

In addition to water sampling, Clarence City Council and the DEP also compared *in-situ* water quality multi-probes, a Horiba Water Quality Checker U-10 (CCC) and a YSI EXO3 Multiparameter Sonde (DEP). The calibrated multi-probes were deployed to the same surface depth of water at the southern end of the beach, until data readings stabilised. Temperature, salinity, turbidity, pH, conductivity, and dissolved oxygen readings were compared.

9.1.4 **Safety**

Wader safety was debated, and it was discussed how extremely valuable wader safety courses are. Everybody present had some experience with wearing waders, which can be hazardous if water gets inside them, e.g. from boat wake or when bending to take a water sample.

As part of wader safety, it is very important to wear a tight belt, and ideally also wear a PFD (Figure 9.2).

Figure 9.2. The gold star combination of waders, belts and PFDs ☺.

9.1.5 **Results**

The enterococci results from Site 1 varied between <10 and 41 MPN/100 mL. (Table 2).

The results from the multi-probe comparison are listed in Table 3. The instruments measured salinity in different units.

Table 2. Summary of enterococci concentration results (MPN/100 mL) sampled on 26 Nov 2019.

Sampler	**Site 1: Beach by the park**
Glenorchy	<10
Clarence	31
Kingborough	10
DEP	41

Table 3. Summary from multi-probe comparison exercise on 26 Nov 2019.

Multi-probe	**Temperature (°C)**	**pH**	**Conductivity (mS/cm)**	**DO (mg/L)**	**Turbidity (NTU)**	**Salinity ***
YSI (DEP)	17.4	8.09	33.0	11.59	24.90	20.71 PSU
Horiba (CCC)	17.1	8.33	33.4	13.3	54.0	2.09 %

* 2.09% is equivalent to 20.9 PSU.

Rain, wind, tide conditions

According to the weather station at Ellerslie (Bureau of Meteorology 2018) there was negligible rain in the three proceeding days to the exercise.

At the time of sampling, the wind was west/soutwesterly, with wind speeds ~ 17 km/hr, and the tide was ingoing at ~ 0.4 m (WillyWeather 2019).

9.1.6 **Conclusions**

The water quality was excellent at the sampling site. The sampling results demonstrated fairly homogeneous water quality conditions, with negligible variability between samplers.

The results from multiprobe comparison, between DEP and Clarence City Council, was also comparable, and continues to be valuable to ensure that equipment is used correctly, and calibrations are performed regularly.

Samplers adopted good aseptic grab sampling technique, removing bottle lids at the last moment before collecting a sample, protecting the bottle and lid from contamination, labelling bottles correctly and storing samples in a chilled esky for subsequent transport to the laboratory. Samplers were aware of potential sources of faecal contamination.

9.1.7 **Acknowledgements**

Thank you very much to all the environmental health officers who participated in this session with great enthusiasm and willingness to share their knowledge and experiences, and to the local councils for valuing and prioritising the RWQ program.

9.1.8 **References**

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9.2 Appendix B – Rainfall data across the Derwent estuary

Table 4. Daily rainfall (up to 9 am) from December-March at four BOM weather stations near the Derwent estuary; Hobart Ellerslie Rd; Hobart Airport; Kingston Greenhill Drive; and New Norfolk West.

	Rainfall (mm)															
	Hobart				Airport				Greenhill				NN west			
Date	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar
1st	1.4	0	2.6	0	3	0	2.6	0	0.6	0	1.4	0	0	0	2.2	0
2nd	0.4	0	0	17	1.8	0	0.2	14	0.6	0	0	17	0	0	0	15
3rd	0.4	0	1.6	0	1	0	0.6	0	4.6	0	2.8	0	1.8	0	7	0
4th	3.4	0	0.6	0	1.6	0	1.4	0	8.8	0	0.8	0	7.8	0	0.6	0
5th	0	0	0	13	0	0	0	6.4	0	0	0	18	0.4	0	0	13
6th	0	0	0	25	0	0	0	29	0.8	0	0	66	2.6	0	0	18
7th	1.4	0	0	0	0.4	0	0	0	5.4	0	0	0.4	3.8	0	0	0
8th	0.8	0	0	2.6	1.2	0	0	0.8	0.6	0	0	1.6	0	0	0	0
9th	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0
10th	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11th	0	2.2	0.4	0	0	1.2	1.2	0	0	5.2	0.6	0	0	3.4	1	0
12th	0	0	0.2		0	0.2	0.6	0	0	0	0.2	0	0	0	0	0
13th	0.2	0	1	0.6	0.2	0	0	0	0.6	0	1	0.2	0.4	0	0	2
14th	0.4	0	0.2	3.4	0.8	0	0	8.4	3.4	0	0.2	3.8	1	0	0.2	2.8
15th	3.6	0	3.8	0	3.6	0	1	0.2	8.2	0	4.8	0	3	0	7.8	0.2
16th	0.6	1.6	0	0	2	2.2	0.2	0	1.6	1.4	0	0	1	5.2	0	0
17th	0	2.2	0	0	0.2	2.2	0	0	0	6	0	0	0	0	0	0
18th	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19th	0	0	0.6	0	0	0	0	0	0	0	2.2	0	0	0	0	0
20th	0	0	0	5.6	0	0	0	3.4	0	0	0	3.8	0	0	0	5.4
21st	0	0	1	0.2	0	0	0	0.8	0	0	1	1.2	0	0	0.4	0
22nd	0	0	0.2	2.2	0	0	0.2	3.4	0	0	0.4	1.2	0	0	0	0.8
23rd	0	25	0	0	0	14	0	0	0	22	0	0	0	36	0	0
24th	0	2.4	0	0	0	3.2	0	0	0	1.4	0	0	0	5	0	0
25th	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26th	0	0	2	0	0	0	6	0	0	0	3.8	0.8	0	0	1.4	0
27th	0	0	1	0	0	0	1.8	0	0	0	1.4	0	0	0	0.4	0
28th	0	0	0.6	0	0	0	0	0	0	0	2.8	0	0	0	0	0
29th	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
30th	0	0		2.4	0	0		2	0	0		2.6	0	0		4.6
31st	3.4	0		0	3.8	0		0	5	0		0	6.8	0		0
	mm rainfall															
	5 - 10															
	10 - 20															
	> 20															

9.3 Appendix C – 2019-20 results for Swimming and Environmental sites

9.3.1 Swimming Sites

	Swimming Site 2019-20																				
Date	HCC					CCC						KC								GCC	DVC	
	Little Sandy Bay Beach (south)	Little Sandy Bay Beach (north)	Nutgrove Beach (east)	*Nutgrove Beach (mid)	Nutgrove Beach (west)	*Bellerive Beach (east)	Bellerive Beach	Howrah Beach (east)	Howrah Beach (mid)	Howrah Beach (west)	Little Howrah Beach	*Blackmans Bay Beach (north)	Blackmans Bay Beach (mid)	*Blackmans Bay Beach (south)	Hinsby Beach	Taroona Beach	Kingston Beach (mid)	Kingston Beach (north)	*Kingston Beach (south)	Windermere Bay Beach	*New Norfolk (Esplanade)	No.excedences over 140 MPN
03-Dec-19	10	10	10	10	10	10	10	10	10	10	169	10	10	10	10	10	10	10	10	10	N/A	1
10-Dec-19	10	10	20	10	20	10	10	10	10	20	10	10	10	10	10	10	10	10	10	52	N/A	0
17-Dec-19	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	63	0
23-Dec-19	10	10	10	10	10	10	173	52	228	10	10	10	20	75	10	10	10	31	10	20	10	2
30-Dec-19	110	10	10	10	10	10	10	10	10	10	10	10	10	10	10	20	10	10	10	N/A	30	0
07-Jan-20	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	187	10	63	1
14-Jan-20	10	10	10	10	10	41	10	31	10	10	10	10	20	10	10	10	10	41	10	10	10	0
21-Jan-20	10	31	10	10	10	10	10	10	10	41	10	10	10	10	10	30	10	30	10	31	96	0
28-Jan-20	10	10	10	10	10	10	10	10	10	41	10	10	10	10	10	10	10	10	10	10	70	0
04-Feb-20	10	10	10	10	10	10	10	31	10	10	10	10	10	10	10	10	41	52	10	10	86	0
11-Feb-20	10	10	10	10	10	10	31	20	63	52	10	63	52	10	10	10	10	10	74	20	52	0
18-Feb-20	10	10	10	10	41	10	20	10	10	20	10	10	110	10	10	10	41	63	86	10	30	0
25-Feb-20	10	10	10	10	31	10	10	10	10	10	63	10	52	10	20	10	10	10	10	10	10	0
03-Mar-20	10	10	10	10	10	10	10	10	10	10	10	20	10	41	10	10	20	10	10	120	20	0
10-Mar-20	10	10	10	10	41	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0
17-Mar-20	10	10	10	31	20	10	10	10	10	10	10	10	10	144	10	10	10	10	10	10	31	1
24-Mar-20	10	10	10	10	10	20	10	10	10	20	10	10	75	63	10	10	10	10	10	10	N/A	0
31-Mar-20	10	41	10	10	20	10	10	10	10	10	10	10	31	10	10	41	10	20	10	52	N/A	0
																						5

Figure 9.3 2019-20 RWQ season swimming site results listed under each local council. Results are enterococci MPN per 100 mL. Last column lists the number of enterococci result exceedances above 140 MPN per 100 mL., which are highlighted.

9.3.2 **Environmental Sites**

	Environmental Site 2019-20																						
	Brooke St Pier	Browns River	Cornelian Bay Beach	Elwick Bay	Geilston Bay	Hobart Rivulet	Kangaroo Bay	Lindisfarne Bay	Marieville Esplanade	Mid-river Derwent Swim	MONA Berridale Bay	MONA Cameron Bay	MONA Jetty	Montagu Bay	New Norfolk (Esplanade)	New Town Bay	Old Beach, Jetty Road	Prince of Wales Bay Marina	Regatta Pavilion	Sullivans Cove	Victoria Dock	Watermans Dock	No.excedences over 140 MPN
03-Dec-19	N/A	95	41	52	N/A	N/A	N/A	N/A	10	N/A	20	10	10	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	0
10-Dec-19	N/A	41	1607	52	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1
17-Dec-19	10	52	10	10	10	473	10	10	10	10	N/A	10	10	10	10	20	738	10	10	10	10	10	2
23-Dec-19	10	120	20	10	10	73	10	10	31	10	N/A	24196	10	10	10	10	N/A	10	10	10	10	10	1
30-Dec-19	N/A	10	10	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	20	N/A	10	N/A	N/A	N/A	N/A	N/A	0
07-Jan-20	10	10	20	10	10	10	10	31	41	10	N/A	20	10	10	30	10	10	20	10	10	10	10	0
14-Jan-20	10	85	216	10	10	10	10	20	31	10	N/A	10	10	10	10	171	10	20	86	10	10	10	2
21-Jan-20	10	131	218	10	10	173	10	41	10	10	85	131	31	10	31	10	N/A	10	10	10	10	10	2
28-Jan-20	10	97	473	20	20	70	10	63	85	10	10	10	10	10	40	10	N/A	10	10	10	10	10	1
04-Feb-20	10	63	10	10	30	10	10	10	41	10	N/A	10	10	10	41	10	10	10	10	10	31	10	0
11-Feb-20	10	10	554	10	41	250	10	266	134	10	41	52	10	10	74	10	135	10	97	10	10	108	3
18-Feb-20	N/A	132	41	10	N/A	N/A	N/A	N/A	75	N/A	52	20	10	N/A	63	N/A	10	N/A	N/A	N/A	N/A	N/A	0
25-Feb-20	10	52	41	10	10	98	10	10	41	10	10	N/A	10	10	10	10	10	10	10	10	10	10	0
03-Mar-20	20	1785	160	10	109	428	41	10	285	10	10	10	10	10	10	10	10	10	10	20	20	10	4
10-Mar-20	10	86	10	10	30	10	10	10	20	10	20	74	20	10	20	10	10	10	10	10	20	10	0
17-Mar-20	10	379	41	20	10	10	10	10	74	10	10	10	10	10	10	10	10	10	10	10	10	905	2
24-Mar-20	N/A	132	10	10	N/A	N/A	N/A	N/A	10	N/A	52	10	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
31-Mar-20	N/A	41	63	110	N/A	N/A	N/A	N/A	41	N/A	31	41	20	N/A	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	0
																							18

Figure 9.4 2019-20 RWQ season Environmental Site results. Results are enterococci MPN per 100 mL. Last column lists the number of enterococci result exceedances above 140 MPN per 100 mL, which are highlighted.