OTAGO REGIONAL COUNCIL

Agenda for a meeting of the Technical Committee to be held in the Council Chamber, 70 Stafford Street, Dunedin on Wednesday, 14 June 2017, following the Finance and Corporate Committee

Membership:

Cr Stephen Woodhead (Deputy Chairperson)
Cr Graeme Bell
Cr Doug Brown
Cr Michael Deaker
Cr Carmen Hope
Cr Trevor Kempton
Cr Michael Laws
Cr Sam Neill
Cr Andrew Noone
Cr Gretchen Robertson
Cr Bryan Scott

Apologies:

In attendance:

Please note that there is an embargo on agenda items until 10:00am on Monday, 12 June 2017

CONFIRMATION OF AGENDA

CONFLICT OF INTEREST

PUBLIC FORUM

MINUTES

Minutes of the meeting held on 3 May 2017, having been circulated for adoption.

ACTIONS

Status report of resolutions of the Technical Committee.

Report No.	Meeting	Resolution	Status

PART A PRESENTATIONS

Yellow-eyed Penguin Trust presentation on conservation science work
Eric Shelton, Trust Board Chair
Sue Murray, General Manager
Trudi Webster, Science Advisor

PART B ITEMS FOR NOTING

Item 1
2017/0802 **Director's report on progress**, DEHS, 08/06/17 5- 14

The report provides information on: Alpine lakes and lake snow; climate change adaption; geomorphic change detection; flood forecasting capabilities; Owhiro Stream flood hazard investigation; Leith Flood Protection Scheme

Item 2
2017/0844 **Trophic Level Status of Lake Waipori and Lake Waihola**, DEHS, 08/06/17 15- 17

The covering report summarises the trophic level monitoring undertaken between 2014 and 2016, water quality data collected over the three periods: 1997-1998; 2002-2004; and 2014-2016, and the water quality results.

The full ORC technical report entitled *"Lake Waipori and Lake Waihola Trophic Level Status"* is circulated separately with the agenda.

Item 3
2017/0848 **Waiwera River Catchment Water Quality Study**, DEHS, 02/06/17 18- 20

The covering report summarises the findings of the water quality study report.

The full ORC technical report entitled *"Water Quality Study: Waiwera River Catchment"* is circulated separately with the agenda.

OTAGO REGIONAL COUNCIL

Minutes of a meeting of the Technical Committee held in the Council Chamber, 70 Stafford Street, Dunedin on Wednesday, 3 May 2017, commencing at 12:05pm

Membership: **Cr Stephen Woodhead** (Deputy Chairperson)
Cr Graeme Bell
Cr Doug Brown
Cr Michael Deaker
Cr Carmen Hope
Cr Trevor Kempton
Cr Michael Laws
Cr Sam Neill
Cr Andrew Noone
Cr Gretchen Robertson
Cr Bryan Scott

Apologies: Nil

In attendance: Nick Donnelly
Scott MacLean
Caroline Rowe
Fraser McRae
Lauren McDonald (Committee Secretary)

CONFIRMATION OF AGENDA
No changes to the agenda**.**

CONFLICT OF INTEREST
No conflict of interest advised.

PUBLIC FORUM
No public forum held.

MINUTES

Minutes of the meeting held on 22 March 2017, having been circulated were adopted on the motion of Crs Neill and Bell

Cr Laws left the room at 12:06pm

ACTIONS

Status report of resolutions of the Technical Committee.

Report No.	Meeting	Resolution	Status
2016/1138 Terms of Reference for the Technical Committee	23/11/16	*That the Terms of Reference for the Technical Committee be considered a final version to be presented to the Council on 7 December 2016 for adoption*	Terms of Reference adopted by Council 7/12/16 CLOSED

PART A ITEMS FOR NOTING

Item 3
2017/0739 **Director's report on progress**, DEHS, 20/04/17

The report provided information about the Clutha bioenergetics and instream habitat modelling; weather events; Leith Flood Protection Scheme, and the Dunedin City District Plan Natural Hazards.

Cr Laws returned to the room at 12:10pm.

Discussion was held on the flood management response to the 12-14 April 2017 rain event. Council staff were thanked for their organisation and communications during the event.

Cr Scott left at 12:12pm and returned at 12:14pm

Moved Cr Hope
Seconded Cr Noone

That this report is noted.

Motion carried

The meeting was declared closed at 12:19pm

Chairperson

REPORT

Document Id: A1002482

Report Number: 2017/0802
Prepared For: Technical Committee
Prepared By: Dr Jean-Luc Payan, Manager Natural Hazards
Dr Dean Olsen, Manager Resource Science
Chris Valentine, Manager Engineering
Date: 8 June 2017

Subject: **Director's Report on Progress**

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1. Alpine lakes monitoring and lake snow

Catchments Otago (University of Otago) submitted a bid titled "*The Southern Great Lakes Research Programme for Sustainable Ecosystems, Communities and Economies*" to the Ministry of Business, Innovation and Employment (MBIE) Endeavour Fund. This proposal focussed on twelve large, alpine lakes from Lake Poteriteri in the south to Lake Coleridge in the North, although Lakes Wakatipu and Wanaka were the focus of much of the work. ORC has been advised that the bid was not successful, failing to make it through the first round of assessments. The research proposed aligned with many of the research priorities relating to lake snow and the broader management of the large, alpine lakes of the southern South Island as outlined in Report 2017/0705 to Technical Committee in March (refer Table 1, Appendix A). To this end, ORC supported the Catchments Otago bid, by providing staff support and committing Dr Adam Uytendaal's time to be a key individual in the proposed research. Staff will consider how to progress aspects of the research relevant to ORC's interests during preparation of the 2018/2028 Draft Long Term Plan.

On a related matter, Dr Phil Novis (Landcare Research) submitted a bid to the MBIE Smart Idea fund to develop monitoring technologies for detecting and quantifying lake snow. The need for such technology was identified at the experts' workshop convened by ORC last year (Work Stream 3 in Table 1, Appendix A). Dr Novis's bid has been accepted into the second round of assessment for funding. ORC is supporting this bid by funding the genetics work Dr Novis is undertaking to determine if the diatom responsible for lake snow is native to New Zealand or not. The proposed work will also capitalise on the monitoring ORC is currently undertaking in the alpine lakes, including the funding and staff time provided for lake snow research in the 2017/18 Draft Annual Plan.

The genetics work by Dr Novis that is being funded by ORC is progressing well, with material obtained from Alaska, USA, Canada and Europe. This work is expected to be completed in late July. This is slightly later than originally planned, to allow for the inclusion of samples from Lake Geneva that are still in transit to NZ.

The Trophic Lake Sampling Program is also progressing well. To date 9 separate monthly sampling rounds have been completed. After a full twelve months of sampling has been carried out and results received from the laboratory, ORC staff will calculate and update TLI's for the lakes. Recently data collected by ORC from Lake Hayes was used to provide an updated data set for detailed analysis of water quality dynamics for the 'Lake Hayes Restoration and Monitoring Plan' commissioned by the Friends of Lake Hayes. Staff are investigating a replacement water quality profiling sonde as the current sonde is nearing the end of its life. Given the deep nature of the lakes (up to 380m), an oceanographic CTD will need to be purchased to allow for water quality profiles to be taken to depths greater than 200m, the depth that the current generation of freshwater CTD's can be deployed to. Staff are in frequent contact with Environment Southland and Limnotrack (Chris McBride; University of Waikato) to keep updated on the development and deployment of the Lake Manapouri profiling buoy. This buoy is still in its developmental stages, with the initial deployment to date focussing on the design of the mooring structure and buoy superstructure to assess its capacity to withstand the high level of exposure that is typical of the large, deep lakes. The buoy has been in place for some months and successfully profiling down to 15 metres. In the coming months it will be commissioned to profile down to 80 metres.

In accordance with the 2016/17 Annual Plan, ORC has engaged NIWA to undertake a detailed review of ORC's lake and river State of Environment (SoE) water quality monitoring network. The purpose of the review is to 'future proof' these programmes so that they are fit for purpose in terms of the site network, monitoring variables and technology, such as the value of adding lake buoys to the SoE monitoring program. The findings of the review will inform preparation of the 2018/28 Draft Long Term Plan. The review will build on ORC's existing monitoring networks rather than starting from scratch, and will focus on identifying notable gaps (e.g. reference sites, under-representation of certain types of sites, etc.). The review is to be delivered by the end of August.

2. Climate Change Adaptation

At the invitation of the Deep South National Science Challenge I am participating in the Climate Change and Stormwater and Wastewater Infrastructure Dialogue. The dialogue is one of a series that have the aim of informing discussion papers that identify gaps in knowledge and subsequently form research projects. The first dialogue session was held on 31 May.

On a related matter, ORC has been advised that the MBIE Endeavour Fund bid for the NZ SeaRise programme will proceed to the second round of assessments. The bid is led jointly by Victoria University of Wellington and GNS Science. South Dunedin would be one of the case studies however the programme would also be of benefit to other Otago communities that must adapt to future sea level rise.

I am continuing to participate in the Climate Change Adaptation Technical Working Group convened by the Minister for Climate Change Issues.

3. Geomorphic Change Detection

As previously advised to committee, ORC is a supporting partner in a proposal to develop GeoTERM – a geospatial toolkit for enhancing river management. The project is being led by Professor James Brasington from Queen Mary, University of London, and includes collaborators from institutes in the UK and the USA, and NIWA, and is primarily funded by the UK's Natural Environment Research Council. The project involves developing software to quantify geomorphic change and sediment flux ("geomorphic change detection") in gravel bedded rivers and streams with multi-temporal elevation data (such as LiDAR).

Otago's Shotover River (or possibly Dart River) will be used to trial the technique, along with other gravel bedded rivers in Canterbury, Hawkes Bay, and Scotland. The method has the potential to improve the way river morphology is managed, with practical implications for the management of erosion and flood hazard, river habitat and gravel extraction.

Dr Ben Mackey and Dr Jean-Luc Payan will be participating in the project start-up workshop this month in Christchurch along with representatives from Environment Canterbury, Hawkes Bay Regional Council and NIWA.

4. Flood forecasting capabilities

Work to extend and improve ORC's flood forecasting capabilities is continuing with flood forecasting models for the Taieri River and Manuherikia River catchments in preparation. Those new models will complement ORC's forecasting capabilities on other catchments (Kakanui River, Water of Leith, Silver Stream, Lake Wakatipu and Lake Wanaka and Pomahaka River).

Investigations on the feasibility of a tool to assist in estimating surface ponding for South Dunedin based on rainfall data (forecast or observed) are also well underway.

5. Owhiro Stream flood hazard investigation

A planned investigation of the flood hazard associated with the Owhiro Stream and main tributaries near Mosgiel has commenced.

Intensification of urban development along some sections of the Owhiro Stream and tributaries (Wingatui area, East Taieri and the vicinity of Hagart-Alexander Drive in particular) could potentially affect the runoff and the capacity of the Owhiro Stream and tributaries.

Intensification of urban development is also changing the public's expectations of the levels of service that should be provided by the ORC scheduled drainage network. The

drainage network is part of ORC's East Taieri Drainage Scheme and provides land drainage to a rural standard. The intensification of urban development, particularly in the Wingatui area is creating demand for some drains to be piped and passed into private ownership or to become part of Dunedin City Council's stormwater system.

There is also a perception that the urban development along the Owhiro Stream is increasing the likelihood and duration of flooding within the Lower Pond, possibly reducing its level of protection and it efficiency to reduce flooding associated with the Taieri River.

The investigation will results in a better understanding of the drainage network capacity and limitations. It will inform a more strategic and robust approach to managing the issues outlined above and to guide future developments in the area.

The results of the investigation are expected later this year and will inform preparation of the 2018/2028 Draft Long Term Plan.

6. Leith Flood Protection Scheme

Construction of the flood protection works on the Union to Leith Footbridge stage of the Leith Flood Protection Scheme has continued (Figure 1). Asbestos containing material was discovered buried in the left bank upstream of the Information Technology Services (ITS) building. The asbestos is being excavated and removed from site in accordance with a plan approved by WorkSafe NZ and the University of Otago. While works could not progress on the left bank because of the asbestos discovery the contractor has reverted to the right bank works, originally scheduled for later in the construction programme (Figure 2). For various reasons including the discovery of asbestos and the weather event in April the construction works will extend beyond the planned date. Staff are continuing to liaise closely with the university so as to minimise disruption to students, staff and visitors.

Figure 1 Water of Leith left bank excavation immediately upstream of ITS building.

Figure 2 Water of Leith right bank wall raising works. Starter bars have been installed along the top of the existing wall in preparation for raising the top by approximately 600mm.

Investigations for the Dundas Street stage of the Scheme are continuing. Proposals have been received from the University of Auckland to construct and test a scale physical model of the proposed works and from engineering consultants to undertake civil and structural design of the works. These two work packages are expected to be awarded early June. Discussions are underway with key stakeholders in regard to the proposed works.

7. Recommendation

That this report is noted.

Gavin Palmer
Director Engineering, Hazards and Science

Appendix A

Table 1. **Research priority work streams, priority ranking, associated costs and justification.** ***The table below complements the summary table provided in the proceedings of the 20 December 2016 experts' workshop.***

Priority Ranking	Code
High - Immediate	**High - Immediate**
High - Medium term	**High - Medium term**
Medium - Medium term	**Medium - Medium term**

Work stream	Sub-program	Priority Ranking	Associated costs	Justification	Lead agency
1) Is *Lindavia intermedia* a native or non-native species? ***Top priority area. Will influence the direction of other work streams***	i) Investigation of cell genetics (microsatellite analysis) of NZ and overseas *L. intermedia* populations	**High - Immediate**	***Currently funded by ORC. To be delivered by end of Jun 17.***	This work will indicate if *L. intermedia* has recently arrived in NZ and should be considered an invasive species.	**ORC**
	ii) Comprehensive examination of NZ diatom samples, collections, reports	**High - Immediate**	**$11K** for detailed assessment of 3 separate catalogued collections Delivery 3 to 6 months.	To determine if previous '*Cyclotella*' identifications are in fact *Lindavia*. To help isolate the length of time the diatom has been present in NZ.	**ORC**
	iii) Historical dynamics of *L. intermedia* in NZ lakes from which it has been reported using paleolimnological diatom analysis of dated sediment cores.	**High - Immediate**	4 priority lakes in Otago **$56K.** ($14K per lake). Delivery 6 to 9 months for Otago's 4 priority lakes. Estimated	This work will allow a precise estimate of the time that *L. intermedia* has been present in NZ and will complement the microsatellite work currently being undertaken in (i) above.	**ORC**

			10 lakes needed to be cored across Otago, Southland, Canterbury and Hawke's Bay		
2) What are the drivers of: **(A) *L. intermedia* dominance in lakes and**	2A i) Literature review of shifts in lake phytoplankton to increased dominance by (*Lindavia*-like) centric diatoms (e.g., climate connection)	**High - Immediate**	$3K – if aligned with 2B i).	This would increase our understanding of shifts and drivers of phytoplankton community structure to one dominated by centric diatoms and provide extremely valuable information to the NZ context.	**ORC**
	2A ii) Are historical *L. intermedia* dynamics correlated to environmental drivers in our lakes?	**Medium - Medium term**	$219K Delivery 3 years [Note: This work is covered in the University of Otago MBIE bid.]	As with 2B ii) this work-stream is extensive and likely best delivered through a University and a number of postgraduate and post-doctoral research programs.	**Catchments Otago / Uni. Of Otago / CRIs / support from RC's**
	2A iii) Are proliferations of *Didymo* and *L. intermedia* in South Island waters related to a common driver or species incursion?	**Medium - Medium term**	$19K minimum Delivery difficult to estimate	If the timing and spread of these two incursions are coherent, then that would provide evidence of a common incursion (both place and time) and support management of future incursions and responses.	**Catchments Otago / Uni. Of Otago / CRIs / support from RC's**

2) What are the drivers of: (B) polysaccharide overproduction by *L. intermedia*?	2B i) Comprehensive literature review on diatom polysaccharide overproduction from similar situations overseas	**High - Immediate**	$10K Delivery 3 to 6 months	Seen as a top priority and would increase our current understanding of TEP production and the lake snow phenomenon. A straightforward exercise that hasn't been undertaken to date.	**ORC**
	2c) Study of the relationships between diatom polysaccharide overproduction and (1) nutrient availability, (2) climate warming, and (3) grazing pressure.	**High - Medium term**	Year 1: $204K Year 2: $211K Year 3: $198K Delivery 3 years [Note: This work is covered in the University of Otago MBIE bid.]	As with 2A ii) this work-stream is extensive and likely best delivered through a University and a number of postgraduate and post-doctoral research programs.	**Catchments Otago / Uni. Of Otago / CRIs / support from RC's**
3) Can we develop technologies for effective sampling and monitoring of *L. intermedia* and lake snow?	i) The development of new sensor technology to monitor in situ polysaccharide concentrations in lakes.	**High - Medium term**	$300K per year for three years - Part of an MBIE Smart Ideas bid – decision on success due Sept 2017.	Capacity to monitor the abundance and spatial variability of lake snow is critical to understanding the environmental drivers that lead to lake snow production. At present these techniques do not exist.	**Landcare Research / Uni. Of Otago / Support from ORC**
	ii) The development of cost-effective and efficient methods for quantitatively sampling lake snow in lakes (at different depths).	**High - Medium term**			**Landcare Research / Uni. Of Otago / Support from ORC**

	iii) Can DNA methods be developed for the sensitive detection of *L. intermedia* in lakes?	**Medium - Medium term**			**Landcare Research / Cawthron / support from RC's**
4) How might the spread of *L. intermedia* between lakes be stopped or slowed?	i) Are the BNZ Didymo sanitation methods adequate for the disinfection of *L. intermedia*?	**High - Immediate**	Currently contracted by MPI who have engaged NIWA to review the effectiveness of Check – Clean – Dry on *Lindavia*	MPI are reviewing their Check/Clean/Dry campaign and how effective it is for other pest species.	**MPI / NIWA**
5) Supporting citizen science		**High - Medium term**	$10K	Links to 3.	**ORC**

REPORT

Document Id: A1009561

Report Number: 2017/0844
Prepared For: Technical Committee
Prepared By: Rachel Ozanne, Environmental Resource Scientist
Date: 8 June 2017

Subject: **Trophic Level Status of Lake Waipori and Lake Waihola**

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1. Précis

The Waipori/Waihola wetland complex is situated on the lower Taieri Plain, 30 km south-west of Dunedin and 10 km from the coast covering approximately 20 km^2. The Waipori/Waihola wetland consists of two large shallow lakes, Waipori (2.2km^2) and Waihola (6.4km^2) and an extensive system of wetlands, lagoons, ponds and vegetated islands, it is regarded as one of the largest and most significant remaining freshwater wetlands in New Zealand and supports a diverse and highly productive ecosystem. As such the Waipori/Waihola wetland complex is listed as a regionally significant wetland in Schedule 9 of Otago Regional Council's (ORC) Regional Plan: Water (2016).

A water quality report ("Trophic Level Status of Lake Waipori and Lake Waihola") has been prepared presenting monitoring data collected over the period 2014 to 2016 to classify the current state of water quality in Lakes Waipori and Waihola and the full data record (1997–2016) is used to assess temporal trends. The report also looks at monitoring data from Lake Waihola catchment collected as part of ORC's larger programme of State of the Environment (SoE) monitoring.

Burns et al. (2000) developed a trophic level index (TLI) for assessing the water quality status of New Zealand lakes. The TLI in Lake Waipori and Lake Waihola was calculated using three key variables of lake water quality (chlorophyll *a*, total phosphorus and total nitrogen). The trophic level categories range from lakes with practically pure water (TLI between 0.0 and 1.0) through to extremely nutrient-rich systems, referred to as hypertrophic (TLI between 6.0 and 7.0).

The trophic level monitoring undertaken between 2014 and 2016 classified both lakes as eutrophic, Lake Waihola with a TLI value of 4.55 and Lake Waipori with a slightly lower TLI value of 4.23. A eutrophic TLI reflects a lake that is significantly enriched with nutrients and is highly productive with a high biomass of algae.

Water quality data for these lakes has been collected in three periods; 1997 to1998, 2002 to 2004 and 2014 to 2016, and roughly the same number of samples were collected in each group. TLI values can be compared between the sampling periods as shown in Table 1. The lakes have mainly been classified as eutrophic (TLI between 4.0 and 5.0), however between 1997 and 1998 the Lake Waipori mid site was classified as mesotrophic (TLI between 3.0 and 4.0) and Lake Waihola South was classified as supertrophic (TLI between 5.0 and 6.0).

Table 1 TLI results for Lake Waihola and Lake Waipori between 1997 and 2016

	2014 to 2016	2002 to 2004	1997 to 1998	1997 to 2016
Waipori All	4.23	4.11	4.02	4.11
Waipori Mid	4.22	3.98	3.96	4.19
Waipori South	4.28	4.24	4.08	4.04
Waihola All	4.55	4.43	4.75	4.58
Waihola Mid	4.43	4.28	4.48	4.40
Waihola North	4.40	4.25	4.68	4.45
Waihola South	4.81	4.77	5.07	4.89

One of the objectives of TLI monitoring is to detect a significant change or trend in a lake over time. The three, two year data sets were analysed together to look at long term trends and results are presented graphically in Figure 1.

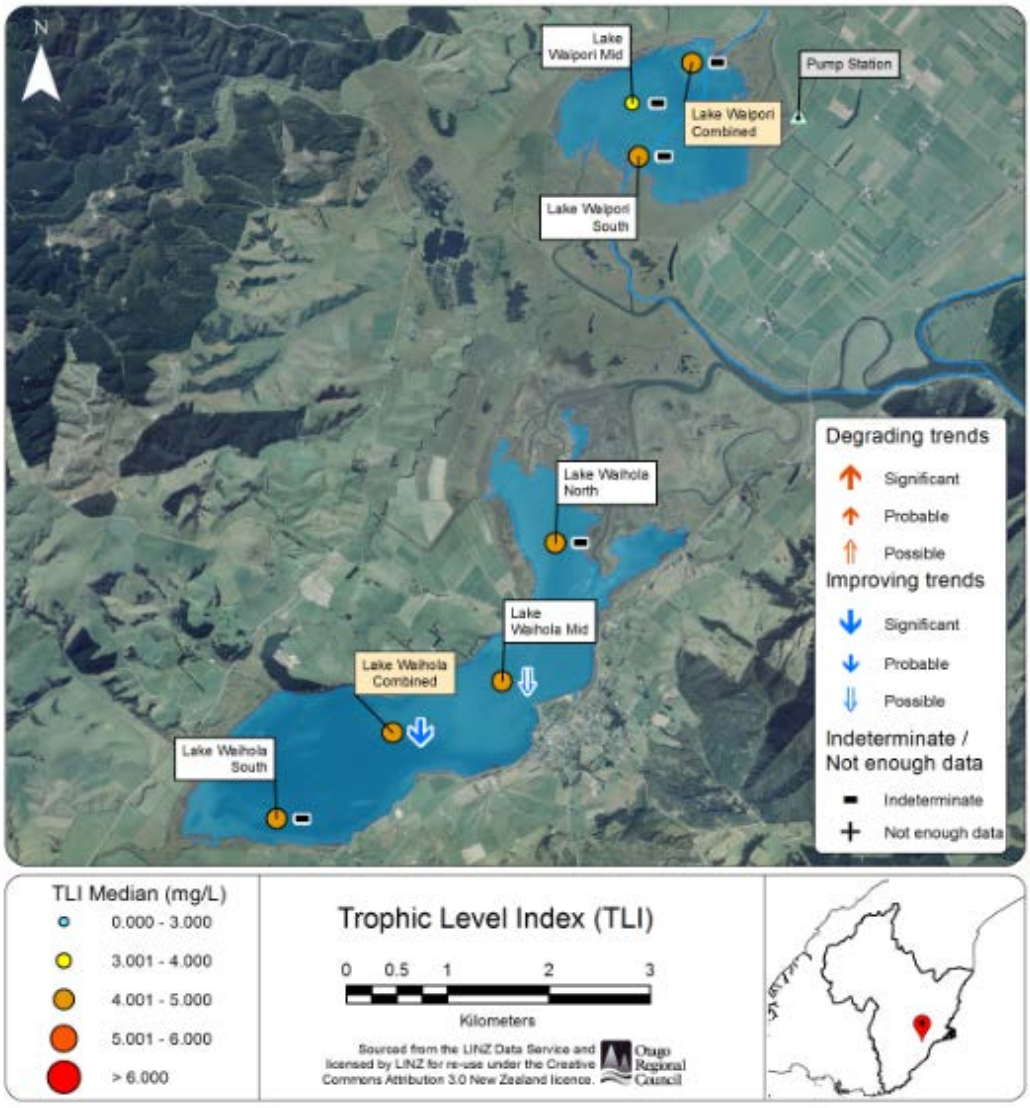

Figure 1 TLI scores and trends in Lake Waihola and Lake Waipori

In Lake Waipori there is no increasing or decreasing TLI trend, however in Lake Waihola the TLI shows a significant decreasing trend over time suggesting that water quality in Lake Waihola may be improving.

Water quality results from the lake TLI monitoring were compared against median values for selected water quality variables from a national dataset of water quality for lakes categorised by dominant catchment land cover (Verburg et al. 2010). Even though Lakes Waipori and Waihola are ranked against a mixed category of shallow and deep lakes, they rank in the top 50% of lakes in New Zealand that are located in predominantly pastoral catchments.

SoE catchment water quality monitoring is undertaken at three sites in the Waipori/Waihola catchment. The Schedule 15 limits (set out in the Regional Plan Water) are met in the Waipori River. The Main Drain[1] only met the Schedule 15 limit for NNN and Lake Waihola (at the jetty) met the limits for NH_4-N and E.coli. The difference in water quality between the Main Drain and the Waipori River catchments is due to the different landuse, the Main Drain supports an intensive agricultural catchment, whereas the Waipori catchment is mainly extensive forestry and sheep and beef. The Main Drain is not a significant contributor to overall nutrient load due to the high inputs from the Waipori River as well as tidal influence.

2. Recommendation

That this report and the technical report "Trophic Level Status of Lake Waipori and Lake Waihola" are received and noted.

Gavin Palmer
Director Engineering, Hazards and Science

[1] The Main Drain is part of the West Taieri Drainage Scheme. It discharges to Lake Waipori via the Waipori Pumping Station (Figure 1). Improvements to the quality of the water discharged by the station are being investigated as part of reconsenting the operation of the station.

REPORT

Document Id: A1009774

Report Number: 2017/0848
Prepared For: Technical Committee
Prepared By: Rachel Ozanne, Environmental Resource Scientist,
Date: 2 June 2017

Subject: **Waiwera River Catchment Water Quality Study**

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1. Précis

The Waiwera Catchment is located in South Otago. It extends for approximately 30km and has an area of approximately 207 km^2. The Waiwera Catchment is known to have relatively high, reliable rainfall. Its headwaters are found in the Wisp Range from which it flows in a northerly direction to its junction with the Clutha River/Mata-Au downstream of Clydevale.

A water quality report ("Water Quality Study: Waiwera River Catchment") has been prepared presenting the results of long-term (State of the Environment or SOE) monitoring at one site in the Waiwera River; as well as intensive water quality monitoring and ecological surveys at ten additional mainstem sites and two tributary sites undertaken in 2015-2016.

Most of the intensive farming in the lower Waiwera Catchment takes place on very poorly drained soils, farming in these areas would not be possible without the construction of extensive artificial drainage (tile drains) to convey water to the nearest watercourse. In the upper catchment to the west of the Kaihiku Ranges the land supports extensive sheep and beef grazing.

Water quality in the catchment shows elevated concentrations of nutrients and bacteria, as shown in Table 1. Inorganic nitrogen or NNN concentrations were at concentrations sufficient to stimulate the growth rate of algae, typically being well above the Biggs (2000[1]) 30-day accrual threshold concentration of 0.075 mg/L. DRP concentrations were also high in the Waiwera, typically being 0.01 to 0.04 mg/L. Bacteria concentrations were high and exceeded the Schedule 15 limit/target at eleven of the thirteen sites and in addition six of the thirteen sites monitored exceeded the Schedule 15 turbidity limit/target. These results are very high for Otago rivers and streams.

Although much of the lower catchment has artificial drainage, the monitoring results show little change in N concentrations between the upper and lower Catchment. What is evident is the seasonal variation in N, which indicates indirect losses of nutrients associated with farming activities (including application of farm dairy effluent) due to nutrient enrichment of the soil during the summer-autumn period followed by leaching during the subsequent winter-spring drainage period. The Clinton oxidation pond

[1] Biggs, B., (2000). *New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams*. Prepared for the Ministry for the Environment. Wellington: Ministry for the Environment.

discharge, downstream of Clinton township, is responsible for the sharp increase in concentrations of TP, DRP and NH_4-N in the Kuriwao Stream. The effect of the discharge is noticeable at the Kuriwao Stream at the Kuriwao Siding Road monitoring site.

Table 1 **Water quality results from the 12 month catchment study. The 80th percentiles of water-quality parameters were compared to the Schedule 15 limit (RPW). Values that exceeded the limit are highlighted in orange**

Site Name	Ammoniacal Nitrogen (mg/L)	Dissolved Reactive Phosphorus (mg/L)	E-Coli (MPN/ 100ml)	Nitrite/ Nitrate Nitrogen (mg/L)	Turbidity (NTU)
Schedule 15 limit	**0.100**	**0.026**	**260**	**0.444**	**5**
Waiwera at Owaka Valley Rd	0.017	0.0308	524	1.34	6.28
Waiwera River Hillfoot Rd	0.017	0.0168	116	1.14	3.30
Waiwera River at Kuriwao Siding Rd	0.022	0.0172	318	1.16	3.04
Kuriwao Stream Old Coach Rd	0.023	0.0318	940	1.42	7.54
Kuriwao Stream Hillfoot Rd	0.018	0.0268	450	1.32	5.28
Awakia Stream at Hillfoot Road	0.107	0.0370	1030	0.38	6.56
Kuriwao Stream u/s Kuriwao Siding Rd	0.033	0.0804	648	1.22	4.60
Waiwera trib at Blaike Rd	0.035	0.0372	564	3.04	19.60
Waiwera trib d/s quarry	0.057	0.0506	1360	1.52	10.08
Waiwera River at Robertson Rd	0.032	0.0338	364	1.16	3.62
Waiwera River at SH1 bridge	0.031	0.0324	378	1.15	3.30
Waiwera River near Clifton	0.035	0.0366	464	1.08	3.60
Waiwera River at Maw's Farm	0.021	0.0280	246	1.30	3.36

Analysis of trends in water-quality parameters at the Maw's Farm long term State of Environment (SoE) monitoring site show that most water quality variables showed no increasing or decreasing trend between July 2006 and February 2017, with the exception of total phosphorus which declined significantly over this period. When compared to Schedule 15 (RPW) limits/targets, all of the variables (other than turbidity) at the Maw's Farm site exceeded the Schedule 15 limits.

The results of the catchment periphyton survey show that long (>2 cm), filamentous algae cover, indicative of eutrophic waters, was generally low at most sites, however three sites exceeded guideline levels (>30% cover); Waiwera at Maw's Farm (36%), Waiwera at Owaka Valley Road (38%) and Waiwera at Robertson Road (31%). The percentage of the bed covered by other periphyton types (including unconsolidated algae, medium and thick mats, didymo and short, (<2 cm) filamentous algae) exceeded the guideline for these periphyton types (>60% cover) at four mainstem Waiwera River sites.

The Waiwera River generally had substrate which should have been favourable for macroinvertebrates to move around on and large enough to offer native fish large interstitial spaces as refuge from flows and predators. However this habitat was compromised by the large amount of deposited sediment which was smothering interstitial spaces and covering substrate.

The Quorer sediment sampling method measures the quantity of fine sediment on and within the upper layer of the streambed, rather than cover. The mainstem Waiwera (Owaka Valley Road and Robertson Road) had some of the highest concentrations of inorganic sediment and exceeded the recommended guideline of 450g/m^2 (Clapcott, 2011[2]).

Macroinvertebrate communities in the March 2017 catchment survey reflected generally 'poor water quality' (Stark, 2007[3]). It is likely that sediment and algae covering the substrate and filling in interstitial spaces is the cause of a paucity of invertebrates at these sites, particularly the sensitive Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) species. Trend analysis indicated that macroinvertebrate metrics at Maw's Farm site had been stable from 2007 to 2016.

Fine sediment accumulation seems to be the main cause of losses in abundance and diversity of macroinvertebrate communities and fish populations in the Waiwera catchment, particularly in the mainstem of the Waiwera River.

The results of this study will be used to guide future policy and compliance decisions and to promote good practice among the community and other stakeholders with a view to enhancing the water quality and ecology in the Waiwera catchment.

2. Recommendation

That this report and the technical report "Water Quality Study: Waiwera River Catchment" are received and noted.

Gavin Palmer
Director Engineering, Hazards and Science

[2] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.

[3] Stark J.D. and Maxted J.R. (2007). *A user guide for the MCI*. Prepared for the Ministry for the Environment. Cawthron Report No. 1166.