Technical requirements to demonstrate no increase in load or concentration of contaminants from land use changes

Introduction

The Government's Essential Freshwater package aims to "stop further degradation of freshwater" and "improve water quality within five years". Farmers are therefore required to obtain resource consents for specific changes in land use as outlined in the National Environmental Standards for Freshwater 2020 (NES-F).

Otago Regional Council may only grant these consents if the decision maker is satisfied that they will not result in an increase of either:

- the load of a contaminant in the catchment; or
- the concentration of a contaminant in the receiving environment – compared with what was occurring at the close of 2 September 2020.

This document has been produced to provide technical advice on what information needs to be supplied to demonstrate that these load and concentration provisions can be met, both for individual farms and for irrigation schemes who collectively manage shareholder farms.

Land use activities

The land use activities covered by the NES-F that need to demonstrate the above are:

- Conversions of plantation forestry to pastoral land use (increase of >10 ha area above 2 Sept 2020 area)
- Conversions of land on farm to dairy farm land (increase of >10 ha area above 2 Sept 2020 area)
- Irrigation of dairy farm land (increase of >10 ha area above 2 Sept 2020 area)
- Use of land as dairy support land (any increase in area from 2014 -2019 base)
- Expansion of winter grazing area (any increase in area from 2014 -2019 base after May 2021)

General requirements

For all applications we need to see:

- clear, detailed descriptions of the relevant existing land use (either Sept 2020 or during the reference period) and proposed land use activities, including relevant details about changes in farm systems;
- clear, detailed descriptions of the receiving environment and its current state (including localised waterbodies and broader catchment area);
- contaminant loading assessments done by suitably qualified and experienced persons[1];
- a clear plan for monitoring and auditing the management of farm activities, and
- a clear plan for how the consent will be monitored.

[1] Council does not currently have a list of suitably qualified and experienced persons. Please provide their credentials with your application.

Qualitative assessments and models should be backed up by data e.g. local measurements or published studies that are relevant to the environment and the activity.

Modelled data should be accompanied by a narrative or tabulated description of the activities and environment, including how these were incorporated into the model(s) and also any assumptions, substitutions or omissions needed to be able to run the model(s).

Receiving environment

Each application needs to consider the local receiving environment and how contaminants may move through the environment, including:

- identifying all components of the local freshwater system and how they are connected (groundwater, surface water and, where applicable, the coastal marine environment);
- identifying nearby water users and sensitive receptors (e.g. wells, springs, wetlands, lakes, lagoons, rivers, streams, drains, estuaries, hapua, aquatic ecosystems, etc.); and
- identify downstream and downgradient receiving environments and the extent to which they might be affected by the proposal.

Contaminants

The list of contaminants to be assessed in the application should be directed by the activity (the changes in contaminant sources) and the receiving environment (e.g. surface water or groundwater). The primary contaminants of concern for freshwater quality that originate from farming are[2]:

- nutrients (primarily various forms of nitrogen and phosphorus),
- pathogens (indicated by E. coli),
- carbon-based compounds (which affect biological oxygen demand, BOD), and
- sediment.

For groundwater receiving environments, we are mainly concerned about the effects on nitrogen (nitrate) and pathogens. For surface water, an assessment of all relevant contaminants listed above is needed, including those contaminants which may be transported into surface waterways directly via run-off and indirectly via seepage and groundwater interactions.

Nitrogen

What do we need, to be satisfied there is no increase in catchment nitrogen load?

Most applicants are likely to assess changes in nitrogen loading with nutrient budgets modelled using Overseer.

To demonstrate that nitrogen load will not increase the applicant should:

- • provide robust nutrient budgets with modelled estimates of nutrient load losses from all properties associated with the application that show how the nutrient loads in the catchment under the proposed land use will be the same as, or lower than they were at September 20203 or the relevant baseline period.

[2] PCE 2012. Water quality in New Zealand: Understanding the science, Parliamentary Commissioner for the Environment, Wellington, March 2012, Available from www.pce.parliament.nz

[3] We recognise in the case of modelling that it may not be practical to provide an assessment for the exact date specified in the NES-F 2020. We recommend modelling be done for a representative period prior to Sept 2020, such as 2019/20 Overseer files (July 2019 to June 2020).

- • provide alongside the nutrient budgets a nutrient summary report detailing the differences between the model analyses, as well as explaining the rationale for the modelling approach.
    - The model/s must show an equal or lower annual average nitrogen loss to water (kg/ha/yr) from the proposed land use, compared with the existing land use on the same property/scheme area, or
    - The model/s must show that any increase in annual average nitrogen loss to water (kg/ha/yr) from the proposed activity will be offset by an equivalent or greater decrease in nitrogen loss from another area of the property or another property within the same catchment by retiring land or converting to lower intensity land use[4], and
    - Reductions in leaching load achieved by moving farming activities with higher leaching potential to poorly drained soils should also demonstrate that nutrients will not be redirected via shallow drainage systems into surface waterways.

We also recommend that:

- • both existing and proposed land use be modelled with the same model and model version so that relative change can be assessed,
- • all model(s) be audited by a suitably qualified and experienced person to verify that the model has been used correctly, and the inputs are valid,
- • additional information be provided on how the new activity/activities will be managed to achieve the modelled nitrogen losses on the farm(s).

What do we need to be satisfied there is no increase in nitrogen concentrations?

Modelling results need to show that nitrogen concentrations will not increase in any nearest surface waterway (including tributaries on or adjacent to the farm) or in the downgradient groundwater at the farm boundary.

Model results showing stable or decreased nitrogen load at a farm- or irrigation scheme scale or the ability to offset nitrogen loads within the same catchment are not sufficient to demonstrate no increase in concentrations.

To demonstrate that concentrations will not increase, the applicant should:

- • provide an assessment that shows how the contaminant concentrations in the local receiving environment under the proposed land use will be the same as, or lower than they were at September 2020, and
- • propose a programme of monitoring the concentrations of contaminants in the local receiving environment to demonstrate the projected neutral or positive effects of the land use change on water quality.

The assessment should include:

- • estimated contaminant leaching concentrations from each land management unit within the farming system (i.e. land that is similar in character and management as well as by commonality flow paths and distance to the receiving environment)

[4] Although offsetting nutrient loads across a catchment or scheme area is theoretically possible, this approach needs to demonstrate that the second requirement of not increasing concentrations can be achieved at the farm or tributary scale. It is also likely to be more difficult to monitor.

- estimated contaminant concentrations in the local receiving environment e.g. groundwater immediately beneath the farm, surface water bodies on or adjacent to the property or springs discharging downgradient of the land
- consideration of the potential changes in maximum contaminant concentrations (in other words, consideration of seasonal and year-to-year variations, not long-term averages or medians over time, as well as spatial variations across the consented area)

The assessment should not:

- • rely on averaging contaminant concentrations across the catchment, the irrigation scheme, or even the whole farm. This could hide potential localised adverse effects (hotspots).
- • rely on modelled dilution or dispersion across the wider catchment to decrease the concentrations. Any assumptions about the effectiveness of contaminant attenuation mechanisms (e.g. denitrification potential) or engineered mitigations (e.g. managed recharge) must be demonstrated by evidence.

Estimating contaminant concentrations:

Estimated leaching concentrations for different land uses, climates and soil types are available from look-up tables, published field experiments and lysimeter trials[5]. Leaching concentration estimates are also available at the farm block level within the Overseer model (as nitrogen loss to water in ppm).

One approach is to use Overseer block data of drainage nitrate concentrations in the different land use management units, taking into consideration the range of estimated concentrations, and the spatial relationship and flow connectivity between the units and the receiving environment.

Leaching concentrations can also be calculated from estimates of nitrogen load from other models, but this requires a reliable estimate of the volume of drainage through the soil for both the current and proposed land use.

The relationship between load and concentration is not necessarily linear, so a modelled reduction in nutrient load does not provide evidence that nutrient concentrations will decrease. Furthermore, increased efficiency of irrigation is a common management method to decrease nutrient leaching load, but the modelled and measured concentrations of nutrients leaching below the root zone may be stable or even increase under efficient irrigation.

Applying a precautionary approach:

Depending on the receiving environment, contaminant concentrations can be more important for achieving water quality outcomes than contaminant loads. Even short-term exposure to unacceptable contaminant concentrations (nitrate or E. coli) can have severe health effects for consumers of drinking-water or aquatic ecosystems. Because of the uncertainties

[5] For example:

Lilburne et al., 2014: *Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury (updated),* Environment Canterbury Technical Report, R14/19.

Norris, et al., 2017: *The MPI SFF root zone reality project (401484) and the HortNZ northern fluxmeters project (HortNZ RI 1009) – summary of year 1 and year 2 activity*, Plant & Food Research report prepared for Foundation for Arable Research (ref X14-08); Horticulture New Zealand; Environment Canterbury; Horizons Regional Council; Hawke's Bay Regional Council; Environment Waikato; Auckland Regional Council; Ravensdown Cooperative Ltd.

involved, a precautionary approach is recommended, e.g. using maximum (peak) concentrations, not long-term averages or farm area averages.

Unless the applicant can demonstrate otherwise, our recommended conservative approach is to assume that any increased nitrate concentration in soil drainage from any part of the converted farm could likely cause an increased nitrate concentration in groundwater beneath the converted land and nearby surface water bodies.

Pathogens/E. coli

What do we need to be satisfied there is no increase in contaminant load or concentrations?

Grazing livestock, effluent irrigation and manure spreading can all be sources of faecal pathogens from farming that can affect groundwater (via leaching) and surface water (via runoff, subsurface drainage systems and discharge of contaminated groundwater).

Pathogens are not modelled in Overseer, so other information will need to be supplied.

To demonstrate that pathogen load and concentrations will not increase, the applicant should:

- provide an assessment that shows how the risk of pathogen contamination in the local receiving environment under the proposed land use will be the same as, or lower than it was at September 2020.

The assessment should:

- provide a detailed description of all proposed changes to livestock management on the property
- provide estimates, based on reputable information sources6, of the changes in pathogen types and loading rates that could result from the changes in livestock management on each block or management unit of the farm
- include details on how livestock and irrigation management actions are likely to affect the risk of pathogen runoff and/or leaching in the current and proposed land uses
- include descriptions of critical source areas where pathogen runoff and/or leaching risks are highest, and how those areas are to be managed
- include details on where and how pathogens are to be monitored in the receiving environment.

Changing from arable or forestry to pastoral farming land use:

[6] For example:

Devane, M and Gilpin, B 2015: *Human health risks of faecal pollution from different sources, A review of the literature*, ESR Client Report CSC15019 for Environment Canterbury, Community & Public Health, Christchurch City Council and the Ministry of Health, December 2015.

Humphries, B. et al., 2020: *Quantification of source loading inputs for a microbial risk assessment tool*, ESR Client report CSC200010 for Horizons Regional Council, Environment Canterbury and Hawkes Bay Regional Council, May 2020. Available at https://www.envirolink.govt.nz/assets/2007-HZLC158-Quantification-of-Source-Loading-Inputs-for-a-Microbial-Risk-Assessment-Tool-v2.pdf

Atwill, E. et al., 2012*: Zoonotic waterborne pathogen loads in livestock*. In: Dufour et al. (eds), Animal Waste, Water Quality and Human Health. World Health Organization (WHO). ISBN: 9781780401232. Available at https://www.who.int/water_sanitation_health/resources/ch3.pdf?ua=1

Introducing livestock to land that has previously been used for arable cropping or forestry will almost always increase the load of pathogens applied to land. Given the same local receiving environment (i.e. likely no change to surface waterways, soils, unsaturated zone thickness or groundwater transport pathways on the farm), an increased load of pathogens will almost certainly increase the risk of pathogen contamination in the receiving environment.

A possible exception is where surface water is absent, groundwater is very deep and there is no potential conduit to the groundwater via deep wells (e.g. wells are fenced off from animals, no effluent irrigated near wells and no effluent irrigation system connected to any well).

Applying a precautionary approach:

The uncertainty in this type of assessment will require us to take a precautionary approach. Unless the applicant can provide evidence of adequate pathogen removal or a very deep groundwater table, we assume that any increase in pathogen loading on the paddock will likely lead to a risk of increased pathogen concentrations in the receiving environment.

Phosphorus

Phosphorus discharges come from fertiliser, animal urine and manure and soil losses. Dissolved phosphorus can enter groundwater by leaching, but surface waterways are generally most affected, typically by dissolved and sediment-bound phosphorus in runoff.

Where the receiving environment includes surface water, the applicant should demonstrate that phosphorus load and concentrations will not increase by:

- providing an assessment that shows how all potential phosphorus sources on the farm will be managed to ensure the risk of phosphorus losses to water under the proposed land use will be the same as, or lower than, they were at September 2020 or the reference period.

The assessment should include:

- estimated (modelled) loads of phosphorus loss to water from the existing and proposed farm activities7
- estimated phosphorus concentrations in the immediate receiving surface waterways,
- a description (including map) of critical source areas in the existing and proposed land use, and how these will be managed to prevent increased phosphorus losses to the receiving environment.

Sediment

Sediment contamination is an issue for surface waterways and should be assessed for all sites where surface water is present on or adjacent to the farm.

Sediment is not modelled in Overseer and other sources of information must be supplied.

Where the receiving environment includes surface water, the applicant should demonstrate that sediment load and concentrations will not increase by:

- providing an assessment that shows how all potential sediment sources on the farm will be managed to ensure the risk of sediment losses to water under the proposed

[7] For example, the phosphorus modelling component in Overseer uses a statistical regression between climate, soil phosphorus and farm management attributes against monitoring data from second order streams. This can be used as a screening tool to show where intervention is likely needed to mitigate the increased risk of phosphorus loss.

land use will be the same as or lower than they were at September 2020 or the reference period.

Slope, soil type, climate, changes in vegetation cover (e.g. tillage, deforestation) and changes in irrigation practices are all factors affecting the risk of sediment runoff.

For high risk activities (e.g. forest conversion or grazing winter fodder crops) on high risk areas (e.g. where the slope is greater than 10 degrees), we recommend that:

- quantitative assessments of soil erosion risk/sediment delivery be provided e.g. using a model such as RUSLE WEPP (calibrated to New Zealand data).
- modelling that takes account of site slope, slope length, soil erodibility, rainfall intensity and distance to the waterway.

Other contaminants

Changing a farm system will change the volume and composition of carbon-based compounds entering the environment from plants and animals. This is especially important for surface water systems because the degradation of organic compounds directly affects oxygen availability for aquatic ecosystems. Oxygen depletion could also affect the mobility of other contaminants in groundwater.

Other potential contaminants from changes in farming land use include changes in the application of pesticides (herbicides, insecticides, fungicides), emerging organic contaminants (such as veterinary medicines, antibiotics, steroids, hormones, etc.) and contaminants from soil treatments or fertiliser (including ammonium, copper, boron, zinc etc. and trace impurities such as cadmium and uranium from phosphate fertiliser). Minor increases in alkalinity and major ion concentrations (e.g. calcium, magnesium, sulphate and potassium) can also result from changing farming land use, although these are not generally considered contaminants.

We recommend that the other contaminants should also be assessed by the applicant, at least on a qualitative basis, by supplying information on changes in carbon sources and agrichemical products to be applied on the farm. The applicant should provide descriptions or any changes in waste or effluent management or other potential sources with high biological oxygen demand and how these sources are managed to avoid impacts on the receiving environment.