Waterways
Centre for Freshwater Management

Wainui Stream water quality analysis and survey of onsite wastewater management systems

Wainui, 2019-2020

WCFM Report 2020-002

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REPORT: WCFM Report 2020-002

TITLE: **Wainui Stream water quality analysis and survey of onsite wastewater management systems: Wainui, 2019-2020**

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Executive Summary

In 2018 the Banks Peninsula Zone Committee received anecdotal evidence from Council and District Health Board staff of risks posed by onsite wastewater management systems (OWMS) in the settlement of Wainui, Banks Peninsula. This study was commissioned by Christchurch City Council and Environment Canterbury to establish whether there was evidence of an impact from wastewater on water quality in Wainui Stream, and to understand the state of onsite wastewater management systems in Wainui. The study consisted of two components: A water quality study, and a residents survey.

The water quality study involved field observations and sampling at nine sites on the Wainui Stream main stem and tributaries (including two tide-affected sites near the stream mouth) over the period from 13/12/19 to 10/02/20. Readings were taken and samples were analysed for: Temperature, conductivity, turbidity, flow velocity, *Escherichia coli*, dissolved reactive phosphorus (DRP), fluorescent whitening agents (FWA), and faecal source tracking.

In the residents survey, 119 properties were visited over four days during the 2019-2020 Christmas-New Year holiday period, and 63 surveys were conducted (53% response rate). Data were collected on basic property characteristics (e.g. age, size and occupancy of dwellings), water use, type of onsite wastewater system installed, system management and maintenance, and residents' awareness of any wastewater issues on their own properties or in Wainui in general.

Water quality results show elevated levels of *E. coli* in the lower catchment of the Wainui Stream. These appear to be mainly from avian and bovine sources, but also indicated minor traces of human sources. Fluorescent whitening agents were also detected in Wainui Stream, but these were not consistently present and never exceeded 'slight' presence. The water quality results are therefore inconclusive regarding wastewater contamination. DRP results were high relative to water quality guidelines for ecosystem health, but not unusual for a rural catchment.

The residents survey confirmed high occupancy in Wainui over the summer holiday period – especially over Christmas and the New Year. At this time of year onsite wastewater systems come under particular strain, and some residents reported having observed problems with their systems at such times, and often following heavy rainfall. Many onsite systems appear to be relatively old, and possibly not up to current standards. Some residents expressed a desire to better understand their systems and what is good practice for onsite wastewater management. Many residents expressed concern about the state of uncertainty in relation to whether or not a reticulated wastewater solution would be implemented for Wainui.

During the course of the investigation, there was not strong evidence that wastewater from private onsite treatment systems was a dominant source of faecal contamination to Wainui Stream. However, given the slight presence of human markers and FWAs in the results, it is

possible that inputs of human contamination could enter the stream under certain circumstances. Factors such as rainfall and visitor numbers may influence the relative contribution of human-derived bacteria versus agriculture- and avian-derived bacteria instream. Longer-term studies may therefore help to establish with more certainty whether wastewater contamination is a significant issue for Wainui Stream.

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Section 1 Introduction

1.1 Background and rationale

In 2018 the Banks Peninsula Zone Committee received anecdotal evidence from Council and District Health Board staff of risks posed by onsite wastewater management systems (OWMS) in the settlement of Wainui (**Figure 1**). After obtaining further expert advice from a domestic wastewater engineer in relation to potential impacts from local wastewater systems on water quality in Wainui, the Zone Committee identified a need for research to determine whether such impacts were in fact scientifically evident. In particular, the Zone Committee wanted to know whether wastewater impacted water quality in the Wainui Stream catchment and, in turn, Akaroa Harbour adjacent to Wainui Settlement.

In response to the Zone Committee's concerns, Environment Canterbury (ECan) and Christchurch City Council (CCC) commissioned a study to examine the state of OWMS in the settlement of Wainui, and the quality of surface water in Wainui Stream and Akaroa Harbour. ECan and CCC approached the Waterways Centre for Freshwater Management, University of Canterbury, to coordinate this study, which was conducted over the 2019/20 summer holiday season. This is when the resident population in Wainui peaks with an influx of visitors, and when local wastewater systems are expected to be under maximum load.

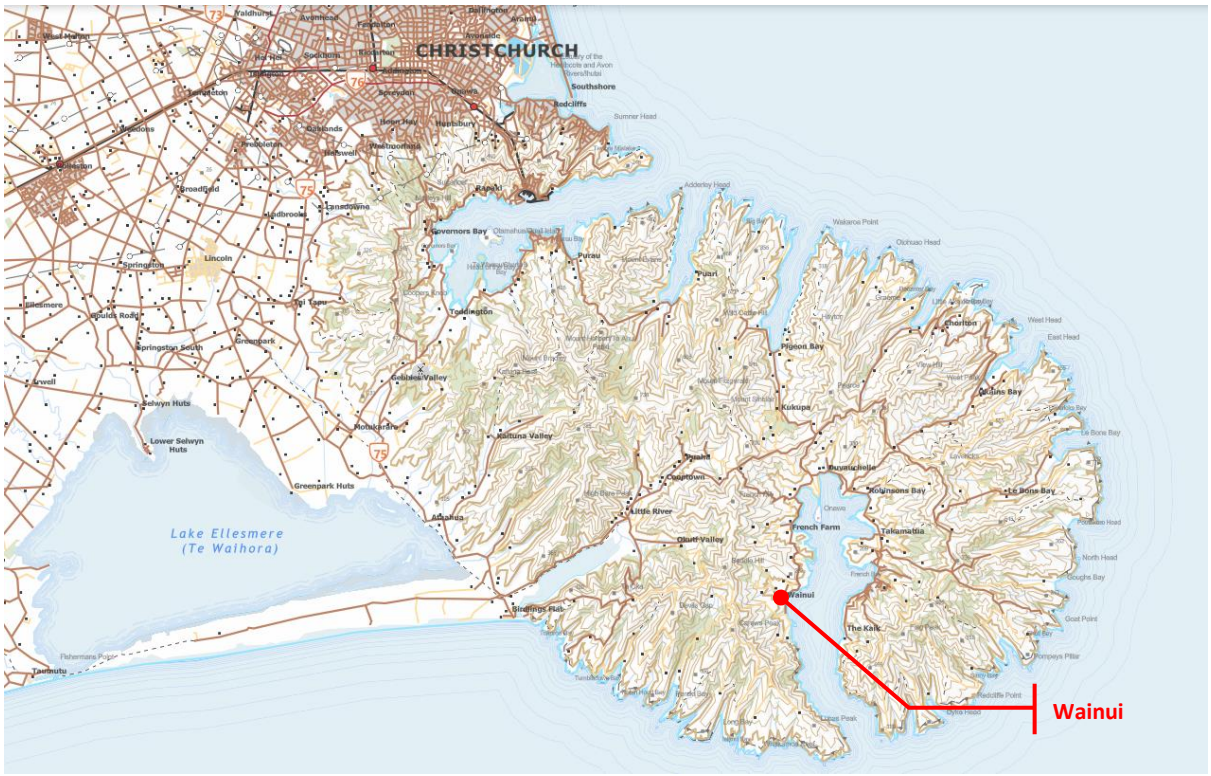

Figure 1: *Location of study site at Wainui, Banks Peninsula*

The driver of the study is the concern of the Wainui residents and Banks Peninsula Zone Committee for the health of the Wainui Stream and the Harbour, which are important to the local community for their ecological value, and as sites of recreation and food gathering. Addressing any actual or potential impacts from wastewater systems is of particular interest for mana whenua – especially Ōnuku Rūnanga – who rely on Akaroa Harbour and surrounding waterways for mahinga kai, and have responsibility as kaitiaki for te mana o te wai.

Years of discussion and debate on various options for wastewater management have produced a considerable degree of uncertainty for Wainui residents. In the absence of a commitment from CCC to provide a local reticulated wastewater scheme, many residents have not been able to make informed decisions about investment in maintaining or upgrading their own private systems. While it is true that opinion in the Wainui community is divided as to the advantages of a new public reticulated system, some clarity from CCC would be beneficial. Establishing whether there is any scientific evidence of an impact from OWMS on stream and harbour water quality may help in considering possible solutions, if needed, for Wainui.

1.2 Previous monitoring of Wainui Stream

There are two sites on Wainui Stream that are regularly monitored by ECan. One site is at the Powell Village Camp and is monitored annually for macroinvertebrates and stream habitat. This was not included in this study. The other site is upstream of the Wainui Main Road Bridge and Wainui Stream Weir. This site is monitored monthly for periphyton and water quality parameters including *Escherichia coli*, water clarity (black disc), turbidity, nitrogen (dissolved inorganic, nitrate-nitrite, ammoniacal and total), and phosphorus (total, and dissolved reactive phosphorus – DRP). The beach is also monitored at the northern end during the bathing season (November to March) for enteroccoci (a saltwater indicator of faecal contamination).

Data from 2007 up to the end of 2018 are available on the LAWA website (LAWA, 2018). Graphs for the three water quality parameters also measured in this study are below: *E. coli* in **Figure 2**; DRP in **Figure 3**; and turbidity in **Figure 4**.

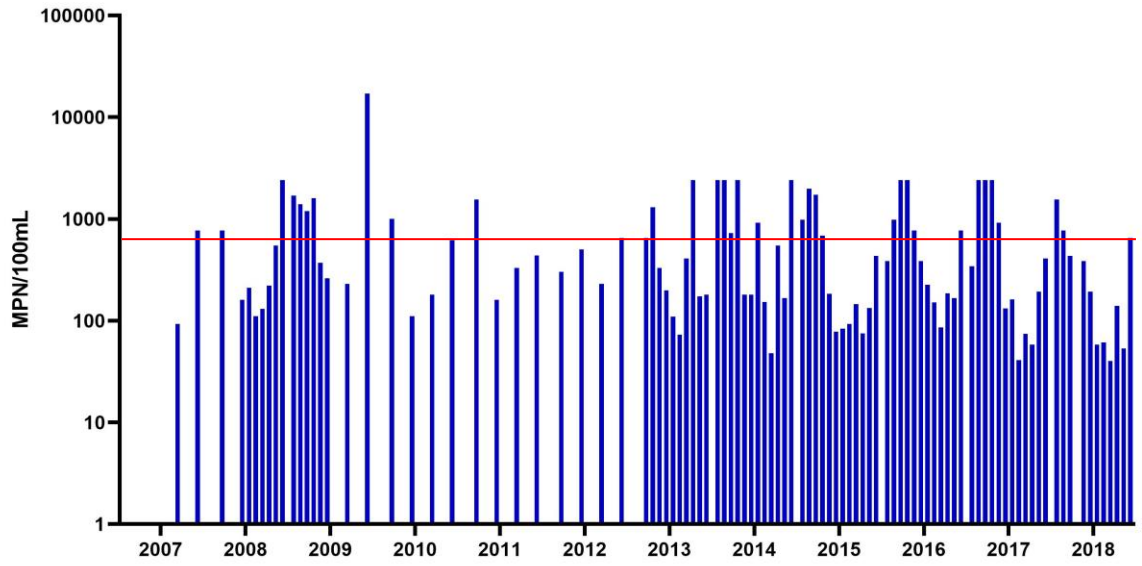

Figure 2: *E. coli* data from 2007-2018 for Wainui Stream upstream of road bridge (LAWA, 2018). Note the y-axis is a logarithmic scale. Red line indicates 550 MPN/100 mL, the 'Action' trigger level for issuing public health warnings for swimming water quality in summer under New Zealand recreational water quality guidelines.

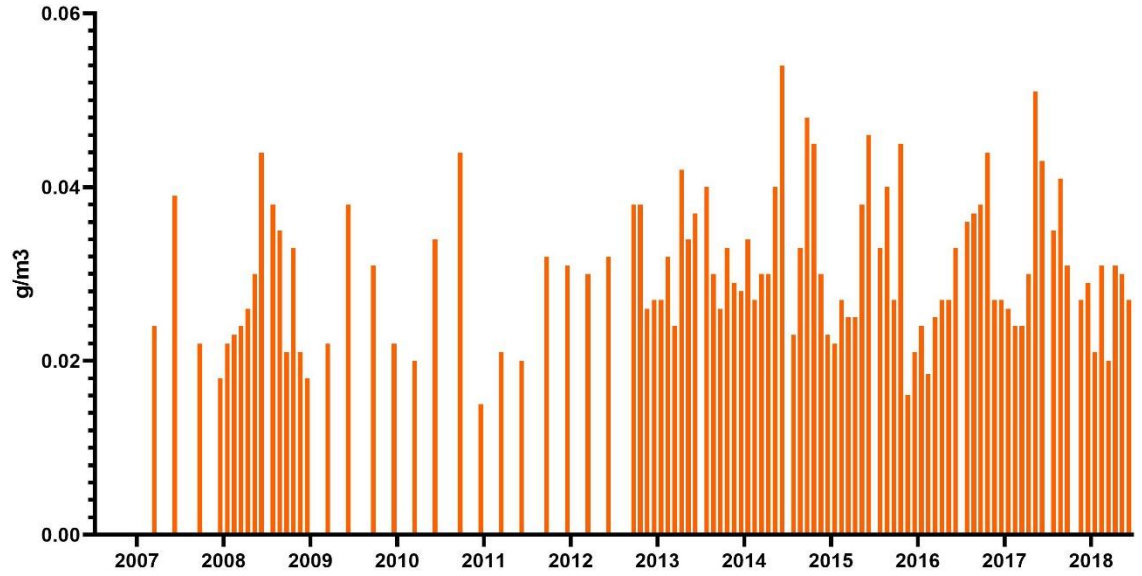

Figure 3: Dissolved reactive phosphorous (DRP) data from 2007 to 2018 for Wainui Stream upstream of road bridge (LAWA, 2018).

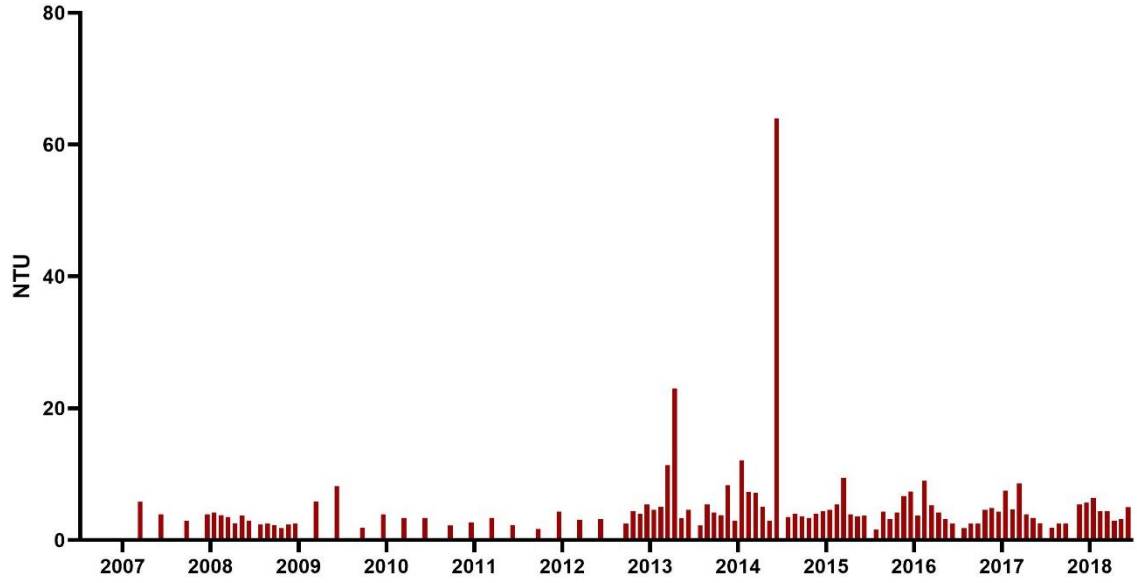

Figure 4: Turbidity data from 2007 to 2018 for Wainui Stream upstream of road bridge (LAWA, 2018).

1.3 Project scope and design

The project was conceived and scoped as a summer student research project, to be supervised by Dr Ed Challies (Waterways Centre for Freshwater Management, University of Canterbury) in conjunction with Jarred Arthur (ECan) and Mike Bourke (CCC).

A water quality study was carried out over nine weeks, starting in late December 2019 and finishing in late February 2020, and spanning the busy Christmas and New Year season and summer holiday period. Design of the sampling program and selection of sampling sites was done with advice and assistance from the ECan surface water quality and ecology team.

A door-to-door survey of residences in Wainui was conducted over four days around Christmas and New Year to elicit information about residential OWMS. The design of the survey and identification of the study area were done in consultation with CCC and ECan staff. The survey was approved by the University of Canterbury Human Ethics Committee on 20 December 2019, prior to the commencement of the research.

1.4 Structure of the report

This report is structured as follows: Section 2 presents the water quality study methods and results; Section 3 presents the residents survey methods and results; Section 4 provides a brief discussion of the results of both studies; and Section 5 makes some recommendations for potential further research.

Section 2 Water quality study

2.1 Sampling site locations

Figure 5 shows the location of all sites sampled in relation to each other, while **Figure 6**, **Figure 7**, **Figure 8**, **Figure 9**, and **Figure 10** show more detailed locations of the respective sites. Of note is that the course of the waterways as depicted by the blue lines (from NIWA's REC2) do not correspond exactly to the stream courses as observed in the field and as seen in the aerial imagery.

Throughout the sampling program the weather was warm-to-hot, often overcast, and windy around sites 1-3 but sheltered at all other sites. There were a few days of rain throughout the sampling program which has been addressed in the reporting of our results.

Detailed site descriptions can be found in 'Appendix I. ', which also includes general observations made at the respective sites. For the raw data containing all field observations see 'Appendix II. Raw site observations'.

NB. Hyperlinks to the water quality results are included here to facilitate easy reading of this report via electronic means. Links to the sample locations map in the results sections will bring the reader back to the map on the next page, the links below can then return the reader to the results they were reading.

E. coli and FST

DRP

Turbidity

Temperature

Conductivity

Fluorescent whitening agents

Figure 5: *Map showing all sites sampled in the Wainui catchment, marked by crosses in yellow with their site number. Rivers shown in blue, their line width graded by stream order, data from the nzRec2_v4 (NIWA). Piped stormwater courses shown in purple, data from Canterbury Maps (Environment Canterbury, 2017).*

Figure 6: *Map showing the detailed location of sites 1 and 1a (under the road bridge), marked in yellow. Rivers shown in blue, their line width graded by stream order, data from the nzRec2_v4 (NIWA). Stormwater courses shown in purple, data from Canterbury Maps (Environment Canterbury, 2017).*

Figure 7: *Map showing the detailed location of sites 2 and 3, marked in yellow. Rivers shown in blue, their line width graded by stream order, data from the nzRec2_v4 (NIWA).*

Figure 8: *Map showing the detailed location of site 4 marked in yellow. Stormwater courses shown in purple, data from Canterbury Maps (Environment Canterbury, 2017). The nzRec2_v4 does not show the river flow in the area, but the location of the stream is clear in the aerial imagery.*

Figure 9: *Map showing the detailed location of sites 5 and 6 marked in yellow. Stormwater courses shown in purple, data from Canterbury Maps (Environment Canterbury, 2017). The nzRec2_v4 (in blue) shows the river course incorrectly as flowing on the road side of the YMCA camp (centre picture), however it actually flows around the far side on the camp where site 5 is marked.*

Figure 10: *Map showing the detailed location of sites 7 and 8 marked in yellow. Stormwater courses shown in purple, data from Canterbury Maps (Environment Canterbury, 2017). Rivers shown in blue, their line width graded by stream order, data from the nzRec2_v4 (NIWA).*

2.2 Water quality methods

2.2.1 Sampling

A total of nine sampling runs were carried out, the first on Friday 13/12/19 and thereafter every Monday from 23/12/19 – 10/02/20 with samples taken between approximately 10am and 3pm (daylight savings time, exact times noted at sampling). Sites were sampled in order from downstream to upstream (3, 2, 4, 6, 5, 7, 8) with sites 1 and 1a (both tidally effected) sampled at either the beginning or the end of the run – whichever time was closer to low tide. **Figure 11** shows an approximation of the sampling time for sites 1 and 1a relative to the tide height on the day of sampling.

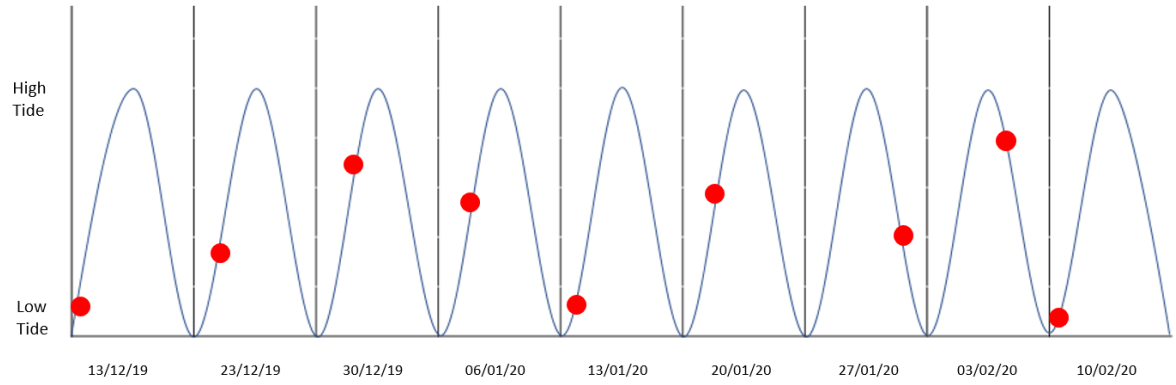

Figure 11: *Approximation of sampling time for sites 1 and 1a (red dots) relative to the tide height (blue line).*

All stream samples and measurements were taken from the middle of the stream. At site 1 sampling and measurement were carried out in the mixing zone of stream and seawater, to the true left side where it was accessible. As site 1a was a pipe outflow, *in situ* measurements were carried out in the pipe end with continuous water flow over the probe, and grab samples were collected directly from the discharge. On one occasion (03/02/20) the pipe was partially submerged, so samples were taken from within the very end of the pipe.

2.2.2 Observations

Observations were made at each site of the weather, wildlife/livestock in the area, people/use of the area, algae or aquatic plants noted in the stream, and the composition of the stream bed, with any other noteworthy observations also recorded.

2.2.3 Conductivity and temperature

At every site *in situ* temperature compensated conductivity measurements were made using the YSI ECO300 conductivity meter. Temperature was also recorded from this meter.

2.2.4 Turbidity

At every site a water sample was taken and analysed onsite for turbidity using the Orion AQ4500 Turbidimeter. Three readings were recorded and their average was used for reporting.

2.2.5 Flow velocity

At every site flow velocity was recorded using the Global Water Flow Probe. Readings were taken in the middle of the stream when possible.

2.2.6 E. coli

Sterile containers were used to collect a 400mL unpreserved water sample at every site, then chilled until delivery to the laboratory. Samples were analysed by Hill Laboratories using the Most Probable Number (MPN) method, and results presented here are rounded to the nearest 1.

2.2.7 Dissolved reactive phosphorus (DRP)

At every site a new container was rinsed three times with stream or harbour water before collecting a 500mL unpreserved water sample, then chilled until delivery to the laboratory. Samples were analysed by Hill Laboratories using the molybdenum blue colorimetry method.

2.2.8 Fluorescent whitening agents (FWA)

At sites 1, 2, 4, 5 and 8 a new container was used to collect a 250mL unpreserved water sample, then chilled until delivery to the laboratory. Samples were delivered to, and results reported by, Hill Laboratories, but the analysis was conducted by Eurofins ELS using a semi-quantitative fluorescence method. Fluorescence of the sample in the blue wavelength is compared to that fluorescence in a series of domestic wastewater dilutions. The result is reported as ‘slight’, ‘moderate’, or ‘a lot’ if the sample fluorescence is comparable to the 25%, 50% or >50% wastewater dilution respectively.

2.2.9 Faecal source tracking

On two occasions (10/2/2020 carried out by the University of Canterbury samplers, and 20/2/2020 carried out by an Environment Canterbury sampler) a 1 L water sample was taken in a sterile bottle from sites 1a and 4, then chilled until delivery to the laboratory at ESR. Faecal source analysis was carried out by PCR Marker analysis. The target animal signatures tested were general, ruminant, human and avian.

2.3 Water quality results

The average water quality results by site can be seen in **Table 1**. A more detailed analysis follows in the sections below. Raw results for all parameters can be found in 'Appendix III: Raw results for all water quality parameters measured'. A hyperlink to the map showing all site locations (**Figure 5**) is included at the bottom of each page in this results section for convenience.

Table 1: *Summary of water quality results, showing the averages for measurements taken. NB. Stream flow is not included in the results as the velocity readings taken were not sufficient to determine the flow rate of the Wainui Stream and tributaries.*

Site	***Number of Readings*** *(n)*	***E. coli*** *(MPN/100mL)*	**DRP** *(g/m^3)*	**Temperature** *(°C)*	**Turbidity** *(NTU)*	**Conductivity** *(µS/cm)*
1	8	659	0.033	15.6	2.88	17,427
1A	7	1657	0.010	17.6	8.20	13 158
2	9	946	0.044	14.7	1.93	245.6
3	9	2140	0.029	16.3	6.80	151.7
4	9	438	0.048	14.7	2.12	151.1
5	9	250	0.045	13.9	1.94	149.6
6	9	369	0.064	13.7	3.55	150.9
7	9	60	0.035	13.5	1.34	144.0
8	9	374	0.049	13.2	5.31	146.5

2.3.1 *E. coli* and FST

E. coli concentrations were measured to determine whether there was any faecal contamination of the Wainui Stream and some of its the tributaries. At two sites (Sites 1A and 4), a Faecal Source Tracking (FST) analysis was performed to determine the animal sources of the faecal matter. **Table 2** and **Table 3** present the minimum, maximum, and average *E. coli* results by site and date respectively. **Figure 12** and **Figure 13** show the individual results in graphical form by site and date respectively.

Map of all sample locations

The highest average *E. coli* concentration over the sampling period was found at Site 3 (2140 MPN/100mL, **Table 2**), while the lowest overall average was found at Site 7 (60 MPN/100mL, **Table 2**). The highest average *E. coli* concentration across all sites was on the sampling date 13/01/20 (1010, **Table 3**), while the lowest average was on 30/12/19 (552 MPN/100mL, **Table 3**).[1]

Site 3 consistently had high levels of *E. coli* (see **Figure 12** and **Figure 13**). On 03/02/20, the *E. coli* levels were low at site 1A, and this was likely due to increased dilution at the time of sampling – the tide had been high during which site 1A is partially submerged under seawater (for example see **Figure**). This result should be interpreted with caution and as a minimum estimate for *E. coli* exiting the pipe. In addition to increased dilution, the salinity of incoming seawater may have also killed *E. coli* in the sample. The spike in *E. coli* at site 2 on 03/02/20 could correspond with the unidentified faeces observed on the stream bank there that day. *E. coli* at site 4 did not show a marked peak at any time in the sampling period, despite faeces from cattle/livestock being observed on the stream bank on numerous occasions.

FST results suggest that the primary source of *E. coli* at Site 1A is avian. This is consistent with field observations of ducks and other birds upstream of this site in the old channel 'loop'. The source of *E. coli* at Site 4 was a mixture of ruminant and avian. This finding is also consistent with field observations of livestock and birds in the area, and that livestock appear to have free access to the stream at that site. Some minor proportions of human input were also identified at both sites. The results from the FST analysis are provided in 'Appendix IV: FST results from ESR'.

Figure 13 plots rainfall data and *E. coli* levels over the sampling period. During rainfall, contaminants such as faecal matter can be washed into waterways via surface runoff. Heavy rainfall could also mobilise sediment in the river, increasing turbidity and potentially increasing the levels of *E. coli* from the stirred-up sediment. **Figure 13** shows that the rainfall events during the sampling period do not have an obvious role in increasing concentrations of *E. coli* at the sites sampled, but rainfall may nevertheless have had some effect at certain sites.

Map of all sample locations

[1] Based on Ministry of Health guidelines (MoH, 2003), a value of >550 *E. coli*/100mL triggers a requirement for further monitoring of a site. A site is considered 'Poor' and unsafe for swimming when the *E. coli* concentration exceeds the acceptable threshold (>540mL/100mL) >30% of the time (MFE, 2017). The 'time' is defined by the sampling period adopted by the monitoring agency. This information is supposed to communicate the likelihood of an infection resulting from swimming on a given day. When the trigger value is reached, the responsible authorities should issue a public warning.

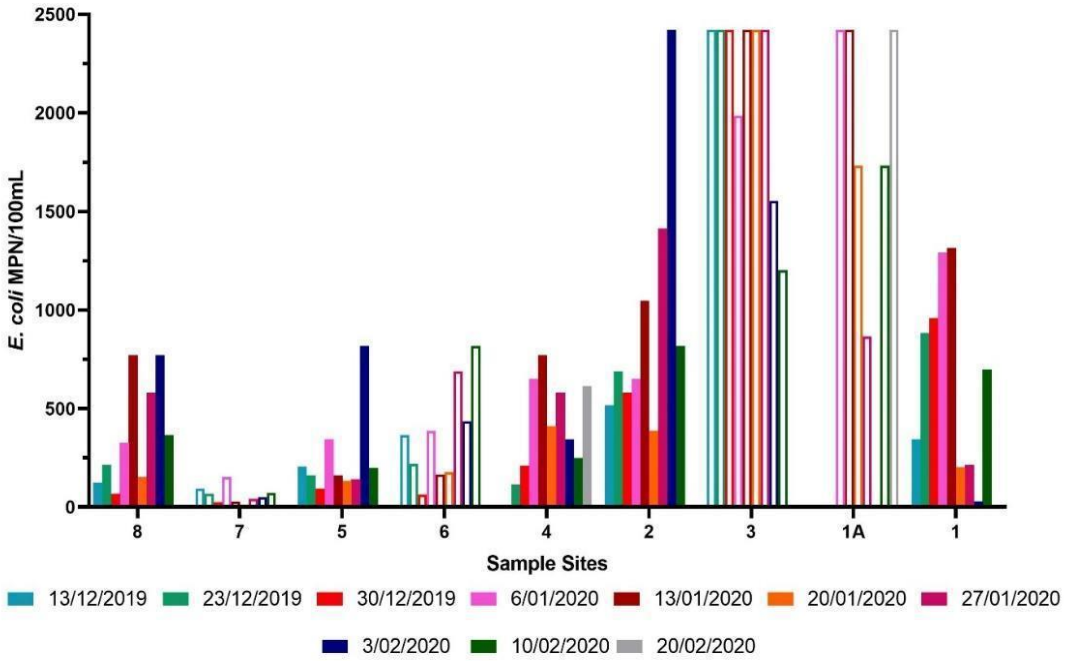

Figure 12: *E. coli numbers (MPN/100mL) from sample sites over the sampling period. Note some results exceeded the maximum of the analytical procedure, and so are recorded as >2420. Sites are in order of influence on the main stem of the Wainui Stream from upstream to downstream. Data from sites on the Wainui Stream main stem are displayed as filled columns, while data from sites on tributaries are shown as unfilled columns.*

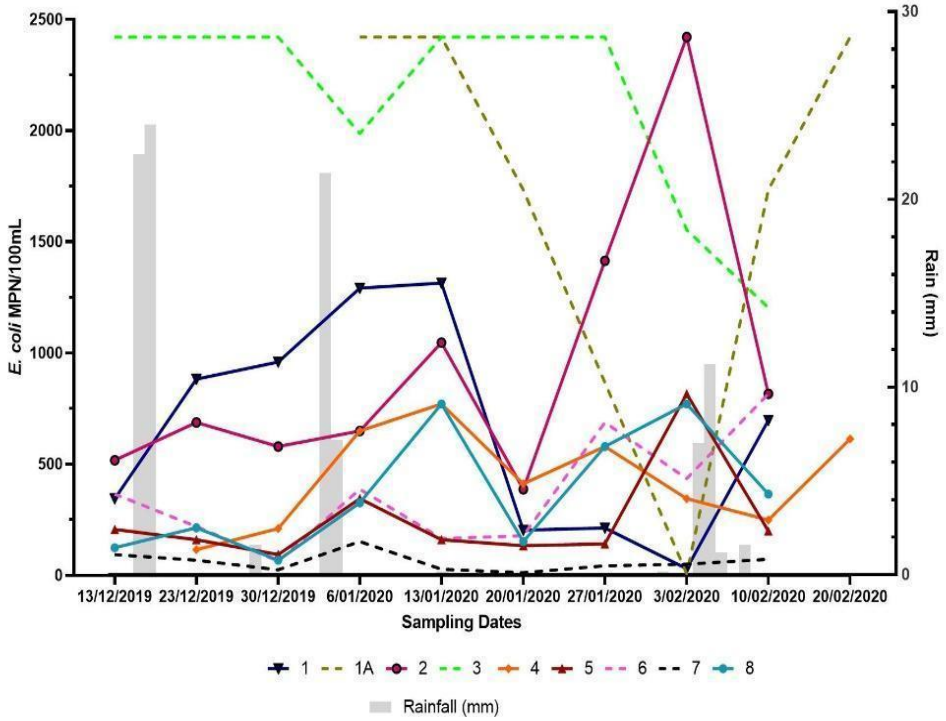

Figure 13: *E. coli concentrations (MPN/100mL) (left Y-axis) and rainfall data (mm) (right Y-axis) over the sampling period. Note some E. coli results exceeded the maximum of the analytical procedure, and so are recorded as >2420. Data from sites on the Wainui Stream main stem are in solid lines while data from tributaries are indicated with dashed lines.*

Map of all sample locations

Table 2: *E. coli: Average, median, range and number of sampling events for all the sampling sites (MPN/100mL). Note some results exceeded the maximum of the analytical procedure, and so are recorded as >2420.*

Site	Average	Median	Lowest	Highest	Number of Sampling events
1	659	697	30	1314	8
1a	1657	1733	6	>2420	7
2	946	687	387	>2420	9
3	2140	2420	1203	>2420	9
4	438	411	115	770	9
5	250	160	93	816	9
6	369	365	64	816	9
7	60	50	12	152	9
8	374	326	68	770	9

Table 3: *E. coli: Average, median, range and number of sites sampled across each sampling date (MPN/100mL). Note some results exceeded the maximum of the analytical procedure, and so are recorded as >2420.*

Date	Average	Median	Lowest	Highest	Number of Samples
13/12/19	581	345	93	>2420	7
23/12/19	596	217	68	>2420	8
30/12/19	552	152	25	>2420	8
06/01/20	912	649	152	>2420	9
13/01/20	1010	770	27	>2420	9
20/01/20	625	203	12	>2420	9
27/01/20	771	579	43	>2420	9
03/02/20	714	435	6	>2420	9
10/02/20	683	697	72	1733	9
20/02/20	1517	1517	613	>2420	2

Map of all sample locations

2.3.2 DRP

Dissolved reactive phosphorous (DRP) samples were collected at all sampling sites. Excess DRP can promote plant and algae growth and contribute to eutrophication, which can degrade water quality. Soil erosion is a potential contributor to elevated DRP. Currently, the only guidelines for riverine phosphorus concentrations that may be applicable to this study are from the ANZECC guidelines for aquatic ecosystem protection (ANZECC, 2000), where the default trigger value for a slightly disturbed lowland river is 0.033 mg total P per L. As DRP is a subset of total P, if DRP exceeds the trigger value then total P would also exceed the trigger value. The DRP result for 76% of samples in this sampling program exceeded the trigger value, meaning that according to the ANZECC guidelines further investigation would be required into whether the desired state for the waterway could be achieved if these results persisted.

Figure 14 and **Figure 15** show the DRP concentrations over time by site and date respectively. They show that site 6 had the highest DRP levels overall while site 1A had the lowest. Visually, the figures show a slight increasing trend for most sites until 10/02/20. Site 1 exhibits the greatest variation in DRP readings. This is likely because the samples were taken at varying times before and after high tide (see **Figure 11**) which mean that the DRP levels will have been more diluted on some sampling dates in comparison to others.

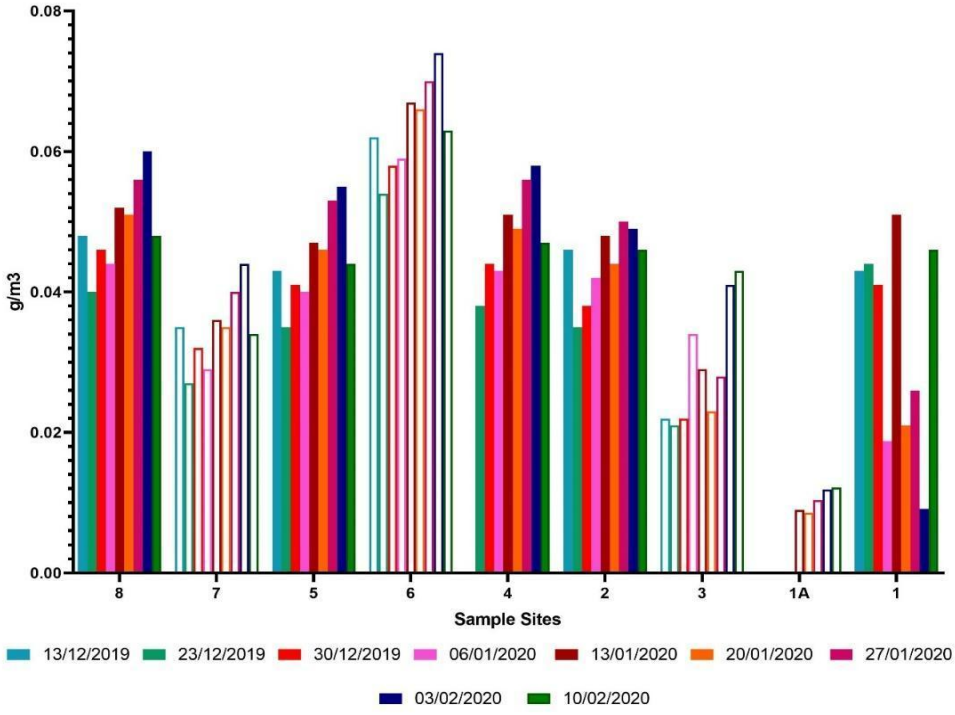

Figure 14: *Dissolved reactive phosphorous (g/m^3) by sampling site over the sampling period. Sites are in order (left to right) of influence on the main stem of the Wainui Stream from upstream to downstream. Data from sites on the Wainui Stream main stem are displayed as filled columns, while data from sites on tributaries are shown as unfilled columns.*

Map of all sample locations

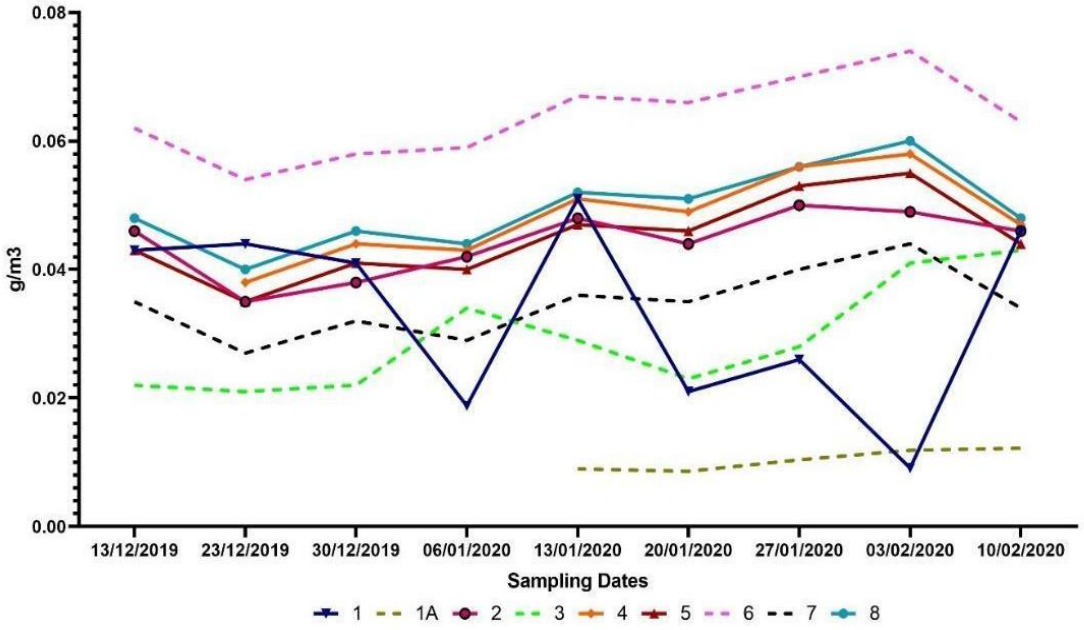

Figure 15: *Dissolved reactive phosphorous (g/m³) over time for each sampling location. Data from sites on the Wainui Stream main stem are in solid lines while data from tributaries are indicated with dashed lines.*

2.3.3 Turbidity

Turbidity is correlated with the water clarity of the stream and tributaries. High turbidity readings can indicate high sediment loads in the water, and often correspond with higher numbers of *E. coli.*

Figure 16 and **Figure 17** show the turbidity readings over time by site and date respectively. The highest turbidity reading was recorded from site 8 on the 20/01/20 (24.6 NTU). This reading was an outlier, though there is a trend of high turbidity readings on that date (**Figure 17**). The high readings may also have been due to an error in sampling. The lowest turbidity reading was recorded site 7 on 10/02/20 (0.67 NTU).

Figure 17 shows the level of rainfall (mm) over the sampling period alongside the turbidity readings. Based on this information, no clear relationship between rainfall and turbidity is evident at the sampling sites. Similarly, no relationship was found between turbidity and *E. coli* levels (R^2=0.06) or between turbidity and fluorescent whitening agents (R^2=0.004). Generally, the observed turbidity values for sites on the Wainui Stream main stem are quite low, while sites on tributaries tended to have slightly higher values (except for site 7). It is possible that land use effects, such as stock access upstream of Site 3, may be increasing turbidity in the tributaries.

Map of all sample locations

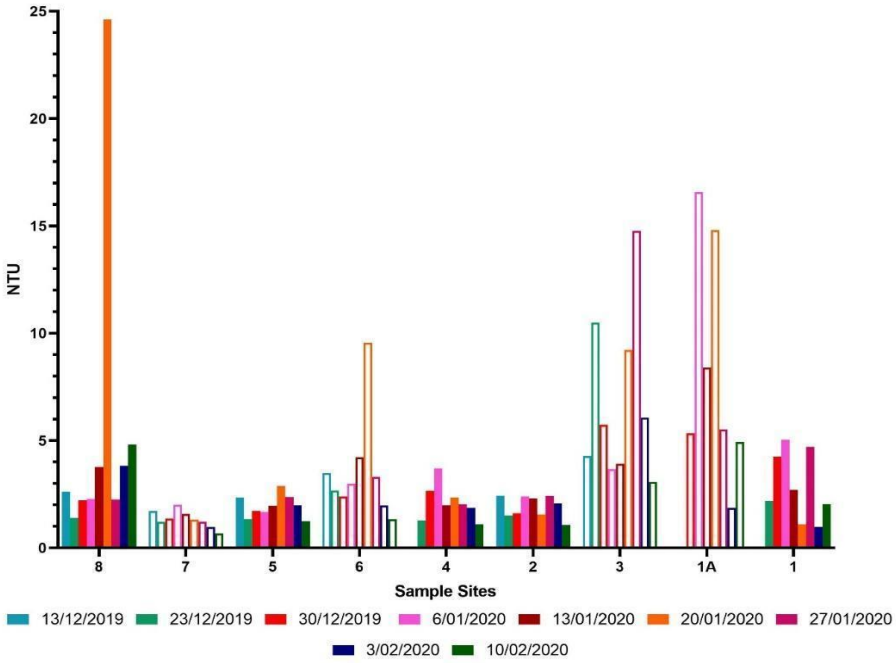

Figure 16: *Turbidity (NTU) by sampling site over the sampling period. Sites are in order (left to right) of influence on the main stem of the Wainui Stream from upstream to downstream. Data from sites on the Wainui Stream main stem are displayed as filled columns, while data from sites on tributaries are shown as unfilled columns.*

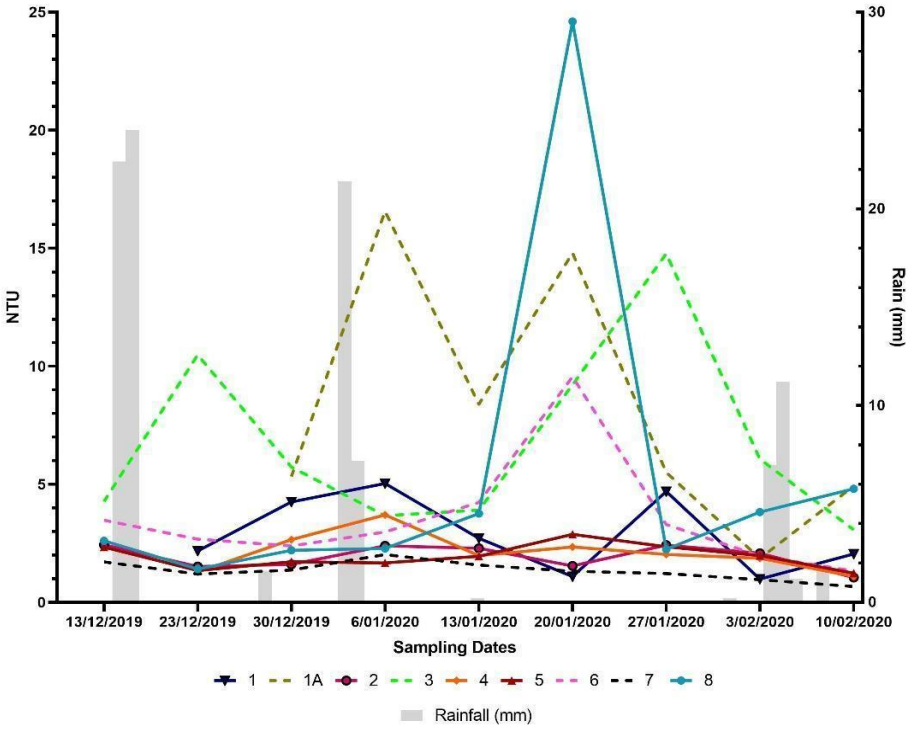

Figure 17: *Turbidity data (left Y-axis) and rainfall data (right Y-axis) over the sampling period. Data from sites on the Wainui Stream main stem are in solid lines, while data from tributaries are indicated with dashed lines.*

Map of all sample locations

2.3.4 Temperature

Water temperature remained quite consistent over the sampling period for each site. The highest temperature recorded was 19.7°C (site 1A) on 27/01/20, while the lowest temperature recorded was 11.8°C (site 8) on 23/12/19. Sites 6, 7 and 8 had the largest temperature range over the sampling period (5.5°C), while site 1A had the lowest range (3.9°C).

Since *E. coli* grows optimally at 37°C, we investigated whether the increase in temperature would lead to higher *E. coli* concentrations. However, there was no significant correlation between temperature and *E. coli* levels at each site (Figure 18, R^2=0.197).

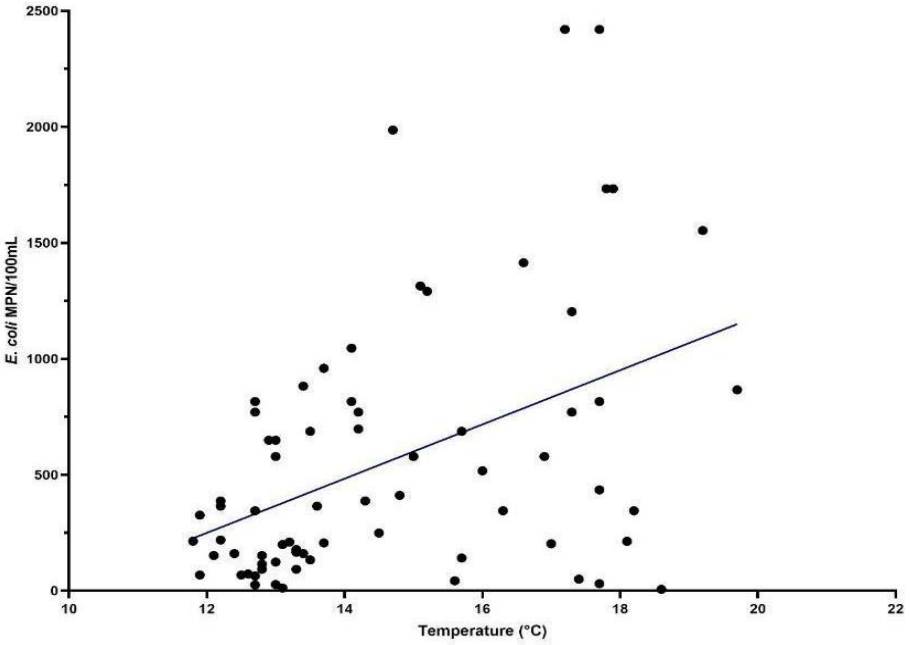

Figure 18: *Relationship between temperature and* E. coli.

2.3.5 Conductivity

Figure 19 shows the conductivity readings for sites 1 and 1A over the sampling period. The conductivity readings for sites 1 and 1A should be interpreted with caution. There were some inconsistencies with the measurements (as mentioned in section 2.1) due to challenges presented by these tidal sampling sites, so the information is mostly an indicator of how much seawater was present in the sample.

Figure 20 shows the conductivity readings for sites 2-8 over the sampling period. As the graph shows, the conductivity readings remain largely stable over time for all sites except site 3. As seen in the site descriptions, site 3 is adjacent to a low culvert and cattle crossing, so this higher conductivity could indicate a higher amount of sediment and runoff at this site.

Map of all sample locations

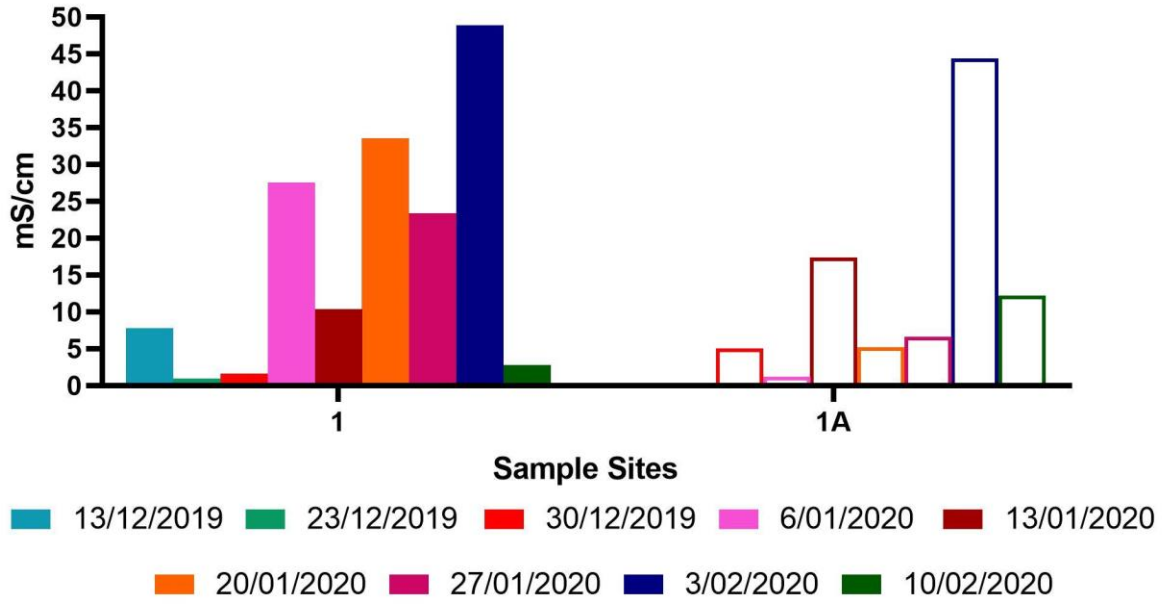

***Figure 19**: Conductivity (mS/cm) for Sites 1 and 1A. Data from Site 1 on the Wainui Stream main stem are displayed in filled columns, while data from Site 1A on a drain leading into the Wainui Stream are shown as unfilled columns.*

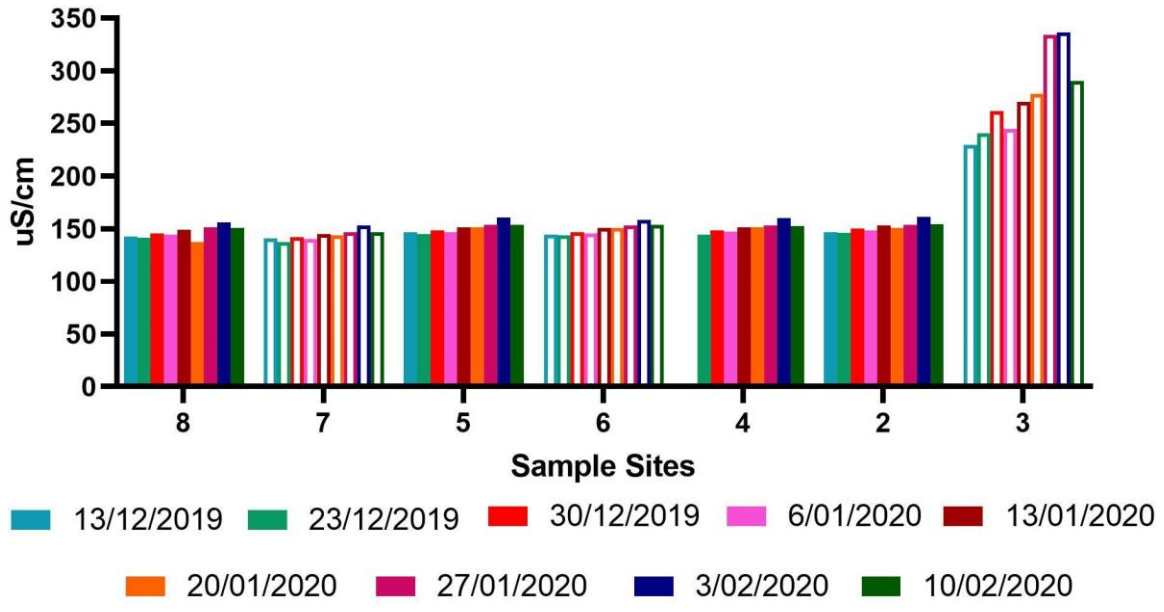

***Figure 20:** Conductivity (µS/cm) for Sites 2-8. Sites are in order (left to right) of influence on the main stem of the Wainui Stream from upstream to downstream. Data from sites on the Wainui Stream main stem are displayed as filled columns, while data from sites on tributaries are shown as unfilled columns.*

Map of all sample locations

2.3.6 Fluorescent Whitening Agents

The Fluorescent Whitening Agent (FWA) sampling and analysis were only completed for Sites 1, 2, 4, 5 and 8. This analysis is designed to indicate the potential presence of domestic wastewater via analysis for whitening agents that are found in most laundry products.

Table 4 shows the results from the FWA analysis. FWAs were not detected for the first three sampling runs (prior to 06/01/20). 'Slight' detections were observed from 06/01/20, but not consistently at all sites. The 06/01/20 sampling date was the only date where FWAs were detected for all the locations sampled.

As a semi-quantitative test, the results are not an absolute marker of domestic wastewater in the stream, and they should be interpreted only in conjunction with other results such as those from FST- see the Discussion for further analysis.

Table 4: *Results from the Fluorescent Whitening Agent (FWA) analysis. 'Slight' detections are highlighted in orange and sites that were not tested are indicated with '-'.*

Site	13/12/19	23/12/19	30/12/19	06/01/20	13/01/20	20/01/20	27/01/20	03/02/20	10/02/20
1	None	None	None	Slight	None	None	None	None	Slight
1A	-	-	-	-	None	None	Slight	Slight	Slight
2	None	None	None	Slight	None	None	Slight	Slight	Slight
3	-	-	-	-	-	-	-	-	-
4	-	None	None	Slight	None	None	Slight	Slight	None
5	None	None	None	Slight	None	None	Slight	None	None
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	None	None	None	Slight	None	Slight	Slight	None	None

Map of all sample locations

Section 3 Residents survey

3.1 Survey methods

A list of properties to be surveyed was compiled with assistance from CCC. We included all properties in the Wainui Bay area that are not on the reticulated sewer network (see Figure 21), with a dwelling where the discharges from the property could potentially have some impact on water quality within the catchment. A total of 124 residential properties were identified within the area marked in Figure 21.

A survey questionnaire was adapted from one used in a previous ECan study of onsite wastewater systems (see Appendix V: Wastewater survey for residents). The questionnaire comprised 38 questions designed to ascertain basic characteristics of the properties in the study area, including the age, size and occupancy of dwellings, water use, type of OWMS installed, wastewater system management and maintenance, and residents' awareness of any issues with their own wastewater systems or with wastewater management in Wainui in general.

Given that Wainui is occupied by a high number of visitors over the summer holiday period, a truncated version of the survey was prepared for respondents who were not the property owners or otherwise not familiar with the history and management of the onsite wastewater system. This truncated version omitted 13 of the 38 questions, and therefore required less time to administer.

The door-to-door survey was conducted over four days over the 2019-2020 holiday period: December 27, 28 and 30, and January 6. Public holidays and Sundays were avoided, and surveying was conducted between the hours of 9:00 am and 5:00 pm. Residents were approached at their properties by two student researchers working as a pair. Those who expressed an interest in participating in the study were provided with a project information sheet (see Appendix VI: Project information sheet for survey respondents) outlining the purpose of the survey, and this information sheet was further explained to them by the researchers as required. Residents who were willing to take part then provided their written consent to participate (see Appendix VII: Consent form for residents survey). The researchers worked through the survey form with participants, posing the survey questions and noting down responses. Responses were later compiled in a Microsoft Excel spreadsheet for analysis.

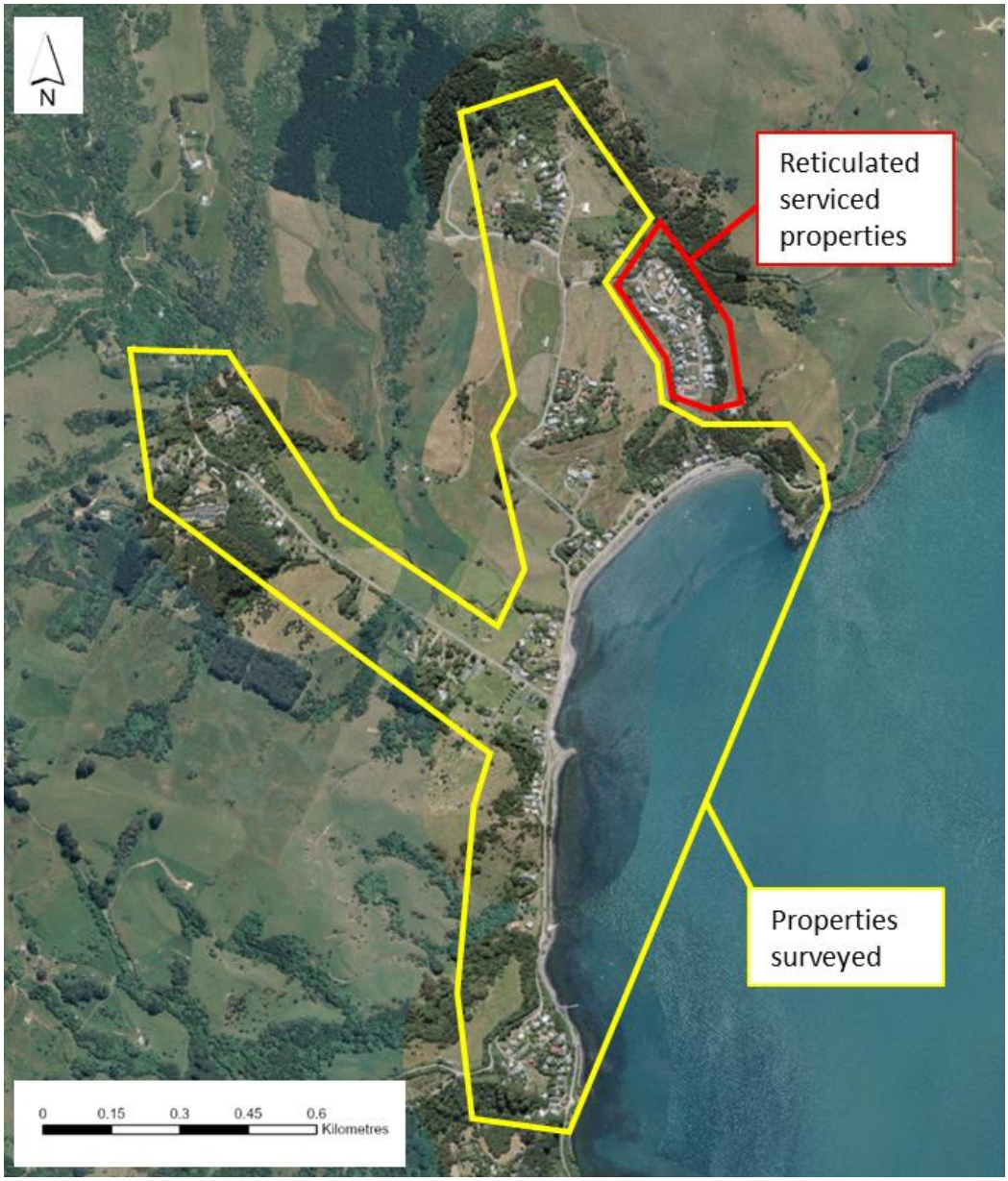

Figure 21: *Wainui properties included (in the area marked in yellow), and excluded (in the area marked in red) from the residents survey.*

3.2 Survey results

Of the 124 properties identified, seven could not be located in the field. Two properties that were not on the original list were located within the study area (on Wainui Valley Road), and these were included in the study. Therefore, a total of 119 properties were visited over the four days. From these 119 properties 63 surveys were conducted (53% response rate). Of the properties not represented in the survey, eight declined to participate and 48 were not occupied when visited (see Table 5).

Table 5: *Residents survey scope and response rates*

	n	%
Properties visited	119	100
Properties surveyed	63	53
Properties unoccupied	48	40
Properties declined	8	7

3.2.1 Property characteristics and occupancy

Figure 22 shows property ownership and use in Wainui during the survey period. The data confirm a high number of visitors in the area over the period, with 84% of respondents identifying the property they were staying at as either their own family holiday home/bach (79%) or a rented holiday home (5%). Permanent residents accounted for 14% of responses. Some respondents reported that they also let their holiday home out to other parties at other times of the year. This is not reflected in the graph.

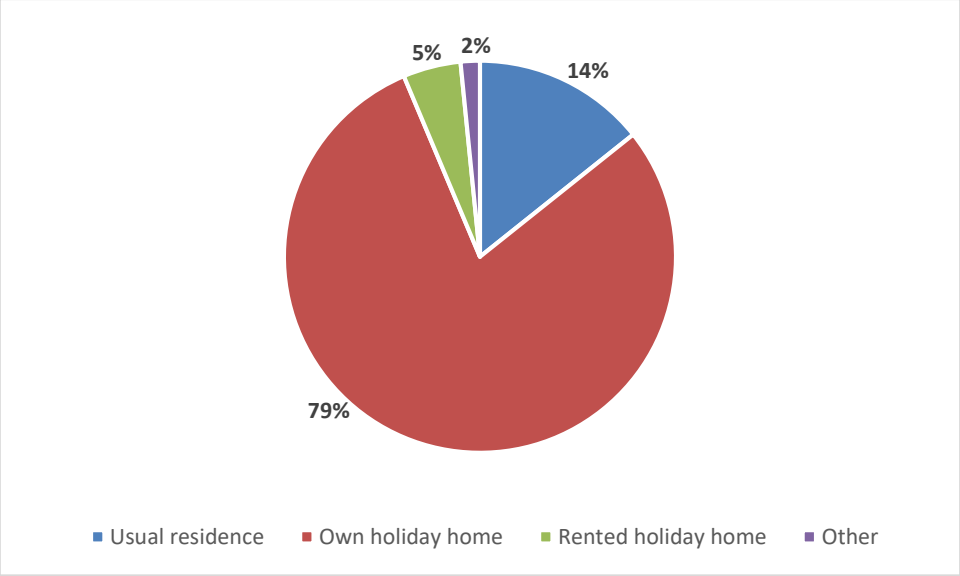

Figure 22: *Property ownership and use in Wainui (n=63)*

Figure 23, Figure 24 and Figure 25 show actual occupancy at the time of the survey, usual occupancy, and maximum occupancy over the holiday period respectively, as reported by respondents for the 63 properties surveyed. Figure 23 shows that over half (~54%) of the properties surveyed were occupied by 2-4 occupants over the survey period. Nine properties were occupied by ≥10 occupants. Figure 24 shows that under usual occupancy, an even greater proportion of properties (~70%) are occupied by just 2-4 occupants. As **Figure 25** shows, however, under peak occupancy 84% of the properties surveyed may be occupied by ≥6 occupants, and 24% may be occupied by ≥12 occupants.

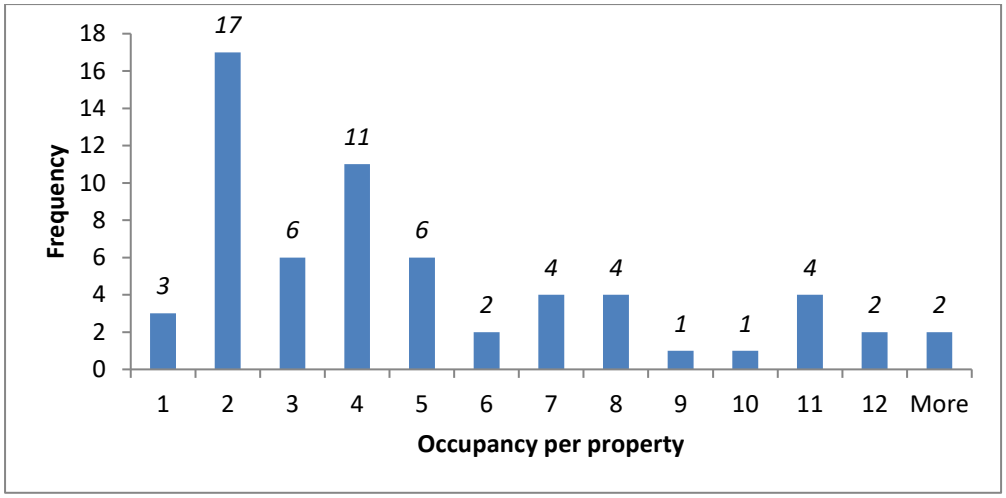

Figure 23: *Occupancy of residences in Wainui (n=63) (Dec 27, 28, 30, Jan 6), Total: 331*

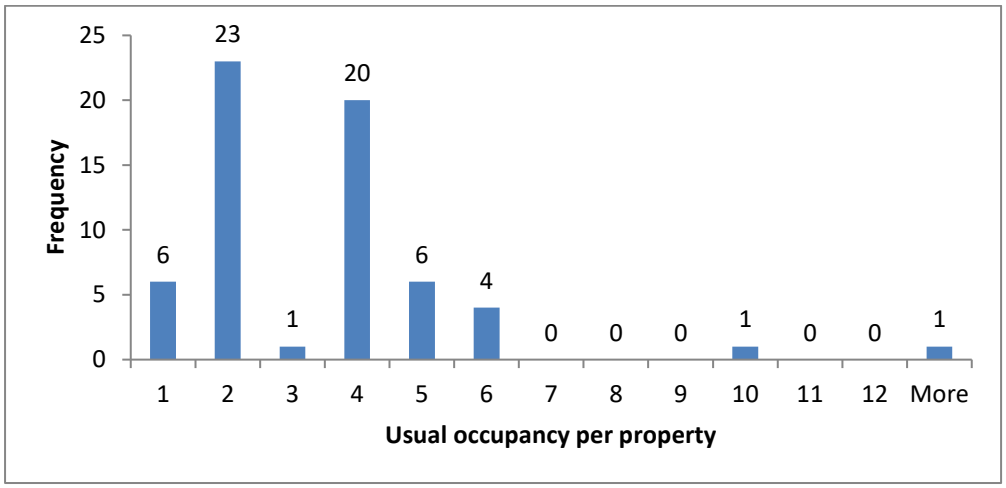

Figure 24: *Usual occupancy of residences in Wainui (n=63), Total:317*

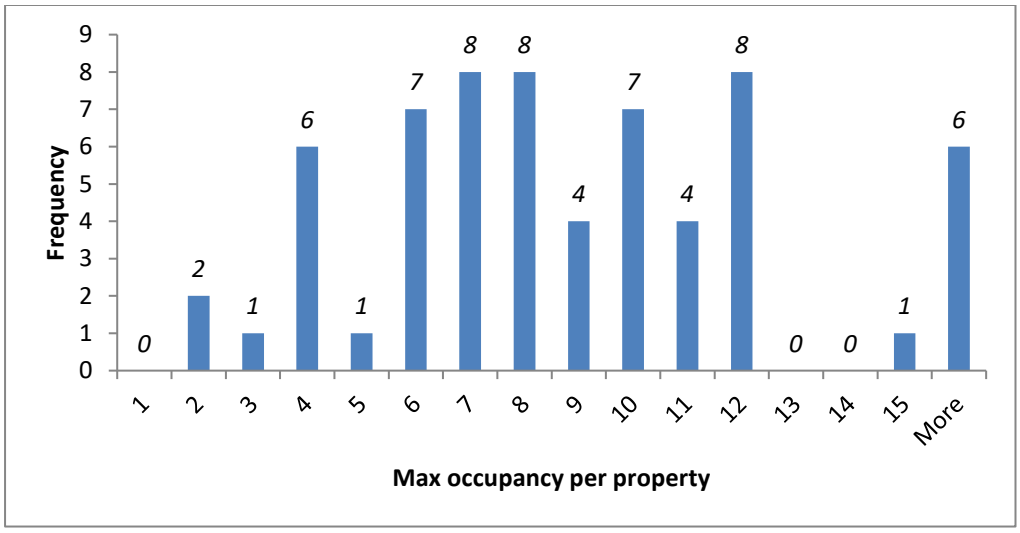

Figure 25: *Maximum holiday occupancy of residences in Wainui (n=63), Total: 791*

The following figures present basic data on the characteristics of the properties surveyed. Figure 26 shows the distribution of properties surveyed by size. Most properties in the area are between 650m^2 and 2,000m^2 in size. In terms of the age of dwellings in the area, Figure 27 shows that the majority (~68%) were built in the period of the 1960s-1980s.

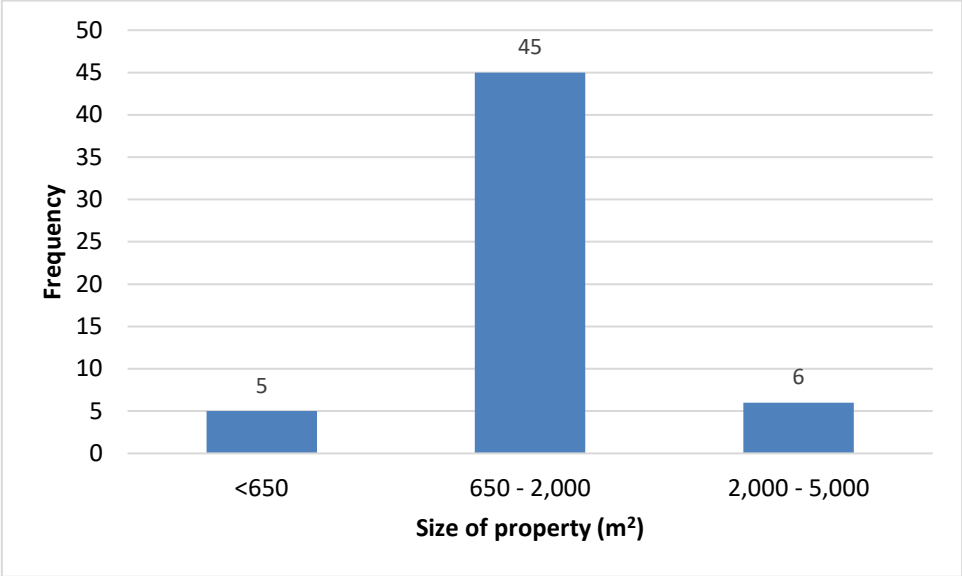

Figure 26: *Property size distribution (n=57)*

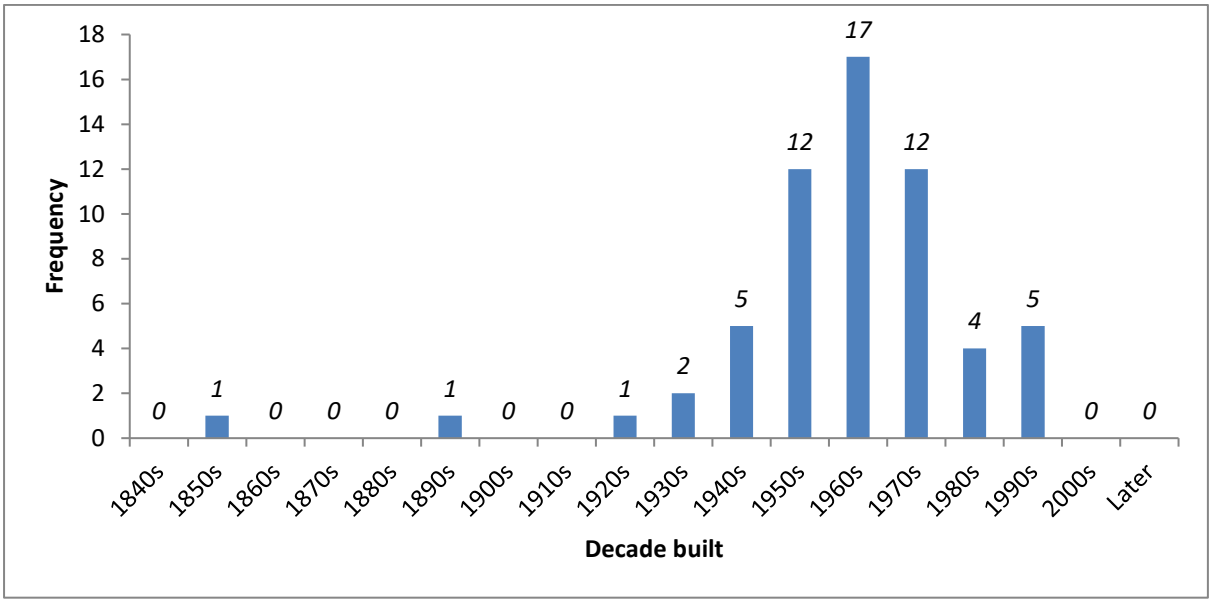

Figure 27: *Decade built for residences in Wainui (n=60)*

Figure 28, Figure 29 and Figure 30 show the distribution of bedrooms, toilets and showers respectively per residence across the properties surveyed. The majority of residences are three-bedroom properties (see Figure 28), and most residences (60%) have one toilet, while 32% have two toilets (see Figure 29). As shown in Figure 30, 81% of residences have one shower and 16% of residences have two showers.

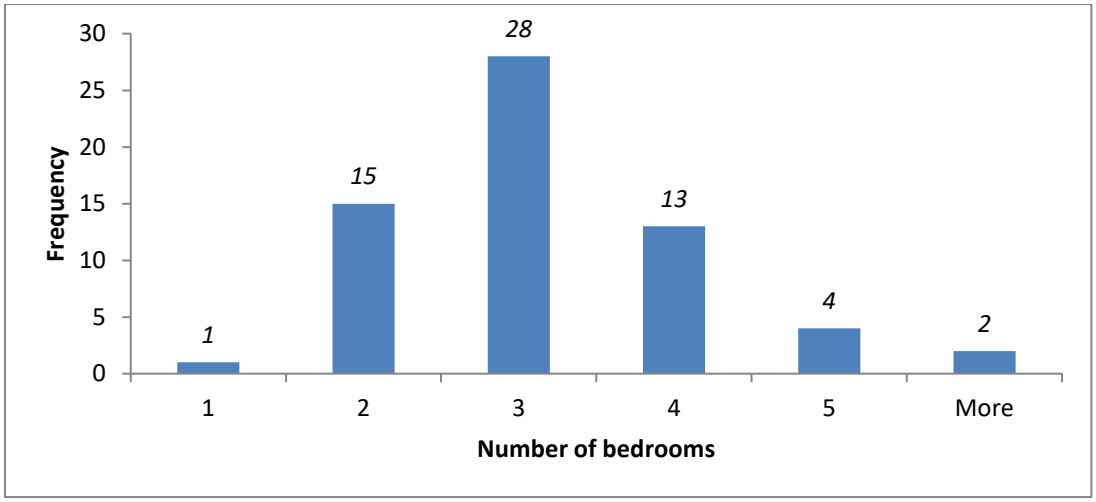

Figure 28: *Bedrooms per residence in Wainui (n=63)*

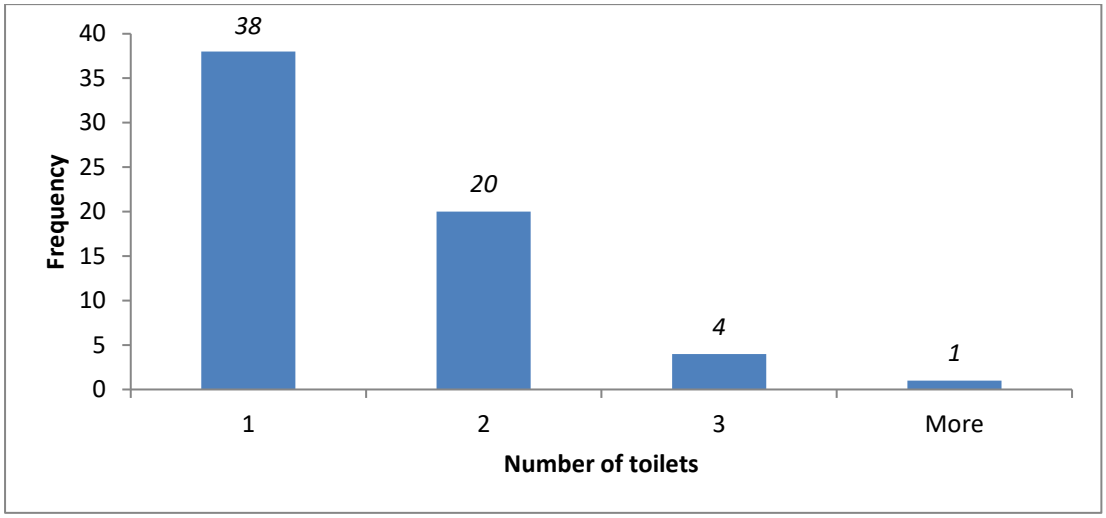

Figure 29: *Toilets per residence in Wainui (n=63)*

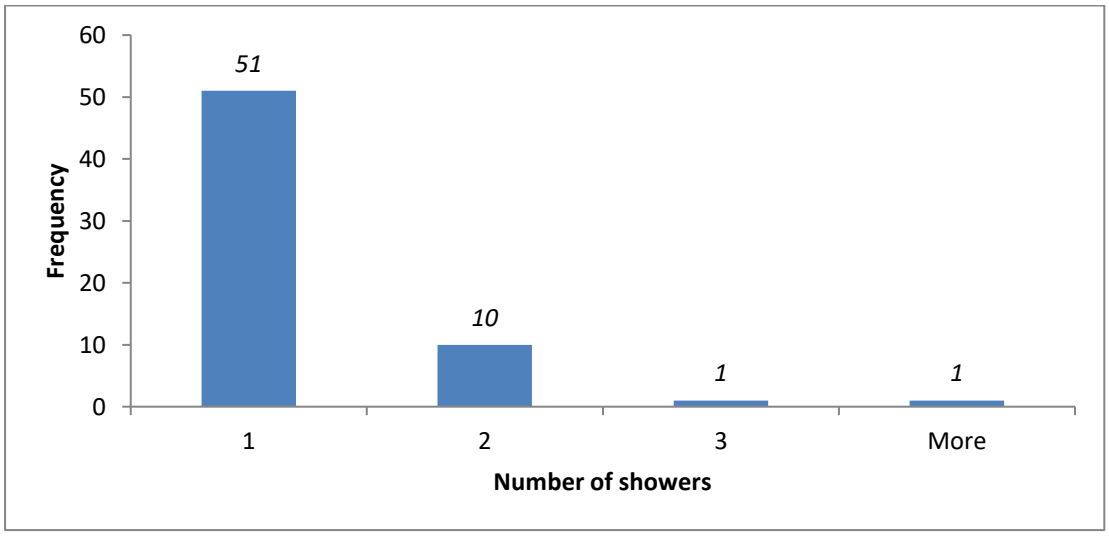

Figure 30: *Showers per residence in Wainui (n=63)*

Figure 31 and Figure 32 show the number of Wainui properties equipped with washing machines and dishwashers respectively. Of the 53 properties equipped with a washing machine, 9 properties reported using the washing machine daily, 32 reported using it weekly, and 11 reported using it less than once a week (and one respondent did not know). Far fewer properties were equipped with dishwashers. Of the 17 properties with dishwashers, 9 reported using the dishwasher on a daily basis. The remainder used it on a weekly basis. Of the 63 properties surveyed, only one reported having an in-sink waste disposal unit.

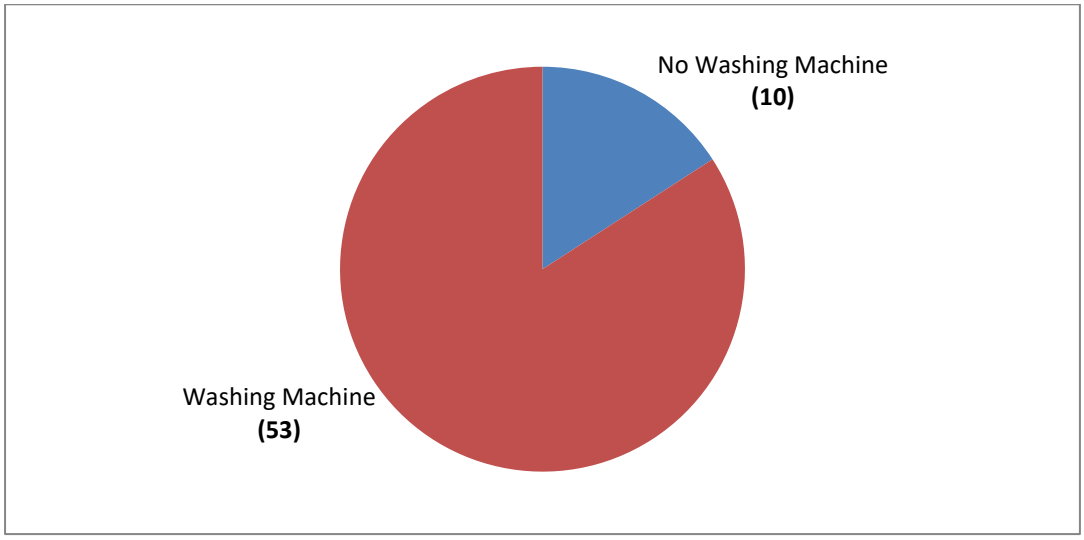

Figure 31: *Washing machines in residences in Wainui (n=63)*

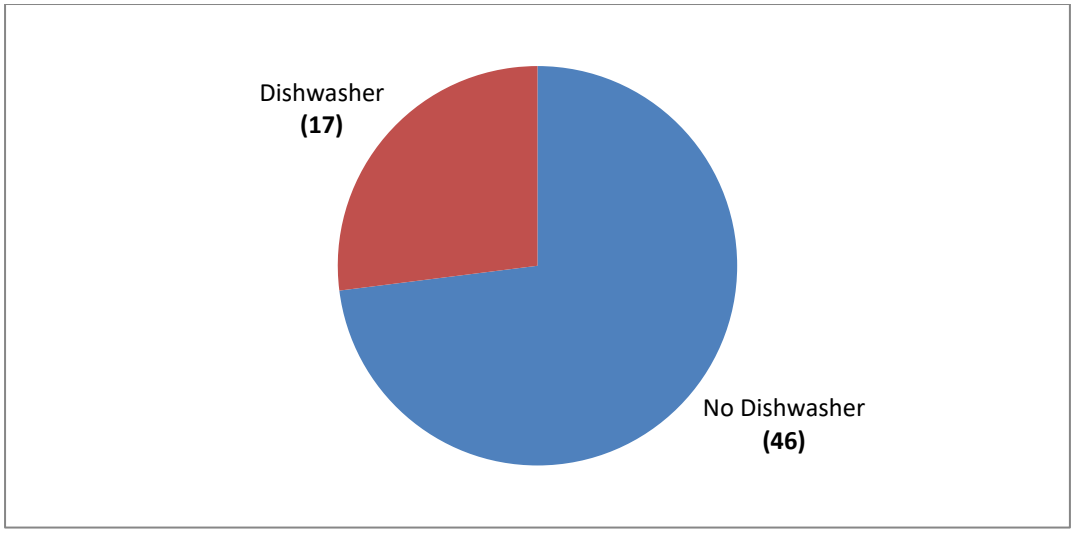

Figure 32: *Dishwashers in residences in Wainui (n=63)*

In terms of water supply in Wainui, of the 63 properties surveyed 56 were serviced exclusively by council supply, 5 were on council supply augmented by spring supply, and 2 were supplied by a private spring.

3.2.2 Onsite septic system characteristics and management

Figure 33 shows the reported decade of installation of onsite wastewater management systems in Wainui. This covers a subset (n=54) of properties surveyed as nine respondents could not confirm or estimate when the system at the property was installed.

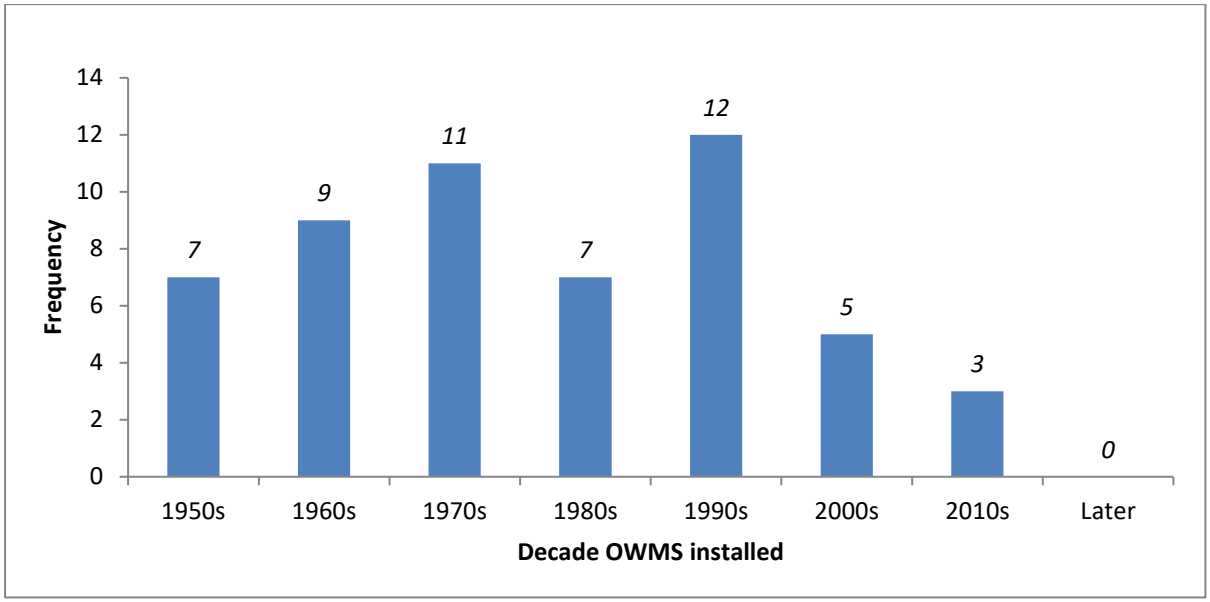

Figure 33: *Installation of OWMS in Wainui by decade (n=54)*

Of 56 properties where respondents knew about the OWMS on the property, the vast majority (52 properties) were served by one onsite system. Three properties reported having two different systems, while one property was reportedly served by three systems. Table 6 shows the different kinds of wastewater treatment and disposal systems installed in Wainui.

Table 6: *Types of wastewater treatment and disposal systems in Wainui*

Type of wastewater treatment system	**Frequency**
Septic Tank	47
Storage tank	13
Vermiculture tank	1
Composting toilet	1
Chemical toilet	0
Incinerating toilet	0
Type of wastewater disposal system	**Frequency**
Dripper irrigation	6
Soakage trench	2
Sand bed	0

Two properties reported having long drops, and therefore no onsite wastewater management system. In terms of treatment systems, the majority of properties (47) are reportedly served by septic tanks, while some (13) are served by storage tanks. Vermiculture systems and composting toilets were rare – with one of each type of system being reported. Chemical toilets and incinerating toilets were not used. In terms of wastewater disposal systems, the most commonly reported system was dripper irrigation (6 properties). Two properties reported having soakage trenches, and no property reported having a sand bed for wastewater disposal.

Most respondents either could not name the brand of their wastewater management system, or believed that the system had no brand name as such (some respondents described such systems as 'home-made' systems). Among the systems that respondents could identify were systems by Oasis and Bio Loo, and components from RX Plastics, Humes, Hynds, McKendry Chalmers, and Bailey Tanks.

Most respondents (39) reported that their greywater was processed through the main wastewater system (i.e. septic tank or similar) rather than a separate system. Eighteen respondents reported that their greywater was processed and/or disposed of separately, and 5 of these reported collecting and re-using greywater for watering the garden or lemon trees. Six respondents did not know how greywater at the property was processed (see Table 7).

Table 7: Greywater processing in Wainui

Greywater process	Frequency	Examples
Main wastewater system	39	
Separate system	18	• Separate soakage pit • Storage tank for garden watering • Grease trap to drain • Holding tank to soakage trench • Pump chamber to dripper irrigation • Holding tank with overflow to stormwater drain
Don't know	6	

Most respondents reported having had their septic system emptied recently. As Figure 34 shows, of the 52 respondents who knew when their system was last emptied, 36 (70%) had had this done in the last three years, while only 6 had had their system emptied prior to 2011. Of the 52 respondents, 23 reported having received a certificate from a contractor to show completion of this maintenance work, while 24 reported not having received such a certificate, and 5 could not recall.

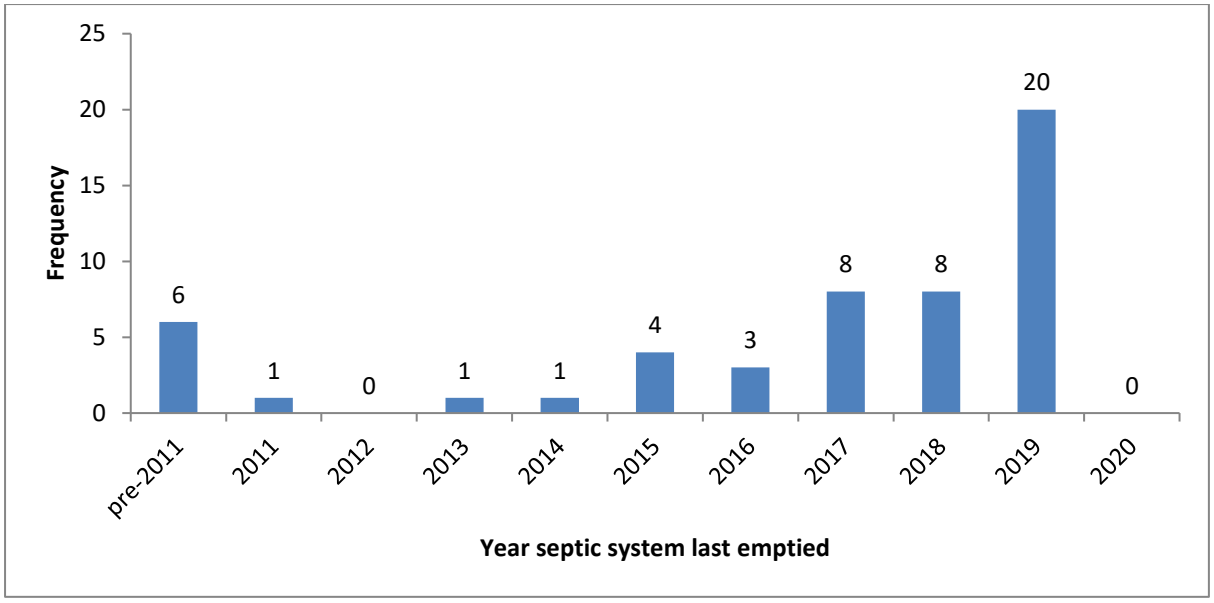

Figure 34: *Year septic system last emptied (n=52)*

Figure 35 shows how regularly the septic systems of 56 respondents are emptied. Evidently this is variable, although it is notable that 14 of these systems require emptying only every five years or more – perhaps due to low occupancy over the course of the year – and 3 respondents reported never having emptied their system.

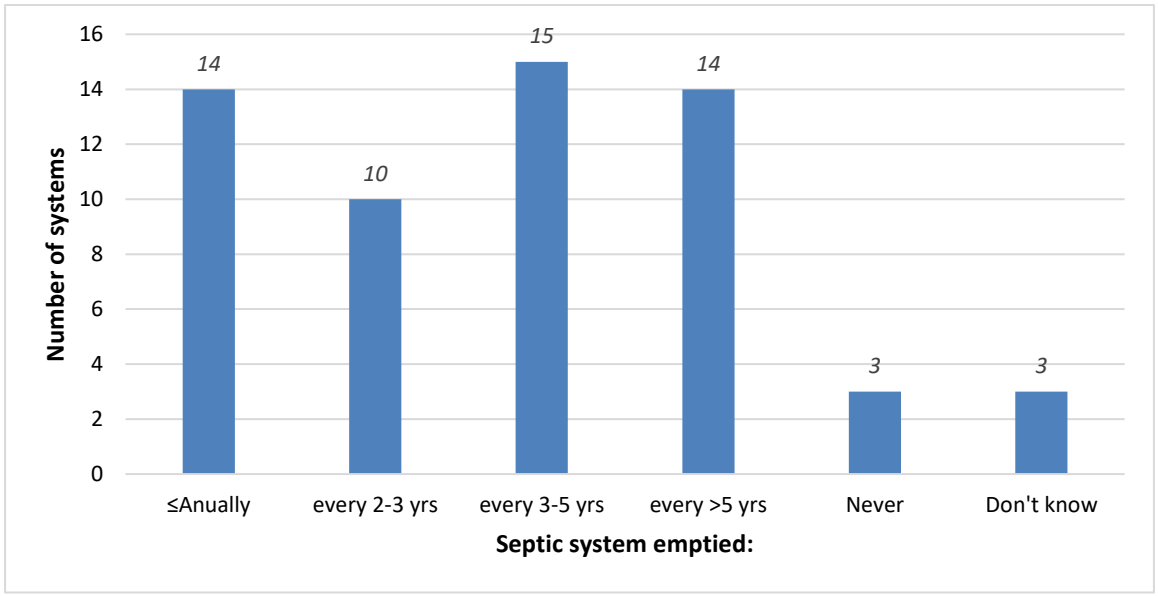

Figure 35: *Frequency of septic systems being emptied (n=56)*

Respondents described a range of actions taken to maintain their systems, including regular visual checks, occasional replacement of parts/components, and flushing or cleaning of lines and tanks. Most respondents (42), however reported that they themselves performed no

maintenance on their systems. Nine respondents reported occasional (as-needed) maintenance by a contractor, and 17 others reported occasional repairs that were carried out by contractors or the home owners. These included such issues as resetting earthquake damaged pipes, replacing damaged pipes, repairing damaged pipes, replacement of pumps, enlargement of soakage pit, repair or replacement of septic tank lid, cleaning/checking of septic tank, and replacing or repairing macerators.

Several respondents reported using different chemical or natural additives in their septic systems, but knowledge of exactly what these products were was limited and additives were sometimes described simply as 'tablets' or 'powder'. Where respondents were more specific, products included Bio Tab, Aqua Kem Blue, Septic Fizzytabs, BioGest Septic Tank Activator, and 'eco-friendly toilet cleaner'. Others reported adding natural products to their system, including lime, yeast, bokashi leachate, organic matter (fish scraps) and 'liquid bacteria'.

3.2.3 Residents' observations

Respondents were asked for their observations in relation to a number of issues with their own onsite wastewater management systems and with wastewater issues in their neighbourhood and the Wainui area in general. A complete record of responses is provided in Appendix VIII: Residents survey – Raw responses. A summary of responses appears below.

Failure of OWMS

Of the 63 respondents, 15 reported having experienced some degree of failure of their own septic system. This was usually described in terms of the system smelling bad as a result of high usage, becoming blocked, or following heavy rainfall. Some respondents also reported surface ponding of wastewater following rainfall or due to blockages. A few respondents also reported problems with blocked drains at times of high occupancy over the Christmas period, and some also reported being aware of a need to limit water use at times of high occupancy. In most cases it was noted that system failures were an occasional rather than a regular occurrence, and in most cases people reported having had the issue fixed.

Wastewater issues at the neighbourhood scale

Asked about issues with septic systems in their neighbourhood, 23 respondents (37%) reported awareness of issues of some kind. Some said they had heard 'rumours' or heard others talking about issues (e.g. of long-drops leaching), while others reported having witnessed issues directly. As above, many associated problems with high rainfall events, noting for example 'sewage smells', 'overflows' and 'run-off' during or after heavy rainfall.

Respondents also claimed that many properties have old septic systems that are in need of repair or pumping out, or systems that are under-sized or otherwise not suitable or up to standard. It was noted by some that systems come under particular pressure over the Christmas period. The point was also made that residents are reluctant to invest in maintaining or upgrading their septic systems, because Council has implied that a mains connection may happen in the future. Several respondents recalled an overflow event that they attributed to the YMCA camp a number of years ago (10-15 years ago), but noted that this hasn't occurred since – although some respondents still reported issues with smell coming from the YMCA system during peak times. Some respondents also reported isolated overflow events as having occurred from other properties more recently.

Some residents believed they had observed sewage or wastewater in the Wainui Stream and Bay. Some respondents noted that some of the stormwater outfalls into the stream smelled like sewage or wastewater/laundry water. Others had seen toilet paper, sewage or cow dung in the stream. Some reported specific overflows that had led to sewage flowing in open stormwater drains leading to the stream. With respect to impacts in the Bay, one respondent noted that the sand can become discoloured after heavy rain events, and another reported having seen tourists use the beach and bushes around the beach as a toilet. Some respondents believed there were issues in 'the loop' at Wainui Stream.

General wastewater management issues in Wainui

Respondents offered a range of reflections on wastewater management in Wainui more generally. Overall, there were a range of opinions about whether the status quo was problematic or not, and whether CCC should install a town system for Wainui.

For many, uncertainty around whether the community will be connected to a mains wastewater system has been a source of frustration and difficulty. Uncertainty on this issue has prevented people from investing in installing new, or maintaining/upgrading existing, onsite systems. Another issue raised was the cost of consents for the installation of new systems. Some respondents called for more guidance from Council on what they should do, and what can be expected in terms of public works. Others suggested that the Council should inspect and advise on the suitability and compliance of existing private systems. Some simply urged Council to 'hurry up' with connecting Wainui up to a new system – or at least to decide whether there would be a mains connection or not. One respondent highlighted the ongoing OWMS maintenance costs to property owners, and suggested that the cost of a new municipal system might be comparable.

Some residents expressed concern about a potential municipal wastewater treatment facility, which may be built nearby and negatively affect their quality of life or business. Others were opposed to a mains system, fearing that this would lead to excessive

development of the area. Several respondents claimed that their system worked well and hadn't caused any problems, and there was therefore no need for a public system.

Some respondents stated that they were interested in learning more about onsite wastewater systems and maintenance, or keen to be more informed about whether they were 'doing the right thing' and whether their system was compliant.

Section 4 Discussion

Water quality analysis

Overall, the results of this study align well with long term ECan monitoring results, obtained from the LAWA site (as shown in Section 1.2). These historic data show seasonal peaks in *E. coli,* and the results of the present study appear reasonably comparable to the 5-year median of 345 MPN/100mL (LAWA, 2018). Turbidity from the LAWA data is mostly <10 NTU which also aligns with the data from this study and likely reflects baseflow conditions. The DRP data from LAWA show results between 0.02 and 0.05 g/m^3. While data from this study range slightly higher (up to 0.06 g/m^3), it should be noted that this study employed weekly sampling, whereas the ECan monitoring from which the LAWA data are derived is conducted monthly. In light of this, we might expect some differences in results due to the time scale. In any case, the DRP results seen in this study are not unusually high for an agricultural catchment on Banks Peninsula, where streams are known to be phosphorus rich due to the geology.

There is evidence of high faecal contamination in the lower catchment, as indicated by the *E. coli* data. This appears to include at least a minor contribution from human sewage sources, as indicated by the faecal source tracking (FST) and analysis of FWAs, particularly after rainfall and later in the holiday season. However, overall the FST suggests that avian and ruminant sources are dominant, and this is consistent with field observations of birds and cows in the vicinity of the waterways. It should be noted that the FST analysis is only representative of two discrete points in time, so while it does indicate persistent inputs of contaminants from livestock and birds, it cannot exclude the possibility of significant human inputs under particular circumstances. The levels of *E. coli* detected could periodically impact on recreational and mahinga kai values of the Wainui Stream, and potentially the Bay in proximity to the Stream mouth, even though the nearby ECan monitoring site (ECAN-10082) at Wainui Beach rarely exceeds safe swimming levels for enterococci.

With regard to FWA results, it is possible that the 'slight' results indicate some domestic wastewater intrusion into the stream following the Christmas/New Year period when the population of Wainui increases significantly. It is important to note that there will be a lag time between an increase in population and any wastewater entering the stream, due to

unknown subsurface flow rates. The FWA test should not be considered in isolation, but with respect to other results that can indicate human wastewater contamination (such as the minor presence of human markers found in the FST).

Although there is sometimes a relationship between DRP and turbidity in catchments where soil erosion is a dominant source of DRP, the data from this study do not indicate a clear relationship between these indicators. As mentioned above, it is noted that the DRP results obtained in this study are relatively high relative to water quality guidelines for ecosystem health, but they are not unusually high for a rural catchment in this area.

Residents survey

The door-to-door survey supported the assertion that Wainui experiences a particularly busy period over the summer holidays, and especially over Christmas and the New Year. It is also evident that onsite wastewater management systems come under increased pressure at this time, and the data reveal that certain properties experience very high occupancy over the peak holiday season. Furthermore, many onsite systems seem to be relatively old, and may no longer be up to standard. Some residents reported issues with their systems at busy times of year and sometimes following heavy rainfall. It should also be noted, however, that many residents reported not having experienced problems with their wastewater systems.

Many residents also expressed uncertainty as to whether their wastewater system was performing effectively or was compliant with the rules and requirements, and some expressed an interest in receiving information or guidance on the topic. It was widely noted that uncertainty around whether CCC will provide a mains wastewater system has led many to hold off investing in new onsite wastewater systems or upgrading existing systems.

Overall findings

Overall, the results indicate the possibility that human wastewater is entering Wainui Stream via subsurface flows, though the results (particularly for FST and FWAs) are inconclusive. Therefore we cannot eliminate the possibility that domestic wastewater may contaminate the Stream and Bay from time to time. Our results do suggest, however, that most *E. coli* in the lower catchment can be attributed to birds and cows.

Section 5 Recommendations

The results of the study did not confirm significant human wastewater inputs into Wainui Stream, but also could not eliminate this possibility. Meanwhile, it seems that birds and cows may be the main sources of *E. coli* in the lower catchment. The following recommendations are offered in case the community wishes to explore or undertake further work.

- More extensive faecal source tracking could be useful in the future, however this is costly. If pursued, sampling should coincide with peak occupancy around Christmas and New Year and any other periods of high occupancy in Wainui.

- Monitor *E. coli* following larger rainfall events, and repeat FST to determine whether *E. coli* of human origin is present.

- Investigate local subsurface flow regimes to better understand the link between rainfall events and possible contamination of the stream and lag times.

- Given the inconclusive results of the faecal source tracking and fluorescent whitening agents test, consider use of alternative markers (such as caffeine).

- To establish likely ecosystem health impacts of elevated DRP, it would be beneficial to collect additional data on nitrates, pH and dissolved oxygen (DO).

- Recent fencing and ecological restoration work appears to have been undertaken in Wainui. Together the community might wish to consider opportunities to further limit bovine and avian *E. coli* inputs (e.g. through fencing and planting).

- CCC might work with residents to raise awareness around wastewater management and promote best practice.

- CCC should endeavour to provide some certainty to the Wainui Community as to whether there will be a reticulated system in the short- to medium-term, or not.

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Appendices

Appendix I. Detailed site descriptions

Sites 1 and 1a

As seen in Figure AI.1 (below) and **Figure 6**, Site 1 was located at the mouth of Wainui Stream, where it mixes with the seawater. As such, the exact location of the sample point varied slightly depending on tide height at the time of sampling.

The main road (Wainui Main Road) runs along the coast and over the bridge next to this site (seen to the right in Figure AI.1). There are residential homes on the inland side of the main road, and a few people were observed walking, swimming and/or boating in the area on most sampling trips, though not the first (13/12/19) or last two trips (03/02/20 and 10/02/20). On three occasions a cruise ship was seen further out in the harbour towards Akaroa. Wildlife observed was mainly birds such as ducks, oyster catchers, and seagulls. The stream bed was rocky with some pebbles, and consistently had green slippery algae growing on the rocks that were submerged at higher tide levels. The sample point was tidal, and samples were taken as close to low tide as possible. This meant it was either sampled first or last out of the nine sites within the 9-3pm sampling window.

Figure AI.1: *Site 1 (taken 06/01/20).*

Site 1a was added to the sampling plan on the third monitoring trip (30/12/19). This was because water was observed flowing out of the concrete pipe underneath the bridge on previous trips (see circled area in Figure AI.2). The flow seemed to vary slightly between weeks. On one trip (13/01/20) the smell of urine was noted and on another (20/01/20) an oily residue was observed on the surface of the water in the pipe and the water directly below its outfall. As seen in Figure AI.3, green algae was growing on the upper areas of the pipe. Brown staining was present on the concrete below the pipe and the pipe was partially submerged during high tides (Figure AI.4).

Figure 6 indicates a stormwater pipe going underneath the main road to the coast some 100m south of the bridge, however no outlet was observed in that area. The variation visible in the road surface suggests that the pipe likely goes towards the bridge and terminates at Site 1A. There is a waterway visible in the aerial imagery of **Figure 6** (though not depicted by a blue river line) flowing from an inlet just upstream of the rocky weir (not visible in **Figure 6**). This follows a loop between the houses and ends at the marked stormwater pipe under the bridge., The 'loop' was the original main stem of the stream, but a 'cut' in the channel was constructed to channel flows more directly to the sea and reduce the flood risk to the houses. It is assumed therefore that site 1a is the piped outlet of the original stream course, which still has some limited flow through it.

Figure AI.2: *Site 1a circled in white (taken 06/01/20).*

Figure AI.3: *Close up of Site 1a (taken 13/01/20).*

Figure AI.4: *Site 1a at higher tide (taken 03/02/20).*

Sites 2 and 3

Site 2 (see **Figure 7** and Figure AI.5) is on the main stem of the Wainui Stream, immediately upstream of a riffle and the tributary sampled at Site 3. The surrounding area is farmland with only grasses and rushes around the stream area, and cows were observed in adjacent paddocks on several occasions. Of note are several changes from the aerial imagery depicted in **Figure 7** to present: The willow trees in the imagery have been cleared, the stream is fenced off from the adjacent paddocks, and riparian planting has been carried out within a riparian reserve towards the bridge.

Small fish were observed in the stream on mutliple occasions, as well as bottom feeders on the final trip (10/02/20). Pukekos and grey herons were seen in the surrounding area. On two occasions (27/01/20 and 03/02/20) the presence of small unidentified faeces were observed on the bank of the stream (see Figure AI.7). The stream bed was rocky with brown sludge covering most of it (see Figure AI.6). On one sampling trip (20/01/20) a patch downstream of this sampling site had dried up, and the velocity of flow at the sampling site varied across the sampling program between 0.1 and 0.3 m/s.

Site 3 was on a small tributary, marked by a river line in **Figure 7** and shown in Figure AI.8. The flow velocity recorded was mostly less than 0.1 m/s, however it did peak at 0.5 m/s on 20/01/20. The upstream area was farmland, with cattle observed on many occasions, and there was a low culvert and crossing allowing cattle to cross the tributary immediately upstream of Site 3 (see Figure AI.9). Pukekos, grey herons and ducks were observed around the site. The streambed was sludgy with sediment and rocky, with aquatic plant life that

grew to almost cover the whole sample site (see Figure AI.10). On 10/02/20 the bank looked like it had been well trodden down, but it was not clear by what type of animal and there was no evidence of cow tread. On 27/02/20, small unidentified faeces were observed in the tributary and on the bank only a few centimetres upstream from where the water samples were taken.

On several occasions people were seen walking through the gate next to the bridge at Site 1, which leads into the reserve where Sites 2 and 3 are. Their destination was not known. No people were seen at Sites 2 or 3 while sampling was occurring.

Figure AI.5: *Site 2 sampling area marked by white number. Site 3 also marked by arrow and number (taken 23/12/19)*

Figure AI.6: *Example of the benthic brown sludge observed in various sites (taken at site 2, 13/12/19)*

Figure AI.7: *Unidentified faeces (circled) at site 2 (taken 27/01/20).*

Figure AI.8: *Site 3 (lower portion of photo), looking downstream showing its connection to the main stem of the Wainui Stream (taken 13/12/19).*

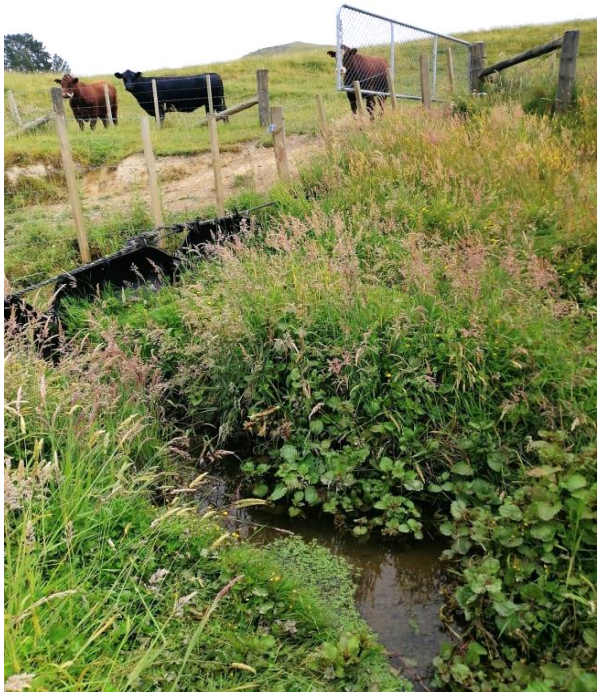

Figure AI.9: *Site 3 looking upstream (taken 23/12/19).*

Figure AI.10: *Site 3, showing growth of aquatic plants (taken 03/02/20).*

Site 4

Site 4 was located on the main stem of the Wainui Stream (see **Figure 8**) in a paddock. This site was accessed freely by cattle at the time of sampling. Wainui Valley Road runs parallel to the stream alongside this reach and there were a few houses on the opposite side of the road (see Figures AI.11 and AI.12). The sampling point was immediately downstream of a stormwater drain flowing out from the road-side stream bank, as seen in **Figure 8**.

Cattle were frequently seen in the paddock or in an adjacent one, and cowpats and tread were observed on the stream bank on multiple occasions. Pukekos were seen in the area, and on one occasion the smell of dead animal was noted. People were seen around the houses and on the road adjacent, though this lessened in February. On one occasion a resident was observed upstream washing their boat on the roadside closest to the stream. The stream banks were covered with grasses, and the stream bed was rocky with a brown or green algae usually covering much of the stony bed. This was generally the fastest flowing site, with flow velocities of 0.3-0.5 m/s. The water level of the stream at this location was visibly lower towards the end of our sampling program.

Figure AI.11: *Site 4, looking downstream (taken 30/12/19).*

Figure AI.12: *Looking upstream of site 4 (taken 23/12/19).*

Site 5

Site 5 was on the main stem of the Wainui Stream, upstream of the confluence with the tributary sampled at site 6. This was located next to the YMCA camp, and immediately downstream from a footbridge, as seen in Figure AI.13 and **Figure 9**. A small valve from a pipe running underneath the bridge was usually dripping, and the camp manager confirmed that this was a fresh water pipe. During most sampling trips after the new year, the camp had groups of children staying, and the bridge was used as pedestrian access for other non-residential parts of the camp. Birds were the only wildlife noted at this site, but they were heard and not seen. The site was mostly under canopy cover, and there was some green algae present and leaf litter in the stream. The stream bed was rocky, with some deposited fine sediment present. The flow velocity was usually 0.1-0.2 m/s, but peaked at 0.4 m/s on 10/02/20. The water level of the stream at this location was visibly lower towards the end of our sampling program.

Figure AI.13: *Site 5, looking upstream (taken 06/01/20).*

Site 6

Site 6 was located on a tributary of the Wainui Stream, immediately downstream from a road bridge, which had the occasional car driving over it (see Figure AI.13 and **Figure 9**). The confluence of this tributary and the Wainui Stream main stem was downstream of Site 5. This was below the camp unlike what is indicated by the river course in **Figure 5**. The flow velocity at this site was generally higher than at site 5, usually varying between 0.2-0.5 m/s. The site was under canopy cover and birds (fantails and kereru in particular) were observed in the area. The stream bed was rocky with some fine sediment or brown algae, and leaf litter.

Figure AI.13: *Site 6, looking upstream (taken 06/01/20).*

Site 7

Site 7 was located on a tributary of the Wainui Stream, off a gravel section of Wainui Valley Road. Its confluence with the main stem of the Wainui Stream was downstream of site 8, as seen in **Figure 10**. There were homes on the opposite side of the gravel road, and the road was used infrequently by cars. As Figure AI.14 shows, the site was covered by native canopy, and had a rocky bed with some brown benthic algae/sediment and leaf litter in the stream. A dozen dead hedgehogs and possums were found dumped approximately 5m from the stream on a bank above, and while not visible from the sample site the odour persisted throughout the sampling program. The flow velocity was generally 0.1-0.2 m/s.

Figure AI.14: *Site 7, looking upstream (taken 06/01/20).*

Site 8

Site 8 was on the main stem of the Wainui Stream near the start of Donovans Road, and was the most upstream site sampled (see **Figure 5** and **Figure 10**). It was immediately downstream of a road bridge (see Figure AI.15) on Donovans Road, which was used infrequently by cars. There was a farm downstream on the other side of the road. Birdsong was heard on most sampling trips, and the site was under canopy cover. The stream bed was rocky with some brown sediment/algae, moss and green algae was also observed on the rocks. The flow velocity varied between 0.1 and 0.3 m/s. On most sampling occasions, a beige foam was observed downstream of the sampling point (see Figure AI.16). This had gone completely by the last trip on 10/02/20. It is likely the foam was of natural origin, forming due to the decay of natural organic matter from the surrounding forest and aeration.

Figure AI.15: *Site 8, looking upstream (taken 06/01/20).*

Figure AI.16: *Beige foam observed downstream of site 8 (taken 06/01/20).*

Appendix II. Raw site observations

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
13/12/2019	**1**	10:57	Windy (NNE, light with moderate gusts), no rain	Sea gulls, grey heron, oyster catcher, whitebait, dolphins offshore	None observed	Green seaweed/algae covering rocks at stream mouth		
13/12/2019	**2**	11:42	Sunny, light wind	Large bullies, inanga observed		Sludge on stream-bed in most places		
13/12/2019	**3**	12:02	Sunny and windy (but site is sheltered), starting to drizzle	On farm but no visible livestock, pukeko seen			Thick sediment, mud	Immediately downstream from stock crossing
13/12/2019	**4**	-						Did not access site without permission
13/12/2019	**5**	13:59	Overcast, calm	Birds	Footbridge and walking track crossing stream in YMCA camp			70% canopy cover. Polythene water pipe observed dripping into water from underside of bridge
13/12/2019	**6**	13:02	Fine/overcast	Nesting birds in trees above, birds in the area (Kereru)	Road bridge just upstream			In native bush, shaded, full canopy cover
13/12/2019	**7**	13:41	Humid and warm	None observed	Pretty inaccessible	Some algae	Sandy, rocky bed	Native bush, 80% canopy cover. A dozen dead possums and hedgehogs dumped at the top of the bank (approx 5m from stream), strong odour
13/12/2019	**8**	13:30	Cloudy	None observed	Limited. Forestry road?			Native bush, 80% canopy cover. Clear water.

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
23/12/2019	**1**	9:15	overcast. light wind (E,SE)	none observed	Residential homes on other side of road. Few people running.	Algae 10m on either side of sampling area	rocks	Low tide was at 06:10 NZST. We sampled probably around midway to high tide.
23/12/2019	**2**	9:43	warm, overcast, no wind	farmland, around 2 cows in the area	none observed	sludge on stream bed in most places	rock, patches of sediment downstream	Cows were able to use crossing this time.
23/12/2019	**3**	9:35	warm, overcast, no wind	farmland, around 2 cows in the area	none observed	sludge on stream bed in most places	rock, patches of sediment downstream	Cows in the immediate area (the crossing). Pool of water was too narrow to do multiple readings for velocity.
23/12/2019	**4**	10:12	warm, overcast, very light wind	cows in neighbouring paddock, pukeko and nest with eggs	homes on other side of the road but no people observed	little algae, plants on bank	rock and some sediment	Clay rockface above stream. Sampling location was downstream of where the tributary joins the stream.
23/12/2019	**5**	10:48	warm, overcast, very light wind	birds could be heard, none observed	some children and adults	very little algae.	Mostly rock with some sediment	Plenty of foliage around and native bush. About 65% canopy cover. Tap/pipe under bridge still leaking. Pants still in the water, some rubbish seen in water.
23/12/2019	**6**	10:30	warm, overcast, no wind	birds could be heard, none observed	people could be heard but none observed		Rock, covered in sludge/algae	Fallen tree about 2m upstream. Unsure if it was there before. In native bush, almost full canopy cover.
23/12/2019	**7**	11:20	warm, overcast, very light wind	birds could be heard, none observed	homes on other side of road but no people observed	some algae on rocks	50/50 rocks and sediment	60-70% canopy cover, native bush. Dead possums and hedgehogs still on bank about 5m vertical of sampling site.
23/12/2019	**8**	11:04	warm, overcast, very light wind	birds could be seen	none observed	Patches of algae on rocks	50/50 rock and sediment	70% canopy cover, native bush. Foam on top of river downstream from sample site. General flow was about the same as last sampling occasion.

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
30/12/2019	**1**	11:45	overcast, windy (southerly)	1 duck seen	few boats to right of bridge ~200m away, cruise ship in harbour	green algae on rocks next to stream outlet	rocky, pebbles	Pipe under bridge flowing (extra sample taken- 1a). Closest low tide to sampling time: 1:46pm
30/12/2019	**1a**	12:05	overcast, windy (southerly)	none observed				
30/12/2019	**2**	9:10	overcast	none observed	chainsaw in earshot	brown algae on bottom	rocky	heavy rain 2 nights prior to sampling
30/12/2019	**3**	8:55	overcast	none observed	none	brown algae on bottom, floating green small leafy plant	rocky, some fine sediment	
30/12/2019	**4**	9:47	overcast	livestock (cows) in adjacent paddock- downstream of sample point	next to road, power lines adjacent	brown/green benthic algae	rocky, some fine sediment	drain flowing into the stream directly above the sample point
30/12/2019	**5**	10:40	overcast	none observed	pants in the river	leaf litter	rocky, some fine sediment	Powell Village YMCA camp, Red pipe from underside of bridge still dripping into the stream, slight off smell
30/12/2019	**6**	10:24	overcast	none observed	road bridge just upstream of sample point	leaf litter, brown benthic algae	rocky	sample point covered by tree cover
30/12/2019	**7**	11:05	overcast	none observed	next to gravel road, car bridge crossing upstream of sample site	leaf litter	rocky, some fine sediment	dead possum smell and dead hedgehogs on ledge above stream
30/12/2019	**8**	11:20	overcast	none observed	road bridge immediately upstream of sample point	mossy rocks	rocky, pebbles, fine sediment	fallen trees upstream

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
6/01/2020	**1**	9:10	partially cloudy, light wind	ducks, sea snails, sand flies	boating, people walking	green algae, seaweed, slippery rocks	rocky and pebbles	Rising tide (low tide ~7am, high tide ~1pm). Found chicken necks and dead fish upstream of 1 and 1a but downstream of all other sites
6/01/2020	**1a**	9:15	partially cloudy	none observed	drain from stormwater/people	none observed	concrete pipe	long pipe from open drainage
6/01/2020	**2**	9:45	blue sky, very warm	pukeko, small birds	farm either side (cattle)	algae (brown) with sediment trapped, stringy/furry grass on banks	rocky with trapped fine sediment in algae	flow doesn't look different from last time
6/01/2020	**3**	9:35	blue sky	grey herons, small birds, pukeko	farming	aquatic plants and grass	mud/rock	green water plant(floating) has grown larger than last visit
6/01/2020	**4**	10:15	sunny, few clouds	cattle upstream in paddock, pukeko, more cow poo and fresh tracks near stream		moss, algae, grass on riverbanks	rocky	Little stream coming out of opposite bank flowing but no flow off the road, though there is a channel from the road. Have to cross the stream upstream of the sample point. We try to stay on the rocks not in the water when crossing.
6/01/2020	**5**	11:20	sunny	none observed	YMCA camp village but no people spotted compared to last week when there were many people around	some green algae	rocky, leaf litter, some fine sediment	
6/01/2020	**6**	10:50	sunny, sample site in shade	none observed	the odd car	brown algae	rocky	
6/01/2020	**7**	11:55	sunny, sample area mostly shaded	heard cows but couldn't see	none observed	none observed	fine brown sediment/algae	dead possum smell still there
6/01/2020	**8**	12:15	sunny, sample spot shaded	none observed	none observed	some moss on rocks	fine brown sediment, rocky	beige foam immediately downstream of sampling site

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
13/01/2020	**1**	12:15	overcast, windy (southerly)	none observed	few cars, jogger, cruise ship in harbour	seaweed on rocks	rocks, pebbles	Fewer people around than last time. Low tide 1pm, 1.4mm of rain at 10am that morning (just prior to sampling)
13/01/2020	**1a**	12:25	overcast	none observed	none observed	slimy		smells like urine
13/01/2020	**2**	9:55	overcast, light rain prior	cows	none observed	slimy	slimy, rocky	
13/01/2020	**3**	9:45	overcast, windy	cows in adjacent paddock	none observed	lots	slimy, pebbly	
13/01/2020	**4**	10:17	overcast	cows in paddock, cow pats and cow trodden potholes on river banks	less than last week	slime, fine brown sediment	rocky	fewer/no boats parked on the road side, fewer people around, tributary flowing steadily
13/01/2020	**5**	10:57	overcast	birds	Groups of children-school or holiday kids camp?	none observed	rocky	
13/01/2020	**6**	10:42	overcast	birds	children in earshot	leaf litter	rocky, fine brown sediments	
13/01/2020	**7**	11:12	overcast	none observed	none observed	leaf litter	rocky, fine brown sediments	
13/01/2020	**8**	11:29	overcast	none observed	none observed	slime	rocky	foam still present

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
20/01/2020	**1**	9:20	sunny	shag, seagulls, ducks	boats in area	algae on rocks	rocky	Tide was around 2 hours away from high tide. We had some rain coming over from Chch (very light drizzle) but does not appear to have rained in Wainui according to the weather forecast.
20/01/2020	**1A**	9:30	sunny	whitebait in water below pipe	none observed	algae/brown sludge on rocks and concrete below pipe	concrete pipe	oily residue on surface on water in the pipe and on the water below
20/01/2020	**2**	10:00	sunny	small fish, whitebait, duck	none observed	sludge on rocks	rocky	downstream where we cross is completely dried
20/01/2020	**3**	9:50	sunny	ducks, no cows observed in area.	none observed	Green leafy plants growing very well, almost taken over that small area before it runs and joins the main river.	sediment	Cattle crossing open but no stock animals seen.
20/01/2020	**4**	10:15	sunny	pukekos, no livestock observed	residents across the road, but no one observed	some sludge on rocks, plants on bank	rocks mostly with some sludge	Might be some pukeko nests around this site again.
20/01/2020	**5**	10:35	sunny	none observed	people at the YMCA campsite	canopy cover, plants on bank	rocky with some sediment	This river seems to be narrower than last time we came out.
20/01/2020	**6**	10:25	sunny	dead bird near entrance to site	none observed but people could be heard at YMCA campsite	canopy cover, plants on bank	rocky	
20/01/2020	**7**	10:47	sunny	dead animals still on bank above, birds heard but not seen	residents across the road, cars driving past	canopy cover, plants on bank, some algae on rocks	rocks and sediment	
20/01/2020	**8**	11:00	sunny	birds heard but not seen	residents across the road but none observed	canopy cover, some algae	rocks and sediment	White foam reduced, river width seems to be reduced slightly.

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
27/01/2020	**1**	912	sunny	birds, mosquitos	people swimming	algae on rocks - seems lesser than previous weeks	rocky	decrease in algae, sample taken 2 hrs before high tide
27/01/2020	**1a**	9:20	sunny	none observed	none observed	rocks on bottom slimy	concrete pipe	
27/01/2020	**2**	9:42	sunny and very hot	pukeko, small fish downstream and lots of whitebait	none observed	usual native on banks, sludge	sludge on rocks	Small poo on bank, different morphology from site 3 - could be ducks? look like mini cow patties
27/01/2020	**3**	9:32	sunny and very hot	cows in paddock but not open to the crossing	assuming human tracks pushed down the side of the sampling site	clovers and greenery growing very well	sludgy	Poo floating in water and on bank - might be pukeko poo. Water very turbid
27/01/2020	**4**	9:55	sunny and very hot	cows in next paddock, birds heard	none observed	plants on bank, some sludge and green algae	rocks with some sludge	Can smell dead animals but couldn't find it. River level looks a lot lower, big cow poos upstream, foam forming upstream.
27/01/2020	**5**	10:25	sunny but shaded and cooler	birds	people heard but not seen	algae upstream, canopy cover	rock	Pants still here. river looks narrower, pipe still leaking - maybe leaking more
27/01/2020	**6**	10:15	shaded and cooler than other sites	fantail, might have nest nearby	YMCA camp, people could be heard but not seen	forest cover, native plants	mostly rock with some sediment	dead bird at entrance to site
27/01/2020	**7**	10:38	sunny but shaded and cooler	birds heard but not seen, dead animals still present	none observed	sludge on rocks	rocky	water level looks lower - samples were taken from maybe about 50cm upstream than usual
27/01/2020	**8**	10:48	sunny but shaded and cooler	birds heard but not seen	none observed	canopy cover, some algae	mostly rock, some sediment	foam almost gone, river looks about the same width

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
3/02/2020	**1**	11:55	overcast	few birds	none observed	bits of seaweed	rocky	
3/02/2020	**1a**	12:05	overcast	few birds	car		pipe	
3/02/2020	**2**	10:10	warm very windy	birds heard	none observed	sludge, native bush on bank	rocks with sludge	poo still on bank, river narrower downstream
3/02/2020	**3**	9:55	warm with very strong winds	birds, cows not in paddock nearby	none observed	lots of clover growth in the water	sludgy	bank has been pushed down some parts wider (see pic), dried up downstream, water looks very turbid
3/02/2020	**4**	10:26	hot overcast windy	none observed	none observed	none observed	rocky	dead animal smell gone (could be the wind), no more foam
3/02/2020	**5**	11:06	hot overcast	none but birdsong	children in camp	none observed	rocky	tree branch on riverbed
3/02/2020	**6**	10:52	overcast, hot, sheltered	fantail	ymca camp not seen but heard	canopy cover	rock with some sediment	can smell poo but can't see it
3/02/2020	**7**	11:24	warm but overcast	birds heard	none observed	foliage, canopy cover and bush on bank	rock with some sediment	dead animal smell still present, river seems lower
3/02/2020	**8**	11:37	overcast, hot, slight wind	birds heard, cicadas	none observed	some green algae- lesser than usual, canopy cover	rocky/sediment	foam gone, river narrower/lower

Date	Site ID	Time (NZST)	Weather	Wildlife/Livestock	People/use	Algae/aquatic plants	Bed/sediment	Other observations
10/02/2020	**1**	10:35	sunny and windy	some birds	Cruise ship, sailing vessels. ECan upstream	algae, spanning about 20m on rocks	rocky	ECan there too doing some sampling
10/02/2020	**1a**	10:45	sunny, cold breeze	few birds	ECan upstream	slippery brown algae	rocky	1.91 seconds/L flow roughly
10/02/2020	**2**	11:15	sunny. warm	lots of small fish and some bottom feeding fish, birds	none observed	sludge on rocks	rocky	no fresh poo on bank
10/02/2020	**3**	11:05	sunny, warm	birds	ECan sampling	less clovers than last week	sediment	Site has widened, maybe from human activity. Downstream has dried up a bit.
10/02/2020	**4**	11:32	sunny, warm	pukeko, birds	none observed	bit of green algae amongst the brown	rocky	can't smell dead animals anymore
10/02/2020	**5**	12:05	sunny. warm	none	children at YMCA	leaf litter	rocky, some sediment	pants gone, tap still dripping
10/02/2020	**6**	11:55	warm, sunny, canopy cover	none observed	people at YMCA	nothing new	rocky	
10/02/2020	**7**	12:22	warm, sunny, canopy cover	none	none	leaf litter	rocky, brown sediment/sludge	
10/02/2020	**8**	12:35	sunny, warm, sheltered	birdsd heard	farmer across the road	some algae on top of rocks, some sludge	rocky	river seems higher here, foam all gone

Appendix III: Raw results for all water quality parameters measured

Date	Site ID	Time (NZST)	Temp (°C)	Conductivity (µS/cm)	Turbidity (NTU) mean (n=3)	Velocity (m/s) midstream	*E. coli* (MPN/100mL)	DRP (mg/L)	Fluorescent whitening agents
13/12/2019	**1**	10:57	16.3	7770	-	-	345	0.043	None
13/12/2019	**2**	11:42	16.0	147	2.44	0.25	517	0.046	None
13/12/2019	**3**	12:02	16.6	230	4.27	0.10	2420	0.022	-
13/12/2019	**4**	Did not access site without landowner permission							
13/12/2019	**5**	13:59	13.7	147	2.34	0.30	206	0.043	None
13/12/2019	**6**	13:02	13.6	144	3.48	0.15	365	0.062	-
13/12/2019	**7**	13:41	13.3	141	1.71	0.30	93	0.035	-
13/12/2019	**8**	13:30	13.0	143	2.61	0.25	124	0.048	None
23/12/2019	**1**	9:15	13.4	945	2.18	-	882	0.044	None
23/12/2019	**2**	9:43	13.5	146	1.51	0.3	687	0.035	None
23/12/2019	**3**	9:35	14.9	241	10.48	0.10	2420	0.021	-
23/12/2019	**4**	10:12	12.8	144	1.29	0.35	115	0.038	None
23/12/2019	**5**	10:48	12.4	145	1.35	0.4	160	0.035	None
23/12/2019	**6**	10:30	12.2	144	2.68	0.1	219	0.054	-
23/12/2019	**7**	11:20	11.9	138	1.20	0.1	68	0.027	-
23/12/2019	**8**	11:04	11.8	142	1.41	0.1	214	0.04	None
30/12/2019	**1**	11:45	13.7	1650	4.25	-	959	0.041	None
30/12/2019	**1a**	12:05	15.8	5050	5.33	-	-	-	-
30/12/2019	**2**	9:10	13.0	150	1.61	0.2	579	0.038	None
30/12/2019	**3**	8:55	14.5	262	5.73	0.10	2420	0.022	-
30/12/2019	**4**	9:47	13.2	149	2.66	0.2	210	0.044	None
30/12/2019	**5**	10:40	12.8	149	1.72	0.2	93	0.041	None
30/12/2019	**6**	10:24	12.7	147	2.39	0.50	64	0.058	-
30/12/2019	**7**	11:05	12.7	142	1.37	0.20	25	0.032	-
30/12/2019	**8**	11:20	12.5	145	2.21	0.30	68	0.046	None
6/01/2020	**1**	9:10	15.2	27500	5.03	-	1291	0.019	Slight
6/01/2020	**1a**	9:15	15.9	1188	16.57	-	2420	-	-
6/01/2020	**2**	9:45	12.9	149	2.40	0.1	649	0.042	Slight
6/01/2020	**3**	9:35	14.7	245	3.67	0.25	1986	0.034	-
6/01/2020	**4**	10:15	13.0	147	3.71	0.4	649	0.043	Slight
6/01/2020	**5**	11:20	12.7	147	1.67	0.15	345	0.040	Slight
6/01/2020	**6**	10:50	12.2	145	2.98	0.30	387	0.059	-
6/01/2020	**7**	11:55	12.1	140	2.02	0.20	152	0.029	-
6/01/2020	**8**	12:15	11.9	145	2.29	0.20	326	0.044	Slight
13/01/2020	**1**	12:15	15.1	10400	2.71	-	1314	0.019	None
13/01/2020	**1a**	12:25	17.2	17390	8.39	-	2420	-	None
13/01/2020	**2**	9:55	14.1	153	2.29	0.30	1046	0.042	None
13/01/2020	**3**	9:45	15.0	270	3.91	<0.1	2420	0.034	-
13/01/2020	**4**	10:17	14.2	152	1.98	0.30	770	0.043	None
13/01/2020	**5**	10:57	13.4	152	1.95	0.25	160	0.040	None
13/01/2020	**6**	10:42	13.3	151	4.23	0.40	166	0.059	-
13/01/2020	**7**	11:12	13.0	145	1.58	0.20	27	0.029	-
13/01/2020	**8**	11:29	12.7	149	3.76	0.15	770	0.044	None

Date	Site ID	Time (NZST)	Temp (°C)	Conductivity (µS/cm)	Turbidity (NTU) mean (n=3)	Velocity (m/s) midstream	*E. coli* (MPN/100mL)	DRP (mg/L)	Fluorescent whitening agents
20/01/2020	**1**	9:20	17.0	33530	1.09	-	203	0.021	None
20/01/2020	**1A**	9:30	17.8	5220	14.80	-	1733	0.009	None
20/01/2020	**2**	10:00	14.3	151	1.55	0.10	387	0.044	None
20/01/2020	**3**	9:50	16.2	278	9.22	0.50	2420	0.023	-
20/01/2020	**4**	10:15	14.8	151	2.35	0.30	411	0.049	None
20/01/2020	**5**	10:35	13.5	151	2.88	0.20	133	0.046	None
20/01/2020	**6**	10:25	13.3	151	9.56	0.20	178	0.066	-
20/01/2020	**7**	10:47	13.1	144	1.32	0.10	12	0.035	-
20/01/2020	**8**	11:00	12.8	137	24.60	0.30	152	0.051	Slight
27/01/2020	**1**	912	18.1	23370	4.70	-	213	0.026	None
27/01/2020	**1a**	9:20	19.7	6640	5.51	-	866	0.010	Slight
27/01/2020	**2**	9:42	16.6	154	2.43	0.25	1414	0.050	Slight
27/01/2020	**3**	9:32	18.5	334	14.77	0.00	2420	0.028	-
27/01/2020	**4**	9:55	16.9	153	2.03	0.30	579	0.056	Slight
27/01/2020	**5**	10:25	15.7	154	2.36	0.20	141	0.053	Slight
27/01/2020	**6**	10:15	15.7	153	3.30	0.30	687	0.070	-
27/01/2020	**7**	10:38	15.6	147	1.22	0.20	43	0.040	-
27/01/2020	**8**	10:48	15.0	151	2.25	0.20	579	0.056	Slight
3/02/2020	**1**	11:55	17.7	48850	0.99	-	30	0.009	None
3/02/2020	**1a**	12:05	18.6	44380	1.86	-	6	0.012	Slight
3/02/2020	**2**	10:10	17.7	161	2.08	0.20	2420	0.049	Slight
3/02/2020	**3**	9:55	19.2	336	6.07	0.00	1553	0.041	-
3/02/2020	**4**	10:26	18.2	160	1.87	0.50	345	0.058	Slight
3/02/2020	**5**	11:06	17.7	161	1.98	0.10	816	0.055	None
3/02/2020	**6**	10:52	17.7	158	1.97	0.40	435	0.074	-
3/02/2020	**7**	11:24	17.4	153	0.96	0.10	50	0.044	-
3/02/2020	**8**	11:37	17.3	156	3.82	0.25	770	0.060	None
10/02/2020	**1**	10:35	14.2	2825	2.05	-	697	0.046	Slight
10/02/2020	**1a**	10:45	17.9	12240	4.93	-	1733	0.012	Slight
10/02/2020	**2**	11:15	14.1	154	1.05	0.20	816	0.046	Slight
10/02/2020	**3**	11:05	17.3	290	3.07	0.00	1203	0.043	-
10/02/2020	**4**	11:32	14.5	153	1.10	0.20	249	0.047	None
10/02/2020	**5**	12:05	13.1	154	1.24	0.40	199	0.044	None
10/02/2020	**6**	11:55	12.7	154	1.33	0.3	816	0.063	-
10/02/2020	**7**	12:22	12.6	147	0.67	0.1	72	0.034	-
10/02/2020	**8**	12:35	12.2	151	4.81	0.2	365	0.048	None
20/02/2020	**1a**	sampled by Ecan sampler for faecal source tracking					2420	-	-
20/02/2020	**4**						613	-	-

Appendix IV: FST results from ESR

ESR
Science for Communities

12 March 2020

To: Jarred Arthur
Environment Canterbury
PO Box 345
CHRISTCHURCH 8140

Email: Jarred.Arthur@ecan.govt.nz

From: ESR Christchurch Science Centre
PO Box 29181
CHRISTCHURCH 8540

Email: faecalsource@esr.cri.nz

REPORT ON FAECAL SOURCE TRACKING ANALYSIS

The following samples were received on 20th February 2020 and were analysed for faecal source PCR markers.

ESR Number	Date Sampled	Site Description	*E.coli* MPN/100mL
CMB200148	20/2/20 9:53	Site 1a	>2,420
CMB200149	20/2/20 10:06	Site 4	613

INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH LIMITED
Christchurch Science Centre: 27 Creyke Road, Ilam, Christchurch 8041 | PO Box 29181, Christchurch 8540, New Zealand
T: +64 3 351 6019 F: +64 3 351 0010
www.esr.cri.nz

Results of faecal source PCR Marker Analysis: Note this results table includes the results from our previous report dated 21st February 2020.

Please refer to the appendix for guidance on interpretation of these results

ESR Number	Description / Site ID	Sampled	*E. coli* MPN / 100mL	General GenBac / 100 ml	Human BacH / 100 ml	Human BiADO / 100 ml	Ruminant BacR / 100 ml	Proportion Ruminant	Ruminant Sheep / 100 mls	Ruminant Cow / 100 mls	Avian GFD / 100 ml
CMB200078	Site 1a	10/2/20		110,000	<33	<43	<36	NC	NA	NA	170
CMB200148	Site 1a	20/2/20	>2,420	2,200,000	800	<43	12,000	1-10%	<41	9	7,900
CMB200079	Site 4	10/2/20		17,000	160	<21	100	1-10%	NA	NA	43
CMB200149	Site 4	20/2/20	613	330,000	1,300	<21	39,000	50-100%	<21	150	200

Abbreviations: NA = sample was not analysed for this marker.
NC = not calculated
LOQ = limit of quantitation

Conclusions:

Site 1A: Much higher levels of faecal contamination were detected in the 20th February sample. An avian faecal source was detected on both sampling events but at much higher levels on the second occasion / 20th February. A ruminant faecal source was also detected in the 20th February sample but at relatively low levels. Further testing showed that cow faecal sources were contributing to this ruminant source. However, there was no evidence that this ruminant source derived from sheep and we cannot exclude other ruminant sources (goat and deer) also being present.

Site 4: As with site 1a, higher levels of faecal contamination were detected in the 20th February sample. Both avian and ruminant faecal sources were detected on both sampling events but at higher levels on the second occasion / 20th February. For the 10th February sample the ruminant faecal source was at relatively low levels, whereas on 20th February the relative levels were very high. As with site 1a, further testing showed that cow faecal sources were contributing to this ruminant source on 20th February. However, there was no evidence that this ruminant source derived from sheep and we cannot exclude other ruminant sources (goat and deer) also being present.

Notes:
Brief details of the methods of analysis are available on request.
These results relate to samples as received.
This report may not be reproduced except in full.

Paula Scholes
Laboratory Operations Technical Lead

Beth Robson
Principal Technician

APPENDIX: Assay Interpretation Guidance Notes

PCR Marker interpretation notes

- Each marker is strongly associated with, but not exclusive to the source tested for. They each have some degree of non-specificity.
- Each marker is a separate test and the levels of the various markers within the same sample cannot be compared. For example, if sample A has a BacH result of 1,000 and a BacR of 100 it is not valid to say there is more human contamination than ruminant in sample A.
- Levels of the same marker in different samples can be compared. For example;
    - If sample A has a BacH result of 1,000 and sample B has a BacH of 10,000 it is valid to conclude there is more human faecal contamination in sample B than in sample A; or
    - If site H sampled in January has a GFD result of 500 and when sampled in February has a GFD result of 10,000, it is valid to conclude the level of avian faecal contamination in February is greater.
    - To be classified as a significantly greater or lesser result the level of marker should vary by a factor of 10.
- Both Human markers are required to be present for a positive human result.
- Ruminant specific markers are reported using a percentage value based on levels of this marker relative to the general marker in fresh ruminant faeces.
    - Samples reported as 50-100% ruminant are consistent with all of the general faecal marker having come from a ruminant source.
    - The lower levels reported (10-50%) may be a consequence of the presence of other sources of pollution, or in fact ruminant sources may still account for all the pollution, but this may include aged faecal material where relative levels of the ruminant marker decline more rapidly than the general marker.
    - Levels less than 10% ruminant suggest a very minor contribution from ruminant sources.

The detection limits of these methods vary depending on the volume of water filtered for analysis. We recommend a minimum volume of 200 mls and a maximum of 1000 mls, this range gives the following detection limits:

mls sample filtered	General GenBac / 100 mls	Human BacH / 100 mls	Human BiADO / 100 mls	Human HumM3 / 100 mls	Ruminant BacR / 100 mls	Ruminant Sheep / 100 mls	Ruminant Cow / 100 mls
< 400 mls	<110	<83	<110	<8	<91	<100	<11
400-700mls	<42	<33	<43	<3	<36	<41	<5
700-1000mls	<21	<17	<21	<2	<18	<21	<2

mls sample filtered	Dog DogBac / 100 mls	Avian GFD / 100 mls	Avian E2 / 100 mls	Gull- 2
> 400 mls	<79	<72	<99	presence / absence test
400-700mls	<31	<29	<40	
700-1000mls	<16	<14	<20	

Valid as at: July 2017

FWA interpretation notes

The analysis of FWAs in septic tank and community wastewater consistently identifies levels between 10 and 70 µg/L. In previous analysis of water samples levels of FWA greater than 0.1 µg/L suggest human sewage, with levels greater than 0.2 µg/L strongly indicative of human sewage. Levels greater than 0.1 µg/L correlate well with other indicators of human pollution and indicate a local or recent source of pollution. FWAs degrade under sunlight exposure and will undergo dilution. Levels lower than 0.1 µg/L may be indicative of dilute or distant sources of human pollution.

Reference: Devane M., Saunders D. and Gilpin B. (2006). Faecal sterols and fluorescent whiteners as indicators of the source of faecal contamination. Chemistry in New Zealand 70(3), 74-7.
http://www.nzic.org.nz/CiNZ/articles/Devane_70_3.pdf

Faecal sterol Intepretation Notes:

Faecal sterol ratios must be interpreted with consideration to the levels of sterols, and relative to one another. For example H1 is typically also above 5-6% in ruminant faeces. Human and ruminant sources generally require at least two of three ratios to reach thresholds.
Plant sterols and mixed sources also have differing effects on sterol interpretations which must be considered.

Conclusions are the best interpretation of sterols in our opinion. Conclusions in **bold** are highly supported by the sterol data, conclusions in brackets are supported by sterol data with some variation from a pure source, or with a lower degree of certainty.

Ratio Key:

Ratios indicative of faecal pollution (either human or animal)		
F1	coprostanol/cholestanol..	>0.5 indicative of faecal source of sterols
F2	24ethylcoprostanol/ 24-ethylcholestanol.	>0.5 indicative of faecal source of sterols.
Human indicative ratios (values exceeding threshold in red)		
H3	coprostanol/ 24-ethylcoprostanol	Ratio >1 suggests human source
H1	% coprostanol	Ratio >5-6% suggests human source
H2	coprostanol/(coprostanol+cholestanol)	Ratio >0.7 suggests human source
H4	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio >0.75 suggests human source
Ruminant indicative ratios (values exceeding threshold in blue)		
R3	24-ethylcholesterol/24-ethylcoprostanol	Ratio <1 suggests ruminant source, ratio >4 suggests plant decay
R1	% 24-ethylcoprostanol	Ratio >5-6% suggests ruminant source
R2	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio <30% suggests ruminant source
Avian indicative ratios (values exceeding threshold in yellow)		
A1	24-ethylcholestanol/(24-ethylcholestanol+24-ethylcoprostanol+24-ethylepicoprostanol)	A1 Ratio >0.4 suggests avian source AND A2 Ratio >0.5 suggests avian source
A2	cholestanol/(cholestanol+coprostanol+epicoprostanol)	

Valid as at: July 2017

Appendix V: Wastewater survey for residents

Wainui Wastewater Survey 2019-2020

1. Is this property:

[a] Your usual residence: **Yes/No**
[b] Your own holiday home: **Yes/No**
[c] A rented holiday home: **Yes/No ***
[d] Other: **Yes/No** explain [e] _____

**** Note: If the respondent is a visitor in a rented holiday home, skip the questions marked with an asterisk below***

2. How many people are currently staying at this property?_____

*3. How many people usually live at this property?_____

4. What would be the maximum number of people at the house on any day over the holiday period?_____

*5. What is the size of the property?

[a] - <650m^2

[b] - 650m^2- 2000m^2

[c] - 2000m^2 – 5000m^2

*6. Age/year built of current house: [a]_____ [b] **known/estimated**

7. Number of bedrooms:_____

8. Number of toilets:_____

9. Number of baths: _____

10. Number of showers:_____

11. Washing machine? [a] **Yes/No**… and how often used? [b]_____

12. Dishwasher? [a] **Yes/No**… and how often used? [b]_____

13. Is there an in-sink kitchen waste disposal unit? **Yes/No**

14. Does the property have a septic system/onsite wastewater system? **Yes/No**

15. If **NO**, how is wastewater/sewage managed?_____

_____

*16. How old do you think the septic system is?_____

*17. How many separate septic systems do you have?_____

18. What sort of septic system does your property have?

Description of septic system	**System 1** ☑	**System 2** ☑
Septic tank	[1.a]	[2.a]
Storage tank	[1.b]	[2.b]
Vermiculture (worm-based) tank	[1.c.]	[2.c]
Chemical toilet	[1.d]	[2.d]
Composting toilet	[1.e]	[2.e]
Incinerating toilet	[1.f]	[2.f]
Disposal to dripper irrigation	[1.g]	[2.g]
Disposal to soakage trench	[1.h]	[2.h]
Disposal to sand bed	[1.i]	[2.i]
Other	[1.j]	[2.j]

19. What brand is the septic system? _____or **Don't know**

*20. When was the septic system last emptied (date)? _____ or **Don't know**

*21. Did the contractor give you a certificate to show work completed? **Yes/No**

*22. How frequently is it emptied? [a] **Annually** [b] **2-3yrs** [c] **3-5yrs** [d] **>5yrs** [e] **Never** [f] **Don't know**

*23. What service or maintenance do you do on your septic system? **None or detail:**____

_____

*24. Or is this done by a contractor? **Yes/No**

*25. How frequently do you/contractor service or maintain the system?

[a] **Monthly** [b] **6 monthly** [c] **Annually** [d] **3-5 years** [e] **Never** [f] **Don't know**

*26. Have repairs been made to the system? [a] **Yes/No.**

If **yes**, what type of repairs and when/by whom: [b] _____

_____

27. Have you ever observed failure of your onsite wastewater system (e.g., slow drainage from toilet, inside overflows, outside ponding, smells, boggy ground, soil collapse)? [a] **Yes/No.** If **Yes** please give details: [b] _____

_____

28. Does water from sinks, drains, shower, toilet, etc. block up at times? [a] **Yes/No**

If **Yes please** give details (when/frequency etc.): [b]_____

_____

29. Do you ever need to restrict your water use? [a] **Yes/No**

If **Yes** give details (why/when/frequency): [b] _____

_____

30. Do you use chemicals or chemical treatments for your septic system? [a] **Yes/No**

If **Yes** give details: [b] _____

31. Where is greywater (kitchen, laundry, bathroom water) discharged? (into the wastewater system or separately?) Where?_____

32. Do you practice **greywater** recovery or reuse (e.g. of bath, shower, basin, laundry water)? [a] **Yes/No**

[b] If **YES**, how do you do this?_____

[c] What brand is the greywater system?_____

[d] Who installed the greywater system?_____

33. What is your drinking-water source (e.g., reticulated [Council supply], roof water, private bore etc.)? _____

34. Are you aware of problems with septic systems in the neighbourhood? [a] **Yes/No**

Please provide details: [b] _____

_____

35. Have you seen any situation where sewage has been visible on the ground surface or in drains? _____

36. Have you seen any situation where sewage has been evident in the stream or the bay?

_____

*37. Have you or members of your household had any gastro-type illness in the last 30 days? [a] **Yes/No**

If **Yes** detail: [b] _____

_____

[c] Did you seek medical attention for this? **Yes/No**

[d] Was a cause found? **Yes/No**. If **Yes**, detail: [e] _____

38. Do you have any further comments about onsite septic systems for wastewater management in Wainui?

_____

_____

_____

Appendix VI: Project information sheet for survey respondents

Waterways Centre for Freshwater Management
Telephone: +64 3 3692545

Email: edward.challies@canterbury.ac.nz

20 December 2019
HEC Ref: 2019/165

Wainui wastewater survey, summer 2019

Information Sheet for survey participants

We are researchers working through the University of Canterbury (UC) on a project supervised by Dr Edward Challies and Dr Brett Robinson, to gain an overview of the current situation with wastewater management in Wainui. The research has been commissioned by the Christchurch City Council (CCC) and Environment Canterbury Regional Council (ECan). We are conducting a brief door-to-door survey of occupants of properties in Wainui over the period between Christmas and New Year 2019 to ask about the occupancy of dwellings and the use and operation of domestic wastewater systems. We will also be testing water quality in Wainui Stream to see if there is any contamination from wastewater.

You have been approached to take part in this study because you are staying at a property in Wainui over the summer holiday period. We are canvassing most properties in the area.

If you choose to take part in this study, we would ask for up to 15 minutes of your time, so we can answer any questions you might have about the research, and then ask you a series of questions about the property, occupancy, water use, and wastewater management. We will note down your responses as we go.

Participation is entirely voluntary and you have the right to withdraw at any stage without penalty. You may ask for any information we have collected to be returned to you or destroyed at any point. If you withdraw, we will remove any information relating to you. However, as we will not be associating your identity with your responses, it will not be possible to remove your data after conclusion of the survey.

The data we collect will be combined and will go into a final report which will be supplied to CCC and ECan, and also shared with Wainui residents – including you if you wish. The report may also be published, but you may be assured of the complete confidentiality of data gathered in this study: neither your identity nor this property will be revealed in the report or made public in any way. The aim is to get an overview of current systems and issues, and not to pinpoint any persons or properties. To ensure confidentiality, only the UC research team will have access to the raw data and consent forms. In the final report, the findings will be presented in such a way that no responses can be linked to particular properties. We take confidentiality very seriously, and will store all data securely on password-protected University servers or locked University facilities. All data will be securely destroyed after 10 years in accordance with UC policy.

Please indicate on the consent form if you would like to receive a copy of the summary of results of the project.

The project is being carried out for CCC and ECan at the request of the Banks Peninsula Zone Committee under the supervision of Dr Edward Challies and Dr Brett Robinson. Dr Challies can be contacted at edward.challies@canterbury.ac.nz, or 03-3692545, and will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee. Please address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and hand it to the researchers.

Thank you very much for your time.

Appendix VII: Consent form for residents survey

Waterways Centre for Freshwater Management
Telephone: +64 3 3692545
Email: edward.challies@canterbury.ac.nz
20 December 2019
HEC Ref: 2019/165

Wainui wastewater survey, summer 2019

Consent Form for survey participants

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me if I agree to take part in the research.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information I have provided should this remain practically achievable.
- ☐ I understand that any information or opinions I provide will be kept confidential to the research team, and that published results will not identify particular participants or properties.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after ten years.
- ☐ I understand that I can contact the research supervisor, Dr Edward Challies (edward.challies@canterbury.ac.nz, 03-3692545) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)
- ☐ I would like a summary of the results of the project, and provide my email address below for this purpose.
- ☐ By signing below, I agree to participate in this research project.

Name:_____Signed:_____Date:_____

Email address:_____

(only required if you wish to be sent a copy of the results)

Please hand this consent form back to the researchers. Thank you.

Appendix VIII: Residents survey – Raw responses

The tables below provide responses to selected questions (where there were useful responses).

23. What service or maintenance do you do on your septic system?

- *None (n=47)*
- 15 years ago- needed some work
- Constantly monitored to ensure it is operating correctly - checked daily/ every second day to see if overflowing or any other problem
- Dig out boulder hole
- Dip stick to check the level
- Pumps replaced
- Visual check
- Visual check; New lid
- Regular checks (self and contractor)
- Cleaned out/ pumped out
- Wash/flush out
- Minor maintenance (contractor checks the system)
- Checked and emptied
- Clean out; New macerators; Visual check
- General maintenance (change parts out once a year)
- Twice a year garden lime put in

26.b. What types of repairs have been made to the system and when/by whom?

- *None (n=41)*
- *Don't know (n=4)*
- Failed drains replaced in 2012, new pipes put in by a contractor
- Standard maintenance, 15 years ago
- Replacement of pumps, repairs made as required, depending on repair it is done by grounds keeper
- Extra field tiles and drainage systems in construction with Eliot Sinclair
- Boulder hole dug out bigger
- Pumps/ Robsons
- New pumps by a contractor
- Re-patched piping
- The lid was fixed recently by the home owner
- Off flow blocked up in 1996 - fixed by a contractor

- Post earthquake, resetting of the joints
- Fill drain broke 18 years ago - installed storage tank
- New pumps
- 12 years ago lid repaired; Scraped the sides and checked for cracks in the septic tank
- Pipings
- Macerator (done by a contractor - 6 month ago)
- Check-up and simple fixes (e.g. tiles realigned)
- 3-4 times in 20 years - had to get something fixed/replaced (all minor problems)

27. Have you ever observed failure of your onsite wastewater system (e.g., slow drainage from toilet, inside overflows, outside ponding, smells, boggy ground, soil collapse)?

- *None (n=47)*
- *Don't know (n=1)*
- Smells only when put wet wipes down into the system - Have stopped doing that now and there is no issue of smells
- Smells in wet weather, especially large rains
- On occasion, blocked toilet from people putting stuff into toilet that blocks it, rarely is true
- The wastewater system used to smell, but fixed by digging larger boulder hole
- Outside ponding from plumbing problems
- Fat trap clogged up, fixed by diverting
- Smelled 2 months ago
- Outside ponding in 2015 - hasn't happened since
- Outside ponding 16 years ago
- Blocked toilet
- Smells
- After large amount of rain, toilet water level was high
- Smells after large water use
- Smells

28. Does water from sinks, drains, shower, toilet, etc. block up at times? Please give details.

- *No (n=56)*
- *Don't know (n=1)*
- Blocked drains. Large system so occasional blockages are common, but not in main

system. 10 years ago main line had blockage.

- When pump was not working
- Not often - happened 27th Dec
- Slow drainage
- When families are here during Xmas
- Three years ago the drainage pipe blocked

30. Do you use chemicals or chemical treatments for your septic system?

- *No (n=46)*
- *Don't know (n=1)*
- Adding yeast to the tank
- Bokashi leachate
- Bio Tab 1T septic treatment (once every three months)
- Drain clean pellets and Aqua Kem Blue
- Tablets (Septic Fizzytabs)
- Septic tank friendly
- Nothing other than toilet paper down the toilet and use eco-friendly toilet cleaner
- Biogest septic tank activator
- Bag of powder
- Very infrequently (every 3 years)
- Tablets
- Organic matter (fish scraps)
- Pills
- Liquid bacteria
- Pills and roadkill
- Once per year - don't want to but grandma puts it in
- Lime for the long drop

31. Where is greywater (kitchen, laundry, bathroom water) discharged? (into the wastewater system or separately?)

- *Wastewater system/Septic tank (n=38)*
- *Don't know (n=8)*
- Soak pit
- Irrigation to garden
- There is a grease trap, and then it goes down the valley

- Separately - grease trap
- Irrigation to garden
- Soak pit
- Holding tank disperses out in disposal field with piping (irrigation)
- Holding tank that is released via piping/ overflow into garden
- Drip lines in front of the property
- Soak line
- Soak pit
- Soakage trench outside the house
- Disposal to drip system
- Grease trap - not sure where else
- Irrigation and some ends up in stromwater drain down the street
- Separately - outside the property - down hill
- Soak pit

34. Are you aware of problems with septic systems in the neighbourhood?

- *No (n=40)*
- Heard people talk about it!
- When there are large rains, smells at the bottom of the hill (stream by beach)
- Some systems have problems (heard through the grapevine)
- Some people struggle with their septic systems
- Some people don't have a right system in place
- People talk about their system not being a "proper" system
- The ground is not suitable for septic tanks / 35 homes have long drops
- Clay pit septic systems/ broken septic systems are not getting repaired as council keeps saying they will put in a system but never did
- There are rumours about longdrops that may leach into the creek
- A lot don't comply septic runoff higher than it should be
- People have issues with systems breaking down
- They are all old
- Overflow onto lawns
- Systems are older than 50 years old - lots of repairs need to be done
- Only in the loop at the Wainui Creek
- Rumours - leaky toilets etc.
- YMCA stinks when full house
- YMCA camp, periodically - 28/12/2019 smells bad & around every Christmas (when

under pressure)

- Holding tanks that are too small overflow - most systems are too old
- 50 year old systems that need pumping out
- Clay pit septic systems

35. Have you seen any situation where sewage has been visible on the ground surface or in drains?

- *No (n=47)*
- Sewage in drain
- YMCA (over 8 years ago)
- YMCA 10 years ago
- The small stream smells sometimes
- Sewage running down the road from YMCA (think it was from YMCA)
- Not for years - 15 years ago
- Only YMCA was smelly
- Water cress growing in drains. Some tanks smell
- Yes - in properties where they are waiting for the CCC sewage system
- Yes - 3 years ago - up the Wainui Valley Road
- Yes - all around the place; however, wasn't until septic tank over flow 1-4 years ago
- Can smell but cannot see
- Yes by the YMCA discharge
- It comes and goes - leachate has gone across the road and into gutters (4 years ago, happened every month before 2015)
- Outside YMCA - smells, coloration in the outlet/drain (storm water drain)
- Yes - from YMCA camp. Massive overflow. Came down the open drain (stormwater)

36. Have you seen any situation where sewage has been evident in the stream or the bay?

- *No (n=54)*
- Smells from the pipes that discharge into the stream
- Cow dung and murky/dirty water in Wainui Stream
- In large rain events, sand gets "discoloured"
- French farm toilets cracked (2017), sewage leached into bay
- YMCA had sewage leaching down the open drain a while ago
- Tourist poo in/on the beach and in changing room and in bushes

- Seaview Lane
- Only in the loop at the Wainui Creek
- Yes - in the stream (smells and toilet paper)

38. Do you have any further comments about onsite septic systems for wastewater management in Wainui?

- Would like to be on a sewerage system
- Wainui wastewater treatment system needs to be modernised
- We don't want the council to put in a wastewater treatment plant, as the plan was to build it next to our place
- Take chlorine out of the drinking water
- Please put a wastewater system for Wainui
- Keen for council to put in a system as less maintenance for our system
- Our system seems to work well
- Would like guidance on what is going to happen/ What to do/ There are questions about the safety and cleanness of Seaview systems / Should we invest in something better for our wastewater system privately (i.e. newer and better septic tanks) or wait for the Council to put a system in? Keen to have the Council put in a system.
- Would like the Council to check on the systems to make sure they are proper (actually work). Don't want the new Council system, as don't want 50+ houses built here.
- Clay isn't suitable for septic tanks, should be connected to Council systems
- Everyone is waiting on the Council to do something. Give people direction on what is happening and what to do. Will they replace the systems or not?
- Hurry up with the sewage system!
- Waiting for it to be connected properly (Council)
- Want sewage system from Council
- Want to know what the Council is doing!
- Council get on with our wastewater system!
- Support going off septic tank
- Get on with the Council system
- Between Council and ECan they should make it easier to get consent to put in a wastewater system. It costs too much to get consent. Cost of compliance is ridiculous, causes people to not comply.
- Trying to learn more about wastewater systems
- We are just house guests so don't know anything about the area
- Happy with what we have

- It's time for the Council to put in a system
- Bring it on, get on with it. Not interested in paying more for the Council to put in a system. Concerned that it is taking too long for them to put in a system (which is bad for the environment).
- The system works well at the moment
- Hope to get on the line one day (Council to put in a system)
- Decisions needs to be made if the Council is going to put in a system or not.
- Wainui must have a sewage system. Many properties have old dysfunctional and broken systems, as they believed the Council will install a system. This has been put on hold for years. Please do it now. Our tank costs $600 a year to empty, the cost of a sewage system would be similar.
- Although we don't have issues, we anticipate a Council sewer system
- The community needs a firm answer on a Council system so they can effectively plan repairs
- Council system would be good
- The system works very well. It's old but I have had no problems... it does not get much use
- Akaroa and Wainui shut be shut down until it is fixed
- Need proper conditions to stop leakage into bay
- Would be great if there was a main sewage system
- The existing systems seem to work for everyone - never had a problem - just the YMCA smells when under pressure
- Divided community about if they want Council's system
- Hoping to be connected to a Council wastewater management system
- Good to have a town system for wastewater
- Council should put a system in
- The system works fine
- I would like to be educated on whether I am doing the right thing with our wastewater system. Is it bad? Is it working well?
- The system functions well
- Make a decision on what they want to do (Council) with the wastewater system.

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