Pre-hearing Meeting

Report on pre-hearing meeting

Section 99 of the Resource Management Act 1991

From: Michael Durand – Team Leader Consents, Environment Southland

To: Commissioners Mike Freeman, Peter Jones and Neville Cook; Schrader Mains Ltd, Department of Conservation, Fish & Game New Zealand, Te Ao Marama Incorporated

Date: 2 December 2015

Application: APP-20158099 – Schrader Mains Ltd

EXECUTIVE SUMMARY

This report follows a pre-hearing meeting on the notified resource consent application to Environment Southland from Schrader Mains Ltd for a dairy farm conversion and associated activities.

The outcomes of the meeting were that:

- The reporting officer and submitters could potentially support the application if good farming practices are adhered to.
- However, there was dispute over whether a consent holder could be held to such practices by any consent granted on an ongoing basis.
- This is because the relevant rule framework requires a land use consent for the *establishment* of a dairy farm only, and not for the ongoing land use activity of dairy farming. This means if consent were granted, conditions relating to good farming practices (generally) would need to be incorporated into a long term permit that has a different and specific purpose (e.g. a discharge permit for discharge of farm dairy effluent). The suitability of a discharge permit for controlling farm management was not agreed.
- Despite this, the applicant and submitters left the meeting agreeing on the areas of farm management that would be important to control nutrient losses from the proposed farm and agreeing to discuss potential conditions between themselves.
- All noted, however, that a decision rested with the hearing commissioners on whether or not such conditions could be included in any resource consent other than the land use consent to establish the farm. The applicant and submitters agreed to discuss potential conditions despite the risk that decision makers may deem such conditions appropriate.

INTRODUCTION

Pre-hearing meeting

1. On 9 November 2015 Environment Southland (ES), conducting its function as consent authority under the Resource Management Act 1991 (RMA), invited the following parties to meet at a pre-hearing meeting:

    a. Schrader Mains Ltd (applicant)

    b. Department of Conservation (neutral submitter)

    c. Fish & Game New Zealand (opposing submitter)

    d. Te Ao Marama Incorporated (opposing submitter)

2. At that stage the application had been notified (on 18 September 2015), submissions closed (on 16 October), three submissions received, and two submitters opposing the application indicated they wished to be heard at a hearing. The requested meeting was therefore a pre-hearing meeting held under section 99 of the RMA.

3. The meeting was requested by ES at the suggestion of the applicant for the purpose of both clarifying and facilitating the resolution of matters and issues arising from the application and submissions. The meeting agenda (circulated on 9 November) outlined these matters and issues as being:

    a. Sensitivity of the receiving environment

    b. Measures to address risks associated with the artificially drained nature of the land

    c. Phosphorus losses as modelled by the Overseer budget

    d. Use of 'Best Practice' methods

    e. Cumulative effects on the receiving environment

    f. Water quality concerns

4. The meeting was held on 12 November at the Environment Southland office and those present were:

    a. Consent authority

        i. Joanna Gilroy (Reporting Officer on the application; Senior Consents Officer, Environment Southland)

        ii. Hilary Lennox (Consents Manager, Environment Southland)

    b. Applicant

        i. Hank Schrader (Applicant)

        ii. Sandra Schrader (Applicant)

iii. Bridget Irving (Partner, Gallaway Cook Allan Lawyers)

iv. Kate Scott (Managing Director, Landpro Ltd)

v. Miranda Hunter (Agribusiness Consultant)

c. Submitters

i. Dean Whaanga (Te Ao Marama Incorporated)

ii. Stevie Ray Blair (Te Ao Marama Incorporated)

iii. Jacob Smyth (Fish & Game New Zealand)

iv. Apology: Department of Conservation

d. Chair: Michael Durand (Team Leader Consents, Environment Southland)

5. There were no additional matters raised by the attending parties.

Statutory and procedural matters in section 99

6. The procedure for a pre-hearing meeting and the status of the report produced are dictated in some detail by section 99. Each of these matters were discussed in the meeting and I do not consider that any procedural issues were identified. For completeness, the outcome of each procedural question is outlined below.

Requiring and requesting attendance

7. Section 99(2) allows consent authorities to request an applicant, a submitter or any other person it considers appropriate to attend a pre-hearing meeting. This can be either at the request of the applicant or submitters or on its own initiative. In this case the applicant requested the meeting to be held and for submitters to attend and ES agreed this was appropriate.

8. If attendance is requested (as opposed to required), any party's decision to attend can be made without prejudice. In this case the Department of Conservation decided not to attend.

Attendance of those delegated to make decisions

9. Section 99(4) states that an officer of the authority who has the power to make the decision on the application may attend, subject to the agreement of all the parties. All the parties in the meeting agreed to the presence of Hilary Lennox.

Chairperson to prepare this report

10. The chairperson of the meeting is to prepare a report outlining the issues that were agreed and the issues that are outstanding. These are outlined throughout the report and summarised in Table 1.

ACCOUNT OF DISCUSSIONS

Main areas of discussion

11. Early in discussions all the parties agreed that it would not be necessary to follow the agenda items strictly in order for them to be addressed effectively. The discussion therefore began with the applicant outlining pertinent aspects of the proposal and the submitters broadly stating their reasons for interest and attendance at the meeting.

12. It was agreed that the receiving environment is known for its water quality issues. The particular sensitivity of the Waituna Lagoon was recognised by the applicants and not disputed by any of the parties. The main reason for the attendance of parties at the pre-hearing meeting was to understand more about how this particular application might affect water quality there. This was essentially an effort to seek clarification – to understand more clearly whether or not the intended land use is appropriate.

13. Three main parts of the meeting followed. These were:

    a. Overseer model losses vs. real life losses and effects: This was a discussion broadly covering the Overseer modelling results for both the status quo and the applicant's proposal. This covered the assumptions behind Overseer modelling, and how these relate to on-farm management practices. Essentially, this discussion explored the question of whether the establishment of a dairy farm will increase losses of N and P to the Waituna Lagoon, by looking at how well the real life situation of an additional dairy farm is reflected in the Overseer model results.

    b. Holding the applicant to account on modelled losses: The Overseer discussion established that actual losses will depend on management practices adopted across the whole farm on an ongoing basis. However, the rule framework under the Regional Water Plan for Southland (RWP) is problematic and does not clearly support Council oversight of farm management practices. Any ongoing consents granted will be for farm dairy effluent discharge (FDE) and water takes only. Whether or not broader management practices (e.g. fencing, management of critical source areas) can be the subject of conditions on a discharge permit, even if the applicant volunteers those conditions, was a point that was disputed and not resolved.

    c. Conditions of consent: This discussion focused on the type of conditions that could be volunteered, if it was accepted that conditions on an FDE discharge permit could stipulate requirements for particular farm management practices, outside of effluent collection, storage and discharge.

Overseer model losses vs. real life losses and effects

14. A discussion of the Overseer modelling approach was lead by Miranda Hunter. Points discussed related to the limitations of the model in helping to understand the effects of the proposed farm and the current activities in the site. Primarily these were as described below.

15. The status quo has been modelled and best practice assumed. The existing activity is relatively well defined and nutrient losses can be demonstrated with overseer results.

16. The modelled results of the proposed dairy conversion are consistent with those seen in trial data. Modelled N losses elsewhere have previously been verified in real life tests, and can therefore be used with relative confidence in an assessment of a dairy conversion.

17. However, Overseer has limitations for modelling some aspects of dairy farming. Significantly, it does not account for good practices that can reduce or avoid P discharges to surface water from overland flow. P is bound to sediment and has various loss pathways, so its losses are a lot more difficult to model and are uncertain. In trials the management of critical sources areas had reduced P losses by up to 80%.

18. This means the potential for favourable outcomes (if good practices were adopted on an going basis by the applicants) are not possible to demonstrate with modelled P losses.

19. Best practice methods proposed by the applicants include set backs from surface water and management of critical source areas, though wintering may occur on the farm in Waituna or elsewhere, depending on availability of winter grazing.

20. Despite this it was widely recognised that the Overseer model results do not describe water quality outcomes: they describe losses from the site, not the receiving environment or the effect of the losses upon it. In the absence of other work, this makes the applicant and the Council's job of assessing the effects of the application difficult. Whether the overall effects of the land use upon the catchment could be readily assessed and understood was a point of contention but was not debated at length.

21. The significant outcome of this discussion was that that Joanna Gilroy and the submitters could potentially view the application favourably if, on an ongoing basis, the modelled N and P losses could be guaranteed.

Holding the applicant to account on modelled losses

22. A potentially favourable view from Joanna Gilroy and submitters was, however, very much tentative. The reason for uncertainty in this area stems from the unusual rule framework in the RWP. Rule 17A, *Transitional rule relating to the establishment of new dairy farms*, is a regional land use rule requiring a discretionary consent for "the establishment of a new dairy farm." This is the only plan rule requiring consent to undertake a farming activity per se, as opposed to a water take or discharge (for example). It is also unusually limited in its scope because it controls establishment of the farm only and not the ongoing activity of dairy farming.

23. The discharge of farm dairy effluent, construction of effluent ponds and other activities that make up the full extent of a dairy farm operation require consents through other rules (e.g. FDE discharge). Others are permitted by specific rules (e.g. fertiliser discharge) or by the absence of relevant controls in the RWP (see section 9(2) of the RMA).

24. Previously ES has held that rule 17A applies when a person wants to create a dairy farm. Land use consents have been granted on that basis but subsequently been surrendered once the farm is established and consent is no longer needed.

25. This means consent holders are only required to comply for a short time period with any farm management practices stipulated in the land use consent. Once the consent is relinquished, it renders immaterial any management practices agreed between the applicant and consent authority at the time of the application. Any ongoing requirements upon the consent holder for compliance with resource consents come about only through the conditions of other permits. For example, the size

of the dairy farm has been partly managed by proxy by the FDE discharge permit (which allows discharge only to the nominated areas – but doesn't manage the overall extent of the farm); herd size has been managed by the cow numbers stated in the FDE permit (but again, this does not limit the land where cows can graze). Section 127 applications can provide a route to change these areas and herd sizes, but ES has limited power to require consistency with any best practices that do not relate directly to effluent discharges.

26. In light of this rule structure and interpretation, a lengthy discussion covered the question of:

    a. Assuming a consent were granted for the proposed activity, how could nutrient losses that are greater than the modelled loses be avoided in the future?

27. The applicants' position was quickly established, and was that conditions of consent on the FDE permit could hold the applicant to certain methods of farm management. The applicants suggested this would provide ongoing certainty for the council and for submitters.

28. However, the efficacy and appropriateness of this approach was challenged by Hilary Lennox, who stressed that ES had already discussed this rule at length through other applications and had no choice but to conclude the land use consent deals only with farm establishment. Essentially this means:

    a. ES cannot control dairying as an ongoing farming activity.

    b. The FDE discharge permit cannot control good practice methods for anything other than an FDE discharge.

    c. If a conversion were to be allowed because decision makers were banking on a future management technique, this provides little certainty. A farmer's vision for farm management can change over time, as can ownership.

29. Support for this position was not reached around the table. The applicant viewed the situation differently and continued to stress that they would like the council to be able to hold them to account – essentially to meet conditions requiring best practices to be adopted. They suggested that conditions of consent could be volunteered to that effect, and therefore could be incorporated into a discharge permit without any legal issues arising.

Conditions of consent

30. Despite the lack of agreement it was decided that a useful discussion could nevertheless take place around the types of management techniques the applicant could use, were it accepted that these could be enforced through consent conditions. This was, therefore, a hypothetical discussion around the question:

    a. To meet the Overseer budget on a long term basis, what would you do?

31. Broadly around the table the following were agreed.

32. To manage and control P losses, important aspects of farm operations are:

    a. Buffer zones around P pathways: swales, watercourses, critical source areas

    b. Stock access to waterways: fencing of waterways, bridging of stream crossings, cambering of tracks

c. Fertiliser use: the timing, rate, placement and recording of fertiliser application

d. Effluent: Low rate of effluent application

33. To manage and control N losses:

a. Cow numbers

b. Fertiliser application rate, timing, placement and recording

c. Enforcement and monitoring requirements – e.g. monitoring of tile drain discharges

d. Re-running of Overseer modelling annually as part of a Farm Management Plan (suggested by Fish and Game, but not broadly agreed)

34. It was agreed by all (except where indicated) that these factors would be included in a description of best practice that seeks to control nutrient losses from a dairy farming operation.

35. However, it was not agreed that these management practices could be included on, or enforced by, conditions of a discharge permit for FDE.

36. It was noted, however, that past commissioner decisions have included conditions that strictly fall outside of the control of FDE discharges. The cases cited were limited in scope, for example relating to winter grazing periods, and were not extensive requirements relating to farm management more broadly.

37. Joanna Gilroy stressed that the uncertainties around the proposal remain significant:

a. uncertainties exist in relation to the effects of the activity;

b. the manner in which a consent could control those effects is also uncertain;

c. these uncertainties are leading her to a position where the application could be either supported or opposed in her s42A report.

Conclusion to meeting

38. At the conclusion of the meeting it was agreed that the applicant and submitters could beneficially use the time to discuss potential consent conditions and explore areas of potential agreement.

39. It was acknowledged by all, however, that this exercise was speculative: that commissioners may deem that land use conditions are not appropriate for a discharge permit, and therefore that farm management techniques would not be able to be enforced by ES on an ongoing basis. If that were determined, then what that means for the potential grant or decline of the applications was also speculative.

SUMMARY OF AGREED AND OUTSTANDING ISSUES

40. Agreed and outstanding issues at the conclusion of the meeting, except where indicated elsewhere in this report, were as follows.

Table 1: Agreed and outstanding issues

Issue (from Agenda)	Agreed	Not agreed
Sensitivity of the receiving environment	That the receiving environment has particular sensitivities	
Measures to address risks associated with the artificially drained nature of the land	Not discussed explicitly	
Phosphorus losses as modelled by the Overseer budget	That Overseer does not take account of land management practices. That good management practices can result in lower real life losses than those modelled	
Use of 'Best Practice' methods	Best practice methods are overall likely to help keep actual nutrient losses close to or less than the modelled results	That long term adoption of farm-wide best practice methods can be required by any consent granted; best practice could only relate to specific activities that need a long term consent (e.g. FDE discharge)
Cumulative effects on the receiving environment	That cumulative effects are difficult to assess, measure, model and understand. That Overseer's contribution to the understanding of cumulative effects is relatively limited, because it models losses from a single farm only and does not model catchment level losses or the effects of nutrients on specific water bodies or ecosystems.	That difficulty of the work means it cannot or should not be done
Water quality concerns	That dairy farming poses risks to water quality and that this particular catchment is relatively sensitive to nutrient losses.	

CONCLUSION

Status of this report and next steps

41. Section 99(6) requires the chairperson to send this report to the consent authority and all the parties so that they have it at least 5 working days before the hearing. The report was sent by email and hard copy to the parties on 2 December. At the time of writing, no parties have advised that they no longer wish to be heard, and the application is scheduled to be heard on 15 January 2016.

42. Section 99(7) **requires** the consent authority to **have regard to** this report in making the decision on the application.

Michael Durand 2 December 2015

Technical Review

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6 July 2015

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IRIS ID: APP-20158099
Enquiries to: Joanna Gilroy

Dear Rebecca

Intention to Commission Report under Section 92(2) of the Resource Management Act 1991 - Application for Schrader Mains Ltd

Thank you for lodging an application on behalf of Schrader Mains Ltd to establish a new dairy farm and to undertake associated activities at Rimu-Seaward Downs Road.

I wish to commission a report (technical review) on the application, in accordance with Section 92(2) of the Resource Management Act[1]. This is because I believe that the proposed activity may have a significant environmental effect on the receiving environment.

The scope of this review includes auditing the AEE contained in the application, the technical comment on water quality and other relevant scientific information.

A decision on notification of the application is postponed until receipt of the report.

Under Section 92B of the RMA you have until 15 working days from the date of this request, which we calculate to be **24 July 2015** to tell the Council, in writing, whether you agree to the commissioning of the report.

If you refuse to agree to the commissioning of the report, or if you do not respond to this request, the Council is required to publicly notify the application under Section 95C of the RMA.[2]

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[1] Under section 92(2) of the Resource Management Act 1991 ("RMA") the Council may, at any time before the hearing of an application, or if no hearing is to be held, before the decision to grant or refuse the application is made, commission a report on the application.

[2] The Council may also decline the application on the grounds that it has inadequate information to determine the application and the Council is required to have regard to whether or not a request to commission a report resulted in further information being available.

Please contact me if you have any questions regarding the intention to commission the report.

Yours sincerely

Joanna Gilroy
Consents Officer

CC: Schrader Mains Ltd, 514 Rimu Seaward Downs Road, R D 1, Invercargill 9871

LINCOLN AGRITECH LTD

Environment Southland
Private Bag 90116
INVERCARGILL 9840.

24 July 2015

Attention: Joanna Gilroy

Dear Joanna

RE: 20158099 SCRADER MAINS LTD APPLICATIONS TO TAKE, STORE AND DISCHARGE WATER, AND ESTABLISH A NEW DAIRY OPERATION AT WAITUNA, SOUTHLAND. TECHNICAL REVIEW OF CONSENT APPLICATION DOCUMENTATION AND ASSESSMENT OF EFFECTS ON THE ENVIRONMENT.

Environment Southland has received an application from Schrader Mains Limited ("Schrader-Mains") to take and discharge water, discharge effluent, and to establish a new (or expanded) dairy operation. The property concerned is currently under dairy and beef grazing, but the applicant wishes to convert the 109.5 ha land area to an independent dairy unit, including dairy milking shed, water supply, land-based effluent system, effluent pond and dairy grazing throughout an area of 103 ha.

The proposed farm lies within the Waituna Creek Catchment, which recharges the Waituna Lagoon, an Intermittently Closed and Open Lagoon or Lake (ICOLL). Waituna Lagoon has an acknowledged predicament relating to nutrient inflows and ecological shifts driven by an over-abundance of water-borne plant nutrients, primarily nitrogen and phosphorus. As a periodically closed system with a tendency to accumulate and re-suspend nutrients in lagoon sediment, the lagoon has arrived at the threshold of an ecological transition termed 'flipping' (from *Ruppia* dominated to algal-dominated). The Lagoon Technical Group (LTG, 2001) made five chief recommendations, one of which rested within the realm of human agency and related to the upstream catchment:

- *"reduced nutrient and sediment concentrations in the inflows and lagoon"*

The Lagoon Technical Group were thus recommending enhancement of the state of Waituna Lagoon by way of reducing the quantum of nutrient and sediment in inflows from the upstream catchment.

Status of Proposal

The planning status of the various proposed activities are classified as in the Regional Water Plan as follows:

1. the land use consent for a conversion to dairying is a discretionary activity under Rule 17A;
2. the land use consent for an agricultural effluent pond is a restricted discretionary activity under Rule 49(a);
3. the consent for a take from a lowland aquifer (Waihopai Groundwater Zone) that has less than 15% of the mean annual land surface recharge allocated and a take less than 2 L/s is a restricted discretionary activity under Rule 23(d)(iii); and
4. the discharge consent for agricultural effluent from a low rate (less than 10 mm/hour) irrigation system on to land in Category A (artificial drainage or coarse soil structure) Category C (sloping land) and Category E (other well drained but very stony flat land) is a restricted discretionary activity under Rule 50(c).

In the context of this technical review, the activities that are more significant in terms of environmental effects are as follow:

A. Land use consent from conversion to dairy and intensification of current land use, particularly as relates to nitrate emissions to groundwater / surface water, suspended solids emissions to surface water, and the generation of bacterial load as indicated by E. coli counts in surface water.
B. The discharge of dung and urine collected from the lane apron and dairy shed hardstands and stored in an effluent pond. Discharge on saturated soils may give rise to direct runoff affecting surface water. The hydraulic loading of effluent application may increase soil drainage and groundwater quality effects.

The water take and effluent storage activities are unlikely to result in discernible or significant water quality effects when operating within good practice guidelines. With reference to the dairy conversion activity, Policy 13B relates to the potential for adverse water quality arising from such a change in land use. The policy arises from a substantial body of research and environmental observation backed up by water monitoring that changing land use from low intensity grazing such as sheep farming to dairying results increased nitrogen and phosphorus losses in soil drainage, and corresponding concentration increases in underlying shallow groundwater. The effect of urine patches deposited by lactating cows under active milk solids production is to introduce urea nitrogen to the soil in quantities that is not readily fixed or cycled within the soil. Increased nitrate nitrogen leaching after microbial mediated nitrification is the typical outcome.

Technical Information Provided with Application Documents

The following information was supplied with the application letter:

- Application Forms and AEE
- Certificate of Incorporation
- Maps & Plans: Site and location plan, Farm plan
- Dairy Effluent Pond: Pond design report
- Water Quality Assessment – Receiving waters assessment
- Conversion Environmental Management Plan (CEMP), including Nutrient Management Plan (NMP)

What can be inferred from Available Information?

The aggregate proposal and application is reasonably comprehensive, and includes explicit assessment of the scale of the activity and sensitivity of the receiving environment. The application places the proposed activity in the northern part of the Waituna Creek catchment, within the so-called Northern Zone as per the Waituna groundwater resource technical report (Rissmann, Wilson and Hughes, 2012).

The pastoral and effluent disposal activities are to occur over the Woodlands and Dacre genetic soil types, primarily the Woodlands type. These are brown soils formed on a loess parent material. Soil type and topography were some of the chief determinants in the delineation of the Northern Zone. The low infiltration capacity of the brown soils (excepting perhaps the Waikiwi) has resulted in extensive and pervasive artificial drainage in the Northern Zone. Artificial drainage may act as a short circuit to open drains and creeks, and certainly serves to intercept excess soil-moisture that would otherwise drain to the shallow unconfined aquifer.

Information Gap Analysis

The application and supporting information is rich with information on farm scale features and regional scale environmental management from existing information sources, however the application is light on the local connections between land use and water quality effects. For example, it is mentioned that the property has an existing bore, but no information on the characteristics of the groundwater system potentially revealed from the bore are cited.

With respect to the nutrient management plan (NMP), the Overseer modelling suggesting that the kale block leaches nitrogen to water at five times the rate of dairy grazed pasture is puzzling. The nutrient balance for the current operation has nitrogen losses to water from the small kale block and the grazed Woodlands soils of 73 ha in almost equivalent tonnages.

- Kale 17 ha = 1.61 tN/yr
- Dairy grazing 74 ha = 1.65 tN/yr

The extremely high nitrogen losses from the kale crop and the substantial down-sizing of kale in the conversion proposal seems to be the major driver for the whole farm nitrogen losses for the current operation exceeding the losses projected by Overseer in the proposed dairy operation. It also needs to be explained why the pastoral nitrogen losses of the current and proposed operations are effectively equal on a per-hectare basis.

- Woodlands dairy grazing = 28 kgN/ha
- Woodlands current grazing = 26 kgN/ha
- Dacre dairy grazing = 17 kgN/ha
- Dacre current grazing = 17 KgN/ha

It was my understanding that beef cattle and dairy support (current operation) should have a lower causation to nitrogen leaching loss than lactating dairy cows.

Eight tile or Novaflow buried drain alignments are shown crossing the property in the last map of the CEMP and the NMP estimates that between 30% and 60% of the property is artificially drained. However, the AEE refers only to soil drainage to the unconfined aquifer as the mode of sub-surface losses of dissolved nitrogen to water. It is not clear to what extent the potential for diversion of soil drainage containing nitrogen and phosphorus into the artificial drainage network is considered in the AEE or NMP Overseer modelling.

Implications of the AEE and Associated Information

On one hand Waituna Creek Catchment and the Waituna Lagoon ICOLL are uniquely sensitive to individual and cumulative increases in nutrient load. On the other hand the transition from beef grazing, kale cropping and dairy support to a dairy platform triggering this consent does not clearly lead to either enhanced or degraded water quality in terms of nutrient load entering Waituna Lagoon. Balancing these considerations and weighing in the property being located on the least nitrate leaching vulnerable soils of the Waituna Catchment (Woodlands and Dacre); it is likely that the dairy conversion proposal would result in little nett increase in nitrogen and phosphorus being released into Waituna Creek or Waituna Lagoon.

Questions remain around the status of existing land use and the baseline conditions, plus the reliability of the estimates contained in the NMP. However, these are issues more suited to weighing up within the s42A report than a technical scientific review. The s42A report may traverse aspects of mitigation and monitoring. This review makes the following suggestions as to mitigation and monitoring of water quality conditions.

- Good management practices, such as are assumed in the Overseer NMP system, should be consistently applied in the proposed dairy conversion,
- Consideration such be given to entirely setting aside the Dacre soils adjoining the unnamed tributary of Waituna Creek to riparian planting, including suitable phreatophyte species,
- Terminal outfalls of tile and mole drains represent opportunities from passive water treatment systems, such as small constructed wetlands,
- Consideration should be given to undertaking periodic sampling of one or more tile drain outfalls and analysis for ammoniacal nitrogen, nitrate nitrogen, total nitrogen, dissolved reactive phosphorus, total phosphorus, total suspended solids and *E. coli* content.

Closure

Please let me know should you require any further information (mobile 027 836 4442).

Yours sincerely

Jens Rekker,
Hydrogeologist,
Lincoln Agritech Limited.

References Cited

Rissmann, C., Wilson, K., and Hughes, B., 2012. Waituna catchment groundwater resource technical report. Environment Southland publication 2012-04, Invercargill. 93p.

Roberston, B., Stevens, L., Schallenberg, M., Roberston, H., Hamill, K., Hicks, A., Hayward, S., Kitson, J., Larkin, G., Meijer, K., Jenkins, C., and Whaanga, D. 2011. Interim recommendations to reduce the risk of Waituna Lagoon flipping to an algal-dominated state. Prepared for Environment Southland by the Lagoon Technical Group (LTG). Environment Southland, Invercargill. 16p.

Waituna Lagoon Technical Group Report 2011 and Action Plan 2015

Waituna Lagoon
No other place like it

Interim recommendations to reduce the risk of Waituna Lagoon flipping to an algal-dominated state

Prepared by the Lagoon Technical Group (LTG)

26 May 2011

Credits

Barry Robertson[1], Leigh Stevens[1], Marc Schallenberg[2], Hugh Robertson[3], Keith Hamill[4], Andy Hicks[3], Shirley Hayward[5], Jane Kitson[6], Greg Larkin[6], Kirsten Meijer[6], Chris Jenkins[6], Dean Whaanga[7].

[1] Wriggle Coastal Management
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[4] Opus International Consultants
[5] DairyNZ
[6] Environment Southland
[7] Te Ao Marama Inc.

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Executive Summary

Waituna Lagoon is currently considered to have a high likelihood of "flipping" from its high value clear-water, seagrass (*Ruppia*) dominated state, to a highly undesirable turbid, algal dominated (phytoplankton/epiphytic) state due to excessive inputs of nitrogen, phosphorus, and sediment from intensification of landuse in the catchment.

In response, Environment Southland (ES) has convened a Lagoon Technical Group (LTG) to provide short-term immediate guidance to minimise the risk of the lagoon flipping and identification of a recommended pathway for the long-term management of lagoon condition. The following recommendations are preliminary and based on the best knowledge on the Waituna Lagoon system, however there are information gaps and as such these recommendations will be reviewed six-monthly and updated. These preliminary recommendations are viewed as necessary due to the urgency and risk of the lagoon flipping and to inform the research needs and mitigation work within the Waituna Lagoon catchment.

A Catchment Technical Group (CTG) is being developed to determine the implications of the Interim Lagoon Recommendations for the catchment.

The key recommendations from this document are:

1. Short term immediate guidance to minimise the risk of lagoon flipping:

    - water quality targets for lagoon health;
    - recommendations for lagoon sediment and nutrient load reductions;
    - lagoon opening/closing decision criteria;
    - monitoring recommendations;
    - recommendations for further research;
    - role of the Lagoon Technical Group (LTG).

2. A pathway for the medium to long-term management of Waituna, which links to the development of a whole catchment plan for lagoon recovery undertaken by the Catchment Technical Group (CTG).

What is the Problem?

Waituna Lagoon is a highly valued, large brackish coastal lagoon that is fed by three streams. It drains to the sea through a managed opening. In terms of estuary classification it is classified as an intermittently closed and open coastal lake or lagoon (ICOLL). Historically the lagoon was surrounded by peat bog wetland which gave the lagoon's water its characteristic brown colour, and low pH. It is a system that has very high ecological habitat diversity and supports an intact seagrass community (*Ruppia* dominated), internationally important birdlife, and large areas of relatively unmodified wetland and terrestrial vegetation. In addition it has been highly valued for its aesthetic appeal, its rich native biodiversity, duck shooting, fishing (for brown trout primarily), boating, walking, and scientific appeal. In 1976, it was listed as a wetland of international importance (Ramsar site), in 1983 was designated a DOC scientific reserve, and the cultural significance to the local Ngai Tahu people was recognised under a Statutory Acknowledgement with the Ngai Tahu Claims Settlement Act 1998.

However, through land development of the catchment over the past century (e.g. clearance of wetlands, drainage enhancement and fertiliser inputs) and an opening regime managed for farm drainage, the lagoon is now experiencing a number of ecological problems. This includes a decline in abundance of *Ruppia* (seagrass) that is central to the lake's ecological functioning, increased abundance of nuisance filamentous algae, and reduced oxygenation of bed sediments. These issues are exacerbated by the lagoon's susceptibility to water quality problems because the lagoon's opening to the sea is intermittent, resulting in periods when flushing of the lagoon is restricted. Therefore, sediment and nutrient inputs tend to affect the lagoon and are key drivers in the changes described above. With recent further conversion of the catchment to more intensive dairy farming, the risks of eutrophication and excessive fine sediment deposition in the lagoon are of concern.

In the last 10 years, monitoring results have highlighted a rapid decline in lagoon condition to the point where it has deteriorated from a high value seagrass (*Ruppia*) dominated state, to a more degraded condition with nuisance epiphyte and algal blooms and sediment anoxia causing stress to the keystone *Ruppia* species. Current expert opinion is that unless urgent intervention occurs, the lagoon could undergo a rapid "flip" to an even more degraded phytoplankton dominated state (e.g. algal bloom), which would endanger the *Ruppia* community and change the fundamental values and character of the lagoon. Such rapid shifts have occurred in other lagoons leading to the loss of valued fisheries and birdlife, as well as cultural and recreational attributes of lagoons.

Lagoon Technical Group (LTG)

To initiate steps to minimise the risk of flipping, Environment Southland (ES) convened a Lagoon Technical Group (LTG) of individuals with particular experience in monitoring the condition of the lagoon, and with scientific knowledge of coastal lagoon ecosystems to:

1. analyse data and other evidence to determine the risk of flipping;

Lagoon Technical Group:
Dr Barry Robertson – Wriggle Coastal Management
Leigh Stevens – Wriggle Coastal Management
Dr Marc Schallenberg - University of Otago
Dr Hugh Robertson - Department of Conservation
Keith Hamill – Opus Consulting
Dr Jane Kitson – Environment Southland
Greg Larkin – Environment Southland
Kirsten Meijer – Environment Southland
Chris Jenkins – Environment Southland
Dean Whaanga - Te Ao Marama Inc
Shirley Hayward – DairyNZ
Andy Hicks – Department of Conservation

2. recommend lagoon management options including:

   - decision criteria for lagoon openings;
   - water quality targets for lagoon health;
   - recommendations for lagoon sediment and nutrient load reductions;

3. recommend monitoring requirements to:

   - assist with decision-making on lagoon openings
   - measure lagoon response to management intervention

4. recommend further research to understand Waituna lagoon processes

The LTG met for the first time on 24 February 2011 to prepare summary information for the Waituna Lagoon stakeholder workshop on 28 February 2011. At that meeting the LTG were tasked with summarising evidence of a problem within Waituna Lagoon, and compile interim recommendations to reduce the risk of Waituna Lagoon flipping (this document).

Purpose of the report

This report documents the progress by the LTG on addressing the above tasks. The LTG has used information available at the time to develop the set of recommendations in this report, but also recognises the need for further studies to fill in gaps in knowledge and refine recommendations. These recommendations will be updated in 6 months to reflect any changes in information.

Environment Southland is developing a Catchment Technical Group (CTG) to determine the implications of the Interim Lagoon Recommendations for the catchment.

Evidence of a problem

Indications that the lagoon is under stress and could "flip" are:

- stream nutrient inputs (N and P) have increased over the past 5-10 years (Appendix 1);

- lagoon nutrient and chlorophyll-*a* concentrations are currently at eutrophic levels in the surface waters (Hamill 2011) (Appendix 2) and are even higher in the bottom waters (Feb 2011 ES monitoring data, see Appendix 4). The lagoon becomes more eutrophic the longer the lagoon is closed to the sea as N and P accumulate from stream inputs and release from anoxic bed sediments, respectively (Appendix 2);

- deteriorating trends are apparent in lagoon total phosphorus (TP) concentrations and winter nitrate concentrations over the past 5 years (Hamill 2011);

- symptoms of eutrophication are apparent including:
  - sediment anoxia that has become widespread throughout the lagoon since 2007 (Stevens & Robertson 2010) e.g. general depth of sediment oxygen penetration (redox potential discontinuity (RPD) has decreased; in 2007: >5 cm, 2009: 0-3 cm, 2010: 0-1 cm);

- the native, brown alga *Bachelotia antillarum* (growing attached to wood, stones, or epiphytic on macrophytes, particularly *Ruppia*) was present at very low abundance in 1995, 2006, and 2007 (Johnson & Partridge 1998, Stevens & Robertson 2007). By 2009 *Bachelotia* had increased to widespread growths throughout the lagoon (94% of monitored sites), which persisted in 2010 (85% of monitored sites) under conditions when the lagoon had been closed for periods of 141 and 137 days respectively (Robertson & Stevens 2009, Stevens & Robertson 2010). Such periods of closure are typical for the lagoon;
- the widespread growth of *Bachelotia* has continued in 2011 while the lagoon has remained open for 160+ days;
- a marked decline in *Ruppia* cover since 2009 can be attributed to loss of habitat through artificial opening of the lagoon, sediment anoxia and epiphyte shading (Robertson & Stevens 2009, Stevens & Robertson 2010) e.g. *Ruppia* recorded at 85% of monitored sites in 2007, 73% in 2009 and 52% in 2010[1]. The 2011 survey recorded only sparse *Ruppia* in the lagoon (H. Robertson pers comm);
- likely release of sediment P to the water column (i.e. internal P loading) based on the presence of widespread shallow sediment anoxia and steadily increasing TP concentrations in the lagoon during closed periods.

In addition to eutrophication, excessive infilling of the lagoon bed by sediments has been widely reported by local fishermen and Environment Southland monitoring data, as occurring in the lagoon since at least 1960 (Stevens and Robertson 2007). This exacerbates the potential for lagoon flipping through wind-induced turbidity, smothering of *Ruppia*, and the increase of sediment-bound P in the lake bed.

Broad goals for lagoon health

The response to catchment and lagoon management interventions would be measured as a shift towards:

- reduced nutrient and sediment concentrations in the inflows and lagoon;
- decreased biomass of phytoplankton and macroalgae;
- increased distribution, abundance and health of *Ruppia* in the lagoon;
- improved sediment oxygenation and reduced sedimentation in the lagoon;
- maintenance or improvement of ecological, recreational and cultural values (e.g. fish, birds, wetland fringing vegetation).

Interim water quality targets for lagoon health

Because the underlying cause of eutrophication is excessive inputs of nitrogen and phosphorus, it is recommended that these be reduced to a level that will enable the lagoon condition to be sustained in a "healthy" state and away from the brink of "flipping". In addition, because eutrophication is exacerbated by excessive inputs of fine sediments, it is recommended that sediment loads be reduced.

To achieve this, it is recommended as an interim approach that the annual average total nitrogen (TN), total phosphorous (TP) and chlorophyll-*a* concentrations in Waituna Lagoon do not

[1] note a different method to record Ruppia abundance was used in 2007. The preliminary method (2007) was more descriptive than quantitative (H. Robertson per s comm)

exceed the mesotrophic/eutrophic boundary classification for NZ lakes given by Burns et al. (2000) as follows:

TP = 0.02mg/L, TN = 0.300 mg/L, Chlorophyll *a* = 0.005 mg/L.
(Appendix 5: shows the range of values for these variables over 2005-2010)

In addition, reducing suspended solids inputs to the lagoon is recommended to reduce sediment deposition and turbidity in the lagoon. Increased turbidity is a factor linked to the flipping of shallow lakes due to the light stress it induces on macrophytes (Scheffer 2004), including *Ruppia.* Based on loadings to healthy estuaries (Swales et al. 2005), and historical loadings to Waituna Lagoon (Cadmus 2004), an **interim sedimentation rate guideline of 0.5 mm/yr** is recommended within the lagoon to protect against excessive turbidity and sediment deposition.

Beyond setting nutrient targets, it is important to identify the nutrient(s) most likely to limit the growth of nuisance algal species. Aquatic plant and algae growth is commonly constrained by the availability of nitrogen or phosphorus or both. If direct experimental data on plant responses to nutrient additions are lacking (as in the case of Waituna Lagoon), the growth-limiting nutrient is often inferred through the ratios of nitrogen to phosphorus (N:P ratio) in the plants, or nitrogen to phosphorus available in the water. However, such an approach is relatively simplistic and for a number of reasons can lead to erroneous conclusions. These reasons include the following:

- available evidence indicates that nutrient uptake, and therefore optimum N:P ratio, differs between the various types of plants i.e. N:P-ratios (by weight) of 7.2:1, 22:1 and 9:1 for microalgae, macroalgae and rooted macrophytes, respectively (Redfield et al. 1963; Duarte 1992)

- the N:P ratio generally assumes a constant supply of nutrients, whereas in reality they are often supplied in pulses (e.g. during floods), with N:P ratios constantly altered depending on both pulse and uptake rates;

- the N:P ratio can vary between surface and bottom waters and on sediment surface which means phytoplankton in surface waters can be exposed to different limitations than epiphytes, macroalgae and rooted plants in bottom water and sediments.

Taking these facts into consideration, and the fact that the lagoon surface water data from 2001-2010 suggests that both N and P could be limiting at different times (Figure 1 provides both TN:TP and DIN:DRP ratios), with possible nitrogen limitation more likely during summer, it is recommended that both nitrogen and phosphorus be targeted for management of Waituna Lagoon.

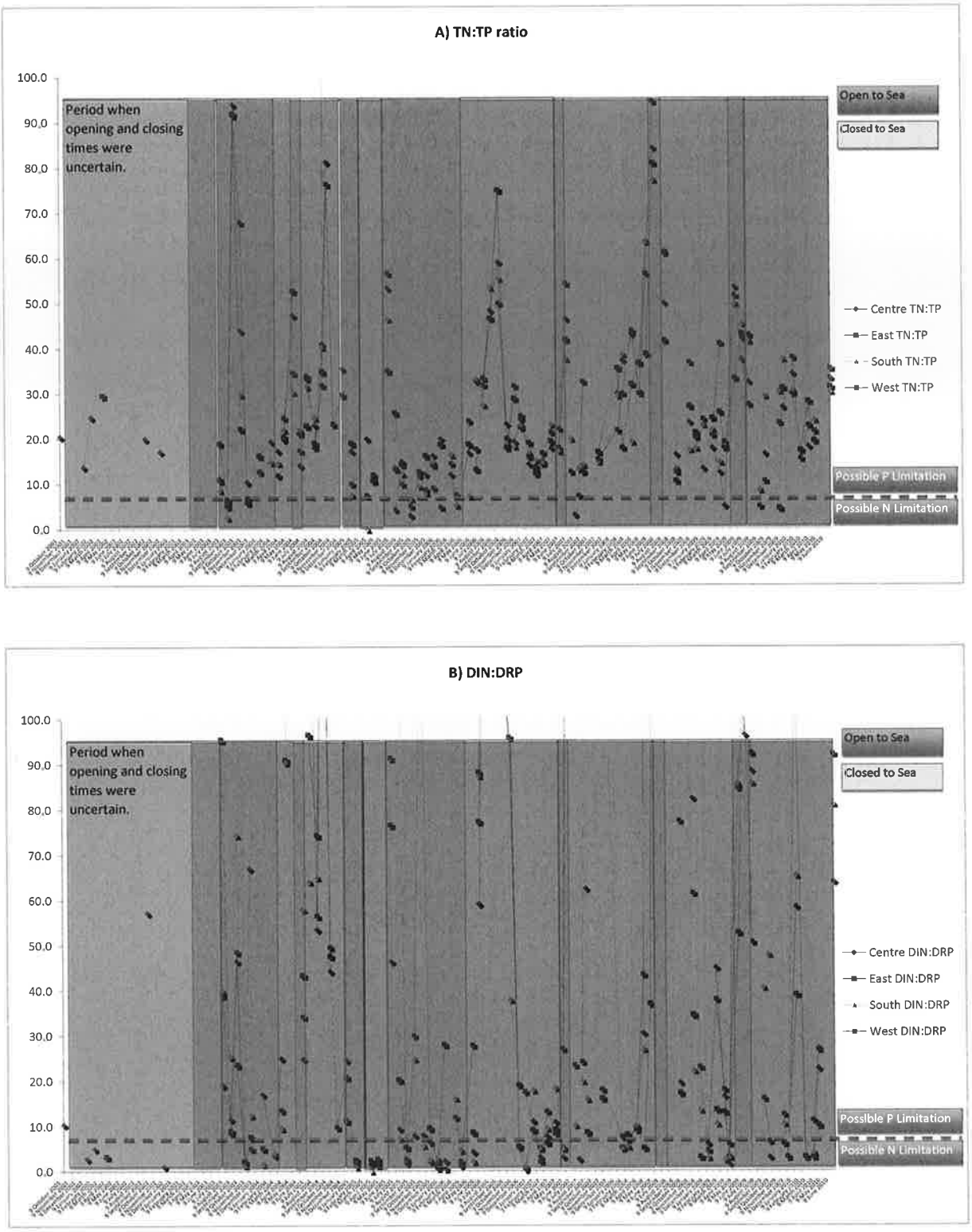

Figure 1: A) Ratio of total nitrogen to total phosphorus (TN:TP) and, B) dissolved inorganic nitrogen to dissolved reactive phosphorus (DIN:DRP) at the four lagoon sites monitored by ES(2001-2010)

Interim recommendations for input load limits

In order to ensure the long-term viability of the lagoon, it is necessary to reduce current nutrient and sediment inputs from the catchment. At present, although the available information for determining appropriate catchment load targets is limited, an initial assessment of potential load targets provides an early indication of the order of magnitude of changes that may be required. However, because new information may support the fine-tuning of these targets in the future, the guidelines must have some in-built flexibility (i.e. we suggest a prudent, adaptive management approach). In addition, to enable revision of the guidelines it is recommended that relevant detailed scientific investigations (experiments and possibly modeling) be undertaken (See section on Monitoring Recommendations).

In the absence of historical input monitoring data prior to 2000, catchment yield estimates have been used to define preliminary nutrient and sediment load reductions needed to protect lagoon values (Table 1 and Appendix 3). Because the lagoon was in relatively good condition prior to 1995, with low abundance of measured nuisance epiphyte growth (*Bachelotia*) and widespread *Ruppia* growth (Johnson & Partridge 1998), the pre-1995 land use was used to estimate targets for catchment nutrient and sediment load reductions. Table 1 also shows the estimated 2009 loadings based on estimated land use at that time.

Because the catchment yield information uses yield data from other NZ catchments as presented in "*Land use and land management risks to water quality in Southland*" (Monaghan et al. 2010) this approach must be viewed as 'ballpark' as it does not account for catchment specific variations such as farm practices, soil types, catchment topography and attenuation processes. As a consequence, it is recommended that a more robust, catchment specific approach using a specific model incorporating catchment inputs and recent land use data be undertaken to more accurately identify these target loads.

Table 1: Estimated input loads of total nitrogen and total phosphorus (tonnes/year) to Waituna Lagoon based on catchment specific yields for land use in 1995 and 2009 (excludes groundwater). Refer Appendix 3 for further details

1995 Loadings	TN (t/yr)	TP (t/yr)
Point Source (septic tank leachate)	2	0.7
Non Point	177	9
TOTAL	179	9.7
Areal Loading to Lagoon (t/km^2/yr)	13	0.7

2009 Loadings	TN (t/yr)	TP (t/yr)
Point Source (dairy pond/irrigation/septic)	27	7
Non Point	396	14
TOTAL	423	21
Areal Loading to Lagoon (t/km^2/yr)	31	1.5

Based on this approach the TN and TP inputs from the Waituna Lagoon catchment are likely to need to be reduced significantly. These interim results suggest N and P load reductions of approximately 50% are required to return to 1995 levels. This would mean a reduction in lagoon areal nitrogen and phosphorus load (i.e. annual load per unit area of waterway surface) from the current estimated levels of 31 tN/km^2/yr and 1.5 tP/km^2/yr to 15 tN/km^2 of lagoon/yr and 0.7 tP/km^2/yr.

However, based on the relationship between area nutrient load rates and lagoon response for 10 New South Wales Intermittently Closed and open Lake or Lagoons (ICOLLs) that are similar to Waituna (in size, opening regime and residence time), it is likely that such a reduction in nitrogen would not be sufficient to return the lagoon to a healthy state but would be for phosphorus (pers. comm. Peter Scanes, Head Coastal Catchments Science, NSW Dept Environment and Climate Change). The data for NSW lagoons categorises ICOLLs into three trophic states; pristine or reference, moderate disturbance and high disturbance and mean nutrient loadings for each are as follows:

Table 2: Trophic states and mean nutrient loadings for 10 New South Wales coastal lagoons that have similar characteristics to Waituna Lagoon (Scanes unpublished data)

Trophic state	TN tonnes/km^2/yr	TP tonnes/km^2/yr
reference (pristine)	2.8	0.2
moderate (some eutrophic symptoms but still support healthy seagrass and fish communities)	6.4	0.7
high (algal dominated, turbid systems, seagrass absent or reduced)	14	2

These findings suggest that the Waituna catchment nutrient loads would need to be reduced to at least 6.4 tN/km^2/yr and 0.7 tP/km^2/yr to meet a condition in which the lagoon still shows some eutrophic conditions but still supports healthy seagrass and fish communities in the long term. This equates to a 75% catchment load reduction for nitrogen and a 50% reduction for phosphorus.

In addition, until the store of old catchment nutrients in the lagoon bed sediments are depleted, release of nutrients from the sediment is likely to delay the return of the lagoon to a healthier state. Experience with similar lagoons in NSW indicates that this may take anything from 2-10 years.

However more study is required to determine the similarities of lagoon responses between Waituna Lagoon and NSW ICOLLS.

In relation to sediment inputs to the lagoon, an alternative approach for deriving SS guidelines has been used. Sediment rate monitoring within Waituna Lagoon shows elevated rates (2.5-3.0 mm/yr) of fine sediment deposition in localised areas since c.1960 to the present day (Cadmus 2004, Stevens and Robertson 2007). Prior to this it is predicted that SS loadings to Waituna Lagoon were much lower (Cadmus 2004). Therefore to reduce the buildup in sediment at localized areas, current loadings will need to be reduced. However, because of uncertainty about current input loads, especially in relation to drainage works and maintenance within the catchment, further work is proposed to determine the extent of catchment load reduction.

Interim guidelines to support lagoon opening decision

Because input reductions may take time to reduce N and P concentrations in Waituna Lagoon to target values, a short term measure is proposed to minimise the risk of the lagoon flipping. The proposed measure is to open the lagoon to dilute nutrients and sediment, and increase flushing to the sea when critical ecological trigger levels are exceeded and when hydrological and sea conditions allow. This process involves setting an initial warning trigger that initiates an increased frequency of lagoon monitoring, and a critical trigger level at which a recommendation on whether the lagoon should be opened is made by the LTG. The draft guidelines have been derived from both Waituna Lagoon monitoring data, and indicators of lagoon health from other shallow lakes. The trigger levels are presented in Table 3, with a rationale for each provided in Table 4.

Table 3: Key indicators and draft warning and critical triggers to guide decisions on whether to open the lagoon to minimise the risk of lagoon flipping

Primary Indicators	Warning trigger	Critical trigger
Chlorophyll *a*	0.008 mg/L	0.012 mg/L

Secondary Indicators	Warning trigger	Critical trigger
Total Phosphorus	0.030 mg/L	0.045 mg/L
Total Nitrogen	0.500 mg/L	0.700 mg/L

Tertiary Indicators	Warning trigger	Critical trigger
Nuisance epiphytes or benthic algae	>30% cover at >50% of sites	>50% cover at >80% of sites
Ruppia and other macrophytes	>20% decrease in site occupancy from baseline abundance[2]	>50% decrease in site occupancy from baseline abundance
RPD (Redox Potential Discontinuity) – bottom sediments	1-3cm at >50% of sites	<1cm at >80% of sites
Turbidity (still under development)	Non-wind-induced, organic and inflow-induced turbidity > 20% above background for non-bloom phytoplankton periods	Non-wind-induced, organic and inflow-induced turbidity > 30% above background for non-bloom phytoplankton periods
Temperature (still under development)	–	–
Bottom water dissolved oxygen	5 mg/L	2 mg/L
Aquatic and surrounding wetland life	Significant adverse effects to biota e.g. fish kills, impacts on critical *Ruppia* life stages, wetland vegetation die back	

Table 4: Rationale for the proposed indicators and draft triggers to guide LTG recommendations on whether to open the lagoon to minimise the risk of lagoon flipping

Primary Indicators	Rationale	Currently monitored by
Chlorophyll *a*	Monitors the biomass of planktonic algae. Blooms of these algae can trigger the loss of macrophytes, eventually triggering lake flipping (Scheffer 2004). The critical trigger of 12 mg/m^3 equates to Trophic Level Index (TLI) = 5 (low supertrophic) and warning trigger of 8 mg/m^3 equates to TLI = 4.5 (mid eutrophic).	ES
Secondary Indicators	**Rationale**	**Currently monitored by**
Total Phosphorus	This is a key plant nutrient as excessive levels stimulate planktonic and epiphytic (slime) algae over *Ruppia* (Schallenberg 2004). The critical trigger of 0.045 g/m^3 equates to TLI = 5 and Warning trigger of 0.030 g/m^3 equates to TLI = 4.5.	ES

[2] Baseline abundance needs to be defined.

Total Nitrogen	This is a key plant nutrient as excessive levels stimulate planktonic and epiphytic (slime) algae over *Ruppia* (Schallenberg 2004). Schallenberg et al. 2010, noted nitrate spikes can occur soon after lagoon closing, probably sourced from newly inundated sediments (old dewatered and decomposed biomass). This spike immediately after closing should not trigger lagoon opening. The warning trigger of 0.5 g/m^3 is greater than the target of 0.3 g/m^3 for the pragmatic reason that current TN concentrations are almost always above the target when the lagoon is closed.	ES
Tertiary Indicators	**Rationale**	**Currently monitored by**
Epiphytes or benthic algae	The proliferation of these algae may trigger the loss of macrophytes, eventually triggering lake flipping (Scheffer 2004).	DOC Arawai Kakariki programme and ES
Ruppia and other vascular macrophytes	These macrophytes have been designated as a keystone community, enhancing lake health and providing many valued ecosystems services (Schallenberg & Tyrrell 2006). The decline in *Ruppia* growth, or die back during a growing season, may facilitate a shift to other primary producers (e.g. phytoplankton; Scheffer 2004).	DOC Arawai Kakariki programme and ES
Turbidity	Low water clarity as measured by turbidity can trigger the loss of macrophytes through reduced light availability. Measure using in-situ turbidity loggers that will allow for separation (eventually) of wind induced, organic and inflow-induced turbidity.	Not monitored by in-situ loggers
Bottom water dissolved oxygen and sediment oxygenation (RPD)	Sediment anoxia can trigger the loss of macrophytes from stress to roots or by the release of internal nutrients bound in sediments. The result is increased bioavailable forms of nitrogen (nitrate and ammonium) and phosphorus (phosphate).	Not monitored
Water temperature	Higher water temperatures can trigger phytoplankton and macroalgal growth, which can flip the lagoon. However, specific temperature triggers for Waituna Lagoon are still under development.	Partially monitored by ES
Aquatic and surrounding wetland life	To protect against significant adverse effects to biota from either nutrient and/or sediment inputs to the lagoon, or any subsequent management actions taken to minimise the potential for lagoon flipping. For example, the negative effect of salinity on *Ruppia* germination.	Some aspects monitored by DOC Arawai Kakariki programme

Timing of lagoon openings needs to consider allowing the lagoon to fill up and ensuring lagoon closure prior to the main *Ruppia* growing and germination period (spring – summer). The timing of open and closed periods has to be carefully considered as prolonged opening events are likely to affect *Ruppia* germination.

A reviewable term of 1-2 years has been set because of the potential for long-term adverse impacts to the lagoon's ecology and the wetlands from more frequent openings. For example salinity stress to *Ruppia* germination, drying out of *Ruppia* beds and fringing wetland plants, invasion of terrestrial weeds into wetland areas, loss of fish habitat, increased inputs of marine sand (refer to Hadwen & Arthington 2006, Robertson et al. 2009, Duggan & White 2010 for further detail).

It is acknowledged that the proposed ecological guidelines may impact upon other lagoon uses and values in some instances, including recreation (incl. fishing and hunting), and for drainge.

Other important considerations are as follows:

1. ***location of lagoon opening*** – openings may potentially occur at different, or multiple, sites to maximise flushing, e.g. historical breakout points near Walker Bay and at the eastern end of the lagoon. However, the feasibility and ecological impacts of alternative opening sites need detailed assessment prior to any use for lagoon management.

2. ***water level prior to opening*** - past experience has shown that the greatest flushing of sediment and nutrients to sea occurs when the lagoon is opened when it has a high water level, lagoon waters are well mixed, and the breakout occurs on an ebbing tide during calm seas.

3. ***artificial lagoon closing*** - further work is required to determine if it is feasible to artificially close the lagoon, and if so, the conditions that would trigger such a response, e.g. to introduce a freshwater phase to promote the germination and growth of *Ruppia*, increase water levels to inundate fringing wetland habitat/vegetation, or improve fish habitat.

4. ***prolonged lagoon opening*** – currently *Ruppia* is under stress from nuisance epiphyte growth which is likely exacerbated by the prolonged opening of the lagoon and the accompanying elevated salinities which promote ideal conditions for *Bachelotia* growth – a marine brown algae. This means *Ruppia* is more susceptible to other stressors e.g. light limitation, sediment anoxia, wind disturbance. By closing the lagoon, it is intended that more favourable habitat for *Ruppia* would result i.e. greater water depths, lower salinities, increased habitat area, less wind disturbance, less smothering by epiphytes. In the longer term it is envisaged that *Bachelotia* tolerance to low salinities would be investigated and that artificially regulating salinity could possibly be used as a tool to control excessive growth.

Due to the complex nature of Waituna Lagoon and the technical considerations in interpreting the monitoring data, lagoon conditions, and ecological requirements, it is recommended to build an interim decision support framework in consultation with the LTG and stakeholders. This framework would explicitly outline the analytical requirements needed to inform management of lagoon opening events.

Monitoring Recommendations

Co-ordinated monitoring of the lagoon needs to be initiated to measure catchment inputs and lagoon condition. This monitoring falls into several categories in terms of urgency, and therefore some aspects require immediate action. To identify these, a detailed monitoring schedule is recommended based on the following guidance.

1. Catchment Inputs

Objective: Catchment inputs of nutrients and sediment to the lagoon under a range of flow conditions need to be measured in order to ensure guideline input loads for N, P and SS Loads are being adhered to.

Parameters: Flow, total nitrogen, oxidized nitrate/nitrite nitrogen, ammonia nitrogen, total phosphorus, dissolved reactive phosphorus, total suspended solids, volatile suspended solids, turbidity, clarity, temperature, salinity/conductivity, dissolved oxygen.

Frequency:

- ***Water quality*** - weekly samples for representative base flows. Hourly samples for representative floods. Flow; monitor continuously at representative catchment (Waituna Creek) and periodically at other flow inputs to enable assessment of relative contributions.

Locations:

- ***Water quality*** - all stream inputs (Waituna, Moffat, Carrans Creeks).

Commencement: Urgent

From these data, calculate daily nutrient and sediment input loads to the lagoon from each stream using flow/WQ variable relationships.

2. Waituna Lagoon

Objective: To determine if the lagoon meets: 1) set water quality and sediment criteria, and 2) guideline triggers which indicate whether the lagoon should be opened or closed (in the short term) to reduce the risk of lagoon flipping. Primary trigger values have been set for TN, TP, and chlorophyll-*a*. In addition, a number of other secondary indicators including; bottom water DO, presence of nuisance epiphytes and benthic macroalgae, *Ruppia* abundance, sediment RPD, water clarity and impacts to other aquatic biota and surrounding wetland life. Sediment monitoring is included to provide preliminary information that will later be used to design a more comprehensive programme to determine the exchange of N and P between the surface waters and the sediment and to estimate the magnitude of the sediment nutrient pool.

Parameters:

- ***Water quality*** - (in surface water and in water immediately (0-5 cm) above the lagoon sediments): total nitrogen, oxidized nitrate/nitrite nitrogen, ammonia nitrogen, total phosphorus, dissolved reactive phosphorus, total suspended solids, volatile suspended solids, turbidity, total organic carbon, dissolved oxygen, Secchi depth, salinity, temperature, depth at sample site, lagoon water level, chlorophyll *a*, phytoplankton abundance and species composition. In addition, measure surface water lagoon metabolism (48 hr in situ DO sensor deployment).
- ***Sediment quality*** - Porewaters; oxidised nitrate/nitrite nitrogen, ammonia nitrogen, dissolved reactive phosphorus. Whole Sediment: total nitrogen, total phosphorus, total organic carbon, grain size (mud sand gravel), sediment RPD, depth of soft mud, depth at sample site, lagoon water level, and sedimentation rate.
- ***Vegetation mapping*** Epiphyte and macroalgal abundance and diversity, particularly the presence of bloom-forming epiphytic and macroalgae (note: a semi-quantitative visual rating scale to describe the abundance of the dominant epiphyte *Bachelotia* has yet to be developed). Seagrass abundance and diversity. Fringing wetland vegetation condition.
- ***Lagoon water level*** – data logger.

Frequency:

- ***Water quality*** – monthly (more frequently if data loggers or automatic samplers are used), planktonic lagoon metabolism quarterly.
- ***Sediment quality*** - monthly; Sediment rate – annually. Criteria to be set to increase monitoring frequency as lagoon approaches trigger values when it is closed e.g. weekly once 80% of threshold value reached.
- ***Vegetation mapping*** – Epiphytes and macroalgae - 3 monthly. Seagrass – annually. Surrounding fringing wetland vegetation – 3 yearly.

Locations:

- ***Water quality*** - Four existing lagoon sites (west, centre, east, south).
- ***Sediment quality*** - Four existing lagoon sites (west, centre, east, south).
- ***Vegetation mapping*** - Epiphytes and macroalgae - Four existing lagoon sites (west, centre, east, south). In addition, sediment RPD, sediment depth, and epiphyte and macroalgal abundance and diversity in representative areas of the lagoon where epiphytes and macroalgae are most commonly found (e.g. the central channel in the east of the lagoon, Walkers Bay, Shands Bay and the southwestern (seaward) edge of the lagoon). Seagrass – at the existing 48 DOC transect sites. Fringing wetland vegetation – transects used in previous surveys (e.g. Johnson & Partridge 1998).

Commencement: Urgent

From these data, determine if lagoon water and sediment targets are met. Assess if lagoon ecological trigger values are met to indicate increased monitoring or opening required. Assess the store of internal nutrients and influence of internal loading. Monitor response of sea-grass and other vegetation to changing conditions.

Peer Review

Scientific peer review of these recommendations was undertaken by Professor David Hamilton (University of Waikato), a specialist in lake management.

The LTG undertook an additional final review just prior to the release of these recommendations.

Role of LTG

It is anticipated that the LTG will continue to provide information and advice so that any decisions regarding the future management and monitoring of Waituna Lagoon are carefully considered. It may also be necessary to seek external support for technical issues that require particular expertise, e.g. lagoon response modelling.

Recommendations for further studies

The LTG has identified a number of priority actions and information gaps, some of which need to be urgently addressed if the risk of the lagoon flipping is to be minimised (Immediate Recommendations) and others where the urgency is somewhat less (Medium Term Recommendations).

Immediate Recommendations

- Identify and evaluate contaminant sources (N, P and sediment) for different landuses in the Waituna catchment and for the catchment as a whole (e.g. use of catchment modeling tools).

- Identify management options and interventions to reduce catchment loads, with ground-truthing to validate model predictions.

- Develop a monitoring schedule to collect data on catchment input loads and lagoon condition.

- Explore options for closing the lagoon as soon as possible after flushing to provide more favourable habitat for *Ruppia* and conditions predicted as less suitable for *Bachelotia* growth.

- Determine whether *Bachelotia* growth is suppressed at low salinities and whether salinity can be used to mitigate against excessive growth.

- Carry out an assessment of lagoon response to contaminants (including internal loading) under different opening and closing regimes, and more comprehensive assessment of contaminant load guidelines to maintain lagoon in healthy state (e.g. lagoon response modeling).

- Assess methods of measuring and monitoring epiphyte production and biomass.

- Assess salinity effects on *Ruppia* for different lifecycle stages.

- Carry out an assessment and comparison of information in relation to Australian ICOLL where *Ruppia* is present.

Medium Term Recommendations

- Plan the transition from short term to long term monitoring and management. This will include the development of an ecological management strategy to determine appropriate options for long term lagoon monitoring and management. The strategy will be informed by the following investigations:

    - once the internal load has been quantified, an evaluation of the available methods for internal (bottom sediment) nutrient removal and their suitability for application in Waituna Lagoon;
    - determine impacts on the wider ecosystem of various opening and closing regimes;
    - define nutrient limitation dynamics of phytoplankton, epiphytes and *Ruppia* to validate the lagoon response model;
    - define environmental limits on *Ruppia* reproduction (e.g. pollination, fruiting, and germination and vegetative reproduction);
    - explore physiological indicators of *Ruppia* stress (e.g. as indicated by alcohol dehydrogenase);
    - define light requirements of *Ruppia*, other macrophytes, epiphytes and phytoplankton.

Catchment Technical Group

Environment Southland is developing a Catchment Technical Group (CTG) to determine the implications of the Interim Lagoon Recommendations for the catchment.

Summary

The key points that arise from this LTG output are:

1. short term immediate guidance to minimise the risk of lagoon flipping:

    - water quality targets for lagoon health;
    - recommendations for lagoon sediment and nutrient load reductions;
    - lagoon opening/closing decision criteria;
    - monitoring recommendations;
    - recommendations for further research.

2. A medium to long-term pathway which primarily consists of the development of a whole ecosystem plan for long-term lagoon recovery, including monitoring and management and a LTG to inform key decisions.

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Appendix 1: Data showing recent changes in nutrient inputs to the lagoon

Table 1 shows the combined catchment inputs from three streams (Waituna, Carran and Moffat Creeks) to Waituna Lagoon based on ES monitoring data. While there is variance between years, the overall trend of increasing nutrient inputs from 2001-2005 to 2006-2010 is clear (Table 1). However, because very few measurements have been collected at elevated flows (floods when inputs are known to be greatest), the data presented in Table 1 almost certainly underestimate actual loading.

Table 2 shows the results of a statistical analysis of trends in loads using a Mann-Kendall test. The trends in total nitrogen, nitrate and total ammonia were all highly significant. The trends in total phosphorus and dissolved reactive phosphorus were not statistically significant, but still of concern, due to the very high values recorded in 2009 and 2010.

Table 1: Combined catchment nutrient inputs as tonnes/yr (mean of the monitored daily inputs - approx.12/yr) from three streams (Waituna, Carran and Moffat Creeks) to Waituna Lagoon based on ES monitoring data (2001–2010)

Year	TN Load (t/yr)	Nitrate-N Load (t/yr)	Ammonia-N Load (t/yr)	TP Load (t/yr)	DRP Load (t/yr)
2002	151	100	5.3	6.3	1.9
2003	194	137	10.0	8.3	2.6
2004	238	142	8	6.1	2.4
2005	167	105	6.3	2.9	1.1
2006	339	172	14.8	22.8	4.7
2007	171	128	8.4	5.7	1.6
2008	209	160	3.3	3.0	1.4
2009	296	151	12.6	22.6	2.1
2010	390	220	13.7	21.5	0.0
Mean 2002-2010	240	146	9.2	11.00	3.0
Mean 2002-2005	188	121	7.4	5.9	2.0
Mean 2006-2010	281	166	10.5	15.1	3.8

Table 2: Trends in nutrient loads to Waituna Lagoon (using Mann-Kendall test of annual loads 2002-2010)

Variable	% annual change	p-value	Statistically significant?
Total nitrogen	+11%	0.02	Yes
Nitrate	+8%	0.02	Yes
Total ammonia	+9%	0.2	No
Total phosphorus	+12%	0.46	No
Dissolve reactive phosphorus	-8%	0.38	No

Appendix 2: Representative data indicating lagoon trophic status:

Hamill (2011) summarises monitoring data to show Waituna Lagoon is in a eutrophic state. Examples are presented below in Figures 1 and 2 of total nitrogen and total phosphorus concentrations at the four lagoon sites plotted against guidelines on eutrophic condition (Burns et al. 2000). The plots show eutrophic nutrient concentrations in the lagoon most of the time, and consistently since 2006, with conditions worsening the longer the lagoon is closed to the sea.

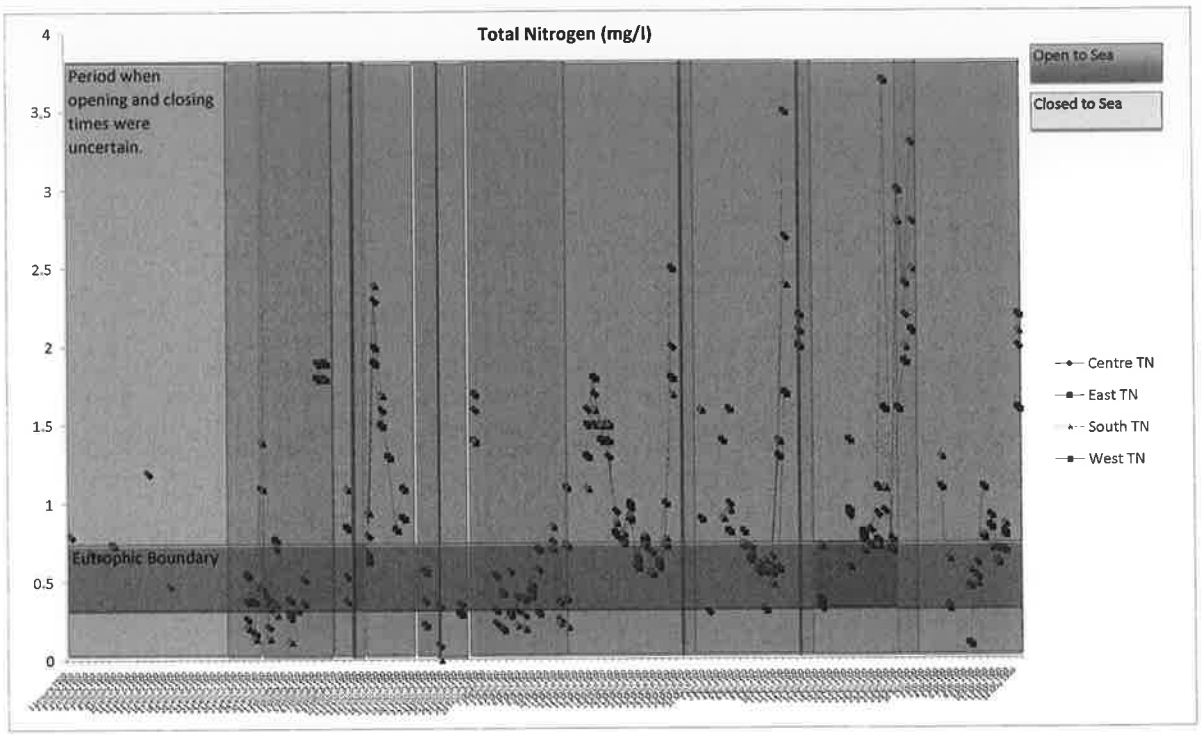


Figure 1: Total nitrogen concentrations at the four lagoon sites (2001-2010). Eutrophic criteria (Burns et al. 2000) shaded in red

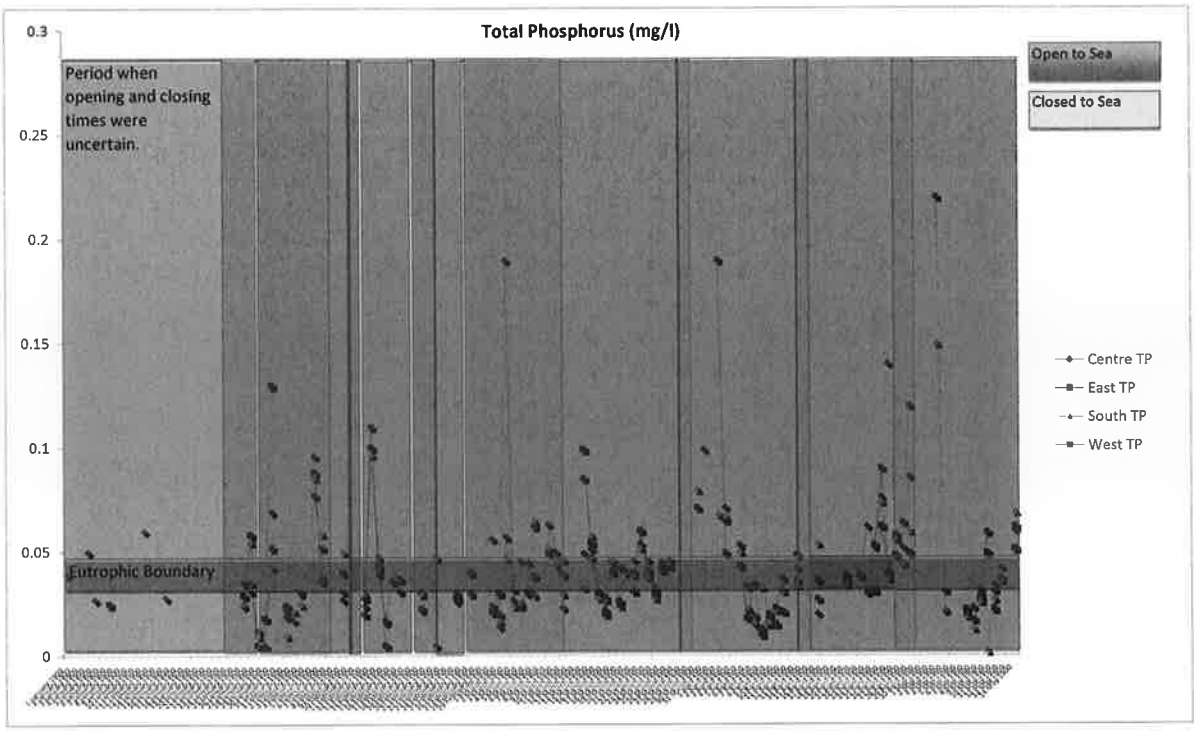


Figure 2. Total phosphorus concentrations at the four lagoon sites (2001-2010). Eutrophic criteria (Burns et al. 2000) shaded in red.

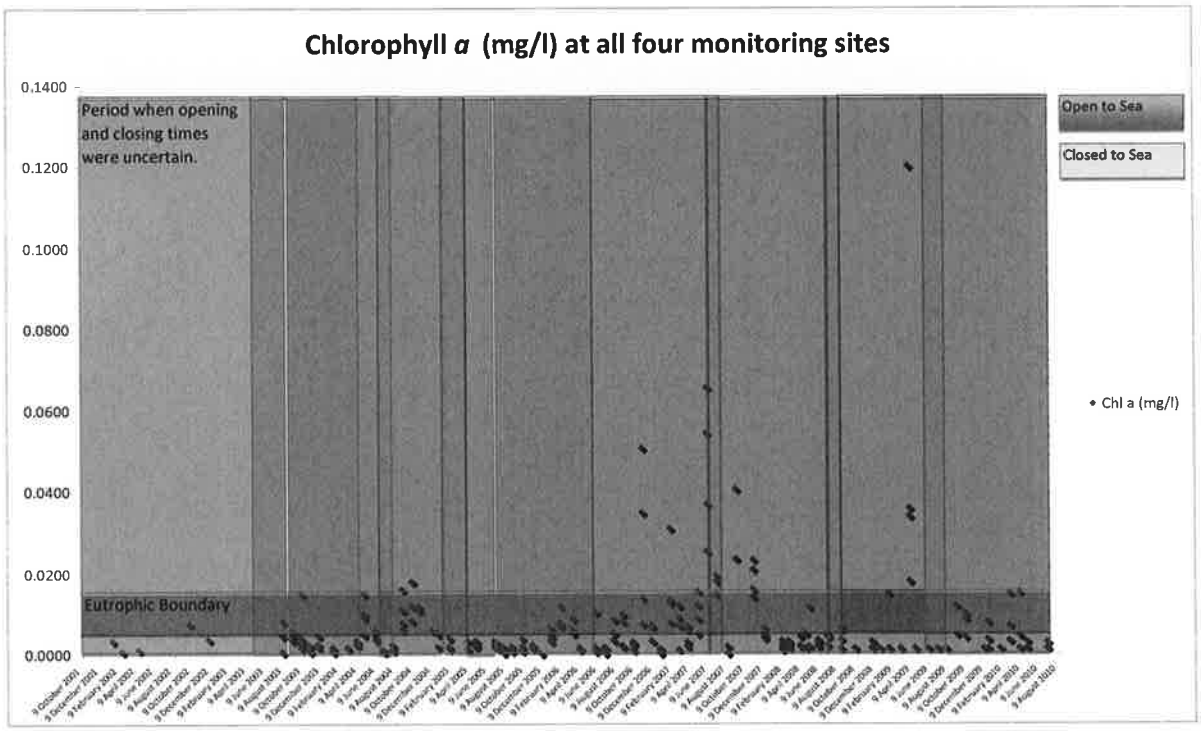


Figure 3: Chlorophyll *a* concentrations at the four lagoon sites (2001-2010). Eutrophic criteria (Burns et al. 2000) shaded in red

Appendix 3: Land use and yield information used to estimate input loads of nutrients and sediment in 1995 and 2009.

Table 3: Land use, N and P yields, septic tank and dairy farm effluent characteristics used to estimate input loads of nutrients and sediment to Waituna Lagoon in 1995 and 2009. Source of yield estimates (Monaghan et al. 2010). Note these estimates are derived from a very simplified approach and do not account for variations in farm practices, soil types, catchment topography and attenuation processes. Source of estimates for septic tanks and dairy ponds from Elliot and Sorrel (2002).

NON POINT LOADINGS	TN (kg/ha/yr)	TP (kg/ha/yr)	2009 Area (ha)	1995 Area (ha)
Dairying Intensive	26	0.80	14204	500
Sheep/beef	10	0.46	1300	15,000
Unimproved Pasture	6	0.17	100	100
Forest (exotic)	3	0.35	640	640
Forest (Indigenous)	3	0.39	3816	3,816
Urban Land use	5	0.50	10	10

	Average Flow	TN (mg/L)	TP (mg/L)	Population equiv.
Septic Tanks	0.4m^3/d/person	28	10	500
Dairy Farm 2 pond system wastewater *	0.04 m^3/d/cow	170	45	20,000

* Final Loadings taking irrigation etc into account (assume 50% of original load)

Appendix 4: Environment Southland Waituna bottom waters Feb. 2011 Monitoring Data (mg/L)

Site	Walker Bay	1km W Carran Creek	Moffat Creek mouth	1.5km E Moffat Creek	Waituna Creek Mouth
Date	2/22/2011	2/22/2011	2/16/2011	2/16/2011	2/16/2011
TN	<0.3	0.3	0.6	<0.3	2.3
NNN	0.002	0.006	<0.002	<0.002	1.5
NH4	<0.010	<0.010	<0.010	<0.010	<0.010
TP	0.079	0.013	0.06	0.015[1]	0.076
DRP	<0.004	<0.004	0.013	0.016[1]	0.019

[1] It has been noted that the results for DRP were greater than that for TP, but within the analytical variation of these methods.

Appendix 5: Range of median water quality within Waituna Lagoon from all four monitoring sites when the lagoon is closed (2005-2010; from Hamill 2011)

TN	TP	Chl *a*
0.78-1.00	0.036-0.042	0.002-0.0037

Strategy and Action Plan for Waituna

August 2015

Department of Conservation
Te Papa Atawbai

Te Rūnanga o NGĀI TAHU

People First
Southland District Council
Te Rohe Pōtae O Murihiku

environment SOUTHLAND
Te Taiao Tonga

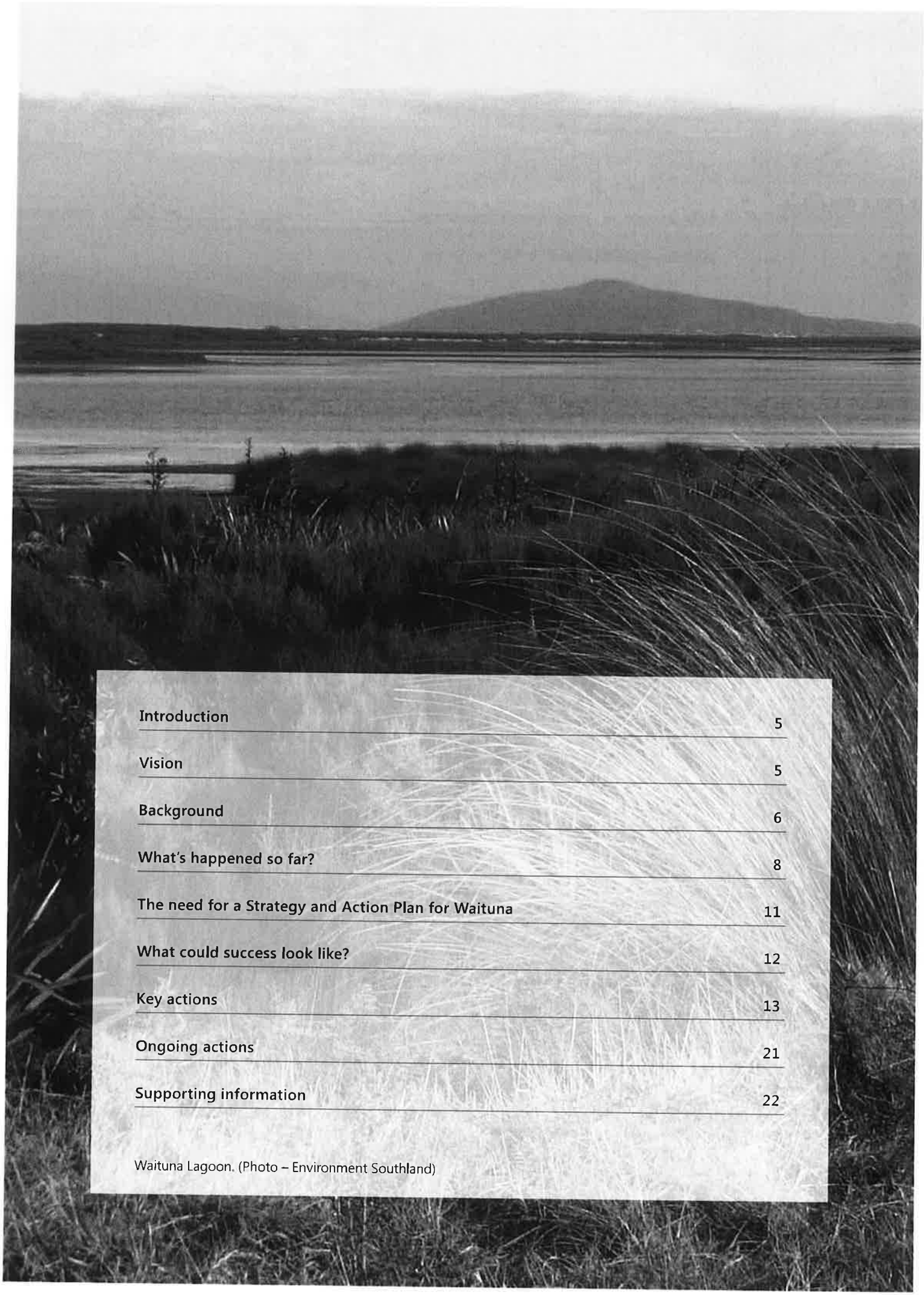
Supported by:

Cover – Waituna Lagoon. (Photo – Environment Southland)

Strategy and Action Plan for Waituna

Defining a pathway for ensuring the wellbeing of the people, the land, the waters, the ecosystems, and the life-force of the Waituna catchment and lagoon, now and for future generations through a partnership approach.

August 2015



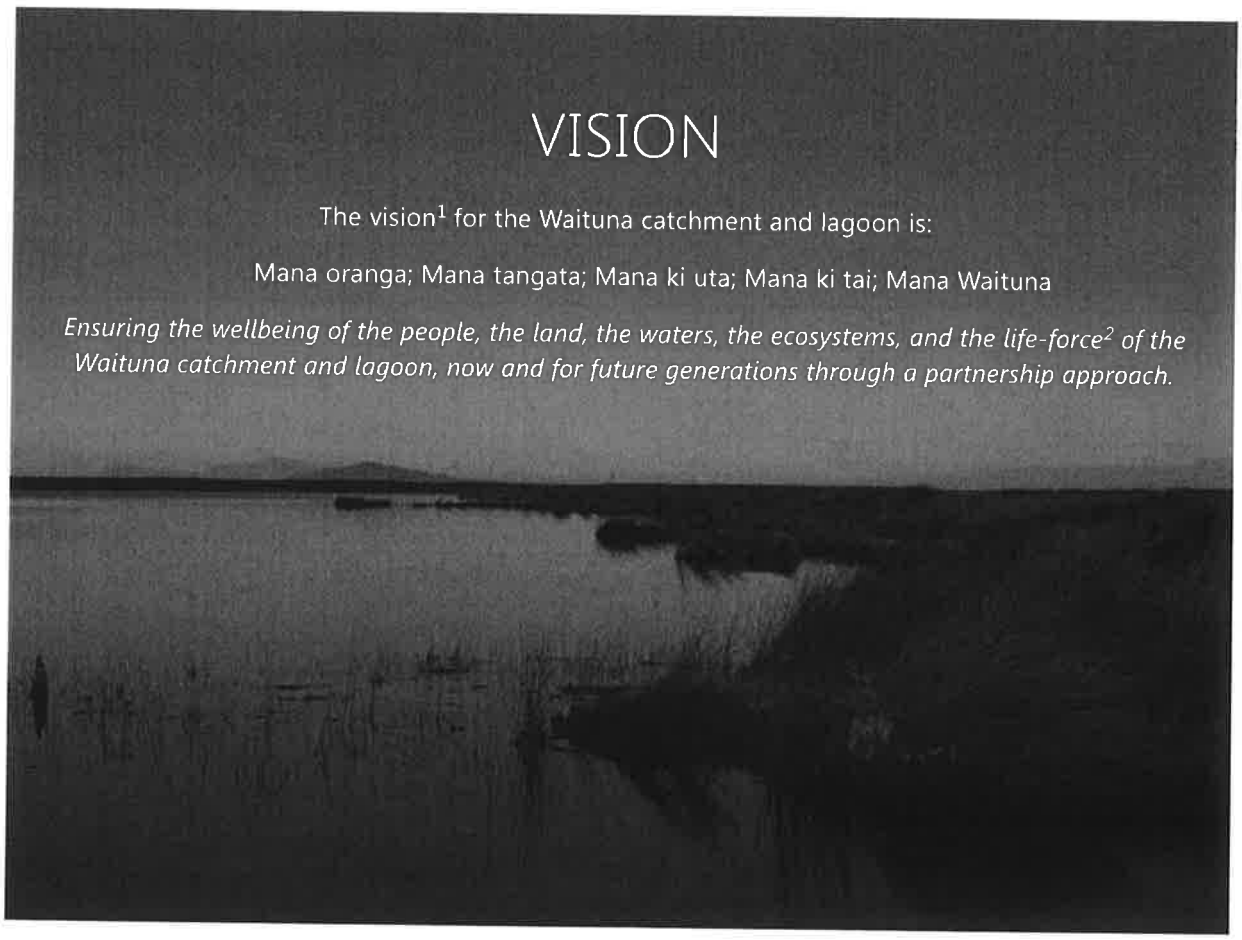
Waituna Lagoon. (Photo – Environment Southland)

INTRODUCTION

This Strategy and Action Plan for Waituna builds on the work that has been done to date and is designed to enable further progress to be made on defining, prioritising and reaching agreement on the next steps for improving the condition of the catchment and lagoon. This is a living document and will be reviewed and updated annually with a report on progress produced.

This plan is in two parts. The first part states the vision, sets the context, describes what has happened so far, outlines why there is a need for a Strategy and Action Plan and defines what success may look like.

The second part identifies goals and the key actions that are proposed to achieve each goal. For each of the actions, the lead and other party(ies) responsible for the action(s) and how progress might be measured are noted. These actions include those that are planned for the short-term and some potential actions that may be undertaken in the long-term (three to five years). A comprehensive Activity Plan in a separate document underpins and provides the detail about the actions. This is also updated regularly.



VISION

The vision[1] for the Waituna catchment and lagoon is:

Mana oranga; Mana tangata; Mana ki uta; Mana ki tai; Mana Waituna

Ensuring the wellbeing of the people, the land, the waters, the ecosystems, and the life-force[2] of the Waituna catchment and lagoon, now and for future generations through a partnership approach.

1 It is important to recognise that the vision and objectives for the Waituna Lagoon are bound by the Ramsar Convention and the requirements of the Ngāi Tahu Settlement Act, Local Government Act, Resource Management Act and various Acts as administered by the Department of Conservation.

2 Life-force is the closest English term that could be used in the translation of this vision. When an environment or living thing's health or wellbeing deteriorates, its ability to function is compromised, becoming sick or dying.

BACKGROUND

Waituna Lagoon is part of the internationally recognised 20,000ha Awarua Wetland. The 1,350ha lagoon and immediately surrounding wetland known as the Waituna Wetland Scientific Reserve (an area of 3,500ha) was designated a Ramsar Wetland of International Importance[3] in 1976, with the wider wetland complex being included in 2008. A key commitment under the Ramsar Convention is to maintain and enhance the ecological health of the wetland.

Waituna Lagoon is one of the largest remaining wetland systems in New Zealand and is made up of a number of nationally significant ecosystems. Its cultural significance to Ngāi Tahu was recognised by a Statutory Acknowledgement under the Ngāi Tahu Claims Settlement Act 1998. The lagoon and wetland have also been a source of food and recreation for the wider community over many generations e.g. fishermen, hunters and trampers.

Waituna Lagoon sits at the bottom of a small (approximately 20,000ha), intensively farmed catchment. Because of many years of land development in the catchment, and changes in lagoon water levels, its health and that of its tributaries is under stress. Land development has included: drainage of wetland areas; clearance of indigenous vegetation; and more recent land use intensification since the 1950s when the main tributaries to the Waituna Lagoon were straightened, and Government schemes cleared and developed land and encouraged other people to do so as well.

Waituna is just one example of a number of lagoons and estuarine systems located at the end of agricultural catchments which are under stress throughout New Zealand. As such, the primary concerns are the loss of nutrients and sediment from land use activities, thus increasing the risk of the lagoon becoming eutrophic, as well as the loss of wetlands through land development. The management of lagoon opening events is important as it influences ecosystem health and farm management practices.

Environmental monitoring shows that the water quality in the lagoon and the creeks that flow into it is under stress. As such, the catchment and lagoon require on-going active management to improve their ecological condition. This is to reduce the risk of the lagoon experiencing a 'regime shift', that is, a change from having clear water and an aquatic environment dominated by aquatic macrophyte plants such as *Ruppia*[4], to one which has turbid and murky water dominated by algal slime and other suspended phytoplankton.

The Waituna Lagoon system is highly complex. Over the last few years there has been significant investment by various parties to develop a greater understanding of the catchment and lagoon. While the level of knowledge has improved dramatically, some of the causes of the water quality decline, and the relationships between land use activities, lagoon openings and lagoon ecosystem health are still not fully understood. Therefore, the agencies and community are taking an incremental approach to undertake actions with known benefits now, whilst continuing to investigate the feasibility of potential actions[5].

3 The Convention on Wetlands of International Importance is known as the 'Ramsar' Convention. It is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Ramsar Convention is the only global environmental treaty that deals with a particular ecosystem. The Waituna Lagoon is particularly deserving of this status because of its extensive range of bird, wildlife, ecological and Ngāi Tahu values.

4 *Ruppia* is a native macrophyte/water plant. Its presence or absence is regarded as a key indicator for the ecosystem health of the Waituna Lagoon and is integral to supporting life in the lagoon.

5 The need for additional action is reinforced not only by the requirements of the recently amended National Policy Statement for Freshwater Management but also by the New Zealand Coastal Policy Statement, Environment Southland's Regional Water Plan and treaty obligations. The Waituna Working Group have also noted that the cost of intervention will be less now than that required if further degradation does occur.

While there is lots of discussion around the environmental concerns at Waituna, the investments families and businesses have made in their land in the Waituna catchment have contributed to the economic and social development of the area, some over a number of generations. Any actions will need to continue to give consideration to the wide ranging values that a wide range of people hold for the Waituna catchment and lagoon, and any legislative requirements.

WHAT'S HAPPENED SO FAR?

In 2001, members of the Waituna community became aware that changing and intensive land use was having effects on the catchment and lagoon and set up the Waituna Landcare Group. Since then the community have held a number of field days to raise awareness about good management practices and worked on projects to improve water quality.

In 2007 efforts were stepped up. With funding assistance from the Government, the Department of Conservation (DOC) Arawai Kākāriki Wetland Restoration Programme[6] supported a number of actions on farms in the catchment. These actions included subsidising riparian fencing, culvert alignment and riparian planting. This was supported by Environment Southland's 'Living Streams' programme.

Another initiative was the joint funding by DOC and Environment Southland of a dedicated Land Sustainability Officer for the Awarua and Waituna catchments to provide targeted advice and assistance to farmers and the community on sustainable land management practices.

By 2011, Environment Southland's State of the Environment reporting (which combined water quality monitoring results with DOC's *Ruppia* monitoring) identified that the health of the lagoon was still under stress. Community and agency efforts took on an added intensity.

With one-on-one support, farmers willingly and quickly made changes to their management practices, often at considerable personal expense. There was an immediate focus on winter grazing management practices for properties with crops beside waterways. This was followed by detailed 'farm-walk' assessments of on-farm practices and the piloting of 'Sustainable Milk Production Plans' for dairy farmers and dairy graziers with support from DairyNZ, Environment Southland and Fonterra staff, and assistance from Federated Farmers. This led to the dairy farming community preparing a Waituna Catchment Action Plan 'Waituna Lagoon and Catchment: dairy farming for lagoon health 2011/2012'. The purpose of this plan was to document the work that the farmers are doing to help to ensure a sustainable future for the Waituna Lagoon and their community. This was updated in October 2012.

On top of this, Environment Southland, with the support of the community, successfully applied to the Ministry for the Environment's 'Fresh Start for Fresh Water Clean-up Fund' to reconstruct stream banks to minimise sediment loss, and to trial constructed wetlands and utilise lagoon opening events to assist with managing nutrient levels.

The 'Sustainable Dairying Water Accord' and its predecessor the 'Clean Streams Accord' have played their part by assisting to get the remaining waterways fenced off on dairy platforms. Fonterra farmers have committed to the environmental modules of the 'Supply Fonterra' programme. This includes fencing of waterways, effluent management, and reporting on nitrogen loss and nitrogen conversion efficiency.

Over time, numerous parties have contributed to the drive that has given this project its ever-evolving momentum, and have also undertaken a vast amount of work over the last decade to learn about the catchment and lagoon, the risks posed to its ecological health and ways to resolve the issues causing the stress.

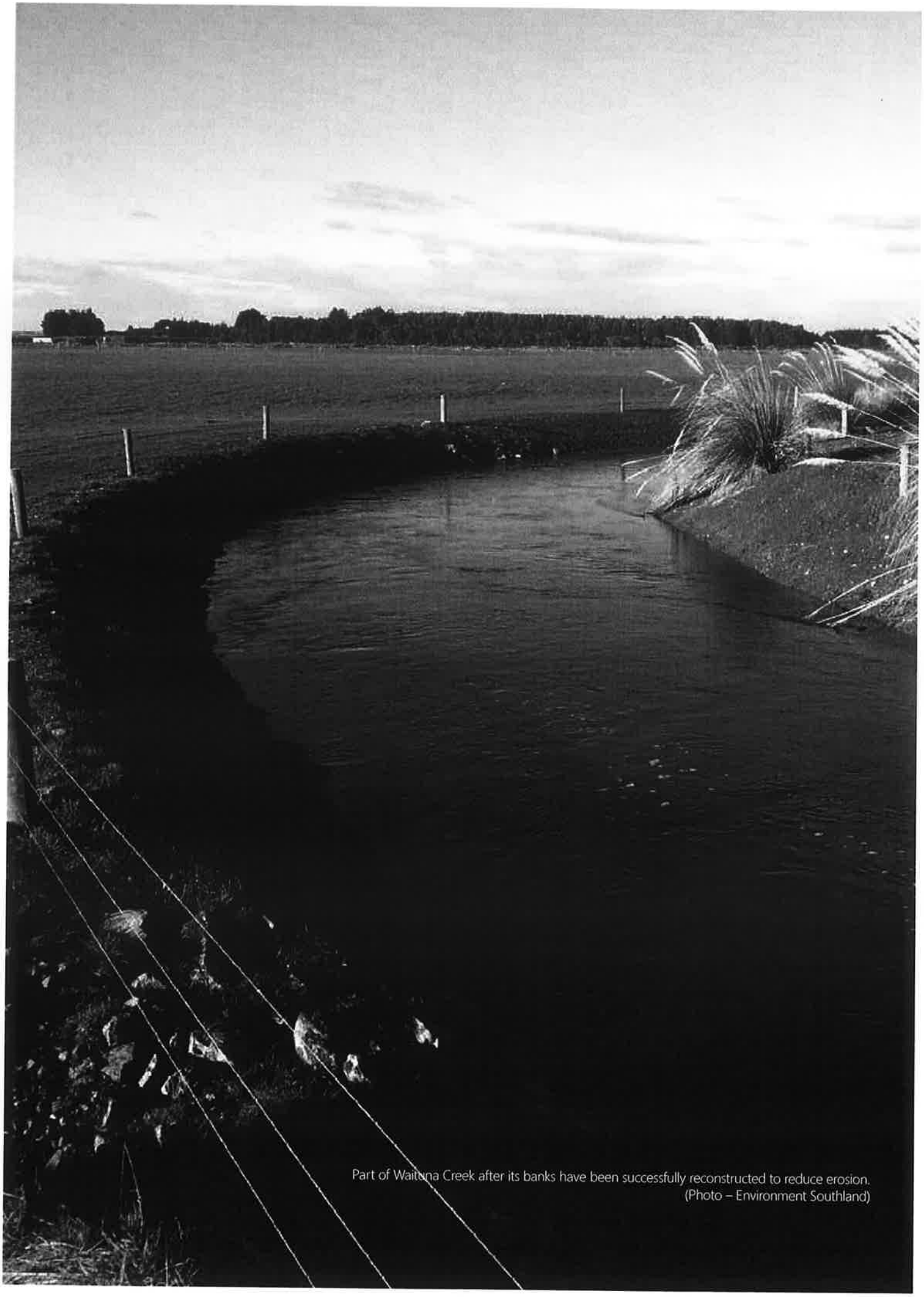
6. The DOC Arawai Kākāriki Wetland Restoration Programme has been working to improve the health of the wetland across the Awarua Wetland since July 2007. The work has included key applied and research projects across the lagoon, wetlands and catchment working alongside the community, Ngāi Tahu, local government and non-government agencies.

A significant cause of the current unstable state of the lagoon is the quantity of incoming nutrients and sediment, through the development and intensification of productive agricultural systems in the catchment. More recent work has shown how the different soil types in the catchment impact upon the nutrient loads from these areas, and the sources of sediment to the lagoon e.g. bank erosion. This understanding will inform the development of actions to reduce nutrient and sediment loads which support sustainable farming and the farming community.

Guidelines and targets prepared by the Lagoon Technical Group identified *Ruppia* as a key indicator of ecosystem health. These guidelines recommended a reduction of nutrients entering the lagoon, with a focus on the protection of *Ruppia* species to maintain and enhance the health of the lagoon.

In 2013, Fonterra and DOC committed to a 10-year Living Water partnership to improve water quality in five key catchments around New Zealand, and the Waituna catchment was one of those chosen.

The Department of Conservation, Environment Southland, Southland District Council, Te Runanga o Ngāi Tahu and Te Rūnanga o Awarua formed the Waituna Partners' Group in August 2013. These organisations have statutory roles in the care and management of the Waituna catchment and lagoon, and signing the Partners' agreement provides a strong commitment to work together for the ongoing improvement of its health and wellbeing. The Partners' Group is supported by a working group made of staff from these agencies, plus the DOC–Fonterra Living Water partnership and DairyNZ. Local landowners assisted the working group with the development of this plan. A formal structure to guide efforts allows for a more comprehensive and coordinated approach and will achieve greater improvements than could be achieved working separately.



Part of Waitōna Creek after its banks have been successfully reconstructed to reduce erosion.
(Photo – Environment Southland)

THE NEED FOR A STRATEGY AND ACTION PLAN FOR WAITUNA

An important component in the development of the plan is to build on work that has already been done to generate confidence, ownership, commitment, understanding and trust between all parties, toward a preferred suite of future actions.

As outlined above, many actions have already been taken. However, if we are to avoid a regime shift within the lagoon a number of additional actions will be needed both immediately and in the future. While there are a number of actions which can be undertaken in the short-term which have reasonably well known and positive outcomes, potential future actions will continue to evolve as more information comes to light and with the development of new technologies and management practices.

One of the purposes of this plan is to provide a vision of the future state of the Waituna catchment and lagoon while also tracking the actions being undertaken by various party(ies) in order to achieve that vision. To do this there needs to be a process with clear deadlines and milestones. It should also be noted that funds, cost sharing and mandate to undertake various actions also need consideration.

The on-going support of the Waituna community is crucial to achieve an improvement in catchment and lagoon health, and to reverse the trend of wetland loss within the catchment. We all have a role to play in improving the health of the catchment and the lagoon.

The need for the plan is reinforced by the Government's adoption of the 2011 National Policy Statement for Freshwater Management. This requires Environment Southland to define 'limits' for achieving objectives in all of Southland's catchments, including Waituna. Environment Southland is responding to this through its Water and Land 2020 & Beyond project. While this plan will inform the limit setting exercise required by the National Policy Statement, it is not about developing Waituna specific rules.

The plan will provide a foundation to facilitate the work being undertaken under the umbrella of the Water and Land 2020 & Beyond project sometime over the next five to ten years. Therefore it needs to recognise the community values for the catchment, the lagoon, and farming in this area.

WHAT COULD SUCCESS LOOK LIKE?

To give life to the vision, these are the things we're aiming to achieve:

OUTCOMES SOUGHT	GOAL/PERFORMANCE MEASURE/S
1. **Thriving communities & sustainable economies**	Healthy people and a vibrant community. Sustainable farming community that ensures their long-term future.
2. **Kaitiakitanga**	Strong relationship between Ngāi Tahu (Awarua Rūnanga) and their culture and traditions with their ancestral lands, sites, waahi tapu and other taonga, and the exercise of kaitiakitanga.
3. **Recreation and sense of place**	Brown trout fishery values, aesthetic appreciation, hunting and other recreational opportunities.
4. **Healthy catchment and lagoon**	Healthy lagoon and wetland ecosystem in which the flora and fauna, for which the Awarua-Waituna is renowned for and recognised under Ramsar, flourish. Abundant and healthy rooted aquatic and wetland plant community in the lagoon, particularly species of *Ruppia* but also wiwi and harakeke (flaxes). Preventing a regime shift from an aquatic plant dominated system to an algal dominated eutrophic system in the lagoon. Catchment and lagoon in such a healthy state that they no longer require the focused intensive attention they currently receive; the focus shifts to sustaining their values and appreciating the positive relationship which exists between the community and the environment in which the community lives. The nutrient and sediment loads to the lagoon are reduced and an opening/closing regime managed so that the lagoon will display some eutrophic conditions rather than be a pristine environment, but will still support healthy macrophyte and fish communities.
5. **Agreed lagoon levels**	Agreed water level management regime for the lagoon which provides for all the values of the catchment.
6. **Mahinga kai**	Abundant and healthy mahinga kai* including: strong kokopu, patiki (flounder), tuna, kanakana (lamprey), waikoura (freshwater crayfish) and inaka (whitebait) populations; a diversity of life as part of a healthy ecosystem; and maintaining healthy recruitment/replenishment of these from the mountains to the sea (ki uta ki tai).
7. **Healthy streams**	Recreation, improved habitat and water quality.
8. **Biodiversity**	Protect, enhance and value biodiversity. Abundant and healthy native fish, plant, invertebrate, reptile and bird populations; protection of wetlands in the catchment as refuges of biodiversity and for the ecosystem services they provide; and lagoon, stream, and wetland ecosystems thrive and support indigenous biodiversity.

* Mahinga kai encompasses the resource harvested, the ability to access the resource, the site where gathering occurs, the act of gathering and using the resource, and the good health of the resource (Tipa 2011).

We are planning to measure, monitor, review and celebrate our successes as we go, and will review the progress annually.

KEY ACTIONS

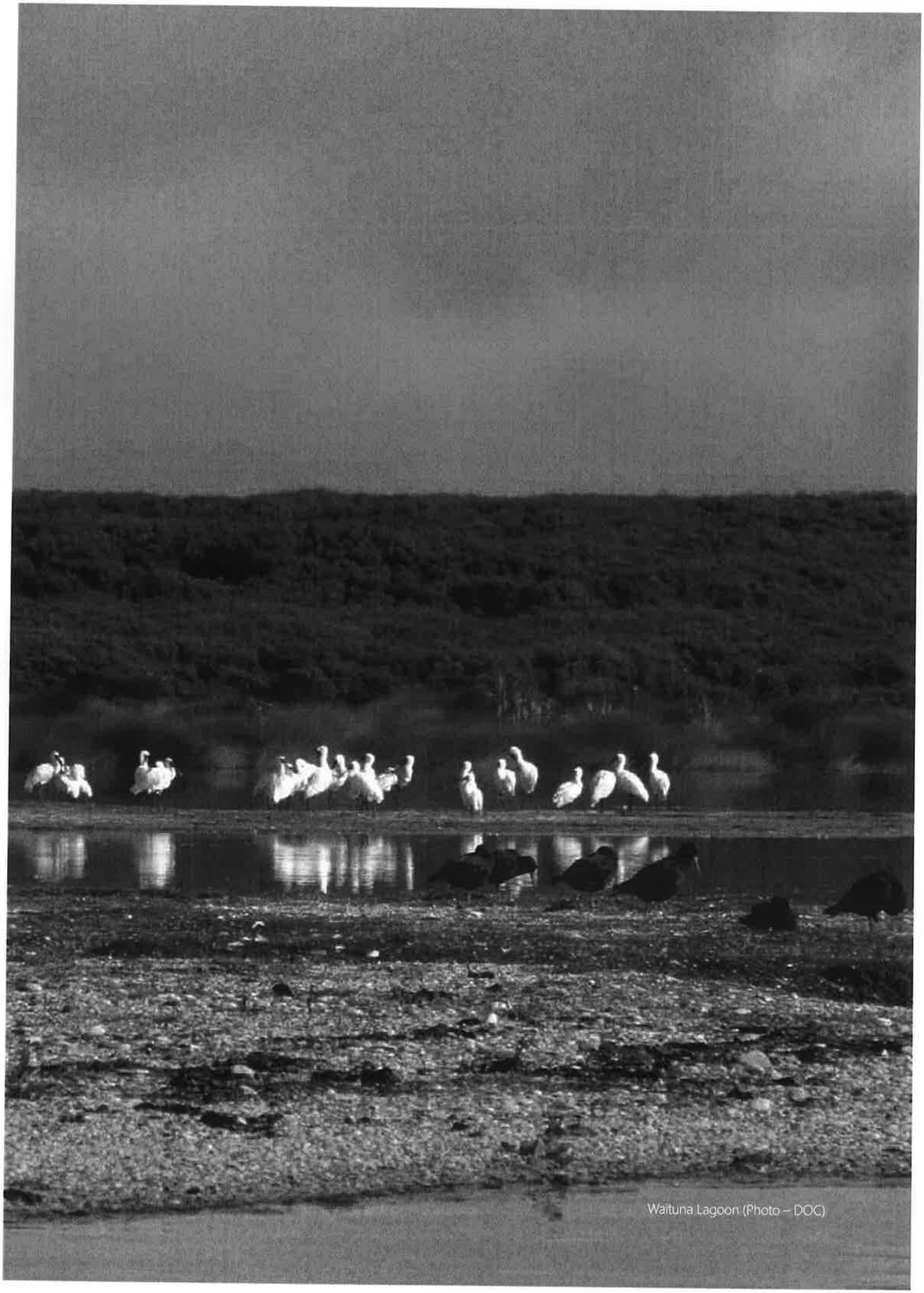
ACTION 1	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Find out what makes the Waituna catchment and lagoon important to people at the individual, community, local and regional levels.	1, 2, 3, 4, 5, 6, 7, 8	• **Environment Southland** in conjunction with all stakeholders	September 2015	• Report completed. • Number of reports this information has fed into. • Community survey on specific values people living, working and undertaking recreational activities in the catchment have.

ACTION 2	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Cultural Opportunities Mapping Assessment and Response (COMAR) project. This work is to provide a Ngāi Tahu whanui assessment on Waituna catchment and lagoon. Mapping in GIS system of place names, mahinga kai and associated histories.	2, 4, 6, 8	• **TAMI (Te Ao Marama Inc) & Te Rūnanga o Awarua** • Department of Conservation • Living Water Partnership	Stage One - 31 March 2015 Stage Two – 30 September 2015 Stage Three – April 2016	• Stage One - Place names, mahinga kai and associated histories in GIS system. • Stage Two – Monitoring and COMAR Plan completed. Ready to start COMAR site work in Spring. • Stage Three – COMAR field work completed, data collected and analysed, report completed.

ACTION 3	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
Undertake research to increase knowledge about nutrient losses by investigating new technologies/ techniques for minimising nitrogen, phosphorus and sediment losses, and the cost/benefit relationships about these, including: • pasture/fodder crop trials; • polishing of discharges from tile drains; • constructed wetlands, including investigation of the effectiveness and costs associated with the development of constructed wetlands and identification of appropriate locations for constructed wetlands within the catchment; • nitrification inhibitors.	1, 4, 6, 7, 8	• **Environment Southland** • **DairyNZ** • **Living Water Partnership**	Ongoing	• Annual reporting by individual parties on results/outcomes of activities undertaken. • Nutrient losses decrease. Water quality improves as a result of these activities.

ACTION 4	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Work with landowners to scope and investigate the potential locations and benefits arising from retirement of land both within the catchment and/ or a buffer area around the lagoon.	1, 2, 3, 4, 5, 6, 7, 8	• Landowners • **Lake Waituna Control Association** • **Environment Southland** • DairyNZ • Living Water Partnership • **Department of Conservation**	30 September 2016	• Soil moisture mapping completed of land surrounding the lagoon at various lagoon levels. • Mapping completed of the sources of nutrients throughout the catchment and the relative contribution to loads to the lagoon. • Potential areas for retirement identified. • Cost/benefit analysis produced for potential areas. • If appropriate, application for government assistance completed.

ACTION 5	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
Minimise environmental risk of effluent storage/ disposal at a farm and catchment level through: • compliance with farm dairy effluent discharge consents; • compliance with industry-led farm dairy and environmental assessments; • implementation of good management practices.	1, 4, 6, 7	• **Dairy farmers** • Environment Southland • Fonterra	At all times	• Number of abatement notices, infringement notices, prosecutions.



Waituna Lagoon (Photo – DOC)

ACTION 6	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Take practical steps to reduce nutrient loads coming into the lagoon from the Waituna catchment. • Managing riparian, winter grazing, and drain maintenance activities according to good practice guidelines. • Preparation of annual nutrient budgets for each farm and, undertake mitigation measures to reduce nutrient loss.	1, 4, 6, 7, 8	• Environment Southland • Southland District Council • Department of Conservation • **Landowners/ individual farmers** • Industry groups e.g. fertiliser representatives, Beef • Living Water Partnership • Waituna Landcare Group	Ongoing	• Ongoing specific water quality monitoring and reporting against baseline to show water quality trends over time within the catchment. • Number of farms with mitigation measures due to dairy conversion rule. • Number of indigenous and vegetation removal consents processed/ managed. • Annual assessment of total catchment nutrient load. • Annual reporting on the length of waterways fenced and length planted. • Length of waterways that have stable banks. • Percentage of farms with nutrient budgets. • Percentage of farms with nutrient management plans. • Percentage of farms with environmental farm plans (or equivalent).

ACTION 7	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Review effectiveness of the current bank reconstruction work and investigate other areas for further works. • Undertake bank stabilisation works to reduce the sediment load to the lagoon. • Implement a wider stream habitat management project to restore in-stream and riparian habitat at priority sites.	1, 3, 4, 6, 7, 8	• **Environment Southland**, with support from Ministry for the Environment's Fresh Start for Freshwater Clean-up Fund and landowners. • Living Water Partnership • Department of Conservation	• Complete current Fresh Start for Fresh Water funded bank reconstruction programme – 30 June 2015. • Undertake further bank reconstruction works as funds become available and individual landowners agree.	• Length of stream bank stabilised. • Photographic record of stabilised banks at long-term photo points. • Length of riparian habitat restored. • Reduction in sediment load in Waituna Creek at State of the Environment monitoring sites. • Monitoring of habitat and native species within both the catchment and lagoon.

ACTION 8	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Investigate options for short and long-term management of lagoon levels with an opening/closing regime. • New consent for management of lagoon opening is in place. (Note: the approval process requires consents and also Department of Conservation approvals given Scientific Reserve Status)	1, 4, 5, 6	• **Lake Waituna Control Association** • **Landowners** • **Environment Southland** • **DairyNZ** • **Department of Conservation** • Iwi • Fish & Game	31 December 2015	• Peer-review report completed – 31 October 2015. • Report prepared which sets out all the values to be considered in the development of the lagoon management regime – 31 December 2015. • A workshop convened with affected and interested parties. • Areas affected by different lagoon levels mapped both in terms of land inundation, elevation of groundwater levels and reduction of drainage efficiency. • The maximum depth of water in the lagoon that can be tolerated by farmers is clarified, and the period for which those higher water levels can be tolerated by the farming community and identify how these impacts affect environmental values • Option confirmed for long-term management of lagoon levels. • Relevant resource consent applications lodged.

ACTION 9	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Identify location and extent of existing wetlands on farms and provide guidelines and assistance with protection. • Protection of existing wetlands and indigenous vegetation.	1, 2, 3, 4, 6, 7, 8	• **Environment Southland** • **Living Water Partnership** • **Department of Conservation** • Landowners • **Southland District Council**	Ongoing	• Location and extent of existing wetlands within the catchment mapped. • Options investigated to provide assistance to landowners who wish to protect/enhance/ enlarge their wetlands. • Bed disturbance provisions of the Regional Water Plan in effect. • Biodiversity provisions of the District Plan in effect.

ACTION 10	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Raise awareness of the importance of mahinga kai in the catchment, how it can be accessed and understand the implications for the Scientific Reserve status of the lagoon.	2, 6, 8	• **Te Ao Marama Inc** • Ngāi Tahu • Department of Conservation • Living Water Partnership • Landowners	30 June 2016	• Mahinga kai communications strategy completed and publically available.

ACTION 11	RELATED OUTCOME(S)	BY WHO? (lead party is shown in bold)	BY WHEN?	HOW MIGHT PROGRESS BE MEASURED?
• Monitor the extent of *Ruppia* coverage and investigate the risks for *Ruppia* re-establishment, including viability of existing seed bank, effect of lack of water clarity, and the optimal depth of water.	1, 2, 3, 4, 6, 7, 8	• **Department of Conservation**	30 March 2017	• Peer-review report completed.

ONGOING ACTIONS

In addition to the actions above, the following actions will be continued by the parties responsible:

ACTION	PARTY(IES) RESPONSIBLE
Communicate first and foremost with the Waituna community, but also the wider general public: • progress for the catchment and lagoon; • people's sense of place and attachment to the catchment and/or lagoon; • issues for the catchment and lagoon.	• Environment Southland • Department of Conservation • Industry bodies e.g. Fonterra • Living Water Partnership • DairyNZ • Ngāi Tahu
Improve opportunities for recreational facilities on public conservation land.	• **Department of Conservation**
Provide advice and assistance on good practice for: • riparian management; • nutrient management; • winter grazing; • drain maintenance; • stock exclusion from waterways and wetlands.	• Environment Southland • DairyNZ • Living Water Partnership • Industry bodies, e.g. Beef & Lamb, Fonterra
Monitor the streams and lagoon to determine the nutrient concentrations and loads entering the lagoon.	• **Environment Southland**
Increase public awareness of the importance of wetlands.	• Department of Conservation • Southland District Council • Environment Southland • Living Water Partnership

SUPPORTING INFORMATION

- DairyNZ Southern Wintering Systems Project
- DairyNZ Waituna Work Programme
- Department of Conservation Arawai Kākāriki Wetland Restoration Programme
- Department of Conservation-Fonterra Living Water Annual Operational Plan Summary (2014/15).
- Environment Southland Waituna Work Programme
- Ngāi Tahu Waituna Work Programme
- Supply Fonterra Environmental Modules
- Sustainable Dairying Water Accord – July 2013
- Ecological Guidelines for Waituna Lagoon. Prepared by the Lagoon Technical Group for Environment Southland – December 2013

The mouth of Waituna Creek (Photo – Environment Southland)