

EXPERT CONFERENCE —WATER QUALITY AND ECOLOGY (RIVERS and WETLANDS)

ENV-2018-CHC — 026, 29, 37, 38, 39, 40, 41, 47, 50

Various s274 parties

Topic: Proposed Southland Water and Land Plan - Southland Regional Council

Date of conference: Tuesday 7 to Thursday 9 May 2019

Venue: Kelvin Hotel, 20 Kelvin Street, Invercargill

Facilitator: Jim Hodges, Environment Commissioner

Recorder: Jan Brown, Southland Regional Council, executive assistant

- 1 The Environment Court directed in its Minute of 15 April 2019 that expert witness conferencing in respect of water quality and ecology (rivers and wetlands) in relation to the appeals against the proposed Southland Water and Land Plan (**pSWLP**) is to start on Tuesday 7 May 2019 and continue until completed.¹

¹ Minute of the Environment Court dated 15 April 2019 at [10(c)], and the Amended Notice of Expert Conferencing dated 18 April 2019.

Attendees

- 2 Witnesses who participated and agreed to the content of this Joint Witness Statement (JWS):

Name	Employed or engaged by	Signature
Roger Hodson	Southland Regional Council	
Dr Kelvin Lloyd	Southland Regional Council	
Prof Russell Death	Southland Fish and Game Council	
Kathryn McArthur	Royal Forest and Bird Protection Society of New Zealand	
Dr Jane Kitson	Ngā Rūnanga ²	
Dr Mark James	Meridian Energy Limited	
Justin Kitto	DairyNZ Limited and Fonterra Co-operative Group	
Susan Bennett	Territorial Authorities ³	
Emily Funnell	Director-General of Conservation	
Brian Rance	Director-General of Conservation	

Environment Court Practice Note

- 3 All participants confirm that they have read the Environment Court Consolidated Practice Note 2014 and in particular Section 7 (Code of Conduct, Duty to the Court and Evidence of an expert witness) and Appendix 3 - Protocol for Expert Witness Conferences and agree to abide by it.
- 4 Mr Kitto acknowledges in his evidence that he is an employee of DairyNZ, which is a party to this proceeding, and that he may not be considered to be independent simply because of that employee status. Notwithstanding that, he confirms that he prepared and will present his evidence in all other respects as an independent expert and in compliance with the Code of Conduct.

² Comprising Waihopai Rūnaka, Hokonui Rūnaka, Te Rūnanga o Awarua, Te Rūnanga o Oraka Aparima, and Te Rūnanga o Ngāi Tahu.

³ Comprising Gore District Council, Southland District Council, and Invercargill City Council.

- 5 Ms Funnell acknowledges in her evidence that she is employed by the Department of Conservation, and while the Department has an advocacy function under the Conservation Act 1987, her role in preparing and giving this evidence is as an independent expert. She goes on to state that she is authorised to provide any evidence that is within her expertise which goes outside the Department's advocacy function.
- 6 Mr Rance also acknowledges in his evidence that he is employed by the Department of Conservation, and while the Department has an advocacy function under the Conservation Act 1987, his role in preparing and giving this evidence is as an independent expert. He goes on to state that he is authorised to provide any evidence that is within his expertise which goes outside the Department's advocacy function.
- 7 Mr Hodson acknowledges that he is an employee of the Respondent, Southland Regional Council. Notwithstanding that, Mr Hodson confirms that he prepared and will present his evidence as an independent expert and in compliance with the Code of Conduct.
- 8 Dr Kitson acknowledges she is a member of Te Runanga o Oraka-Aparima and also whakapapa to Te Runanga o Awarua and Waihopai Runaka. Her expertise is partially derived from those cultural associations. She notes that whilst she is of Ngai Tahu descent, she is required to be impartial and unbiased in her professional opinions expressed.
- 9 Dr James is also engaged by Alliance Group Limited as part of the Southland Water and Land Plan process.

Experts' qualifications and experience

- 10 These are set out in each experts' statement of evidence.
- 11 The wetland experts (Dr Lloyd and Mr Rance) note that they restricted their input to matters relating to wetlands primarily.

Purpose of expert conference

- 12 The purpose of the conference is to assist the Court by responding to a series of questions, agreed by the experts as the conference progressed, relating to river water quality, wetlands and ecology and associated issues that the court may wish to consider when determining the appeals. For each question, the experts state matters on which they agree and on which they do not agree, with reasons.
- 13 The experts note that lakes and estuaries are addressed in a separate JWS and the two need to be read together.

Key information sources relied on

- 14 The experts relied on the following key sources of information:
- (a) Environment Southland, 2000, Southlands' State of the Environment report for Water – October 2000. Environment Southland Publication Number 2000-21. ISBN Number: 0-909043-16-7.
 - (b) Environment Southland and Te Ao Marama Incorporated, 2010. Our Health: Is our water safe to play in, drink and gather kai from? Part 1 of Southland Water 2010: Report on the State of Southlands Freshwater
 - (c) Snelder, T., Fraser, C., Hodson, R., Ward, N., Rissmann, C., Hicks, A., 2014. *Regional Scale Stratification of Southland's Water Quality – Guidance for Water and Land Management*. Prepared for southland regional council by Aqualinc Research Limited, Report No: C13055/22, March 2014.
 - (d) Environment Southland, 2016(b), *Water Quality in Southland*, <http://www.es.govt.nz/Document%20Library/Factsheets/Other%20factsheets/Water%20Quality%20in%20Southland%20web.pdf>
 - (e) Kitto, J. and Hodson, R.J.W. 2016, Water quality state and trends for southland. Dairy New Zealand Poster. 2016 New Zealand Fresh Water Conference Proceedings, Invercargill.

- (f) Hodson, R. and Akbaripasand, A., 2016. *State and Trends in Freshwater Macroinvertebrate Community Health in Southland*. New Zealand Fresh Water Conference Proceedings, Invercargill.
<http://www.es.govt.nz/Document%20Library/Presentations/Science%20Conference%20Posters%202016/State%20and%20Trends%20in%20Freshwater%20Macroinvertebrate%20Community%20Health%20in%20Southland.pdf>
- (g) Hodson R., Dare J., Merg M., Couldrey, M. (2017), Water Quality in Southland: Current State and Trends. Environment Southland publication No: 2017-04.
- (h) Australian and New Zealand Environment and conservation Council. 2000. Australia and New Zealand guidelines for fresh and marine water quality. Townsville: Environment Australia
- (i) Ausseil A-G.E., Gerbeaux P., Chadderton W.L., Stephens T., Brown D., and Leathwick J. 2008: Wetland ecosystems of national importance for biodiversity: criteria, methods, and candidate list of nationally important inland wetlands. Landcare Research Contract Report LC0708/158. Prepared for the Department of Conservation.
- (j) Hodson R., De Silva N. 2018. Assessing the State of Periphyton in Southland Streams and Rivers. Environment Southland publication No: 2018-19
- (k) Land, Air, Water Aotearoa (LAWA) 2018 www.lawa.org.nz
- (l) McAllister, T.G., Wood, S.A., and Hawes, I. 2016, The rise of toxic benthic Phormidium proliferations: A review of their taxonomy, distribution, toxin content and factors regulating prevalence and increased severity. Harmfull algae, vol. 55, 282-294
- (m) Stark JD, Maxted JR 2007. A user guide for the Macroinvertebrate Community Index. Prepared for the Ministry for the Environment. Cawthron Report No.1166. 58 p.

- (n) New Zealand Government (2017). National Policy Statement for Freshwater Management 2014 updated August 2017 to incorporate amendments from the National Policy Statement for Freshwater Amendment Order 2017
- (p) Ministry for the Environment and Ministry for Primary Industries Freshwater Management Guidance: A draft technical guide to the Periphyton Attribute Note Under the National Policy Statement for Freshwater Management 2014 (as amended 2017)
- (q) MfE/MoH 2009 - Ministry for the Environment and Ministry of Health. 2009. New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters – Interim Guidelines. Prepared for the Ministry for the Environment and the Ministry of Health by SA Wood, DP Hamilton, WJ Paul, KA Safi and WM Williamson. Wellington: Ministry for the Environment.
- (r) Robertson H. A, Ausseil A-G, Rance B, Betts H and Pomeroy E. (2018) Loss of wetlands in Southland, New Zealand. *New Zealand Journal of Ecology* 43(1): 33-55.
- (s) Moran, E., McKay D., Bennett, S., West, S., and Wilson, K. (2018). The Southland Economic Project: Urban and Industry. Technical Report. Publication no. 2018-17. Environment Southland, Invercargill, New Zealand. 383pp

Attachments to this JWS

15 To assist the Court, the following maps are attached to this JWS and show the spatial extent of areas used for different environmental management and assessment purposes referred to in this JWS:

- 1 Freshwater Management Units (FMU). This shows the FMUs that have been developed by the regional council in accordance with the New Zealand NPSFM. The FMU process required in accordance with Section CA of the NPSFM will be undertaken later, and does not form part of this conference.

2 Surface Water Quality Management Units (SWQMU). The experts note this is a water quality classification system designed for Southland based on the River Environment Classification and the Maitai River Conservation Order. Within each of these units, specific water quality standards are set out that must be met in the receiving environment where discharges have occurred. Specific water quality standards are set out in Appendix E of the Operative Plan and the pSWLP. The classifications in Appendix E have remained the same over this period and the only change to the standards has been the addition of the standard relating to sediment cover. The State of the Environment Monitoring Reports undertaken in 2000 and 2010 used these standards. The individual units are:

- Natural State Waters
- Lowland soft bed
- Lowland hard bed
- Hill
- Mountain
- Lake Fed
- Spring Fed
- Lowland/Coastal lakes and Wetlands
- Hill Lakes and Wetlands
- Maitai 1
- Maitai 2
- Maitai 3

3 Physiographic Zones, which reflect the inherent risks to water quality as result of land use, and which takes into account the matters listed in the EIC of Dr Snelder at paragraph 14.

16 The following Appendices are attached;

Appendix 1 Degraded sites by FMU in Southland

Appendix 2 At-risk sites by FMU in Southland

Appendix 3 Summary of trend results of water chemistry and MCI for the period January 2008 to December 2017, reproduced from Appendix 1 of the evidence-in-chief of Mr Kitto.

Proposed plan provisions relevant to this conference

17 The draft agenda provided to the experts by counsel for the parties set out the following plan provisions which are stated as being relevant (at a high-level) to this conference, and have been included as directed by the Court.⁴

The experts were directed by counsel that the plan provisions themselves are not a topic/issue for the experts to consider.

- (a) Te Mana o te Wai (page 5 of the Appeals version of the pSWLP).
- (b) Purpose and Framework (page 7 of the Appeals version of the pSWLP).
- (c) Issues:
 - (i) Water quality (page 15 of the Appeals version of the pSWLP).
 - (ii) Surface Water (page 16 of the Appeals version of the pSWLP).
 - (iii) Indigenous Biodiversity (page 17 of the Appeals version of the pSWLP).
- (d) Objectives 1 (noting this objective is not subject to appeal), 3 (noting this objective is not subject to appeal), 6, 7, 14 and 15 (noting this objective is not subject to appeal).
- (e) Policies 45 and 47.
- (f) Appendix E (noting that the content of Appendix E is outside the scope of the hearing on Topic A and is to be considered as part of the hearing on Topic B).

Definitions

18 The experts agreed and relied on the definitions set out below for the purpose of the topics discussed at this expert conference:

- (a) Ecosystem health as set out in Appendix 1 NPSFM.

⁴ Minute of the Environment Court dated 2 April 2019 (on conferencing) at [7(v)].

- (b) Enhancement or improvement of water quality (in the specific context of SOE monitoring and measurable biophysical or chemical water quality attributes) – a statistically significant beneficial change in the attribute.
- (c) Maintenance of water quality (in the specific context of SOE monitoring and measurable biophysical or chemical water quality attributes) – the situation where there is no deterioration of an attribute through either time series analysis or assessment of a parameter within an accepted range of variability.
- (d) Degraded and at risk sites – the experts have developed criteria to define sites as set out below.
- (e) Macroinvertebrates - aquatic animals without a back-bone or spine that can be caught by using a 500µm net or sieve (i.e. visible to the naked eye without using a microscope), such as insect larvae, worms and snails.
- (f) MCI (Macroinvertebrate Community Index) as in Stark and Maxted report listed above - which is a tool for assessing water quality. Different macroinvertebrate taxa are assigned a tolerance score based on their tolerance to organic enrichment. The index is then calculated by summing the scores for all species present at a site.
- (g) Periphyton – the mixture of algae, cyanobacteria and other micro organisms that grow attached to submerged surfaces in aquatic environments. Periphyton is an essential part of the aquatic ecosystem, being a primary contributor to the food chain.
- (h) Excessive periphyton growth – filamentous or matt algae percentage aerial cover or benthic chlorophyll-a which is in excess of the relevant numerical standard or attribute objective.
- (i) QMCI – Quantitative Macroinvertebrate Community Index, as defined in Stark and Maxted above.

- (j) SQMCI – Semi-quantitative Macroinvertebrate Community Index, as defined in Stark and Maxted above.

19 The experts note they have avoided using the terminology of limits and objectives as contained in the NPSFM. Instead the experts have used the term thresholds in this JWS. Parameters or indicators of water quality have been ubiquitously called attributes throughout this statement.

Degradation and overall water quality

20 The definition of over-allocation in the NPSFM is:

the situation where the resource:

- (a) has been allocated to users beyond a limit; or
- (b) is being used to a point where a freshwater objective is no longer being met.

21 The experts agree that from a water quality and ecological perspective, this NPSFM definition is not able to be applied until the full FMU process has been completed. Until this is done, the experts consider and agree that some interim criteria are required and have used criteria for degradation instead of over-allocation under Objective 6 for ecosystem health and human health (the two compulsory national values in Appendix 1, NPSFM). This is discussed further below and in Appendices 1-2.

22 Objective 6 of the decisions version of the pSWLP is:

there is no reduction in the overall quality of fresh water and water in estuaries and coastal lagoons, by:

- (a) maintaining the quality of water in water bodies, estuaries and coastal lagoons, where the water quality is not degraded; and
- (b) improving the quality of water in water bodies, estuaries and coastal lagoons, that have been degraded by human activities.

23 The experts see the application of this Objective in the plan, requiring consideration of **overall** water quality, as problematic for the following reasons:

- (a) ecosystem health could be determined by one or a combination of specific attributes if a threshold is exceeded, e.g. arsenic. Aggregation of multiple attributes may mask the effects of a single attribute on ecosystem health.
- (b) in the absence of a repeatable methodology to aggregate multiple attributes or sites, the assessment of overall water quality is subjective. To develop such a framework would be a substantial and complex body of work requiring significant agreement across multiple disciplines.
- (c) any attempt to spatially aggregate water quality data across multiple sites:
 - (i) limits the ability to consider locality specific effects in an appropriate level of detail.
 - (ii) is limited by the representativeness of the monitoring network.

24 The experts consider it essential to provide for the ability to consider effects on an appropriate spatial scale. Currently Objective 6 is directive but is subjective, and can be interpreted in a number of different ways, e.g. spatially, temporally and across multiple attributes. Ms Bennett has concerns about the absolute nature of the Objective and its application, particularly if overall is deleted for the reasons set out in her evidence. Mr Kitto supports these concerns for the reasons set out in his evidence.

Preliminary matters discussed by the experts

Need for an integrated approach

25 The experts agree that water quality and ecology must be considered using an holistic, whole of catchment approach as well as site specific considerations. This requires consideration of historic and current land use, the quality and quantity of groundwater, rivers and streams, lakes, wetlands, estuaries and the sea on an integrated basis. As they are all inter-related the risk of drawing incorrect conclusions increases if considered in isolation of each other. The

experts focused on the compulsory national values in the NPSFM, and key attributes that are relevant to ecosystems and human health.

Consideration of Te mana o te wai

- 26 The experts agree that there is a requirement to recognise the national significance of Te mana o te wai, as provided for in the plan. There is a need to consider mauri, the health of the people, the health of the environment, and the health of the waterbody. Dr Kitson and Ms Cain highlighted that the state of the environment and Te mana o te wai require other indicators to be described. Whilst these have not been addressed in this JWS the experts consider that this will need to be provided for in the plan structure.

Trend analysis

- 27 The experts acknowledge that trend analysis has significant limitations. They agree that the longer the trend period available for analysis the better, but of the available options at the moment they agree that 10 year LAWA method is the more appropriate to use of those available. It provides additional statistical resolution in the determination of trend direction.
- 28 A table included in Appendix 1 of Mr Kitto's evidence summarises trends for the Waiau, Aparima, Oreti and Mataura FMUs. This is included as Appendix 3 of this JWS. The tables in appendices 1-2 indicate trends for individual degraded and at risk sites. When considering these trends, the user needs to take into consideration where the site is and what the attribute is, because there is no overall measure of water quality.
- 29 Some sites and attributes are improving, some are degrading, and caution must be used in trying to draw overall conclusion in relation to trends.

Wetlands

- 30 For the purpose of this conference, with regard to wetlands, the wetland experts agree that that the major issues/concerns/factors that need to be managed are: any hydrological change, land use or development that reduces wetland area and condition. Wetland condition factors of concern include: eutrophication, sedimentation, weed invasion, harvest and fire. The experts agree that these pressures will need to be addressed in the plan.

- 31 The wetland experts agree that wetlands occupy approximately 47,000 hectares in Southland, which has been assessed as approximately 11% of their historic extent in Southland. Southland contains a rich diversity of wetlands classes and types. These include wetland types that are unique to southern New Zealand. Southland is a national stronghold for bog and fen wetland classes. The extent, number, diversity and condition of Southland wetlands, especially in the lowlands, is of importance for the conservation of the associated fauna and flora (including threatened species). Many Southland wetlands are of regional, national or international importance.
- 32 The wetland experts agree that clearance of wetlands is continuing to happen in Southland, and that the rate of clearance has not slowed in recent decades. The extent of wetland loss varies with different wetland types and locations within Southland. The greatest extent of recent loss of wetland extent has been on the Southland Plains, particularly near the Awarua-Waituna Ramsar site. Agricultural development is the key pressure causing the recent loss of wetlands in Southland. Additional recent wetland loss has been caused by an horticultural, afforestation and peat mining. Degradation and modification of wetlands is also of concern.
- 33 It is unclear as to the extent to which wetland losses have been approved under consent processes
- 34 There is limited information on trends relating to wetland condition.

Groundwater

- 35 The experts relied on the groundwater evidence-in-chief (EIC) of Mr Rodway, taking particular note of the following, where the figures in brackets are the paragraph numbers in the EIC:
- (a) Anthropogenic contamination of groundwater is widespread in Southland. In particular, nitrogen and faecal contamination are of primary concern, both from a human and ecosystem health perspective.
(14 (a))

- (b) For the 17-year period 2000 to 2016, increasing trends in groundwater NNN (nitrite and nitrate nitrogen) have been determined at 15 of the 23 (65%) regional State of the Environment (SoE) monitoring sites with sufficient data for analysis. Decreases in concentration were detected at 3 of 23 sites monitored by the Council and 1 of 6 sites monitored by GNS with trend direction at the remainder of the sites being unable to be determined with confidence. (14 (c))
- (c) Monitoring and modelling shows that approximately 50% (by area) of managed aquifers have NNN concentrations higher than 1.0 mg/L. This indicates that one fifth of the region's groundwaters may pose a risk to ecosystem health in streams, particularly those with a high proportion of groundwater sourced base flow and during periods of low flow. (14 (d))
- (d) In 2015, 80 of 296 (approximately 27%) of groundwater monitoring sites sampled for faecal contamination had median E. coli values in excess of drinking water standards. (14(e))
- (e) Southland has a mosaic of unconfined, shallow groundwater aquifers that exchange groundwater to surface water relatively quickly. Approximately 40 to 60% of all of the water in Southland streams is groundwater from these aquifers. However, it is highly variable across the region, with lowland streams having a much higher proportion of groundwater than alpine streams. (21)
- (f) ... groundwater within unconfined aquifers with hydraulic connection to surface waters is generally young, with average residence time or age of less than 10 years. ... (22)
- (g) Groundwater can transfer significant amounts of nitrogen and phosphorus that can have eutrophication effects in surface water environments such as streams, rivers, wetlands, estuaries, lagoons and the coastal environment. (23)

Estuaries

- 36 The experts relied on the evidence of Mr Ward in relation to estuaries, taking particular note of the following where the figures in brackets are the paragraph numbers in the EIC:
- (a) Estuarine and lake/lagoon health is a reflection of the inherent capacity of a system to process contaminants and the pressure on the system i.e. nutrient/sediment contribution due to contemporary land use. (13)
 - (b) New River Estuary (Oreti FMU), Jacobs River Estuary (Aparima FMU) and Toetoes (Fortrose) Estuary (Mataura FMU) are all currently receiving sediment and nutrient inputs beyond their assimilative capacity and show signs of eutrophication and expansive degraded areas. A reduction of further nutrient and sediment inputs is required to prevent further deterioration. (16(a))
 - (c) Waikawa Estuary and Haldane Estuary (Mataura FMU) are currently in a moderate to good health state (16(b))
 - (d) Freshwater Estuary (Fiordland and Islands FMU) on Stewart Island is a near pristine system and used as a reference condition estuary. (16(c))

What needs to be considered when assessing and managing for ecosystem and human health for Southland rivers and wetlands?

- 37 The experts agree that the following need to be considered when assessing and managing for ecosystem and human health - water quality, physical habitat, habitat connectivity, flow quantity and variability, harvesting (fishing, water cress), invasive species, catchment characteristics, life history stage, parasites and disease, pathogens, mahinga kai, periphyton, cyanobacteria, land use and drainage, hydrology, sedimentation, eutrophication and fish passage.

Assessment criteria used by the experts

- 38 The experts used the following information in evidence for assessing ecosystem and human health. Further details on information sources are set out in the evidence.

Attribute	Reference	Numeric used	How used	Commentary
Nitrate and Ammonia toxicity	NPSFM	NOF bands	Assessment against bands (Mr Hodson and Dr Kitson)	The experts agree that other ecosystem health effects are manifested at lower concentrations than toxic effects. In general managing for ecosystem health will address toxic effects however there are local circumstances where toxic effects must be considered.
			No effects approach (A band threshold) (Ms McArthur and Dr Kitson)	
			National bottom line (Mr Kitto)	
			Considered inappropriate (Dr Death)	
Nitrate/Nitrogen for ecosystem health effect	ANZECC 2000 (generally used by experts other than Dr Death)	Physico-chemical trigger value	Separate values were used for upland and lowland river types	Indication of potential risk that requires further exploration to determine if ecosystem health is poor and potential causes.
	Death et al (used by Dr Death and Ms McArthur)	Table 1 of EIC	Bottom line values for SWQMU.	Concentrations above the value will have adverse effects on ecosystem health.
Total Nitrogen	ANZECC (relied on by Mr Hodson and Dr Kitson)	Physico-chemical trigger value	Separate values were used for upland and lowland river types.	Indication of potential risk that requires further exploration to determine if ecosystem health is poor and potential causes.
Dissolved Reactive Phosphorus for ecosystem health effect	ANZECC 2000 (generally used by experts other than Dr Death)	Physico-chemical trigger value	Separate values were used for upland and lowland river types	Indication of potential risk that requires further exploration to determine if ecosystem health is poor and potential causes.

Attribute	Reference	Numeric used	How used	Commentary
	Death et al (used by Dr Death and Ms McArthur)	Table 1 of EIC	Dr Death used bottom line values for SWQMU. Ms McArthur used the B Band.	Concentrations above the respective value will have adverse effects on ecosystem health.
Total Phosphorus	ANZECC (relied on by Mr Hodson and Dr Kitson)	Physico- chemical trigger value	Separate values were used for upland and lowland river types.	Indication of potential risk that requires further exploration to determine if ecosystem health is poor and potential causes.
MCI	Stark and Maxted (Used by Dr Kitson, Ms McArthur. Dr Death and Mr Hodson)	Water quality classes	Dr Death used bottom line values from Table 1 in EIC for SWQMU.	Provides quality classes which are used in the interpretation of MCI scores. Dr Death assessed state against new proposed MCI numerics compared to those in Appendix E.
	Appendix E (Used by Dr Kitson, Mr Hodson)	Standards for SWQMU	Compliance threshold	Applies the quality classes from Stark & Maxted to the SWQMU differentially by class.
	NPSFM (Used by Dr Kitson and Ms McArthur)	MCI of <80 or degrading trend.	Compliance threshold	Threshold for action.
Periphyton	NPSFM (Used by Mr Hodson)	NOF attribute framework	Assessment against bands.	
	Appendix E (used by Mr Hodson)	Standards for SWQMU	Compliance threshold	
E.coli for human health for recreation not for food gathering or drinking water.	NPSFM with LAWA as the primary data source. (used by Dr Kitson and Mr Hodson)	Human health for recreation for all waters.	Attribute bands and median attribute statistic.	
		In addition used median >130 – used by Dr Kitson		

Attribute	Reference	Numeric used	How used	Commentary
	2003 MOH Recreational guidelines (used by Ms McArthur and Mr Hodson)	Identified sites with a median >540. Suitability for recreation grading – applied to sites identified in Appx K of operative RWP and additional sites where grading completed.	Indicator of concern. Suitability grading.	 Derived from surveillance monitoring as opposed to long-term SOE monitoring.
Water Clarity for swimming	MfE Guideline No. 1 (used by Ms McArthur)	<1.6m	Concern for safe contact recreation.	
Water clarity for ecosystem health	ANZECC	Lowland - <.8m Upland <.6m	Separate values were used for upland and lowland river types.	In Hodson et al 2017 report rather than EIC.
Toxic algae (primarily for recreation)	MfE MOH 2009 (used by Mr Hodson and other experts agree)	>20% cover	Assessment criteria – levels in excess trigger public health warning.	

Comparison of water quality in Southland and nationally

39 Ms McArthur has undertaken a comparison of how Southland water quality compares with the rest of the country at a broad level. She has done this by using national quartiles from the LAWA data platform to assess the state of multiple water quality attributes against all sites in combination of altitude class and land cover. This indicates to her that water quality at a number of sites in Southland is degraded. However, she has not relied on this as her only method of assessment. Dr Death concurs with the conclusions and approach used by

Ms McArthur. Dr Kitson is also in agreement as a general summary, but considers there is a need to have more local information.

- 40 Mr Kitto, Dr James and Mr Hodson see a number of limitations in the national comparison because of possible local variations (in particular climate and geology) and concerns with inaccuracies in the LAWA classifications of land cover. However, in general there is agreement amongst all the experts that there are water quality issues in parts of Southland.

Interim thresholds that the experts consider appropriate in terms of “holding the line”

- 41 The experts acknowledge that the Council’s approach is to “hold the line” as set out in Objective 6 of the pSWLP. This requires an understanding of what is meant by degradation and when improvement should be considered. The pSWLP relies on Appendix C and Appendix E as the methods for assessing degradation. The experts agree that these are inadequate as the sole definition of degradation. To ensure progress is made towards the compulsory national values relating to ecosystem health and human health, additional methods for assessing degradation should be considered prior to the limit setting process being completed.
- 42 When considering how to determine whether degradation has occurred, the Court may also wish to consider adding methods to address the following issues on an interim basis:
- nitrogen and phosphorus
 - deposited fine sediment;
 - macroinvertebrates;
 - periphyton;
 - stream and riparian habitat;
 - attributes to address human health for recreation.
- 43 All experts agree that all of the above need to be considered together when addressing ecosystem health. The experts note that when further analysis is undertaken, it may be necessary to add other attributes, such as temperature, fish and Dissolved Oxygen. They also agree that nitrogen and phosphorus and

shade standards would be appropriate as a means of managing effects on periphyton but different approaches may need to be taken in situations where invasive species are present.

44 The experts spent considerable time discussing what methods should be used to assess degradation and recognise that many different factors need to be considered. However, it is clear that there are areas of the region that are degraded with respect to ecosystem health, as evidenced by:

- nitrate and ammonia concentrations above the NPSFM band A for toxicity, (Mr Kitto and Ms Bennett have concerns at using band A as a toxic threshold)
- the trophic status of estuaries (in particular the poor condition of New River and Jacobs River estuaries),
- MCI scores breaching Appendix E standards,
- periphyton with the potential to exceed national bottom lines in the NPSFM.

45 It is similarly clear there are areas of the region that are degraded with respect to human health for recreation, using the following criteria:

- the E.coli concentrations in bands D and E of the NPSFM, or where banding is not yet assessed, E.coli median value >130 cfu/100 ml;
- the historical occurrence of cyanobacteria coverage in excess of 20%.

46 The experts have also identified areas of the region that are considered to be "at risk" with respect to ecosystem health using the following criteria:

- Nitrate, Total Nitrogen, Dissolved Reactive Phosphorus and Total Phosphorus concentrations in excess of the ANZECC 2000 physio chemical trigger level for nutrient effects.
- deteriorating MCI trend.

47 For the avoidance of doubt if any one of the listed criteria in paragraphs 42 and 43 is met, a water body would be considered to be degraded. Individual sites that meet the degraded criteria are identified in Appendix 1. Similarly, a water

body would be considered at risk if any one of the listed criteria in paragraph 44 is met. Individual sites that meet the at risk criteria are identified in Appendix 2. Sites that are considered degraded may also be at risk for other attributes and these have not been identified in Appendix 2. Appendices 1 and 2 were prepared by Dr Kitson and reviewed by Mr Hodson and other experts accepted the tables.

- 48 Additional water bodies may be degraded or at risk of being degraded when considered against criteria not included in paragraphs 42-44. This would result from the establishment of appropriate criteria for nitrogen, phosphorus, and other attributes relevant to periphyton, MCI and fish. The experts were unable to agree on thresholds that they could provide for the Court at this time.
- 49 Dr Death has undertaken considerable work in relation to nitrogen, phosphorus and MCI values that other experts consider provides a very helpful base for further consideration. Environment Southland has also undertaken significant further work in this area that will be directly relevant to addressing the above issues. Analysis of this work is likely to be undertaken over the next several months and the experts consider that prior to the Topic B hearings it should be possible to provide the Court with interim thresholds that could be used for the above, pending the finalisation of the FMU process. The experts consider this is desirable to ensure degradation in terms of ecosystem and human health is addressed.

What is the current state of river water quality and ecosystem and human health in Southland?

- 50 Mr Hodson has provided a comprehensive overview of Southland's surface water bodies and the state and trends in river water quality. All experts agree with this overview, except where specifically noted below.
- 51 For the base data to address this question the experts used the Environment Southland SOE and NIWA Southland monitoring specific data. Dr Death used the NIWA 2013 model built using national data from 2009 to 2012 including Southland SOE data. The other experts used a five-year period to assess state, generally within the period 2009-2017. While the experts used data from

slightly different sources and periods, they consider it provides a coherent and consistent picture of the current state of water quality.

- 52 Dr Death used the Surface Water Quality Management Units (SWQMS) system to address this question and other experts generally based their assessment on individual SOE sites grouped into the five FMUs in Southland. Mr Hodson also used the SWQMU system to assess MCI and periphyton.
- 53 Each of the five FMUs contain a variety of SWQMUs and these illustrate the changes in river classifications as you move down the river. The experts consider it would be useful to characterise each FMU in terms of individual SWQMU but this has not been done at this stage. It would require a separate GIS exercise. In the absence of this having been done, it is not possible to directly compare the work done by Dr Death with the work done on an FMU basis. However, Dr Death's work shows the same general patterns as identified below for FMUs – that reaches under natural vegetation have relatively good water quality, but that as rivers move down towards the coast and agricultural intensification increases, water quality declines. In reaching these conclusions, Dr Death considered nitrate, dissolved reactive phosphorus (DRP) and MCI, as generated by modelling and set out in his evidence. Mr Hodson noted that there are other pressures than just agricultural intensification.
- 54 Using Dr Death's proposed thresholds, he concluded the majority of mountain reaches are below proposed nitrate nitrogen and DRP concentrations, however a high proportion still do not meet an acceptable bottom line for MCI. Some lake fed reaches are below acceptable bottom lines for MCI. Most, if not all, spring-fed reaches are below acceptable bottom lines for MCI. Some hill reaches are below acceptable bottom lines for MCI. Lowland hard bed, lowland soft bed and Mataura 3 have the greatest number of reaches that are below acceptable bottom lines for nitrate, DRP and MCI
- 55 Throughout the Southland region waterbodies are highly valued for cultural purposes, especially mahinga kai and recreation.

State of FMU1 – Fiordland and Islands

- 56 The experts note that the FMU is largely Conservation Estate, with some smaller areas of development (e.g. parts of Stewart Island, Milford) but there is no data readily available to enable an assessment of current state to be made. The experts agree in areas with minimal land use pressures, water quality can be expected to be good
- 57 The wetland experts agree that this FMU is notable for its intact wetlands within an intact setting. The notable wetland types and features are:
- (a) the extensive mountains, numerous river valleys and high rainfall combine to create an abundance of wetlands. A notable feature of the wetlands is their intact condition within an intact natural setting. There are extensive, diverse and relatively in-tact lowland wetland systems:
 - valley floor – e.g. Pyke and Freshwater Valleys
 - extensive blanket bog – e.g. West Cape
 - intact estuarine wetlands at the mouths of the major rivers that enter the fiords.
 - (b) Many of the lowland wetlands retain their natural woody vegetation, unlike other parts of Southland.
 - (c) Numerous alpine seepages and associated wetland types.

State of FMU2 - Waiau

- 58 This FMU has a total area of 862,700 ha. The experts agree that in broad terms, water quality in the lakes and to west and north of the catchment, which are predominantly in conservation estate, have good water quality. To the east and south, there are the townships of Te Anau, Manapouri and Tuatapere, land uses include sheep and beef (148,113 ha), and dairy (19,450 ha).
- 59 Flows below the Manapouri Lake Control Structure (MLC), which is located below the confluence of the Mararoa River and the Waiau River, are significantly reduced because of the diversion to the Manapouri Power Scheme. The Waiau FMU includes Lake Te Anau, Lake Manapouri, Green Lake, Mavora Lakes and Lake Monowai, and freshwater that ends up in Te Waewae Lagoon.

- 60 The wetland experts agree that the north of this FMU is characterised by extensive glacially-scoured landscapes creating flat and gentle topography conducive to wetland formation.
- (a) There is an outstanding network of bog and fen wetlands in the Te Anau Basin and eastern Fiordland Valley floors; and
 - (b) Lacustrine wetland sequences occur on the fluctuating margins of Lakes Te Anau and Manapouri.
- 61 In the south, there are predominantly riverine wetlands associated with the Waiau River, and smaller, scattered bogs and fens.
- 62 There is an elevation in nitrogen concentrations where the Mararoa River joins the Waiau River and at some sites as you get nearer the coast, a further elevation in nitrogen, an elevation of *E.coli* and turbidity and a decrease in clarity. By way of specifics there are one or more sites in the Mararoa River and lower Waiau catchment with elevated dissolved reactive phosphorus (DRP), nitrate, ammonia and total nitrogen levels above the ANZECC ecosystem health thresholds. In addition there are elevated *E.coli* levels above the median attribute statistic under the National Objectives Framework (NOF). The remaining sites are below these thresholds.
- 63 In terms of MCI values, all monitored SOE sites within the Waiau FMU meet the standards in the operative regional water plan. Dr Death notes that he disagrees with these standards. Against the national classification (Stark and Macted), one site is classified as "fair" one recorded as "excellent" and 12 sites are classified as "good". Dr Death's disagreement is something that could be addressed in the interim process before the Topic B hearing referred to further in the JWS.
- 64 In terms of the periphyton criteria in the NPSFM there are sites in the upper and lower catchment which are within band A; sites in the upper catchment in band B; and a small number of sites in the lower catchment in band C. There have been exceedences of the operative RWP mat and filamentous algae/periphyton

cover standard at some of these sites (Mararoa River for both, and Upukerora River for mat, and Whitestone River for filamentous).

- 65 The experts agree that within the Waiau FMU there are sites that are considered degraded, as summarised in Appendix 1.
- 66 Didymo is an invasive species of diatom that grows on the bed of waterbodies, and can occur at nuisance levels, particularly in the Waiau FMU. Didymo responds differently to nutrients than other types of periphyton and can proliferate in low nutrient waters. The nuisance growth of Didymo complicates the use of MCI as an indicator of organic enrichment as it affects MCI in similar ways to other nuisance periphyton growth, although in the absence of organic enrichment.
- 67 Where there is high biomass, it may not be appropriate to apply the NOF periphyton biomass attribute or other periphyton standards and the presence of Didymo requires different management and mitigation strategies to other nuisance periphyton. Didymo needs to be assessed as a special case. The only known practical management option for Didymo is using flushing flows, which is only an option in regulated rivers and does not eliminate Didymo.
- 65 This issue could be further explored in an interim process prior to the Topic B hearing.

State of FMU3 - Aparima

- 68 The Aparima FMU covers around 206,700 hectares (6.5% of the region) and is a smaller FMU in comparison with the other FMUs in Southland. Around 168,000 hectares or 81 percent of the FMU is developed land and it also contains large areas of public conservation land. The towns include Otautau, Drummond, Colac Bay/Oraka and Riverton/Aparima. The agricultural land consists mostly of dairy and drystock properties. Land uses include sheep and beef – 68,616 ha, and dairy 56,550 ha.
- 69 The FMU includes Lake George, the Waimatuku Estuary and Aparima River, and Jacobs River Estuary. The wetland experts agree there are extensive

outwash plains with occasional large fens and bogs (e.g. Mt Hamilton, Castle Downs) in the northern part of the FMU, alluvial plains with scattered bogs (e.g. Bayswater) in the central part, and wetlands formed by coastal processes in the south (e.g. Lake George, Long White Lagoon).

- 70 Appendices 1 and 2 summarise degraded and at risk sites in FMU 2. The Jacobs River Estuary at the base of this FMU is degraded, as described in Mr Ward's evidence.

State of the FMU4 - Oreti

- 71 The Ōreti FMU covers around 420,400 hectares (13.1% of the region). Around 330,000 hectares or 78.5 percent is developed land and there are also large areas of public conservation land. This FMU is by far the most populated in the region, with around 61,264 residents (or 14.6 people/km²) mostly concentrated in and around Invercargill. Other towns include Lumsden, Browns, Mossburn, Wallacetown, Winton, and Bluff. The agricultural land is primarily dairy farming in the south and a mix of pastoral properties in the north – sheep and beef 152,156 ha, and dairy 100,198 ha.
- 72 The Oreti FMU encompasses water bodies draining to New River Estuary, Bluff Harbour and Awarua Estuary, which form part of the RAMSAR Waituna-Awarua Wetland of International Importance. New River Estuary's current area is 4,557 hectares (roughly 27% less than its original extent).
- 73 The wetland experts agree that in the upper Oreti catchment there are occasional fens and bogs on valley floors and the only occurrence of kettle hole (ephemeral) wetlands in Southland. On the Southland plains there are scattered peat bogs. In the south of the FMU there is the Awarua/Waituna RAMSAR wetland containing extensive estuarine wetlands associated with the New River Estuary and Awarua Estuary. Also present are extensive palustrine wetlands that form the western portion of the Awarua Plains/Waituna wetland complex. It is noted that the FMU boundary for the Oreti and Maitua cuts through the Awarua/Waituna wetland complex.
- 74 Appendices 1-2 summarise degraded and at risk sites in FMU 4. The New River Estuary at the base of this FMU is degraded, as described in Mr Ward's evidence.

State of FMU5 - Matāura

- 75 The Matāura FMU covers around 640,000 hectares (20.0% of the region) and it is the second largest developed FMU in Southland. Around 550,500 hectares, or 86 percent of the land, is developed (the highest percentage of the five FMUs in the region) and there are also large areas of public conservation land mainly in the headwaters. The towns include Edendale, Wyndham, Waikaia, Gore and Matāura. The FMU has mostly dairy farming on the plains (87,083 ha) and sheep and beef farming 392,399 ha.
- 76 Waituna Lagoon is a sub-unit within this FMU and forms part of the RAMSAR Waituna-Awarua Wetland of International Importance. Lake Brunton is a shallow brackish coastal lagoon located in Waipapa Bay. Fresh water from the Matāura FMU ends up in a number of coastal environments, including Waituna Lagoon, Toetoes Harbour, Haldane Bay, Waikawa Harbour, Lake Brunton and Lake Vincent.
- 77 The wetland experts agree that in the headwaters of the Waikaia River on schist uplands there are numerous seepages and associated wetlands. The central portion of the FMU has very few wetlands remaining. In the south of the FMU there are several important wetlands. In the south-east there are several estuaries, coastal lakes and other wetlands. In the south-west there are extensive palustrine wetlands and Waituna Lagoon forming the eastern portion of the Awarua/Waituna RAMSAR site.
- 78 Appendices 1-2 summarise degraded and at risk sites.

Other Matters

Is there a need for the plan to make provision for mahinga kai and other cultural indicators and values?

- 79 Dr Kitson considers it essential that the plan makes provision for mahinga kai and other cultural indicators and values. Further work will be required to develop these. A start should be able to be made before Topic B hearings commence.

What do the experts consider is causing degradation of water quality and ecology in Southland?

80 This question is answered in part in the evidence of Mr Hodson at paragraphs 18, 19, and 20. Other experts are in agreement with this and also note that recent land use intensification, river modification, high risk activities including poor management of those activities, and in urban areas aging infrastructure has contributed to degradation with respect to ecosystem and human health. Ms McArthur notes that the evidence of Mr Rodway (paragraphs 97-110) is also relevant, particularly with respect to high risk activities.

How should the plan make appropriate provision for threatened species?

81 Protecting water quality is important for protecting threatened species, but is not a mechanism on its own for ensuring their security. Threatened species are affected by a variety of catchment and reach scale stressors, e.g. competition, predation, habitat modification loss and disturbance, loss of habitat connectivity. Wetland drainage and habitat modification are two of the biggest potential threats. For the avoidance of doubt threatened species discussed here includes aquatic and those terrestrial and avian species that utilise aquatic systems. This is simply identifying there is an issue and further work will be required to address it appropriately.

How should the plan address wetlands?

82 The experts agree the loss of wetlands is a critically important issue, and that there is a need to enhance, restore and increase the extent of wetlands to maintain and enhance ecosystem health. Most experts agree that this requires urgent and effective action and the plan should go as far as possible to achieve this. Mr Kitto noted his evidence does not address the issue of wetlands.

What are the risks of acting and not acting in relation to the setting of interim thresholds?

83 The experts agree that there are already degraded sites in Southland, and until such time as appropriate thresholds are established and changes made to stressors affecting ecosystem health, water quality may not be maintained or improved as required by Objective 6.

- 84 While the experts recognise that the FMU process will address this at some time in the future, interim criteria has been developed for critical attributes to determine degraded sites that can be used in the shorter term. Additionally the experts have identified a process to develop attribute thresholds to apply until FMU objectives and limits are developed.

In the interim are different attributes required for different FMUs?

- 85 The experts agree for the interim process recommended there should be no difference between FMUs.

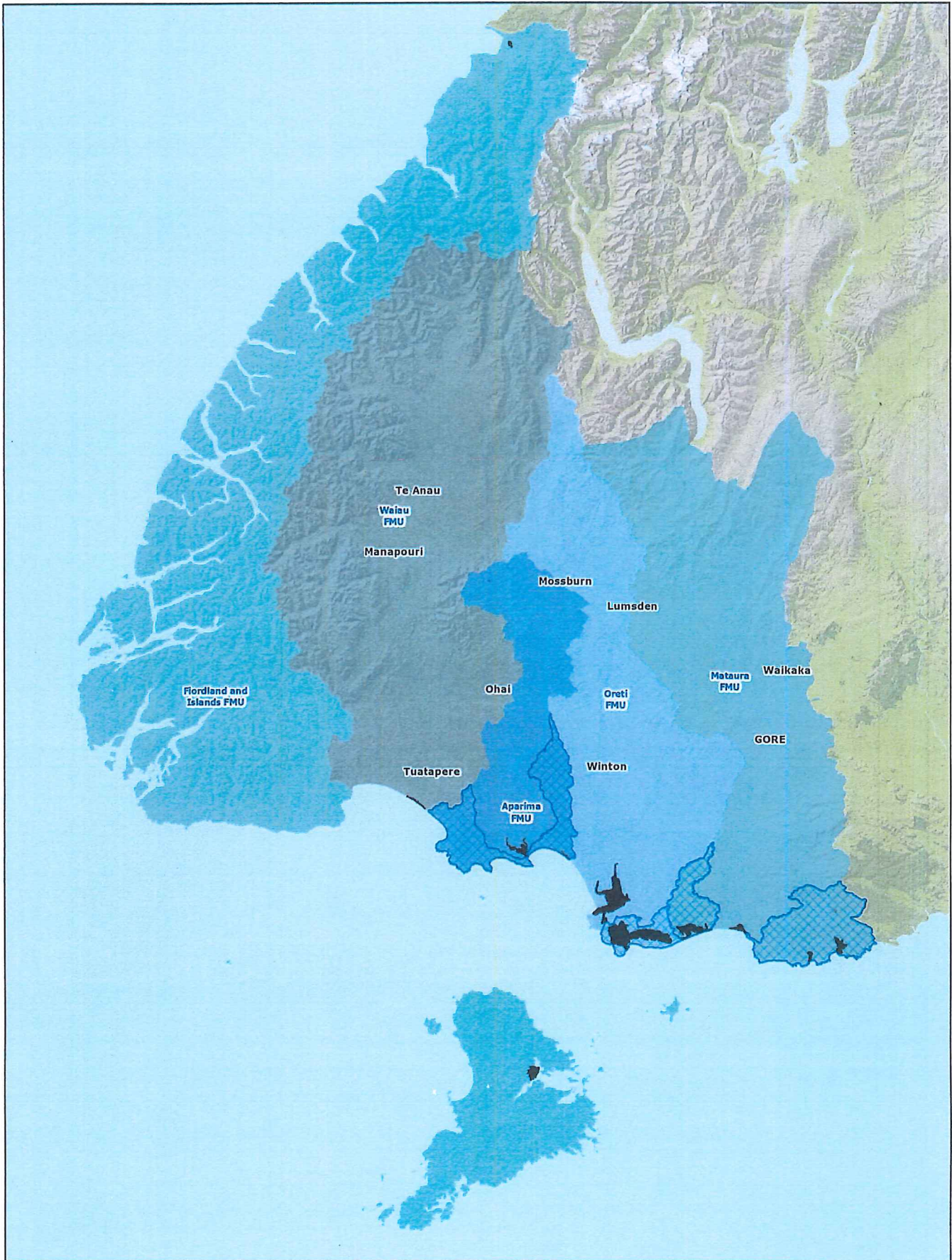
How will climate change influence water quality and ecology in the Southland region?























- 86 The experts did not have time to address this at the conference, and nor do they have the information upon which to provide the advice. However they consider it to be a significant threat.

What comments did the expert have on specific plan provisions?

- 87 The experts did not specifically address individual plan provisions other than Objective 6, but consider that the plan should make appropriate provision for the matters raised in this JWS. They also note that changes to Appendix E are needed on an interim basis, pending completion of the FMU process.

Map Series 6: Freshwater Management Units



 <p>environment SOUTHLAND REGIONAL COUNCIL Te Tāiao Tonga</p>	<p>Map Series 7 Freshwater Management Units Map 1</p>	<table border="0"> <tr> <td></td> <td>FMU Sub Units</td> <td></td> <td>Mataura FMU</td> </tr> <tr> <td></td> <td>Estuaries</td> <td></td> <td>Oreti FMU</td> </tr> <tr> <td></td> <td>Aparima FMU</td> <td></td> <td>Waiau FMU</td> </tr> <tr> <td></td> <td>Fiordland and Islands FMU</td> <td></td> <td></td> </tr> </table>		FMU Sub Units		Mataura FMU		Estuaries		Oreti FMU		Aparima FMU		Waiau FMU		Fiordland and Islands FMU			<p>0 10 20 40 Km</p> <p>An interactive version of this map is available on the Environment Southland website - www.es.govt.nz While every effort has been made to ensure the content is correct, Environment Southland cannot guarantee the accuracy of the data. This information should not be reused in any manner without consultation.</p> <p>DATA SOURCE: ES GIS 2016</p>
	FMU Sub Units		Mataura FMU																
	Estuaries		Oreti FMU																
	Aparima FMU		Waiau FMU																
	Fiordland and Islands FMU																		

Appendix 1

DEGRADED SITES

This table is only populated for attributes that exceed the degraded assessment criteria.

[Data sources: LAWA state and trends as at may 2019: Nitrate (Total Oxidised nitrogen), Ammonia*, *E.coli*; Hodson and Akbaripasand (2016): MCI state; Mr Hodson EIC pg 15: Periphyton state; Cyanobacteria: Hodson pers. com, and references with Mr Hodson's EIC].

* for Ammonia a number of sites 'state' assessment is incorrectly displayed on LAWA, LAWA processed output files have been used by Mr Hodson to ensure that the more conservative of the two NOF attributes (median and max) is used rather than the assessment using the median only as displayed visually on LAWA.

WAIIAU FMU:

Site	Ecosystem Health				Human Health				
	Nitrate - toxicity	Trend	Ammonia - toxicity	Trend	MCI	Periphyton ¹	<i>E. coli</i>	Trend	Cyanobacteria
Lill Burn at Lill Bunn-Monowai Road						Degraded	Degraded	NA	
Orauea River at Orawia Pukemaori Road							Degraded	Likely improving	
Waiau River at Tuatapere						Degraded	Degraded	Likely improving	Degraded
Upukeroa at Te Anau Milford Highway									Degraded
Whitestone River d/s Manapouri-Hillside									Degraded

¹ Periphyton does not have a trend assessment.

APARIMA FMJU:

Site	Ecosystem Health						Human Health		
	Nitrate-toxicity	Trend	Ammonia-toxicity	Trend	MCI	Periphyton ²	<i>E. coli</i>	Trend	Cyanobacteria
Waimatuku Stream at Lorneville Riverton	Degraded	Very Likely improving					Degraded	Very Likely improving	Degraded
Waimatuku Stream at Rance Rd					Degraded				
Otautau Stream at Waikouro	Degraded	Very Likely improving	Degraded	Very Likely improving			Degraded	Likely improving	
Otautau Stream at Otautau-Tuatapere Road	Degraded	Very Likely improving	Degraded	Indeterminate			Degraded	Likely improving	
Otautau Stream at Otautau					Degraded				
Aparima River at Thornbury	Degraded	Very Likely improving			Degraded	Degraded	Degraded	Very likely improving	Degraded
Opouriki Stream at Tweedie Road	Degraded	Very likely degrading	Degraded	NA			Degraded	Very likely improving	
Pourakino River at Traill Road							Degraded	Very likely degrading	
Hamilton Burn at Affleck Road	Degraded	NA							Degraded

² Periphyton does not have a trend assessment.

ORETI FMU

Site	Ecosystem Health					Human Health			
	Nitrate-toxicity	Trend	Ammonia-toxicity	Trend	MCI	Periphyton ³	E. Coli	Trend	Cyanobacteria
Irthing Stream at Ellis Road	Degraded	Likely degrading					Degraded	Indeterminate	
Murray Creek at Castlerock Road					Degraded				
Murray Creek at Double Road					Degraded				
Dipton Stream at South Hillend-Dipton Rd						Degraded			Degraded
Otapiri Stream at Otapiri Gorge	Degraded	Indeterminate					Degraded	Likely improving	
Bog Burn d/s Hundred Line Road	Degraded	Very Likely improving					Degraded	Indeterminate	
Makarewa River at Lora Gorge Road							Degraded	Indeterminate	
Dunsdale Stream at Dunsdale Reserve							Degraded	Very likely degrading	

³ Periphyton does not have a trend assessment.

MATAURA FMU:

Site	Ecosystem Health					Human Health			
	Nitrate-toxicity	Trend	Ammonia-toxicity	Trend	MCI	Periphyton ⁴	E. coli	Trend	Cyanobacteria
Brightwater Spring West at Garston Kings					Degraded				
Mataura River at Parawa							Degraded	Very likely degrading	
Waikaia River at Waikaia							Degraded	Indeterminate	Degraded
Waikaia river u/s Piano Flat									Degraded
Waikaia River at Waipounamu Bridge Road							Degraded	Very likely degrading	
Longridge Stream at Sandstone	Degraded	Very likely degrading	Degraded	Likely degrading	Degraded	Degraded	Degraded	Likely degrading	
North Peak Stream at Waimea Valley Road	Degraded	Very Likely improving					Degraded	Very likely improving	
Sandstone Stream at Kingston Crossing Rd	Degraded	Indeterminate	Degraded	NA	Degraded		Degraded	Very likely degrading	

⁴ Periphyton does not have a trend assessment.

Site	Ecosystem Health					Human Health			
	Nitrate-toxicity	Trend	Ammonia-toxicity	Trend	MCI	Periphyton ⁴	<i>E. coli</i>	Trend	Cyanobacteria
Waimea Stream at Mandeville	Degraded	Very likely degrading			Degraded		Degraded	Indeterminate	
Otamita Stream at Mandeville	Degraded	Likely improving					Degraded	Indeterminate	
Mataura River at Gore							Degraded	Likely degrading	Degraded
Waikaka Stream at Gore	Degraded	Very Likely improving	Degraded	Very Likely improving			Degraded	Likely improving	
Mataura River 200m d/s Mataura Bridge			Degraded	Indeterminate	Degraded		Degraded	Indeterminate	
Mimihau Stream at Wyndham							Degraded	Indeterminate	
Mokoreta River at Wyndham River Road	Degraded	Likely improving					Degraded	Likely improving	
Mataura River at Mataura Island Bridge	Degraded	Very Likely improving				Degraded	Degraded	Likely degrading	Degraded
Meadow Burn at Round Hill Road					Degraded				

Site	Ecosystem Health					Human Health			
	Nitrate-toxicity	Trend	Ammonia-toxicity	Trend	MCI	Periphyton ⁴	E. coli	Trend	Cyanobacteria
Oteramika Stream at Seaward Downs	Degraded	Very likely degrading	Degraded	Very likely degrading			Degraded	Very likely degrading	
Waikawa River at Progress Valley							Degraded	Indeterminate	
Tokenui River at Fortrose Otara Road	Degraded	Very Likely improving	Degraded	NA			Degraded	Indeterminate	
Waikopikopiko Stream at Haldane Curio Bay							Degraded	Indeterminate	
Waituna Creek at Marshall Road	Degraded	Very Likely improving	Degraded	Very Likely improving	Degraded	Degraded	Degraded	Indeterminate	
Carran Creek at Waituna Lagoon Road							Degraded	Indeterminate	

AT RISK SITES

This table is only populated for attributes that exceed the 'At Risk' assessment criteria. [Data sources: LAWA: Nutrients state and trends; Hodson and Akbaripasand (2016): MCI trends].

WAIU FMU

Site	TON	Trend	Total N	Trend	DRP	Trend	Total P	Trend	MCI Trend
Upukerora River at Te Anau Milford Highway									Significantly Decreasing
Whitestone River d/s Manapouri-Hillside	At Risk	Likely degrading	At Risk	Very likely degrading					
Maraoroa River at Weir Road	At Risk	Indeterminate	At Risk	Indeterminate					Significantly Decreasing
Waiau River 100m u/s Clifden Bridge									Significantly Decreasing
Pig Creek at Borland Lodge									Significantly Decreasing

APARIMA FMU

Site	TON	Trend	Total N	Trend	DRP	Trend	Total P	Trend	MCI Trend
Aparima River u/s Dunrobin									Significantly Decreasing
North Etal Stream u/s Dunrobin Valley Rd			At Risk	NA					
Hillpoint Stream at Waikana Road									Significantly Decreasing
Aparima River at Wreys Bush									Significantly Decreasing
Pourakino River at Ermedale Road									Significantly Decreasing
Waimeamea River at Young Road									Significantly Decreasing

ORETI FMU

Site	TON	Trend	Total N	Trend	DRP	Trend	Total P	Trend	MCI Trend
Oreti River at Lumsden Bridge			At Risk	Likely improving					Significantly Decreasing
Hedgehope Stream at Block Road									Significantly Decreasing
Mokotua Stream at Awarua			At Risk	Very Likely improving					

MATAURA FMU:

Site	TON	Trend	Total N	Trend	DRP	Trend	Total P	Trend	MCI Trend
Mataura River d/s Robert Creek Confluence									Significantly Decreasing
Mimihau Stream Tributary at Venlaw Forest					At Risk	NA			Significantly Decreasing
Waikaia River u/s Piano Flat									Significantly Decreasing

3

Appendix 1: Summary of trend results of water chemistry and macroinvertebrate community index for the period January 2008- December 2017. Adapted from LAWA 2018 (accessed 6 March 2019).

Freshwater Management Unit	Clarity	Turbidity	Dissolved reactive phosphorus		Total phosphorus	Ammonical nitrogen		Total oxidised nitrogen		E.coli	Macroinvertebrate community index
			phosphorus	phosphorus		nitrogen	nitrogen				
Waiau	Total sites	9	9	9	9	9	9	9	9	9	9
	Total sites analysed	6	1	2	8	4	8	7	6	4	4
	Improving	3		0	4	2	0	3	4	0	0
	Worsening	1	1	1	2	1	5	3	2	1	1
	Indeterminate	2		1	2	1	3	1	3	2	3
	% improving	50	0	0	50	50	0	43	67	0	0
	% worsening	17	100	50	25	25	63	43	33	25	25
% indeterminate	33	0	50	25	25	38	14	0	75	75	
Aparima	Total sites	8	8	8	8	8	8	8	8	8	8
	Total sites analysed	3	2	7	8	4	7	7	8	1	1
	Improving	3	2	3	8	2	4	4	6	0	0
	Worsening	0	0	2	0	0	3	2	2	0	0
	Indeterminate	0	0	2	0	2	1	1	0	1	1
	% improving	100	100	43	100	50	57	57	75	0	0
	% worsening	0	0	29	0	0	43	29	25	0	0
% indeterminate	0	0	29	0	50	0	14	0	100	100	
Oreti	Total sites	16	16	16	16	16	16	16	16	16	16
	Total sites analysed	8	1	12	15	10	14	13	17	8	8
	Improving	1	0	4	7	4	9	8	6	4	4
	Worsening	3	0	5	3	5	3	3	5	2	2
	Indeterminate	4	1	3	5	1	2	2	6	2	2
	% improving	13	0	33	47	40	64	62	35	50	50
	% worsening										

% worsening	38	0	42	20	50	21	23	29	25
% indeterminate	50	100	25	33	10	14	15	35	25
Total sites	23	23	23	23	23	23	23	23	23
Total sites analysed	13	3	21	21	14	21	22	20	14
Improving	3	1	7	17	6	9	11	3	3
Worsening	5	2	8	1	4	8	6	7	6
Indeterminate	5	0	6	3	4	4	5	10	5
% improving	23	33	33	81	43	43	50	15	21
% worsening	38	67	38	5	29	38	27	35	43
% indeterminate	38	0	29	14	29	19	23	50	36

Mataura

Bob

M. Jones

J. H. M.

Hodges, Jim

From: Death, Russell <R.G.Death@massey.ac.nz>
Sent: Friday, 10 May 2019 7:57 a.m.
To: Kate McArthur; Mark James; Hodges, Jim; 'Justin Kitto'
Cc: 'Jan Brown'; kelvin.lloyd@wildlands.co.nz; 'Roger Hodson'; brance@doc.govt.nz; jane@kitsonconsulting.co.nz; sue.bennett@stantec.com; efunnell@doc.govt.nz; psjimboh@gmail.com
Subject: RE: Jim's version - Expert conferencing agenda -water quality and ecology (rivers wetlands)

Mōrena

I am similarly happy with the JWS and Dr James suggested changes outlined in his email 9/5/2019

Ngā mihi
Russell

Russell Death
Professor Freshwater Ecology
Innovative River Solutions
College of Sciences
Massey University
Private Bag 11-222
Palmerston North 4442
New Zealand.

If you don't deal with reality; reality will deal with you

"Being a naturalist in the 21st century is like being an art enthusiast in a world where an art museum burns to the ground every year." Alex Wild

From: Kate McArthur <kate@thecatalystgroup.co.nz>
Sent: Friday, 10 May 2019 7:32 a.m.
To: Mark James <markj@aquaticsciences.co.nz>; 'Hodges, Jim' <Jim.Hodges@justice.govt.nz>; 'Justin Kitto' <Justin.Kitto@dairynz.co.nz>
Cc: 'Jan Brown' <jan.brown@es.govt.nz>; kelvin.lloyd@wildlands.co.nz; 'Roger Hodson' <roger.hodson@es.govt.nz>; brance@doc.govt.nz; jane@kitsonconsulting.co.nz; sue.bennett@stantec.com; efunnell@doc.govt.nz; Death, Russell <R.G.Death@massey.ac.nz>; psjimboh@gmail.com
Subject: Re: Jim's version - Expert conferencing agenda -water quality and ecology (rivers wetlands)

Kia ora Jim,

I confirm I agree with the signed JWS and I also confirm I have no objections to the suggested changes of Dr James as outlined in his email below.

Nga mihi
Kate

Kate McArthur
Practice Leader - Water
The Catalyst Group
m: 0210374362

----- Original Message -----

Subject: RE: Jim's version - Expert conferencing agenda -water quality and ecology (rivers wetlands)

From: Mark James

To: "'Hodges, Jim'", 'Justin Kitto'

CC: 'Kate McArthur', 'Jan Brown', kelvin.lloyd@wildlands.co.nz, 'Roger Hodson'

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Hi Jim

As requested this email is to confirm I agree with the JWS signed by other experts subject to the changes/additions listed and underlined below:

Paragraph 44 first bullet point to read:

- nitrate and ammonia concentrations above the NPSFM band A for toxicity, (Mr Kitto, Dr James and Ms Bennett have concerns at using band A as a toxic threshold). Dr James considers this is appropriate for avoiding enrichment due to nitrogen but not necessarily toxicity.

Paragraph 47

For the avoidance of doubt if any one of the listed criteria in paragraphs 44 and 45 is met, a water body would be considered to be degraded. Individual sites that meet the degraded criteria are identified in Appendix 1. Similarly, a water body would be considered at risk if any one of the listed criteria in paragraph 46 is met. Individual

sites that meet the at risk criteria are identified in Appendix 2. Sites that are considered degraded may also be at risk for other attributes and these have not been identified in Appendix 2. Appendices 1 and 2 were prepared by Dr Kitson and reviewed by Mr Hodson and other experts accepted the tables.

Paragraph 48

Additional water bodies may be degraded or at risk of being degraded when considered against criteria not included in paragraphs 44-46. This would result from the establishment of appropriate criteria for nitrogen, phosphorus, and other attributes relevant to periphyton, MCI and fish. The experts were unable to agree on thresholds that they could provide for the Court at this time.

Paragraph 62

There is an elevation in nitrogen concentrations where the Waiau River joins the Mararoa River and at some sites as you get nearer the coast, a further elevation in nitrogen, an elevation of *E.coli* and turbidity and a decrease in clarity. By way of specifics there are one or more sites in the Mararoa River and lower Waiau catchment with elevated dissolved reactive phosphorus (DRP), nitrate, ammonia and total nitrogen levels above the ANZECC ecosystem health thresholds. In addition there are elevated *E.coli* levels above the median attribute statistic under the National Objectives Framework (NOF). The remaining sites are below these thresholds.

Regards
Mark James



Regards
Mark James

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