



# Lauderdale Canal

## Water Quality Investigation

*Prepared for:*

**Clarence City Council**

frc [environmental](#), part of SLR

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## 1 Introduction

Lauderdale Canal (the canal) is located on the north-western side of Ralph's Bay, part of the Derwent Estuary. The canal was originally constructed between 1914 and 1924, with the swing bridge on South Arm Road, later replaced with a concrete culvert in the late 1950s.

The canal does not connect to Fredrick Henry Bay to the east as originally designed, its current use is largely recreational (Figure 1.1).



Figure 1.1 A view of Lauderdale Canal looking east from South Arm Road.

Significant sediment deposits have collected in the mouth of the canal. This has resulted in reduced tidal turnover and eutrophication events leading to poor water quality and odour complaints from the public. The canal is controlled and maintained by Clarence City Council.

### 1.1 Site Inspection

The site was inspected in July 2023 to map the bathymetry of the canal (works undertaken by Water Technology, see Appendix A) and to observe vegetation, fauna and public use of the canal.

Isolated patches of seagrass (likely *Nanozostera muelleri*) were observed in the Ralphs Bay outside of the mouth of the canal (Figure 1.2), but no seagrass was recorded in the canal.



Figure 1.2 Isolated patch of seagrass in Ralphs Bay.

Riparian vegetation of the canal is dominated by native saltmarsh species at the water's edge (Figure 1.3), transitioning to planted native gardens with exotic species higher on the banks.



Figure 1.3 Riparian vegetation dominated by native saltmarsh species.

Riparian species included *Distichlis distichophylla* (Australian salt-grass), *Austrostipa stipoides* (coastal spear grass), *Juncus kraussii* (sea rush), *Ficinia nodosa* (club rush), *Samolus repens* (creeping brookweed), *Sarcocornia quinqueflora* (samphire), *Plantago coronopus* (buck's horn plantain), *Tecticornia arbuscula* (shrubby glasswort), *Suaeda australis* (seablite), *Atriplex cinerea* (grey saltbush), *Tetragonia implexicoma* (ice-plant), *Carpobrotus rossii* (pigface), *Osteospermum fruticosum* (African daisy), *Gazania linearis* (gazania), *Acacia* spp., *Casuarina* spp. and *Eucalyptus* spp.

Vegetation higher on the slope from the riparian vegetation was dominated by areas of mown grass with scattered large Eucalypts, Casuarina and Acacia, and maintained gardens (Figure 1.4).



Figure 1.4 Recreational open space areas surrounding the canal.

Crustaceans and molluscs were observed on all submerged hard structures within the canal. A number of water birds were observed using the canal to forage and nest (Figure 1.5).



Figure 1.5 Water birds using the canal.

## 2 Water Quality

There have been a number of monitoring campaigns of water quality in the canal. This data was collated and compared to the Tasmanian Default Guideline Values (DGV) for Aquatic Ecosystems of Tasmanian Estuarine Waters for poorly flushed, slightly to moderately disturbed ecosystems – lower estuary (EPA 2021; Table 2.1 to Table 2.5), noting there are different DGV for base and flood flows, and to the guideline for Enterococci in the *Public Health Act 1997*.

Between 2006 and 2021, water quality data, and particularly the concentration of *Enterococci*, was collected periodically at the canal jetty (Table 2.1 to Table 2.4). Temperature, salinity, pH and turbidity were also measured in some monitoring events over this period.

Enterococci are bacteria that are used as an indicator of faecal contamination. Their presence may indicate that other pathogens (disease-causing agents) are present such as viruses, bacteria and protozoa. Enterococci are normally present in the human gastrointestinal tract, the female human genital tract and in the gastrointestinal tract of other warm-blooded animals. Common sources include sewage effluent, agricultural and stormwater runoff, sewage from ships, recreational population using the water, wildlife (including birds), domestic animals, and septic systems, with concentrations commonly increasing following rainfall (Ozcoasts 2018).

A potential source of nutrients in the canal are the septic systems associated with residential properties (Map 2.1). As septic tanks age and degrade, the likelihood of them leaking into the surrounding environment increases. Routine maintenance is also required so that tanks do not overflow. As the area is redeveloped it is likely that properties will be connected to the sewage system reducing this risk.

From 2006 to 2021, the concentration of Enterococci exceeded the DGV in approximately 30% of the monitoring events (11 occasions), and exceeded the Public Health Act Guidelines on 6 occasions, with most exceedances in 2020. That is, at these times there was a risk to public health. While there were some exceedances following rainfall, there were also exceedances when there had been no, or very little rainfall.

Faecal sterols and sterol ratios can be used to assess the source of these pathogens (Watson 1998); however, this can be problematic (Larson et al 2022), and interpretation needs to be done with care. The ratio of coprostanol to cholesterol is commonly used as an indicator of human sewage, with a ratio of >0.7 indicating human sewage may be present.

The composition of sterols in the water were assessed in June 2020 (Table 2.6), to assist in determining the source of the Enterococci and other potential pathogens. In summary,

the sterol data collected at this time indicated high inputs of sterols from algae, dinoflagellates and ducks, with low-level contribution from human waste, with the ratio of coprostanol to cholesterol significantly lower than 0.7:1.

In 2023 water quality data was collected at two sites in the canal, near the jetty, and near the bridge, at the entrance to the canal. Samples were collected at low and high tide in base flow conditions in August, and following heavy rainfall in October, and were analysed for the concentration of nutrients and Enterococci, with sterols analysed in some samples (Table 2.4, Table 2.5 and Table 2.6).

In the 2023 surveys, the concentration of ammonia, chlorophyll a, and dissolved oxygen commonly exceeded the DGV, indicating water quality was very poor. Based on this limited data set, the concentration of ammonia was generally higher after rainfall, and lowest at high tide near the channel entrance, that is, there appeared to be some limited flushing near the mouth of the canal. There were no distinct patterns with the other parameters.

Ammonia is the form of nitrogen most readily taken up by phytoplankton, with the growth of phytoplankton resulting in the observed high levels of chlorophyll a. High concentrations of phytoplankton commonly lead to high concentrations of dissolved oxygen during the day as the phytoplankton produces oxygen, and low concentrations at night, as the phytoplankton continues to respire, consuming oxygen. This poor water quality is a risk to the aquatic ecology of the canal.

In 2023, the concentration of Enterococci exceeded the DGV in most of the surveys, at both sites, and on 3 occasions exceeded the Public Health Act guideline. Concentrations were generally slightly higher at the jetty than at the entrance, and were higher on the low tide than on the high tide. That is, there may be some flushing of water near the mouth that reduces the concentration of Enterococci. As in previous surveys, high concentrations of Enterococci do not appear to be correlated with rainfall.

The ratio of coprostanol to cholesterol in each survey was significantly lower than 0.7:1 and it is consequently likely there is little human effluent in the water samples.

Table 2.1 Collation of water quality data collected in base flows 2006-2007.

	Units	DGV	7/11/06	14/11/06	21/11/06	28/11/06	5/12/06	12/12/06	19/12/06	2/1/07	16/1/07	30/1/07	6/2/07
Location			Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal
Rainfall in past 7 days	mm	-	0.4	15.6	24	0	4.2	2	5	21.6	0.2	1.6	1.8
Temp	°C	10.8-	13.4	13.2	16.8	16.1	17.4	16.9	15.5	18.1	20.6	15.5	17.9
Salinity (ppt)	ppt	35.1	31.1	31.6	31.7	33.9	34.4	34.8	35.2	35.5	34	32.7	34
pH	pH units	7.4-8.5	7.77	7.8	7.78	7.91	7.96	7.87	7.91	7.85	8.12	8.21	8.21
Turbidity	NTU	3.8	2	4	4	5	6	3	3	2	8	3	4
Enterococci	/100 mL	40/140*	164	<10	<10	<10	<10	<10	31	<10	10	53	10

Grey shading denotes concentrations that did not comply with the DGV, blue indicates higher than recreational Public Health Act guideline\* for Enterococci (140 /100 mL).

Table 2.2 Collation of water quality data collected in base flows 2007-2016.

	Units	DGV	13/2/07	20/2/07	27/2/07	6/3/07	13/3/07	20/3/07	27/3/07	17/12/13	19/1/16
Location			Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal
Rainfall in past 7 days	mm	-	0.2	22.6	9.8	11.2	4.4	0.6	4.4	12	5.4
Temp	°C	10.8-18.6	19.2	20	21	16.2	15.7	17	16.7	-	22.5
Salinity (ppt)	ppt	35.1	35.5	33.9	34.8	34.3	34.6	34.8	34.7	-	34.3
pH	pH units	7.4-8.5	8.25	8.21	8.22	8.32	8.34	8.35	8.36	-	8.53
Turbidity	NTU	3.8	4	1	-	-	-	-	-	-	7
Enterococci	/100 mL	40/140	20	<10	20	<10	10	<10	<10	>24196	10

Grey shading denotes concentrations that did not comply with the DGV, blue indicates higher than recreational Public Health Act guideline\* for Enterococci (140 /100 mL).

Table 2.3 Collation of water quality data collected in base flows 2020.

	Units	DGV	24/3/20	31/3/20	15/4/20	21/4/20	29/4/20	6/5/20	13/5/20	21/5/20
Location			Canal Jetty	Canal Jetty	Canal Jetty	Canal Jetty	Canal Jetty	Canal Jetty	Canal Jetty	Canal Jetty
Rainfall in past 7 days	mm	-	7.8	3	10.6	6	0.2	23.4	7.8	1
Enterococci	/100 mL	40/140	379	20	110	109	282	75	156	1017

Grey shading denotes concentrations that did not comply with the DGV, blue indicates higher than recreational Public Health Act guideline\* for Enterococci (140 /100 mL).

Table 2.4 Collation of water quality data collected in base flows 2021-23.

	Units	DGV	28/9/21	10/8/23	10/8/23	10/8/23	10/8/23	28/8/23	28/8/23
Location			Mid Canal	Canal Jetty low tide	Canal Bridge low tide	Canal Jetty high tide	Canal Bridge high tide	Canal Jetty high tide	Canal Bridge low tide
Rainfall in past 7 days	mm	-	6.6	1.2	1.2	1.2	1.2	4.2	4.2
pH	pH	7.4-	-	8	7.9	8	8	8	7.8
Turbidity	NTU	3.8	-	1.1	1.8	2.5	11	1.8	1.4
Enterococci	/100 mL	40/140	<10	259	85	20	41	41	20

Grey shading denotes concentrations that did not comply with the DGV, blue indicates higher than recreational Public Health Act guideline\* for Enterococci (140 /100 mL).

Table 2.5 Collation of water quality data collected in flood flows in 2007 to 2023.

	Units	DGV	9/1/07	23/1/07	8/4/20	29/6/20	23/10/23	23/10/23	24/10/23	24/10/23
Location			Mid Canal	Mid Canal	Mid Canal	Canal Water	Canal Jetty	Canal Bridge	Canal Jetty	Canal Bridge
Rainfall in past 7 days	mm	-	33.6	64.6	64	65.6	41.2	41.2	44.2	44.2
Temp	°C	10.8-18.6	17.1	18.6	-	-	-	-	-	-
Salinity (ppt)	ppt	35.1	33.4	32	-	-	-	-	-	-
pH	pH units	7.4-8.5	8.03	8.02	-	-	7.9	7.8	7.9	7.9
Turbidity	NTU	3.8	2	1	-	-	1	9	1.6	1.2
Enterococci	/100 mL	40/140	<10	10	75	<10	295	169	41	10

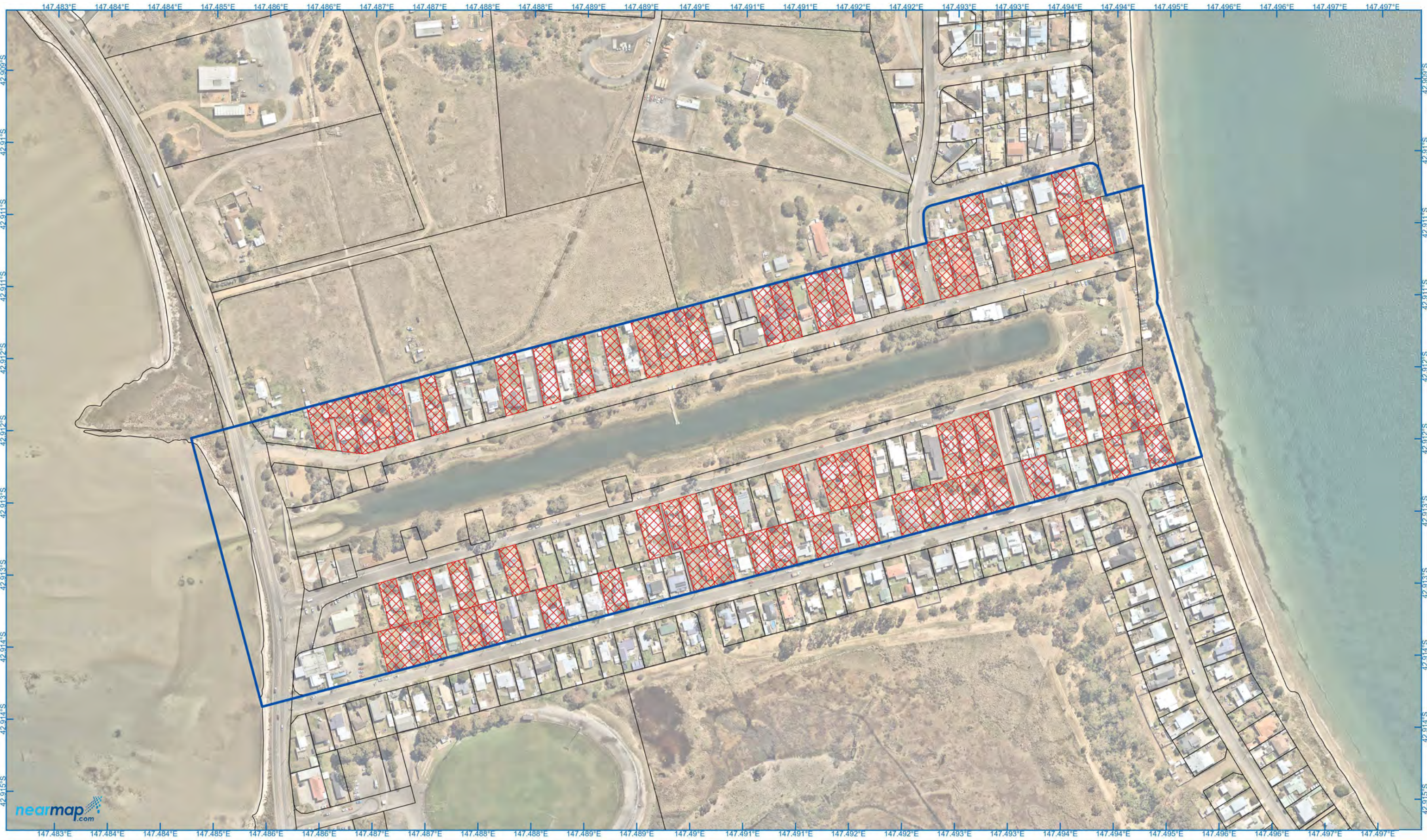
Grey shading denotes concentrations that did not comply with the DGV, blue indicates higher than recreational Public Health Act guideline\* for Enterococci (140 /100 mL).

Table 2.6 Collation of sterol and nutrient water quality data.

	Units	DGV	29/6/20	10/8/23	10/8/23	10/8/23	10/8/23	28/8/23	28/8/23	23/10/23	23/10/23	24/10/23	24/10/23
Location			Canal Water	Canal Jetty Low	Canal Bridge Low	Canal Jetty High tide	Canal Bridge High tide	Canal Jetty Low tide	Canal Bridge Low tide	Canal Jetty	Canal Bridge	Canal Jetty	Canal Bridge
Rainfall in past 7 days mm				1.2	1.2	1.2	1.2	4.2	4.2	41.2	41.2	44.2	44.2
<b>Physio-chemical</b>													
Conductivity	µS/cm	-	-	46400	46800	47600	47000	47100	46900	40600	42500	43100	41700
Dissolved Oxygen	mg/L	7.9-9.4	-	9.9	9.2	11	11	11	8.6	8.4	7.7	8.3	8
<b>Biological</b>													
Chlorophyll a	µg/L	1.9	-	3.4	2.2	2.3	3.5	8.5	-	5	3.7	4.6	5.4
Enterococci			<10	259	85	20	41	41	20	295	169	41	10
<b>Nutrients</b>													
Ammonia	mg/L	0.011	-	0.022	0.041	0.023	<0.005	0.011	0.041	0.038	0.022	0.051	0.037
Nitrate	mg/L	0.012	-	0.005	0.003	0.003	0.004	<0.002	0.003	0.027	0.004	0.007	0.012
Nitrate + Nitrite	mg/L	0.033	-	0.005	0.003	0.004	0.005	<0.002	0.004	0.028	0.005	0.008	0.014
Nitrogen, Total	mg/L	0.414	-	0.37	0.41	0.34	0.42	0.42	0.45	0.43	0.036	0.47	0.51
Nitrogen, Total Kjeldahl	mg/L	-	-	0.36	0.4	0.34	0.42	0.42	0.45	0.4	0.36	0.47	0.49
Phosphorus, Dissolved Reactive	mg/L	0.008	-	0.007	0.009	0.008	0.008	0.004	0.006	0.011	0.006	0.007	0.008
Phosphorus, Total	mg/L	0.041	-	0.029	0.029	0.028	0.053	0.032	0.039	0.049	0.04	0.053	0.054

	Units	DGV	29/6/20	10/8/23	10/8/23	10/8/23	10/8/23	28/8/23	28/8/23	23/10/23	23/10/23	24/10/23	24/10/23
<b>Sterols</b>													
24 ethyl coprostanol	µg/L		<0.1	<0.1	-	<0.1	-	<0.1	-	<0.1	-	-	-
Brassicasterol	µg/L		2	<0.1	-	<0.1	-	0.5	-	0.8	-	-	-
Campesterol	µg/L		0.2	<0.1	-	<0.1	-	<0.1	-	<0.1	-	-	-
Cholesterol	µg/L		2.4	17	-	10	-	1.5	-	1	-	-	-
Coprostanol	µg/L		0.1	<0.1	-	<0.1	-	0.1	-	0.1	-	-	-
Dinosterol	µg/L		4.5	<0.1	-	<0.1	-	0.3	-	<0.1	-	-	-
Epicoprostanol	µg/L		-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	-	-
Iso fucosterol	µg/L		<0.1	<0.1	-	<0.1	-	2	-	0.7	-	-	-
Phytol	µg/L		33	11	-	5.8	-	7.7	-	3.6	-	-	-
Sitosterol	µg/L		0.9	<0.1	-	<0.1	-	0.3	-	0.1	-	-	-
Ratio of coprostanol to cholesterol			0.04:1	<0.005:1	-	<0.01:1	-	0.06:1	-	0.1:1	-	-	-

Grey shading denotes concentrations that did not comply with the DGV, blue indicates higher than recreational Public Health Act guideline\* for Enterococci (140 /100 mL).






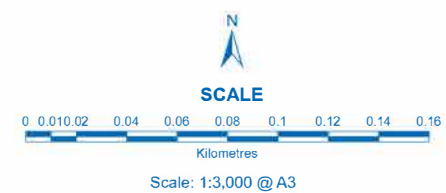
**221004 - Lauderdale Canal**

Map 2.1: Potential Properties Serviced by Septic Tank.

**SOURCES**  
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**LEGEND**

-  Property boundaries
-  Study area
-  Potential properties serviced by septic tank (Clarence City Council)



**PROJECTION**  
 Coordinate System: GDA 1994 MGA Zone 55  
 Projection: Transverse Mercator  
 Datum: GDA 1994

**DATE**  
 2024-04-03  
**DRAWN BY**  
 JA  
**VERSION**



### 3 Summary of Port Lauderdale Canal Flushing Study

In support of the assessments, a baseline hydrodynamic model of Lauderdale Canal and its surrounding area was developed by Water Technology using the MIKE21 flexible mesh model platform (Water Technology 2024; Appendix A). An animation of the model has also been provided electronically.

The base model simulation represents existing tidal flushing conditions within the Lauderdale Canal using surveyed bathymetry, and was used to understand the hydrodynamics within the canal. To assess the potential to improve tidal flushing in the canal, a second scenario (test case) was simulated. The test case simulated the impact of removing approximately 200 cubic metres from the entrance to the canal (Figure 3.1), with all material above -0.3 m AHD (corresponding to the existing levels in the Ralphs Bay Conservation Area) removed from this area (Appendix A).



Figure 3.1 Proposed area of sediment to be removed.

The study found that:

- Sediment buildup governs water flow during ebb-tide under the culvert/bridge.

- Tidal flow appears to be severely restricted, therefore limiting water flow in and out of the canal when the water level drops to the level of sediment buildup.
- The upstream reaches of the canal, which have a deeper bed profile than the mouth of the canal, are likely to have a very limited water turnover due to minimal tidal influence.
- The restricted tidal flushing, especially in the upstream reaches, is a likely contributor to the poor water quality in the canal.
- By dredging the canal entrance, tidal flushing in the canal is significantly improved, even for very low water levels.
- Water surface elevations along the edges of the canal bed immediately upstream of the culvert/bridge can be expected to reduce if the mouth of the canal is dredged.
- Dredging the canal will enhance tidal flushing in the canal and have a net beneficial impact on water quality.
- It is likely that sediment would need to be removed every 5 to 10 years.

### 3.1 E-folding Times

In the modelling flushing rates were quantified using ‘e-folding’ times. The e-folding time is a measure of how long it takes for the water within a confined waterway (such as a canal) to be exchanged. The appropriate e-folding times for water in marina developments depends on the nature of the runoff entering the marina, water quality in the marina and surrounding area, and potential impact on the receiving water and associated ecology. Short periods (e.g. less than ten days) are preferred, as this will prevent adverse impacts to water quality in the marina, such as excessive algal growth, or decreases in the concentration of dissolved oxygen (USEPA Coastal Marinas Assessment Handbook).

Current e-folding times in Lauderdale canal are considerably longer than this, and decreased significantly with dredging (Table 3.1).

Table 3.1 E-folding times for Lauderdale canal in days (Water Technology 2024).

Site	Base case (pre-dredge)	Dredged
Midway	34	8
Upstream	116	41

## 4 Summary, Discussion and Recommendations

The field assessment and modelling indicate that water quality in the canal is frequently poor, and turnover is low. In particular, the concentration of ammonia, chlorophyll a, and Enterococci are commonly high, and the concentration of dissolved oxygen commonly does not meet guideline values. At times the concentration of Enterococci exceeds the public health guidelines. That is water quality is commonly poor and poses a risk both to aquatic ecological values and to public health.

Ammonia is the form of nitrogen most readily taken up by phytoplankton, with the growth of phytoplankton resulting in the observed high levels of chlorophyll a. High concentrations of phytoplankton commonly lead to high concentrations of dissolved oxygen during the day as the phytoplankton produces oxygen, and low concentrations at night, as the phytoplankton continues to respire, consuming oxygen. This poor water quality is a risk to the aquatic ecology of the canal.

Analysis of sterols were used to assess the likely source of the Enterococci, and in both 2020 and 2023, human waste did not appear to be a major contributor. Domestic animals and wildlife are likely contributors, with high concentrations exacerbated by the poor turnover in the canal.

Options to improve the quality of water in the canal by improving water sources include:

- connection of more houses to the sewage system, starting from the upstream lots
- servicing and upgrading the existing septic systems, and
- direct upstream stormwater to pipe flowing east to Roches Beach, and downstream to just inside connection to Ralphs Bay – to reduce e-folding time and also assist in keeping the canal clear.

While water quality may be slightly improved by reducing the source of nutrients (from stormwater, septic systems or from animal excrement) the turnover of water in the canal is so low (e-folding time over 100 days in the upstream section), that solely addressing inputs is unlikely to resolve the issue.

Consequently, it is strongly recommended that the turnover time is improved by removing sediment from the entrance channel. Modelling indicates that removing approximately 200 cubic metres of sediment from the entrance, so that there is no build-up of sediment higher than the invert level of the culvert in the entrance area, would significantly improve water quality in the canal. Further, bank stabilisation and erosion control works at the mouth of the canal may assist in reducing the need for dredging (Appendix A).

Sediment could be removed either using a dredge or backhoe operated from the bank. Prior to removal and disposal, the sediment should be tested for contaminants and acid sulfate potential (ASS). Where it is anticipated the sediment will be disposed of underwater, contaminants should be assessed according to the National Assessment Guidelines for Dredging 2009 (NADG; Commonwealth of Australia 2019) and where it may be disposed of on land, according to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM; Australian Government 2013) soil guideline. Noting that the trigger values in these two protocols are largely the same, but there are slight differences in assessment methods. Acid sulfate potential should be assessed according to the latest version of the Australian guidelines (Sullivan et al. 2018a and 2018b).

Further modelling can be used to assess the most efficient configuration, including the impacts of filling the upstream end of the canal with the dredged sediment, the impact of increasing the depth all the way along the canal, what scenario is likely to minimise the frequency of dredging that is required, and whether opening the other end of the canal improves flushing. An indicative budget to test these scenarios via modelling is approximately \$35,000, on the assumption that no further bathymetric measurements are required.

## 5 References

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## **Appendix A Lauderdale Canal (Ralphs Bay Central) Flushing Study**