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THE PROCESS FOR SETTING NITROGEN LEACHING LIMITS USING OVERSEER FOR A WASTEWATER DISCHARGE CONSENT

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Abstract

More intensive farming operations potentially have a greater impact on the environment. Horizons Regional Council (HRC) acknowledged this when developing their combined regional plan (One Plan) by introducing resource consent requirements based on farming type and land class. As part of a project to irrigate wastewater from the Foxton community onto a bull beef operation, consent from HRC was required. The conditions associated with this consent specified nitrogen leaching limits as required under the One Plan due to the intensification of land use as a direct result of the new irrigation system.

The volume of wastewater requiring irrigation annually is variable. Also, the same farming operation will likely have different modelled leaching values as predicted using OVERSEER® as a result of version updates during the course of the consent term. This introduces complications when having to meet set nutrient leaching compliance limits. Furthermore, HRC advisors wanted to limit stock class and numbers, despite a need for them to change to meet pasture seasonal growth, market demands and variability in stock class.

While it was preferable to not specify an annual consent limit for nitrogen leaching, and include it as a management function, recent Environment Court proceedings required the specification of a nominated limit.

For this project consent conditions were developed and proposed to the Environment Court that provided for seasonal variability and version changes. Variability was to be managed by ensuring nitrogen leaching losses did not exceed a nominated value (34 kg N/ha/y) when averaged over a rolling five-year period; and version changes were managed by recalculating and the resetting of the consented nitrogen leaching limit using the initial input data file.

Keywords: OVERSEER®, nitrogen leaching, resource consents, compliance, regulations

Regulatory management using OVERSEER®

There are several roles that OVERSEER® can play in regulatory management of resource consents: firstly, in predicting the scale of effects on the environment for consent applications which can then be used to set limits in the consent conditions, and secondly, as a tool to assess on-going compliance with consent conditions and the scale of effects once consents have been granted.

Some Regional Council Plans (eg. Canterbury, Horizons, and Waikato regions) specifically require the use of OVERSEER® as an effects and compliance assessment tool for nutrient losses from farming activities. The nutrient loss limits specified in those Plans for triggering different classes of consents have usually been generated by OVERSEER®.

However, the use OVERSEER® has the potential to be used out of context and beyond the initial intent of the programme; with rules and consent conditions developed which are inconsistent with how OVERSEER® works, processes and generates information.

Assessments of effects

When processing resource consent applications, Councils want robust assessments of effects for proposed activities, and they want certainty that the predicted impacts from the proposed land management practices will hold true upon implementation. Leaching of nutrients to groundwater is typically the key consideration for assessing effects during consent processing by Councils, and this can be predicted using OVERSEER®. As noted above, OVERSEER® is specified by some Regional Plans as the model required to be used for assessing likely effects.

OVERSEER® is capable of predicting annual average nutrient losses below the rooting zone and via surface run-off from a wide range of soil types, topography, climates, farming practices and production options (stock and crops). The assumptions, limitations, principles, and sub-model relationships relied upon by OVERSEER® need to be well understood by nutrient managers and consent authority assessors in order to avoid misinterpretation or misapplication of its outputs.

It is important to note that OVERSEER® does not predict the resulting groundwater concentrations because it is not designed to account for processes within the underlying groundwater body. The impact of subsurface geology, contaminant adsorption, dilution, transport rates, attenuation, transformation and mineralisation are not considered. Separate groundwater modelling or calculation expertise is required to estimate groundwater changes.

The subsequent effects of groundwater seepage on surface water are even more complex and less reliable to model or predict. Experts in a wide range of fields need to collaborate to estimate the nutrient loads on surface water and their subsequent dilution and effects on aquatic ecology, and such work is often needed to enable the completion of a thorough assessment of environmental effects.

Compliance assessments

OVERSEER® has been used as a compliance tool in consent conditions and, for consent applications, to demonstrate compliance with nutrient loss limits that define the consent classifications set by Regional Plans. The rationale and methods used to set the values of

nutrient loss limits are not always clearly described. These limits will reflect a calculation from a specific date which can become outdated during the lifetimes of the Regional Plan and consents.

One-off nutrient loss assessments typically occur in support of consent applications, but annual assessments will usually be required as part of an annual farm management plan to demonstrate compliance with consent conditions and nutrient limits. In many cases consent conditions do not clearly provide appropriate limits upon which to base the OVERSEER® modelling and assessments of compliance. Such limits can include restrictions on the parameters of farming systems, nutrient inputs, and nutrient losses as predicted by OVERSEER®.

It is obviously crucial for OVERSEER® practitioners to fully understand how to run this model and to ensure that the modelled inputs correctly represent the actual farming system being assessed. This includes seasonal variability and the impact of averaging of both input and output data. A strong working knowledge of farming systems and their relative effects on nutrient losses is also necessary to develop a farm management plan which minimises those losses.

Nutrient loss limits set by Regional Plans and resource consent conditions tend to be fixed and a breach of those limits may not be justified to the Regional Council's satisfaction by any commentary regarding the reasons why OVERSEER® has predicted higher nutrient losses. The limitations of OVERSEER® and its inherent error range for predictions will not generally allow for breaches to be ignored. The OVERSEER® version and methodology used for setting the nutrient loss limits will often not match the current OVERSEER® version and methodology used for any compliance assessments, and this creates difficulties of comparing apples with apples.

Case study – Foxton WWTP irrigation

Horowhenua District Council (HDC) are developing a land discharge (irrigation) system of Foxton's treated wastewater – being a conversion from its current discharge directly into the adjacent river to an irrigation scheme. The wastewater treatment plant (WWTP) and its proposed irrigation site are located at Matakarapa which is surrounded by a former meander of the Manawatu River (Foxton Loop) and the main river channel just upstream of the estuary, as shown on Figure 1 below. Out of the 140 ha site, only 63 ha is to be irrigated (outlined in yellow on Figure 1).

Figure 1: Foxton WWTP and land discharge area

The current bull beef farming operation will continue, with a small increase in stock numbers (the current 180 head will increase to 230 head on average). The numbers of cattle will increase in response to increased pasture growth as a direct result of the wastewater irrigation providing nutrients and water.

Irrigation of a beef farm triggers the need for a farm intensification land use consent from HRC under their One Plan. Resource consent applications for Foxton's wastewater irrigation were lodged with HRC in November 2014 and have since been heard by the Environment Court (March and December 2017). The Court is currently drafting its decision.

In this case, the consent was required for the establishment of a new intensive farming operation, not re-consenting or further intensifying an existing irrigated beef farm. The scrutiny and controls provided in the One Plan were more intensive as a consequence of this being a new activity, and further scrutiny arose from the human wastewater source used for the irrigation which was seen to have cultural and public health implications.

The One Plan specifies nitrogen loss limits for soil capability classes and timelines which new and existing intensive farming activities must meet in order to be Permitted or Controlled activities. These limits were set in 2010, based on earlier OVERSEER® modelling of farm management scenarios on a range of soil types.

The nitrogen losses predicted by OVERSEER® for the Foxton project exceeded the One Plan limits for Controlled activities. The scale of the exceedance and its significance of effects on groundwater and nearby surface water became crucial issues that were intensively scrutinised and debated with some submitters and the Court.

During the Environment Court processing of these consent applications, two watershed events occurred:

1) a new version of OVERSEER® was released which significantly increased the predicted nutrient losses for the same scenarios (existing and future farm systems); and
2) the Environment Court issued a Declaration in response to a successful application from the Wellington Branch of the New Zealand Fish and Game Council and the Environmental Defence Society against HRC, which required HRC to explicitly assess the effects of any breaches of the One Plan's nutrient leaching limits when processing farm intensification consent applications and to impose fixed nutrient leaching limits in consent conditions for assessing future compliance.

In addition to locking in a nominated nutrient (nitrogen) leaching rate as a limit for the Foxton WWTP irrigation project, HRC also wanted to lock down the parameters of the farming system, including stock numbers and some farming practices that affected nutrient inputs and losses.

Difficulties with using OVERSEER®

The three main concerns identified in this project with using OVERSEER® for consent compliance purposes are:

1) Whether a fixed nitrogen leaching limit is appropriate;
2) Management of compliance when new versions can significantly change predictions; and
3) Certainty of compliance.

Each of these concerns are addressed below.

Fixed limit appropriateness

The One Plan simply specifies fixed annual maxima that were based on modelling predictions using a previous version of OVERSEER® which was current almost 10 years ago. The One Plan maxima have not been updated to reflect any changes in values attributable to more recent versions of OVERSEER® and the One Plan does not have a process available for accounting for the effects of OVERSEER® versions on predicted nutrient loss values. It may be some time before HRC notify and then make operative any changes to the One Plan to address these issues and concerns.

The Declaration reinforced that the One Plan requires consent conditions to specify fixed limits for nitrogen leaching. The process of determining the consent limits relies upon assessments of the effects of nitrogen losses compared with the nitrogen leaching limits and surface water quality target values set by the One Plan.

The key question is can you have a fixed annual average value as a consented limit? On the face of it, the answer should be yes, but in reality the answer is no – it needs to be able to be varied over the terms of the Regional Plans and resource consents. This is because of the

naturally dynamic biological systems and the effects that different versions of OVERSEER® have been shown to have on predicted nutrient losses.

Further and more critically, the OVERSEER® model is an annualised average model and there are seasonal variations in a dynamic biological system. The farming system is seasonal and also has some long-term responses to climatic conditions and farm management practices. The wastewater quality is also seasonal and affected by wet and dry years (the daily flows and annual volumes are particularly affected by rainfall). Combining these dynamic systems creates complications for OVERSEER® to model and for farmers to manage. The consequence for use as a regulatory compliance tool is that for 50 % of years the predicted value will be greater than the number calculated, meaning non-compliance for 50 % of future years; this in itself is *ultra vires* because an upper limit cannot be imposed when it is certain to be exceeded so frequently, and where the actual maximum of the likely range is unknown or unspecified.

Compliance management for version changes

OVERSEER® version updates may result in computation of a different nutrient loss which might exceed consent limit despite no changes to farming inputs or management. The Foxton consenting process provided a notable example of this. While processing the Foxton consent applications the current version of OVERSEER® changed from 6.2.0 to 6.2.3. As a direct result of the version updates, the predicted nitrogen losses from the same system increased 28% from upper 20's to upper 30's kg N/ha/y. Yet in the real world, nothing would have changed.

This highlights the risks of fixing a Regional Plan and/or consented limit without any flexibility for updating it in the event that a new version changes the predictions significantly. It also highlights the importance of being able to re-run earlier years' input files in the most recent OVERSEER® version to compare predictions and demonstrate how much the version updating has changed the predicted nutrient losses.

It is inevitable that there will be changes to predictions as OVERSEER® versions are released – possibly up as well as down. However, it would be reasonable to anticipate that the magnitude of changes will tend to become smaller over time as the accuracy of the OVERSEER® model and its underlying science more closely represents the real world.

It is clear that there needs to be a robust means of providing flexibility for varying the consented limits set for OVERSEER® predictions of nutrient losses caused by version updates, while ensuring that there is certainty of the limit's numeric value and that changed limits are not allowing environmental effects to gradually worsen in the real world. The original benchmark farm system also needs to be capable of being compared with future modifications to the farm system to demonstrate whether the effects from nutrient losses are likely to be improving or worsening.

Compliance certainty

Is non-compliance really non-compliance, or is it within the initial modelling range? How can we be sure?

Year-to-year variations in wastewater irrigation and farm system parameters are inconsistent with the model's presumption of steady-state input conditions over long timeframes, which makes any predictions problematic for determining each year's compliance.

Seemingly minor changes to farm systems can give rise to relatively large changes to nutrient loss predictions. The integrated and balanced nature of farm systems and the complex OVERSEER® model mean that care needs to be taken to rebalance all input parameters when changes are made.

Suggested solutions

Limits

In the absence of any flexibility in One Plan limits, criteria were developed for specifying a consent limit based on a 5-year rolling average. This allows some years of elevated predictions to occur without breaching consented limits so long as they are balanced by other years of lower predictions within the relevant rolling 5-year period. It also allows for implementation of farm management responses to actively reduce losses in future years so that the 5-year rolling average is maintained below the consented limit.

A range of wastewater scenarios has been 'tested' alongside different bull beef farming options to be sure that the integrated system can comply with the proposed consent limits. This has also indicated how a range of farm management practices could vary nutrient losses and the likely scale of effects on nutrient losses.

In addition to limiting nutrient losses, HRC have set limits for inputs such as annual nitrogen application loads, and some specified farm management practices. While fixing some input parameters, there still needs to be some scope for flexibility in farm management, so care needs to be taken to select which inputs and practices are specified in consent conditions as bottom-line requirements. This flexibility allows the farmer to implement additional measures in years where nutrient losses are at risk of becoming too high for compliance, or to respond to changes in weather conditions, pasture growth, and stock numbers.

In the case of Foxton, the use of cut and carry remains an available back-up mitigation option for such years without it being required in specific circumstances by a consent condition. The number and type of stock also are not specified or restricted by any consent conditions; HRC were seeking to restrict these aspects of the farm system at one stage in the process.

Version change management

It is logical and imperative that the same input package (base input file) used at the time of consent granting should continue to be used as a reference benchmark that is modelled using the current OVERSEER® version throughout the term of the consent so that each year's actual results can be properly compared with those of the original system.

The Foxton process allowed agreement to be reached on fixing a numerical limit for nutrient losses and agreed that the limit could change during the term of the consent to reflect changed

predictions from future versions of OVERSEER®. This requires the fixed base input file to be re-run in the future versions in order to determine the new limit.

Compliance certainty

The use of a 5-year rolling average value for compliance purposes addresses the described uncertainty by providing a representative range of predictions and by appropriately comparing the consent limit with long-term average predictions. Uncertainty is also managed through comparisons with a fixed base input file that has been re-run when new versions of OVERSEER® have been released. This ensures that the farming system sources of changes in nutrient loss predictions are able to be identified and quantified separately from those resulting from version changes.

Conclusions

OVERSEER® should not be used as a compliance tool unless:

Fundamentals about its operation and use are understood; and

Variability of natural systems are provided for; and

Limits are benchmarked to reference input files instead of fixed numerically; and

Changes to the modelled results caused by new versions of OVERSEER® are able to be used to re-set compliance limits in consent conditions.

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