

**BEFORE THE ENVIRONMENT COURT
I MUA I TE KOOTI TAIAO O AOTEAROA**

UNDER The Resource Management Act 1991
(RMA)

IN THE MATTER Appeals under clause 14(1) of the First
Schedule of the Act in relation to the
Proposed Southland Water and Land Plan

BETWEEN **MERIDIAN ENERGY LIMITED**
Appellants

AND **SOUTHLAND REGIONAL COUNCIL**
Respondent

STATEMENT OF EVIDENCE OF ANDREW BAZEL CONRAD FEIERABEND

FOR

MERIDIAN ENERGY LIMITED

29 July 2022

Topic B6 Infrastructure

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Appellants

AND SOUTHLAND REGIONAL COUNCIL

Respondent

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QUALIFICATIONS AND EXPERIENCE

- 1 My name is Andrew Bazel Conrad Feierabend.
- 2 I am employed by Meridian Energy Limited (Meridian). My qualifications and position with Meridian are described in my primary statement of evidence in chief dated 2019¹.
- 3 This statement of evidence is made with the benefit of my understanding of the operational needs and requirements of the Manapōuri Power Scheme (MPS). I have acquired this knowledge through my position with Meridian and my involvement in the development of the Southland Regional Planning process. This evidence is factual in nature rather than being an expression of expert opinion.

BACKGROUND AND SCOPE OF THIS EVIDENCE

- 4 This statement of evidence is complimentary to and expands on my evidence in chief presented at that part of the Topic A hearing which settled the objective and key policy architecture of the proposed Southland Water and Land Plan (pSWLP).
- 5 The purposes of my statement are to:
 - (a) describe the necessity for the pSWLP to adequately recognise at a policy level reverse sensitivity, because of the impact third-party activities can have on the nationally significant MPS;
 - (b) provide practical examples of third-party activity that can impact on the MPS's operation and generation output;

¹ Statement of Evidence in Chief of Andrew Bazel Conrad Feierabend dated 19 February 2019 for Topic A hearing.

- (c) outline the reason Meridian requires an exception to the water quality standards contained in Appendix E of the pSWLP to provide for and enable the effective ongoing maintenance and operations of the MPS; and
 - (d) provide practical examples of where resource consents might be required for which it would be appropriate for the exception to apply as proposed.
- 6 I am authorised to present this evidence as a representative of Meridian and on behalf of the Company.
- 7 In preparing this evidence I have reviewed:
- (a) The Decision Version of the pSWLP and subsequent interim decisions of the Court;
 - (b) The National Policy Statement for Freshwater Management 2020 originally gazetted (**NPSFM 2020**);
 - (c) The National Policy Statement for Renewable Electricity Generation 2011 (**NPSREG 2011**);
 - (d) The Southland Regional Policy Statement (**SRPS**);
 - (e) The expert evidence prepared on behalf of Meridian Energy by Dr Jennifer Purdie on climate change; Dr Jack McConchie on hydrology; David Hunt on energy; Dr Kristy Hogsden on periphyton and water quality; and Jane Whyte on planning.

REVERSE SENSITIVITY – THIRD-PARTY EFFECTS ON THE MPS AND THE NEED TO RECOGNISE THESE IN THE PSWLP

- 8 I have been responsible for Meridian's response to and participation in the development of the Southland Regional Policy Statement (SRPS) and the pSWLP. This has included oversight of the preparation of all submissions, further submissions, appeals, and evidence associated with these proceedings.
- 9 Through both the SRPS and pSWLP processes, Meridian has advocated that recognition of reverse sensitivity should be addressed. Its submissions on this matter are aimed at ensuring that the effects of third-party development and use of natural resources, and the associated potential

impact on the operation of the MPS, are properly recognised and assessed where new activities require a resource consent.

- 10 This approach is consistent with giving effect to the provisions of the NPSREG 2011². The Regional Council in response to Meridian's submissions has provided a recognition in the SRPS for managing reverse sensitivity with respect to renewable energy³ but has not made any commensurate provision for this matter in the pSWLP. Meridian is particularly concerned that this approach leaves a significant gap in the pSWLP and risks plan administrators and decision-makers overlooking this important matter when processing resource consents under the pSWLP.
- 11 Since taking up my role in Meridian there have been numerous third-party applications to consent activities that have raised reverse sensitivity effects for the MPS. Some of these effects have been identified by the Southland Regional Council through identifying affected parties; others have been identified by Meridian. Some of the issues can be resolved through the setting of appropriate consent conditions, but other issues may be unresolvable with the applicant. In this context, it is the requirement for consideration of third-party activities that is important.
- 12 Reverse sensitivity in the Waiiau Catchment, as it relates to the operations of the MPS, broadly falls under the following headings:
- (a) allocation of water for land use intensification in a fully allocated catchment;
 - (b) allocation of water for land use intensification that could lead to increased contaminants in the Waiiau River, both above and below the Manapōuri Lake Control (MLC) structure;
 - (c) instream works, including gravel extraction from the Mararoa River and its catchment; and
 - (d) the use of land, lake and river margins adjoining or close to structures associated with the operation of the MPS from a dam safety and monitoring perspective.

² Objective D Managing reverse sensitivity effects on renewable electricity generation activities
Policy D Decision-makers shall, to the extent reasonably possible, manage activities to avoid reverse sensitivity effects on consented and on existing renewable electricity generation activities.

³ Policy ENG.2 – Benefits of renewable energy and Method ENG.1 – Regional Plans – Policy INF3 – Infrastructure Protection – Method INF1 – Regional Plans

- 13 Of these matters, the first two have the most significant potential impact in the context of the operation and generation capacity of the MPS. New applications for the taking of surface and groundwater water for land use intensification above the MLC structure derogate from Meridian's current allocation given the catchment's fully allocated status. Such applications directly impact on the amount of water available to generate renewable electricity. Meridian has resisted consents for such takes in the past. This has not stopped such applications being promoted, applied for, and in one case granted.
- 14 Meridian is also interested in such applications from the perspective of land use change, increased stock units per hectare, and the impact associated with increased fertiliser application or scope for contaminant discharge. In real terms, new activity can result in increasing contaminant loadings to surface water and connected groundwater in the upper and lower catchment. In this regard I refer to the evidence of Dr Hogsden which shows that in relation to some key contaminants of concern there is a deteriorating water quality trend in parts of the catchment.
- 15 If these matters are not appropriately managed, the flow of water from the Mararoa diversion to Lake Manapōuri could be jeopardised. As Dr McConchie's evidence explains, inflows into Lake Manapōuri from the Mararoa River are an important source of flows for renewable electricity generation.
- 16 In addition, if contaminant loadings to the Lower Waiau River were to increase as a result of third-party land use and associated discharge activities, as has occurred in recent years as discussed by Dr Hogsden and Dr McConchie, invariably calls from some sectors of the farming community with interests in the catchment would assert that this matter should be managed through increasing the assimilative capacity of this part of the river through additional base flows.
- 17 Both these propositions (the prospect of reduced ability to use Mararoa River flows for generation because its quality is unsuitable for diversion into Lake Manapōuri; and the prospect that Meridian will be asked to discharge additional water at MLC to dilute the effect of contaminants introduced to the catchment downstream by third parties) risks reducing the water available to allow the MPS to continue to fulfil its important role in producing large and flexible renewable electricity.

- 18 Instream works above the MLC structure in the Mararoa sub-catchment, particularly gravel removal for roading and other uses, can potentially impact on the geomorphological functioning of the Lower Waiau River which by its nature is gravel deficient. My understanding is the Mararoa River is an important source of gravel supply to the of the Lower Waiau River.
- 19 Removing gravel from the Mararoa and Lower Waiau River can change channel configuration, cause bed degradation or aggradation, and change the extent of gravel beaches. All of these can have effects on erosion or flooding, natural character, and ecology.
- 20 In 2020 Meridian participated in a resource consent process by a local earthwork contractor in the Mararoa River to ensure suitable management conditions were imposed to mitigate this risk⁴. This included commissioning a study that showed that bed load transport of gravel and sediment was much lower than that estimated by the applicant, and that the proposed extraction potentially represented the entire annual bed load of the Mararoa River.
- 21 The purpose of engaging in this type of process is to ensure that from a reverse sensitivity perspective the MPS is not erroneously targeted as being the cause of adverse geomorphological or water quality effects in the Lower Waiau River, which are in reality primarily caused by other (often later) activities over which Meridian has no control.
- 22 In addition, a number of recreational activities that require resource consents have been promoted over the years including rafting, walking, and mountain biking. Meridian engages in these matters because of issues arising from dam safety and potential impacts on monitoring sites associated with the operation of the MPS.
- 23 It is Meridian's position that reverse sensitivity is resolvable through amendments advanced in Ms Whyte's planning evidence to Policy 26. The purpose of these amendments will ensure that Plan users, administrators and decision-makers are aware of the issue of reverse sensitivity and that steps are taken to manage it, including appropriately considering if the scheme operator is an affected party in the context of the use proposed.
- 24 Meridian has no interest in unreasonably interfering in other people going about their business in the catchment. Rather, Meridian takes seriously the

⁴ Te Anau Earthworks Land Use Consent Gravel Auth – 1091409

value and importance of the MPS's contributions to New Zealand's increasing need for flexible renewable electricity generation. With that in mind, Meridian seeks appropriate recognition in the pSWLP of the potential for third party activities to adversely affect the operation of the MPS.

APPENDIX E PSWLP – ANCILLARY CONSENTING PROCESSES

- 25 “Appendix E – Receiving Water Quality Standards” of the pSWLP was effectively rolled over from the Operative Regional Water Plan⁵. It is generally agreed, as evidenced by the joint witness statement on water quality, that Appendix E falls short of expectations in the context of the earlier version of the National Policy Statement for Freshwater, which applied during the development of the pSWLP.
- 26 Meridian understands the Regional Council proposes to address these shortcomings outside the pSWLP process and as part of the Freshwater Management Unit (FMU) planning process. Potentially this may involve a plan change to Appendix E after the pSWLP is made operative.
- 27 Meridian was successful in seeking an exception to the provisions of Appendix E for the operation of the MPS as part of the decisions arising from the Council hearing. The exception included in the pSWLP by Council decision was to recognise that because of the effects of the MPS that alter natural flows, some standards in Appendix E may not be able to be met. The standards that apply are based on the effects of discharges after reasonable mixing with the receiving water⁶.
- 28 Some parties requested via their appeal and section 274 notices that the MPS exception be removed from the Plan because of a lack of clarity about its purpose. Through the same process there are also a number of amendments proposed by parties that seek changes to the standards within each water classification type⁷. There is a particular focus on sediment management and the visual clarity standards of Appendix E.
- 29 Given the shortcomings of Appendix E and following mediation and discussions with parties, Meridian considers the exception provision for the MPS can be better targeted to apply only where consenting processes are

⁵ Operative Regional Water Plan for Southland dated January 18, 2010 – Appendix G – Water Quality Standards.

⁶ Appendix E – Receiving Water Quality Standards pSWLP paragraph 1.

⁷ Consolidated pSWLP showing relief of parties – revised 25 May 2022.

required to authorise an ancillary and operational activity of the MPS, where that use will not have a permanent effect on water quality.

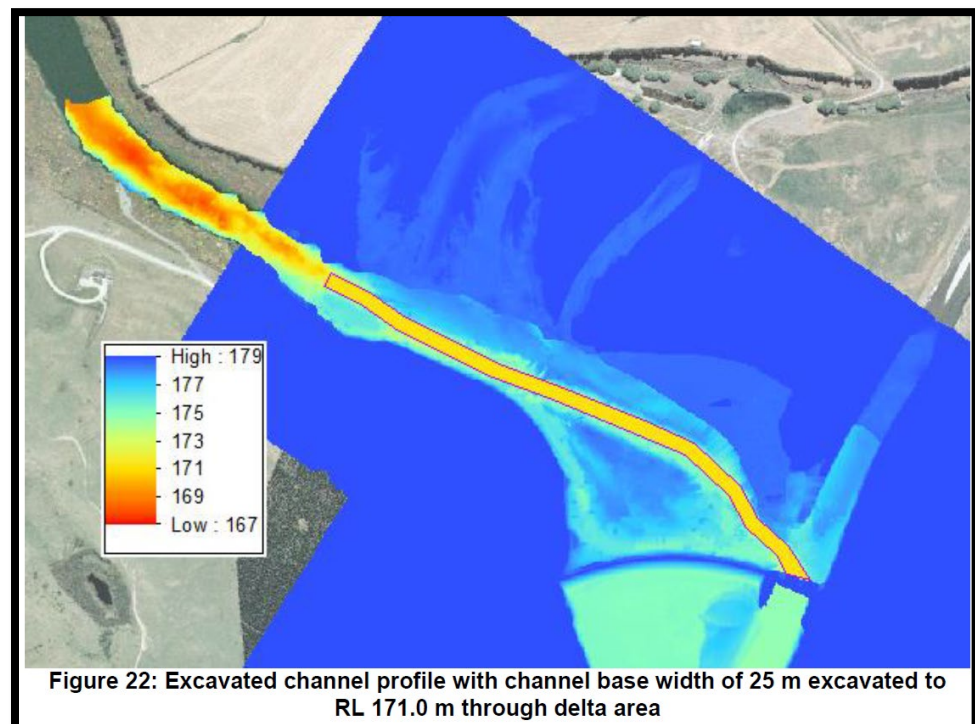
- 30 There are a number of activities associated with the operation of the MPS that necessitate instream works from time to time to maintain the generation output of the scheme and ensure flows can be appropriately managed.
- 31 This work can include both scheduled and unplanned, but necessary, work. Examples are:
- (a) channel realignment and channel conveyance;
 - (b) gravel extraction near structures;
 - (c) maintenance of wharf structures and jetties at Pearl Harbour and West Arm on Lake Manapōuri.
 - (d) maintenance of the Te Anau and Manapōuri Lake Control Structures;
 - (e) reconfiguration and construction of a new barge jetty and boat haul out at Supply Bay on Lake Manapōuri;
 - (f) installation of monitoring equipment associated with the operation of the scheme including water stilling wells and turbidity measuring equipment.
- 32 These activities inherently and unavoidably have temporary sediment discharges associated with them and at times will need a resource consent if they are not provided for as a permitted activity, either because of a locational matter or because they cannot satisfy a pSWLP standard.
- 33 By way of example Meridian is currently working on a proposal to improve flushing flow reliability to the Lower Waiau River to help reduce the impacts of nuisance periphyton and improve instream values.
- 34 Meridian endeavours to provide up to five flushing flows from November to May each year as set out in a voluntary protocol developed in 2013⁸ and linked to its primary consents. The protocol is attached as Appendix 1 to this evidence.
- 35 The purpose of these flushing flows is to help manage the accumulation of didymo, an undesirable introduced type of algae that has adverse effects on

⁸ Protocol For: Controlled Releases of Voluntary Supplementary Flows from the Manapōuri Lake Control (MLC) Structure to the Lower Waiau River.

instream values as described by Dr Hogsden. The delivery of regular flows has been inconsistent with the intent of the protocol. The protocol appropriately recognises that hydrological constraints can be an issue during each flushing flow season, i.e., when inflows and lake levels are low, there may not be water available to flush the system.

- 36 Meridian has been analysing the level of reliability of flushing flows since 2019 to better understand the constraint causes. In short, it has established that the channel in the Waiau Arm is too shallow from a lake head perspective to deliver flushing flows in the way the protocol intended.
- 37 In order to resolve this issue, Meridian is investigating excavation of the river channel of the Waiau Arm as shown in Figure 1 to an optimal depth of RL 172 for a width of 25 metres (as opposed to RL 171 shown). Meridian is committed to carrying out this work if it is technically feasible and it can be granted resource consent.
- 38 If this enhancement work proceeds, in excess of 100,000 cubic metres of material will need to be excavated out of the river channel for the project to be effective. The outcome of the project is expected to significantly increase the reliability of the current flushing flow regime to the Lower Waiau River.

Figure 1 – Proposed Channel Excavation Waiau Arm above MLC structure



- 39 The mechanics and methodology for undertaking this work are currently being worked through. Resource consents will be required, and managing the effects of sediment, water clarity and temperature as part of this project is expected to be challenging and likely to require a mitigation response outside the reasonable mixing zone requirements of Appendix E. Depending on the final excavation methodology chosen, the application at best will be a discretionary activity but there is a strong possibility it may be non-complying activity under the pSWLP.
- 40 Under the current plan architecture, if no exception is provided as set out in Ms Whyte's evidence, then there is a prospect that this highly beneficial project will be unable to gain consent when viewed in the context of Objectives and Policies of the Plan as they relate to the MPS and Appendix E⁹. Given the national significance of the MPS and its operational and locational needs, it is Meridian's view that this position would be unreasonable and inconsistent with the NPSREG 2011 and could lead to a perverse outcome whereby the Plan operated to prevent a project that is intended to deliver outcomes beneficial to the environment.

CONCLUSION

- 41 In conclusion I make the following observations with respect to the pSWLP architecture on reverse sensitivity and Appendix E as it applies to and affects the operations of the MPS:
- (a) The SRPS recognises reverse sensitivity as an issue that applies to the MPS and its operation, and provides a method promoting that the matter be recognised in the Regional Plan. In doing so the SRPS gives effect to the NPSREG 2011.
 - (b) This evidence provides a range of reverse sensitivity examples which have been encountered by Meridian in the past 12 years.
 - (c) The Council decisions version of the pSWLP does not recognise reverse sensitivity as a matter of consideration. Ms Whyte's proposed amendment to Policy 26 addresses this matter and achieves that outcome. This gives effect to the higher order planning documents.
 - (d) "Appendix E – Receiving Water Quality Standards" of the pSWLP is recognised by most parties as having a range of deficiencies as far as

⁹ Particularly Objective 2,6 and Policies 15A and 15B of the PSWLP

giving effect to the NPSFM 2020 is concerned. Meridian understands this is a matter the Regional Council proposes to address as part of the FMU plan process.

- (e) The MPS has operational needs for new instream works and maintenance that I have outlined, and which will from time to time be subject to consenting processes. At the time of this beneficial and necessary work being undertaken there may be temporary water quality outcomes that do not meet the requirements of Appendix E.
- (f) The pSWLP needs to provide an express exception for the MPS from the Appendix E standards. The exception proposed recognises that temporary effects associated with such activities can be managed through the consenting process of the Plan. Ms Whyte's planning evidence provides an exception provision to Appendix E for this.



Andrew Feierabend

Statutory and Compliance Strategy Manager, Meridian Energy

29 July 2022

Appendix 1

Protocol For: Controlled Releases of Voluntary Supplementary Flows
from the Manapōuri Lake Control Structure (MLC) to The Lower Waiau
River

MANAPOURI TAILRACE AMENDED DISCHARGE (MTAD)
WATER PERMIT TO DAM AND DIVERT THE WATERS OF LAKE
MANAPOURI AND THE WAIAU AND MARAROA RIVERS

(RESOURCE CONSENT NO. 206156)

PROTOCOL FOR:

CONTROLLED RELEASES OF VOLUNTARY¹ SUPPLEMENTARY
FLOWS FROM THE MANAPOURI LAKE CONTROL (MLC)
STRUCTURE TO THE LOWER WAIAU RIVER

FINAL 9 APRIL 2013

AMENDED 7 NOVEMBER 2014

AMENDED 12 FEBRUARY 2016

AMENDED 16 NOVEMBER 2018

1. INTRODUCTION

This Protocol satisfies Condition 7² of Resource Consent No. 206156 held by Meridian Energy Limited (Meridian) to dam and divert the waters of Lake Manapouri and the Waiau and Mararoa Rivers with respect to the Manapouri Tailrace Amended Discharge Project (MTAD).

The Protocol provides for the controlled releases of supplementary flows from the Manapouri Lake Control (MLC) structure to the Lower Waiau River. This is to assist in managing periphyton biomass primarily didymo which has been introduced to the Waiau Catchment since the establishment and operation of the Manapouri Power Scheme. It is accepted by all parties that didymo is not an environmental effect that can be attributed to the establishment and operation of the Manapouri Power Scheme. The use of supplementary flows can assist mitigate the adverse effects of didymo. The parties recognise Meridian is not legally required to provide the supplementary flows but that these will have benefits to overall river health which includes sediment transport, eel migration and general ecosystem health.

Meridian has consulted the Waiau Working Party and the Guardians of Lakes Manapouri, Monowai and Te Anau and Te Ao Marama Inc during the development of this Protocol.

2. CONDITION 7

Condition 7 to Resource Consent 206156 states:

Lower Waiau River Voluntary Supplementary Flows

¹ For ease of reference the Protocol shall refer to 'supplementary flows' to avoid repetition of 'voluntary' as stated in condition 7 and the title of the Protocol.

² Condition 7 was inserted into this MTAD Water Permit (Consent No. 206156) in 2012 by way of a change of consent conditions, to replace Conditions 7 to 13 of the consent originally granted to MTAD in 2010.

The consent holder shall prepare and implement a protocol relating to controlled releases of voluntary supplementary flows from the Manapouri Lake Control (MLC) structure to the Lower Waiau River, in order to assist in managing periphyton biomass. The protocol shall include the following:

- (a) Any monitoring to be undertaken to assess periphyton biomass;*
- (b) The size, duration, frequency and timing of the supplementary flows considered useful to assist in managing periphyton biomass;*
- (c) The circumstances, relating to periphyton biomass and natural flow occurrences, under which controlled releases of supplementary flows will be considered by the consent holder;*
- (d) The circumstances, relating to lake levels and security of electricity supply, under which controlled releases of supplementary flows may not be able to be provided by the consent holder;*
- (e) The procedures to be followed by the consent holder in considering and deciding upon the provision of a controlled release of a supplementary flow, in terms of the circumstances in (c) and (d) above.*

The consent holder shall consult the Waiau Working Party the Guardians of Lakes Manapouri, Monowai and Te Anau and Te Ao Marama during the development of the initial protocol and any subsequent changes to the protocol.

The protocol shall be forwarded to Environment Southland for its certification as to compliance with this condition, prior to the 1st of December following the grant of consent to this condition. Any changes to the protocol shall also require certification from Environment Southland prior to implementation. The results of any monitoring undertaken in terms of this protocol shall be forwarded to Environment Southland annually, in conjunction with the monitoring results provided under Condition 7. This shall include the dates and flow parameters of all controlled releases of supplementary flows provided under this protocol by the consent holder in the preceding year.

3. BACKGROUND

Meridian has funded extensive monitoring of periphyton biomass in the Lower Waiau River for the last 10 years. As a result, a basic understanding of biomass and flow relationships has been developed, including the ecology and seasonality of didymo growth and biomass. This information is intended to be used to underpin decisions relating to the provision of supplementary flows to assist in managing periphyton biomass set out in this Protocol. In the event better science becomes available the outcomes of this research will be used to promote changes to the Protocol.

At this time, the primary indicator of periphyton biomass is the Standing Crop Index (SCI). NIWA has related the SCI to the periphyton guidelines and suggested indices to guide the management of periphyton biomass which are approximate to the levels in the New Zealand Periphyton Guidelines³ (Biggs 2000) .

In general, the main impacts of periphyton biomass as understood at this time are the aesthetic impact, the effect on recreational activities and the effect on river health. As stated above, periphyton biomass is measured as the Standing Crop Index. This is a relationship between the extent of cover and thickness of the periphyton mat.

An SCI of 220 is a similar amount of periphyton to the 35 g ash free dry matter Periphyton Guideline limits for the protection of trout habitat and angling values. An SCI of 600 corresponds approximately to the guideline (120 mg/m² Chl α) for aesthetics and trout habitat for visual cover

³ Biggs, B.J F., (2000) **New Zealand Periphyton Guidelines: Detecting Monitoring and Managing Enrichment of Streams. Report to MFE.**

by filamentous algae. The SCI is used in preference to the exact Guideline values due to the ease of field measurement and production of data, as it does not involve laboratory methods.

"Traffic light" indices for periphyton management have been developed by NIWA specifically for the Lower Waiau River⁴. These are green (all is well), amber (a supplementary flow response should be considered) and red (a supplementary flow response is required). This is based on the SCI index of periphyton biomass which is described from an application perspective later in this Protocol.

The purpose of the Protocol is to provide clarification around when the consent holder will consider providing controlled releases of supplementary flows from the Manapouri Lake Control (MLC) to the Lower Waiau River. It is acknowledged the primary purpose of providing such flows is to assist in the management of the effects of periphyton biomass particularly didymo.

4. REVIEW OF OPTIONS FOR MONITORING 2014

In late 2013 Meridian requested NIWA review options for amending the survey procedure to increase efficiency while still providing the data required by the protocol for decision making over the release of voluntary supplementary flows. Cathy Kilroy of NIWA prepared the report "Managing nuisance periphyton in the Lower Waiau River - review of options for monitoring November 2013 updated July 2014". The report options were discussed at a WWP meeting on 25 July 2014 and subsequently circulated to the parties to the protocol – the Guardians of Lakes Manapouri, Monowai and Te Anau, and Te Ao Marama Inc. The outcome of consultation on this matter was that the options of using existing flow data to guide decision making on the timing of surveys and reduced survey effort (reduced monitoring sites and frequency) based on the existing monitoring protocols would be trialled for a year commencing in November 2014.

Monitoring of periphyton biomass will be undertaken by appropriately qualified, experienced personnel under the direction of the consent holder. The monitoring set out in sections 4.1 to 4.4 below amended the monitoring regime implemented under the Protocol effective from 9 April 2013 and was undertaken as a trial for a year beginning 1 November 2014 through to the end of May 2015. At the completion of this period the efficacy of the amended monitoring was to be reviewed. Subject to confirmation from the parties to this Protocol that the amended monitoring is appropriate, it will be adopted and continued for the following monitoring seasons/years.

4.1. Monitoring sites

The monitoring sites will be:

Lower Waiau River (from downstream): Clifden, Monowai, Excelsior; (three sites in total); and Mararoa River Station Bridge (reinstated November 2015).

The amended monitoring for the trial period removed two sites from the Lower Waiau River (Tuatapere and Jericho) and all the sites on the Mararoa River (Whitestone, The Key, Station Bridge, Normans and Kiwi Burn swing bridge).

The Station Bridge site on the Mararoa River was re-instated following the review of the trial period of the amended monitoring) as a comparison site in an unmanaged river and is not included in decision making under this Protocol.

The timing and frequency for monitoring will be: determined in accordance with the decision support matrix⁵ set out in Appendix 1 commencing at the beginning of November through to the

⁴ Kilroy, C., Wech, J. (2011) **Five Years of an adaptive management programme to mitigate excess periphyton in the Lower Waiau River. NIWA client Report CHC 2011-056. 45p.**

⁵ Kilroy, C. (2014) **Managing nuisance periphyton in the Lower Waiau River – Review of options for monitoring, prepared for Meridian Energy, November 2013, updated July 2014. NIWA Client Report No: CHC2013-151. 50p.**

end of May. Antecedent flow data will be checked every two weeks during this period by NIWA who shall advise Fish and Game of the need to survey (with best endeavours of adequate lead in time). The aim is to reduce surveys while the river is in green status while ensuring that periods in the red status are detected and considered for voluntary supplementary flow releases as set out in Appendix 2.

All monitoring will be at times of minimum flow or as close to, (i.e 16 m³/s measured at the MLC or 50 m³/s at Sunnyside). If there is a flood⁶, monitoring will be undertaken as soon as possible after flows return to minimum flow, and the 2-weekly schedule restarts from the post flood sampling date.

4.2. Monitoring methods

All monitoring will:

- Undertake visual assessments, using the underwater viewer (see Kilroy and Biggs 2008).⁷
- Measure water clarity at each site, using the black disk method (mean of two readings, one per person).

4.3. Post-monitoring procedure

Once monitoring is completed:

- Data sheets from all three monitoring sites will be forwarded for processing after the survey is completed (normally within 24 hours).
- The data will be processed and results (SCI at each site) reported back to Meridian normally within one working day of receipt of the data sheets.
- SCI results will be reported for individual sites, including the assigned collective status according to their traffic light indices provided by NIWA.
- Reporting will include a commentary on growth in the Lower Waiau River (from the SCI results, and from field observations). This will be made available on a monthly basis to the Chairman of the Waiau Working Party and the Chairman of the Guardians of Lakes Manapouri, Monowai and Te Anau;

The traffic light index to be used by the consent holder to determine the timing of supplementary flows is as follows:

Green – all is well: SCI at all sites < 220; or the mean SCI < 200;

Amber – alert- response considered: at least one site with SCI > 220 and the mean SCI >200<300; or the mean SCI is between 200 – 600;

Red – response required: at least two sites with a SCI > 220 and the mean SCI >300, or the mean SCI is > 600.

4.4. Duration of monitoring

Amended monitoring trial 1 November 2014 to May 2015

The amended monitoring programme was undertaken for a trial period of a year commencing in November 2014 until the end of May in the following year (2015). The frequency and number of surveys was determined in accordance with the Decision Support Matrix set out in Appendix 1. A

⁶ "Flood" is defined as any flow event greater than 50 m³/s (daily mean flow) at MLC

⁷ Kilroy, C., Biggs B.J.F (2008). **Management of periphyton (didymo) blooms in the Lower Waiau River: an adaptive Management trial 2006 - 2008. NIWA client Report CHC 2008-054. 45p.**

review of the amended monitoring was to occur at the completion of the trial period (end of May 2015).

Review of the amended monitoring trial

NIWA reviewed the implementation of the amended monitoring regime following completion of the trial period at the end of May 2015. The review considered the practicalities of the amended monitoring methodology and whether useful information was lost by reducing the number of surveys and the number of sites surveyed. The review and its findings is in section 3 of the NIWA report "Managing nuisance periphyton in the Lower Waiau River - results for 2014 -15 and review of an amended monitoring protocol"⁸. The review concluded that the amended monitoring methodology is an appropriate approach and recommended that it continue for future monitoring seasons since the trial period had demonstrated that it successfully met the requirements of the consent and the amended Protocol (7 November 2014). The review also recommended re-instating one site on the Mararoa River (Station Bridge) to provide a comparison site in an unmanaged river. The site would not be included in the decision making under Appendix 2 of the Protocol.

The NIWA Report and review findings were presented to the parties to the Protocol, at the Waiau Working Party meeting on 27 November 2015, the Guardians of Lakes Manapouri Te Anau and Monowai meeting on 18 November 2015, and to Te Ao Marama. The parties to the Protocol supported the Review findings and recommendations to continue the amended monitoring methodology and to re-instate one survey site on the Mararoa River at Station Bridge in the monitoring programme.

4.5. Variable Flow Releases

A recommendation regarding more variable flow releases was made in the NIWA reports on the annual nuisance periphyton program carried out in 2015-16, 2016-17 and 2017-18 seasons under the protocol. The purpose of the recommendation was to promote and investigate the flows releases to assist in managing nuisance periphyton. The recommendation involved a trial based on a more variable flow release by modifying the shape of the flushing flow hydrograph from that typically made under the protocol. To date the flow releases made under the protocol have met its definition specified as "flows peaking between 160 m³/s and 250 m³/s with a mean flow of 120 m³/s over 24 hours." (see section 5.1 below).

Analyses of the effects of nine previous supplementary flow releases in the NIWA annual reports (Kilroy and Wech 2016 and Kilroy 17a) led to the recommendation for trials of supplementary releases that varied from the current specification of the protocol. The NIWA 2018 annual report further recommended the trials and considered that varying the length and/or recession of the flow release hydrograph may assist in dislodging loose didymo remnants that maybe left after a more rapid recession.

The NIWA report "Review of Options for Periphyton Management in the Lower Waiau River" October 2017⁹ was commissioned by Meridian following discussions at the Waiau Working Party meetings of 27 November 2015 and 13 December 2016 regarding alternative options to assist in the management of nuisance periphyton. The report discussed three categories of control - higher flows (the current method under this protocol), manipulation of low flows and using chemicals. In regard to the option of high flows, the report reviewed all flow releases made since 2007-08 including releases made under this protocol. It recommended the current programme under the protocol continue to accumulate more data that could help improve the relationships for predicting the effects of supplementary flow releases and other high flows. In conjunction with this option, the WWP meeting further discussed the implementation of the more variable flow releases in the

⁸ Kilroy C, (October 2015) **Managing nuisance periphyton in the Lower Waiau River – Results for the 2014 – 15 and reiew of an amended protocol. NIWA Client Report CHC 2015-079**

⁹ Kilroy C, (October 2017) **Review of options for periphyton management Lower Waiau River NIWA Client Report 2017112CH)**

2017-18 season as recommended by the previous annual reports. However, no flow releases were able to be made in 2017-18 season due to lake levels and water availability.

A further presentation on trialling the variable flow releases was made by Cathy Kilroy of NIWA to the Waiau Working Party (WWP) on 5 June 2018. The meeting resolved to support the trials commencing in the 2018-19 season noting that the trial releases may not meet the protocols specifications for flows peaking between 160 m³/s and 250 m³/s with a mean flow of 120 m³/s over 24 hours and that the water available for releases each season is 15GWh as currently provided for by the protocol.

The NIWA reports and WWP recommendations regarding the trials of the variable flow releases have been provided to the other parties to the protocol. Each party (the Waiau Working Party, Guardians of Lakes Manapouri, Monowai and Te Anau, Te Ao Marama and Southland Fish and Game) has supported and agreed to the amendment of the protocol to enable the trials of the more variable flow releases. The trials are to commence in the 2018-19 season (1 November to 31 May) subject to water availability (as currently occurs under the protocol) for up to a 10 year period to enable the accumulation of sufficient data on the more variable releases to analyse their effectiveness. A conclusion regarding the effectiveness of the variable releases will be made as soon as practically possible given that in previous years 2015-16, 2016 17 and 2017-18, seasons only 1 or 2 releases are often possible, and occasionally no flow releases, due to lake levels and water availability. A short report following each release is provided to the Chairs of the parties to the protocol and the seasons results are analysed the annual report for that season, as currently occurs under the protocol.

5. SUPPLEMENTARY FLOWS CONSIDERED USEFUL TO ASSIST IN MANAGING PERIPHYTON BIOMASS

5.1. Flow size and duration

Based on current knowledge, NIWA has recommended that flows with peaks above 160 m³/s and a mean of 120 m³/s are useful to assist in managing periphyton biomass, including didymo (Kilroy 2010)¹⁰. Flows at or above this magnitude already occur naturally and, under certain conditions, can be released as controlled supplementary flows.

Flows above 250 m³/s are unable to be generated whilst adhering to the Manapouri lake level guidelines (constrained by the MLC structure capacity) and are entirely reliant on naturally occurring rainfall inflow events that raise the Lake Manapouri level to a height that triggers the flood rules, or raise the Mararoa River flow to high levels.

Controlled releases of supplementary flows with the aim of assisting in managing periphyton biomass are, therefore, defined as flows peaking between 160 and 250 m³/s and with a mean flow of 120 m³/s over 24 hours.

Meridian will provide a maximum of 15 GWh of storage water released (i.e. water which otherwise would be retained for optimal energy generation) for all supplementary flows between December and the end of May. This is the equivalent of approximately 4 full artificial supplementary flows per summer of the type described in clause 5.1 of this protocol. More than 4 flows may be provided if releases are in part an augmentation of natural events and the storage flows released overall are provided within the maximum GWh provided¹¹.

For the purposes of the trials of the more variable flow releases beginning in the 2018-19 season, the releases may not reach the above flows peaking between 160 and 250 m³/s and with a mean flow of 120 m³/s over 24 hours. This is due to the variable shape of the release hydrograph which may be over a longer duration than 24 hours and have a different rate of

¹⁰ Kilroy, C, (2010) Management of nuisance periphyton growths in the Lower Waiau River using flushing flows: an update 2009 – 10. NIWA Client Report CHC 2010-083. 44p.

¹¹ 1 GWh equates to 2351020 cubic meters of storage water from Lake Manapouri. Hence 15 GWh equals 35265300 m³

recession. The maximum of 15 GWh of storage water released (i.e. water which otherwise would be retained for optimal energy generation) for each season remains.

5.2. Flow frequency and timing

Based on current knowledge, NIWA has recommended that supplementary flows may be useful to assist in managing periphyton biomass during the months of December to May. From previous monitoring undertaken, it is considered that natural or artificial flows at or above the flow size presented above are required at approximately 4 week intervals, to maintain periphyton biomass at suitable levels.

To minimise impacts on recreational activities ramping up should generally not commence prior to 22:00 hours on a Sunday and ramping down will be completed by 12:00 hours on a Friday for artificial releases. Releases to augment a natural event will be released to maximise the benefit of the event being augmented.

6. CIRCUMSTANCES RELATING TO PERIPHYTON BIOMASS AND NATURAL FLOW OCCURRENCES

The period agreed by the parties to this Protocol for controlled releases for the management of periphyton biomass if required are generally between 1 December and 1 May in any year: Target dates for 4 supplementary flows will be agreed with Fish and Game New Zealand Southland Region prior to each season for this period. An additional provision is made for circumstances relating to a SCI reading of red in the month of May. For the purposes of this Protocol a natural flow event or an augmented flow within four weeks of the target date with flows peaking over 160 m³/s and with a mean flow of 120 m³/s over 24 hours will be considered to have met the requirements of this protocol. No additional controlled release during that time period will be considered necessary under the protocol. The naturally provided flow component of any event will not be considered part of the 15 GWh provision, but the provision of additional water above the operational requirements (e.g. Flood Rules) will be.

Where the SCI for periphyton biomass control is red and has extended into the first three weeks of May then an additional supplementary flow shall be provided by the consent holder unless constrained by matters relating to security of supply. The consent holder obligation to this requirement will only exist if the 15 GWh storage provided for under the Protocol has not been called upon in the preceding months to the degree that the required flow can be provided from this reserve.

7. CIRCUMSTANCES RELATING TO LAKE LEVELS AND SECURITY OF ELECTRICITY SUPPLY

7.1. Lake levels

The levels of Lakes Manapouri and Te Anau are primarily managed in accordance with the Lake Level Guidelines, which are a requirement of their current consent conditions. They set maximum durations for the lakes to be in each range and the minimum elapsed time between events which penetrate each range.

The operation in the main range is not constrained other than by the requirement to maintain continuous variation in lake levels so as to avoid impacts such as wave-cut platforms. The guidelines also require management of the mean lake level to ensure that this falls within the main range limits.

MLC was designed to allow for control of Lake Manapouri level for hydroelectricity generation and to manage flood flows from Lake Manapouri. The ability of MLC to discharge high flows while Lake Manapouri level is not in the flood range is limited by a number of factors, including

the level of Lake Manapouri and headwater level at MLC, Waiiau Arm flows, and Mararoa River flows.

When Lake Manapouri is in the low range there is insufficient head to produce controlled releases of supplementary flows of the required size. When the Lake is in the high range, according to the flood rules, discharges from MLC above minimum flows are required and there is sufficient water to enable the provision of these flows.

Meridian will generally not build lake levels in anticipation of controlled releases of supplementary flows. There are a number of issues with pre-emptive attempts to build levels. These include:

Rainfall uncertainty: The lake catchments do not have a seasonal pattern to the rainfall. Significant events may occur at any time of the year. Maintaining lake levels in the upper portion of the main range will significantly reduce the ability to capture events and increase flood risks;

Variability of lake levels: Due to limited lake storage capacity and the variable nature of inflow patterns, the Manapouri Power Scheme (MPS) is regarded as a 'run-of-river' power scheme. Therefore, levels in Lakes Manapouri and Te Anau also generally reflect the variable nature of inflows and limited storage capacity. This variability is important for the maintenance of lakeshore vegetation, aquatic macrophytes and shoreline geomorphology.

Building and maintaining the lake levels in the upper portion of the main range is inconsistent with this approach to lake level management. As a result, building of Lake Manapouri levels would only be considered by Meridian in exceptional circumstances and in light of all relevant information regarding environmental and generation supply factors.

7.2. Electricity supply

There are 2 main areas of security of supply concern in relation to providing controlled releases of supplementary flows. These are risks to generation supply due to potential low water supplies and distribution constraints.

8. PROCEDURES FOR CONTROLLED RELEASES OF SUPPLEMENTARY FLOWS

The procedures outlined below will be followed when deciding upon the provision of a controlled release of supplementary flows for periphyton management.

8.1. Steps to be Followed

Four controlled releases of supplementary flows will be provided during 1 December to 1 May identified in Clause 6 of this Protocol if the SCI conditions fall within the amber or red indices specified in section 3.4 of the Protocol and if the lake levels and electricity supply security circumstances allow. A fifth flow on May will be considered if the circumstances described in paragraph 6 of this protocol exist.

Lake levels, catchment hydrology, hydro risk curves, distribution and line constraints including the likelihood of outages will be considered by the consent holder for each potential controlled release of a supplementary flow. A fifth flow in May will be considered if there is an SCI reading of red during the third week and if there are sufficient GWh remaining as set out in clause 6 of this protocol.

Prior to undertaking a supplementary flow release the consent holder will liaise with a nominated representative of Fish and Game Council and inform the Chairman of both the Waiiau Working Party, the Guardians of Lakes Manapouri, Monowai and Te Anau and Te A O Marama of the timing of the supplementary flows.

All decisions made will be documented, giving the reasons for the decision. The decision will follow the process in **Appendix 2**.

If a flow cannot be provided, Meridian will, in exceptional circumstances, make endeavours to manage lake levels to provide the flow (in accordance with the responses set out in **Appendix 2**). Any such a flow will meet the 4 week lead-up to the subsequent flow release and consequently be considered to meet that flow requirement.

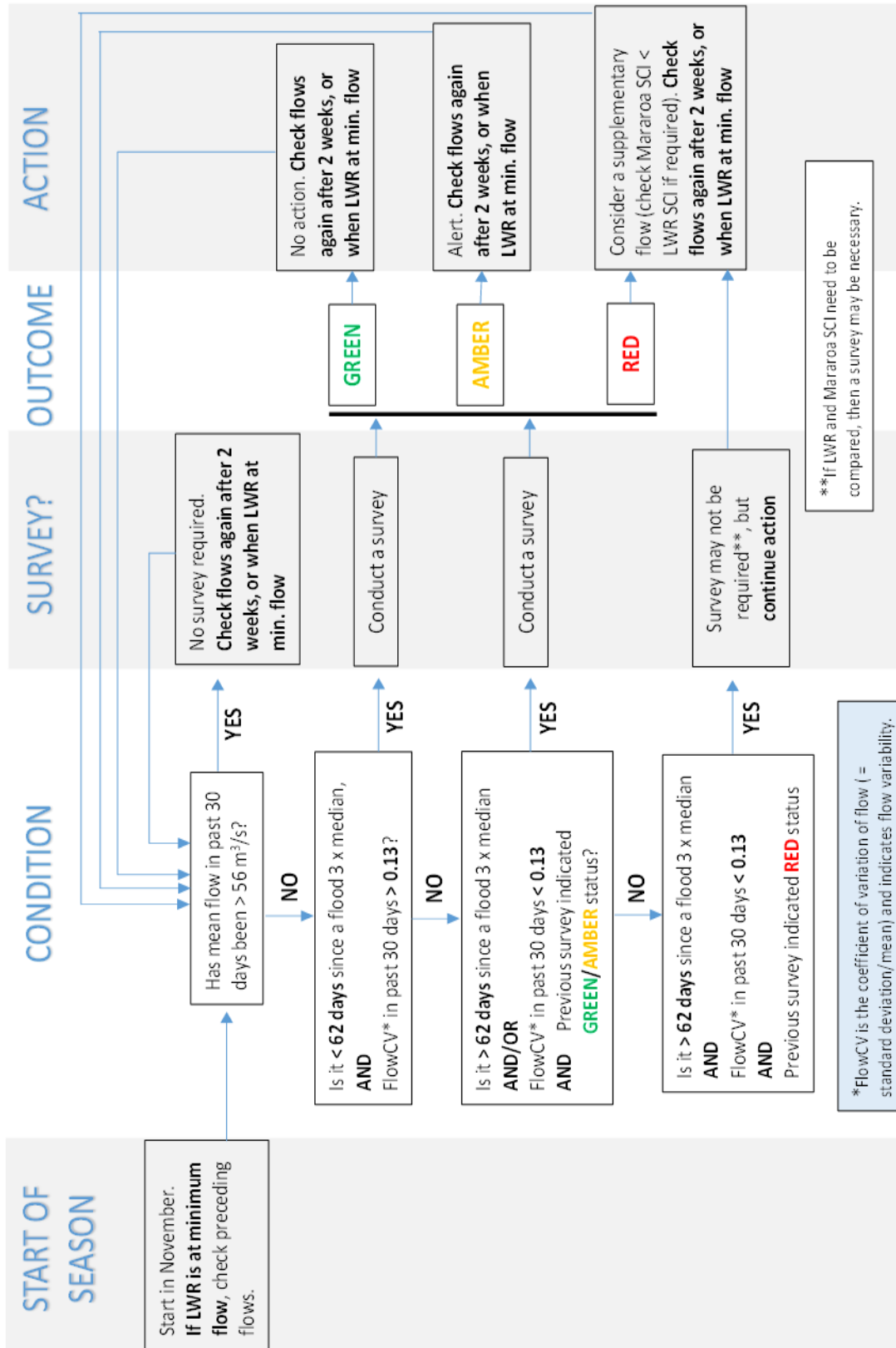
9. REPORTING

After each supplementary flow Meridian shall provide a report stating the number of GWh used and the remaining GWh left for the rest of the season. A copy of the report shall be forwarded to the nominated representative of Fish and Game Council, the Chairman of the Waiau Working Party, the Chairman of the Guardians of Lakes Manapouri, Monowai and Te Anau and Te Ao Marama.

The results of all monitoring undertaken in terms of this Protocol will be forwarded to Environment Southland annually¹², in conjunction with the results of other monitoring required by the conditions of consent for MTAD. A copy of the results shall also be forwarded to the Chairman of the Waiau Working Party and the Chairman of the Guardians of Lakes Manapouri, Monowai and Te Anau, and Te Ao Marama.

¹² NIWA Report entitled "Managing nuisance periphyton in the Lower Waiau River" prepared under MTAD consent 2061546 condition 7.

APPENDIX 1. DECISION SUPPORT MATRIX



APPENDIX 2. PROCEDURES FOR IMPLEMENTATION

Note to be read in conjunction with Appendix 1 – The consent holders' obligation under this protocol to provide supplementary flows equates to a maximum 15 GWh total storage for the season

Concern	Lower Waiau River Environmental Indices	Agreed Supplementary Flow Release	Electricity Supply Concerns	Agreed Response
Green	None SCI at all sites < 220; <u>or</u> mean SCI < 200	None	Not Applicable	None

Concern	Lower Waiau River Environmental Indices	Agreed Supplementary Flow Release	Electricity Supply Concerns	Agreed Response
Amber	<p>Controlled releases of supplementary flows could assist in managing periphyton biomass.</p> <p>At least one site with SCI > 220 AND mean SCI >200<300,</p> <p>OR</p> <p>Mean SCI 200 - 600</p>	<p>Consideration of the release of a supplementary flow of 160-250 peak m³/s with a mean flow of 120 m³/s across 24 hours (<i>unless a flow of this peak and mean has occurred within the prior 4 weeks for any programmed flows</i>)</p>	<p>Manapouri lake levels above the level to produce flows of 160 m³/s and no hydro risk curve concerns for the next 9 months.</p>	<p>Either release the flow on a timed basis (<i>The flow is to be commenced at 10pm during a week day avoiding week ends</i>).</p> <p>Or supplement a Lake Manapouri flood flow or a Mararoa River turbidity event with a controlled release (<i>only if Lake Manapouri at levels which achieve overall peak and mean needs</i>)</p>
			<p>Manapouri lake levels below level to produce flows of 160 m³/s and no hydro risk concerns for the next 9 months.</p>	<p>Meridian to assess options for awaiting inflows sufficient to provide a controlled release of a supplementary flow</p>
			<p>Hydro risk for the next 9 months show security risks</p>	<p>None (<i>flow would only occur as a result of Mararoa River turbidity flows or Lake Manapouri flood flows and would not be supplemented with any controlled release</i>)</p>

Concern	Lower Waiau River Environmental Indices	Agreed Supplementary Flow Release	Electricity Supply Concerns	Agreed Response
Red	<p>Controlled releases of supplementary flows would assist in managing periphyton biomass.</p> <p>At least two sites with SCI > 220 AND mean SCI >300,</p> <p>OR</p> <p>Mean SCI > 600</p>	<p>Controlled release of a supplementary flow of 160-250 peak m³/s with a mean flow of 120 m³/s across 24 hours (<i>unless a flow of this peak and mean has occurred within the prior 4 weeks for any programmed flows</i>)</p>	<p>Manapouri lake levels above level to produce flows of 160 m³/s and no hydro risk curve concerns for the next 9 months.</p>	<p>Either release the flow on a timed basis (<i>The flow is to be commenced at 10pm during a week day avoiding week ends</i>).</p> <p>Or supplement a Lake Manapouri flood flow or a Mararoa River turbidity event (<i>only if Lake Manapouri at levels which achieve overall peak and mean needs</i>)</p>
			<p>Manapouri lake levels below level to produce flows of 160 m³/s and no hydro risk concerns for the next 9 months</p>	<p>Meridian to consider reasonable endeavours (such as generation withdrawal) to conserve storage levels to provide a controlled release of a supplementary flow</p>
			<p>Hydro risk curves for the next 9 months show security risks</p>	<p>Meridian to assess options for awaiting inflows or conserving storage levels such as generation withdrawal) sufficient to provide a controlled release of a supplementary flow</p>