Chatham Island Water Quality Summary – March 2016

Water quality monitoring is carried out for a number of streams, lakes and lagoons of Chatham Island for physico-chemistry and microbial water quality on a regular long term basis, to assess the current state of the islands natural waterways, and detect short and long term trends.

Water quality is monitored at 14 stream sites and 8 lake or lagoon sites on the main Chatham Island (Figure 1). Te Whanga Lagoon is monitored at 3 sites, while all other streams and lakes are monitored at one site each.



Figure 1: Routine water quality monitoring sites for streams and lakes or lagoons on Chatham Island

Water quality monitoring state and trends

Long term water quality results were analysed for current state based on 5 years of monitoring data; and long term trends based on 11 years of monitoring data, since monitoring began in April 2005. The current state is represented by box plots in Appendix 1 which portray the median as the middle line (50th %ile), the inter quartile range where 50% of central values fall as the box, the non-outlier minimum and maximum as whiskers, and outliers and extremes as discrete points. Appendix 2

represents long term trends as analysed by a seasonal kendall test for significant increases or decreases (represented by Δ for significant increase or $\mathbf{\nabla}$ for significant decrease) and the magnitude of change represented by the relative sen slope estimator (>1 = meaningful).

Dissolved Oxygen

Streams, lakes and Te Whanga Lagoon on Chatham Island are generally well oxygenated with the exception of Washout Creek and Whangamoe Inlet Stream, which often experience decreased dissolved oxygen concentrations, as a potential result of river mouth closures. Dissolved oxygen concentrations have been fairly steady over the 11 years of monitoring with only Blind Jims Creek showing a significant and meaningful increase.

Water Temperature

Water temperature is fairly consistent between streams; and the lakes and lagoon, with the shaded Awatōtara Stream, and Mangahōu Stream slightly cooler than other streams. No significant trends have been detected for water temperature variation.

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For many streams on Chatham Island the pH indicates acidic water, typical of peat soils. Waitaha, Blind Jims Creek, Waitāmaki Creek, Waimāhana Creek and Mangapē Creek have a more buffered pH similar to those found in Canterbury, indicating the influence of differing geology throughout the island, and a decrease of peaty soils at these sites. pH is most acidic for Awatōtara Creek which is located within a peaty catchment. pH of the lakes and Te Whanga Lagoon sites on Chatham Island are fairly similar with median concentrations ranging from 8-9 pH. pH has been fairly steady over the 11 years of monitoring with only Te Whanga Lagoon at Blind Jims Creek and the Southern Basin showing a significant and meaningful increase.

Dissolved Organic Carbon

Similar to pH, dissolved organic carbon (DOC) concentrations differ for Blind Jims Creek, Waitāmaki Creek, Waimāhana Creek and Mangapē Creek, in comparison to other streams on Chatham Island. The volcanic peaty make up of soils on the island influence the leaching of organic matter, contributing to elevated DOC concentrations for many of the streams on the island. Inflow streams on the north western edge of Te Whanga Lagoon show lower DOC concentrations where the catchment is comprised of less peaty soils and organic matter is likely reduced via filtration by the more sandy soils of this area.

In comparison to the streams of the island, the lakes and Te Whanga Lagoon sites have much lower DOC concentrations, with the exception of Lake Te Wāpu, which has much greater concentrations that all the other lake and lagoon sites. DOC has not shown any significant change in either the stream or lake/lagoon sites over the past 11 years of monitoring.

Nutrients

Phosphorus – Dissolved reactive phosphorus (DRP) concentrations are greatest for Washout Creek, Whangamoe Inlet Stream and Waimāhana Creek, with significant and meaningful increases of DRP for Waimāhana Creek over the past 11 years. Total phosphorus concentrations reflect the DRP concentrations for Washout Creek, Whangamoe Inlet Stream and Waimāhana Creek. Additionally, total phosphorus is elevated for, Waitāmaki Creek and Mangapē Creek in comparison to their dissolved reactive phosphorus concentrations, indicating increased particulate phosphorus. Elevated particulate phosphorus is potentially due to organic matter, increased run-off and soil erosion, or bankside disturbance. However, total phosphorus is significantly and meaningfully decreasing for Mangapē Creek.

Dissolved reactive phosphorus concentrations are greatest for Lake Hurō and Te Whanga Lagoon at Blind Jims Creek and Waitāmaki Creek, however only Lake Te Wāpu and Lake Hurō have elevated total phosphorus concentrations. It is likely that the elevated TP concentrations in Lake Te Wāpu are driven by particulate phosphorus given the DRP concentration is low. These results mirror the elevated DOC concentrations in the lake and it is likely the particulate phosphorus is bound in organic matter which would also be driving the high DOC concentration. Total phosphorus concentrations for Lake Hurō, Lake Marakapia and Te Whanga Lagoon at Blind Jims Creek, Waitāmaki Creek and the southern basin show significant and meaningful decreasing trends over the past 11 years.

Nitrogen – Dissolved inorganic nitrogen (DIN) and total nitrogen concentrations are greatest for Washout Creek, Mangapē Creek and Lake Hurō and Lake Te Wāpu. Long-term nitrogen trends vary among the island. Awaīnanga River shows a significantly and meaningfully decreasing trend for DIN, while Awamata Stream, Awatōtara Creek, the North Tributary of Rakautahi Stream, Blind Jims Creek, Te One Creek and Waimāhana Creek are increasing for total nitrogen indicating an increase of organic nitrogen. Lake Rangitai shows a significant and meaningful decrease for total nitrogen, while Tenant's Lake shows a significant and meaningful increase for total nitrogen.

Chlorophyll a

Chlorophyll *a* concentrations for the lakes and Te Whanga Lagoon sites reflect the levels of nutrient enrichment of each site. Chlorophyll *a* concentrations are greatest for Lake Te Wāpu and Lake Hurō, where nitrogen and phosphorus concentrations are greatest. A significant and meaningful decrease of chlorophyll *a* concentrations for Lake Hurō and Te Whanga Lagoon at Blind Jims Creek, and the southern basin are likely related to decreases of TP.

Water Clarity

Water clarity (measured by a clarity tube) of the streams on Chatham Island are heavily influenced by leaching from the peaty organic soils, therefore show similar trends among sites to DOC concentrations. The clearest of streams are those with the lower DOC concentrations such as Blind Jims Creek, Waitāmaki Creek and Waimāhana Creek, where the sandy soils of the stream catchments filter out particles that may reduce water clarity. Conversely, Mangapē Creek has reduced water clarity, but low DOC concentrations, suggesting the source of reduced water clarity is more related to suspended particles such as sediment, rather than discoloration of water from leaching of peat soils. Sources of suspended particles may be related to overland flow and unrestricted stock access. However, water clarity for Mangapē Creek is significantly and meaningfully improving. Additionally, water clarity for Whangamoe Inlet Stream and the North Tributary of Rangitai Stream is significantly and meaningfully improving.

Water clarity in the lakes and Te Whanga Lagoon is more related to in-lake nutrient and chlorophyll *a* concentrations, where water clarity is influenced by algal production, supported by nutrient enrichment. Water clarity for Lake Te Wāpu and Lake Hurō reflect increased chlorophyll *a* concentrations. These chlorophyll *a* concentrations indicate increased algal production that requires elevated nutrient concentrations to support and promote algal growth; and limits the visible water clarity of a lake.

Water clarity is significantly and meaningfully increasing for both Te Whanga Lagoon at Blind Jims Creek and Lake Hurō in response to decreasing trends of chlorophyll a and nutrient concentrations over the past 11 years.

Lake Eutrophication

The trophic level index for lake and lagoon sites of Chatham Island is a calculation derived from annual average total nitrogen, total phosphorus and chlorophyll *a* concentrations; used to indicate the level of eutrophication. The supertrophic and hypertrophic states of Lake Hurō and Lake Te Wāpu reflect the nutrient enrichment, and subsequent elevated chlorophyll *a* concentrations and reduced water clarity. Te Whanga Lagoon shows a recent improvement of eutrophication over recent years at all three sites, reflecting the significant decline of TP in particular, however the Southern Basin site has recently returned from a mesotrophic state to a eutrophic state (Tables 1 and 2).

Site Name	2010-11	2011-12	2012-13	2013-14	2014-15	
Tenant's Lake	Eutrophic	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	
Lake Hurō	Hypertrophic	Supertrophic	Supertrophic	Eutrophic	Supertrophic	
Lake Marakapia	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	
Lake Rangitai	Eutrophic	Mesotrophic	Mesotrophic	Oligotrophic	Oligotrophic	
Lake Te Wāpu	Hypertrophic	Supertrophic	Supertrophic	Supertrophic	Hypertrophic	
Te Whanga Lagoon - Blind Jims Creek	Supertrophic	Supertrophic	Eutrophic	Mesotrophic	Mesotrophic	
Te Whanga Lagoon - Southern Basin	Eutrophic	Eutrophic	Mesotrophic	Mesotrophic	Eutrophic	
Te Whanga Lagoon - Waitāmaki Creek	Eutrophic	Eutrophic	Mesotrophic	Mesotrophic	Mesotrophic	

Table 1: Annual Trophic State for Lake and Lagoon sites of Chatham Island

Table 2: Description of Trophic States

TLI	Tropic state	General Description
<1	Ultra-microtrophic	practically pure, very clean, often have glacial sources
1-2	Microtrophic	very clean, often have glacial sources, very low nutrient enrichment
2-3	Oligotrophic	clear and blue, with low levels of nutrients and algae
3-4	Mesotrophic	moderate levels of nutrients and algae
4-5	Eutrophic	green and murky, with higher amounts of nutrients and algae
5-6	Supertrophic	very High nutrient enrichment and high algae growth
>6	Hypertrophic	saturated in nutrients, highly fertile, excessive algae growth

Microbial Water Quality

Microbial water quality is monitored for faecal indicator bacteria such as *Escherichia coli* in freshwater, and both *E. coli* and *Enterococci* in water with a saline influence such as Te Whanga Lagoon and the Nairn River at the mouth. Generally, stream sites such as Mangapē Creek and Nairn River had the greatest faecal indicator bacteria concentrations, as opposed to the lagoon and Lake Rangitai. Both Mangapē Creek and Nairn River are likely influenced by overland run-off and unrestricted stock access in grazed pasture catchments. Occasional spikes in *E.coli* for Te Whanga Lagoon at Blind Jims Creek may be caused by re-suspension of benthic sediment reservoirs of faecal bacteria during strong wind, or unrestricted stock access combined with run-off near the lakes edge. *E.coli* is showing a significant and meaningful decreasing trend for Te Whanga Lagoon at the Southern Basin. This site generally has the lowest *E.coli* concentrations.

National Policy Statement – National Objectives Framework

The National Policy Statement (NPS) was initially released in 2014 with the intention to set objectives and policies for the management of freshwater at a national level throughout New Zealand and to direct local councils towards establishing objectives and limits. The National Objectives Framework (NOF) within the NPS provides a framework of numeric values and attribute states for freshwater management, and sets national bottom lines of minimum acceptable states for the compulsory values of ecosystem health and human health for recreation. The framework is structured in a grading based format from A to D, with the D category being below the national bottom line state. For more information refer to "National Policy Statement for Freshwater Management 2014" (MfE, 2014).

For streams in Chatham Island, nitrate-nitrate-nitrogen (NNN) for all sites falls within the "A" attribute state, indicating that nitrate toxicity is of little concern for these streams with unlikely effects, even on sensitive aquatic species (Table 3). However, ammonia toxicity results are more variable, with some streams falling within the 'B' and 'C' categories, where some sensitive aquatic species may be impacted by elevated ammonia concentrations. Neither NNN nor ammonia concentrations for streams on Chatham Island fall below the national bottom line for these parameters.

For lake and lagoon sites monitored on Chatham Island, ammonia toxicity results are variable among sites with Lake Rangitai, Tennants Lake, and Te Whanga Lagoon at Waitāmaki Creek and the Southern Basin within the 'A' attribute state, indicating minimal concern of species loss due to ammonia toxicity at these sites. However, Lake Te Wāpu, Lake Marakapia, Lake Hurō, and Te Whanga Lagoon at Blind Jims Creek fall within the 'B' and 'C' attribute states, indicating a potential impact of ammonia toxicity on sensitive species. For total nitrogen in lakes and lagoons, there was an even mix of sites between the 'B', 'C' and 'D' bands with Lake Te Wāpu and Lake Hurō falling below the national bottom line objective. Total Phosphorus for Lake Te Wāpu, Lake Hurō and all three Te Whanga Lagoon sites fall within the 'C' attribute state, which is mirrored by Chlorophyll *a* attributes state of 'B' and 'C' for these sites. This indicates a risk of excessive algal or plant growth at these sites, due to impacts of elevated nutrients.

For the two streams monitored for *Escherichia coli* on Chatham Island, one of each falls within the 'A' and 'B' categories for activities involving occasional immersion, indicating a low to very low risk of infection from contact with water, however for activities involving full immersion, neither site falls within the minimum acceptable state. For lake sites, four sites are monitored for *Escherichia coli*. All four sites fall within the 'A' attribute state for activities involving partial immersion, indicating a very low risk of infection from contact with the water. However, two of the four sites, Lake Rangitai and Te Whanga Lagoon at Blind Jims Creek both fall below the minimum acceptable state for activities involving full immersion.

	NNN	NH4-N	TN	ТР	Chlorophyll a	E.coli	
	Summary	Summary	Summary	Summary	Summary	Median	95th % ile
Awamata Stream	А	В					
Awatōtara Creek	А	А					
Te Awainanga River	А	В					
Washout Creek	А	В					
Whangamoe Inlet Stream	А	В					
North Trib Rakautahi	A	А					
Waitaha Creek	А	С					
Blind Jims Creek	А	В					
Waitāmaki Creek	A	В					
Waimāhana Creek	А	А					
Mangapē Creek	А	В				А	*
Mangahōu Stream	A	А					
Te One Creek	А	А					
Nairn River						В	*
Lake Rangitai		А	В	А	А	А	*
Lake Te Wāpu		В	D	С	С		
Tennants Lake		А	С	А	А		
Lake Marakapia		В	С	В	А		
Lake Hurō		В	D	С	С		
Te Whanga Lagoon - Blind Jims Creek		С	С	С	С	А	*
Te Whanga Lagoon - Waitāmaki Creek		А	В	С	С	А	А
Te Whanga Lagoon - Southern Basin		A	В	С	В	A	A

Table3: National Objective Frag	mework Attribute States for Strea	ams and Lakes on Chatham Island
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Appendix 1Box and Whisker plots of current state for Streams, and
Lakes and Lagoons on Chatham Island (5 years)









Site Name



	Dissolved Reactive Phosphorus	Dissolved Inorganic Nitrogen	Total Nitrogen	Total Phosphorus	Dissolved Organic Carbon	Clarity Tube	Dissolved Oxygen % saturation	рН	Water Temperature	Chlorophyll a	E. coli	Enterococci
Awamata Stream	NS	NS	Δ* 5.50644	NS	NS	NS	NS	NS	NS			
Awatotara Creek	NS	NS	Δ*** 8.94189	NS	NS	NS	NS	NS	NS			
Te Awainanga River	NS	▼ ** -5.62267	NS	NS	NS	NS	NS	NS	NS			
Washout Creek	NS	NS	NS	NS	NS	NS	NS	NS	NS			
Whangamoe Inlet Stream	NS	NS	NS	NS	NS	Δ** 5.1748	NS	NS	NS			
North Trib Rakautahi	NS	NS	Δ** 9.094	NS	NS	Δ* 3.5379	NS	NS	NS			
Blind Jims Creek	NS	NS	Δ* 11.493	NS	NS	NS	Δ*** 1.7909	NS	NS			
Waitaha Creek	NS	NS	NS	NS	NS	NS	NS	NS	NS			
Mangape Creek	NS	NS	NS	▼* -6.17836	NS	Δ* 3.5379	NS	NS	NS		NS	
Mangahou Stream	NS	NS	NS	NS	NS	NS	NS	NS	NS			
Te One Creek	NS	NS	Δ* 5.231	NS	NS	NS	NS	NS	NS			
Waitamaki Creek	NS	NS	NS	NS	NS	Δ^{***} 7.5965	NS	NS	NS			
Waimahana Creek	Δ** 9.23876	NS	Δ** 7.205	NS	NS	NS	NS	NS	NS			
Tennants Lake	Insufficient data	Insufficient data	Δ* 5.77125	NS	NS	Δ^* 0	NS	NS	NS	NS		
Te Whanga Lagoon - Blind Jims Creek	Insufficient data	Insufficient data	NS	▼*** -21.957	NS	Δ*** 6.316	NS	Δ^{*} 0.599	NS	▼*** -29.35578	NS	NS
Lake Rangitai	Insufficient data	Insufficient data	▼* -5.04987	NS	NS	NS	NS	NS	NS	NS	NS	
Lake Huro	Insufficient data	Insufficient data	NS	▼*** -14.064	NS	Δ* 11.551	NS	NS	NS	▼*** -25.285		
Te Whanga Lagoon - Waitamaki	Insufficient	Insufficient	NS	▼***	NS	NS	NS	NS	NS	NS	NS	NS
Creek	data	data	110	-13.001	115	110	115	110	110	115	115	115
Lake Te Wapu	Insufficient data	Insufficient data	NS	NS	NS	NS	NS	NS	NS	NS		
Lake Marakapia	Insufficient data	Insufficient data	NS	▼** -11.251	NS	NS	NS	NS	NS	NS		
Te Whanga Lagoon - Southern Basin	Insufficient data	Insufficient data	NS	▼ ** -9.323	NS	NS	NS	Δ* 1.013	NS	▼* -11.9268	▼ * -56.60	NS
Nairn River											NS	NS

Appendix 2 Long term trends for streams, lakes and lagoons on Chatham Island (11 years)

NS = not significant * P<0.05 ** P<0.01 *** P<0.005 Insufficient data = Insufficient data (<10 years) required for trend analysis