Report – Final

24 September 2025

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From	GHD, Beca & Stantec Consultant Team	**Project No.**	12669824
Project Name	Technical Advice on WW Discharge Standards - Phase 2		
Subject	Responding to request for additional advice on priority items relating to the Discharge to Water Standard		

Dear [redacted]

1. Introduction

The Water Services Authority – Taumata Arowai (herein referred to as Taumata Arowai), under its statutory authority conferred by the Water Services Act 2021, is developing National Wastewater Environmental Performance Standards (The Standards) that will apply to new or renewed resource consents for publicly operated wastewater treatment plants (WWTPs). Consistent with the proposed legislation amendments announced by the Minister of Local Government in August 2024, principally revisions of the Water Services Act 2021, the Resource Management Act 1991, and the Local Government (Water Services) Bill, the proposed changes seek to implement "a single Standard rather than a minimum (or maximum), which would be implemented in resource consents".

The Government's rationale for these amendments is the need to:

- Provide directive provisions that ensure regional councils implement a single Standard approach in resource consents and cannot set additional or higher requirements than the Standard in consenting conditions (apart from on an 'exceptions' basis).
- Allow Taumata Arowai to set infrastructure and operating requirements that, if implemented by a wastewater operator, will meet the treatment requirements in the Standard.
- Allow an easier resource consenting path or 'pre-consented option' for lower-risk small-scale modular wastewater treatment plants that meet the wastewater environmental performance Standard.
- The proposed new approach intends to meet the following objectives of Taumata Arowai:
  - Reduce the regulatory burden by ensuring environmental regulation in water services legislation is proportionate to risk and benefit.
  - Deliver much greater standardisation of treatment systems and related infrastructure.
  - Enable material cost efficiencies in the design, build and operation of wastewater systems.
  - Provide councils with greater certainty of costs.

In line with this policy directive, Taumata Arowai engaged Ernst & Young Strategy and Transactions Limited (EY) and Tonkin & Taylor Ltd (T+T) in early 2024 to undertake a Performance Standards Options Assessment for wastewater discharges to land and discharge to water. The Assessments produced initial environmental performance standards. Feedback received from the Technical Review Group, convened by Taumata Arowai to review and provide advice on the draft Standards, highlighted the need for further technical advice and assurance

that the proposed Discharge to Land and Discharge to Water Standards (which are the two components that make the National Wastewater Environmental Performance Standard) were coherent and practical approaches to consenting of WWTPs.

To undertake this assessment and progress work on the Discharge to Land Standard and Discharge to Water Standard, Taumata Arowai engaged GHD, Stantec and Beca to provide technical advice on specific matters. The additional technical advice was provided in two reports in early 2025 and published on the Taumata Arowai Website[1]. Subsequently a third report was produced in July 2025 by GHD, Stantec and Beca providing additional technical advice on the Discharge to Land Standard regarding Rapid Infiltration Systems (RIS).

Following public consultation on the Discharge to Land Standard and the Discharge to Water Standards, a wide suite of feedback was provided to Taumata Arowai. The feedback was consolidated into themes and ultimately 'Priority Items' that required further consideration. GHD, Stantec and Beca were engaged again to provide additional advice regarding the Priority Items.

1.1 Scope of work

The current scope of work is therefore to provide further advice on the Priority Items associated with the Discharge to Land and Discharge to Water Standards. This scope has been separated into two parts: one focused on the Discharge to Land Standard Priority Items, and another focused on the Discharge to Water Priority Items. This scope is addressing the Discharge to Water Standard Priority Items.

The Priority Items associated with the Discharge to Water Standard have been provided to GHD, Stantec and Beca by Taumata Arowai, and this scope of work has provided technical advice in response to each item. It is understood Taumata Arowai will consider this technical advice, and were considered appropriate, incorporate the advice and any proposed updates into the Discharge to Water Standard.

1.2 Purpose of this report

The purpose of this short form report is to:

– Provide technical advice in response to the provided Priority Items, to support the further development of the Discharge to Water Standard (herein referred to as the Standard).
– Provide information that Taumata Arowai can use to further inform an Order in Council and summarise the rationale for the conclusions reached regarding the Priority Items.

This report should be read in conjunction with the Technical Advice on Discharge to Water Standards report, previously prepared for Taumata Arowai[1].

1.3 Limitations

This report: has been prepared by GHD, and subconsultants Beca and Stantec, for Taumata Arowai and may only be used and relied on by Taumata Arowai for the purpose agreed between GHD and Taumata Arowai as set out in section 1.2 of this report.

GHD and it's subconsultants otherwise disclaim responsibility to any person other than Taumata Arowai arising in connection with this report. GHD and it's subconsultants also exclude implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD and it's subconsultants in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD and it's subconsultants has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD and it's subconsultants described in this report (refer to section 1.4, and throughout this report). GHD and it's subconsultants disclaim liability arising from any of the assumptions being incorrect.

GHD and its' subconsultants have not been involved in the development of the Order in Council prepared separately by Taumata Arowai and has had no direct contribution to the Order in Council other than in the development of this report for the purpose as stated in Section 1. GHD and its' subconsultants exclude and disclaim all liability for all claims, expenses, losses,

[1] **12656252_GHD_REP - Technical Advice on Discharge to Water Standards - REV0.docx** and **12656252_GHD_REP - Technical Advice on Discharge to Water Standards - REV0.docx**

damages and costs, including indirect, incidental or consequential loss, arising directly or indirectly in connection with the Order in Council.

GHD and it's subconsultants have prepared this report on the basis of information provided by Taumata Arowai and others who provided information to GHD (including Government Authorities), which GHD and it's subconsultants have not independently verified or checked beyond the agreed scope of work. GHD and it's subconsultants do not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.4 Assumptions

The following assumptions have been made when providing advice on the Priority Items relating to the Discharge to Water Standards which makes up this document:

- The Priority Items provided by Taumata Arowai are a consolidation of feedback obtained through numerous submissions on the Discharge to Water Standard. The individual submissions have not been reviewed by the Consultant team. Taumata Arowai have provided additional information where relevant.
- Taumata Arowai will provide any response to submissions as they deem appropriate. It is assumed the advice provided in this document will be utilised to inform their response to submissions and any amendments to the Standard. The advice provided for each priority is not intended to be directly used as a response to submissions.
- Iwi perspectives on the Priority Items will continue to be addressed separately by Taumata Arowai.
- The intent of the National Wastewater Standard is to protect against a variety of potential effects in the receiving environment; to adequately protect public health and to enable the maintenance or improvement of receiving environment condition.
- Under current RMA requirements, consent renewals are considered "de novo" which means that the application for a renewal is considered as if it is a new consent application, and it has been assumed that this practice will continue. The assessments undertaken in this report have assumed that any consents issued for treated wastewater discharges will include treatment requirements or other conditions set out in the wastewater standards

The following exclusions apply to this scope of work:

- Specific response to submissions has not been provided.
- Advice on implementation of the Standard and interaction with other legislative requirements is not provided.
- Specific detailed documentation on how to implement the Standard at a design and operational level has not been developed as part of this scope of work.
- Updates to the Standard, or previously provided technical advice reports, is not included in this scope, rather this scope provides additional information to be considered by Taumata Arowai in further progressing the Standards.

2. Priority Items

The Priority Items provided by Taumata Arowai, which are to be addressed in this report, are summarised in Table 1. Each item is specifically addressed in the following subsections.

Table 1 Summary of Priority Items for Discharge to Water Standards and agreed approach.

Nº	Item	Item Description	Proposed Approach to address Item (as agreed with Taumata Arowai)
1	Treatment limits and toxicity	Some treatment limits are based on an annual mean (TSS, BOD_5, TN, TP). For these parameters, Taumata Arowai require advice on a maximum concentration that the discharge may not exceed, and the statistical arrangements that would apply (for example, would this be a daily concentration, weekly mean, 90th percentile, etc). There will need to be tailored / special arrangements for the small plant standard which reflect the less frequent monitoring arrangements associated with those plants. Ammoniacal nitrogen treatment limit is set at 90%th percentile. Taumata Arowai require advice on whether: – there should also be a maximum value (to prevent toxicity in aquatic environment); alternatively, should the approach remain the same as proposed in the discussion document, as this reflects a balance between stricter treatment limits and operational / practical achievability.	Confirm appropriateness of current approach, provide response to calculation of percentiles (compliance period, number of samples and method of demonstrating compliance etc.). Nutrient effects (e.g. eutrophication) have been covered by annual average limits because impacts are generally caused by gradual cumulative build up in a catchment or waterbody over time. Note annual average approach also allows for seasonal variation in treated wastewater quality.
2	Pathogen treatment limits	There was strong feedback across all receiving environment categories that the pathogen treatment limit was too low. It is not clear whether this is because the limits are set too low, treatment plants are able to achieve considerably higher treatment outcomes in practice, or because submitters were comparing "in stream" treatment requirements in consents to "end of pipe" proposals in the discussion document. Taumata Arowai require review of the pathogen treatment limits to ensure the outcome is that for all receiving environments it should result in contact recreational bathing quality. We also require advice on the approach to be taken for pathogen treatment where there is shellfish gathering: – option 1 is for the standard to set out the minimum requirements for a QMRA (structured risk assessment) – this would result in pathogen treatment limits being set by regional council on the basis of the QMRA. If this option is	– Confirm basis for the limits we have proposed. – Cross check with modern consents, and consider what the implications are if we change them – Consultant team continues to support Option1 and questions the applicability of Option 2. It will likely have significant implications for level of treatment and therefore cost for WWTP plants. – Consultant team will review and provide science-based justification for advice. – Consultant team to establish minimum requirements for QMRA (which will need to consider model requirements). Full QMRA approach would require a hydrodynamic model (to stand up in a hearing). An additional 1-hour workshop with Taumata Arowai to discuss this topic further, including how QMRA could apply to Freshwater.

N°	Item	Item Description	Proposed Approach to address Item (as agreed with Taumata Arowai)
		chosen, we will require advice on the minimum requirements for a QMRA to be included in the Order in Council; option 2 is an approach where there is no risk assessment. This would mean that, where a discharge point is within 4km of an existing shellfish bed, there is a set pathogen treatment ("shellfish harvesting treatment limit").	Following the meeting on 1 July 2025 between Taumata Arowai and the Consultant Team, how the QMRA item affects small schemes need to be considered but is the 'parking lot' (i.e., is not addressed within the current hour allocation).
3	Open ocean receiving environment treatment limits	There was strong feedback that open ocean receiving environment treatment limits are set too low (the criticism is that the outcome of these treatment limits could be partially or untreated wastewater being discharged). Taumata Arowai require: – review of treatment limits in existing consents to ensure the proposed open ocean treatment limits are commensurate with existing modern arrangements; – consideration of whether the Order in Council could specifically require secondary treatment (consistent with the approach in the EU directive for urban wastewater treatment); following review, advice on whether open ocean treatment limits are appropriate or need to be changed.	– Consultant team to investigate existing modern consents. – From existing consents review treatment limits. – Consideration of secondary treatment will be done through consent review We note that modern consents may have set treatment limits on the basis of being influenced by community expectation and may not be solely science based.
4	Plants in low energy coastal receiving environment category	Some councils have identified treatment plants in submissions they consider are currently in the low energy coastal receiving environment category – in the opinion of these councils, the receiving environments these plants discharge to are high mixing / dynamic environments and they belong in the open ocean category. Taumata Arowai require review of these plants and the nature of the receiving environment, to determine whether the arrangements are appropriate and if options for change are required. Taumata Arowai will provide a list of the plants (Bluff and Timaru). There may need to be direct contact with these councils and Taumata Arowai can facilitate that.	Review the category definition and carry out high-level assessment for Bluff and Timaru based on existing information provided by Councils.
5	Very low dilution receiving environment category	The existing proposal in the discussion document is that plants discharging to very low dilution freshwater environments are an exception to the standards framework – consents will be subject to standard RMA processes. A decision has been made that these plants discharging to this category of receiving environment will be subject to the discharge to water standard. Taumata Arowai therefore require advice on the treatment limits that will apply to plants in this	– Review current plants in this situation (e.g., Pukekohe, Beachlands, examples provided by Taumata Arowai etc.) and the technology types present – Note that to meet NPS outcomes of no further degradation and improvement of stream health, this would mean that the quality of the discharge would be very high i.e.: even

N°	Item	Item Description	Proposed Approach to address Item (as agreed with Taumata Arowai)
		category. This would include advice about whether any special arrangements need to apply for small plants. Taumata Arowai can provide some additional information about high performing plants in this category that are in submissions and contact other councils with plants in this category.	meeting the receiving environment standards set out in the NPS bottom lines and Regional Plans. – Consider low dilution treatment categories and consider whether lower limits can be set at a level that is achievable by technology. This would be unlikely to meet the point above. – Review international example which had limits for very low dilution categories. – Consider any special arrangements needed to apply for small plants – Additional 1 hour workshop with Taumata Arowai to discuss progress/direction Note: Consortium to go away and think about this further, including small plants and provide updated approach for discussion with Taumata Arowai.
6	Standardisation of treatment arrangements for plants discharging to hard bottom streams / periphyton risk assessment	The existing proposal in the discussion document is that TN and TP limits for plants discharging to hard bottom freshwater environments will be determined through a periphyton risk assessment. A decision has been made to standardise the arrangements for determining treatment limits for these plants. Taumata Arowai will require advice on how to achieve this. This will include consideration of the proposal made by Manawatu District Council (which is, in summary where a chlorophyll level linked to the attribute state for periphyton in the NPS FM is present, set TN and TP limits will apply).	– Review the proposal made by Manawatu District Council. – Have an internal workshop to work through proposal and approach. – Note - we expect this will be very tricky because the current limits related to periphyton are **very** low. 0.001 and 0.007 for band A and B for nitrogen. Additional 1-hour workshop with Taumata Arowai to discuss approach before completion of task
7	Small Plant Standard	Provide advice on an effective, practical consent condition for desludging of ponds based on proposals in submissions (likely to be depth measure rather than periodic desludging).	Obtain and review current consents and current O&M Plans, leverage expertise in the team, and collate outcomes to provide advice.

It is noted that these Standards are proposed as consented limits. Actual performance of a WWTP (and a design target) will need to achieve lower concentrations to ensure compliance (i.e. limit in the Standard will require lower design quality targets which incorporate a risk factor to allow for inevitable variability in treated wastewater quality). This is especially important for plants that experience colder climates or peaking in population.

3. Treatment Limits and Toxicity (Item 1)

Alignment of this priority item, with other priority items, was required following the initial draft submission of this report. To streamline how these alignments were made, a singular section collating the alignment of proposed limits across all priority items has been included at the end of this report, refer to Section 10. Updates to the content of this section, particularly Table 3, are therefore captured in Section 10 of this report.

This section provides responses to Priority Item 1, as outlined in Table 2. The following sections present comments and recommended actions.

Table 2 Priority Item 1 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
1. Treatment limits and toxicity	Some treatment limits are based on an annual mean (TSS, BOD_5, TN, TP). For these parameters, we require advice on a maximum concentration that the discharge may not exceed, and the statistical arrangements that would apply (for example, would this be a daily concentration, weekly mean, 90th percentile, etc). There will need to be tailored / special arrangements for the small plant standard which reflect the less frequent monitoring arrangements associated with those plants. Ammoniacal nitrogen treatment limit is set at 90%th percentile. We require advice on whether: there should also be a maximum value (to prevent toxicity in aquatic environment); alternatively, should the approach remain the same as proposed in the discussion document, as this reflects a balance between stricter treatment limits and operational / practical achievability.	Confirm appropriateness of current approach, provide response to calculation of percentiles (compliance period, number of samples and method of demonstrating compliance etc.). Nutrient effects (e.g. eutrophication) have been covered by annual average limits because impacts are generally caused by gradual cumulative build up in a catchment or waterbody over time. Note annual average approach also allows for seasonal variation in treated wastewater quality.

3.1 Treatment Limits for TSS, BOD_5, TN and TP

Following a review of the previously proposed limits for Total Suspended Solids (TSS), Carbonaceous Biochemical Oxygen Demand (BOD_5), Total Nitrogen (TN), and Total Phosphorus (TP), we propose the additional inclusion of 90th percentile (90%ile) limits for TSS and $cBOD_5$, as detailed in the table below (Table 3). The purpose of these 90%ile values is to provide an appropriate upper limit (see section 3.2, which explains why the use of maximum values are not appropriate).

The 90%ile values have been derived using a simplified design logic of doubling the median values, which has been observed to be generally appropriate for biological treatment systems. However, this method appears not to be suitable for 'low energy coastal' receiving environments as the resulting 90%ile values would exceed environmentally acceptable thresholds. Therefore, using technical judgement and experience, we have reduced this value compared to other 90%ile values to meet the thresholds.

Note, Table 3 has been replaced by the updates presented in Section 10, please refer to Table 24 to Table 27 presented in Section 10 for the most up to date information. Whilst some limits remain unchanged, the superseded information in Table 3 has been struck out.

Table 3 Parameters covered by the discharge to water standard. Refer to Section 10 for the updated version of this table.

Parameter	Lakes	Rivers (low dilution)	Rivers (moderate dilution)	Rivers (high dilution)	Estuaries	Low energy coastal	Open ocean
$cBOD_5$ median (mg/L) (existing value)	15	10	15	20	20	~~50~~	Not applicable
$cBOD_5$ 90%ile (mg/L) (additional value)	30	20	30	40	40	~~70~~	Not applicable
TSS median (mg/L) (existing value)	15	10	15	30	25	~~50~~	~~Not applicable~~
TSS 90%ile (mg/L) (additional value)	30	20	30	60	50	~~70~~	~~Not applicable~~

For TN and TP, we recommend maintaining the currently proposed annual median values and have not suggested an upper 90%ile value. The primary reasoning for this is that the general nutrient and eutrophication type effects (from TN and TP) are a relatively long-term issues which relate to the "typical" load rather than a transitory increase in load. This is reflected in the relevant guidelines that relate to nutrient effects which are for average conditions. A portion of TN is related to toxicants (e.g. ammoniacal-N and nitrate-N), however ammoniacal-N is controlled through the specific ammoniacal-N limit and nitrate-N can be controlled through the overall TN limit (given this form of nitrogen is commonly a lesser component, percentage wise).

Ninety percentile limits have been added for $cBOD_5$ and TSS based on our technical experience of what can be reasonably expected from biological treatment systems and their inherent variability in performance.

Refer to Section 10.2 for information on additional changes made to the Open Ocean limits, and Section 10.3 for information on changes made to the low energy coastal limits. These further changes were made in response to further feedback from stakeholders.

3.2 Treatment Limits of NH_4-N

3.2.1 Ammonia toxicity

The United States Environmental Protection Agency (USEPA, 2013) provides scientifically derived acute and chronic water quality criteria to protect aquatic life from ammonia toxicity. These thresholds reflect sensitivity to un-ionised ammonia and are based on standard conditions of pH 7 and temperature 20 °C.

- The acute criterion is set at 17 mg/L total ammonia nitrogen (TAN), representing a 1-hour average concentration. This threshold should not be exceeded more than once in three years, to prevent short-term toxicity effects.
- The chronic criterion is defined as 1.9 mg/L TAN, based on a 30-day rolling average. To account for short-term peaks within this period, the highest 4-day average must not exceed 2.5 times the chronic limit (i.e., 4.8 mg/L TAN). Like the acute threshold, these chronic limits should not be exceeded more than once every three years.

In New Zealand, ammonia trigger values for the protection of freshwater species are outlined in the ANZG (2018) for aquatic receiving environments. These values are based on chronic toxicity data collected from five aquatic animal species (including species native to New Zealand) representing four different taxonomic groups. The recommended thresholds are designed to protect 95% of aquatic species from the toxic effects of ammonia exposure. The freshwater trigger value for total ammonia-N is 0.9 mg/L at pH of 8 (temperature is not taken into consideration).

The updated National Policy Statement for Freshwater Management (NPS-FM, 2024)[2] outlines ammonia attribute states from A (representing a high level of aquatic protection) to D (indicating conditions below the nationally acceptable threshold). These classifications aim to limit ammonia's toxicity and support ecosystem health. The national bottom line (boundary between attribute states C and D) is defined by **annual median** and **95%ile** concentrations of 1.30 mg/L and 2.20 mg/L of total ammonia-N, respectively, measured at pH 8 and 20°C. These thresholds correspond to the protection of 80% of aquatic species.

It is important to note that under the previous version of the NPS-FM (2020), ammonia attribute states, ranging from A to D, were defined using **annual median** and **maximum** concentrations of 1.30 mg/L and 2.20 mg/L of total ammonia-N, respectively. In the updated version of the NPS-FM (2024), the **maximum** concentration has been replaced by the annual **95%ile**.

3.2.2 Sampling error in wastewater monitoring

Wastewater treatment plants operate as complex biological systems. Their performance can be affected by a range of factors. These include staff-related challenges (e.g. injuries or absence due to health issues), sudden changes in the type or amount of incoming wastewater (such as toxic spills or heavy industrial loads), and analytical inaccuracies (e.g. performance issues due to laboratory error or limitations in detection methods).

According to the United States Environmental Protection Agency (USEPA, 2023), sampling error in wastewater monitoring can be attributed to several factors including:

– Spatial variability: Water quality differs across locations (e.g. influent vs effluent, surface vs depth)
– Temporal variability: Conditions fluctuate over time due to flow changes, rainfall, or operational cycles
– Sampling technique: Errors from improper collection, handling, or preservation can distort results.
– Analytical limitations: Instrument calibration and matrix effects can introduce uncertainty.

3.2.3 Statistical approaches in compliance frameworks

Rather than enforcing strict maximum limits, percentile-based standards are preferred. Percentile standards provide a more realistic and statistically sound method for assessing compliance in biological wastewater treatment systems where occasional variability is expected. Percentile standards help account for occasional spikes in data without classifying a system as non-compliant. However, a maximum value may reduce flexibility and increase the risk of non-compliance without delivering an associated environmental benefit.

Percentile standards are relevant given two key factors that can lead to unexpectedly high sample results[3]:

– Sample contamination or laboratory error, which can occasionally produce inaccurately elevated concentrations
– Variability within the treatment process itself, where not all portions of treated effluent receive identical treatment.

In general, using the 90%ile offers several advantages over applying a maximum value:

– Percentile-based standards are statistically designed to represent the upper range of normal operating conditions, excluding rare or exceptional events
– Biological treatment systems are variable due to factors such as influent fluctuations and operational constraints. A maximum limit may classify a system as non-compliant based on a single outlier, even when overall performance is protective of the environment
– The 90%ile approach ensures that the majority of discharges remain below a protective threshold. When combined with appropriate mixing zone assessments and toxicity benchmarks (e.g. USEPA acute and chronic criteria), it provides robust environmental safeguards. Percentile-based limits are widely used in New Zealand and overseas (e.g. ANZG, USEPA) because they are reliable and work well with risk-based approaches to managing contaminants like ammoniacal nitrogen. Additionally, setting a maximum value can lead to overly conservative design or operational requirements that may not be practically achievable, especially for smaller

[2] National Policy Statement for Freshwater Management 2020 – Amended October 2024
[3] New Zealand Municipal Wastewater Monitoring Guidelines, September 2002

or older plants. Percentile limits help protect the environment while still being practical for treatment systems to achieve.

We therefore suggest maintaining the upper 90%ile values and strongly advise against adopting maximum values.

4. Pathogen treatment limits (Item 2)

Alignment of this priority item, with other priority items, was required following the initial draft submission of this report. To streamline how these alignments were made, a singular section documenting the alignment of proposed limits across all priority items has been included at the end of this report, refer to Section 10. Updates to the content of this section, particularly Table 5 and Table 6, are therefore captured in Section 10 of this report.

This section provides responses to Priority Item 2, as outlined in Table 4. The following sections present comments and recommended actions.

Table 4 Priority Item 2 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
2. Pathogen Treatment Limits	There was strong feedback across all receiving environment categories that the pathogen treatment limit was too low. It is not clear whether this is because the limits are set too low, treatment plants are able to achieve considerably higher treatment outcomes in practice, or because submitters were comparing "in stream" treatment requirements in consents to "end of pipe" proposals in the discussion document. We require review of the pathogen treatment limits to ensure the outcome is that for all receiving environments it should result in contact recreational bathing quality. We also require advice on the approach to be taken for pathogen treatment where there is shellfish gathering: – option 1 is for the standard to set out the minimum requirements for a QMRA (structured risk assessment) – this would result in pathogen treatment limits being set by regional council on the basis of the QMRA. If this option is chosen, we will require advice on the minimum requirements for a QMRA to be included in the Order in Council; option 2 is an approach where there is no risk assessment. This would mean that, where a discharge point is within 4km of an existing shellfish bed, there is a set pathogen treatment ("shellfish harvesting treatment limit").	– Confirm basis for the limits we have proposed. – Cross check with modern consents, and consider what the implications are if we change them – Consultant team continues to support Option1 and questions the applicability of Option 2. It will likely have significant implications for level of treatment and therefore cost for WWTP plants. – Consultant team will review and provide science based justification for advice. – Consultant team to establish minimum requirements for QMRA (which will need to consider model requirements). Full QMRA approach would require a hydrodynamic model (to stand up in a hearing). We suggest an additional 1-hour workshop with Taumata Arowai to discuss this topic further, including how QMRA could apply to Freshwater. Following the meeting on 1 July 2025 between Taumata Arowai and the Consultant Team, how the QMRA item affects small schemes need to be considered but is the 'parking lot' (i.e., is not addressed within the current hour allocation).

4.1 Microbiological water quality standards

There is minimal international precedent for applying end-of-pipe standards for pathogens in treated wastewater (using faecal indicators such as enterococci, *E. coli*, and total faecal coliforms). Most international practices apply receiving environment standards (e.g. bathing water quality) directly to the discharge.

In the current pathogen limit approach, criteria for public health protection were adopted from the Ministry for the Environment's Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE,

2003)[4]. These guidelines establish risk-based thresholds for contact recreation by referencing faecal indicator organisms, *Escherichia coli (E. coli)* for freshwater environments and *Enterococci* for marine settings.

The guidelines establish threshold values based on Microbiological Assessment Categories (MACs), which classify the health risk associated with recreational exposure. **MAC Grade A** represents the highest level of water quality and lowest risk of illness (Sample 95%ile **≤ 130 *E. coli*/100 mL** for freshwater and Sample 95%ile **≤ 40 *Enterococci*/100 mL** for marine waters).

The approach adopted here has been to achieve the MAC Grade A concentration at the end of the adopted zone of mixing for each receiving environment. This has been derived by back calculating the concentration based upon the assumed level of mixing and dilution in each receiving environment category, as described in the following sections.

4.2 Reasonable mixing

The February 2025 Technical Advice on Discharge to Water Standards Report[1] outlined the treatment limit approach for pathogens and assumed a 'full-mixing' scenario, either with the background flow of the river or within a designated coastal mixing zone. In contrast, many existing consents are based on the concept of 'reasonable mixing'. This is less than full mixing and typically measured in a distance from the discharge and subsequent dilution. Examples of reasonable mixing zones outlined in the Northland Regional Plan and Otago Regional Council provisions are summarised below.

4.2.1 Proposed Northland Regional Plan

The approach set out in the Proposed Northland Regional Plan[5] is set out below:

For the purpose of a discharge of a contaminant permitted by a rule in this Plan:

1) *in relation to flowing surface water bodies, a distance downstream of the point of discharge that is the lesser of:*

   a) 200 metres if the bed width of the surface water body is greater than 30 metres at the point of discharge, or

   b) a distance equal to seven times the bed width of the surface water body, but which must not be less than 50 metres from the point of discharge, or

2) *in relation to a lake, wetland or coastal water, a distance 20 metres from the point of discharge.*

For the purpose of a discharge of a tracer permitted by C.6.9.2 Discharge of tracers – permitted activity, the zone of reasonable mixing is the extent of the waters for which the tracer is used to define.

For the purpose of activities that require resource consent, the zone of reasonable mixing will be determined consistent with 1) or 2) above unless the nature or scale of the discharge requires that a case-by-case basis determination is more appropriate, in which case the extent of departure from the zone defined under 1) or 2) above will be determined in accordance with D.4.4 Zone of reasonable mixing.

4.2.2 Otago Regional Council

The reasonable mixing approach set out by the Otago Regional Council[6] is set out below:

For river, modified watercourse, and artificial watercourse locations with flowing water present at all times:

(a) no longer than 200 m along the longest axis of the zone or 10 times the wetted channel width for that location (whichever is the lesser); and

(b) occupies no greater than two-thirds of the wetted channel width for that location; and

[4] Ministry for the Environment. (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Wellington, New Zealand.
[5] https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/
[6] [6] https://www.orc.govt.nz/media/grdbjr2d/memo_mixing-zones-and-receiving-water-standards_rozanne_nov-2023.pdf

(2) For river, modified watercourse, and artificial watercourse locations with intermittent flows: no longer than 20 m at times of flow and 0 m at no flow;

4.3 Treatment limits for pathogens

4.3.1 Initial (February 2025) approach

To determine the initial (as documented in the February 2025 report) proposed pathogen treatment standard, the MAC Grade A thresholds were applied to back-calculate the end-of-pipe treatment limits, using the lowest dilution ratios available for representative freshwater and marine receiving environments.

For example, using the initial approach for Rivers and Streams with Low Dilution (10–50 times) for (*E. coli*): the methodology used the lowest available dilution factor (i.e. 10) to derive pathogen treatment standard. Using the recreational water quality limit of 130 cfu/100 mL (MAC Grade A for contact recreation), the proposed end-of-pipe treatment standard for *E. coli* was therefore calculated as:

Current End-of-Pipe Standard = 130 cfu/100 mL × 10 = 1,300 cfu/100 mL

This approach aligned with a back-calculation method that assumed full mixing.

4.3.2 Amended approach

The proposed pathogen treatment limits were expressed as 90%ile values, which were less stringent than the 95%ile thresholds recommended in the Ministry for the Environment's 2003 Microbiological Guidelines (MfE, 2003)[7]. Hence, upon reflection and following feedback from stakeholders, the initial (February 2025) approach is not considered sufficiently precautionary as zones of 'full-mixing' may still coincide with areas used for contact recreation, potentially exposing users to elevated health risks.

Under an amended approach, it could be assumed that contact recreation may occur within the defined mixing zone, and a partial mixing assumption of 50% could applied rather than full mixing. This approach is more precautionary, considering that the potential exposure of recreational users to contaminants before full mixing occurs.

For example, for rivers and streams with low dilution ratio (10), the recreational water quality threshold of 130 cfu/100 mL (*E. coli*) is therefore adjusted as below:

Amended End-of-Pipe Standard = (130 cfu/100 mL × 10) ÷ 2 (50% of full mixing) = 650 cfu/100 mL

Table 5 and Table 6 below present the initial and amended limits for E. coli and Enterococci in freshwater and coastal environments, respectively.

It is proposed that the more precautionary approach, assuming 50% mixing, is adopted.

Table 5 Initial and amended Limits – Freshwater

Parameter (cfu/100mL)	Lakes and natural ponds (dilution ratio >50)	Rivers and Streams (low dilution, >10 and <50)	Rivers and Streams (moderate dilution, >50 and <250)	Rivers and Streams (high dilution, >250)
Initial Approach – *E. coli* (90%ile)	6,500	1,300	6,500	32,500
Amended Approach – *E. coli* (90%ile)	3,250	650	3,250	16,250

[7] Ministry for the Environment. (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Wellington, New Zealand.

Note, the limits presented in Table 6 have been replaced by the updates presented in Section 10. Please refer to Table 26 and Table 27 presented in Section 10 for the most up to date information. Superseded information in Table 6 has been struck out.

Table 6 Initial and amended Limits – Coastal

Parameter (cfu/100mL)	Estuaries (dilution ratio >50)	Low energy coastal (dilution ratio >100)	Open ocean (dilution ratio >1000)
Initial Approach – *Enterococci* (90%ile)	2,000	4,000	40,000
Amended Approach – *Enterococci* (90%ile)	~~1,000~~	~~2,000~~	~~20,000~~
Note: Additional coastal discharge environment being currently considered. If implemented, the above limits will need to be reviewed.			

Further consideration, based on further feedback, has been made for the basis of the coastal receiving environment pathogen limits, which is described in Section 10.1.

4.3.3 Implications for freshwater and coastal environments

4.3.3.1 Freshwater

The proposed freshwater pathogen limits are defined as 90%ile values, which typically require disinfection treatment to meet the compliance thresholds. UV systems are designed to perform much better than the 90%ile values. Under the amended approach, the limits are more stringent and would likely require enhanced levels of disinfection (such as increased UV dose).

This amended approach addresses potential public health risks by considering exposure within the defined zone of reasonable mixing (assumed to be 50% of full mixing). However, implementation of the revised standards is not expected to result in significant operational or capital expenditure implications.

4.3.3.2 Coastal

Note the information presented in this Section is superseded by the information presented in Section 10 and is retained for information purposes, to demonstrate the progression in rationale for these limits. Please refer to Section 10 for the most up to date information.

In coastal environments, the Enterococci limit for open ocean discharges is set at 40,000 cfu/100 mL (90%ile), a threshold that may not require disinfection in all cases such as some oxidation pond systems. However, a revision to 20,000 cfu/100 mL (90%ile) is expected to require disinfection to consistently achieve compliance.

Estuarine and low-energy coastal environments (where dilution is typically limited) would likely require disinfection under both the initial proposed and amended standards to address pathogen risks.

Adopting an amended open ocean limit of 20,000 as a 90%ile would likely have significant implications, potentially requiring disinfection across <u>all</u> open ocean discharges including those from oxidation ponds. This will likely have further implications in terms of those treatment plants, that currently do not disinfect, requiring disinfection and associated upgrades (such as clarification) to enable disinfection to be effectively implemented. This may not be practicable from an economic perspective.

As requested by Taumata Arowai, we have provided a list of current WWTP's that discharge to the open-ocean coastal environment.

At the time of providing this advice (July 2025), an additional coastal "near-shore" environment was being considered and therefore it is suggested that for coastal environments, the following approach is to be proposed:

1. This additional coastal environment is firstly defined, which would potentially identify a further 'near shore coastal' environment;
2. The revised 'open-ocean' coastal environment is then defined.

3. Based up on the above, provide a revised set of possible amended pathogen limits.

The outcome of this process is presented in Section 6 where the receiving environment is defined and in Section 10 where the final proposed Standards are presented.

4.4 Quantitative Microbial Risk Assessment (QMRA)

A Quantitative Microbial Risk Assessment (QMRA) is an established process to assess the potential public health risks associated with the discharge of treated wastewater to water. It has been widely used in New Zealand for well over a decade as part of the resource consenting process for discharges from wastewater treatment plants[8,9].

Public health risks considered in a QMRA are based on potential modes of exposure at receiving water locations that may be impacted by the treated wastewater discharge from an individual wastewater treatment plant (WWTP). Potential modes of exposure at a given location may include one or more of the following: primary contract recreation (e.g. swimming), secondary contact recreation (e.g. kayaking), or consumption of raw shellfish gathered from the location. Where bivalve shellfish beds are present, consumption of raw shellfish typically has the highest public health risk out of the three potential exposure pathways.

In all cases, public health risks are assessed in terms of individual infection or illness risk for a particular mode of exposure at each location. Where the resultant public health risks are considered unacceptable, mitigation measures are considered to mitigate the risks to below an acceptable level. However, there is not currently a nationally consistent definition for what constitutes an acceptable level of public health risk.

For public health risks associated with **contact recreation** (both primary and secondary), the initial approach proposed under the discharge to water standard is based on an indicator organism concentration limit for each receiving environment category. See response to the first aspect of Item 2 – pathogen treatment limit for further discussion on this aspect.

For risks associated with **consumption of raw shellfish**, a QMRA is proposed based on relevant human pathogen (e.g. norovirus), rather than indicator organism (e.g. *enterococci*), where shellfish gathering beds are within a defined distance from a treated wastewater discharge. To better reflect potential public health risks, site-specific dilutions at receiving water locations where shellfish is gathered are considered along with appropriate pathogen bioaccumulation rates.

The below subsections set out minimum requirements for the Order in Council for a QMRA required under the Discharge to Water Standard for public health risks associated with consumption of raw shellfish gathered from marine waters potentially impact by treated wastewater. The trigger for requiring a QMRA when shellfish gathering beds are within 4km of the treated wastewater discharge was included in the Consultation Discussion Document on the Standards. This distance is similar to that which has been considered in recent QMRAs undertaken for consenting purposes in NZ. It also proposes a definition for an acceptable level of public health risk and considers applicability of the QMRA approach for freshwater.

4.4.1 Minimum QMRA Requirements (Marine Waters)

4.4.1.1 Scope

This section presents recommended minimum QMRA requirements for new and existing discharges to coastal and estuarine waters that could impact ingestion of raw shellfish gathered for recreational use. It is intended to be used to inform the development of the Order in Council, rather than to be a guideline for practitioners carrying out a QMRA.

The following aspects have not been considered:

– Potential impacts of treated wastewater discharges on primary and secondary contact recreation, which were considered as part of the treatment limits for pathogens developed for each receiving water environment (see 4.1 and Section 4.3)

[8] McBride, G (2011). *A Quantitative Microbial Risk Assessment for Napier City's ocean outfall wastewater discharge*, prepared for Napier City Council.
[9] McBride, G (2016). *Health Risk Assessment for Town Reef Shellfish*, prepared for Napier City Council.

- Potential suite of resource consent conditions to incorporate findings, including any treatment requirements, of the QMRA
- Frequency of review of resource consent conditions or QMRA during 35 year consent term
- A specific 'small plant' standard for QMRA. However, the minimum QMRA requirements have been written such that they are applicable for both 'small' and larger WWTPs.

4.4.2 Minimum QMRA Requirements (Marine Waters, Shellfish)

Minimum requirements for a QMRA for the Order in Council are summarised in Table 7, with further commentary provided in the form of supporting guidance notes.

Table 7 Minimum QMRA requirements (Marine Waters, Shellfish)

Element	Minimum Requirement (Order in Council)	Guidance Note
Expertise	QMRA to be undertaken by suitably qualified and experienced practitioner (SQEP), that is 'independent' of the applicant.	– Typically requires input from range of practice areas (i.e. multiple SQEP). – Requires SQEPs to remain up to date with industry best practice
Methodology	Broad approach involves the following steps: – Identify concentration of pathogenic micro-organisms in treated wastewater discharge – Establish fate of pathogenic microorganisms in the environment – Quantify exposure – Determine risk of illness from exposure	– Exposure pathway assumed to be ingestion of raw bivalve shellfish gathered from marine waters – Analysis to be carried out to reflect the likely variations in range of assumed QMRA inputs (e.g. treated wastewater quality, dilution, exposure). Analysis can use a Monte Carlo risk simulation approach or a "worst case" analysis approach. – Minimum inputs required for each step outlined in Table 8. In each case the SQEP is to confirm the appropriate approach to reflect the scale of the potential risks. Adopted value(s) for inputs should be supported by appropriate references.
Output	– Risk of illness for each shellfish gathering location presented in the form of mean Individual Illness Risk (IIR) – Summary report, including any recommendations to mitigate public health risk to below acceptable level.	– Recommendations may include treatment requirements (e.g. minimum UV dose under defined conditions), monitoring requirements (e.g. treated wastewater enterococci monitoring as an indication of UV disinfection system performance)

Minimum inputs required to be considered for key elements of a QMRA are summarised in Table 8 alongside supporting guidance notes. It is important that the minimum requirements in the Order in Council are kept sufficiently broad to reflect the rate of change in this practice area; particular examples are provided with the supporting guidance notes.

Table 8 Minimum inputs required for key elements of a QMRA (Marine Waters, Shellfish)

Element	Minimum Inputs (Order in Council)	Guidance Note
Treated wastewater discharge	WWTP flow	– Consider flows over design horizon of WWTP, range or worst-case. Could include constructing a synthetic future flow dataset (e.g. future 365 day flow profile)
	Human pathogen(s) of concern	– Select human enteric pathogen, such as norovirus, relevant for exposure via shellfish ingestion. – Review available data sources (e.g. site-specific or similar catchments, New Zealand or global) and determine if need to collect data – Consider appropriate range of pathogen concentrations in wastewater under 'normal' and 'outbreak' scenarios

Element	Minimum Inputs (Order in Council)	Guidance Note
		– Given rate of change in this practice area, it is not recommended to specify a particular enteric pathogen of concern or analytical method. Historically rotovirus was considered, however vaccine has resulted in lower prevalence. Some virus can be enumerated via cell culture and PCR, however others cannot at present..
	WWTP reduction of pathogen	– Consider appropriate Log Reduction Value (LRV) of pathogen through WWTP, range or worst-case – SQEP, such as wastewater treatment specialist, to advise on expected LRV for a given wastewater treatment process or series of wastewater treatment processes. Advice should be supported by appropriate references or WWTP performance data .
Fate in environment	Exposure site location(s) of shellfish beds	– Identify locations of shellfish gathering beds. – Typically requires seeking advice from Regional Council, Public Health and local Runanga. It can also involve consultation with the general public where public shellfish gathering is prevalent. – May consider existing and historic kaimoana gathering areas
	Site-specific dilutions in receiving water at exposure site locations	– Consider appropriate dilutions to use in receiving water at location of each shellfish gathering bed. – Typically requires carrying out hydrodynamic modelling to develop 365 day dilution profile under La Nina and El Nino conditions or assessing worst-case dilution at each location. – Assumes no background concentration of human pathogen in receiving waters from other potential sources such as stormwater (i.e. incremental risk associated with WWTP discharge is considered).
	Die-off or inactivation	– State extent of assumed die-off or inactivation in environment for each pathogen of concern, range or worst-case.
Quantify exposure for each site	Exposure route	– Exposure is via ingestion of uncooked bivalve shellfish gathered from the identified shellfish bed location
	Bioaccumulation rate	– Consider appropriate bioaccumulation rate(s), range or worst-case.
	Ingestion quantity	– Consider appropriate meal size for type of shellfish, range or worst-case.
Determine illness risk	Illness risk modelling	– Consider appropriate illness risk model for pathogen of concern and state any additional assumptions (e.g. percentage of infections that continue to illnesses). – State basis of modelling carried out, Monte Carlo or worst-case. For Monte Carlo, state number of model simulations carried out and number of consumers of shellfish exposed per day.
	Illness Risk	– Summarise results of illness risk modelling for each scenario and shellfish gathering location considered. Present results as mean Individual Illness Risk (IIR).
	Acceptability	– Compare mean IIR results to acceptable risk level. See Section 4.4.3. – If required, provide recommendations how to mitigate risk to below acceptable level.

4.4.3 Acceptable Level of Risk

The Ministry for the Environment's Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003)[10] includes a Microbiological Assessment Category (MAC) system for contact recreation in marine waters comprising the following four-tiered scale based on **illness** risk:

– No observed adverse effect level (NOAEL) in most epidemiological studies – taken to be less than one illness in every 100 exposures (i.e. < 1%).
– A detectable increase in risk level above the threshold level for reported illness (LOAEL) – equivalent to an average probability of five illnesses in every 100 exposures (i.e. between 1% and 5%).
– A substantial elevation in the probability of all adverse health outcomes for which dose-response is available – equivalent to an average probability of one illness in every 10 exposures (i.e. between 5% and 10%)
– A significant risk of high levels of illness, i.e. greater than a 1 in 10 chance of illness (or >10%).

NOAEL and LOAEL are associated with suitability for recreation grades of Very Good and Good which are beaches that are satisfactory for swimming at all times and most of the time respectively.

Recent QMRAs prepared as part of WWTP resource consent applications for discharge of treated wastewater to marine waters have often considered that a mean Individual Illness Risk (IIR) from raw shellfish ingestion gathered at all potential exposure site of less than 1% as acceptable.

Hence, for a QMRA carried out under the Discharge to Water standard, it is recommended that the following definition of acceptable level of risk is included in the Order in Council:

– **The acceptable level of risk is defined as being a mean Individual Illness Risk (IIR) from raw shellfish ingestion gathered at all potential exposure sites of less than 1%.**

4.4.4 Applicability for Freshwater

4.4.4.1 Shellfish

Minimum requirements for Order in Council

A QMRA prepared for ingestion of raw freshwater bivalve shellfish gathered at potential exposure sites would follow the same approach as that prepared for coastal and estuarine bivalve shellfish. Hence it is recommended that the minimum requirements presented in Section 4.4.2 apply to bivalve shellfish gathered from both marine and freshwaters.

Similar to marine waters, a QMRA would be required in freshwater where shellfish gathering beds are within a defined distance from a treated wastewater discharge. For marine waters, the defined distance is within 4km of the treated wastewater discharge in the Consultation Discussion Document on the Standards. To provide consistency, a similar defined distance could be adopted for freshwater. To be precautionary, the SQEP should also confirm the minimum upstream and downstream distance to be considered for the QMRA.

Acceptable risk level for freshwater

The Ministry for the Environment's Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003)[10] includes a Microbiological Assessment Category (MAC) system for freshwaters comprise the following four-tiered scale based on **infection** risk:

– No Calculable Risk Level (NCRL) for infection – taken to be less than one infection in every 1000 exposures (i.e. less than 0.1%).
– An increase in risk level above threshold level for infection – equivalent to an average probability of one infection in every 100 exposures (i.e. between 0.1% and 1%)
– A substantial elevation in probability of infection compared to New Zealand background level – equivalent to an average probability of one infection in every 20 exposures (i.e. between 1% and 5%).
– A significant risk of high levels of infection – greater than a 1 in 20 chance of infection (i.e. > 5%).

[10] Ministry for the Environment. (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Wellington, New Zealand.

It is recommended that the acceptable risk level for QMRAs carried out under the Discharge Water standards is based on illness risk, rather than infection risk, and is consistent for shellfish gathered from marine and fresh waters. Hence it is recommended that the definition for acceptable level of risk presented in Section 4.4.3 apply to bivalve shellfish gathered from both marine and freshwaters (i.e. a mean IIR of less than 1%).

4.4.4.2 Mahinga Kai

Two exposure pathways were considered for mahinga kai such as watercress:

– exposure via gathering at potential exposure sites
– exposure via consumption of unwashed mahinga kai gathered from potential exposure sites.

Exposure via the gathering of mahinga kai at potential exposure sites is expected to have a similar public health risk as primary or secondary contact recreation, depending on the nature of gathering.

Exposure via the consumption of unwashed mahinga kai such as watercress gathered from potential exposure sites is expected to have a similar order or lower public health risk as primary contact recreation (e.g. swimming). This is on the assumption that excess water is removed from watercress prior to eating and that the quantity of residual water is of a similar order or less that what swimmers typically ingest, which is an average in the order of 50mL/swim[11].

Exposure via gathering or consumption of unwashed mahinga kai such as watercress is expected to have a similar order (or lower) public health risk as primary contact recreation. Hence, for these exposure pathways it is considered that the indicator organism concentration limits in the Discharge to Water Standard are sufficient and a QMRA is not required.

A QMRA is only required where bivalve shellfish beds are present. As noted in introduction to Section 4.4, where bivalve shellfish beds are present, consumption of raw shellfish gathered from potential exposure sites typically has the highest public health risk out of the three potential exposure pathways (i.e. primary contact recreation, secondary contact recreation and consumption of raw shellfish).

[11] Wood, D., and Hudson, N. (2023). Quantitative Microbial Risk Assessment for Nelson North wastewater treatment plant – Phase 2, prepared for Nelson City Council.

5. Open ocean receiving environment treatment limits (Item 3)

Alignment of this priority item, with other priority items, was required following the initial draft submission of this report. To streamline how these alignments were made, a singular section documenting the alignment of proposed limits across all priority items has been included at the end of this report, refer to Section 10. Updates to the content of this section, particularly Table 11, are therefore captured in Section 10 of this report.

This section provides responses to Priority Item 3, as outlined in Table 9. The following sections present comments and recommended actions.

Table 9 Priority Item 3 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
3. Open ocean receiving environment treatment limits	There was strong feedback that open ocean receiving environment treatment limits are set too low (the criticism is that the outcome of these treatment limits could be partially or untreated wastewater being discharged). We require: – review of treatment limits in existing consents to ensure the proposed open ocean treatment limits are commensurate with existing modern arrangements; – consideration of whether the Order in Council could specifically require secondary treatment (consistent with the approach in the EU directive for urban wastewater treatment); – following review, advice on whether open ocean treatment limits are appropriate or need to be changed.	– Consultant team to investigate existing modern consents. – From existing consents review treatment limits. – Consideration of secondary treatment will be done through consent review – We note that modern consents may have set treatment limits on the basis of being influenced by community expectation and may not be solely science based.

5.1 Open Ocean Limits Included in Discussion Document

The discussion document included a single limit for open ocean discharges of 50 mg/L total ammoniacal-N measured as an annual 90%ile.

A pathogen limit of 40,000 cfu/100 mL for *Enterococci* as an annual 90%ile was also proposed. Pathogen limits were reviewed as part of Item 2 (refer to Section 4) and further considerations of these limits in response to further feedback are captured in Section 10.

The applicability of Quantitative Microbial Risk Assessment (QMRA) is also covered in the response to item 2 (refer to Section 4) and therefore no further comment is provided here on the treatment implications of QMRA.

However, it should be noted that should a QMRA identify a level of disinfection is required to address shellfish gathering ingestion risk, these treatment requirements to disinfect will drive further reductions is in associated contaminants (such as Total Suspended Solids). This co-dependency was identified in the February 2025 technical report that informed the discussion document.

5.2 Potential to Allow Untreated Sewage to be Discharged

Concentrations of total ammoniacal-N in raw sewage typically represent 70-80% of the total nitrogen, and the concentration to total ammoniacal-N can vary widely, depending on the influent source. Concentrations of total ammoniacal-N can vary typically between 12-50 mg/L in moderate strength municipal wastewaters. However, concentrations in some areas, particularly with low water usage, can be up to 100 mg/L.

Raw sewage typically contains very high concentrations of Enterococci bacteria ranging from 100,000 - 10,000,000 cfu/100mL.

Based on the above, the initial treatment requirements for open ocean could be interpreted as providing minimal treatment, if for example, consideration was made to the ammonia limit independently of any treatment requirements associated with QMRA for shellfish.

This was not the intent of the open ocean standard and further consideration is given here to avoid potential misinterpretation. We note that in applying the standards, no one parameter is viewed in isolation. All must comply.

The rationale for the limits is as follows:

- The open ocean limit of 40,000 cfu/100mL has been derived based upon assumed dilutions and whilst some long residence time ponds may not require disinfection to achieve this end of pipe limit many plants will.
- The nearshore coastal, low energy coastal and estuaries/harbour Enterococci limits will most likely require disinfection.

It is noted that the requirement for QMRA for shellfish risk will drive stricter limits when these public health risks are present in the receiving environment.

For the open ocean limit, with the exception of ammoniacal-N which can typically be around 45 - 55 mg/L in the treatment plant influent, all proposed end of pipe standards are below the levels typically expected in raw municipal sewage as it enters the Wastewater treatment plant (ammoniacal-N can be much stronger in trade waste effluents). For ammoniacal-N once the dilution ratio is applied the resultant concentration in the receiving waters would be 0.05 mg/L. The toxicity limit in guidance is 0.9 mg/L. Therefore, an end of pipe limit of 50mg/L is very unlikely to result in environmental toxicity impacts. We further note that nitrogen related toxicity is not a key issue in the coastal environment.

We have also recommended adding a TSS limit for the open ocean of 100 mg/L as a median and 150 mg/L as a 90%ile. This is recommended to address potential effects on visual clarity in receiving waters. This is less than raw sewage (which could typically contain concentrations between 180-400 mg/L) and will require a moderate level of treatment to achieve this which balances the potential cost implications of providing treatment with the potential for adverse effects.

The final Open Ocean Enterococci, ammoniacal-N and TSS limits have therefore been reviewed and can be found in Table 26 and Table 27, in Section 10.

5.3 Definition of Open Ocean Receiving Environment

It has been proposed that ocean outfalls are split into two categories as follows:

– The spatial criteria for an open ocean outfall, as defined in the Taumata Arowai discussion document, is that it is not within the estuaries category, and is further than 500m from mean high water spring (MHWS), OR covered by a minimum of 10m water depth through entire tidal cycle.
– The criteria for the low energy coastal defined in the discussion document is that it is not considered either an estuary or an open ocean with the intention of encompassing the remaining inshore waters.
– Both categories introduce a mixing zone of 100m by which the centreline dilutions should achieve a minimum of 100:1 for the open ocean and 20:1 for the low energy coastal (and estuary) categories as modelled by CORMIX at nominal slack water conditions (nominated as depth averaged velocity of 0.02 m/s or the current velocity which is exceeded 90% of the time).

We note our advice for Priority Item 4 (low energy coastal receiving environment, Section 6) is that the 500m distance boundary has limited documented evidence to back it up, whereas the 10m depth contour is both easily definable on NZ Bathymetric Charts and typically outside of the surf zone. It would therefore be beneficial to change the open ocean definition to be >500m AND a minimum of 10m water depth.

The 10m depth stipulated in the definitions does not need to be referenced in the Order in Council to a defined datum. It refers to the minimum depth of water that is required over the outfall. The applicant could chose to do site specific surveys to confirm the applicable depths of water or could use the available bathymetric maps available from LINZ (**NZ Chart Catalogue - spatial viewer | Charts**), which typically show the 10m depth contour. This depth contour is with reference to the Chart Datum which may vary between charts, but on any given chart will be

the lowest depth which is always covered by water, hence reference to this chart datum will give a conservative estimate of the depth of water above an outfall located on the sea bed.

For the purposes of this advice, we have assumed that the definition of open ocean will be changed to a minimum of 500m length from MHWS **AND** a minimum 10m water depth and this change affects the level of likely dilution available in the receiving environment. We also recommend for clarity the definition of the 500m length is measured from MHWS to the inshore end of the outfall diffuser.

5.4 Review of Treatment Limits in Existing Consents

As part of the review of open ocean treatment limits, we have undertaken an analysis of the current version (July 2025) of the consents database to:

- Document all the open ocean and low energy consents listed in the WWTP database.
- Provide an overview of relevant consent treatment limits. This was partially documented in the WWTP database and has been confirmed and updated.

5.4.1 Basis of Limits in the Current Consents

Based on the July 2025 version of the Taumata Arowai consents database and the July 2025 receiving environment classification (i.e., not including a nearshore coastal category) there are 40 existing consents that discharge to the low energy coastal and open ocean receiving environment category[12]. There are some sites that have staged consents or multiple consents for each location.

Consent limits for these were extracted from the consents database and analysed for relevant limits for Carbonaceous Biochemical Oxygen Demand ($cBOD_5$), Total Suspended Solids (TSS) and Total Ammoniacal-N (NH_4-N) concentrations.

Table 10 below summarises:

- The number of consents with and without end of pipe limits – noting that consents without end of pipe limits normally have environmental monitoring programmes associated with them to determine any adverse effects of the discharge in the receiving environment.
- Average, median, 25%ile and 75%ile values across each of the parameters for typical average or median limits and for upper percentile limits.
- Maximum values where applicable.

Table 10 Analysis of low energy coastal and open ocean consent limits from active consents (July 2025).

	$cBOD_5$ (average limit) (mg/L)	$cBOD_5$ (%tile limit) (mg/L)	TSS (average limit) (mg/L)	TSS (%tile limit) (mg/L)	NH_4-N (average limit) (mg/L)	NH_4-N (%tile limit) (mg/L)
Number of Consents with Limits	21	24	18	24	8	12
Number of Consents with no Limits	19	16	22	16	32	28
25%ile value	20	24	30	45	5	19
Average Value (arithmetic mean)	71	115	38	102	13	30
Median value	25	30	35	80	8	32
75%ile value	30	55	50	100	19	40
Maximum Value	1,000	1,800	100	600	35	55

[12] As per the current version of the Taumata Arowai Consents Data base, accessed in July 2025.

5.5 Consideration of Secondary Treatment

In late 2024, the European Union (EU) adopted a revision to its Urban Wastewater Treatment Directive (UWWTD)—the first major update since 1991.

In the new UWWTD secondary treatment to urban wastewater before discharge will become obligatory to all agglomerations of 1,000 population equivalent (PE) or more by 2035[13]. This applies to all waters, although the majority of discharges are to inland freshwaters rather than ocean outfalls.

By 2039, EU countries will have to ensure the application of tertiary treatment, such as the removal of nitrogen and phosphorus, in all plants covering 150,000 PE and above, and by 2045 in plants covering 10,000 PE and above. Quaternary treatment removing a broad spectrum of micropollutants will be mandatory for all plants over 150,000 PE (and over 10,000 PE based on a risk assessment) by 2045. Under the new UWWTD known viruses, emerging pathogens, chemical pollutants (including per- and polyfluoroalkyl substances or PFAS), microplastics and antimicrobial resistance will be strictly monitored.

The requirements for secondary treatment from the UWWTD are summarised in Figure 1 below:

Table 1: Requirements for discharges from urban waste water treatment plants subject to Article 6 of this Directive. The values for concentration or for the percentage of reduction shall apply.

Parameters	Concentration	Minimum percentage of reduction (see Note 4)	Reference method of measurement
Biochemical oxygen demand (BOD_5 at 20 °C) without nitrification (see Note 1)	25 mg/l O_2	70-90 40 under Article 6(4)	Homogenised, unfiltered, undecanted sample. Determination of dissolved oxygen before and after five-day incubation at 20 °C ± 1 °C, in complete darkness. Addition of a nitrification inhibitor
Chemical oxygen demand (COD) (see Note 2)	125 mg/l O_2	75	Homogenised, unfiltered, undecanted sample Potassium dichromate
Total Organic Carbon (see Note 2)	37 mg/l	75	EN 1484
Total suspended solids	35 mg/l (see Note 3)	90 (see Note 3)	— Filtering of a representative sample through a 0,45 µm filter membrane. Drying at 105 °C and weighing — Centrifuging of a representative sample (for at least five mins with mean acceleration of 2 800 to 3 200 g), drying at 105 °C and weighing

Note 1: The parameter can be replaced by another parameter: total organic carbon (TOC) or total oxygen demand (TOD) if a relationship can be established between BOD_5 and the substitute parameter.

Note 2: Member States shall measure either the Chemical oxygen demand (COD) or the Total Organic Carbon.

Note 3: This requirement is optional.

Note 4: Reduction in relation to the load of the influent.

Figure 1 Requirements for Secondary Treatment under EU Wastewater Directive[14]

There are a number of factors which determine how Article 6 is applied. For coastal discharges the following considerations are relevant:

[13] **https://www.waternewseurope.com/council-confirms-new-wastewater-directive/**
[14] **https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32024L3019**

– For agglomerations (urban areas) of 2,000 PE and above but below 10,000 PE which discharge into coastal waters, the obligation to provide secondary treatment does not apply until 31 December 2037 (in 12 years).
– For agglomerations discharging into less sensitive areas, the obligation does not apply until 31 December 2037 (in 12 years). 'Less sensitive areas' are defined under EC Directive 91/271/EEC, and defined as follows:
    - *'A marine water body or area can be identified as a less sensitive area if the discharge of wastewater does not adversely affect the environment as a result of the morphology, hydrology or specific hydraulic conditions which exist in that area....'*
    - *Additionally, 'The following elements shall be taken into consideration when identifying less sensitive areas: open bays, estuaries and other coastal waters with a good water exchange and not subject to eutrophication or oxygen depletion or which are considered unlikely to become eutrophic or to develop oxygen depletion due to discharge of urban wastewater'*

Whilst the compliance metric varies, broadly comparable average concentration limits for secondary treatment for $cBOD_5$ are 25 mg/L and for TSS 35 mg/L. Total ammoniacal-N is not included.

It should be noted that the UWWTD also requires additional nitrogen and phosphorus removal in 'sensitive areas'. These are described as:

> *'estuaries, bays and other coastal waters which are found to have a poor water exchange, or which receive large quantities of nutrients. Discharges from small agglomerations are usually of minor importance in those areas, but for large agglomerations, the removal of phosphorus and/or nitrogen should be included unless it can be demonstrated that the removal will have no effect on the level of eutrophication'.*

5.6 Amendment to Open Ocean Treatment Limits

Based on the above analysis the following points can be summarised:

– The current consent limits included in the consultation document, by including only total ammoniacal-N and Enterococci, could be misinterpreted, so could be strengthened.
– Of the various end of pipe limits in current consents, $cBOD_5$ and TSS are more common in consents than total ammoniacal-N, with many consents having no limits for these parameters and relying on environmental monitoring programmes in the receiving environment to determine compliance. Based on this analysis, consideration could be given to adding limits for $cBOD_5$ and TSS to the end of pipe limits.
– Secondary treatment requirements from the UWWTD are typically focussed on $cBOD_5$ and TSS removal, however stricter requirements apply to either larger treatment plants or those discharging into sensitive areas, with these stricter requirements being phased in over time. Additionally, discharges into 'sensitive areas' are required to implement additional nutrient removal to recognise the risk of eutrophication type effects.
– However, in New Zealand open coastal environments BOD is rarely an issue, and a minimum 500m length of outfall **AND** 10m water depth would provide sufficient dilution through the water column (from the point of discharge to the water surface and beyond as mixing increases) to avoid adverse effects related to Dissolved Oxygen (DO) depletion in the receiving environment. We therefore consider the imposition of a BOD limit for these types of discharges would not be required for NZ outfalls meeting the open ocean criteria.
– The potential effects of treated wastewater discharges on the colour and clarity of receiving waters does however require some consideration. There is the potential for these types of effects to occur in the receiving environment and the imposition of a TSS standard would be beneficial in controlling these types of effects.

Based on the above analysis, Table 11 below included a possible amendment to the open ocean limits which has subsequently been the subject of further revision.

Note, the limits presented in Table 11 have now been replaced by the updates presented in Section 10. Please refer to Table 26 and Table 27 presented in Section 10 for the most up to date information. Further explanation on the additional changes is outlined in Sections 10.1 to 10.3, and above in Section 5.2. Superseded information in Table 11 has been struck out.

Table 11 Open Ocean – Possible Amendments to Limits. - Note this table is superseded by Table 26 and Table 27.

Parameter / Receiving Environment	Estuaries / Harbours	Low Energy Coastal	Open Ocean Existing	Open Ocean Possible Amendment
NH_4-N 90 percentile	15	20	50	50
$cBOD_5$ median (mg/L)	20	~~50~~	~~N/A~~	~~N/A~~
$cBOD_5$ 90%ile (mg/L)	40	~~70~~	~~N/A~~	N/A
TSS median (mg/L)	25	~~50~~	~~N/A~~	~~50~~
TSS 90%ile (mg/L)	50	~~70~~	~~N/A~~	~~100~~
TN annual median (mg/L)	10	10	~~N/A~~	N/A
TP annual median (mg/L)	10	10	N/A	N/A

Note:

– 90%ile values are proposed for $cBOD_5$ and TSS in response to Priority Item 1 and are included within the Table for completeness. Only median values were proposed in the Discussion Document for these parameters.

5.6.1 Implications of Possible Amendments

There are a wide range of treatment processes in use across New Zealand for discharges to open ocean environments.

Some have high levels of treatment, such as recent consents granted to Watercare for Snells Beach. This consent has average consent limits for $cBOD_5$ and TSS of 5 mg/L (for both) as equivalent median values, and nitrogen removal requirements in addition to this.

There are other sites throughout New Zealand where secondary treatment has been adopted some years ago; these include some of our larger urban centres where the receiving environments are already under pressure from a range of catchment inputs. These plants include Te Maunga (Tauranga) where average consent limits for $cBOD_5$ are 25 mg/L and TSS of 50 mg/L as an equivalent average or median value.

At Moa Point (Wellington), average consent limits for $cBOD_5$ are 20 mg/L and TSS of 30 mg/L as an equivalent average or median value.

At Rosedale (Auckland's North Shore), average consent limits for cBOD5 are 20 mg/L and TSS of 35 mg/L as an equivalent average or median value.

At Christchurch, 66 percentile limits of BOD 20 mg/L and TSS 50 mg/L apply.

However, there are many consents in NZ currently that have no BOD limits (as per Table 10, 19 out of 40 consents have no average BOD limits), and a similar number have no TSS limits (22 out of 40 have no average TSS limits).

Overall, it is considered that TSS is a contaminant of concern given potential visual clarity and colour effects in the receiving environment. Many existing consents have TSS as a limit to control these types of effects after reasonable mixing.

Many existing oxidation pond systems without a process to reduce algal solids will require an upgrade to minimise the risk of non-compliance with the possible amended open ocean limit for TSS shown in Table 11.

BOD is unlikely to be a contaminant of concern given the mixing that is proposed to occur with the adopted definition of minimum 500m outfall length AND 10m water depth. If the definition was to remain at 500m length OR 10m water depth, our advice on the appropriateness of a BOD limit would need to be reviewed, as in these cases potential effects on DO depletion could be more apparent.

There are also a number of outfalls in NZ that have significant trade waste components, and the end of pipe discharge is a mix of municipal/domestic sewage and high strength industrial trade waste. In these cases, if the potential end of pipe limit for TSS were to apply to the mixed effluent, there would be significant treatment upgrades required.

In the Gisborne example, the point of compliance for TSS is post-treatment of the municipal/domestic waste stream only and prior to mixing with the trade waste flow.

Such an approach is recommended to be considered further here to address these concerns.

Taumata Arowai provided further stakeholder consideration of these limits with regard to economic factors. This subsequently led to revisions to some of the limits proposed in Table 11. The outcome of which is presented in Section 10.

6. Plants in Low Energy Coastal Receiving Environment Category (Item 4)

Alignment of this priority item, with other priority items, was required following the initial submission of this report. To streamline how these alignments were made, a singular section documenting the alignment of proposed limits across all priority items has been included at the end of this report, refer to Section 10. Proposed limits for the new Nearshore Coastal Cateogry are documented in Section 10.

This section provides responses to Priority Item 4, as outlined in Table 12. The following sections present comments and recommended actions.

Table 12 Priority Item 3 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
4. Plants in low energy coastal receiving environment category	Some councils have identified treatment plants in submissions they consider are currently in the low energy coastal receiving environment category – in the opinion of these councils, the receiving environments these plants discharge to are high mixing / dynamic environments and they belong in the open ocean category. We require review of these plants and the nature of the receiving environment, to determine whether the arrangements are appropriate and if options for change are required. We will provide a list of the plants (Bluff and Timaru). There may need to be direct contact with these councils and we can facilitate that.	Review the category definition and carry out high-level assessment for Bluff and Timaru based on existing information provided by Councils.

6.1 Category Definition

The Standards proposed that the coastal outfalls are split into two ocean categories as follows:

- The spatial criteria for an ***open ocean*** outfall, as defined in Table 10 of the Technical Advice document[1], is that it is not within the estuaries category, and is further than 500m from mean high water spring (MHWS), OR covered by a minimum of 10m water depth through entire tidal cycle.
- The criteria for the ***low energy coastal*** defined in same Table 10 is that it is not considered either an estuary or an open ocean with the intention of encompassing the remaining inshore waters as noted in Table 6 of the Technical Advice document[1]. This table however defines low energy coastal as areas "sheltered from large waves and long period waves. Occur in gulfs and behind islands and reefs on the open coast and includes recessed harbours and embayment's." the same table defines open ocean as "Water that is remote from estuaries, fiords, inlets, sheltered harbours, and embayment's. Typically, >500m from a shoreline and relatively high energy for mixing."

Both categories use the CORMIX defined Regulatory Mixing Zone (RMZ) of 100m by which the centreline dilutions should achieve a minimum of 100:1 for the *open ocean* and 20:1 for the *low energy coastal* (and *estuary*) categories as modelled by CORMIX at nominal slack water conditions (nominated as depth averaged velocity of 0.02 m/s or the current velocity which is exceeded 90% of the time). We note that the dilutions in this definition are less than those assumed to be representative of typically higher dilutions achieved by such discharges, equivalent to the Dilution Factor for the Freshwater Standards.

This introduces a discrepancy around the intention of the definitions based on Table 6[1], as there would be an argument for a section of coast that is exposed to large waves and long period swell on an exposed coastline to be a medium to high energy environment but because it is within the 500m distance and shallower than 10m deep it hence falls into the low energy category.

This could be clarified by either of the following:

- Extend *low energy coastal* definition to cover all coastlines not covered by *open ocean* by renaming *nearshore* however the treatment limits which account for nutrient effects in sheltered waters which are assumed to accumulate contaminates over time, may be overconservative for open coastlines where longshore currents and wave mixing replenish receiving waters.
- Include a new *nearshore* category in addition to the others which accounts for discharges in waters closer than 500m and shallower than 10m deep, but also allows for increased mixing experienced on open coastlines similar to the *open ocean* category. This would need to account for the risk of discharging near to the shore by incorporating treatment requirements, particularly to address public health risks, as with *low energy coastal*. This is the preferred option from a risk perspective. We note that new treatment limits would need to be defined for this new category.

It should be noted that the 500m distance boundary has little definitive evidence to justify it and was determined based on reflection of outfall distances of NZ ocean outfalls in the following paper, Bradley (2016), **Wastewater outfalls – International perspectives relative to New Zealand**, whereas the 10m depth contour is both easily definable on NZ Bathymetric Charts and typically outside of the surf zone. It would be beneficial to change the open ocean definition to be >500 **AND** a minimum of 10m water depth (as discussed in Section 5.3) .

6.2 Review of Bluff and Timaru Outfalls

The councils of both Bluff and Timaru have made submissions relating to the definition of low energy coastal environment with their outfalls being less than 500m from the shore. These outfalls have been assessed against the definition above as follows:

6.2.1 Bluff Outfall

The Bluff outfall extends approximately 50m offshore along a laid across a rocky shore platform to a shallow surface discharge into Foveaux Strait through a two opposite ports. This would categorise the outfall as a *low energy coastal* outfall as per the Proposed Standards. While the discharge plume is likely to attach itself to the shore, the seabed reaches -10m depth within a couple hundred metres and then soon dips down to -30m allowing for upwelling currents and long period swells to continue mixing beyond the initial mixing zone. See Figure 2 below.

Due to the steep seabed in front of the bluff peninsula, the waves break on the shore which can be seen around the outfall as in Figure 3.

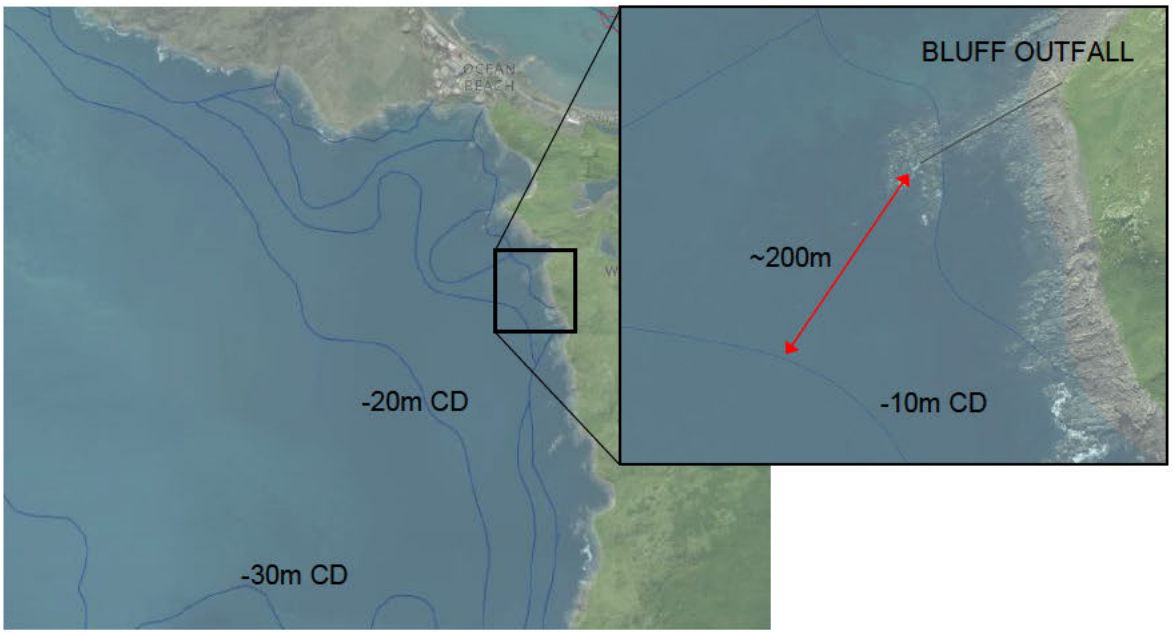

Figure 2: Location of bluff outfall illustrating nearshore bathy (LINZ Data Service)

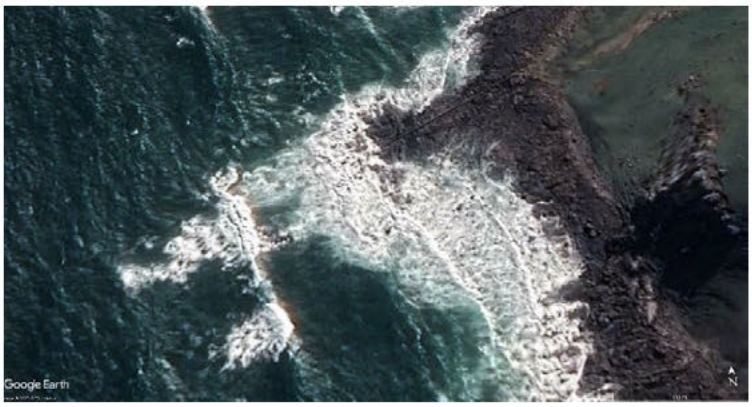

Figure 3: Waves breaking around Bluff Outfall (Google Earth)

There is a risk that the discharge plume can attach itself to the shoreline, however, as noted in the application AEE submission, the "human health effect risk of the activity can be mitigated through maintaining signage and continuing with the monitoring required as condition of the existing consent.[15]" This risk could also be addressed by requiring a more stringent treatment limit than the open ocean category for this type of discharge.

The Bluff outfall case supports the inclusion of a new nearshore category which reflects a more energetic environment than *low energy coastal* however, this still presents an increased risk from *open ocean* due to the proximity to shore.

6.2.2 Timaru Outfall

Timaru Wastewater Outfall is an off-shore outfall being 400m long (from mean sea level) with the final 100m being the diffuser discharging at a depth less than 10m, see Figure 4. This would categorise the outfall as a *low energy coastal* outfall as per the Proposed Standards. However, it is noted that as presented in the submission due to the site specific conditions, the outfall achieves substantially higher dilution ratios than the required 20:1 which would be achieved 5m from the diffuser. By contrast, at 100m the dilution ratio modelled by CORMIX is 94:1 which is closer to the 100:1 required by an open ocean outfall. This is at the current velocity of 0.022m/s which is exceeded 90% of the time.

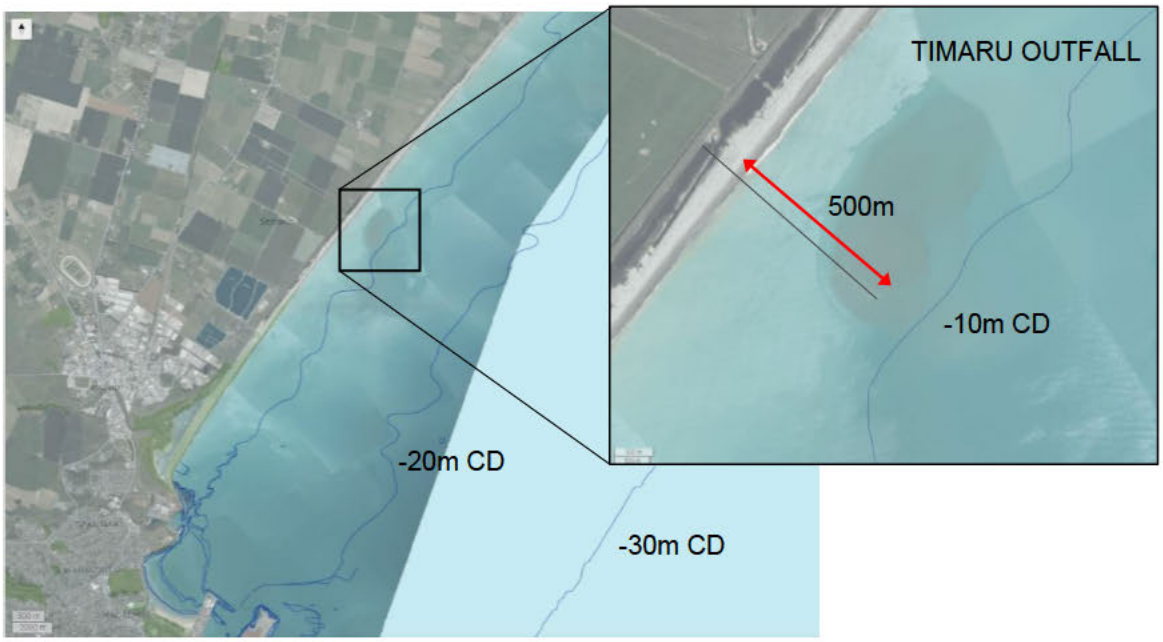

Figure 4 Location of Timaru Outfall illustrating nearshore bathy (LINZ Data Service)

[15] **Bluff Wastewater Treatment Plant and Disposal Infrastructure Approvals | Ministry for the Environment**

While the receiving environment of the Timaru Wastewater Outfall is not considered to be Low Energy, as noted by the submission, there is still a risk that this nearshore plume could attach itself to the shore, as is seen in Figure 5 or be entrained within the surf zone, which in some coasts around New Zealand could be as wide as 500m. In this case, changing the condition of ***open ocean*** to "AND" would lead to the outfall being required to be longer to satisfy the condition of being 10m deep which is further from shore. With no change to the categories, this discharge would then fall into the "low energy coastal" category which is unduly restrictive. Therefore, it would be more appropriate to develop and apply a new ***nearshore*** category, which better reflected the specific relevant risks.

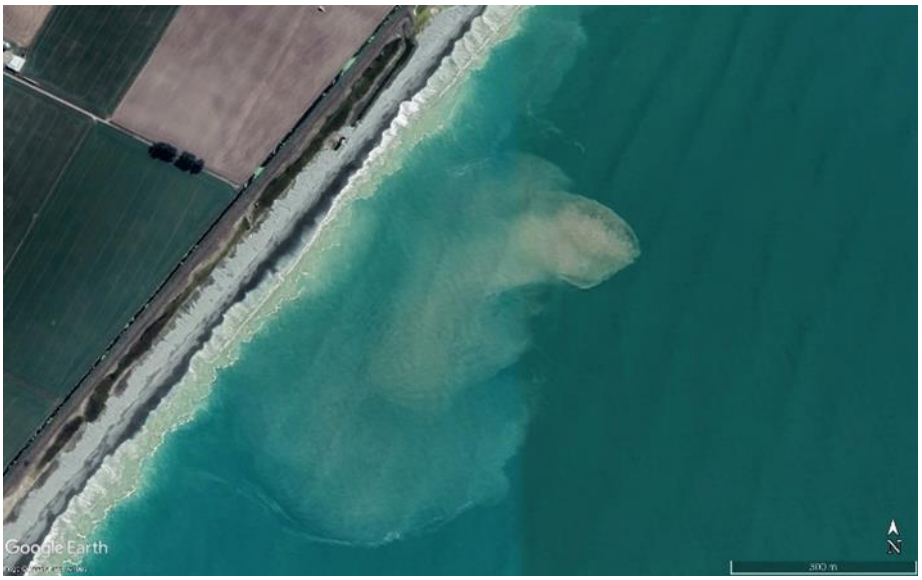

Figure 5 Timaru Outfall Plume Aerial (Google Earth).

6.2.3 Discussion

Within the nearshore region, the dilution ratios intended to be achieved in the receiving environment after full or reasonable mixing (as shown in Table 9 of the Technical Advice Document[1]) may not reach the excess of 1000 fold as for the *open ocean* outfall without contacting a sensitive receiving environment, such as the beach, shore or river mouth which would need to be defined on a case-by-case bases and thus is contrary to the purpose of a nationally consistent standard. Hence the treatment conditions defined as part of the Standard would need to take into account such lower dilution ratios. However, in the case of both Bluff and Timaru, it is likely that both will ultimately exceed the 100 fold dilutions required by the *low energy coastal* category with the Timaru Outfall achieving this within 149m (approx. 1.5 times the RMZ).

On the proposed recommendations made in the Timaru submission:

– It is not clear what is referred to as the "model uncertainty range" and this is not an output from the CORMIX model results.
– Extending the RMZ from 100m to 200m would increase the risk of the plume reaching a sensitive receiving environment prior to achieving full or reasonable mixing.
– The consideration to increase the exceedance of the ambient current velocity tested in modelling to 80% would no longer refer to slack water conditions where the semi-diurnal nature of New Zealand tides lead to slack water conditions occurring approximately 8% of the time.

Hence none of these actions would be recommended. However, a new ***nearshore*** category with a fit for purpose treatment standards may be more achievable for Timaru and also Bluff.

Slack water conditions at outfalls in the nearshore category would be similar to the low energy coastal. Hence, the required minimum centreline dilution for the nearshore category would be 20 by 100m as for the low energy coastal. However, the further dilution available as the plume moves away from the outfall will be significantly higher for the nearshore category compared to the low energy and would be similar to that achieved for the open ocean category which assumes a further 10 fold dilution as the plume moves away from the outfall. This means that the assumed dilution ratio for the proposed nearshore category would be 200.

6.3 Recommendations for Order in Council

It is recommended that the following revisions (removals struck out and additions underlined) to the method and criteria to determine the relevant categories are considered when developing the Order in Council:

Discharge into the open ocean:

– Applicant to determine if the discharge section of the outfall is:
  - Not into an estuary, as defined above, **AND**
  - Further than 500m from mean high water spring (MHWS), ~~OR~~ **AND** covered by a minimum of 10m water depth through entire tidal cycle, **AND**
  - Achieves a minimum centreline dilution of the plume of 100 at 100m from the diffuser as modelled by CORMIX using the $Q_{effluent}$ (as defined in Section 2.1.2.3, Eq 1[1]) at nominal slack water conditions (nominated as depth averaged velocity of 0.02 m/s or the current velocity which is exceeded 90% of the time).
    – If the discharge complies with these criteria, then the open ocean category applies.

Discharge into the nearshore:

– Applicant to determine if the discharge section of the outfall is:
  - Not into an estuary nor open ocean as defined above, **AND**
  - An area that is exposed to large waves and long period waves and not sheltered by gulfs, behind islands reefs on the open coast nor within recessed harbours and embayment's, **AND**
  - Achieves a minimum centreline dilution of the plume of 20 at 100m from the diffuser as modelled by CORMIX using the $Q_{effluent}$ (as defined in Section 2.1.2.3, Eq 1[1]) at nominal slack water conditions (nominated as depth averaged velocity of 0.02 m/s or the current velocity which is exceeded 90% of the time).
    – If the discharge complies with these criteria, then the nearshore category applies.

Discharge into a low energy coastal environment:

– Applicant to determine if the discharge section of the outfall is:
  - Not into an estuary, nearshore nor into the open ocean, **AND**
  - Achieves a minimum centreline dilution of the plume of 20 at 100m from the diffuser as modelled by CORMIX using the $Q_{effluent}$ (as defined in Section 2.1.2.3, Eq 1[1]) at nominal slack water conditions (nominated as depth averaged velocity of 0.02 m/s or the current velocity which is exceeded 90% of the time).
    – If discharge complies with these criteria, then the low energy coastal category applies.

If an existing outfall does not achieve the required minimum centreline dilutions, there are modifications that can be made to increase this initial dilution, such as the fitting of a check valve to the ports to increase the velocity of the plume from the ports and hence the dilution, or additional ports could be added to the outfall to spread the discharge. Otherwise, the outfall could be extended or relocated to an area with better dilutions.

Note that the treatment requirement definitions for the nearshore category need to be defined by others and should reflect the reduced risk of nutrient effects compared to discharges to the Estuary category and the risk to public health from shoreline contact of the plume at sensitive locations.

Supporting advice notes:

– The areas described above for nearshore could be considered subjective. This definition could include numeric values for the wave height and period, which would make it more objective. However, developing numeric values would be a potentially complex process and would need to be carefully ground-truthed before including it in the Order in Council. Also, in operation, there may be difficulty in applicants being able to determine, on a site-specific numeric basis, what the relevant wave height and period is at their outfall, especially in places where there is no wave buoy. However, they would be able to get an expert opinion on the narrative criteria, which could be subject to challenge.

– So, whilst further work could be undertaken to better define “large waves and long period waves” numerically, or provide a buffer distance between the area and the gulf, island, numeric criteria and examples of how to determine them would be better provided in the Guidance document rather than including it in the Order in Council.

7. Very Low Dilution Receiving Environment Category (Item 5)

Alignment of this priority item, with other priority items, was required following the initial draft submission of this report. To streamline how these alignments were made, a singular section documenting the alignment of proposed limits across all priority items has been included at the end of this report, refer to Section 10. Updates to the content of this section, particularly Table 15 and 16, are therefore captured in Section 10 of this report.

This section provides responses to Priority Item 5, as outlined in Table 13. The following sections present comments and recommended actions.

Table 13 Priority Item 5 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
5. Very low dilution receiving environment category	The existing proposal in the discussion document is that plants discharging to very low dilution freshwater environments are an exception to the standards framework – consents will be subject to standard RMA processes. A decision has been made that these plants discharging to this category of receiving environment will be subject to the discharge to water standard. We therefore require advice on the treatment limits that will apply to plants in this category. This would include advice about whether any special arrangements need to apply for small plants. Taumata Arowai can provide some additional information about high performing plants in this category that are in submissions and contact other councils with plants in this category.	– Review current plants in this situation (e.g., Pukekohe, Beachlands, examples provided by Taumata Arowai etc.) and the technology types present. – Note that in order to meet NPS outcomes of no further degradation and improvement of stream health, this would mean that the quality of the discharge would be very high i.e.: even meeting the receiving environment standards set out in the NPS bottom lines and Regional Plans. – Consider low dilution treatment categories and consider whether lower limits can be set at a level that is achievable by technology. This would be unlikely to meet the point above. – Review international example which had limits for very low dilution categories. – Consider any special arrangements needed to apply for small plants. – Additional 1 hour workshop with Taumata Arowai to discuss progress/direction. Note: Consortium to go away and think about this further, including small plants and provide updated approach for discussion with Taumata Arowai.

7.1 Relevant feedback from submissions

The Discussion Document outlined plants that discharge to rivers or streams with very low dilution (<10 dilution ratio) are currently excluded from the proposed Discharge to Water Standards. Some territorial authorities expressed concern this would mean a significant number of plants that fall into this category are excluded from the benefits of the Standards. Some of these plants, despite high-quality discharges, would have to face the RMA consenting processes instead.

On this basis Taumata Arowai have determined plants discharging to rivers or streams with very low dilution receiving environments (<10 dilution ratio) need to be subject to the Discharge to Water Standard. This section therefore outlines the proposed limits that could apply to the very low dilution receiving environment for rivers and streams.

Information supplied by Taumata Arowai, in relation to this Priority item, outlined, in summary:

– There are current Plants that fall into this very low dilution category that are already meeting most of the low dilution category limits.
– Some Councils believe more stringent limits would better protect water quality, public health, and balance nitrogen and phosphorus in the discharge
– Proposed limits for the very low dilution category.

The feedback and proposed limits were taken into consideration when addressing this Priority Item. It is important to note the proposed limits provided suggested dissolved oxygen (DO) could be a potential replacement for $cBOD_5$ limits (to align with the NPS-FM limits). This suggestion is not considered appropriate given DO is normally measured in the receiving environment, and not at the end of pipe, which is where the Standards are applied.

7.2 Very low dilution categories in international literature

Leveraging the literature review undertaken and documented in the previous Discharge to Water Technical Report[1] a review of international standards that consider very low dilution was revisited. 'Very low dilution' categories, or categories where the dilution ratio was <10, were mentioned in the following Canadian and Scottish guideline documents:

– The *British Columbia Municipal Wastewater Regulation 2013*, which states discharges into an environment with < 10 dilution ratio are prohibited.
– The *Scottish EPA Regulatory Method (WAT-RM-03) Sewage Discharges to Surface Waters 2016*, which states that for discharge to very low dilution environments (< 10 dilution ratio) enhanced treatment is required, the exact nature of which will vary on a case-by-case basis.
    - Factors which should be considered as part of treatment enhancement include the dilution available, existing pollution pressures and likelihood of further discharges on the watercourse, and proximity of Protected Areas.
    - The guideline further notes, if enhanced treatment cannot be achieved, discharge to very low dilution environments will be refused (i.e., is not permitted).

Given these documents outline discharges to very low dilution environments are either prohibited or require enhanced treatment, no associated treatment limits are presented in either guidance document.

7.3 WWTP in very low dilution environments

Based on information provided by Taumata Arowai and industry experience across the Consultant team, several WWTPs which are currently discharging to very low dilution river and stream environment were identified. An analysis of the associated discharge limits was undertaken using the current Taumata Arowai consent database, to determine the range of treatment limits currently applied. Table 14 provides a summary of the relevant consent conditions for the plants considered.

Of note, Pukekohe WWTP uses mass loads for total nitrogen (TN) and total phosphorus (TP) limits, not concentrations, based on the rationale that treated wastewater is discharged to a tributary of the Waikato River, and loads were considered more appropriate than concentration during the consenting process because it aligned with the approaches taken in other granted wastewater discharge consents which discharge to the Waikato River. The loads are proposed as medians over the summer (December to May inclusive) and winter (June to November inclusive) seasons:

– Stage 1 (First 4 years of consent):
    - Total nitrogen limit (Summer) = 88 kg/day
    - Total nitrogen limit (Winter) – 185 kg/day
    - Total phosphorous limit (Summer) – 36 kg/day
    - Total phosphorous limit (Winter) – 85 kg/day
– Stage 2 (After first 4 years of consent):
    - Total nitrogen limit (Summer) = 88 kg/day
    - Total nitrogen limit (Winter) – 185 kg/day

- Total phosphorous limit (Summer) – 22 kg/day
- Total phosphorous limit (Winter) – 85 kg/day

These loads have been converted to concentration equivalents in Table 14. It is important to note the Pukekohe treatment plant has been designed to achieve better than the concentration equivalents.

Table 14 Summary of relevant consent limits at WWTP in very low dilution environments

Plant	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	Total Nitrogen (mg N/L)	Total Phosphorus (mg P/L)	*E. coli* (Public Health) (cfu/ 100mL)
Paraparaumu WWTP (consent expired 2022)	Annual mean = 15 Annual max = 25	Annual mean = 15 Annual max = 25	No more than 3 samples, out of the 36 samples per year, can exceed 3.6 mg/L	No limit specified	Must monitor but no limit specified	No limit specified
Pukekohe WWTP[1] (Stage1 – first 4 years)	Median 5day = 10 90%tile = 20	Median = 15 90%tile = 25	Median = 5 90%tile = 10	4[2] Loads: S = 88 kg/d W = 185 kg/d	1[3] Loads: S.= 36kg/d W = 85kg/d	Median = 126
Pukekohe WWTP[1] (Stage2 – After 4 years)	Median 5day = 5 90%tile = 10	Median = 5 90%tile = 10	Median = 1 90%tile = 2.3	4[2] Loads: S = 88 kg/d W = 185 kg/d	1[3] Loads: S.= 22kg/d W = 85kg/d	Median = 50
*Beachlands WWTP[4]	90%tile = 15	90%tile = 15	S. 95%tile = 4 W. 90%tile = 5	No limit specified	No limit specified	No limit specified

Notes:

Summer and Winter represented by S. and W. respectively

[1] **Median**: no more than 12 samples in any 24 consecutive fortnightly samples shall exceed the limit. **90th Percentile**: no more than two samples in any twenty consecutive samples events shall exceed the limit. **Summer median load**: calculated from samples collected on a fortnightly basis over the entire summer period (December to May inclusive). **Winter median load**: calculated from samples collected on a fortnightly basis over the entire winter period (June to November inclusive).

[2] Not listed in the consent. Mass load limits convert to concentration equivalent of TN 4 mg/L

[3] Not listed in the consent. Mass load limits convert to concentration equivalent of TP 1 mg/L.

* Note that the Beachlands consent expired in 2022 and is in the process of being renewed.

[4] **$cBOD_5$ and TSS** 90th percentile determined on the basis of 10 consecutive samples. **Ammoniacal nitrogen** 95th percentile determined on the basis of 20 consecutive samples.

The treatment systems of each plant reviewed were also considered, as this influences the level of treatment that can be achieved based on technology present. The current treatment systems for the three plants reviewed are as follows:

– **Paraparaumu:** Biological nutrient removal and UV disinfection system.
– **Pukekohe:** Activated sludge reactors, enhanced membrane bioreactor and UV disinfection system.
– **Beachlands:** Activated sludge and clarifier system, phosphorus removal facility, sand filters or equivalent and UV disinfection. Note that Watercare are proposing to upgrade this to MBR based upon most recent proposal/consents.

7.4 Proposed limits

7.4.1 Justification

The determination of proposed limits was based on a review of the National Bottom Line limits set out by the NPS-FM[16], existing relevant consents (documented in the section above), and current treatment limits of technology (LoT).

Determining achievable limits for the very low dilution category has been driven in part by achievable LoT, and in part by best practice for environmental protection. The technical team have had insight into works investigating the LoT and acceptable environmental treatment limits across several studies and Business Cases in recent years. Consideration of LoT has also taken into consideration the treatment train, for example the use of a membrane bioreactor rather than ultrafiltration or reserve osmosis.

Of relevance is the recent Waikato Wastewater Northern Metro Detailed Business Case for Pukete and Ngāruawāhia which adopted achievable discharge limits based on LoT. Information relating to the adopted limits is captured in a 2022 committee agenda including a memorandum of understanding[17] . The minimum treated wastewater quality standards adopted were very high and based on current best practice and delivering "best for river" outcomes which include having a river that is swimmable and safe to gather food from.

Discharges in the very low dilution category are likely to contribute most of the flow or maintaining flow in the receiving environment. On this basis, discharges need to be of a quality that is environmentally acceptable, but feasibility achievable based on available technology.

The proposed limits and the basis for selection are outlined below and summarised Table 15.

– **Carbonaceous biochemical oxygen demand ($cBOD_5$) and total suspended solids (TSS)** have proposed limits of an annual median of 5 mg/L and a 90th percentile (90%ile) of 10 mg/L. These have been based on what is achievable within the LoT.
– The proposed limit **ammoniacal nitrogen (toxicity)** will remain the same as the low dilution category. The limit of 1 mg/L as annual 90%ile is regarded as challenging but achievable, requiring a fully nitrifying WWTP. This is achievable with current technology.
– **Total nitrogen (TN)** and **total phosphorus (TP)** proposed limits considered the current LoT, and what plants with enhanced treatment (such as Pukekohe WWTP) are already achieving. The TP limits could be lower from an environmental perspective but will be challenging to meet with current LoT.
– The proposed limit for ***E. coli*** is consistent with the recreational / bathing water limit set out in the NPS-FM. The proposed standard assumes meeting MAC Grade A with no dilution at the point of discharge (i.e. to meet the swimability criteria at point of discharge). This level of disinfection is being achieved by several plants already.

It is important to note, that 90th percentile limits have been included for $cBOD_5$ and TSS in alignment with the additional inclusion of these limits proposed in Section 3 (Priority Item 1) for the other dilution categories. The limits outlined for the low dilution, moderate dilution and high dilution categories are aligned with what has currently been proposed in Table 3, Section 3.

No additional considerations needed to be made for plants servicing populations less than <1000, given their relatively small contribution to the total catchment nutrient load. Therefore, similar limits have been proposed, as outlined inTable 16.

Note, the limits presented in Table 15 and Table 16 have been replaced by the updates presented in Section 10. Please refer to Table 24 and Table 25 presented in Section 10 for the most up to date information. Superseded information in Table 15 and Table 16 has therefore been struck out.

[16] Ministry for the Environment. National Policy Statement for Freshwater Management 2020 (amended 2024)
[17] Waipā District Council, Service Delivery Committee Agenda - 21 June 2022. Including Memorandum of Understanding in respect of Hamilton-Waikato-Waipa Metro Area Wastewater Projects. **Service Delivery Commitee Public Agenda - 21 June 2022.pdf**

Table 15 Proposed Standards for >1,000 population equivalent for river and stream receiving environments[18]

Category	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	Total Nitrogen* (mg N/L)	Total Phosphorus* (mg P/L)	E. coli (Public Health) (cfu/ 100mL)	Enterococci (Public Health) ~ (cfu/100mL)
Statistic used:	Annual median Annual 90%ile	Annual median Annual 90%ile	Annual 90%ile	Annual median	Annual median	Annual 90%ile	Annual 90%ile
Rivers and streams*							
Very low dilution ratio	**5** **10**	**5** **10**	**1**	**4**	**0.5**	**130**	**N/R**
Low dilution ratio	10** 20**	10** 20**	1	5	1	~~1,300~~**	N/R
Moderate dilution ratio	15** 30**	15** 30**	3	10	~~3~~	~~6,500~~**	N/R
High dilution ratio	20** 40**	30** 60**	25	35	10	~~32,500~~**	N/R

Notes:

Standard to apply at end of discharge pipe direct from plant to receiving water OR piped discharge from constructed wetland to receiving water.

Ammoniacal Nitrogen limit of 1mg/l as Annual 90%ile will be challenging and will require a fully nitrifying WWTP. This is achievable with current technology.

* More restrictive Standards to control potential periphyton issues may apply for total nitrogen and phosphorus for discharges to hard bottom streams

~~** Subject to change depending on the approach to be confirmed for other priority items (items 1, 3 and 4).~~

N/R indicates that recommendation is for no Standard to be imposed for this parameter and receiving environment as not relevant to potential effects

[18] The determination for a 'small' treatment plant is defined in the previous Discharge to Water Technical Report.

Table 16 Proposed Standards for <1,000 population equivalent for lakes, and river and stream receiving environments (existing WWTP's)

Category	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	E. coli (Public Health) (cfu/ 100mL)	Enterococci (Public Health) ~ (cfu/100mL)
Statistic used:	Annual median Annual 90%ile	Annual median Annual 90%ile	Annual 90%ile	Annual 90%ile	Annual 90%ile
Rivers and streams*					
Very low dilution ratio	**5** **10**	**5** **10**	1	130	N/R
Low dilution ratio	10** 20**	10** 20**	1	~~1,300**~~	N/R
Moderate dilution ratio	15** 30**	15** 30**	3	~~6,500**~~	N/R
High dilution ratio	20** 40**	30** 60**	25	~~32,500**~~	N/R

Notes:

Standard to apply at end of discharge pipe direct from plant to receiving water OR piped discharge from constructed wetland to receiving water.

Ammoniacal Nitrogen limit of 1mg/l as Annual 90%ile will be challenging and will require a fully nitrifying WWTP. This is achievable with current technology.

* More restrictive Standards to control potential periphyton issues may apply for total nitrogen and phosphorus for discharges to hard bottom streams

~~** Subject to change depending on the approach to be confirmed for other priority items (items 1, 3 and 4).~~

N/R indicates that recommendation is for no Standard to be imposed for this parameter and receiving environment as not relevant to potential effects

8. Standardisation of Treatment Arrangements for Plants Discharging to Hard Bottom Streams (Item 6)

This section provides responses to Priority Item 6, as outlined in Table 17. The following sections present comments and recommended actions.

Table 17 Priority Item 6 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
6. Standardisation of treatment arrangements for plants discharging to hard bottom streams / periphyton risk assessment	The existing proposal in the discussion document is that TN and TP limits for plants discharging to hard bottom freshwater environments will be determined through a periphyton risk assessment. A decision has been made to standardise the arrangements for determining treatment limits for these plants. Taumata Arowai will require advice on how to achieve this. This will include consideration of the proposal made by Manawatu District Council (which is, in summary where a chlorophyll level linked to the attribute state for periphyton in the NPS FM is present, set TN and TP limits will apply).	– Review the proposal made by Manawatu District Council. – Have an internal workshop to work through proposal and approach. – Note - we expect this will be very tricky because the current limits related to periphyton are very low. 0.001 and 0.007 for band A and B for nitrogen. Additional 1-hour workshop with Taumata Arowai to discuss approach before completion of task

8.1 Manawatu District Council (MDC) proposal

The MDC submission recommended that if a discharge to a hard-bottomed or rocky waterway does not cause the waterway to drop below the national bottom line for chlorophyll a, those waterways should be included in the discharge to water standard. As shown in Table 18 the National Objectives Framework (NOF), Attribute Band D for Periphyton reflects scenarios involving significant alteration of natural flow regimes or habitat structure, corresponding to significant adverse effects on ecosystem health and water quality.

Table 18. Periphyton (tropic state), Freshwater Body Type: Rivers, Attribute Unit: mg chl-a/m² (milligrams chlorophyll-a per square metre)

NOF Attribute Band and Description	Numeric Attribute State (Default Class)	Numeric Attribute State (Productive Class)
	Exceeded no more than 8% of samples	**Exceeded no more than 17% of samples**
A – Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat	≤50	≤50
B – Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat	>50 and ≤120	>50 and ≤120
C – Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat	>120 and ≤200	>120 and ≤200
National Bottom Line	200	200
D – Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat	>200	>200

At low risk sites monitoring may be conducted using visual estimates of periphyton cover. Should monitoring based on visual cover estimates indicate that a site is approaching the relevant periphyton abundance threshold, monitoring should then be upgraded to include measurement of chlorophyll-*a*.
Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC "Dry" Climate categories (that is, Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (that is, Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore, the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.

Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chlorophyll-a) is 3 years.

MDC does not support the exclusion of hard-bottom streams from discharge standards. In addition, MDC opposes the use of site-specific risk assessments as the sole basis for setting treatment standards. MDC further supports the inclusion of periphyton (using chlorophyll *a* as a surrogate) in discharge standards, with emphasis on maintaining in-stream ecological health rather than relying solely on end-of-pipe measurements.

The pros and cons of the MDC proposal are outlined in Table 19 below.

Table 19. The pros and cons of the MDC proposal.

Pros	Cons
– Site-specific attribute states on periphyton, using 3 years of monthly data, backed up by NIWA research from 2000 periphyton guidelines	– As long as not meeting national bottom line go to DtW standard. This may result in significant adverse effects / could make it worse, too permissive.
	– Narrower lens of assessment than proposed in DtW
	– Chlorophyl a in fresh water is not 'end-of-pipe' and is therefore inconsistent with TA requirements.

The proposal only triggers standards if national bottom lines are exceeded, making the approach practical for operators where chlorophyll *a* data is available. MDC proposes that such site-specific assessments can be effectively applied, as MDC already manages periphyton using this method.

8.2 Periphyton Growth

Nutrient-based parameters, specifically Total Nitrogen (TN) and Total Phosphorus (TP), are used as indicators of the potential for a discharge to promote periphyton growth in hard bottom rivers and streams.

Periphyton is the slime and algae found on the beds of stream and rivers. It is essential for the function of healthy ecosystems, but when it proliferates it can become a nuisance, degrading swimming and fishing spots, clogging irrigation and water supply intakes[19].

A hard-bottomed stream is one where the substrate is dominated by particles of gravel size or greater (i.e., <50% of the bed is made up of sand/silt)[20]. Based on the Sediment Assessment Methods developed by Clapcott et al. (2011)[21] for New Zealand streams, streambed sand and silt percentages are evaluated using key protocols such as the Visual Estimation Method, Shuffle Method, Grid-Point Intercept Method, Sediment Cover Scoring, and Reference Condition Comparison.

To assess whether the water body is a hard bottom stream, the potential zone of influence of the discharge as determined by the SQEP should be assessed using the above method. If the definition is met within this area then the stream will be considered to be hard-bottomed for the purpose of this Standard.

The relationship between nitrogen and phosphorus levels and periphyton growth is highly site-specific, largely related to flow and nutrient availability but also including a range of other factors. *Derivation of Nutrient Criteria for Periphyton Biomass Objectives* report for MfE by LWP, April 2022, developed targets to protect against periphyton overgrowth in rivers in NZ. The derivation of the targets was based on a national scale model of the relationships between nutrient concentrations in the rivers and observed Chl-a from Regional Council SOE monitoring. The report states that the large observed uncertainties in the model "*.. reflect the complexity of the underlying processes and incomplete knowledge of the drivers of periphyton biomass.*"

Guidance from the Ministry for the Environment's (MfE) 2022 publication, *Guidance on Look-Up Tables for Setting Nutrient Targets for Periphyton,* are used in developing the proposed nutrient-based wastewater standards (TN and TP). The wastewater standards have been derived based on site-specific conditions within the receiving environment, including the River Environment Classification (REC), the nominated National Objectives Framework (NOF) band, the acceptable level of risk of effect (assumed to be 10% of under-protection of water quality), and the relevant dilution factor. It is understood that whilst the NPS-FM is undergoing review and the science and guidance documents informing and supporting it remains valid, including these reports.

The REC is a database of catchment spatial attributes, summarised for every segment in New Zealand's network of rivers. The attributes were compiled for the purposes of river classification, while the river network description has been used to underpin models. The lookup tables outlining TN and TP criteria across various NOF bands and REC Classes (for shaded and unshaded sites) are presented in Appendix A.

It is noted that, a number of the in-river limits presented in Appendix A are several orders of magnitude more stringent than can be currently achieved in highly treated wastewater such that they will not be able to be met after dilution and mixing in some locations into which treated wastewater is discharged. In such cases the suitability of the location receiving the treated wastewater and the current limit of technology for wastewater treatment will be considered and are intended to be addressed through the risk assessment and numerical limits set out in Section 4.

After consideration of a range of approaches for deriving the numerical limits for Periphyton, an approach which requires that discharges to hard-bottom streams adopt a site-specific risk assessment approach has been selected. This method enables a range of variables influencing the potential for periphyton growth to be assessed within the appropriate environmental context and the limits will be applied based on degree of risk and ability to mitigate. This enables the nutrient thresholds to account for local stream sensitivity and manages the potential for adverse ecological impacts related to periphyton growth.

The approach adopts a Limit of Technology (LoT) basis to set the most stringent treated wastewater limits. A limiting factor in the nitrogen reduction is the presence of recalcitrant nitrogen, which is typically dissolved organic

[19] Biggs, B.J. (2000). New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams
[20] Stark, J.D. et al. (2001). Protocols for sampling macroinvertebrates in wadeable streams. Prepared for the Ministry for the Environment, New Zealand.
[21] Clapcott, J.E. et al. (2011). Sediment Assessment Methods: Protocols and Guidelines for Assessing the Effects of Deposited Fine Sediment on In-stream Values. Prepared for the Ministry of Science and Innovation, New Zealand.

nitrogen that is not readily removed. At the low concentrations associated with the most stringent limits, this portion becomes a significant component of the nitrogen present and makes further reductions in the total nitrogen not possible with current technologies. It is noted that this recalcitrant nitrogen would have a lower degree of availability to algae in the environment than inorganic nitrogen (e.g., ammonia and nitrate) and hence has less risk of causing periphyton issues in the water body[22]. Hence, it is noted that even at LoT levels, the risk of periphyton growth will remain in the more sensitive areas since wastewater treated to achieve the LoT will still require significant mixing and dilution to meet the targets in the receiving environment that are required to protect the most sensitive scenarios.

The below sub-sections sets out minimum requirements for the Order in Council for the risk assessment process to be undertaken under the Discharge to Water Standard to manage the risk of excess periphyton growth in hard bottomed streams receiving treated wastewater discharges. It also provides numerical limits for the quality of the treated wastewater under a range of risk categories.

8.3 Periphyton Risk Assessment – Proposed Approach

TN and TP limits for treatment plants discharging to hard-bottom freshwater environments are proposed to be determined through a periphyton-based risk assessment undertaken by an independent and Suitably Qualified and Experienced Practitioner (SQEP)[23]. The approach comprises the following three steps:

Step 1a: Determination of Scheme Risk

The initial step in this approach involves assessing the Scheme Risk. This risk should be led and reported by a SQEP, independent of the applicant and is required to include a risk assessment workshop with relevant subject matter experts which must include a freshwater ecologist with at least 10 years relevant experience.

The process should identify and assess the likelihood of the factors resulting in the consequence of an excess of periphyton growth within the zone influence of the discharge and downstream of the discharge point. The SQEP will determine the appropriate zone of influence noting that periphyton growth within the zone of reasonable mixing is to be considered an adverse effect and that locations that are sensitive to periphyton growth will exist and must be identified and included in the assessment scope. The SQEP should also consider any relevant existing monitoring data and the degree to which it indicates whether the discharge from the treatment plant IS contributing to any increased risk of periphyton growth within the zone of influence in the receiving environment. This could be considered specifically under Step 1b Environmental Risk.

The scheme risk factors to be assessed must include the following matters as a minimum, and can also include other factors that are relevant to the scheme:

– **Dilution Ratio:** Categorised as: High, Medium, Low and Very Low as per the Discharge to Water Standard freshwater categories.
– **Shading:** Assessed using methods adapted from *Stream Ecological Valuation (SEV): A Method for Assessing the Ecological Functions of Auckland Streams* (Technical Report 2011/009, October 2011), or equivalent alternative, and carried out by trained practitioners.
    - The effectiveness of the shading present should be evaluated in relation to impacts on water temperature since warmer waters are known to increase the risk of periphyton growth.
    - Measurement involves calculating the mean percentage shade across 10 cross-sections within a 100 m reach, approximately centred on the discharge point.
    - Assessments should be conducted during mid-summer.

[22] Fan et al. (2017) Dissolved organic nitrogen recalcitrance and bioavailable nitrogen quantification for effluents from advanced nitrogen removal wastewater treatment facilities. Environmental Pollution 229 (2017) 255-263
[23] The definition for a SQEP will need to be defined in supporting Guidance documentation. There is no formal definition of a SQEP in New Zealand legislative documents, however the Users' Guide: NES for Assessing and Managing Contaminants in Soil to Protect Human Health 17, does provided some guidance on what skills and background a SQEP may need to meet. The guidance indicates they should be independent, apply good professional practice, and reports against relevant industry guidelines. The practitioner should essentially be an expert in some specific and relevant fields and experienced in drawing together multidisciplinary inputs and drawing conclusions. A SQEP should be willing to certify that the content of the information and report(s) they have developed complies with good practice and professional standards, and to stand by the conclusions of the report. For example, a person certifying a report should be someone who could ultimately stand in the Environment Court and provide expert testimony, and whose experience and qualifications stand up to Court scrutiny.

- **Discharge Timing:** to be assessed based on the timing of discharge relative to environmental risk periods such as lower flow periods and in summer months.
- **Natural Flushing of River:** Assessed based on the typical accrual period for Periphyton growth in between rainfall events and based on whole year mean daily flow data and where a flood is defined as 3 times the median flow[24].

Each scheme related risk that is identified is required to be categorised as low, medium, high or very high. This will be determined in the risk workshop and confirmed by the SQEP.

Step 1b: Determination of Environmental Risk

The second step in this approach involves assessing Environmental Risk of the proposed scheme. The process should again identify and assess the likelihood of the factors resulting in the consequence of an excess of periphyton growth within the zone influence of the discharge and downstream of the discharge point. The environmental risk factors to be assessed must include the following matters as a minimum, and can also include other factors that are relevant to the environmental risk of the scheme:

- **REC Classification:** The REC classification of a river or stream is a way of categorising a waterway in relation to physical and biological characteristics at a range of spatial scales. Characteristics that are important for management such as hydrology, hydraulics, water quality and biological communities are similar within classes and significantly different between classes. Classes can be treated as management units, each of which can be linked to a monitoring strategy, used as a framework for reporting environmental data, or as units that have specific management provisions such as in regional plans. Rivers that share the same class can be treated as similar to one another and different to rivers in other classes[25].

  The SQEP will determine the appropriate REC class from MfE Data Service, River Environment Classification New Zealand (2010) and then apply a risk rating attributed to the REC class based on the summary below:

Type of Risk	Category 1 (low risk)	Category 2 (medium risk)	Category 3 (high risk)	Category 4 (very high risk)
REC Class	– CX/GM – CX/M – CX/L – CX/H – CX/Lk	– CD/Lk – WX/H – CD/H – WW/Lk – CW/H – WX/L – CW/L	– CW/M – CD/M – CW/GM – CW/Lk	– WD/Lk – WW/H – WW/L – WD/L – CD/L

- **Nature of the Riverbed:** This factor assumes the bed of the stream is "hard bottomed" and is assessed by subject matter experts based on the variability of bed morphology, including the number of riffle/run/pool features and the relative risk of riverbed features contributing to the establishment and growth of periphyton.
- **Site Specific Monitoring Results:** Where monitoring results are available regarding the treated wastewater quality (with TN and TP as key parameters) and receiving environment attributes at a representative location downstream of the discharge point. The location should include any sensitive areas that could be influenced by the discharge. The SQEP will assess the attributes and trends shown in the data over a minimum 3 year period and based on an at least monthly sampling regime which incorporates the summer period when low flow and warmer water temperatures will occur.

  Treated wastewater quality results must be analysed alongside the receiving environment data which may use either *Chlorophyll a* or ash free dry matter (AFDM) to represent levels of periphyton present.

Based on this assessment, the SQEP is required to determine the risk of the discharge leading to a degradation in water quality which has either resulted in an increased presence of periphyton or has the potential to do so. Assessment should include reference to the NOF framework and requires water quality to remain above relevant

[24] Matheson F, Quinn J and Hickey C, 2012, Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision-making framework: Phases 1 and 2 Final report, Prepared for Ministry of Science and Innovation

[25] Snelder T, Biggs BJF, Weatherhead, M, 2010, New Zealand River Environmental Classification Guide, prepared for Mfe.

national bottom lines and maintain or improve water quality within the same or better NOF attribute band up and down stream of the discharge.

Each environmentally related risk that is identified is required to be categorised as low, medium, high or very high based on the knowledge of the SQEP and input from relevant subject matter experts. The resultant risk category will be confirmed by the SQEP.

Step 2: Category and Potential Standards for Treated Wastewater

Following the assessment of Scheme Risk and Environmental Risk as outlined in Step 1, the SQEP must consider all risks and ratings and provide an overall periphyton risk assessment category for the proposed wastewater scheme. The overall risk assessment category is required to be categorised as low, medium, high or very high. The risk category is based on an aggregation of the Scheme Risk and Environmental Risk factors that have been identified in Step 1a and 1b.

The SQEP may determine whether particular factors should receive greater or lesser weighting depending on the likelihood of the contribution of each factor to an excess of periphyton growth within the zone of influence of discharge and downstream of the discharge point (each factor is not required to have equal weighting).

Based on the overall periphyton risk assessment category identified by the SQEP, Table 20 and Table 21 provide the corresponding numerical treatment standards for TN and TP based on the selected category. The numerical limits assume a minimum of 50% mixing and dilution has occurred. The Limit of Technology (LoT) is based on treatment capability in 2025. The TN limits for Very low and Low Dilution ratio streams are similar which reflects the high sensitivity of the water body to TN and the use of the LoT for these limits, i.e., the treatment plants cannot reliably achieve better than this with current technologies. This means there remains a potential residual risk of adverse effects on periphyton when applying this Standard since the New Zealand scientific literature referred to elsewhere in this response suggests precautionary levels of TN can be orders of magnitude lower than these limits.

Thus the effectiveness of the LoT approach proposed relies on the wastewater treatment plants' operational performance being optimised to reduce nutrient concentrations and minimise the potential for periphyton growth, rather than setting more stringent standards that would be more protective of the environment but unable to be reliably achieved, year round, by current technology. Therefore, because of the potential for improvement in technology and treatment capability over time, it is proposed that the LoT for TN and TP be reviewed on at least a 10 yearly basis to enable the wastewater sector environmental performance to more effectively respond to and manage the risk of periphyton growth in hard bottomed streams.

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Table 20 Standards for treated wastewater, Total Nitrogen mg/L

Risk Category	DtW Dilution Ratio: Very Low	DtW Dilution Ratio: Low	DtW Dilution Ratio: Medium	DtW Dilution Ratio: High
Category 1 (Low)	4	5	10	35
Category 2 (Medium)	4*	4	7	20
Category 3 (High)	4*	4*	4	10
Category 4 (Very High)	4*	4*	4*	4*
Practical Limit of Technology (LoT): The practical limits of current treatment technology (2025) are generally considered to be TN with an annual median concentration of 4 mg/l. It is intended that the LoT be reviewed on a minimum 10 yearly basis. *These limits are set as an annual median not to be exceeded and with best endeavours to achieve better than this for higher risk scenarios which may include low flow, summer periods or especially sensitive locations with history of periphyton issues.				

Table 21 Standards for treated wastewater, Total Phosphorus mg/L

Risk Category	DtW Dilution Ratio: Very Low	DtW Dilution Ratio: Low	DtW Dilution Ratio: Medium	DtW Dilution Ratio: High
Category 1 (Low)	0.5	1	3	10
Category 2 (Medium)	0.3	0.7	1	5
Category 3 (High)	0.25*	0.5	0.5	1
Category 4 (Very High)	0.25*	0.25*	0.25*	0.25*
*Practical Limit of Technology (LoT): The practical limits of current treatment technology are generally considered to be 0.25 mg/l TP as an annual median. It is intended that the LoT be reviewed on a minimum 10 yearly basis. It is noted that where phosphorus removal is achieved by chemical treatment, metals are often also monitored and limits set. This is outside the scope of the parameters included in this Standard.				

8.4 Mitigation

The outcome of the risk assessment process may be amended through the application of mitigating actions such as, but not limited to:

- Improve quality of treated wastewater with lower concentrations of TN and TP removal prior to discharge
- Alternative modes or locations of discharge
- Use of storage to manage discharges at times of elevated environmental risk
- Increase in proportion of stream shaded
- Inducing flows that will flush the stream and clear merging periphyton growth.
- Improvement in freshwater habitat and community structure, including increased numbers of periphyton "grazers"

The applicability and effectiveness of any proposed mitigation measures and the extent to which they adjust the risk rating for the scheme or environmental factors must be demonstrated and applied by the SQEP.

Where mitigation is applied and confirmed to be effective, the risk assessment process should be repeated and the appropriate numerical standard applied.

8.5 Outputs

The output of the risk assessment process is a technical report prepared by the independent SQEP which sets out:

- the risk assessment process followed,
- the subject matter experts involved and their credentials,
- evidence and references used in selecting their methodology and reaching their decision and;
- the outcomes of the risk assessment process with identification of the appropriate numerical limits for the discharge of treated wastewater.

The report must undergo a technical review and quality assurance by another SQEP who has not been involved in the process. This additional SQEP should be independent of the first and working for a separate organisation such that an objective review is undertaken. This review will cover appropriateness of methodology, calculations and data analysis, robustness of the risk assessment process and outcomes.

8.6 References

Auckland Council, 2011, *Stream Ecological Valuation (SEV): A Method for Assessing the Ecological Functions of Auckland Streams* (Technical Report 2011/009)

Biggs BJF. 2000a. *New Zealand periphyton guidelines: detecting, monitoring and managing of enrichment of streams: Volume A — Background and guidelines*. Wellington: Ministry for the Environment.

Matheson F, Quinn J and Hickey C, 2012, Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision-making framework: Phases 1 and 2 Final report, Prepared for Ministry of Scient and Innovation.

Snelder T, Biggs BJF, Weatherhead, M, 2010, New Zealand River Environmental Classification Guide, prepared for MfE.

9. Small Plant Standards – Desludging (Item 7)

This section provides responses to Priority Item 7, as outlined in Table 22. The following sections present comments and recommended actions.

Table 22 Priority Item 7 for Discharge to Water Standards

Item	Description (from Taumata Arowai)	Proposed approach
7. Small plant standard	Provide advice on an effective, practical consent condition for desludging of ponds based on proposals in submissions (likely to be depth measure rather than periodic desludging).	Obtain and review current consents and current O&M Plans, leverage expertise in the team, and collate outcomes to provide advice.

9.1 Assumptions

- Small wastewater treatment plants ('small plants') have been assumed to be those that serve less than 1,000 population equivalent (PE).
- Small plants where treatment is provided by oxidation pond(s) also referred to as facultative ponds or waste stabilisation ponds, ('ponds'), and primarily discharges to water have been considered. For clarity, 'ponds' for the purpose of this memo do not include:
  - Ponds with designed deep sludge cells;
  - Wetland treatment systems[26];
  - Anaerobic ponds;
  - Septage or sludge storage ponds/lagoons; or
  - Imhoff tanks.

9.2 Methodology

The general approach included the following steps:

- Review national database of wastewater consents, developed by Taumata Arowai, to identify relevant wastewater treatment plants (WWTPs);
- Review relevant current consents, previously obtained by Taumata Arowai or as part of the Discharge to Water Technical Advice (Phase 1);
- Obtain and review relevant current Operation and Management Plans (or similar) that were readily available;
- Review relevant submission points provided by Taumata Arowai;
- Review relevant New Zealand guidelines on pond-based systems;
- Discuss key issues with the technical team; and
- Collate outcomes and key findings.

For the consent review, individual consents were inspected using key word search terms to identify the following:

- Consent trigger for sludge / depth of sludge (of any sort) included in conditions.
- Whether there is a requirement to have an Operation and Management Plan (OMP) or similar such as a Pond Management Plan or relevant section in an Odour Management Plan.
- Whether the minimum consent requirements for the OMP (or similar) referred to sludge management in any way.

9.3 Background and NZ guidelines

The WaterNZ Good Practice Guide (2017)[27] provides a good overview of several types of pond-based systems, including the sludge management associated with them. Relevant aspects from the Guide are summarised below.

[26] Any consents that included a wetland treatment system in conjunction with an oxidation pond were included in the search criteria.
[27] Good Practice Guide for Waste Stabilisation Ponds: Design and Operation, 2017, Water New Zealand.

Sludge accumulates in the bottom of an oxidation pond over time. The rate of sludge build up varies according to a range of factors (e.g. period since last de-sludging, age of the sludge, history of chemical addition to the sludge, presence or absence of aeration and mixing, climate, and influent loading), and requires site-specific management.

Increasing sludge depths in a pond-based system result in:

- Reduced effective pond volume available for treatment
- Reduced hydraulic retention time (HRT)
- Increased risk of odour nuisance and sludge rising to the surface.

Periodically checking the sludge levels in the oxidation pond should be performed to assess sludge accumulation alongside sludge characterisation in terms of total and volatile solids content to assist with planning and budgeting for sludge removal.

Ideally sludge depth profiles should be undertaken at least every 5 years. The evaluation of sludge accumulation is complicated, in that sludge build up within the oxidation pond varies both over the pond area and with depth. Sludge levels are often found to be higher near the inlet, outlet and in the corners of the pond. Older, more compacted sludge is found on the base of the pond, while newer and less dense sludge is found at the sludge-water interface. When the depth of sludge is significant (e.g. approaching 0.9 m from the water surface), it can potentially impact treatment performance, and sludge depth profiling should be undertaken more frequently.

9.4 Summary of available consents

37 consents meeting the criteria (Section 4[27]) were inspected using key word search terms. A targeted selection of seven consents (identified by the project team and known to have oxidation ponds as part of the primary treatment, but serving Medium to Large PE) were inspected to determine the extent to which the management of sludge in the pond was a condition of consent (using the same search terms as for the small WWTP).

Table 23 summarises the results of the search terms applied to small and selected medium/large WWTPs, in relation to sludge or desludging consent requirements.

Table 23 Summary of sludge related consent requirements from inspected consents

Scheme size	No. inspected	No. sludge condition	No. OMP condition	Comments
Small	37	1	18 (49%)	– One consent with condition requiring a report within 6 months detailing the existing sludge levels within the ponds and, if required, the proposed method of removal. – Three consents referred to 'sludge' or 'desludge' in the OMP requirements (see comments below for Small scheme example A, B and C). – Generally, the OMP conditions did not refer to sludge or desludging management (in terms of depth, volume or other sludge related issues).
Medium	3	1 (Narrative)	2	– No numerical triggers for sludge/desludging requirements – Narrative condition to monitor sludge level (1 consent) (see comments below for medium-large schemes) – General requirement to have an OMP or similar in place, with high-level reference to de-sludging (not a numerical definition) (see comments below on OMP condition) – 1 consent included Appendix 'Routine Tasks' attached to the consent, listing sludge depth to be measured 'as required' and pond desludging to be done 'as required' (not tied to a specific consent condition)
Large	4	1 (Narrative)	3	– 1 consent included narrative sludge trigger in relation to occupation of excess pond volume, but sludge was not included in OMP requirements – Consents generally required OMP or similar, but did not include sludge/desludging requirements

For the 37 ‘Small’ scheme consents reviewed, 49% included a requirement to provide an OMP (or similar).

Out of these, three consents (referred to as A, B and C, below) made reference to sludge management, paraphrased as follows, noting Small Scheme Example A contained both a sludge reporting requirement (in a narrative condition) as well as a separate management plan to address sludge:

Small Scheme Example A:

Provision of Reports

> *7. Within six months of the granting of this consent the consent holder shall provide a report to the [Scheme A] Regional Council detailing the existing sludge levels within the ponds and, if required, the proposed method of removal, timeframe in which the sludge is to be removed and disposal location.*

Management Plan

> *18. The consent holder shall provide the [Scheme A] Regional Council with a management plan which details the procedures that will be implemented to operate in accordance with the conditions of this resource consent.*
>
> *g) A process to determine sludge levels within the oxidation ponds and wetlands for the duration of consent.*
>
> *h) Details on any proposed removal of sludge from the wetland cells and the proposed disposal site;*

Small Scheme Example B:

> *The consent holder shall implement and maintain a management plan which shall include operating procedures to avoid, remedy or mitigate against potential adverse effects arising from:*
>
> *ii) the build-up of sludge in the pond system.*

Small Scheme Example C:

> *Within 3 months of the date of commencement of this consent the consent holder shall prepare an operations and management plan for the [Site C] Township Wastewater treatment system and submit to Council (Manager Compliance) for approval.*
>
> *b) Details of the procedure for determining the accumulated volume of sludge in the oxidation pond, and criteria for determining when ‘desludging’ of the pond will occur.*

An additional small scheme consent (known to the author, but not included in the initial search criteria), but which is classed as ‘Discharge to Land’ was also reviewed, and included the following as a condition of consent for Maintenance and Management:

> *The [Scheme] shall be correctly operated and maintained in an effective and workmanlike manner, including desludging as and when required to maintain its design capacity of 50% of the total depth of the pond.”*

For the Medium-Large Scheme consents inspected, two schemes included narrative requirements for sludge management:

- *The consent holder shall monitor the sludge levels of the oxidation ponds annually during autumn and shall submit the results of this monitoring in writing to the consent authority by 31 August each year; and*
- *Desludging of F2 where total accumulation of sludge reaches a point where the sludge occupies too much of the pond volume.*

For one Operation Management Plan, there was a high-level requirement set out as follows:

- *The consent holder shall prepare an Operations and Management Plan including…X) The operation of the de-sludging pond;*

Summary of key findings from consents inspected:

– There were few instances of consent conditions specifying sludge monitoring / management/desludging; Of the few, the requirement was referred to in high level, narrative terms only;

– There were no small schemes that defined numerical or specific trigger levels for instigating sludge management steps or planning for pond desludging;
– Consents generally required and OMP (or similar) to be in place, but few included specific reference to sludge or desludging monitoring and/or management.

9.5 Operations and Management Plan (or similar)

Operation and Management Plans (or similar) are not held within the national consents database.

Two Pond Management Plans (PMP), familiar to the author were reviewed to gauge the general approach to sludge management, with particular emphasis on identifying whether the PMP required the depth or volume of sludge to be assessed (irrespective of the method employed). Key aspects of the two PMPs are described below.

Both schemes (referred to as Scheme A and B below) are for 'Large' schemes. For Scheme A (but not for Scheme B), a PMP was a requirement of the consent. For both schemes, the general intent of the PMP is to recognise that whilst pond desludging is not considered a normal operational event, it is required as part of the overall operation, management and performance of the schemes. The PMPs include a narrative 'trigger' to initiate desludging when sludge comes within one metre of the surface for greater than 10% of the pond area while the pond is at normal dry weather operating water level or when treatment capacity appears to be significantly reduced.

> *Further, Scheme B described the process of annual sludge surveys (for the purpose of defining sludge accumulation contours) as follows:*
>
> *An annual sludge survey will consist of sludge and clear water depth measurement recorded at a minimum of twelve sampling locations evenly spaced on the pond. These locations shall be recorded by GPS.*
>
> *Typically to achieve consistent results these surveys are to be carried out by external contractors specialising in pond surveys…*
>
> *When a sludge contour survey indicates a pond is at/near the trigger level, closely monitor pond performance and health while planning for desludging.*

9.6 Submissions on standards

Taumata Arowai provided excerpts of submissions from two parties. Key matters raised with respect to pond sludge management were:

– Desludging of oxidation ponds should be required when sludge exceeds a specific ratio of sludge depth to pond depth,
– Inclusion of regular sludge readings,
– Inclusion of 3 to 5 yearly sludge surveys to monitor sludge levels in the ponds (as opposed to setting specific desludging intervals in the consent),
– Consideration that additional desludging of plants also then requires the disposal of the sludge which may be expensive if landfills stop accepting biosolids and they are outside of the limits set out in these wastewater standards.

9.7 Recommendations for Order in Council

It is recommended that, as a minimum, small plants with oxidation ponds should have in place a site-specific Operation and Management Plan (or similar) that specifies how sludge will be monitored and states a trigger level based on minimum clear water depth for when desludging is required. This requirement should be included as a consent condition.

Supporting advice notes:

– Trigger level for desludging typically when the sludge comes within 0.9m of the surface for greater than 10% of the pond area at normal pond operating water level. Desludging should be carried out within 1 to 2 years of the trigger being reached.
– Carry out regular sludge surveys to monitor sludge levels at a frequency appropriate for size of WWTP, incoming load, period since last desludging, and treatment performance. This is typically 3 to 5 yearly, i.e. 5

years for new or recently desludged ponds, and 3 as the pond approaches the desludging trigger. The method of the sludge survey should be appropriate for the WWTP size.

10. Recommended Limits

Following the submission of responses to each priority item, as documented in Sections 3 through to 9, alignment was needed between the outcomes of the following items:

– Item 1: Treatment Limits and Toxicity
– Item 2: Pathogen treatment limits
– Item 3: Open Ocean receiving environment treatment limits
– Item 4: Plants in low energy coastal receiving environments
– Item 5: Very low dilution receiving environment category

This section outlines an overview of the recommended limits proposed for the Discharge to Water Standard. The justification and research supporting these limits are documented in the previous sections of this report. If amendment to values have been made, or if the values presented below differ from those reported in earlier sections, then further justification has been provided here.

Table 24 through to Table 27 provides the updated recommended limits proposed for the Discharge to Water Standards.

Table 24 Proposed Standards for >1,000 population equivalent for lakes, and river and stream receiving environments[28].

Category	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	Total Nitrogen* (mg N/L)	Total Phosphorus* (mg P/L)	E. coli (Public Health) (cfu/ 100mL)	Enterococci (Public Health)~ (cfu/100mL)
Statistic used:	Annual median Annual 90%ile	Annual median Annual 90%ile	Annual 90%ile	Annual median	Annual median	Annual 90%ile	Annual 90%ile
Lakes	15 30	15 30	3	10	3	3,250	N/R
Rivers and streams							
– Very low dilution ratio – Dilution ratio: <10	5 10	5 10	1	4	0.5	130	N/R
– Low dilution ratio – Dilution ratio: >10 and <50	10 20	10 20	1	5	1	650	N/R
– Moderate dilution ratio – Dilution ratio: >50 and <250	15 30	15 30	3	10	5	3,250	N/R
– High dilution ratio – Dilution ratio: >250	20 40	30 60	25	35	10	16,250	N/R

Notes:

- Standard to apply at end of discharge pipe direct from plant to receiving water OR piped discharge from constructed wetland to receiving water.
- Ammoniacal Nitrogen limit of 1mg/l as Annual 90%ile will be challenging and will require a fully nitrifying WWTP. This is achievable with current technology.
- More restrictive Standards to control potential periphyton issues may apply for total nitrogen and phosphorus for discharges to hard bottom streams
- N/R indicates that recommendation is for no Standard to be imposed for this parameter and receiving environment as not relevant to potential effects

[28] The determination for a 'small' treatment plant is defined in the previous Discharge to Water Technical Report.

Table 25 Proposed Standards for <1,000 population equivalent for lakes, and river and stream receiving environments (existing WWTP's)

Category	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	E. coli (Public Health) (cfu/ 100mL)	Enterococci (Public Health)~ (cfu/100mL)
Statistic used:	Annual median Annual 90%ile	Annual median Annual 90%ile	Annual 90%ile	Annual 90%ile	Annual 90%ile
Lakes	15 -	15 -	3	3,250	N/R
Rivers and streams					
– Very low dilution ratio – Dilution ratio: <10	5 10	5 10	1	130	N/R
– Low dilution ratio – Dilution ratio: >10 and <50	10 20	10 20	1	650	N/R
– Moderate dilution ratio – Dilution ratio: >50 and <250	15 30	15 30	3	3,250	N/R
– High dilution ratio – Dilution ratio: >250	20 40	30 60	25	16,250	N/R

Notes:

– Standard to apply at end of discharge pipe direct from plant to receiving water OR piped discharge from constructed wetland to receiving water.
– Ammoniacal Nitrogen limit of 1mg/l as Annual 90%ile will be challenging and will require a fully nitrifying WWTP. This is achievable with current technology.
– More restrictive Standards to control potential periphyton issues may apply for total nitrogen and phosphorus for discharges to hard bottom streams
– N/R indicates that recommendation is for no Standard to be imposed for this parameter and receiving environment as not relevant to potential effects

Table 26 Proposed Standards >1,000 population equivalent for coastal receiving environments.

Category	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	Total Nitrogen (mg N/L)	Total Phosphorus (mg P/L)	Enterococci (Public Health) (cfu/100mL)
Statistic used:	Annual median Annual 90%ile	Annual median Annual 90%ile	Annual 90%ile	Annual median	Annual median	Annual 90%ile
Estuaries / Harbours Dilution ratio: >50	20 40	25 50	15	10	10	2,000
Low energy coastal Dilution ratio: >100	30 60	30 60	20	10	10	4,000
Nearshore coastal Dilution ratio: > 200	50 80	50 80	35	50	N/R	8,000
Open ocean Dilution ratio: >1000	N/R	100 150	50	N/R	N/R	40,000

Notes:

– Standard to apply at end of discharge pipe direct from plant to receiving water OR piped discharge from constructed wetland to receiving water.

– N/R indicates that recommendation is for no Standard to be imposed for this parameter and receiving environment as not relevant to potential effects

Table 27 Proposed Standards <1,000 population equivalent for coastal receiving environments.

Category	$cBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Ammoniacal Nitrogen (toxicity) (mg N/L)	Enterococci (Public Health) (cfu/100mL)
Statistic used:	Annual median Annual 90%ile	Annual median Annual 90%ile	Annual 90%ile	Annual 90%ile
Estuaries / Harbours Dilution ratio: >50	20 40	25 50	15	2,000
Low energy coastal Dilution ratio: >100	30 60	30 60	20	4,000
Nearshore coastal Dilution ratio: > 200	50 80	50 80	35	8,000
Open ocean Dilution ratio: >1000	N/R	100 150	50	40,000

Notes:

- Standard to apply at end of discharge pipe direct from plant to receiving water OR piped discharge from constructed wetland to receiving water.
- N/R indicates that recommendation is for no Standard to be imposed for this parameter and receiving environment as not relevant to potential effects

10.1 Changes to proposed coastal receiving environment pathogen limits

Further consideration has been made for the basis of the coastal receiving environment pathogen limits based upon the anticipated near field and far field dilution ratios. This has also included consideration of the proposed new nearshore coastal receiving environment category.

Table 28 below describes the:

- MAC Grade A receiving environment concentration of 40 Enterococci cfu/100mL
- The minimum CORMIX centreline dilution at 100m assumed for each receiving environment category assumed to represent the zone of initial dilution in the near field
- The calculated concentration at the end of the near field based upon the above near field dilution factor
- A far field dilution factor assumed based upon potential wind and current mixing characteristics for the various receiving environments.
- The derived Enterococci limit for each coastal receiving environment.

These limits are included in the final proposed limits tables (Table 26 and Table 27).

Table 28 Assumed near field and far field dilutions for the differing coastal receiving environments.

	Estuaries/Harbours	Low Energy Coastal	Nearshore Coastal	Open Ocean
MAC Grade A (Enterococci cfu/100mL	40	40	40	40
Minimum CORMIX dilution at 100m	20	20	20	100
Concentration at end of near field	**800**	**800**	**800**	**4000**
Far field dilution factor	2.5	5	10	10
Proposed Enterococci Limit (90%ile cfu/100 mL)	**2,000**	**4,000**	**8,000**	**40,000**
Overall dilution factor applied	**50**	**100**	**200**	**1000**

10.2 Revised Open Ocean Limits

We have recommended adding a TSS limit for the open ocean of 100 mg/L as a median and 150 mg/L as a 90%ile. This is recommended to address potential effects on visual clarity in receiving waters. This is less than raw sewage (which could typically contain concentrations between 180-400 mg/L) and will require a moderate level of treatment to achieve this which balances the potential cost implications of providing treatment with the potential for adverse effects.

10.3 Proposed Nearshore Coastal Limits

We have assumed the nearshore environment is less sensitive to nutrient effects than freshwater, particularly given the confined nature of freshwater environments compared to the coast. Unlike freshwater categories, the nearshore environment does not have the issue of cumulative contribution of nutrients from the wider catchment affecting the sensitive estuarine environment. However, potential effects on dissolved oxygen depletion and visual clarity may be an issue.

On this basis we have included BOD and TSS limits to control these effects but have suggested higher limits for total ammoniacal-N of 35 mg/L (90%ile) and TN of 50 mg/L (as a median).

10.4 Statistical Basis for Limits for Small Plants

Section 3.2.3 discusses the statistical basis for the limits that have been proposed in the Standards. We recommend that the basis of the limits remain as median and 90%ile.

A potential issue with the determination of compliance with the limits arises for the small plants as the frequency of sampling proposed for these plants is quarterly, giving 4 samples per year. Whilst the median and 90%ile statistics can be determined for 4 samples, we do not recommend this.

For small plants, we recommend that a “number of allowed exceedances” approach is used. Using this approach, on the basis of quarterly sampling, the proposed limits would become:

- Median limit would become “two samples per year can exceed the numerical limit”
- 90%ile would become "one sample per year can exceed the numerical limit”

This will apply compliance pressure to ensure that asset owners appropriately manage their WWTPs and will also enable a simple determination of compliance in any given year, given a sampling frequency of quarterly.

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