Southland Intensive Winter Grazing NES Advisory Group

10 December 2020

OBSERVERS: Ministry for the Environment, Ministry for Primary Industries, Te Ao Marama Incorporated (TAMI), Local Government New Zealand

Executive Summary

Intensive winter grazing (IWG) can present high risk to water quality and therefore it is important that IWG is well-managed and well-regulated. This must ensure the expectations of farmers are clear, practicable and enforceable and water quality is appropriately protected[1].

The Southland NES Advisory Group (the Group) brought together a diverse range of perspectives and values and the members are unanimous in their view that the current National Environment Standard for Freshwater[2] (NES-FW) does not deliver the required quality of regulation. To ensure effective management and to avoid risk of perverse outcomes[3], change is required.

The Group is strongly of the opinion that freshwater farm plans (FFPs) that provide farm-specific solutions to the risks posed by IWG are the best way to protect freshwater. While a pathway already exists through the NES-FW for IWG that is undertaken according to an FFP, that route is currently unavailable and will remain unavailable until Government has promulgated further regulations to bring into operation Part 9A of the Resource Management Act (RMA).

Accordingly, the Group's **primary recommendation** is to institute an *interim* regime that will allow IWG to occur as a permitted activity provided it is undertaken consistent with the farm-specific IWG module (for an example of these see Appendix 1). The group also advises that the IWG Plan become part of the certified FP or a module within them.

The IWG Module would require farmers to identify risks and mitigations at the paddock scale and show that any departure from the standard conditions of the NES-FW (Regulations 26(4) and 29 (3)) will not result in greater risk to freshwater health than would occur with compliance with those standard conditions. Specific guidance and direction on how to do that will be required, although many tools are already available (including the template included as Appendix 1). An interim IWG Module will need to be submitted to the regional council and be subject to an audit regime.

The Group also acknowledges that the NES-FW provides a pathway for IWG by way of resource consent. However, as outlined within this report, due to the perverse outcomes this could lead to and the scale of consenting task for the regional council(s)[4], – for a temporary period, until FFPs are in place – this pathway should be the exception than the norm.

While the issues with the NES-FW would be largely overcome by the adoption of the interim approach outlined above, the Group considers that changes are also required to the standard conditions (Regulations 26 (4)). In particular, the Group considers that freshwater health outcomes would be improved by a requirement to protect *critical source areas* (CSAs) but that with such a requirement several of the existing standard conditions that are impractical to apply may be dispensed with. Others need minor amendment or clarification to resolve identified issues. These are detailed in the recommendations.

[1] There will also be benefits to animal welfare but the Group has not considered these benefits in detail
[2] Specifically, Regulations 26-29.
[3] See Table 1 for summary of practical issues and potential perverse outcomes
[4] Southland Regional Council has estimated that without change, it would need to process between 800-1500 additional consent applications next year.

Recommendations

The Group recommends that government:

1. **A - Where Permitted Activity (PA) conditions cannot be met, an alternate PA pathway is provided via an IWG module. These modules would need to be submitted to the regional council and be subject to audit processes. An example template is provided (see Appendix 1) to assist with the development of these modules. OR**

   B - Defer the application of the Regulations 26 (4) until such time as FFPs are in place

2. **Amend condition 26 (4) (b) IWG must not be conducted on slopes greater than 15 degrees.**
3. **Delete the pugging conditions (Regulation 26 (4) (c)) and replace with a requirement to protect critical source areas (see Recommendation 6)**
4. **Delete the replanting date condition (Regulation 26 (4) (e)) and replace with a requirement to protect critical source areas (see Recommendation 6)**
5. **Clarify that reference to 'drains' in Regulation 26 (4) (d) does not include sub surface drains**
6. **An additional condition is inserted that requires Critical Source Areas in intensive winter grazing area(s), must be protected (uncultivated and ungrazed).**
7. **Amend Regulation 29(3) so that it applies as a further condition of Regulation 26 (4) and can accordingly be departed from if the IWG is undertaken in accordance with a FFP or IWG module.**

Key quotes from Group members:

"We've got a strong track record of seeing marked improvements when we work together – cross industry and with our communities."

"We are all focused on improving outcomes and it's just the how."

"There is low tolerance, by farmers, for farmers who are not improving their intensive winter grazing practice as they are seen to be "letting the side down" and bringing the practice into disrepute."

Introduction

The Southland NES Advisory Group AKA ‘The Group’

The Group was set up following on from the hui with Ministers O’Connor and Parker in September and is made up of 2 Southland farmers (1 sheep and beef, 1 dairy); Beef and Lamb NZ, Dairy NZ, Environment Southland, Federated Farmers, Fish and Game, with iwi (Te Ao Marama Incorporated, TAMI) and staff from LGNZ, Ministry for Environment and Ministry of Primary Industries as observers.

The Group met early in October and agreed their purpose to produce concise, practical recommendations to address implementation concerns with the NES Freshwater, with their focus being the Intensive Winter Grazing elements. They have been working closely together since then to seize the opportunity, to provide suggestions to the Ministers.

The Group has applied a Southland view to the work that is the majority of the members’ expertise, however the recommendations have been shared with other regions and the opportunities that are suggested could apply nationally.

Background

“Intensive winter grazing is defined in the NES-FW as “grazing livestock on an annual forage crop at any time in the period that begins on 1 May and ends 30 September of the same year”. Intensive winter grazing (IWG) is a common practice used to feed cattle, sheep and deer outdoors throughout Southland, much of Otago and other parts of New Zealand during the winter months.

Why do we need IWG and how is it done in Southland?

The Commissioners Hearing Report on the proposed Southland Water and Land Plan stated that “due to low pasture growth during winter months and large areas of poorly draining soils, intensive winter grazing forms an integral part of pasture based livestock systems in Southland.”[5]

Southland farmers spend most of the year preparing for the winter by growing feed that can be used during the winter period. This includes crops like swedes, kale and fodder beet which grow through summer and autumn, and hold their condition through the winter. These crops provide much more feed per hectare than grass, meaning that stock can be fully fed for the winter on a smaller area of the farm, leaving the grass paddocks undamaged for the spring, when many animals are producing milk. Other feed is also harvested during the growing months and fed to stock during the winter, including grass in the form of silage, baleage or hay, as well as straw from arable crops.

There are alternative options to managing stock during the winter but these are limited. They could include; wintering on grass with supplementary feed or indoor wintering, but implementing these systems to the scale required would pose feed supply challenges during winter and spring, particularly in case of poorer growing seasons.

Research conducted by Environment Southland shows that approximately 68,000ha of fodder crop are grown annually for IWG across approximately 3,000 farms in the Region.

[5] pSWLP Hearing Commissioners Report available here

What are the risks and how is Southland addressing them?

Despite the utility of IWG to farmers and therefore the region more widely, it is acknowledged to be high risk activity with regards to freshwater health. Some of the environmental risks, in particular relate to:

- Condensing a large number of animals into relatively small areas can result in the accumulation of nitrate beyond the soil's ability to retain it, at that time of year;
- The bare soil left by the intensive grazing of crops can result in the risk of sediment and other nutrients being carried off the paddock into waterways.

Appeals on the proposed Southland Water and Land Plan are currently before the Environment Court. The Plan is a significant step on the Region's journey to implement the National Policy Statement for Freshwater Management (NPSFM) and applies controls for IWG across high risk areas or undertaken in risky ways, and farmers are required to demonstrate that mitigation measures will decrease sediment and nutrient losses to waterways[1]. Since 1 May 2019, IWG is linked to a requirement for a Farm Environmental Management Plan, and requires good management practice including back fencing breaks, riparian buffer zones, and progressively grazing slopes from the top to the bottom.

In Southland, awareness of the associated risks has heightened dramatically over the last 5 years, resulting in many farmers making significant changes to their practice, without regulatory requirement. It is now common to see a range of good management practices implemented in a bespoke, farm specific way, including the protection of critical source areas, wide buffers adjacent to waterways, minimum tillage, catch crops, back fencing, strategic grazing of stock towards waterways, and use of portable water troughs.

Compliance Monitoring

There is general agreement that there remain some farmers who need to improve the management of their IWG to protect freshwater health. There is acceptance that for some of those, it will take regulation and enforcement to force a change in practice.

During the 2019 IWG season (May – September) Environment Southland undertook compliance flights to monitor farmers' implementation of required good management practices. They found there was widespread evidence of poor practice and this was reinforced by members of the public and the media. On the ground inspections and enforcement action where necessary, followed on from the flights.

As good management practices were not being consistently applied, Environment Southland and a range of industry groups (DairyNZ, Beef + Lamb NZ, Federated Farmers MfE and MPI) worked together to ensure a consistent and proactive approach to getting the message out to farmers about the required good management practices. All parties have worked hard to help farmers lift their performance through providing advice and making information available; as well as implementing a solution to modify consent conditions for farmers struggling with excess stock due to a slow down at processing plants because of COVID-19.

This year, cultivation flights were completed before grazing started to identify high risk areas and those landowners were offered specific assistance. This was supported by communications across parties to ensure consistent messaging. This was then followed up with aerial inspection flights by the compliance team during the season. The inspections showed considerable improvement in the adoption of good management practices than in the previous year with only a small number of properties requiring follow-ups, mostly relating to education around critical source areas and back fencing. This joint initiative is ongoing, with the industry groups working together to ensure farmers make good plans for next year's winter grazing season.[7]

[6] See Appendix N and rule 20 of the pSWLP
[7] Extract from Compliance Monitoring report (2020)

This has been supported by the initiation of a pilot app which has been trialled by farmers in the Aparima Community Environment project. The further development of this tool is an opportunity to link to the expediting of the recommendations in this report.

These examples shows how regulations can be combined with education to improve freshwater health.

Methodology

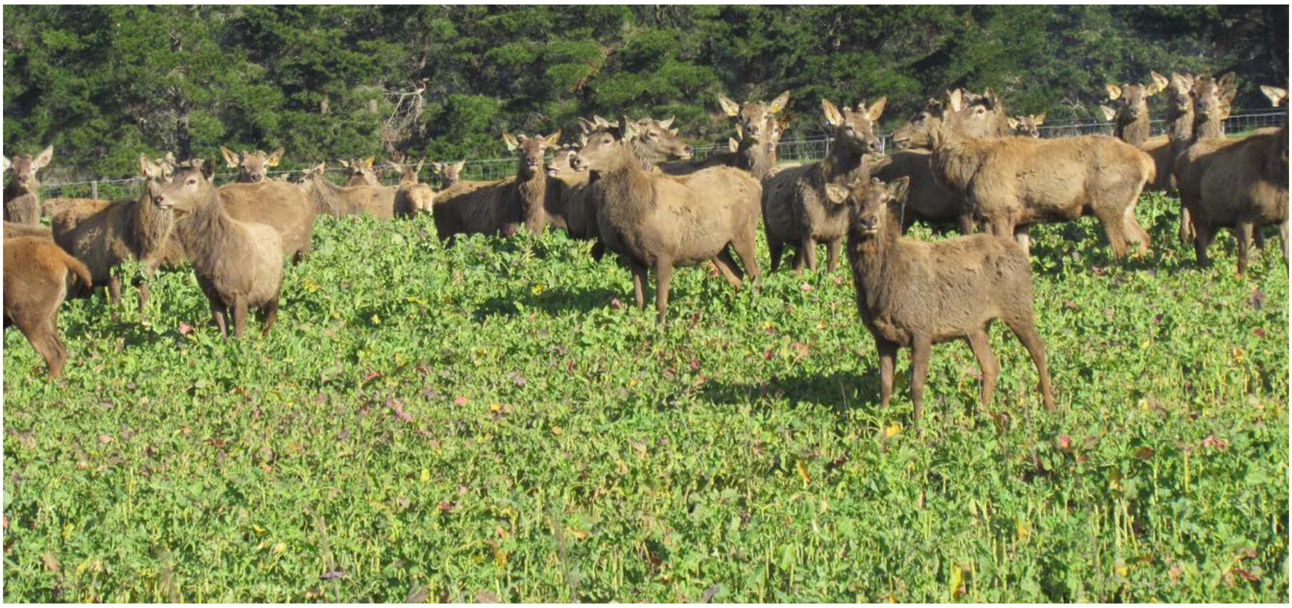
The Group was asked to provide a review and practical recommendations for implementation of the NES-FW. Their concerns stemmed from the impact on both the community and Council of imposing one-size-fits-all restrictions on farmers some of whom are already taking the right steps to protect the environment.

The approach the Group took to this task was:

1. Review the Intensive Winter Grazing (subpart 3) elements of the National Environmental Standards (gazetted 3 August 2020) with an effects-based lens and to assess how could the rules be implemented as they are;
2. Analysis of the Permitted Activity standard criteria
3. Propose recommendations to:
   a. Make minor alterations to the regulations to:
      i. Improve practical implementation and enforcement;
      ii. Reduce risks of perverse outcomes;
      iii. Improve environmental benefits.
   b. Identify any specific points that aren't addressable via 1 and 2
4. Throughout this process the Group members have been liaising with their organisations, as well as the sector more widely to discuss issues, and test possible solutions.

There are widespread concerns that aspects of the IWG regulations in the NES for Freshwater will be challenging or impossible to implement, as well as potentially causing perverse freshwater health outcomes and undermining the positive effects being achieved by large numbers of farmers.

This report has been provided to make recommendations to Ministers on how the NES could be improved to achieve reduced risk to freshwater health through targeted and appropriate regulation.



Recommended Approach

The NES Intensive Winter Grazing regulations (subpart 3) come into force on 1 May 2021 and has a three pathway approach:

1. Enables the lowest risk winter grazing to be carried out as a permitted activity within specified conditions (Clause 26(4)).
2. Allows those who cannot meet the specified conditions to show how adverse effects will be mitigated via a certified freshwater farm plan, and therefore proceed, with that, as a permitted activity.
3. Where specified conditions cannot be met, and where adverse effects from those cannot be shown to be mitigated in a certified freshwater farm plan, a restricted discretionary consent is required.

IWG activities that cannot meet permitted activity standards can continue temporarily without a consent if all conditions in s20A(2) RMA apply. However, any consent application must be made within 6 months of subpart 3 coming into force, i.e. by 31 October 2021. Advice provided to the Group indicates that the FFP process will not be available for some time, leaving an 'interim' issue with the implementation of the NES-FW ie. the absence of the second pathway above. This means that IWG grazing activities will need to either comply with standards in Reg 26(4) or require a consent application to be submitted by 31 October 2021 at the latest.

The group considers the second pathway to be **essential** as it will enable conditions to be relatively stringent, providing additional oversight of most winter grazing, without creating an overly bureaucratic regime and perverse outcomes that would otherwise arise. Without this pathway, the NES will drive very large numbers of consents to be required, including from those operating in accordance with industry best practice.

It is also important to note, farmers generally wish to avoid the uncertain costs and outcomes associated with the consent process. Therefore, actions likely to benefit freshwater health can be incentivised by enabling them to be pursued without a resource consent. Some of the recommendations have been proposed with this in mind.

Intensive Winter Grazing Modules

We recommend a new, interim step is introduced in the form of an intensive winter grazing module of a freshwater farm plan (FFP), until a process for certified freshwater farm plans is available.

These need to be prioritised and rolled out, prior to the wider certified FFP structure being in place. A number of versions of these exist and are used by Industry and Regional Councils – e.g. Appendix 1.

The introduction of these modules would ensure farms which cannot meet the conditions – Clause 26(3) – can improve the management and outcomes associated with their IWG activities in the meantime (i.e. prior to certified FFPs being available. But avoiding the need for communities and Regional Councils to establish complex consenting and enforcement procedures, for a short-term, temporary period.

Requirements and Suggested Content

These modules would require farmers to:

- Identify the elements of IWG activity which generate the most risk for their property;
- Outline their plans to mitigate these specific risks; and
- Demonstrate that any adverse effects will not be greater than if they had met the specified conditions, as per the requirements of a certified freshwater farm plan in 26(3)(b).

Where that is not possible (i.e. appropriate mitigations are not able to be implemented), a consent would be used ensuring a necessarily high bar for highest risk IWG, in line with the stated purpose of the NES.

A number of matters that an IWG module would be required to address should be outlined. The group recommends the following critical matters:

1. Paddock risk assessment / selection (identify the risk factors associated with a paddock[8])
2. Crop establishment / paddock set up (mitigation of risk factors through buffers, exclusion of CSAs, cultivation methodology, trough and supplementary feed placement plan)
3. Strategic crop grazing (plan for strategic grazing to mitigate risks)
4. Post crop grazing management (planned next crop, mitigation of risks until re-sowing)

These plans would need to be bespoke and regionally adaptable to enable farmers to be proactive about managing their specific risks and ensure their focus is directed at freshwater health rather than just regulation adherence.

Audit and Assurance

The IWG module (e.g. Appendix 1) could be the certified Freshwater Farm Plan to manage IWG activities, until certified FFPs are available. In the meantime, these modules would need to be submitted to Council so that they can be audited. The audit approach would need to be determined and could either apply to all farms or a sample of them, which could be chosen at random or selectively (e.g. if issues arise during the season). Environment Canterbury's audit standards[9] could be made use of in order to fast-track this element.

Regulatory oversight and assurance needs to be provided for, to give Regional Councils, the Ministry and industry confidence that this interim step will deliver the desired outcomes and contribute to halting further decline in freshwater health. To enable this the Group suggests that an additional clause is added to the NES-FW clause 26 (4) to enable IWG modules to be enacted, for a temporary period of time, in advance of the FFPs.

Implementation Suggestion

An IWG module could be put in place relatively quickly, and they could then form part of the broader FFP once they are established (or be superseded once the FFP are in place) and a wider certification approach is available. An example of a national template that could be easily rolled out – adapted to regional needs and apply local values etc. – is attached at Appendix 1.

In addition to Appendix 1 there are a number of other existing examples of similar templates that could also be made use of which would ensure fast roll out and uptake of these modules. These could be rolled out (to some degree) via the use of an app similar to the one currently in development in Southland[10].

Recommendation 1

A. Where Permitted Activity (PA) conditions cannot be met, an alternate PA pathway is provided via an IWG module. These modules would need to be submitted to the regional council and be subject to audit process. An example template is provided (see Appendix 1) to assist with the development of these modules. OR

B. Defer the application of the Regulations 26 (4) until such time as certified FFPs are in place

[8] As range of these of these resources exist e.g. Horizons.
[9] https://www.ecan.govt.nz/document/download?uri=3759146
[10] How to use the winter grazing app - https://youtu.be/N_BEdESmGP4

Permitted Activity Conditions

The Group recommends some alterations to the conditions to ensure that they are practical and effects focused. Each of the existing conditions and high-level feedback about them are each outlined below.

Mean Slope

'The mean slope of a paddock that is used for intensive winter grazing must be 10 degrees or less'

The use of mean slope, and paddock scale to drive this condition create a number of challenges:

- large parts of Southland (and New Zealand's) farmland is very undulating - any one paddock can have a lot of variation throughout. Therefore calculation of the "mean slope" is problematic for both farming and consenting purposes;
- the paddock scale of this condition may limit positive strategic practices within a paddock, and could also create loopholes leading to farmers 'gaming the rules' by moving or removing fences;
- use of 'mean slope' may enable steep slopes to be cultivated if they only form a small portion of a paddock;
- stringent conditions based on slope may drive more intensive grazing to lower slope but "leakier" soils.

Determining absolute slope is straightforward for farmers and regulators through use of a free clinometer mobile phone app.

The proposed Southland Water and Land Plan has a maximum allowable slope (20 degrees) for cultivation enabling the low slope parts of a paddock to be cultivated, but steep areas must be left uncultivated. This solution focuses on the risk posed by cultivating steep slopes, is simple for farmers and regulators to determine, and encourages farmers to remain focussed on the use of lower risk land for intensive winter grazing.

If a farmer did wish to include steeper slopes in their intensive winter grazing area, there are mitigations available that would need to be outlined in the IWG module as outlined above. These may include the use of minimal tillage techniques (direct drill) which also protect soil structure, increased buffer zones along waterways to accommodate increased risk of nutrient run-off associated with steeper areas and strategic grazing of the crops.

Further to recommendations below, the Group has also recommended an additional condition regarding the management of critical source areas (Recommendation 6) which could include increased vegetated buffers. This will further strengthen the requirement to mitigate risks of intensive winter grazing on slopes.

Recommendation 2

Amend condition 26 (4) (b) IWG must not be conducted on slopes greater than 15 degrees.

Pugging and Replanting Date

'On a paddock that is used for intensive winter grazing, pugging at any one point must not be deeper than 20 cm; and pugging of any depth (5cm+) must not cover more than 50% of the paddock.'

'On a paddock that is used for intensive winter grazing, the land that is used for intensive winter grazing must be replanted as soon as practicable after livestock have grazed the land's annual forage crop (but no later than 1 October of the same year).'

Both these conditions have difficulties in terms of practical implementation, consenting or enforcement perspective, and as they are will have minimal benefit to freshwater health. Further, compliance (or absence of) is likely to be very difficult to prove and defence may exist under s351 (natural event).

They aim to manage the effects of bare soil being left for long periods, by minimising overland flow and sediment run off. Once stock are removed from an intensive winter grazing area, the ground can quickly harden which reduces the likelihood of run-off and the highest risk period for any paddock is when it is freshly cultivated as the fine soil is more mobile. This risk is not addressed by these conditions.

Pugging

There are a number of implementation challenges for this condition, from a farming and an enforcement perspective, including:

- Determining depth of a single hoof print is challenging due to the soil displacement that occurs with each hoof placement and the settling effect that occurs once the ground is left undisturbed (i.e. at which point in the winter period does the definition apply?)
- Determining the scale across a paddock to e.g. cover more than 50% also challenging, but would be required to enable enforcement of this condition.
- The ability of farmers to comply with this condition is largely weather dependant which could make enforcing this element highly problematic and possibly challengeable under s341 of the RMA.
- Farmers are encouraged to utilise portable troughs to enable cattle to be kept off previously grazed areas – but this discourages that practice by providing an exception only for permanent troughs.

Replanting Date

The practical implementation concerns include:

- Perverse outcomes can arise from the planting of some crops too early. For example: brassicas will mature too early if they are frosted at a young age; grass struggles to compete with weeds if planted in cooler soils and therefore requires more weed spraying.
- Replanting decisions are determined by weather conditions including soil moisture and temperature and therefore are very hard to predict and obtain advance consent for.
- Climate change and national variability make these dates even harder to predict.
- Non-compliance would be virtually impossible to monitor, prove and therefore enforce.

Basing sowing decisions on an arbitrary date could cause more harm than good. This is highlighted by some perverse outcomes and other negative consequences that the condition in its current form, may cause:

- It will encourage heavy machinery use on paddocks when soil conditions are not appropriate – i.e. too wet or cold.
- This may result in soil damage, crop failures (creating an additional high risk in the post-cultivation period) and additional weed spraying.

- It may also result in more bare soil if farmers are pushed to avoid second cropping winter crop paddocks in an attempt to meet this condition, they may instead need to cultivate new paddocks.

In addition, behaviour change education and the sharing of examples of good practice such as direct drilling, under-sowing and cut and carry crops is also necessary. There are many examples of support available to industry such as the ECan Winter Forage Crop grazing and Wet Weather Management guidance[11]

The Group suggests that the risks and environmental outcomes such as minimising sediment run-off, can be better addressed by critical source area management (Recommendation 6) – which could include the provision of mandated buffer(s) – and that these conditions should therefore be removed.

Recommendation 3

Delete the pugging conditions (Regulation 26 (4) (c)) and replace with a requirement to protect critical source areas (see Recommendation 6)

Recommendation 4

Delete the replanting date condition (Regulation 26 (4) (e)) and replace with a requirement to protect critical source areas (see Recommendation 6)

Area of the Farm for IWG

'The area of the farm used for intensive winter grazing must be no greater than 50 ha or 10% of the area of the farm, whichever is greater.'

This condition will likely drive the wrong behaviours and could stifle innovation, such as encouraging farmers to operate their winter grazing more intensively to stay within the condition, and/or discouraging them from changing to lower yielding or mixed crops which may provide better environmental outcomes. An alternate improvement would be a focus on the amount of feed provided from the farm during the winter period.

Additional challenges associated with this condition are:

- Measurability in the field is very impractical from an enforcement perspective
- Flexibility for farmers is removed, fore example, in a poor growth year where crop yields are low, additional areas of alternative crops (such as turnips or rape) may need to be sown late to provide enough stock feed for the winter period.

However as long as the second pathway exists, enabling farmers to show how the use of larger land area for winter grazing may achieve better environmental outcomes, we are not recommending a change to it.

Buffers: Drain Definition

'On a paddock that is used for intensive winter grazing, livestock must be kept at least 5m away from the bed of any river, lake, wetland, or drain (regardless of whether there is any water in it at the time).'

[11] Available here - https://www.ecan.govt.nz/document/download?uri=3892930

Ungrazed buffers are an accepted and well understood good management practice. There are some concerns around the requirement to move existing fences but we have not made any recommendations in this regard as we believe this is a condition that can be lived with.

Currently the use of 'drain' in the NES-FW, refers to the National Planning Standard definition (*"any artificial watercourse designed, constructed, or used for the drainage of surface or subsurface water, but excludes artificial watercourses used for the conveyance of water for electricity generation, irrigation, or water supply purposes"*) can be interpreted to include subsurface drains i.e. tile and mole drains.

This inclusion would necessitate a 5m buffer from all parts of the extensive tile/mole drain network when intensive winter grazing and a 50m buffer from stockholding areas. This network has been established over several decades and cannot be practically mapped. However, experts have estimated that in Southland these drains cover approximately 200,000 hectares. As a result of how the rules are written very few farms would be able to meet the PA conditions, and IWG would be driven to free draining, leakier soils.

We seek clarification that this condition does not include subsurface drains, as this would be unworkable from both implementation and enforcement perspectives. A consenting pathway to meet this condition would also be problematic due to the absence of required information (huge amounts of unmapped tile draining was carried out by previous generations).

The Group understands from Ministry officials that subsurface drains weren't intended to be captured.

Recommendation 5

Clarify that reference to 'drains' in Regulation 26 (4) (d) does not include subsurface drains

Critical Source Area Management

Critical source area (CSA) management is not currently covered by the regulations, however, substantial evidence[12] shows that the practices addressing CSA's and the avoidance, or interception of, overland flow result in the reduction of multiple contaminants associated with IWG activities (phosphorus, sediment and faecal microbe losses). Studies looking at CSA management during grazing of a winter forage crop by dairy cows in South Otago found that sediment losses could be reduced by c.80% and phosphorus by c.60-70%.[13]

Critical source area definition from the proposed Southland Water and Land Plan:

(a) a landscape feature like a gully, swale or a depression that accumulates runoff (sediment and nutrients) from adjacent flats and slopes, and delivers it to surface water bodies (including lakes, rivers, artificial watercourses and modified watercourses) or subsurface drainage systems; and

(b) areas which arise through land use activities and management approaches (including cultivation and winter grazing) which result in contaminants being discharged from the activity and being delivered to surface water bodies.

[12] See MFE Chapter 17 Regulatory Impact Statement
[13] Monaghan et al., 2017

It is important to note that this definition focuses on critical source areas which are connected to waterways and if farmers focus their efforts in these locations (see Appendix 2 and referred to there as 'contaminant transfer zones'), freshwater health outcomes will improve.

Existing Good Management Practice[14][15] supports the avoidance of cultivating these areas and leaving them in pasture to protect soil structure and reduce surface runoff and there are straightforward mechanisms to determine the size of buffer areas required in these cases, as outlined in the Land and Water Science letter. The IWG module or FFP would give farmers the opportunity to outline those alternative mitigations if they were implemented.

The management of critical source areas may not address the nitrate loss risk which this condition also attempts to mitigate. However nitrate loss mitigation is very farm, crop and season specific and is more appropriately addressed via bespoke farm plans or the recommended IWG module.

We recommend all CSAs, in IWG area(s), be identified[16] prior to any cultivation and a minimum width of 5m be left uncultivated and ungrazed, therefore providing a filter for any sediment runoff that occurs. This could be managed via the Intensive Winter Grazing Module (as per recommendations 1.)

The strengthened management of CSAs will provide improved freshwater health outcomes, be more practical for implementation and enforcement, have wider benefits beyond IWG, and contribute significantly, towards addressing the effects which the pugging and re-sowing date and slope conditions intend to manage.

Recommendation 6

An additional condition is inserted that requires Critical Source Areas in intensive winter grazing area(s), must be protected (uncultivated and ungrazed).

Reference Period

Rule 29(3) restricts the use of permitted and restricted discretionary activity rules to the land used for IWG during the reference period. This limits the area of land able to be used for IWG to a maximum area of the farm as was used for that purpose during that period.

This rule could result in a worse environmental outcomes and stifle innovation or better practices. For example, it may encourage farmers to use the maximum amount of an IWG area of the farm during the reference period to avoid losing the ability to do so. This discourages farmers from changing to lower yielding or mixed crops which may provide better outcomes.

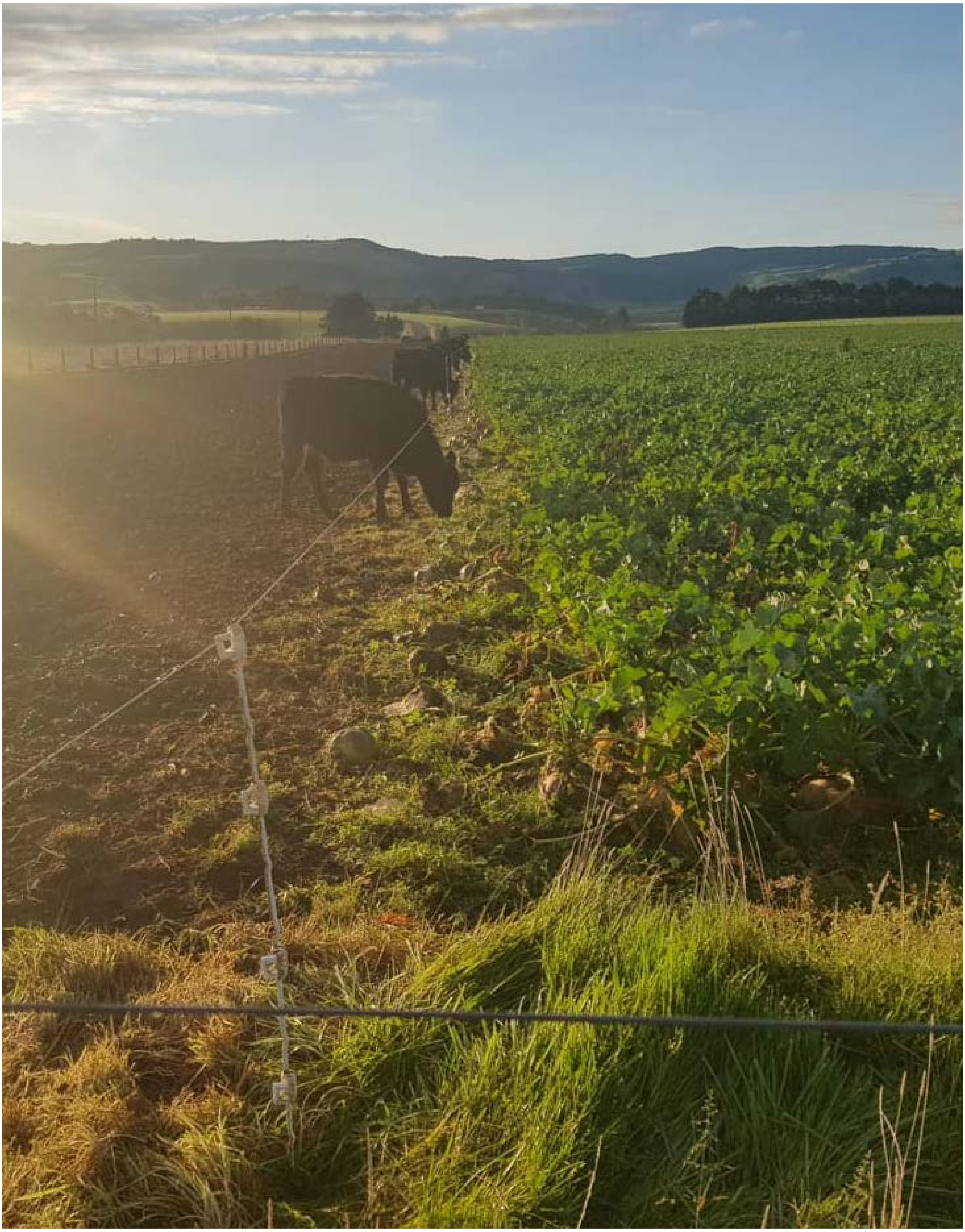
We recommend an amendment to the reference period condition in Rule 29(3) be provided to enable an exception if there are clear freshwater health benefits. For example, if a farmer wanted to shift their existing intensive winter grazing from a high leaching location to a lower leaching location (e.g. lower rainfall, flatter land, heavier soils or lower attenuation), the regulatory pathway should encourage improved outcomes. This could be achieved through an IWG module or certified FFP. On the other hand, the requirement to obtain a resource consent (and the associated uncertainty and cost) may be a barrier to making this positive change.

[14] Industry agreed GMP's available here: https://beeflambnz.com/knowledge-hub/PDF/industry-agreed-good-management-practices-relating-water-quality.pdf and the IWG Pan Sector Policy Guidelines
[15] Dairy NZ supporting information wintering-standard-operating-procedure.pdf (dairynz.co.nz) and break-fed-wintering.pdf (dairynz.co.nz)
[16] Digital Elevation Models (DEM) can be used to objectively identify CSA's for the purpose of excluding these areas from intensive winter grazing.

Where the benefits are not clear, or adverse effects not able to be clearly mitigated, the "third pathway" (resource consent) would still be required, enabling much more scrutiny.

Recommendation 7

Rule 29(3) becomes a further condition, rather than a standard which automatically causes the activity to become non-permitted.



Appendix 1

Draft Intensive Winter Grazing Module

Note: These modules would need to be bespoke and regionally adaptable to enable farmers to be proactive about managing their specific risks and ensure their focus is directed at freshwater health rather than just regulation adherence.

Purpose: To support farmers undertaking winter grazing activities. This completed module should provide sufficient detail and content required by Councils for managing winter grazing activities based on regional and national rules.

How to use this: This document is not a tick box exercise and will require you to think through why and how you will be doing what you plan to do. The end result should be fewer environmental impacts, better animal health, and increased soil health. Note that this will be a starting point and further detail will likely be required depending on the location, form, and extent of winter grazing occurring within the farming system. If you are intending to expand your winter grazing activities, this will definitely be the case.

Context: At a high level, what a Council is trying to assess is what effects are likely to come from your winter grazing activities. This will depend on the land you are farming as well as your management of it. This module will provide you, and them, with assurance that you are doing a good job managing the risks that are present in your specific situation. These plans would need to be bespoke and regionally adaptable to enable farmers to be proactive about managing their specific risks and ensure their focus is directed at freshwater health rather than just regulation adherence.

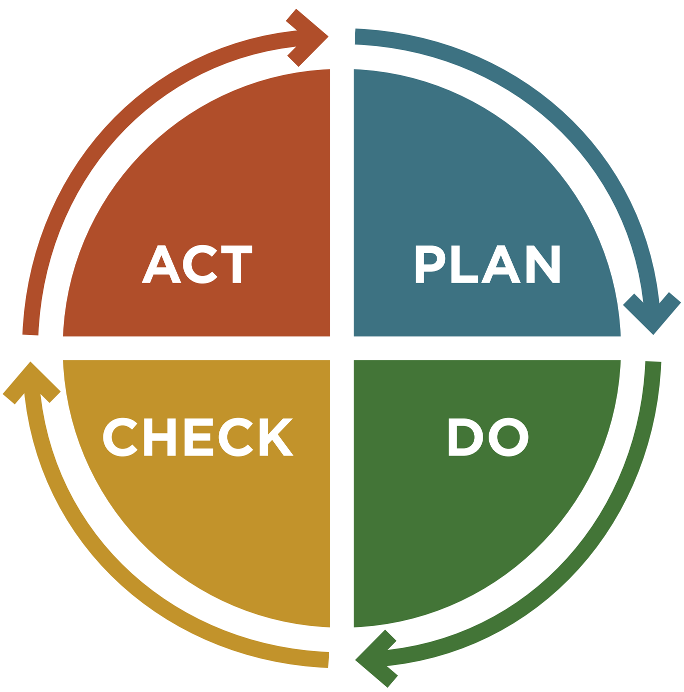
Process: This should be a 'living' document and adjusted overtime as needed. There are four main steps that this document takes you through:

Step 1: PLAN – This is where you gather information, assess what risks are present, and make a plan to manage the risks you identified. In this document, this is Parts 1 and 2.

Step 2: DO – This is where you implement your management actions and adverse weather plan. Make sure to monitor your impacts. In this document, this is Part 3.

Step 3: CHECK – This is where you, or a 3rd party, check up on the implementation of your management implementation and progress. In this document this is Part 4.

Step 4: ACT - This is where you review and adjust the plan as needed. In this document, this is Part 5. Then you start the process again.



Part 1: Farm And Cropping Overview

Years covered by this plan			
Farm Name:		• Water management zone:	
Owner:		• Water management sub zone:	
Manager:		• Ground water management zone :	
Contact details	Phone:	Email:	
	Mailing address:		
Location of property[17]:			
Legal Description and Agribase number:			
Total Farm area (ha):			
Average area used for wintering every year		Total Area (ha) used for wintering over 5 years.	

Crop and Animal Descriptions

Livestock	
List all possible animals you might have on a winter crop throughout the entire consent period. For each type of stock, list the expected number of animals grazing a winter forage crop on this property per year.	
Beef R1/R2 heifers	
Dairy R1/R2 heifers	
Beef adult cattle	
Dairy Adult cattle	
Lambs	
Mixed age sheep	
Deer Hinds	
Deer Stags	
Others	

Feed System			
List all possible crops and supplementary feeds (for intensive winter grazing) you might grow throughout the entire consent period. Note the expected area of each crop you would utilise on a yearly basis.			
Annual forage crop 1		Area (ha):	
Annual forage crop 2		Area (ha):	
Annual forage crop 3		Area (ha):	
Annual forage crop 4		Area (ha):	
Annual forage crop 5		Area (ha):	
Supplement feed 1:		Feeding location/ infrastructure	
Supplement feed 2:		Feeding location/ infrastructure	
Supplement feed 3:		Feeding location/ infrastructure	
Supplement feed 4:		Feeding location/ infrastructure	
Supplementary feed Comments			

[17] A different management plan is expected to be completed per property.

Part 2: Plan - Winter Grazing Content and Context

Goal Setting and Context

Please outline how winter grazing currently fits, or will fit into your farming system. You can write this out and/or tick the boxes below.

- ☐ **Pasture renewal:** to utilise forage crops as part of our pasture renewal programme with the aim of renewing all pastures over the next ____ years. This will be done in a way that enhances the production system without impacting our soils and waterways and supports healthy animals.
- ☐ **Resilient system:** to ensure the stock we carry through winter have adequate feed supply while ensuring that our cropping system supports healthy soils, healthy water, healthy people and healthy animals.

Farm Mapping and Paddock Selection

All areas proposed to be winter cropped and grazed on the farm need to be identified on a map. Use this section to include a Farm map showing paddocks to be used for wintering during the period being applied for. Please include key features like paddock boundaries and waterways, wetlands, bores, or drains

Risk Assessment

In order to manage the risks associated with your planned winter grazing activities, you must first know what risks are present, and what impact they can have. The table below takes you through aspects of a winter grazing activity increases the risks to waterway (as well as human) health and wellbeing.

This table can be completed at a paddock or Land Management Unit scale. A Land Management Unit is an area of land that can be farmed or managed in a similar way because of underlying physical similarities. For winter grazing activities, you can group together paddocks that have similar slope or soil characteristics.

In the next section, you will describe how you will be managing the risks associated with your planned winter grazing activities.

Risks	✓	Impact
Slope		Sediment or phosphorus potentially entering waterways
Steeper slopes (greater than 8 degrees -Class C[18]) are present within paddocks		
Steeper slopes (greater than 8 degrees) are intended to be cultivated		
Steeper slopes (greater than 8 degrees) will be winter grazed		
Steep slopes (between 8-15 degrees- Class C) will be winter grazed		
Steep slopes (greater than 16-20 degrees- Class D) will be winter grazed		
Steep slopes (greater than 21 degrees or more - Class E or higher) will be winter grazed		
Erosion		
Soils are identified as having erosion risks		
Soils have a moderate erosion risk		
Soils have a high erosion risk		
Erosion is visible within the paddock(s) to be cropped		
Overland transport of nutrients		
Waterway is within the paddock being winter grazed		
Water within paddock to be winter grazed flows into nearby waterway		
Cultivation is done via a method where soil is exposed (i.e. not direct drill)		
Cultivation is done down the slope rather than across it		
Presence of a Critical Source Area within the paddock		
Soils are heavy or poorly drained		
Paddock is prone to flooding		
Total risks present		
Scale of risks		(1-3 Low, 2-4 Medium, 4+ High)
Risks	**✓**	**Impact**
Contaminants		Contaminants, like pathogens such as E.Coli, potentially impacting on human health
Waterway is within or close by the paddock being winter grazed		
Drinking water bore or takes are close to paddocks or downstream of winter grazed area		
Stock have access to waterways (x2)		
Total risks present		
Scale of risks		(1 Medium, 2+ High)

[18] The 'Class B' and other Classes of slope in this section are based on the New Zealand Land Resource Inventory assessment. Ideally, these assessments would be made at paddock scale. LRI classes are based on the risk of erosion and how challenging it is for different machinery operations. Class A is 0-3degrees (flat to gently undulating), Class B is 4-7 degrees (undulating), Class C is 8-15 degrees (rolling), Class D is 16-20 degrees (strongly rolling), Class E is 21-25 degrees (moderately steep hill country), Class F is 26-35 degrees (steep hill country), and G is 35 degrees or greater (very steep cliffs). According to LUC handbook, slopes greater than 15 degrees are not particularly suitable for normal crop rotations and tend to have high cultivation costs. More information can be found in Appendix 1 (page 137-138): https://nzsss.science.org.nz/app/uploads/2016/04/luc_handbook.pdf

Risks	✓	Impact
Nutrient Leaching		Nitrogen potentially entering waterways
Winter grazing is occurring on free-draining/gravelly soils		
Subsurface drains within the paddock		
Nutrient concentration		
Animals are intensely concentrated in a small area while the soil is cold and wet		
Critical Source Areas will be cultivated or grazed		
Total risks present		
Scale of risks		(1 Low, 2+ High)

Risks	✓	Impact
Stock class type		Maintain soil health and structure
Sheep are winter grazed		
Young cattle are winter grazed (around 350kg) (x2)		
Cattle are winter grazed (above 350kg) (x3)		
Hinds are winter grazed (x2)		
Stags are winter grazed (x3)		
Soil type		
Soils are imperfectly draining		
Soils are poorly draining		
Crop type		
Kale crop		
Bulb Brassica crop like swede or fodder beet (x2)		
Total risks present		
Scale of risks		(1 Low, 2 Medium, 3+ High)

Risks	✓	Impact
Winter Grazing is occurring close to an area used to collect Mahinga kai		
Winter Grazing is occuring close to a wai tapu site		
Total risks present		
Scale of risks		(0 Low, 1+ High)

Summary of Risks In this section, tick the level of risk you identified based on each impact category			
	LOW	**MEDIUM**	**HIGH**
Sediment and Phosphorus impact			
Contaminant impact			
Nitrogen impact			
Soils impact			
Maori Values impact			

Risk Management

As you found when completing the risk assessment, some paddocks will pose higher risks than others based on the characteristics of the land, soil, and site. These are things that can't really be controlled but can be managed so that the risk to freshwater, soil, and human health is lowered. This section provides you with some context about what environmental management goals should be front of mind when grazing winter crops and provides a set of management options for you to reference. These are just that, options.

However, note that they do follow good management principles and are proven ways to reduce the risks posed by winter grazing activities. Discuss how you will be putting these into action on your farm (if suitable to your situation). Focus on how you will be managing the medium and high risk impacts you identified as part of the risk assessment.

You can check out these resources for more info: https://beeflambnz.com/knowledge-hub/PDF/winter-forage-crops-management-during-grazing.pdf and https://beeflambnz.com/knowledge-hub/PDF/ten-top-tips-winter-grazing-crops.pdf

<table>
<tr><th colspan="2">Management Goal</th><th>Management Option[19]</th><th>Risk Assessment Value</th><th>Management Actions</th></tr>
<tr><td rowspan="10">Reduce the likelihood of sediment or phosphorus entering waterways</td><td>Slow the flow of water over the surface of exposed soils</td><td>Strategic grazing from top of paddock down the slope with long-narrow feed breaks</td><td rowspan="10">Sediment and Phosphorus Risk Impact level</td><td rowspan="10"></td></tr>
<tr><td rowspan="3">Reduce the likelihood of contaminants entering waterways</td><td>Buffer strips are established at the base of large or steep slopes to slow the slow of water</td></tr>
<tr><td>Buffer strips established within paddock to slow the flow of water and trap nutrients</td></tr>
<tr><td>Riparian buffer strips or ungrazed areas established around Critical Source Areas and waterways (note this must be 5m width for waterways 1m or wider)</td></tr>
<tr><td rowspan="6">Reduce the time and extent of bare soil exposed to stock and the elements</td><td>Sowing of crops along, rather than up and down, the slope of the paddock where safe to do so</td></tr>
<tr><td>Use of direct or minimum till cultivation</td></tr>
<tr><td>Leave a 'buffer' between grazed area and the waterway or critical source area. Note, this must be 5m from a waterway that is 1m or wider.</td></tr>
<tr><td>Re-sow the paddock as soon as is it practical to do so (based on weather and soil moisture levels).</td></tr>
<tr><td>If Critical Source Areas have to be cultivated and grazed then grazing is done lightly and when soil and weather conditions allow and preferably at the end of the season (when the soil is at its driest).</td></tr>
<tr><td>Sediment is prevented from entering larger waterbody via sediment trap/dam</td></tr>
</table>

Management Goal		Management Option[19]	Risk Assessment Value	Management Actions
Reduce the likelihood of contaminants, like E.Coli impacting on human health	Stock have limited or no access to waterways or contaminant transport pathways	Stock are excluded from waterways that are 1m or wider by a 5m buffer.	**Contaminant Risk Impact level**	
		Stock water reticulation system operating effectively and efficiently		
		Bailage/feed sites where stock tend to congregate are away from waterways and critical source areas		
Reduce the likelihood of Nitrogen entering waterways	Track the inputs, utilisation, and losses of nutrients from the farming system	Use of nutrient modelling tool to understand and manage nitrogen losses occurring on-farm	**Nitrogen Leaching Risk Impact level**	
		Soil nutrient status is used to guide post- grazing planting and plant nutrient requirements		
	Utilise excess nutrients	Establishment of 'catch crop' to soak up excess nutrients remaining in soil		
		For heavier soils, fallow periods are kept to a minimum		
	Limit risk of nutrient concentration transport via drainage	Treat drains as critical source areas and limit stock access		
Maintain soil health and structure	Limit stock movements and concentration	Secure (movable) stock water	**Soil Health and Structure Risk Impact level**	
		Back-fencing behind animals, especially cattle		
		Paddock has multiple entry/exit points to prevent stock congregation around one gateway		
	Limit heavy machinery use on fragile soils	Place bailage/additional feed in paddock before it is too wet to access		
	Reduce structural damage risk to soils	Stock can be moved to an alternative area, such as a run-off block or laneway, to prevent damage to soil or animal health during storm events		

[19] These options are based on good management principles and practices within the Pan Sector Policy Guidelines (2018), Beef and Lamb NZ and DairyNZ resources, as well as findings from the Pastoral 21 Research programme

Adverse weather plan[20]

We can't predict the future, but we can plan for it. Note down what plans you have in place to identify when stock should be moved to an alternative location, what and where this area is, and any other actions you may take to reduce the risk to soil or animal health if there is a storm or adverse weather event.

Example: When a heavy rain is forecast, I will prepare laneways and grassed paddocks to take on stock as needed. If soils are becoming too pugged or stock health is at risk due to flood or excess water, I will shift them to a grassed paddock.

[20] More guidance to come in this space, e.g.https://www.dairynz.co.nz/media/253711/1-42_Wet_weather_strategies_to_minimise_pasture_and_soil_damage.pdf

PART 3: DO - Keeping to the Plan

This section should be used while implementing your winter grazing is activities. Below is a timeline guide for what you should be doing when.

TIMELINE

When?	What?
12-18 Months ahead of grazing	*Select your paddocks based on the risks they pose*
6-9 months ahead of grazing	*Choose your crop type and cultivation methods carefully. Plan how you will transition animals onto the crop.*
During grazing	*Utilise good grazing management principles and monitor stock and soil health*
Post- Grazing	*Regrass or re-sow as soon as practicable*

Keep your management plan and timeline on hand for yourself as well as others in your team who are supporting you. It will also help you meet the monitoring audit requirements by the Council. Note that this content does not need to be sent into the Council. Instead farmers keep a basic record, similar to how health and safety monitoring work. Monitoring records would be expected to be provided to the Council upon request.

Check out this resource for further information: https://beeflambnz.com/knowledge-hub/PDF/winter-forage-crops-management-after-grazing

1. Note down things that did not go as planned and how you managed this
2. Update the Council on any major changes to the management actions you submit to them.

Action	Dates Taken	Stored/Saved In:
Photos (geo-located[21]) of wintering paddocks prior to stock grazing		
Photos ((geo-located) taken during winter		
Photos (geo-located) taken at end of season		

3. Update the Council on any changes to location of winter grazing that you did not identify
4. Monitoring of practice and providing photographic proof. These should be on-hand in case you are audited.

[21] Guidance will be provided on how to 'geo-locate' photos as well as save them to a single folder in a smart phone.

PART 4: Check up how you did[22]

Once you have gone through a winter grazing season, it is important to reflect on what worked well, and what didn't. Did your management activities effectively manage the risks present? This should be done at the end of every winter grazing season. Note down the answers to the below questions to get your thoughts going...

1. Did you graze the number and type of animals you were intending to?	
2. Do you have photos of the paddocks grazed?	
3. How long were stock on the grazing block for?	
4. Was the location of water troughs and supplementary feed suitable to prevent substantial pugging damage?	
5. Was the paddock sown and grazed to plan?	
6. Did you need to implement any wet weather management?	
7. How are you planning to manage this block/s post-grazing.	

[22] The following sections (including appendixes) are very much work-in-progress. More than happy to receive feedback and work more with the Ministries and officials on these sections (and others).

PART 5: Review and Improve

Based on your Check, is there anything you would or should change in your management of the risk(s) present? Are there any issues with the grazing of these blocks? How have you overcome the issues?	

Appendix 2

Land and Water Science statement on identification of critical contaminant transfer to waterways

Land and Water Science
90 Layard Street
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03 214 3003
www.landwaterscience.co.nz

31st July 2019

Application of Digital Elevation Models (DEM) to identify zones of critical contaminant transfer to waterways

Using simple topographic and hydrological methods, it is possible to objectively identify and rank areas that represent a high risk to water quality from farm runoff. The following informal letter is in response to a request to provide a brief example of how Li-DAR could be used to identify 'critical transfer zones' to exclude these areas from intensive winter grazing. However, where Li-DAR is lacking, a similar albeit less resolved assessment can be undertaken utilising national scale Digital Elevation Models.

Here we propose that all of farm is potentially a 'source' of contaminants to waterways, but that the zone of contaminant transfer is where the greatest opportunity for mitigating any losses exists. Most commonly, contaminant transfer zones coincide with ephemeral watercourses that channel drainage from the land to open waterways during intermittent runoff events (Figures 1 and 2). Each ephemeral stream course and associated transfer zone has a corresponding catchment or watershed. When soils are saturated, or rainfall intensity exceeds the infiltration capacity of the soil within the capture zone area, ephemeral drainage pathways are activated. The episodic channelisation of overland flow via the ephemeral drainage network has long been recognised as a key control over nutrient, sediment, and microbial export from farm directly to waterways.

Leaving the transfer zone as a vegetated buffer can aid in the reduction of contaminant export via physical filtering and the reduction of runoff velocity. In Figure 3, arbitrary buffer zones of 5, 10 and 30 m around the ephemeral drainage network (critical transfer zone) are provided as an example of how DEM derived mapping can be used to identify these high-risk areas objectively. Buffer widths can be further refined using soil hydrological properties and slope to allow a variable width buffer along the length of the critical transfer pathway. Further, the flow accumulation area may be used as a threshold for how much of the ephemeral network requires a vegetative buffer (Figure 2). Importantly, the widely used River Environment Classification (REC), a landscape-based classification of surface waterways, was not designed to identify ephemeral waterways or associated capture zones.

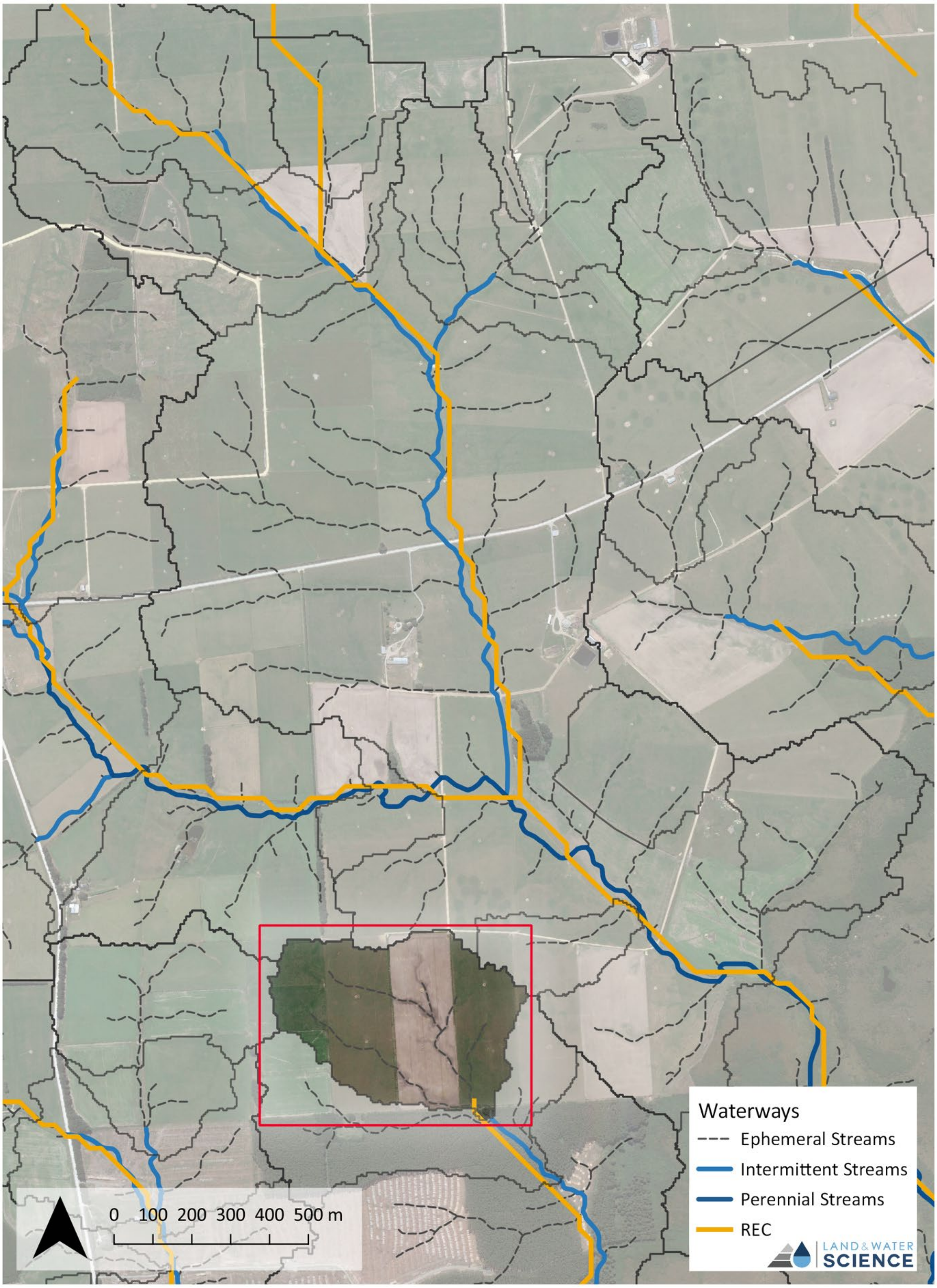

Figure 1: Drainage shed (unshaded = 22.5 Ha), associated ephemeral drainage network (dashed black lines) and their connection to the intermittent and perennial stream network. The drainage shed includes an area of winter grazing that drains directly to the surface water network. Here the lower reaches of the ephemeral drainage network act as transfer zones. The waterways are derived from LiDAR, where REC is the national River Environment Classification for comparison.

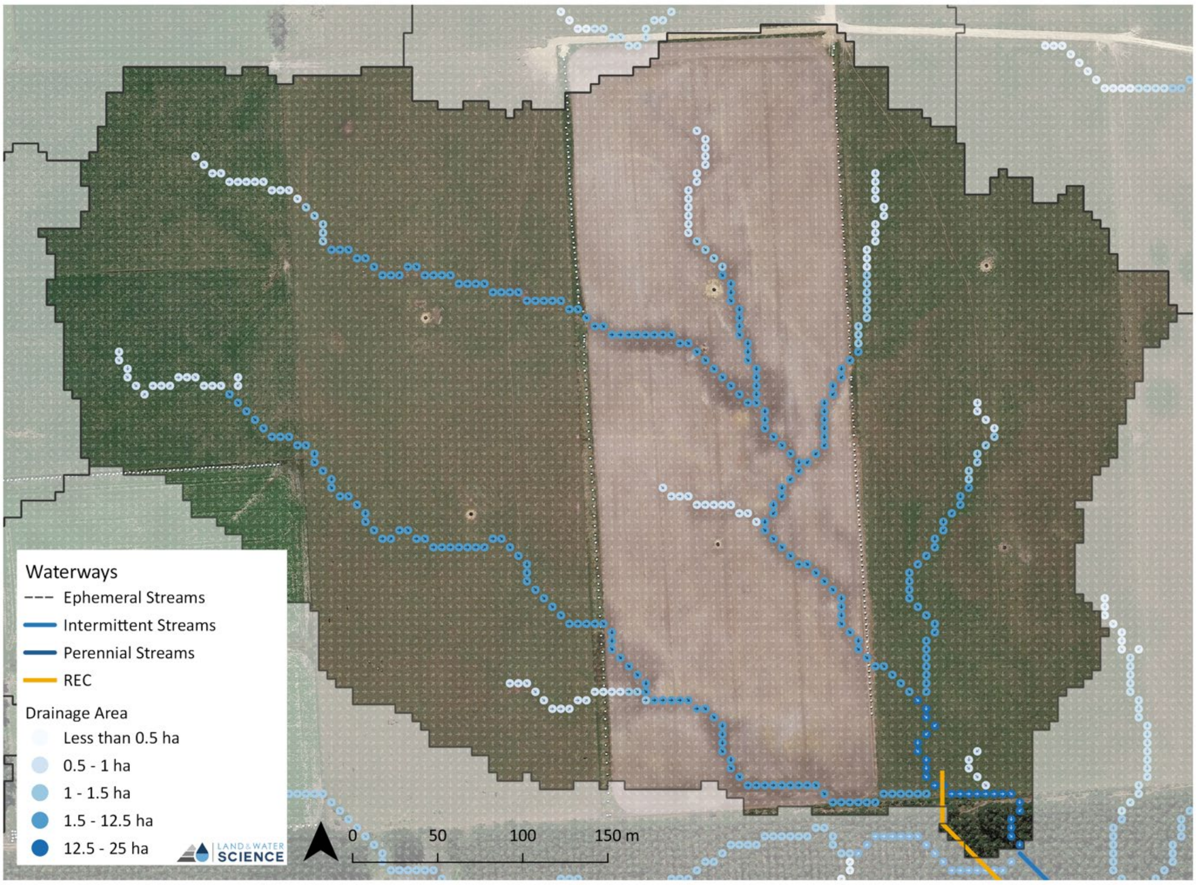

Figure 2. Close up of ephemeral drainage pathways and associated drainage area (unshaded) and their connection to the stream network. Note the area of winter grazing (bare ground) directly within the ephemeral drainage network. Small arrows (1 m^2) depict drainage water flow direction, and coloured circles denote flow accumulation, which increases downgradient towards the intersection with the intermittent and perennial stream network. Flow accumulation area may be used as a threshold for how much of the ephemeral network should be left vegetated.

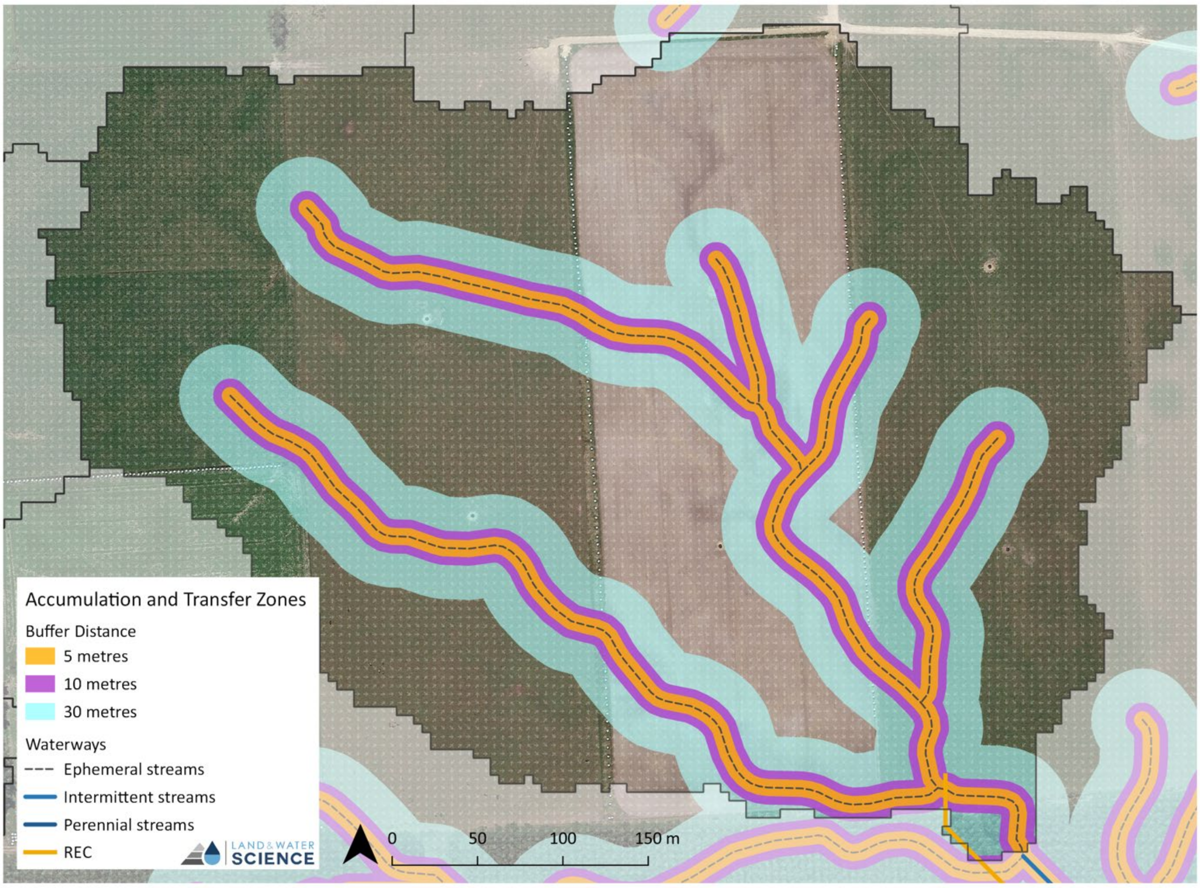

Figure 3. Arbitrary buffers of *five, ten and thirty-meter width around the ephemeral stream network that acts as critical transfer zones to surface waters. Various management practices may be used to trap or filter out contaminants within these transfer zone areas. Buffer widths can be refined according to local soil and topographic properties. Further, the area of flow accumulation may be used as a threshold for how much of the ephemeral network should be left vegetated (see Figure 2). This would reduce the area of buffering required.*

Identifying 'critical transfer zones' provides an objective, topographically guided, basis for identifying locations for reducing runoff from farm. This type of analysis can be readily automated and applied at scale. Land and Water Science Ltd have generated a number of such analysis for catchments across New Zealand.

Sincerely,

Clint Rissmann, PhD

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Reference

Couldrey, M., Pearson, L., Rissmann, C., and Newe, H. (2018). Peak runoff control for farm contaminant retention in the Waituna Catchment. Land and Water Science Report 2018/12. 53p.

Appendix 3

Section 32 Report on Physiographic Zones

Winter Grazing and Dairy Farming

The following memo seeks to describe the susceptibility of particular parts of Southland to dairy grazing and winter grazing practices.

1. **Dairy Grazing**

Dairy cows grazing pasture excrete between 60-90% of the nitrogen they consume in urine and faeces, and over 70% of the nitrogen excreted is in urine (Haynes & Williams, 1993). This urinary nitrogen is deposited unevenly across the pasture, resulting in small, localised areas that contain a large amount of nitrogen known as urine patches. N losses to the environment occur primarily as leaching below the root zone to groundwater as NO_3^- or as losses to the atmosphere as either N_2O or N_2 gas via denitrification or as NH_3 gas via volatilisation of NH_4^+. N lost to shallow groundwater often ends up in streams during summer low flow recharge and can result in detrimental eutrophication effects. The majority of NO_3^- leaching occurs under a urine patch due to a difference in the loading rate of N from urine (~ 1000 kg $N.ha^{-1}$) (Di & Cameron, 2002; Haynes & Williams, 1993) and the capacity for plants to uptake this N (~ 300 – 700 kg $N.ha^{-1}$) (Moir et al, 2010 & refs within) resulting in an excess of N. In the Southland Region, nitrogen losses from dairy farms are approximately 60% greater than those from intensive sheep/beef/deer pasture farm systems (Ledgard 2014 and refs. within). Phosphorus losses from dairy farms are approximately 25% greater than those from intensive sheep/beef/deer pasture farm systems (Ledgard, 2014 and refs. within). However, phosphorus losses vary considerably with land type and form.

2. **Winter Grazing**

In-situ grazing of forage crops over the months of May – August has been shown to make a disproportionately large contribution to nutrient losses from the total farm system (De Klein et al. 2010; Monaghan et al. 2013; McDowell & Monaghan 2015; McDowell & Stevens, 2008; McDowell & Houlbrooke, 2008; Shepherd et al. 2012; Smith et al. 2012). Proportions of N and P lost and the mechanism of loss is dependent on the land form and type.

3. **Susceptibility across Southland**

Nutrient losses from these practices are exacerbated when they occur on parts of the landscape that are susceptible to either nitrogen or phosphorus loss. For example, dairy grazing on shallow stony soils that have no/very little ability to remove nitrogen or store water, resulting in transport of any excess or unused nitrogen below the root zone with drainage. In another example, organic soils, especially newly developed soils are susceptible to phosphorus loss because of the inherent low anion storage capacity of the soil meaning any excess water soluble phosphorus is transported with drainage and lost from the system.

The Physiographic Units provide a mechanism for identifying these areas of high susceptibility. Each of the Physiographic Units that are most susceptible to nutrient loss under dairy grazing and winter grazing are presented below with an explanation of the reasons for this. Particular regard is given not only to the contamination of the direct receiving environment but also to down gradient affects. For example a contaminated aquifer feeding a stream during baseflow may cause the stream to exceed a particular water quality threshold.

- **Old Mataura Physiographic Unit**

The Old Mataura Unit is characterised by highly weathered alluvial gravels of the Luggate and Shotover Formations (Turnbull & Allibone, 2003, Rissmann et al., 2015). The unit is exclusive to the Mataura Catchment and where overlain by well drained shallow stony soils or fragic pallic soils (i.e., Old Mataura Unit) there is little capacity to attenuate N loss. The predominance of well drained shallow stony soils that have little ability to denitrify or hold water (Topoclimate, 2001) means the area is highly susceptible to nitrate leaching to groundwater. The highly weathered nature of the gravels that make up the aquifer results in little/no ability to remove nitrogen and low transmissivity rates, meaning the water moves very slowly and nitrogen concentrations can build to high levels. Commonly these levels exceed the maximum allowable value (MAV) for drinking water (NZDWS, 2008; Rissmann, 2012; Rissmann et al., 2015). Great unsaturated zone lag times (3 – 9 years) (Chanut et al., 2014) also equate to a longer delay in peak nitrate delivery than in equivalent areas (i.e. Oxidised Physiographic Unit). Where ever there is this combination of the Luggate and Shotover formations overlain by well drained shallow stony soils or fragic pallic soils we see elevated groundwater nitrate (Rissmann 2012; Rissmann et al., 2015). Because the unit is dominated by land surface recharge (LSR) there is no flushing of the aquifers by alpine derived water (Rissmann et al., 2015).The median groundwater nitrate-N concentration within the unit is 10.0 mg/L, the highest of any Physiographic Unit (Physiographic User Guide, 2015). Also important to consider with the Old Mataura Unit is its contribution of groundwater to streams during baseflow in the summer months (Liquid Earth, 2010). It is hypothesised that contaminated groundwater from the Balfour area (within Old Mataura) increases the nitrate concentrations in the Waimea Stream considerably under baseflow and that this is contributing to the declining water quality in the Waimea Stream (Moreau and Hodson, 2015; Hodson, 2015) and the overall nitrogen load in the system. The Waimea Stream at Mandeville is one location in Southland that exceeds the national bottom line for periphyton (Hodson, 2015) and is showing increasing trends in surface water nitrate (Moreau and Hodson, 2015).

Summary

- Soils and aquifers do not remove nitrogen
- Due to low aquifer transmissivities nitrate concentrations can build to very high (toxic) levels
- Nitrogen can be rapidly transported below the root zone
- Nitrate concentrations exceed the MAV in many places
- Contribution of contaminated groundwater to surface water during baseflow degrades surface waters. The Waimea Stream is showing significant degradation and is getting worse.
- Lag times are slightly longer than in other equivalent areas (Oxidising Physiographic Unit)
- No/little riverine flushing due to almost exclusive LSR

➢ **Oxidising Physiographic Unit**

The Oxidising Unit is characterised by areas of soils with an oxic redox state (show little capacity to remove nitrate) underlain by aquifers that also show no little capacity to remove nitrate. Like the Old Mataura Unit these areas are susceptible to nitrate leaching through the soil profile to groundwater and nitrate concentrations become elevated in the underlying aquifers. As with the Old Mataura Unit the Oxidising Unit is dominated by land surface recharge (LSR) and hence receives no flushing by alpine water. The main difference in these units is that the aquifers are younger and less weathered meaning groundwater flows more quickly in these systems and that for equivalent nitrate loadings nitrate concentrations may not reach the same levels those seen in the Old Mataura Unit. Groundwater nitrate hotspots are common under the Oxidising Unit and in some places nitrate concentrations exceed the MAV (Hodson, 2015; NZDWS, 2008; Liquid Earth, 2010; Rissmann 2012; Rissmann et al., 2015). The median groundwater nitrate-N concentration within the unit is 5.7 mg/L, the third highest of any Physiographic Unit (Physiographic User Guide, 2015). In a similar manner to the Old Mataura Unit, aquifers within the Oxidising Unit contribute to baseflow in adjacent streams potentially increasing nitrate concentrations in-stream and overall nitrogen load in the system. The median surface water nitrate-N concentration within the unit is 2.1 mg/L, the second highest of any Physiographic Unit (Physiographic User Guide, 2015).

Summary

- Soils and aquifers do not have ability to remove nitrate
- Groundwater nitrate concentrations are the third highest of any unit and exceeds the MAV for drinking water in some areas.
- Contribution of contaminated groundwater to surface water during baseflow contributes to degradation of surface waters.
- No/little riverine flushing due to almost exclusive LSR

- **Peat Wetlands Physiographic Unit**

The Peat Wetlands Unit is characterised by areas of organic or intergrade soils underlain by peat. Peat areas are particularly prone to phosphorus loss especially is the land has been recently developed (Rissmann et al., 2012; McDowell & Monaghan, 2015). Organic soils have a low anion storage capacity and therefore do not retain phosphorus in the soil profile as well as soils with a higher mineral content (Rissmann et al., 2012; McDowell & Monaghan, 2015). For similar reasons, peats soils are also poor at retaining K and SO_4 and other agronomically applied chemicals including Ca and Mg. Peat wetlands also show elevated *E.coli* presumably due to high void space and consequently less effective filtering/retention of microbes.

Several streams within or hydraulically connected to the Peat Wetlands Unit within the Waituna catchment are showing increasing trends for dissolved reactive phosphorus (DRP). Median groundwater phosphorus concentrations for areas of peat wetland across the southern portion of the Waituna catchment are 50 times higher than those of the northern half of the catchment (Rissmann et al., 2012).

Summary

- Organic soils are poor at retaining phosphorus and other agronomically applied chemicals.
- Peat soils are poor at filtering out microbes equating to high instream *E.Coli* counts.
- Several streams within or that drain the unit are getting worse with regards to DRP.
- Development of land within the Peat Unit for dairy or wintering should be avoided due to the high risk of P and *E.coli* loss.

- **Central Plains Physiographic Unit (Particularly susceptible to losses under dairy grazing)**

The Central Plains Unit is categorised by aquifers that have little or no ability to remove nitrogen overlain by fine textured soils that have a high proportion of mafic derived clay content. Whilst the soils in this Unit have the ability to remove nitrogen the clay content causes them to crack in the dry summer months allowing drainage water carrying nitrogen to be flushed directly into the aquifers (Rissmann et al., 2015). During the winter these soils then expand and the cracks close forcing water to flow through the soil, through the artificial drain network or overland. This means the Central Plains Unit is highly susceptible to nitrate accumulation in groundwater during late summer and autumn when nitrogen that has accumulated in the soil zone over summer is flushed through the system in the first drainage event. Over winter the Unit acts no differently to the Gleyed Physiographic Unit (Rissmann et al., 2015). Ground and surface waters within the Central Plains Unit are showing significant deterioration. The median groundwater nitrate-N concentration within the unit is 6.1 mg/L, this is second only to the Old Mataura Unit (10.0 mg/L) (Physiographic User Guide, 2015). Some samples of groundwater within the Central Plains Unit exceed the MAV for drinking water (NZDWS, 2008; Rissmann 2012; Rissmann et al., 2015). The Central Plains Unit is dominated by land surface recharge so receives little/no flushing by alpine water (Rissmann et al., 2015). The median surface water nitrate-N concentration within the unit is 5.5 mg/L, this is the highest of any Physiographic Unit (Physiographic User Guide, 2015) and is currently showing an increasing trend (Moreau and Hodson, 2015; Hodson, 2015).

Summary

- Aquifers susceptible to nitrate accumulation.
- Soils allow direct transport of nitrate to aquifers in late summer – autumn.
- Groundwater contributes to streams at baseflow, the Waimatuku in particular is showing significant degradation and water quality is getting worse.
- No/little riverine flushing due to almost exclusive LSR.

- **Riverine Physiographic Unit**

The Riverine Physiographic Unit is categorised by recent and fluvial soils overlying oxidised aquifers. These soils are classed as having a severe nutrient leaching risk. Soils and aquifers within the Riverine Unit have no/little ability to remove nitrogen. Nitrogen losses in these areas under wintering can be large (Smith et al., 2012). The Riverine unit is differentiated from the Old Mataura and Oxidised units by a high degree of flushing by river waters, primarily alpine but also bedrock river recharge. Flushing by alpine and bedrock river water provides an ecosystem service by diluting and transporting nutrients in the groundwater. The high degree of river water flushing regulates the concentration of nitrate to values far below the NZ Drinking Water Standard, with nitrate nitrogen concentrations that are below the national bottom line of 6.9 mg/L.

Losses of nitrogen from these areas contribute to the overall load within the catchment. Due to the potentially large magnitude of losses per hectare these areas may contribute a disproportionate amount of nitrogen to the system. In the Oreti, Aparima, Waiau and Mataura the ultimate freshwater receiving environments are the estuaries. Of these the Jacobs River (Aparima) and New River (Oreti) estuaries are showing signs of degradation and decreasing trends in water quality/state of eutrophication (Stevens & Robertson 2012; Stevens & Robertson 2013; Townsend and Lohrer, 2015).

There are significant unknowns around the fate of nitrogen derived from dairy and winter grazing on the Riverine Unit:

- Whether the majority or a significant proportion of the nitrogen lost is flushed through the estuaries to the sea in winter high flow events.
- Whether some/any of this nitrogen is taken up by macrophyte/periphyton growth in the River and in this then a problem in the estuary at a later time?
- Are N losses from dairying and winter grazing on the Riverine Unit a significant contributor to the degradation of the estuaries?
- Nitrogen lost from these areas during drainage events not associated with high flows may be a significant contributor to adverse effects in the downstream ecosystem.

Due to the majority of soils within the Riverine unit being classified as having severe N leaching loss dairying and winter grazing activities on the Riverine Unit will contribute to the load of nitrogen in the catchment. In regards to the catchment, this contribution is likely to be disproportionate to the land area (Smith et al., 2012; Ledgard, 2013. Whether this nitrogen load from winter and dairy grazing on Riverine is having direct significant impacts on the downstream ecosystems is unclear.

Conclusions

The Old Mataura, Oxidising and Peat Wetlands Physiographic Units have been identified as the most susceptible to nutrient loss and water quality degradation resulting from dairy and winter grazing. The Central Plains unit has been identified as being highly susceptible to dairy farming specifically. It should be noted that the Riverine Physiographic Unit is also susceptible to nitrogen loss but due to flushing by alpine water nitrogen does not accumulate in this environment. Nitrogen is transported down catchment and likely contributes a significant load to the downstream ecosystem. The inclusion of this as a unit of high susceptibility can be considered based on the outline provided above.

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