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OVERSEER® Nutrient Budgets information base for the Rotorua catchment

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OVERSEER® Nutrient Budgets information base for the Rotorua catchment

Report prepared for Bay of Plenty Regional Council

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1. Executive Summary

A water quality target has been set for Lake Rotorua limiting nitrogen (N) input to the lake to 435 tonnes (t) each year, significantly less than the 755 t N/yr estimated to be the post attenuation steady state load assuming no further intensification. National Institute of Water and Atmospheric Research (NIWA) modelling has reported that dairying contributed 36% of the 755 t N/yr N loading. The Bay of Plenty Regional Council is developing draft rules to achieve the 270 t N reduction required from rural land. This will set out how much N each landowner can legally discharge from their property.

The purpose of this report is to compare measured N leaching values against OVERSEER® nutrient budget (hereafter referred to as OVERSEER) modelled N leaching values for the same farm system. This report will help with understanding how OVERSEER modelled values reflect against measured trial N leaching data in the Rotorua catchment.

The two research trials used in this comparison exercise were the Wharenui research trial and the Parekarangi Trust research trial. The Wharenui research trial investigated practical mitigation options, such as the use of nitrification inhibitors (DCD) and restricted grazing, at reducing N and phosphorus (P) losses. The Parekarangi Trust research trial investigated the implication of reduced N fertiliser applications on N leaching. The analysis of these two trials showed that the comparison between measured vs. modelled N leaching values are reasonable when drainage values are aligned and the relativity of treatment effects (DCD, restricted grazing, reduced fertiliser) was of the right order. However, the analysis indicated that when drainage values are not aligned differences in measured and modelled N leaching occur.

When drainage is aligned OVERSEER estimates of N leaching compare reasonably well with measured N leaching values for the two research trials investigated in this report. However, further investigation is warranted to better understand the reason and implication, of drainage not aligning, without altering soil properties to match drainage for the modelled and measured data.

2. Introduction

Pastoral agriculture plays a significant role in the economy of the Rotorua District. However, pressure has come on the pastoral agricultural sector to reduce its impact on the water quality of local rivers and lakes. A "sustainable load" target has been set for Lake Rotorua of no more than 435 t of nitrogen (N) entering Lake Rotorua each year (BOPRC, 2014). National Institute of Water and Atmospheric Research (NIWA) modelling in 2011 predicted that at steady-state around 755 t N/yr will enter Lake Rotorua, and a reduction of 320 t N/yr would be required (Rutherford et al., 2011). Dairy farming was identified as contributing 36% of the N loading from only 11% of the catchment area (Rutherford et al., 2011).

The purpose of this report is to analyse the data from two research trials on dairy farms in the Lake Rotorua catchment to compare measured N leaching values against OVERSEER® Nutrient Budget (herein after referred to as OVERSEER) modelled estimates. OVERSEER is a nutrient management tool which assists farmers in examining nutrient use and movement within a farm. OVERSEER calculates and estimates the nutrient flows (including N) in a farming system and can be used to identify where efficiencies in managing nutrients can be made as well as the potential risk of environmental impacts from losses through runoff, leaching, and greenhouse gas emissions (Wheeler et al*.,* 2003).

The two research trials analysed in this report are the Wharenui research trial and the current Parekarangi Trust research trial. The Wharenui research trial was part of a three-year Sustainable Farming Fund (SFF) project, which aimed to demonstrate practical mitigation options to reduce N and phosphorus (P) losses from farms into the Rotorua Lakes (Ledgard et al., 2008). The Parekarangi Trust research trial is part of a recently completed SFF project, with two years of usable data (NB: post-SFF data collection is continuing at the Parekarangi trial until December 2015). The Parekarangi Trust research trial aims to investigate the implications of reduced N fertiliser application on N leaching. In both research trials, N leaching was measured in paddocks using porous ceramic cup samplers, under standard management practice and compared with that from paddocks with a mitigation practice implemented.

The scope of this report is to compare the results from the two research trials where N leaching was measured with estimates using OVERSEER, and to analyse and report on any potential differences between modelled and measured results.

2.1 Description of the experiments

Wharenui research trial

A three year SFF project on 'Practical mitigation options to reduce N and P losses from farms into Rotorua lakes' was carried out on the Ngati Whakaue Tribal Land (Wharenui) farm from 2005 till 2008. Measurements of N and P losses with and without mitigation practices were examined. The N experiment focused on the Wharenui dairy farm and examined the effects of a nitrification inhibitor (DCD) and wintering off practices. The following treatments with six replicates were analysed:

1. Normal grazing and fertiliser regime (control treatment)
2. Normal grazing and fertiliser regime with nitrification inhibitor (DCD) applied twice, following the May grazing and the subsequent winter grazing (DCD treatment).
3. No grazing from May through to the end of September (equivalent of two missed grazing's) (No grazing treatment). During this period, the pasture was mown twice and baled (Ledgard et al., 2008).

Nitrogen leaching was measured using porous ceramic cup leachate collectors (12-14 per plot; 6 replicates / treatment), installed at a depth of 60 cm. Leachate samples were collected after intervals of approximately 40-50 mm drainage (as estimated using a water balance model (Woodward et. al., 2001)) and were analysed for ammonium-N and nitrate-N (Ledgard et al., 2008).

Parekarangi Trust research trial

In autumn 2012, a farm system scale experiment using 12 paddocks was established at the Parekarangi Trust farm. The following treatments with six reps were analysed:

1. Normal grazing and fertiliser regime (plus-N fertiliser treatment)
2. Normal grazing and no fertiliser (nil-N fertiliser treatment)

Each paddock in the farm system trial had 25 porous ceramic cup leachate collectors installed at a depth of 60 cm (150 per treatment). The trial started in late-autumn 2012 and while some leachate collections were made in winter 2012, there was insufficient time for treatment effects to develop and therefore data from 2012 was not used in this evaluation. In 2013 and 2014, a sample of leachate from each collector was obtained at intervals after approximately 75 mm of drainage and analysed for nitrate-N concentration (Sprosen and Ledgard, 2014 and Kingi et al. 2015). Because porous cups do not provide a measure of drainage (unlike lysimeters), drainage was estimated using a water balance model (Woodward et. al., 2001). Daily rainfall was measured on the farm and temperature and solar radiation data were obtained from the Rotorua airport meteorological station belonging to NIWA. The amount of nitrate-N leached below 60 cm depth was calculated by multiplying the nitrate-N concentration by its associated drainage (Sprosen and Ledgard, 2014). Rising plate meter readings were taken before and after grazing's to estimate pasture intake during grazing. Grazing management and N fertiliser application followed standard farm practice and both sets of nil-N and plus-N treatment paddocks were grazed as closely together as possible (Sprosen and Ledgard, 2014).

2.2 How OVERSEER estimates nitrogen leaching

OVERSEER reports a whole-farm N leaching estimate, which is a sum of estimated losses from the individual blocks within the farm plus 'system losses' not associated with the individual blocks. It is extremely difficult to evaluate the model at the whole-farm level because N leaching losses would have to be measured in many different areas within the whole farm system (at great cost). Any evaluation is therefore undertaken at a block-scale, which is the scale that is most like grazing trials (Shepherd, 2014). The two experiments reported here are equivalent to a grazed pasture block within the model.

The method of estimating N leaching depends on a calculation chain as documented in Appendix 8.1. The key steps are:

- *Estimating animal dry matter and nutrient intakes* – using an animal metabolic model and estimates of pasture and supplement nutrient contents.
- *Estimating nitrogen excretion and partitioning between dung and urine* – excreta N is estimated based on of the difference between N eaten and N removed in product. Relative proportions of N in dung and urine are estimated from the N content of the diet.
- *Distributing this excreta deposition across the year* – based on the pattern of feed intake during the year and estimating amounts not directly voided onto the paddocks (e.g. during milking or if cows are removed and put on a stand-off area).
- *Estimating the proportion of deposited dung/urine leached* – using submodels for the urine patch and between-urine patch areas on the paddock.
- *Estimating drainage using a water balance model* – a key driver of N leaching (primary drivers of drainage are rainfall, PET and soil type).

Because OVERSEER has been developed as a long-term model, this brings challenges when trying to use it to compare outputs with annual experiment measurements. Two of the practical challenges are:

- *Rainfall input and calculated drainage* - OVERSEER climate inputs assume a long-term average climate pattern for a site whereby a user input of annual rainfall is distributed over the year using a series of regional patterns. The outcome is a drainage distribution pattern that can be quite different to the experiment because individual years rarely match the long-term average. To some extent, this can be overcome in the development version of OVERSEER used for this project because we were able to enter monthly climate data.
- *Linking production year with drainage season* - the dairy "production year" in pastoral agriculture is June-May. Because the production year ends in May, two production years actually span the main winter drainage period. The climate data for OVERSEER covers a 12-month period. Given this mismatch between production year and drainage/N leaching season, the question then becomes how do we align climate and production year when comparing OVERSEER against an annual experiment? The approach we used is described in section 3.1.

3. Methodology for comparison

This project utilised a development version of OVERSEER. The development version of OVERSEER is the building block for the next version of OVERSEER, at the time of the release of this report the development version was the building block of OVERSEER 6.2.0*.* The development version allows input of monthly climate data measured at the trial site locations. This allows us to model the actual monthly distribution of drainage at each site; without this facility, OVERSEER would have estimated drainage using the long-term drainage pattern for that location (as described in section 2.2). The following approach was adopted to compare the measured N leaching values against modelled N leaching values:

1. Gather required information from the experiments to enable an appropriate OVERSEER file to be set-up.
2. Review the experiments to ensure that the OVERSEER file was set-up in the most appropriate way to represent the experiment.
3. Create OVERSEER files for the two experiments, documenting any assumptions made, for example due to missing farm data.
4. Analyse and report on the comparison of modelled and measured N leaching values.

3.1 Modelling approach

The modelling approach required to successfully model the two research trials involved several steps:

1. Ensuring that the actual trial was represented as accurately as possible.
2. Entering actual trial climate data (monthly rainfall, PET and temperature) into OVERSEER.
3. Ensuring grazing of the trial paddocks (timing and numbers) was accurately represented in OVERSEER.
4. Ensuring that measured trial drainage values matched OVERSEER estimated drainage values.

Accurate comparison of measured and modelled N leaching values should be based on similar drainage values. With the site soil and climate data entered, OVERSEER did not predict the same drainage values as those predicted using the Woodward 2001 methodology. To achieve similar drainage values, the non-standard layer on the soil description page was altered to adjust soil water properties.

In terms of setting up the information in OVERSEER, both the trial farms were dairy farms and therefore farm management data was supplied based on the dairy calendar (June to May). The drainage season was from May to October, and therefore climate information needed to cover the drainage period and the critical period preceding it (not the dairy calendar year). It was assumed that the farm management was static so it effectively repeated in the second OVERSEER year. Figure 1 shows the relationship between timing of farm management data and climate data entered into OVERSEER.

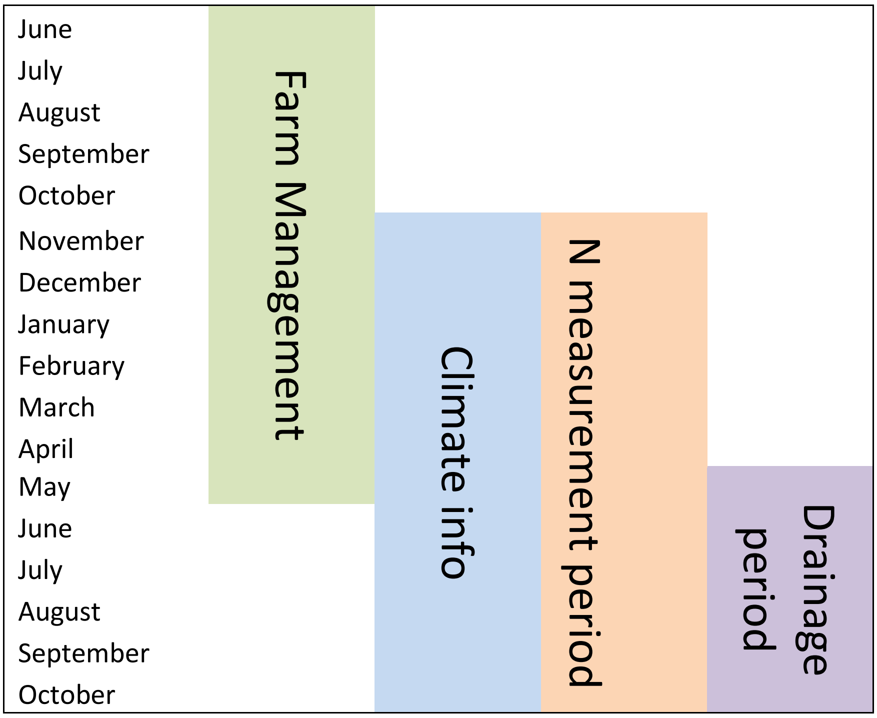

Figure 1: *Description of months of farm management and climate information entered into* OVERSEER *relative to that for the period of measurement of N flows and drainage*

3.2 Modelling the experiments

Wharenui research trial

The information required to set-up the OVERSEER file to represent the Wharenui site was sourced predominantly from available AgResearch trial data. This included; climate information from January 2005 to January 2008, treatment areas, topography, soil and fertiliser information. As part of the research trial, a desktop scenario analysis of various management options to optimise production and to reduce N leaching had been carried out using OVERSEER (Ledgard *et al.*, 2008). From this information, an OVERSEER file was set-up to describe the 'average' Wharenui farm nutrient losses. From this OVERSEER nutrient budget, additional information was determined about the farm; size of effluent block, effluent system and cow herd information. Where no information was available OVERSEER default values were used or the field had to be left blank. Appendix 8.2 and 8.3 describe the OVERSEER input information used and sources of information in more detail. The Wharenui research trial was set-up as one farm file in OVERSEER with 5 blocks (Table 1). There was insufficient information available on cow grazing numbers and timing of the treatments to set the treatments up as individual OVERSEER files.

Table 1: *Wharenui* OVERSEER *block set-up*

Farm blocks	Area (ha)
Control	2.23
DCD	2.29
No Winter	1.62
Main Block	228.86
Effluent block	45
Total Farm Area	280

To ensure that drainage aligned between the measured and modelled values, the soil profile description inputs needed to be set to a stony non-standard layer at a depth of 10 cm in 2006 and 5 cm in 2007. Modelled N leaching values were sourced from the block nutrient budget report in OVERSEER (not the whole farm nutrient budget report), to enable direct comparison with measured values.

Parekarangi Trust research trial

The information required to set up the OVERSEER file to represent the Parekarangi Trust research trial was sourced predominantly from available AgResearch trial data. This included climate information from November 2012 to October 2014, treatment areas, topography, soil and fertiliser information. The farm consultant (Mark Johnston, Agribusiness Solutions Limited) was contacted for cow herd and production details and supplements imported. Perrin Ag Consultants had completed some OVERSEER modelling for the farm and supplied us with their OVERSEER file. From this OVERSEER nutrient budget additional information was determined; size of effluent block and effluent system. Where no information was available OVERSEER default values were used or the field had to be left blank. Appendix 8.4 to 8.7 describes the OVERSEER input information used and sources of information in more detail. The treatment blocks within the Parekarangi Trust research trial were set-up as individual OVERSEER files. This enabled us to accurately reflect grazing numbers and timings on the treatment blocks.

To ensure that drainage aligned between the measured and modelled values, the soil profile description inputs needed to be set to a stony non-standard layer at a depth of 5 cm. OVERSEER N leaching values were sourced from the block nutrient budget report (not the whole farm nutrient budget report) for comparison of research trial results with modelled values.

4. Results and discussion

4.1 Wharenui research trial comparison

The results from the Wharenui research trial for the three treatments are shown in Table 2. The modelling comparison only compared the 2006 and 2007 data, due to insufficient information available on farm management and climate required to accurately model the 2005 period.

Table 2: *Comparison of modelled and experimental data of drainage and N leaching values (Ledgard et al., 2008) for the Wharenui research trial. Modelled drainage values were set in* OVERSEER *by adjusting soil properties to match experimental drainage values. Experimental and modelled values are for a 12 month period.*

		Experiment		**Modelled**	
Year	**Treatment**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**
2005	Control	86	650	-	-
	DCD	74	650	-	-
	No grazing	56	650	-	-
2006	Control	77	818	71	817

	DCD	72	818	71	817
	No grazing	55	818	54	817
2007	Control	72	502	59	502
	DCD	70	502	62	502
	No grazing	55	502	50	502

4.2 Parekarangi Trust research trial comparison

The results from the Parekarangi Trust research trial for the two treatments are shown in Table 3. The modelling involved only the 2013 and 2014 data, due to lateness in commencing the trial in 2012 (therefore, treatment effects had not developed) and there was also insufficient information available on farm management and climate for that period.

Table 3: *Comparison of modelled and experimental data of drainage and N leaching values for the Parekarangi research trial. Experimental and modelled values are for a 12 month period.*

		Experiment		**Modelled**	
Year	**Treatment**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**
2013	Plus-N	75	707	62	683
	Nil-N	17	707	46	683
2014	Plus-N	31	673	54	630
	Nil-N	17	673	34	630

4.3 Experimental leaching data

The experiments provide useful information on N leaching losses from grazed pastures in the Bay of Plenty region, albeit only on pumice soils. It should also be recognised that the measurements carry an error, given the difficulty of measuring N leaching from grazed pastures (Lilburne et al, 2012). Table 4 summarises the results as an average of two experiment years. Both sites experienced large amounts of drainage, with similar amounts at both sites. The drainage is an estimate based on a daily water balance model of Woodward et al, (2001). The key points arising from the Wharenui data are:

- Large losses were measured at the Wharenui site (c. 75 kg N/ha), probably as a result of high drainage (season and climate) and the soil being a free draining pumice.

- The DCD effect was small, in line with other research experience in the North Island (Gillingham et al., 2012).
- Removing the dairy cows in May-September decreased N leaching losses by c. 25%, i.e. a significant source of leachable N was deposited/applied outside of the winter/early spring months.

Table 4*: Comparison of modelled and experimental data of drainage and N leaching for the two Rotorua field trials (average of two experimental years)*

Site	Treatment	Experiment		Modelled	
		N leached (kg/ha)	**Drainage (mm)**	**N leached (kg/ha)**	**Drainage (mm)**
Wharenui	Control	75	660	65	660
	DCD	71	660	67	660
	No grazing	55	660	52	660
	% change				
	DCD	5		-2	
	No grazing	26		20	
Parekarangi Trust	N applied	53	690	58	657
	No N applied	17	690	40	657
	% change				
	N effect	68		31	

N leaching losses at Parekarangi were smaller than at Wharenui, despite similar drainage volumes and soil-type. There was also more variation between the two years at this site, compared with Wharenui. A possible reason for this could be due, at least in part, to differences in soil N status. The Wharenui site had previously been used for farm dairy effluent application and so may have accumulated more organic N in soil over time. In contrast, the Parekarangi site had only been converted to dairying out of sheep and beef farming within the past 20 years. There tends to be a curvilinear shaped response to soil organic C and N accumulation with time, with soils tending to eventually achieve a plateau in C and N concentration in the topsoil. For example, combining data from a range of sources and soil-types, Schipper & Sparling (2011) suggested the rate of C (and by inference N) accumulation between 5-25 years was about one quarter of that for 0-5 years. Jackman (1964) looked at chronosequences of C and N accumulation in a range of soils and locations. The half-life for accumulation was >10 years for Oropi soil (the nearest regional comparison), indicating a long period before the soil reaches ‘capacity’.

The variation in N leaching between the two years, particularly for the ‘Plus-N’ treatment is probably related to the summer 2013 drought and to N fertiliser which had been applied prior to the drought and after the drought in autumn. A large rainfall and drainage event followed the autumn N application and likely led to significant direct leaching of fertiliser-N (Ledgard et al., 1988). Lucci et al., (2013) demonstrated a significant leaching risk from fertiliser N applications associated with a drought period and once the soils had wetted up in the autumn and drainage started. This would be supported by the observation that measured N leaching losses were similar between years for the nil-N treatment (Table 3).

The apparent anomalously large N loss due to fertiliser would also explain the apparent 4-5 fold (c. 77%) decrease in N leaching losses between plus-N fertilised and nil-N treatments in the first year. The c. 45% difference in N leaching between these two treatments in the second year, is more in line with other measured N leaching losses comparing nil-N and plus-N fertilised systems (e.g. the RED trial at DairyNZ’s Scott Farm: Ledgard et al., 2006).

4.4 OVERSEER estimates

For the average of the two years at each site, there was reasonable agreement between modelled and measured N leaching when the modelled and measured drainage was matched (Table 4). Agreement was good from the Wharenui research trial. However, the model estimated nil or minimal DCD effect (5% reduction was measured). The effect of removal of cows from grazing in winter was estimated to be a 20% decrease in N leaching (26% measured).

Measured N leaching losses at the Parekarangi Trust research trial were more variable between years particularly for the plus-N fertiliser treatment, as discussed in section 4.3. A third year of measurements are occurring currently (2015) and would be valuable to include these measurements in any additional analysis. OVERSEER was unable to capture the suggested extreme drought/fertiliser N effect in the first year (Table 3). This is not surprising given that it is a long-term average model and was not designed to be able to model short-term perturbations, for example caused by weather extremes.

If we take the second year of the Parekarangi research trial as more typical of measured N losses (Table 3), OVERSEER overestimates N leaching losses by 15-20 kg N/ha for both treatments. Again, this has to be put in the context of one set of annual measurements. We have noted earlier that losses from fertilised/grazed pasture at Parekarangi seem low compared with Wharenui, this could possibly related to a shorter period of time in dairying than the Wharenui site and with lower N inputs (including effluent). In the second year of the Parekarangi trial, OVERSEER indicated a c. 40% decrease in N leaching as a result of withdrawing N fertiliser from the system. This was within the range of similar studies, the RED trial (Ledgard et al., 2006) and long-term N trial (Ledgard et al., 1999) in the Waikato region, which revealed a decrease in N leaching of c. 50%.

While the results from this analysis of measured and modelled N leaching look reasonably good, given errors around measurement in experimentation at this scale, these comparisons are based on matching OVERSEER drainage with that reported for the experiment. Users will not be able to do that for a standard farm file. In that case, the user would have to use the OVERSEER estimate. Unfortunately (and surprisingly), there were differences between measured and modelled drainage. The estimated drainage was much less than reported for the experiments, with the consequence that N leaching estimates were also much less (Table 5).

Table 5: *Comparison of modelled and experimental data of drainage and N leaching values for the Wharenui and Parekarangi Trust research trials base farm systems, comparing raw drainage values and soil properties adjusted to ensure experimental and modelled drainage align (matched drainage).*

		Experimental		**Modelled (matched drainage)**		**Modelled (raw drainage)**	
Year	**Treatment**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**	**N leaching (kg N/ha/yr)**	**Drainage (mm/yr)**
Wharenui							
2006	Control	77	818	71	817	43	709
2007	Control	72	502	59	502	25	331
Parekarangi							
2013	Plus-N	75	707	62	683	47	628
2014	Plus-N	31	673	54	630	43	570

It should be noted that the reported drainage values for the experiments were not measured but used a daily water balance model (Woodward et al., 2001). This is standard practice for such research studies where ceramic cup samplers have been used. However, when the Woodward model drainage estimates have been compared with the OVERSEER estimate over a 20 year period for a range of sites, agreement between the two models was good (Shepherd et al., 2011). Recent work by Wheeler and Bright (2015) has also shown good agreement in modelled drainage between

OVERSEER and IRRICALC. Worth considering is that all comparisons of drainage have been between models, not between model and measured.

The discrepancy may be because we are, in this case, comparing an annual experiment with the model, rather than long-term climate data. Further investigation is required to see if this is the cause.

5. Conclusion

This report compared the results for measured N leaching from two research trials with OVERSEER modelled estimates of the two trials and analysed any potential differences between modelled and measured results. The analysis showed that when drainage values align, the comparison with measured values (which, in themselves, can carry an error of c. 25% (Lilburn et al. 2012) was reasonable, and the relativity of treatments effects (DCD, withholding animals and decreased fertiliser N inputs) was of the right order.

The analysis in this report highlighted an issue with OVERSEER's estimate of drainage at both of these sites, compared with the daily water balance calculation used to estimate the drainage in the experiments. Consequently, this had large implications for estimated N leaching losses (underestimated) when drainage in the model was not matched to the experiment site. However, it is important to bear in mind the use of the daily water balance model (Woodward *et al.* 2001) to determine drainage is still reliant on soil water properties and this may not necessarily be soil water properties measured onsite.

Further investigation of the differences in drainage is warranted, given the importance of drainage estimates as a driver of N leaching. A short-term solution could be to 'sensibility' test the OVERSEER drainage estimate on any report against other estimates for the farm.

From the NRC Committee on Models in the Regulatory Decision Process (NRC, 2007):

> *"Models will always be constrained by computational limitations, assumptions and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all aspects for a particular regulatory application. These characteristics suggest that model evaluation be viewed as an integral and on-going part of the life cycle of a model, from problem formulation and model conceptualization to the development and application of a computational tool."*

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7. Acknowledgements

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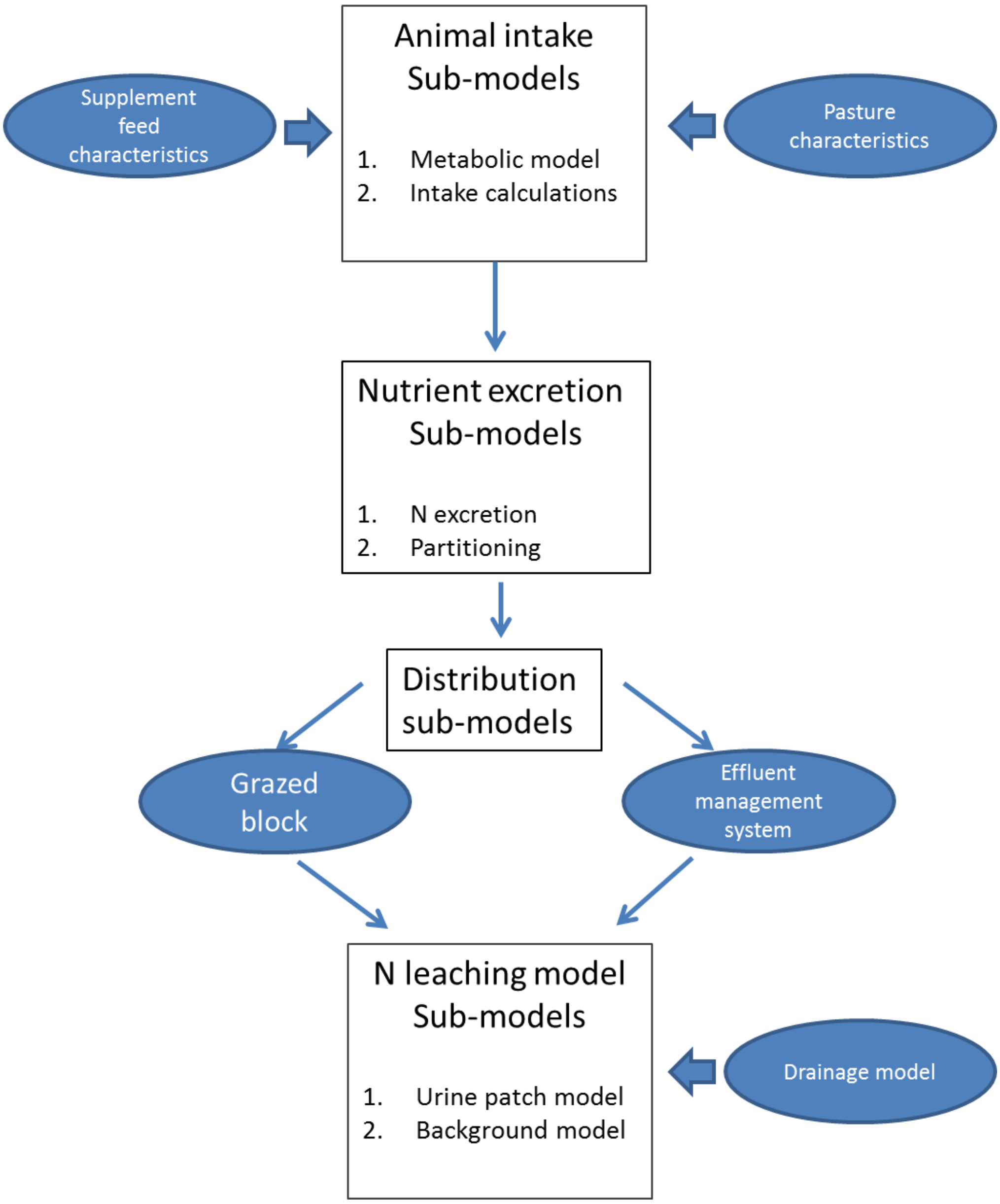
8. Appendices

8.1 Summary of the OVERSEER N leaching calculation for grazed pasture



8.2 Wharenui research trial OVERSEER file inputs

OVERSEER Inputs	OVERSEER Inputs	OVERSEER Entry	Source of Info
Farm general	***Region***	Rotorua	AgResearch
Farm blocks (ha)	Control	2.23	AgResearch
	DCD	2.29	AgResearch
	No Winter	1.62	AgResearch
	Main Block	228.86	Assumed
	Effluent block	45	AgResearch
	Total Farm Area	280	AgResearch
Structures	***Structures***	No	AgResearch
Animal Distribution	***Relative productivity***	No difference	AgResearch
Effluent System	***Management system***	Spray from sump	AgResearch
Supplements imported	***Type***	n/a	No information available
Enterprises	***Replacement rate***	23%	OVERSEER Default
	Cow numbers	820 (Peak)	AgResearch
	Breed	Friesian	AgResearch
	Maximum weight	Default	OVERSEER Default
	Production	270000.0	AgResearch
	Animal health supplements	n/a	
	Milk shed feeding	n/a	
	Wintering off	60% June, 30% July	AgResearch
General	***Topography***	Flat	AgResearch
	Distance from coast	40 km	AgResearch
Climate	***Rainfall seasonal variation***	Default	OVERSEER Default
	Mean annual rainfall, temperature and Annual PET	Appendix 8.3	AgResearch
	PET seasonal variation	Moderate	OVERSEER Default

Soil description	***Soil order***	Te Ngae (PUMICE)	AgResearch
	Soil profile	Sandy loam	AgResearch
	Soil texture group	Medium	AgResearch
	Non-standard layer	Stony	AgResearch
	Depth to non-standard layer	10 cm 2006 and 5 cm in 2007	AgResearch
Drainage/runoff	***Drainage class***	Well	AgResearch
	Hydrophobic conditions occur	Default	OVERSEER Default
	Pugging damage	Rare	Assumed
	Drainage method	n/a	AgResearch
Soil tests	***Olsen P***	38	OVERSEER Default
	QT K	5	OVERSEER Default
	QT Ca	6	OVERSEER Default
	QT Mg	16	OVERSEER Default
	QT Na	5	OVERSEER Default
	Organic S	7	OVERSEER Default
	ASC/PR	Default	OVERSEER Default
	Slow release K	Default	OVERSEER Default
Soil settings	***K leaching potential***	Default	OVERSEER Default
Pasture	***Pasture type***	Ryegrass/White Clover	AgResearch
Supplements removal	***Type***	n/a	No information available
Fertiliser	***Type***	Soluble Fertiliser (N)	AgResearch
	Rate	36	AgResearch
	Months	May and July	AgResearch
Irrigation	***Months***	n/a	AgResearch

Animals	***Access to streams***	No	AgResearch
Effluent	***Application depth***	12-24 mm	AgResearch
Solid effluent application	***Blocks***	Effluent	AgResearch

8.3 Wharenui research trial OVERSEER climate inputs

	Month	Rainfall (mm/month)	Drainage (mm/month)	PET (mm/month)	Temperature (C)
2005	November	45	0	121	13.5
	December	188	88	118	17.2
2006	January	178	109	129	17.7
	February	178	130	114	17.9
	March	149	71	90	15.5
	April	231	170	57	14.7
	May	152	111	44	11.1
	June	101	70	37	6.7
	July	78	46	37	8.0
	August	132	84	49	8.1
	September	36	0	72	10.7
	October	84	10	88	11.6
	November	63	4	94	13.7
	December	87	13	125	13.8
2007	January	141	49	119	17.6
	February	13	0	115	17.7
	March	171	74	92	16.9
	April	29	0	65	13.0
	May	77	34	50	11.5
	June	80	36	35	8.5
	July	198	166	32	8.7
	August	132	93	48	9.1
	September	78	21	62	10.1
	October	87	30	92	11.6

8.4 Parekarangi Trust research trial OVERSEER file inputs

OVERSEER Inputs	OVERSEER Inputs	OVERSEER Entry	Source of Info
Farm general	***Region***	Rotorua	AgResearch
Farm blocks (ha)	**Nitrogen trial**	16	AgResearch
	No Nitrogen trial	14.5	AgResearch
Structures	***Structures***	Nil	AgResearch
Animal Distribution	***Relative productivity***	No difference	Perrin Ag
Effluent System	***Management system***	Holding Pond	Perrin Ag
	Pond solids	Spread on selected blocks	Perrin Ag
		Emptied every 1 year	Perrin Ag
	Liquid effluent	Stir and spray regularly	Perrin Ag
Supplements imported	***Type***	PKE	Mark Johnston
	Amount - N trial	20 T (2012-13) and 18 T (2013-14)	Mark Johnston
	Amount - No N trial	28 T (2012-13) and 26 T (2013-14)	Mark Johnston
	Destination	Milking Shed	Mark Johnston
	Type	DDG (Brewers Grain)	Mark Johnston
	Amount - N trial	6 T (2012-13) and 5 T (2013-14)	Mark Johnston
	Amount - No N trial	6 T (2012-13) and 5 T (2013-14)	Mark Johnston
	Destination	Milking Shed	Mark Johnston
Enterprises	***Replacement rate***	23%/yr	Perrin Ag
	Cow numbers	Appendix 8.5	AgResearch
	Breed	F X J cross	Perrin Ag
	Median calving date	18th Aug (2012-13) and 20th Aug (2013-14)	Mark Johnston
	Drying off	22nd April (2012-13) and 13th May (2013-14)	Mark Johnston

	Maximum weight	OVERSEER default	OVERSEER Default
	Production	Appendix 8.5	Mark Johnston
	Animal health supplements	Nil	Perrin Ag
	Milk shed feeding	Nil	Perrin Ag
General	***Topography***	Rolling	AgResearch
	Distance from coast	50	AgResearch
Climate	***Rainfall seasonal variation***		OVERSEER Default
	Mean annual rainfall, temperature and Annual PET	Appendix 8.6	AgResearch
	PET seasonal variation		OVERSEER Default
Soil description	***Soil order***	Pumice	AgResearch
	Soil profile	Sandy loam	AgResearch
	Non-standard layer	Stony	AgResearch
	Depth to non-standard layer	5 cm	AgResearch
Drainage/runoff	***Drainage class***	Well	AgResearch
	Hydrophobic conditions occur		OVERSEER Default
	Pugging damage	Rare	Assumed
	Drainage method	Nil	AgResearch
Soil tests	***Olsen P***	38	OVERSEER Default
	QT K	5	OVERSEER Default
	QT Ca	6	OVERSEER Default
	QT Mg	16	OVERSEER Default
	QT Na	5	OVERSEER Default

	Organic S	7	OVERSEER Default
	ASC/PR	Default	OVERSEER Default
	Slow release K	Default	OVERSEER Default
Soil settings	***K leaching potential***	Default	OVERSEER Default
Pasture	***Pasture type***	Ryegrass/White clover	AgResearch
Supplements removal	***Type***	n/a	AgResearch
Fertiliser	***Type***	Appendix 8.7	
Irrigation	***Months***	Nil	AgResearch
Animals	***Access to streams***	No	AgResearch
Effluent	***Application depth***	12-24 mm	Perrin Ag
Solid effluent	***Blocks***	Effluent & rest of farm	Perrin Ag
	Month applied	October	Perrin Ag

8.5 Parekarangi Trust research trial OVERSEER cow number inputs

	Month	N Trial	No N Trial
2012	July	0	0
	August	40	48
	September	43	45
	October	48	0
	November	0	0
	December	42	50
	January	50	50
	February	58	50
	March	80	80
	April	0	0
	May	73	88
2013	June	0	0
2013	July	92	0
	August	0	15
	September	81	42
	October	17	17

	November	8	17
	December	17	17
	January	50	25
	February	50	25
	March	50	92
	April	25	25
	May	58	50
2014	June	0	0

*Cow numbers have been scaled to represent average number of cows on the treatment blocks per month

8.6 Parekarangi Trust research trial OVERSEER climate inputs

	Month	Rainfall (mm/month)	Drainage (mm/month)	PET (mm/month)	Temperature (C)
	November	13	0	102	12.9
	December	115	3	108	17.1
2013	January	9	0	125	17.3
	February	15	0	105	17.6
	March	29	0	82	17.5
	April	173	83	44	14.8
	May	157	129	23	11.4
	June	160	151	11	8.6
	July	43	29	15	7.6
	August	156	124	29	9.8
	September	203	157	44	10.7
	October	67	30	79	12.1
	November	96	20	110	15.3
	December	119	35	113	16.5
2014	January	52	0	122	16.3
	February	11	0	95	17.7
	March	23	0	81	15.7
	April	205	122	40	15.1
	May	83	62	21	10.6
	June	135	122	12	10.0
	July	66	52	15	7.6
	August	144	127	29	8.2
	September	169	118	55	10.9
	October	97	15	88	11.9

8.7 Parekarangi Trust research trial OVERSEER fertiliser inputs

Year	Product	Aug	Sep	Nov	Dec	Jan	Apl
2012-13	Nitrogen	40	37	21		35	40
2013-14	Nitrogen	40		25	37		35