SUBMISSION **Job 11011**

To: Taumata Arowai (email: kōrero@taumataarowai.govt.nz)

From: Lowe Environmental Impact (email: office@lei.co.nz)

Date: 17 April 2025

Subject: Summary of issues related to LEI's submission on proposed wastewater environmental performance standards

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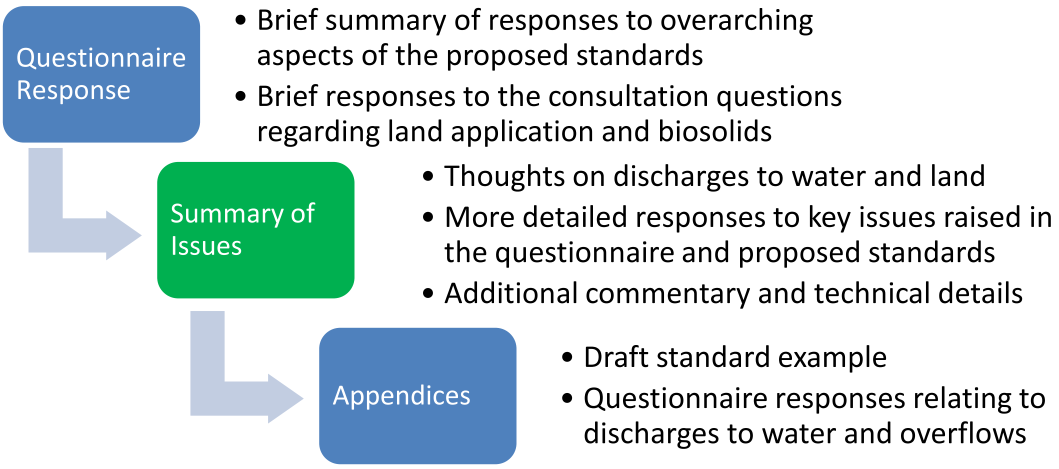
This document serves as the second in a series of papers that collectively provide a submission from Lowe Environmental Impact (LEI) regarding Taumata Arowai's proposals for national standards for wastewater discharges. This is LEI's Summary of Issues that discusses several technical matters relating to land (and water) discharges. This document in its current form is a DRAFT and will be updated prior to lodging. It is intended to contribute to and assist discussion and submissions being prepared by others.

INTRODUCTION

On 24 February 2025, Taumata Arowai invited submissions on proposed wastewater environmental performance standards for New Zealand. When addressing the specific questions that Taumata Arowai have sought feedback on, LEI identified a range of issues that needed more detailed explanations. Some of these issues are not incorporated into the questionnaire but are important elements of designing and operating successful land discharge systems. To address this, LEI has prepared this separate Summary of Issues and more detailed technical documents (this document and appendices).

LEI's submission is comprised of several documents which are linked as follows:



The intention of this structure is to provide LEI's core views on the questionnaire topics and to refer readers to the linked documents for more in-depth information. This enables readers to choose to read the technical detail that suits their level of interest.

This Summary of Issues document provides more integrated feedback on key elements of the proposed land discharge standards. This reflects LEI's extensive experience with land treatment across New Zealand and the complex interrelated nature of designing and operating land treatment systems. Combined land and water discharge systems (which often include storage) add another layer of complexity, which is also addressed where relevant in this Summary of Issues and/or technical documents.

GENERAL FEEDBACK ON THE PROPOSED STANDARDS

LEI supports the introduction of national wastewater standards for discharges to land and water, overflow and bypass discharges, and biosolids applications to land. Most of the proposals are appropriate at a high level and reflect good practices for managing wastewater and minimising adverse effects on the environment. We consider that it is appropriate that Taumata Arowai develops a nationally consistent approach, however this should be based on good science, engineering and management. This will ultimately reduce local influence and variability of consenting processes and decisions, plus reduce costs and time to get systems operational. Where these proposed standards are met, there will also be reductions in Regional Council concerns and opposing submissions on consent applications.

As described below and in the supporting appendices for LEI's submission, some elements of the proposed standards are inconsistent with good practice guidelines that are regularly used now for land discharges. The proposed standards refer to the New Zealand Guidelines for Utilisation of Sewage Effluent on Land (2000) by the New Zealand Land Treatment Collective (NZLTC), but some elements of the site assessment and classification processes outlined in the proposed standards are not consistent with these Guidelines. We note that AS/NZS 1547:2012 is for the design and operation of on-site wastewater systems, which can guide, but in our view is not appropriate for scaling up to land discharge systems for public wastewater systems. To assist and support, there would be benefit for the NZLTC Guidelines (or an iteration of them) to be updated to address more recent developments and to provide most of the guidance that the proposed standards anticipate will be developed during implementation. This might mean a focussed version of the NZLTC Guidelines could provide specific criteria and land discharge design procedures for a range of discharge and land management systems that comply with the proposed standards.

While the consultation documents for discharges to water and land do not provide a consent activity status i.e. permitted, controlled or discretionary, LEI support the use of controlled activity status and longer consent terms for discharges that meet the proposed standards. We also believe there is scope for expanding the range of discharge types and reducing the constraints for discharges to both water and land that are enabled by the proposed standards.

Land discharge systems commonly include discharges to water during wet periods, so we have included some commentary on key aspects of discharges to water that are relevant to dual discharge or what the proposed standards call 'mix and match' systems. It is important that the proposed standards are integrated and consistent for dual discharges, ideally with incentives to favour discharges to land over discharges to water because this is favoured by most Regional Plans and tangata whenua. We note that some aspects of the proposed standards as currently written would incentivise discharges to water instead of incentivising discharges to land.

There is an opportunity to develop the land discharge standards and guidance to integrate with the water discharge standards and ensure that land discharge systems are designed and operated in accordance with good practices. Time is short for achieving this, but we believe that it is very important to allow for this to occur before finalising the proposed water discharge standards. This will avoid creating conflicting or inadvertent outcomes for discharges to land and water when implementing the proposed standards.

To assist with developing national standards, we have proposed improvements below to help bridge gaps in the design process and address the proposed standards' variance with good practice.

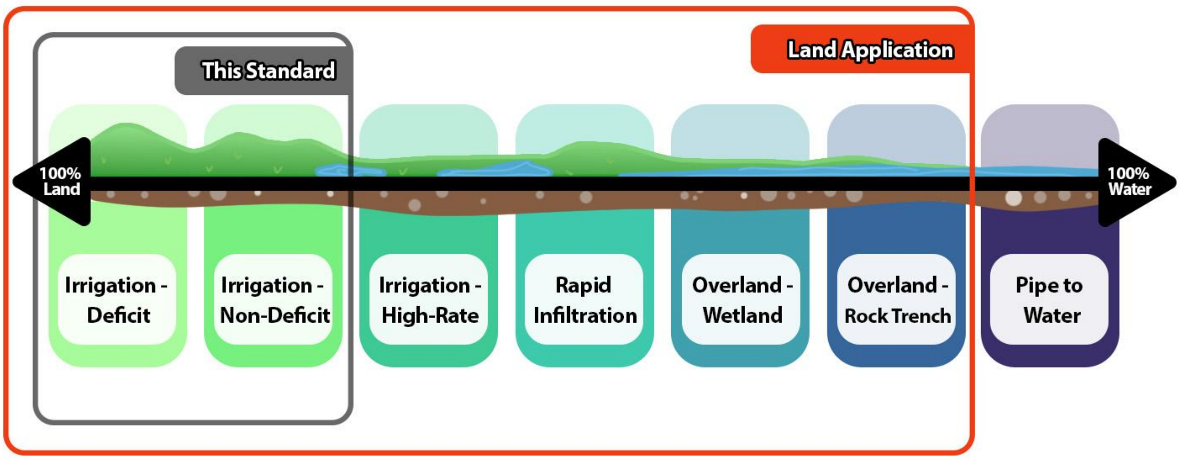
ISSUES RELATED TO THE PROPOSED LAND DISCHARGE STANDARDS

As noted above and in our responses to the questionnaire, some responses require more detailed information. The additional technical details are provided below and/or in the attached appendices.

Scope

<u>What is included</u>
The intent of the proposed standards is to focus on low-risk irrigation systems, using spray irrigators or sub-surface driplines to apply low to modest volumes and nutrient loads to land. This intent is a sensible first step for standards, as the effects on the environment are likely to be more consistently predictable and less than minor, so long as saturated soils are avoided and drainage rates are kept reasonably low. Storage ponds and/or water discharges are strongly recommended for enabling many land discharge systems to cease or reduce application depths over winter and during wet weather events.

<u>Discharge Continuum</u>
Land application systems fall on a continuum of low-rate to high-rate systems, of which when related to soil moisture conditions are considered to reflect deficit to non-deficit conditions. Such systems fall into a wider suite of discharge methods, as shown below and discussed in more detail in Appendix 2.



Recycle water

We note that the proposed standards exclude reuse or recycling of treated wastewater for non-potable purposes, and provide examples of excluded uses such as irrigation of sports fields, parks, horticulture, or dust suppression. LEI supports these exclusions for the examples in the current draft, as they generally can have higher public health risks.

However, it isn't clear if other types of reuse are excluded other than by restricting the *type of land use* that is allowed by the proposed standards.

There are various definitions for reuse and recycling in the supporting information that could lead to confusion. Where discharges to land are providing some agronomic benefits, this beneficial reuse can be either a by-product or a core purpose of the land discharge system. LEI's philosophy has always been that land discharge systems should be aiming to achieve at least some agronomic benefits, not just be seen as disposal systems, which are simply an extension of the 'flush and forget' mentality of sewage services.

For clarity, LEI is of the view that the proposed standards should include all forms of low-rate irrigation and non-public land uses, i.e. it should not preclude irrigation of forested areas, cut and carry pasture, non-human consumed harvested crops, and pasture areas.

Intensification

Land discharge consents often include land use nutrient loss (intensification) assessments and consents. It is not possible to separate land use nutrient management from consents for discharges of treated wastewater to land; they are inextricably linked and integrated. Typically, an appropriate starting point for a risk assessment is for the land treatment system to maintain the current nutrient loss rates. Should this not occur, or by virtue of establishing new irrigation, then additional considerations will need to be given with intensification provisions as prescribed in many regional plans. The proposed standards and technical advice are silent on this aspect and further guidance should be provided.

Management responsibilities

Where the land is not owned by the Council (it is leased from farmers instead), there is overlap of liability for compliance and site management. Roles and liabilities can be effectively managed through lease agreements and Management and Operation Plans. Our experience with a range of industries, Councils, contractors, and farmers co-operatively operating various land treatment systems has proven how well these arrangements can work. A critical aspect for systems is the establishment of enduring relationships, and appropriate guidance that change of council staff, revision of council budgets and sale of properties do not influence the long term performance of the system. This is potentially as important as risk assessment and design components. The proposed standards have deferred such information to implementation, however we are of the opinion that management of these relationships should lie more firmly in the proposed standards themselves.

High-rate systems

We note that rapid infiltration and wetland systems are excluded from the proposed standards. LEI believe that it would be quite straightforward to develop a discharge standard for rapid infiltration and wetlands that provide land treatment and discharge services. However, we acknowledge that such guidance should sit parallel to the proposed standards.

Groundwater Injection

Injection into groundwater is excluded from the proposed standards. LEI support this, as the character of the groundwater body will determine the appropriate discharge constraints. It is not possible to specify national standards for discharge volumes and quality because of the highly variable groundwater characteristics. We note that such discharge options would be an exception and not the norm, and therefore warrant specific critical consideration.

Discharge Quality and Integration with Discharge to Water

Many discharges to water often already have land application components or will include these in future if they transition to land treatment. We note that many WWTP's are typically unable to switch their treatment processes, or control discharge quality, to suit differing receiving environments. There may be exceptions such as where a wetland or UV system is incorporated into the treatment train that wastewater passes through before it discharges to the waterway or land. Consequently, the standards for discharges to water must integrate with and be compatible with the land discharge standards.

Mix and Match/Dual Systems

A key aspect of this integration is to ensure that the dilution calculations for discharges to water are adaptable to account for reducing volume, and time of discharges to water so that they occur when storage and application to land are diverting wastewater from the waterway. The proposed standards would benefit from a clear calculation methodology that accounts for discharges to water that avoid low river flows and instead target periods of faster river flow rates. Storage may increase the volumes that are discharged to water during some days, but the faster river flow rates can more readily assimilate discharges and will typically be more heavily contaminated by stormwater and farm runoff than low river flows.

Clarifying What is Proposed

At a high level, the proposed standards provide details of exclusions; leaving the question of what is included. A more constructive and positive approach could be to take a direct approach clearly setting out what is included, therefore leaving no doubt as to what is not included. A revised title could be **"discharge to land of treated municipal wastewater using piped irrigation technology".**

Site Suitability and Risk Assessment Process

Refinement of Risk Criteria

The proposed standard discharge limits should reflect the site suitability criteria and outcomes of design parameters, operational constraints, and mitigation measures. Guidance for the site risk assessment, including adjustments for these mitigation measures, needs to be developed to create an integral package which is agreed upon with experts before creating the final Regulations.

Design limiting factor

When developing a land application system it is common to identify the design limiting factor. Often this relates to the constraints of the site. With design and appropriate mitigation the limiting factor can switch to another factor. The proposed standards identify this approach in so far as limits being set for application rates, nitrogen, phosphorus and pathogens. However, the proposed standards do not provide for mitigation to switch the limiting factor to other parameters.

Typically, in land application systems for municipal wastewater, nutrient and pathogen mitigation can be provided so that the limiting factor switches to hydraulic loading, being the ability to get water into the soil and not generate excessive drainage, saturated conditions, ponding or runoff. It is LEI's view that the proposed standards should provide for firstly mitigation to allow the limiting factor to switch, and secondly soil hydraulic limitations to be considered other than the proposed limit on application rate and depth.

There is also a balance between treatment processes to adjust (reduce) concentrations of individual contaminants and land discharge and/or land use management to cope with the loads applied. The iterative process needs to consider potential adjustments to all aspects of the wastewater system and select the optimum combination of responses.

Rigidity of Standards

There is often tension between prescriptive standards that are inflexible and guidelines that are open to debate and interpretation. It is LEI's position that it is better for New Zealand to adopt robust standards that provide 'recipes' for common types of land discharge systems and their soil types. This will be prescriptive for limits ideally based on soil types and then mitigation measures that allow for flexibility to match each unique site and WWTP.

Suitability and Selection Criteria

The site selection and soil suitability assessments presented in the proposed standards appear to be generally based on AS/NZS 1547:2012. These are assessments for designing and operating on-site domestic wastewater management systems – typically for servicing single dwellings. This AS/NZS is inappropriate for applying its constraints to large-scale WWTP discharges because it is relevant to small automated on-site wastewater systems. Specifically, it does not reflect large-scale spray irrigation systems and the active management of these systems for large volumes of treated wastewater.

Alternative Assessment Criteria

When considering existing assessment criteria, we suggest that the existing Dairy NZ land assessment and classification system could be used instead of that in the proposed standards. Dairy effluent and treated human effluent can be largely discharged to land with similar constraints, albeit more restrictive subtleties for protecting human health.

The Dairy NZ Farm Dairy Effluent Code of Practice (FDE CoP[1]) utilises assessment criteria that classifies soil and landscape features as follows:

A. Artificial Drainage or Coarse Soil Structure
B. Impeded Drainage or Low Infiltration Rate
C. Sloping Land (>7° slope) and "Hump and Hollow" Drained Land

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[1] https://www.dairynz.co.nz/media/xomlwdav/fde-design-standards-and-cop-2015.pdf

D. Well Drained Flat Land (<7° slope)
E. Other Well Drained but Very Stony Flat Land (<7° slope)

The Dairy NZ FDE CoP uses these classifications in combination with the nutrient content of the effluent, nutrient budgets, knowledge of soil water holding capacity, soil infiltration rates, and climate data to determine the appropriate application depths as follows:

Table 1: Application depth and storage requirements for different soil and landscape features (modified from: Houlbrooke & Monaghan, 2009)

FDE risk category	**A**	**B**	**C**	**D**	**E**
Soil and landscape feature	**Artificial drainage or coarse soil structure**	**Impeded drainage or low infiltration rate**	**Sloping land (> 7°) and Hump and Hollow drained land**	**Well drained flat land (< 7°)**	**Other well drained but very stony [(a)] flat land (< 7°)**
Application depth of FDE to land (mm)	< Soil water deficit	< Soil water deficit	< Soil water deficit	< 50% of PAW_{30} (b)	≤ 10 mm & < 50% of PAW_{30} (b)
Storage requirement	Apply FDE only when soil water deficit exists	Apply FDE only when soil water deficit exists	Apply FDE only when soil water deficit exists	Do not apply within 24-hours of soil saturation	Do not apply within 24-hours of soil saturation

(a) Very stony = soils with > 35% stone content in the top 20 cm of soil.
(b) Soil water holding capacity in upper 30 cm of soil.

Further opportunity to use the FDE CoP assessment criteria is provided in Appendix 2.

Consistency of Taumata Arowai Proposals with Adequately Operating Existing Systems
We note that the proposed standards are intended to apply to existing and new land discharges. A large number of existing sites, soils, and discharge regimes do not comply with the constraints proposed for these standards, yet they have been operating successfully for many years. This is because the application management, mitigation measures, land uses, and/or receiving environment are appropriate for keeping adverse effects within acceptable ranges.

It would be unfortunate if the proposed standards were used to enforce unnecessary upgrades to WWTP treatment and/or changes to the land discharge design and operation – especially if they are operating adequately. We note that in many cases tens of thousands of dollars have been spent on investigation, design and consenting, and this has produced an acceptable system, denoted by the granting of a resource consent. Additional costs would be unwarranted for upgrades. Equally, the lessening of system performance down to the proposed standards would cause system redundancy and potentially an increase in effects to that which saw existing consents granted.

Determination of Site and Risk Categories and Assignment of Class

The proposed standards apply two categorisation phases in the determination of Site Class (Class 1, 2 or 3). It is understood that the tool for categorising risk is under development and consequently, no review is able to be provided by LEI. This section provides comments on the suitability and application of the factors that are used to define the Site Capability Category.

Risk and mitigation are key to assessing the potential for effects from a land treatment system and so support for the Class approach is conditional on an appropriate and adequate risk assessment tool being available.

The proposed standards document would benefit from being clearer in the adoption and use of the terms Risk Category, Site Capability Category and Class, in particular, to avoid overlapping meanings for the terms. For example, the site assessment diagram[2] of the proposed land discharge standards uses Levels 1-5 for the initial Risk Category and Categories 1-5 for the Site Capability Category, but these terminologies are not consistent with the categories used in the site classification matrix[3] of the proposed land discharge standards. We also note that the combination of Category 4 site suitability with Category 4 site risk in this matrix states "Standards don't apply (Category 5)." It would be more consistent and clearer if this was Class 4, not Category 5.

Site Capability Category Factors

Seven factors are listed for determination of the Site Capability Category. LEI is generally in support of the factors adopted but notes some tension between being prescriptive (Category descriptors given in the site capability assessment Table) and enabling professional judgement (notes above and below this Table in the supporting Technical Advice document[4]).

The **Drainage** factor is well aligned with similar classification systems. There is scope to further refine the drainage to align with the FDE risk classification as given in S-Map soil description sheets. This would adjust the categories to "high risk" and "low risk" soils.

The **Soil Type and Suitability** factor focuses on soil texture which is not well aligned with footnote 1 for the site capability assessment table presented in the supporting technical document for the proposed standards. It is appropriate to evaluate the soil type/sibling/series and its suitability to receive wastewater. Soil texture, which is typically related to one soil horizon, does not encompass the soil type and suitability. There may be scope to combine the soil specific factors (drainage, soil type and suitability, soil moisture regime) in-line with other evaluation systems (the FDE methodology has been identified elsewhere in this memo).

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[2] Page 28 of the Discussion document: Proposed wastewater environmental performance standards

[3] Top right of page 29 of the Discussion document: Proposed wastewater environmental performance standards

[4] Pages 23-25 of the Technical Advice on Wastewater Performance Standards: Discharge to Land (GHD)

Inclusion of **Climate & soil moisture regime** as factors to determine Site Capability is appropriate and recommended. The associated descriptors are not necessarily related to the factor. Instead, descriptors could be linked to the ability to support more, or less permissive irrigation regimes i.e. non-deficit, deficit, deferred.

The value of the **Land use** factor is in describing the potential for growing a high nutrient removal crop. It is noted that an either/or approach has been adopted for this factor. There is scope to refine these descriptors to reflect a broader range of crops. This would allow for consideration of low production and non-productive land uses more easily e.g. plantation or indigenous forestry).

LEI supports the use of **Topography** as a factor. It is noted that slope has been used as a proxy for topography. The shape of the landform should be considered in wastewater application, in addition to slope. Regarding the slope and, based on our experience of these systems, our recommendation is that Category 1 should be changed to <5 degrees (or <3 degrees to align with NZ soil description conventions).

Depth to groundwater is key to the ability for vadose zone treatment of applied wastewater. Depths adopted for this factor could be linked to data used to develop the ESR/GNS Microbial Risk Assessment tool. This would assist to avoid extensive reassessment of the Site Capability through additional assessments.

In addition to **Natural Hazards**, considerations may be wāhi tapu sites, current and planned infrastructure, fencing, energy sources and location of services (gas line, power lines, chorus fibre cables etc).

Use of Mitigation

As noted in the GHD technical advice, an iterative process is typically followed when designing land treatment systems, whereby the site's risks and characteristics are addressed through buffers, soil moisture triggers, design features (types of sprinklers or sub-surface driplines), application rates, nutrient and hydraulic loads, discharge management protocols, storage, weather event controls, farm management, and various mitigation measures. After several iterations, the final design and operating constraints are used to determine whether the discharges are appropriate for the land and contribute acceptable losses to groundwater and surface water.

A flaw in the proposed standards is the use of mitigations to change the site's risk category. This is incorrect, as the site's inherent risks remain unchanged, but the risks of adverse effects from the discharges of treated wastewater to that land are reduced with mitigation.

Limits should be set based on design iteration outcomes. It is therefore important that single limits are not fixed for all land discharge systems to achieve, as this is inconsistent with best practice methodology that should be followed when designing and consenting land treatment systems. However, specific limits should be set that reflect the limitations of site characteristics. Potential limits should focus on nutrients, pathogens and soil hydraulics, with mitigation allowing the limit applied to be changed to account for the most relevant limiting factor.

Further, the proposed standards do not provide any details on how design and operational features of the land discharge system would be taken into account. These can be very important to reduce the risks of adverse effects on the land, groundwater, and surface water. It is noted that the details are to be provided in future guidance materials for helping suitably qualified practitioners to adjust site scores, but we are of the opinion that it is important to address this up front as part of the assessment system, ideally with management having its own minimum standard. Ideally, the implementation guidelines would have been completed or at least at an advanced stage before these proposed standards were published for submissions, as they may address this issue. However, the absence of guidance has restricted the ability for potential submitters to fully review and understand the proposed standards and implications. The NZLTC Land Treatment Guidelines and relevant elements of the Dairy NZ FDE CoP should be incorporated into the guidelines for these proposed standards.

Discharge Rates

Low rate applications are the intended scope of these proposed standards, being limited to no more than 5 mm/h and 15 mm per application event and modest nutrient load limits for Class 2 and 3 sites.

However, from a hydraulic perspective, the frequency of application events is not considered, which does not address or limit drainage to groundwater, particularly during winter and for moderately draining soils. Ideally, the application event frequency should allow for return periods (typically 3-14 days) and to apply these loading rate limits as an average over the return period. A maximum 24-hour application rate is still necessary to prevent excessive intermittent applications, but a limit of 15 mm may not be appropriate for all soils and sites.

Timing and soil moisture are crucial parameters that are used to control irrigation events to minimise drainage losses and maximise agronomic benefits. A water balance approach can be more appropriate for estimating land areas, where the annual soil moisture deficit is used to estimate the annual irrigation depth. During summer, a return period of 1-3 days may be appropriate, while much longer return periods will be needed during wet periods and winter months. The proposed standards are silent on managing soil moisture. This is a flaw that needs to be addressed, as this is the basis for potential adverse effects.

A vital consideration is whether the application rates are deficit based (being application does not induce drainage) or non-deficit (allowing drainage to result following application). This directly affects land area required, plant growth rates, soil characteristics, land management, and drainage rates of water and nutrients leached to groundwater. Soils with even and slow matrix flows are better suited to receiving non-deficit applications sustainably, whereas sloping sites and soils with excessive drainage or drainage limitations should ideally be irrigated on a deficit basis.

Irrigating up to 15 mm per application event, if daily, will rapidly become non-deficit during autumn and remain non-deficit into late spring or even early summer. Deficit irrigation only occurs during late spring into autumn with pauses during wet periods and throughout winter. Immediately, this suggests that year round irrigation is not possible, necessitating either large storage or alternative discharge means. The proposed standards are silent on this factor; and could/should be more specific about the intended types of discharge regimes and consistent with this terminology.

Including a specific change in drainage depth from the current depth of drainage within the proposed standards would be more effective than limiting just the application events and annual nutrient loads. Ie annual drainage shall not increase by more than a set [50%] percentage. We note that LEI developed a similar soil moisture based controlled activity rule along these lines for municipal wastewater for the Wellington Regional Council.

Discharge Quality

E. coli

The standards' proposed limits for *E. coli* for Class 2 and 3 are very low (stringent) and below (less than) the limits for discharges to water except for rivers that provide low dilution rates (< 50 times). These proposed standards do not take into account the soil's innate ability to remove pathogens. Given the cost and ability to achieve these pathogen reductions for many small communities that have pond based WWTPs, there is no incentive to discharge to land, so water discharges will be preferred. It will be very difficult for many WWTP's to achieve these limits and for land treatment systems, they are not appropriate.

We note that the limits for *E. coli* do not provide any flexibility for different designs, mitigations, or management practices. Driplines reduce health risks for stock and people, especially when installed sub-surface. Buffers, application timing during the day and wind speed restrictions are examples of mitigations that can address health risks for sprinkler systems. Resting periods between irrigation events and stock access or harvesting also protect against health risks. We believe that these mitigations should be incorporated into decision making.

Nutrient concentration

The nitrogen and phosphorus load limits in the table at the bottom right of page 29 of the proposed standards imply that total nitrogen is typically about five times the concentration of total phosphorus. This conflicts with the 1-10 times range of relationships between these nutrients for the proposed discharge to water standards. Water New Zealand's Good Practice Guide: Waste Stabilisation Ponds indicates that total nitrogen is typically about 3-5 times total phosphorus for pond-based WWTP's and typically about 1-3 times total phosphorus for WWTP's that include denitrification processes. The low phosphorus concentrations will have the consequence of increasing sludge production at WWTP, which consequently needs to be managed. Consistency is required.

Nutrient mass loading

LEI strongly supports the proposal to adopt a nutrient mass loading approach. We consider input limits are a very useful management tool and can be easily monitored for compliance.

Regarding the limits, nitrogen loads of up to 150 and 250 kg N/ha/y and total phosphorus loads of up to 50 kg P/ha/y are supported. These are in our view sustainable for the categories of soils and risks that are used in the proposed site risk assessment where low nutrient export rates (from harvesting and/or stock) occur. However, allowing nitrogen loads of 500 kg /ha/y seems to be a fairly high load that a system applying this level should require specialised input. This is particularly so given these higher rates will most likely be non-deficit, which may generate high losses of nutrients to groundwater and surface water. These high rates can easily exceed that which can be used for agronomic benefit, a catchment nutrient balance with offsets in nutrient loss from a non-wastewater application site is considered necessary to allow the high loading rate system's effects to be managed.

Undersupply of nutrients and over treatment

When hydraulic loads are elevated, soils and plants can become deficient in nitrogen, which may force scheme operators to add synthetic fertiliser to the land. This would defeat the purpose and cost of removing nitrogen from the treated wastewater before discharging it to land. It is much better to retain nitrogen in the form of ammonia in the treated wastewater as much as possible and irrigate it to land for maximum plant growth benefits. Consideration should be given not to over treat wastewater and instead aim to use the land as part of the treatment system and not just a dispersal area.

Nutrient removal through land management

There is no explicit consideration of land management implications or nutrient removal by stock exports, cut and carry, or crop harvesting in the site capability assessment. However, the original GHD advice included all inputs (fertiliser and excreta) and exports (animals and harvesting) in these limits, so the total nitrogen and total phosphorus loads appear to be the net loads applied from all sources after subtracting all nutrient losses. The net load approach creates operational difficulties, while a set input load per ha, as mentioned earlier, is easy to administer and show compliance. The loading rate definition issue requires clarification.

Grazing

Stock grazing the irrigated land is a common pasture management system, and stand-down periods can protect animal health. The calculation of net nutrient loads if this is used needs to be very clear and explicit in the standards as to what inputs are included and what losses subtracted. LEI recommends simplifying this to only assess nutrient inputs from fertiliser and treated wastewater for loads up to 250 kg N/ha/y, with nutrient budgets for higher application rates.

Nutrient modelling and land management

Many Regional Plans seek to control nutrient losses (especially nitrogen) through nutrient management plans. OverseerFM® (or alternatives) is used to demonstrate whether the likely losses are acceptable. Crops and stock are incorporated into OverseerFM® calculations. While OverseerFM® should not be used as a reliable predictor of leaching concentrations or loads, it is still a useful tool for indications of long-term nutrient management factors that should be included here for nation-wide standardisation of assessments. We note that Farm Plans require this anyway. Modelling nutrient losses need to be considered in the proposed standards, especially as they may align or have obligations as set by other regulatory processes.

In our view, limits on hydraulic and nutrient loads applied to land, combined with soil characteristics, are not sufficient on their own to predict or manage nutrient losses. Pasture (land cover) management, crop nitrogen content, grazing, and harvesting all affect nutrient losses. Monitoring data held by LEI indicates that nitrogen losses can be similar across a wide range of application rates. Low application rates are sometimes losing as much nitrogen as higher application rate systems. A dominant factor in nutrient losses is winter irrigation, as soils are wetter and plants are less able to absorb water and nutrients.

The proposed discharge standards would benefit from allowing different discharge limits and designs for different land categories, similar to the proposals for different kinds of water bodies. This would make the land discharge standards more broadly applicable and more flexible for real world situations.

Wastewater Contaminants

What to monitor

The treated wastewater parameters requiring monitoring to demonstrate compliance with the proposed standards are volume, total nitrogen, total phosphorus, and *E. coli*. These are the minimum parameters to monitor in wastewater for land discharges of treated wastewater.

While not necessary for setting limits, $cBOD_5$ and cations (sodium, potassium, calcium, and magnesium) in the treated wastewater should be included in land discharge monitoring programmes because these parameters can affect soil characteristics and plant health. Sodium is particularly important for soil properties except for sandy soils.

The proposed standards include monitoring of soils for cations, which LEI supports, but physical characteristics such as field capacity, plant available water capacity, and hydraulic conductivity should also be included. Vegetation health should also be regularly monitored. It is also helpful to monitor plant dry matter mass and nitrogen content when it is harvested.

Trade waste

Where a community's wastewater system receives significant hazardous trade waste inputs from industries, relevant toxic metals should also be monitored in the treated wastewater and sludge. Regional Councils could be allowed to retain their discretion to impose monitoring and limits for these industrial contaminants.

Emerging Contaminants

Emerging contaminants are raised as a topic for feedback. LEI note that this is a very broad and evolving issue and is relevant for both discharges to water and discharges to land. Studies to date have identified concerns and adverse effects on aquatic ecosystems, but soils and plants appear to be much more robust and less susceptible to harmful effects; however changes in this opinion should be informed by topical robust research as it evolves. This highlights that standards should have the ability to evolve over time.

Monitoring for emerging contaminants in treated wastewater is difficult, as there is a huge range of compounds that could be considered, but most are at trace concentrations and many are unable to be reliably identified by laboratory techniques or at reasonable cost. Analyses of soils, biota, and plants for these contaminants and their metabolites are even more difficult and complex than for water and aquatic ecosystems.

We note that many years of complex research are required for determining whether specific contaminants are causing adverse effects and to identify an appropriate limit for confidently preventing adverse effects on soil quality, soil biota, plants, and groundwater quality.

Treatment processes typically used in New Zealand do not target or achieve high removal rates for most emerging contaminants. If treatment processes are required to remove more of these contaminants, the WWTP's will generate more sludge (biosolids) that needs to be managed, and some emerging contaminants will tend to accumulate in the sludge instead of being broken down. If the sludge is applied to land, especially if this is where the treated wastewater is discharged, emerging contaminants may be discharged to land at higher rates. However, this means that higher concentrations in sludge will require management.