BEFORE INDEPENDENT COMMISSIONERS APPOINTED BY THE SOUTHLAND REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND IN THE MATTER	of various resource consent applications for periodic openings of Waituna Lagoon Waipārera by Te Rūnanga o Awarua, the Department of Conservation and the Southland Regional Council (Environment Southland) [the Applicants]
Application No.	**APP-20242456**

Evidence of Ashley David Rabel – Water Quality and Coastal Ecology

on behalf of the Applicants

Dated: 11 July 2025

Department of Conservation | *Te Papa Atawhai*
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Executive Summary

1. This evidence provides context and understanding of how the proposed consent will manage and respond to water quality in Waituna Lagoon. It outlines the current water quality status of the lagoon, describes observed changes in water quality under open and closed phases, and explains the water-quality-related conditions proposed in the consent that would allow mechanical openings to occur.

2. Waituna Lagoon has a long history of being mechanically opened to the ocean. These openings have resulted in two distinct water quality states—open and closed phases. During open phases, a "flushing" effect occurs, where the exchange of incoming seawater and outgoing freshwater improves water quality across most measured parameters. In contrast, during closed phases, the lagoon becomes hydrologically isolated, leading to the accumulation of nutrients and contaminants, and a general decline in water quality.

3. Applying the National Policy Statement for Freshwater Management 2020 (NPS-FM) bands to the lagoon during the closed phase, total nitrogen (TN), phytoplankton (chlorophyll-α), and trophic state index (TLI) are all classified in the D band, while total phosphorus (TP) and planktonic cyanobacteria are graded as C band. During the open phase, TN, chlorophyll-α, and TLI improve by one grade to the C band, TP remains unchanged, and planktonic cyanobacteria improve to the A band. Regardless of whether the lagoon is open or closed, Escherichia coli (E. coli) consistently remains in the A band.

4. Appendix B of the consent outlines water quality triggers for lagoon openings, using both primary and secondary indicators. Primary indicators reflect risks to ecological or human health, while secondary indicators highlight deteriorating conditions or potential for algal blooms. Under Condition 5, the lagoon may be opened when *critical* levels are reached for primary indicators, with flexibility to consider other ecological values and supporting water quality data.

5. The proposed Monitoring Plan for water quality applies methods consistent with Environment Southland's current State of the Environment (SoE) monitoring. While simplified, it is expected to provide sufficient information to guide decisions around lagoon openings.

6. While the proposed conditions of this consent are not just tailored to target water quality outcomes, if granted the consent should not result in further decline of water quality within Waituna Lagoon.

Introduction

1. My full name is Ashley David Rabel.

2. I have been asked by the Applicants to provide expert evidence on their application for resource consents to provide for periodic openings of Waituna Lagoon to the sea.

Qualifications and experience

3. I am employed by Environment Southland as Acting Manager – Science Investigations and Operations. I have worked for Environment Southland since 2022, and prior to my current role, I was the Team Leader for the Aquatic Ecosystems science team.

4. Before joining Environment Southland I was contracted to WAI Wānaka as both a Science Communicator and Science Co-ordinator.

5. I completed an MSc. (Zoology), Post Graduate Diploma (Zoology), and Bachelor of Science (Biological Sciences), at the University of Canterbury in 2014.

6. I have 6 years' experience in the application of science in environmental management between my current and previous role. Until recently, I spent 3 years as the regional representative for the New Zealand Coastal Sciences Society and have been a professional member of both the New Zealand Freshwater Sciences Society and the New Zealand Marine Sciences Society. I have also been a regional committee member for Te Apārangi, the Royal Society of New Zealand (Wānaka).

7. I provided evidence during the hearing process for Plan Change 5 to the Regional Coastal Plan for Southland and co-authored Environment Southland's *Regional Catchment Science Summaries* (2024) and the most recent *Regional Baseline State Report* (November 2023). These reports assess the current state of freshwater and groundwater across Murihiku Southland in relation to regionally proposed environmental targets.

8. I have been involved in Environment Southland's scientific work on Waituna Lagoon since 2022. This has included the collection and analysis of monitoring data to support advice provided to Environment Southland during the use of Section 330 emergency powers—first in January 2024 to respond to an algal bloom, and again in September 2024 to prevent further harm to the lagoon's ecological health.

Code of Conduct

9. Although this is a Council hearing, I have read the code of conduct for expert witnesses as contained in the Environment Court's Practice Note 2023 (the Code). I have complied with the Code when preparing my written statement of evidence.

10. The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence below. The reasons for the opinions expressed are also set out in the evidence below.

11. Unless I state otherwise, this evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

12. For the avoidance of doubt, in providing this evidence as an expert witness in accordance with the Environment Court Code of Conduct, I acknowledge that I have an overriding duty to impartially assist the Commissioners on matters within my area of expertise. The views expressed are my own expert views, and I do not speak on behalf of the Applicants and, in particular, I do not speak for Environment Southland.

Scope

13. I have been asked to provide evidence in relation to water quality and coastal ecology.

14. My evidence addresses the following matters:

    a. A description of the state of water quality in Waituna Lagoon, and how it behaves during open and closed phases;

    b. How the water quality triggers proposed will work to ensure water quality is maintained and how openings can occur if poor water quality occurs;

    c. The appropriateness of the proposed consent for the maintenance of water quality in the lagoon, and;

    d. How monitoring will support the proposed consent conditions.

    e. Comparison of impacts of the proposed consent on water quality compared to "no consent" or natural opening conditions.

Material Considered

15. In preparing my evidence I have read and relied upon the following documents:

    (a) Application documents, technical audits, and s92 responses to requests for information, in particular:
    (i) The technical review of conditions for opening Waituna Lagoon supplied as Appendix A to the consent application.

    (b) The Regional Council Notification report dated 5 August 2024.

    (c) Identification of freshwater and estuarine attributes, baseline state, and current state in Murihiku Southland (Environment Southland, 2023).

    (d) Waituna catchment science summary (Environment Southland, 2024).

    (e) State of the Environment monitoring data collected by Environment Southland.

    (f) The s42A reports including:
    (i) Section 42A report – Te Rūnanga o Awarua, Department of Conservation, Environment Southland, APP-20242456 (Consent Hearing Report)

16. I have visited the Waituna Lagoon site on numerous occasions since 2022.

Submissions considered:

17. In preparing this evidence I have reviewed all the submissions on this proposed consent. I have considered those submissions that directly discussed the water quality, particularly those that discuss nutrient concentrations in the lagoon: A. Egbers, T. Fogarty, C McCrostie, C.R. McCrostie, K. & R. Munro, and Southland Federated Farmers.

18. I agree with the statements that express water quality would benefit from frequent (annual) openings. However, I acknowledge that there are other components of this ecosystem that would be adversely affected, and an opening regime that responds to these multiple values is necessary to manage overall lagoon health.

Current Water Quality in Waituna Lagoon

19. Waituna Lagoon is based at the bottom of the Waituna catchment, and corresponding Freshwater Management Unit (FMU). The FMU is approximately 20,500ha in size with land use mostly comprised of Dairy (~49.3%) and Sheep and Beef (~23.3%) farmland (Waituna Science Summary). In the past 25 years there have been large changes in land use, with a substantial growth in dairy farming (Waituna Science Summary). This change in land use has resulted in increased contaminant loss, putting waterbodies in the FMU under pressure.

20. The most recent state assessment for the Waituna Freshwater Management Unit (FMU) was carried out by Environment Southland in 2023. This assessment evaluated attribute states using NPS-FM methodology for each of the catchment's three main creeks—Moffat, Carran, and Waituna—as well as Waituna Lagoon. The results show that both Moffat and Carran Creeks are in the D band for dissolved reactive phosphorus (DRP) and dissolved inorganic nitrogen (DIN). Waituna Creek was assessed as B band for DRP and D band for DIN. Although nutrient loads were not calculated as part of this assessment, earlier studies indicate that all three creeks carry substantial loads of total nitrogen (TN) and total phosphorus (TP), (Snelder et al., 2021).

21. Assessment of Waituna Lagoon was conducted in two phases: open and closed. A corresponding water quality state was calculated for each phase, as summarised in Table 1. The results indicate that water quality improves when the lagoon is in an open phase.

22. Water quality improves during an open phase due to the incursion of low-nutrient ocean water into the lagoon on high tides, and the discharge of nutrient-rich freshwater from the lagoon immediately after opening and during low tides. This process effectively "flushes" accumulated contaminants out to sea, while also diluting remaining nutrient concentrations within the lagoon (e.g. Schallenberg et al., 2010). Additionally, the resulting saline conditions help suppress freshwater-obligate cyanobacterial species, reducing both their biovolume and measured chlorophyll-a levels (ES monitoring data). These changes occur without any observed alteration in catchment or groundwater inputs.

23. Conversely, when the lagoon is closed—lacking both a discharge point and dilution from ocean water—water quality deteriorates as nutrients accumulate (see Fig. 1). Elevated nutrient levels in the water column promote cyanobacterial growth, which is reflected in increased chlorophyll-a concentrations and biovolume. Until recently, Waituna Lagoon was

Table 1: Summarised attribute states for Waituna Lagoon as presented in the Waituna Catchment Science Summary[1]. The states have been calculated using 5 years data from 2017-2022. The Hauora targets are not those in the consent application but developed and proposed by Environment Southland and Te Ao Mārama Inc on a regional scale.

	Brackish lakes and lagoons (Waituna Lagoon)		
Ecosystem health attributes	Hauora target	Current state (closed)	Current state (open)
Phytoplankton	B	D	C
Total phosphorus	B	C	C
Total nitrogen	C	D	C
Ammonia toxicity	A	B	B
Nitrate toxicity	A	B	B
Macrophytes	B	B	-
Trophic state	B	D	C
Human contact attributes			
E. coli	A	A	A
Cyanobacteria (planktonic)	A	C	A

"-" data not available.

artificially opened on an almost annual basis, typically during winter when water levels were elevated. These openings have contributed to managing water quality by facilitating the export of accumulated nutrients and reducing the risk of eutrophication. However, they have also altered the lagoon's hydrological regime, shifting it from a predominantly freshwater system to a more variable estuarine environment. This transition has had implications for other ecological values, including habitat composition and species assemblages, as outlined in the expert evidence of M. de Winton and Professor M.

Schallenberg. This highlights that while lagoon openings can support certain water quality objectives, they may simultaneously compromise other aspects of ecosystem health, particularly those dependent on freshwater-dominant conditions.

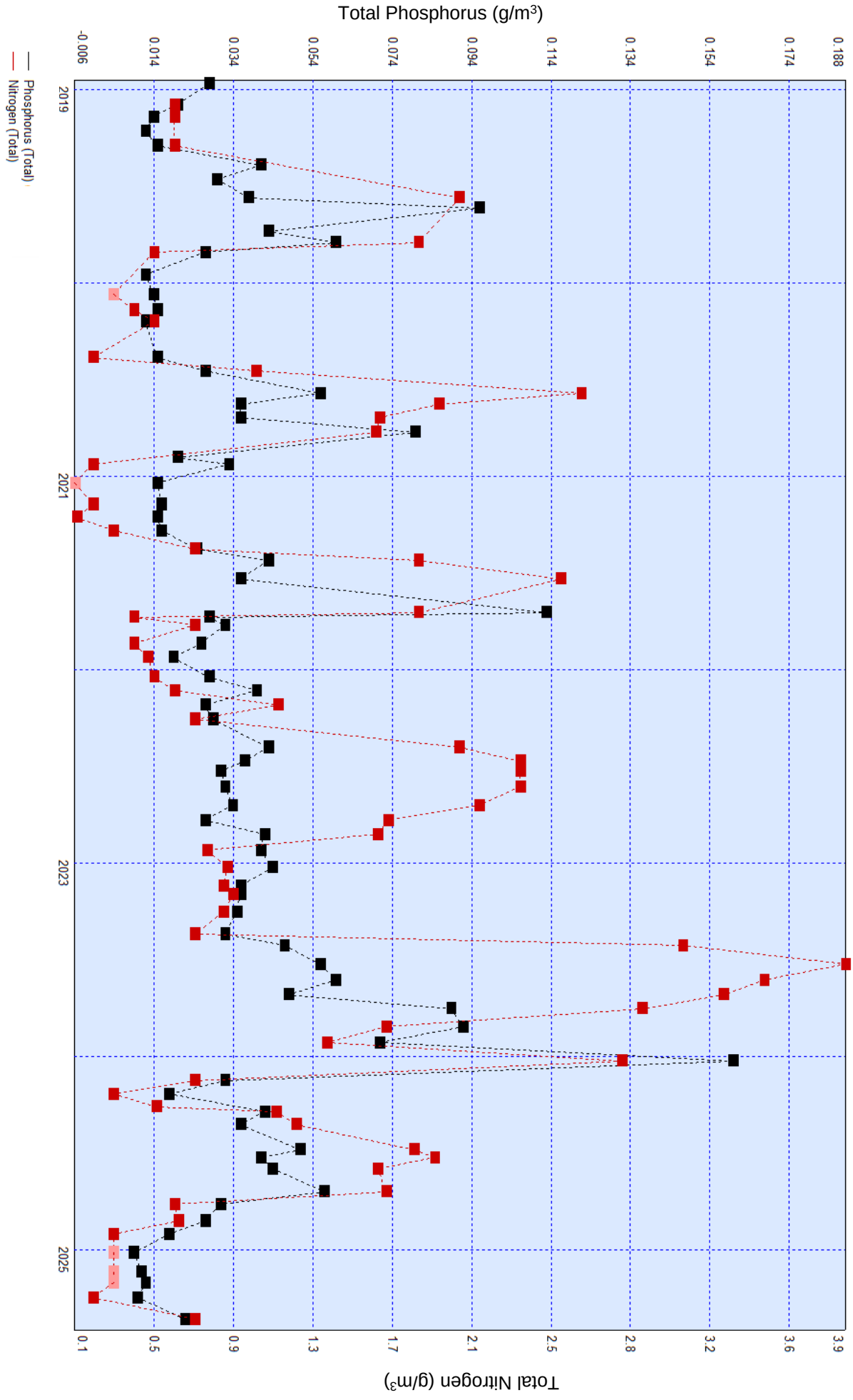


Fig 1. Total nitrogen and total phosphorus concentrations (g/m^3) as measured at Environment Southland's central Waituna Lagoon monitoring location. Data range is from 2019 to May 2025.

Water Quality opening triggers

24. The water quality attributes listed in Appendix 1 and referenced in Condition 6 of the proposed consent are divided into primary and secondary indicators. Primary indicators are directly linked to water quality and signal when intervention is required to maintain ecological integrity or safeguard human health. These include:

    a. **Chlorophyll-*a*** – An indicator of phytoplankton biomass in the water column. Elevated chlorophyll-*a* levels may reflect degraded conditions driven by nutrient enrichment and are a key indicator of trophic state and ecosystem health.
    b. **Cyanobacterial biovolume** – A direct measure of cyanobacteria present in the water column. High biovolume levels signal increased risk of harmful algal blooms and are relevant to both ecological and human health assessments (NPS-FM).
    c. **Bottom-water dissolved oxygen** – A measure of dissolved oxygen concentration near the lagoon bed. Persistent low oxygen (hypoxic) conditions can result from stratification, decomposition, and eutrophication processes, posing significant risks to aquatic life.

25. Secondary indicators are also important for understanding water quality trends and provide early warning of conditions that may lead to adverse ecological outcomes. In the context of the lagoon, these indicators contribute to broader system-level change and are subject to both regional and national management targets. While the ecological implications of these parameters are addressed in the evidence of Professor Marc Schallenberg, I will briefly describe their relevance to water quality:

    a. **Total phosphorus (TP)** – A measure of all forms of phosphorus in the water column, including particulate and dissolved fractions. TP is linked to regional water quality targets and is subject to a national bottom line under the NPS-FM (2020).

    b. **Total nitrogen (TN)** – Represents the total load of organic and inorganic nitrogen in the water column. TN is also regulated by both proposed regional objectives and the national bottom line under the NPS-FM (2020).

    c. **Water clarity (Secchi depth)** – Assessed using a Secchi disk, this metric reflects the vertical clarity of the water column. It serves as a proxy for suspended solids and water discolouration, and provides insight into light availability, which influences aquatic plant growth and ecosystem dynamics.

26. Each indicator in the framework is assigned both *warning* and *critical* threshold levels. *Warning* levels are set within the upper range of historically observed values for the lagoon but are designed to remain above the national bottom lines specified in the NPS-FM (2020), where applicable. These *warning* thresholds act as precautionary signals—intended to alert the applicants before conditions reach historically high or ecologically harmful levels.

27. Reaching a warning level may warrant an increase in monitoring frequency to ensure that any progression toward critical levels is detected in a timely manner. In addition, meeting a warning threshold triggers notification of the Science Advisory Group (SAG), enabling them to review the data and be prepared to provide timely advice to the applicants on the need for a mechanical opening.

28. *Critical* levels represent thresholds where indicator values approach or exceed the upper limits of historical observations for the lagoon but remain below the national bottom lines specified in the NPS-FM (2020). These levels indicate a heightened risk of adverse ecological effects, including increased likelihood of algal blooms, harm to aquatic life, and potential human health risks. When any monitored indicator reaches a critical level, the Science Advisory Group (SAG) is expected to provide formal advice to the consent holders regarding the necessity of a lagoon opening, within 5 days of receiving the results – as proposed by the applicants. Primary indicators are weighted more heavily in this process, and their exceedance may result in a mechanical opening being undertaken as soon as reasonably practicable. Secondary indicators, whilst not having the same weight as primary, may still trigger openings through condition 5 of the consent. This is expected to be done as a precautionary measure to avoid any detrimental ecological outcomes occurring, such as algal blooms driven by high nutrient levels.

29. The proposed trigger indicators should be monitored in accordance with the monitoring plan (outlined below) and assessed against the relevant criteria as results become available. If this process is followed, and the SAG is able to provide timely advice to the consent holders as intended, it should enable proactive management of algal blooms and other significant changes in the lagoon's water quality.

30. While this evidence is focussed on water quality, a range of other ecological, cultural, and social values need to be considered when managing lagoon openings. This is covered in condition 5 of the proposed consent "*One or more of the primary lagoon water quality and ecosystem health indicators in Appendix 1 have reached a Critical Indicator Level, or to*

prevent or mitigate an emergency situation where the ecological and cultural values of the lagoon are under imminent risk of significant decline, taking into account the indicators listed in Appendix 1 and Appendix 2". While this doesn't specify water quality, given the intrinsic link between water quality and lagoon ecological health, this condition should also provide sufficient ability to address water quality issues.

Proposed Lagoon Monitoring programme

31. Each of the attributes listed in Appendix 1 to the proposed conditions is offered to be monitored by the applicants at varying frequencies across four representative sites within the lagoon. For water quality and human health indicators, monthly discrete sampling is proposed, consistent with the National Environmental Monitoring Standards (NEMS). In addition, bottom-water dissolved oxygen is proposed to be measured continuously at a central lagoon location, with logged data retrieved on a monthly basis.

32. Monthly, discrete, monitoring is likely sufficient and achievable by the applicants, provided frequency of monitoring increases in response to any indicator reaching a warning level.

33. Continuous measurement of dissolved oxygen in the bottom waters of the lagoon is advantageous as it will capture daily fluctuations, which is when critical levels may be reached.

34. In the proposed monitoring plan, all samples are to be analysed by accredited laboratories and it is expected that the applicants ensure appropriate protocols are followed. This should provide adequate certainty in the results and provide a level of accuracy necessary.

Comparison of impact of the proposed consent compared to "no consent" or natural openings

35. Due to the lagoon's long history of being opened to the sea on an almost annual basis, there is limited empirical data available to assess the effects of a more natural opening regime—i.e., one with intervals greater than two years. The best available information comes from modelling work by Hamilton et al. (2012), which simulated lagoon health under different opening scenarios. Their model demonstrated that without management intervention nutrient conditions in the lagoon would result in degraded water quality, including increased risks algal blooms, and declines in key macrophyte species, leading to a potential regime shift. These findings highlight the lagoon's sensitivity to nutrient accumulation during

prolonged closure periods and underscore the importance of managing lagoon openings to prevent deterioration in water quality and ecosystem health.

36. Although empirical data remain limited, the lagoon closure exceeding two years from 2022 – 2024 offers valuable real-world insight into these processes. During this extended closure, nutrient concentrations steadily increased, with total nitrogen declining below the national bottom line and TP increasing substantially (Fig 1). This nutrient buildup contributed to a substantial cyanobacterial bloom (Fig. 2), with chlorophyll-*a* levels comparable to those recorded in Te Waihora / Lake Ellesmere (LAWA)—a hypertrophic coastal lake in Canterbury known for frequent algal blooms. This event reflects the water quality conditions that could occur under a natural opening regime with infrequent openings. While the proposed consent incorporates fish passage triggers to prevent similarly prolonged closures, the evidence indicates that longer intervals between openings correspond with progressive declines in water quality, emphasizing the need for the water quality triggers described earlier.

37. By having a range of proposed conditions that allow for the opening of the lagoon, as well as considerations of seasons, the likelihood of negative impacts on the lagoon is reduced. It is my opinion that there will be a positive outcome on water quality through this proposed consent compared to no consent being in place.

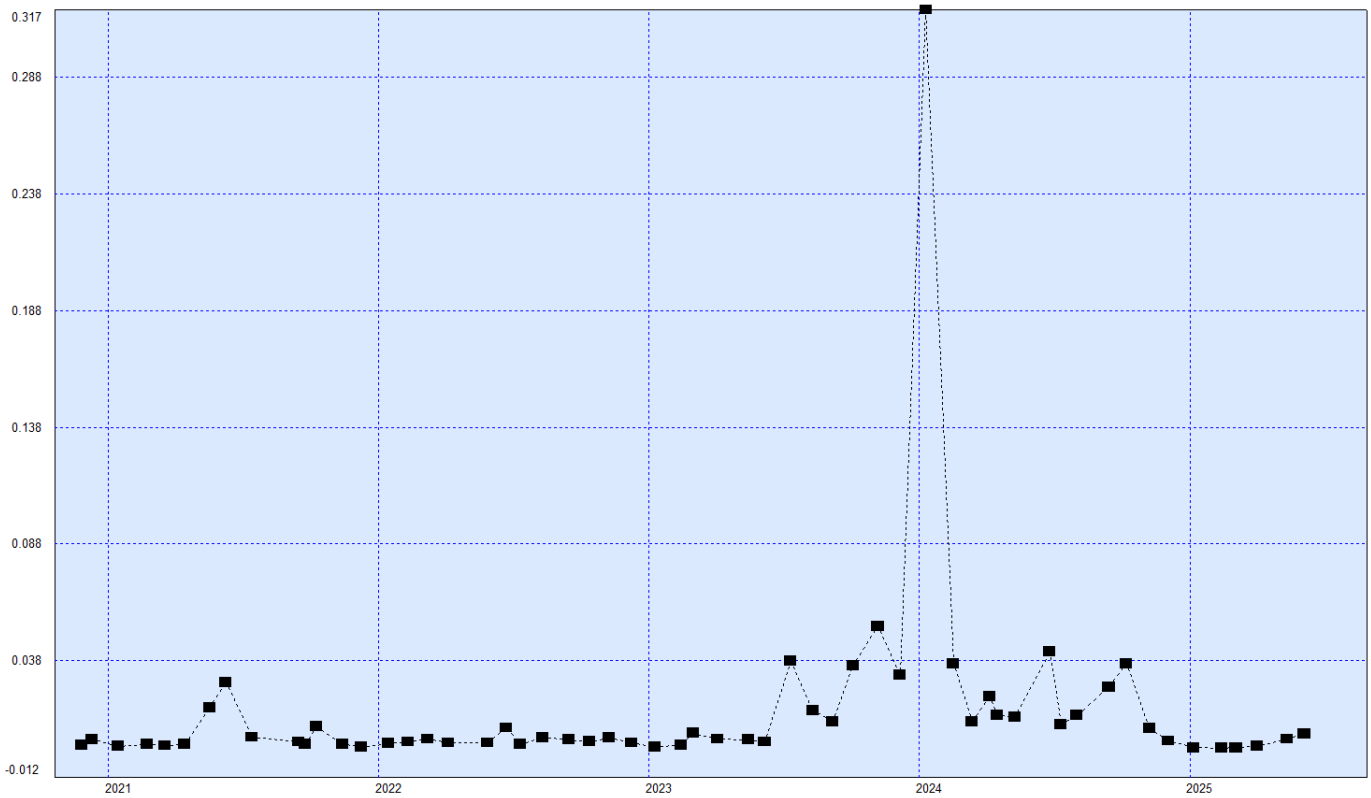


Figure 1: Chlorophyll-a concentrations (g/m^3) in Waituna lagoon from 2012 to Jun 2025. The peak values are those that occurred during the algal bloom in the summer of 2023/2024 and comparable to hypertrophic Te Waihora / Lake Ellesmere.

Section 42A Report

38. I have reviewed the Section 42A report by Ms. Petricevich of SLR Consulting, with particular attention to Section 2.8: Effects on the Environment.

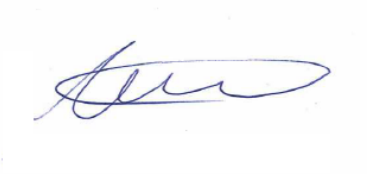
39. Both my assessment and Ms. Petricevich's concur that poor water quality resulting from prolonged lagoon closure presents a substantial risk. We also agree that, overall, the consent conditions are likely to result in net positive effects on lagoon water quality.

40. Although not addressed in my evidence, I agree that suspended sediment should be included in the monitoring plan. While it is unlikely to serve as a primary or secondary trigger for lagoon opening (partially covered by visual clarity indicators), monitoring suspended sediment is valuable for understanding potential adverse effects of opening on water quality.

Conclusion

41. The proposed consent enables lagoon openings based on water quality triggers, particularly when primary indicators (like chlorophyll-a, cyanobacteria, and dissolved oxygen) reach critical levels. This, alongside condition 6, should help maintain water quality by preventing prolonged closures, which are associated with nutrient buildup, harmful algal blooms, and degraded ecological conditions. While total nitrogen and phosphorus are contributors to water quality decline, they are secondary indicators in the proposed consent. This means nutrient concentrations could temporarily fall below national bottom lines without directly triggering a lagoon opening — highlighting a potential gap in water quality management. However, it is acknowledged that there are numerous values to delicately balance when considering overall health of the lagoon.

42. In the absence of any consent (i.e., relying on natural openings), prolonged closures—as observed from 2022 to 2024—could lead to substantial declines in water quality. The proposed consent, with its structured monitoring, thresholds, and expert advisory process, is more likely to protect lagoon health under current and future conditions.



Ash Rabel

Dated 11 July 2025

Appendix 1

	Water quality, biosecurity or ecosystem health indicator	Warning indicator level	Critical indicator level
PRIMARY indicators	Chlorophyll-*a* (a sustained visible algal bloom* over a period of 14 days or longer)	0.012 - 0.06 mg/L	≥ 0.06 mg/L
	Cyanobacteria	Biovolume great than 5mm³/L (and more than 50% of phytoplankton biovolume present as toxic or potentially toxic cyanobacteria	Biovolume greater than 10mm³/L (and more than 80% of phytoplankton biovolume present as toxic or potentially toxic cyanobacteria)
	Bottom water dissolved oxygen concentration	< 2 and ≥ 0.5 mg/L	< 0.5 mg/L
	Incursion of a new non-native species that is a significant biosecurity risk	Incursion of worrisome species but low risk of proliferation	High risk species incursion (eDNA or positive sighting or capture of new non-native species)
Interpretation	* A "visible algal bloom" shall be identified by: (i) A chlorophyll-a concentration and/or (ii) An observations by an appropriately qualified and experienced person. These observations shall include the location and approximate extent and intensity of the visible algal bloom on each day of observation.		

Appendix 2A:

	Water quality or ecosystem health indicator		Critical indicator level
SECONDARY indicators	Total phosphorus concentration	≥ 0.05 and < 0.1 mg/L	≥ 0.1 mg/L
	Total nitrogen concentration	≥ 0.75 and < 1.5 mg/L	≥ 1.5 mg/L
	Water clarity (Secchi disc depth)	≥ 0.5 m and < 1 m	< 0.5 m
	Nuisance epiphytes or benthic algae**	>10% cover	>30% cover
	Macrophytes**	<30% lagoon wide cover abundance	<20% lagoon wide cover abundance
	*Ruppia megacarpa***	Present at <20% of lagoon monitoring sites	Present at <10% of lagoon monitoring sites
	Diadromous fish (inanga, lamprey/kanakana, eel/tuna) density (Waituna Creek)	Declines in diadromous fish populations (density and/or biomass)	Substantial declines in diadromous fish populations (density and/or biomass)
	Toxins/pathogens	Cyanotoxin producing genes in cyanobacteria present, but no cyanotoxins detected. Prolonged level of *E. coli* >260 cfu/100ml and not human source	Cyanotoxins detected across lagoon *E. coli* prolonged level above 1200 cfu/100ml

** Based on the results from annual surveys undertaken in late summer.

Table of primary and secondary attributes referred to for the in the consent application.

References

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