BEFORE THE HEARING PANEL OF SOUTHLAND REGIONAL COUNCIL

In the matter of sections 88 to 115 of the Resource Management Act 1991

And

In the matter Applications for resource consents by:

WOLDWIDE ONE LIMITED, WOLDWIDE TWO LIMITED,
Applicants

BRIEF OF EVIDENCE OF CAIN DUNCAN

16 September 2019

QUALIFICATIONS AND EXPERIENCE

1 My full name is Cain Ross Duncan and I am currently employed as the Otago/Southland Sustainable Dairying Manager with Fonterra Co-Operative Group.

2 I hold a Bachelor of Resource Studies and a Masters in Applied Science from Lincoln University which were completed in 2000 and 2005 respectively. I achieved a Certificate of Completion from Massey University for satisfying the course requirements for the Advanced Certificate in Sustainable Nutrient Management in 2014. This is part of the training required for understanding and using of OVERSEER®.

3 In addition to the above qualifications I hold a Certificate of Completion for satisfying the course requirements for Advanced Farm System Modelling from Massey University.

4 I am a current Certified Nutrient Management Advisor having satisfied the criteria under the Nutrient Management Advisor Certification Programme managed by the Fertiliser Association of New Zealand. I completed my last annual assessment for this programme in December 2018.

5 I have 7 years' experience in the dairy industry in the role of a Sustainable Dairy Advisor. This role involves providing advice and support to Fonterra shareholders to assist them in developing and adopting practices that will improve the sustainability of their farming operations. I work one on one with our suppliers, to accelerate their adoption of good management practices, meeting Fonterra's minimum standards and complying with regional rules and consents.

6 Since 2013 Fonterra has annually collected data from its farmer shareholders to enabled modelling of individual farms nitrogen loss using OVERSEER®. Last year this resulted in the processing of over 9500 OVERSEER® files by Sustainable Dairy Advisors and QCONZ. Each year I process between 50-100 OVERSEER® files as part of this programme as well as a number of regulatory and predictive budgets for shareholders throughout the year.

7 I have a sound knowledge of farm systems and their relationship with nutrient management plans, having provided these to Fonterra shareholders in recent years.

8 Prior to my employment with Fonterra I worked for the London Borough of Tower Hamlets and the London Borough of Haringey (United Kingdom) as a Planning Officer/Enforcement Manager in their respective Planning sections for a total of 7 years. Before moving to the United Kingdom I worked as a Compliance Monitoring Officer for Environment Canterbury.

9 I have read, and agree to comply with, the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. Other than where I state that I am relying on the evidence of another person, I confirm that the issues addressed in this evidence are within my area of expertise. I have not omitted to consider material facts known to me that alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

10 This evidence addresses the following issues:

10.1 OVERSEER® assumptions, limitations and uncertainties.

10.2 OVERSEER® FM v6.3.2 modelling for four seasons (13/14 – 16/17) on Woldwide One Limited **"WOL"**, Woldwide Two Limited **"WTL"** and the attached support land to the north of WTL (known as SH96 and Marcel Blocks) as well as a modelled scenario for these areas of land taking into account the proposed farm system changes and mitigations.

10.3 OVERSEER® FM v6.3.2 modelling for the 17/18 season for the Horner Block and a proposed scenario for this area based on increased barn effluent being applied.

10.4 OVERSEER® FM v6.3.1 modelling for Woldwide Runoff Limited **"WRL"** for the 16/17 and 17/18 seasons as well as a proposed scenario for this area of land based on its future use if consent is granted for expanded dairying at WOL and WTL.

10.5 Additional reductions in phosphorus outside of that modelled in OVERSEER®.

10.6 The reporting officers position including effluent application rates, the disposal of effluent especially on Braxton soils, which have shrink and swell properties, modelling concerns and the applicability of good management practices.

11 I am aware that Ms Legg's evidence indicates that some of the areas I have modelled do not necessarily need land use consent and that the Applicants' opening legal submissions will deal with this. The fact that I have modelled those areas does not mean that I accept they require a land use consent. That is not an issue on which I am giving evidence, as it is addressed by others.

BACKGROUND

12 The following abbreviations have been used to describe the land associated with the Woldwide group of farms:

WOL – Woldwide One Limited

WTL – Woldwide Two Limited

Support Land – SH96 and Marcel Blocks being the non-dairy platform land north of Winton Wreys Bush Highway.

WRL – Woldwide Runoff Limited incorporating the Merrivale Block and the leased Merriburn Block.

13 I have been involved in producing various end of season and scenario nutrient budgets for the Woldwide Group of farms since early 2017. This includes producing nutrient budgets and nutrient loss analysis for the previous expanded dairying consent applications for WOL and WTL.

14 Farm systems information was provided by Mr De Wold for the various farm nutrient budgets that have been produced. In addition to this, fertiliser inputs have been provided by Ravensdown (except for the 2014/15 season when the information was obtained from Ballance Agri Nutrients), milk production figures from Fonterra and details of supplements, cow numbers and land area for the dairy farms from Ivan Lines of the Agribusiness Group.

15 Soil areas were produced from soil mapping undertaken by John Scandrett of Dairy Green Ltd. Climate settings were initially obtained from the Overseer climate station tool prior to the upgrade to OverseerFM.

16 In the 2013/14 nutrient budget for WOL, WTL and the Support Land a conservative nitrogen loss figure of 15kg/ha/yr was used for a 38ha section of the SH96 Block that was not under the ownership of Woldwide Farms in 2013/14 (and no accurate information was available on its use at that time). This figure represents an average nitrogen loss figure from a sheep farm on lighter soils.

17 The Merriburn Block was incorporated into WRL in the 2017-18 dairy season, however there was only limited information made available on its past production potential and previous stocking rates. This was largely due to the passing away of one of the previous owners who had overseen the property.

18 This has resulted in difficulties being able to source information to model the use of the Merriburn Block prior to 2017. In general terms it is known that the property was used for the rearing and wintering of young stock (R1's and R2's) for the former Milkpride dairy management company.

19 On this basis a 2016-17 nutrient budget has been produced for WRL, which reflects the actual inputs for the Merrivale Block (which was under the ownership of WRL) and a conservative estimate of the land use occurring on the Merriburn block.

20 It is important that the use of the land prior to the property being leased to WRL is reflected as the available evidence indicates it was a significantly more intensive use than what is proposed and currently occurring on the Merrivale Block. This is significant as in 2017-18 WRL was understocked, resulting in considerable difficulty controlling pasture growth, which in turn impacted on pasture quality and animal growth rates.

21 In addition, I note that Mrs De Wolde's evidence and that of Ms Legg describes what can lawfully occur and is likely to happen if the consents are not granted. In that case the applicants are not limited

to what happened in 2017-18 and the 2016-17 gives some indication of the types of losses that might occur.

22 A number of updates[1] have been made to the OVERSEER® modelling during the course of the application as a result of updates to OVERSEER®, changes in the interpretation of policies within the Proposed Southland Water and Land Plan, the outcome of hearing decisions and most recently to correct a modelling error whereby effluent slurry had been incorrectly applied to the Marcel Block. The final versions of Nutrient Budgets/Analysis Reports are:

– Nutrient Budgets/Analysis - Woldwide 1, 2, SH96 & Marcel Block (Supplementary Report – Horner Block) – Overseer FM Ver 6.3.2– 14/09/19

– Nutrient Budgets/Analysis Woldwide Runoff (Supplementary Report) Version 3 – 05/09/19.

OVERSEER® ASSUMPTIONS, LIMITATIONS AND UNCERTAINTIES

23 OVERSEER® is a tool used by farmers and advisors to assess nutrient use, loss and movements within a farming system. The computer model calculates and estimates the flow of nutrients in a farming system and identifies the risk of environmental impacts through nutrient loss.

24 OVERSEER® uses animal stocking rate and productivity to estimate animal requirements (MJME), which is then used to estimate production.

Assumptions

25 There are four main assumptions underpinning the use of OVERSEER® as a modelling tool. They are:

[1] Updated Overseer Modelling Published to Environment Southland on 16.09.19 reflecting removal of slurry from Marcel Block and updated OVERSEER® version to 6.3.2 (WOL, WTL, SH96, Marcel and Horner Block only)

25.1 OVERSEER® assumes steady state conditions, i.e. the farm is at a state where there is minimal change each year.

25.2 OVERSEER® uses long term average inputs such as rainfall, PET and temperature and thus produces annual average outputs.

25.3 OVERSEER® assumes the inputs into the model are actual and reasonable.

25.4 OVERSEER® assumes some specific good management practices (GMP's) are used. For effluent and fertiliser it is assumed that the stated rate is applied evenly at the time stated. The model also assumes runoff from yards, races bridges, silage stacks are all dealt with in a manner that doesn't result in large point source discharges. The exception to this is for phosphorus where OVERSEER® assumes 30% of phosphorus deposited on lanes is lost to surface waterways.

Limitations

26 The key limitations of the OVERSEER® model are:

26.1 OVERSEER® does not predict transformations, attenuation or dilution of nutrients between the root zone or farm boundary and the eventual receiving waterbody.

26.2 OVERSEER® uses long term average climate data and therefore doesn't account for climatic extremes or years where climate allows for exceptional (or poor) pasture growth. The model provides a "typical" year's result based on a long term average.

26.3 OVERSEER® does not calculate the impacts of a conversion process, rather it predicts the long term annual average nutrient budgets for the changed land use.

26.4 OVERSEER® is not spatially explicit beyond the level of defined blocks.

26.5 Not all management practices or activities that have an impact on nutrient loss are captured in the OVERSEER® model.

26.6 OVERSEER® has not been calibrated against measured data from all farming systems, soil types or environments.

Uncertainty

27 Uncertainty pertaining to the OVERSEER® centres around the model's ability to accurately determine nutrient losses, however these are practically impossible to measure accurately. Measured results from parts of paddocks or more rarely whole paddocks have been carried out using lysimeters, suctions cups and other collection technologies but it is not possible to capture nutrient losses from a whole farm and across the multiple soil and landscape variations that may occur. This means there are few benchmarks to compare against.

28 OVERSEER® is used for modelling a wide range of farm systems in many different geographical settings; validation or calibration data for all circumstances is not possible, therefore the issue is really the uncertainty associated with whole farm nutrient loss estimates will increase for situations that are well outside the calibration /validation range.

29 Pastoral blocks within OVERSEER® have been through the most calibration and testing (most of which has been on dairy farms) but more data from calibration/validation of the OVERSEER® model is required to reduce the uncertainty, most notably for:

- Cropping and Sheep and Beef
- Clay and shallow and light textured soils
- High Rainfall locations >1200mm

30 Traditionally Overseer has been calibrated against a set of farmlet trials however Version 6 (2012) has also undergone a range of logic tests to ensure that parts of the model were responding as expected and to test for unforeseen consequences of changes. In addition to this expert opinion on the model and its responses were also

provided. The farmlet trials utilised in the calibration and validation of Overseer are outlined in Table 1 below:

Management block	Nitrogen calibration	Phosphorus calibration
Pastoral	Calibration (undertaken in 2012) used nutrient loss measurements from farmlet studies at eight locations. These were: Edendale, Southland (intensive beef); Tussock Creek, Southland (dairy); Kelso, Otago (dairy); Lincoln University Dairy Farm, Canterbury (dairy); Massey University Dairy Farm, Manawatū-Whanganui (dairy); Ruakura, Waikato (dairy); Scott Farm, Waikato (dairy); and Wharenui, Bay of Plenty (dairy). A recalibration exercise is currently underway.	Calibration (undertaken in 2005) used data from 23 sites: Canterbury (2), Otago (3), Southland (2), Manawatū (5), Northland (2), Waikato (4), West Coast (2), Wellington (1), Hawkes Bay (2).
Crop	Arable crops – very limited calibration (one Lincoln site).	Arable crops – none due to a lack of experimental sites. Forage crops – limited to 2 sites in Otago and 1 in Southland.
Fruit crop	None due to a lack of experimental sites.	None due to a lack of experimental sites.
Trees and scrub	None due to a lack of experimental sites.	None due to a lack of experimental sites.
Wetlands and riparian	Very limited calibration based on published studies.	Very limited calibration based on published studies.
House	Very limited calibration (based on one international study).	None.

Table 1 – Overseer Calibration and Validation (Parliamentary Commissioner for the Environment, 2018[2])

31 Uncertainty around OVEERSEER® outputs tends to be much lower within the range of the calibration data set outlined in Table 1. Most of the calibration and validation data used to date is focused on flat, pastoral, dairy enterprises, with primarily free draining soils and moderate rainfall located in the Waikato, Southland, Canterbury and Manawatu. Most of the modelling undertaken on WOL, WTL, Marcel, SH96 and Horner Block sits within the range of the calibration data.

32 Consistency in entering inputs into OVEERSEER® is critical to the precision of the model i.e. do multiple users get the same result. Insuring modelling is consistent across scenarios and following agreed protocols such as the Overseer Input Standards are essential

[2] Parliamentary Commissioner for the Environment (2018). *Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways.* Pg 31.

to obtaining accurate farm loss estimates and consistency between modelled scenarios.

33 When scenarios are compared the focus should be on the difference in modelled outputs rather than the overall nutrient loss estimate.

34 The use of OVERSEER® as a modelling tool has been recognised by a number of Regional Councils across New Zealand and has been accepted by the Environment Court for use by councils in regional plans to manage nitrogen losses. It is specifically recognised in the Proposed Southland Water and Land Plan where an OVERSEER® nutrient budget (or an approved alternative) is required for Farm Environmental Management Plans (FEMPs) for all landholdings over 20ha. I am not aware of alternative being approved by Environment Southland.

Modelling Steps Taken to Reduce Uncertainty

35 The following steps have been undertaken to minimise the impact of uncertainties on the modelling results:

35.1 The Best Practice Data Input Standards (BPDIS) have been complied with to ensure consistency in entering inputs into OVERSEER®. No deviations from the BPDIS were made.

35.2 A consistent method and methodology was used between scenarios to ensure comparable results.

35.3 Blocking was undertaking using farm level soil mapping and took into account land use, management systems, soils, stock and topography.

35.4 An experienced and qualified OVERSEER® user with a good knowledge of dairy farm systems was used to drive the model and produce the associated nutrient budgets.

35.5 The outputs from the OVERSEER® modelling were sense checked against expected results relative to soil types, land use, climate and inputs.

35.6 A site visit was made to all properties associated with the OVERSEER® modelling to ensure a good understanding was obtained of the land features.

OVERSEER® Modelling Results

36 Modelling has been undertaken for a number of properties associated with the Woldwide group of farms. In total there is 1554ha of land allocated as follows:

- 502ha – WOL, WTL, Support Land (SH96 & Marcel) located at Heddon Bush.
- 160ha – Horner Block located at Heddon Bush
- 892ha – Woldwide Runoff Limited (WRL) (Merrivale and Merriburn) located at Merrivale

37 WOL and WTL are adjoining dairy farms with maximum consented cow numbers of 1340. The farms are located on predominately flat land comprised of well drained Drummond soils and poorly drained Braxton soils (can be subject to cracking in dry conditions). Wintering barns are located on both properties to reduce the number of cows needing to be wintered outside on crops. Both farms have effluent storage ponds that allow for the deferred irrigation of farm dairy and wintering barn effluent using low depth irrigation technology.

38 The Support Land to the north of WTL is comprised of two areas commonly referred to as the SH96 Block and Marcel Block. These areas have been used for a number of support functions in recent years including winter grazing of mixed age cows on crop, the winter grazing of young stock on grass, silage production, harvesting of fresh grass and the application of effluent slurry. Like WOL and WTL the topography of the support land is predominately flat land and is comprised of well drained Drummond and Glenelg soils.

39 The Horner Block is located to the southwest of WOL and in recent times has been used for the production of cut and carry silage and the wintering of mixed age cows and young stock on grass and a range of crops. Accurate records of crop areas were not available at the time of producing nutrient budgets for the Horner Block and thus

a current nutrient budget was produced based on the 2017-18 cut and carry operation. This is a very conservative approach to modelling the existing nitrogen and phosphorus losses on Horner Block as it represents a low nitrogen and phosphorus loss system.

40 WRL is located approximately 25km to the southwest of WOL and WTL and is comprised of the leased Merriburn block (385ha) and the owned Merrivale block (507ha). WRL is used to graze young stock from five dairy farms with baleage being made during periods of surplus grass production. Baleage is used to supplement the winter grazing of young stock at WRL and is also sold to other Woldwide farms. In addition to the raising of young stock and baleage production, WRL also has approximately 100ha of commercial pine plantation and 60ha of Beech forest.

41 It is proposed to make changes to the current operations to remove on paddock winter grazing from the Heddon Bush area, which has a high environmental impact (high proportion of light soils that are prone to nitrogen leaching) and can negatively impact on cow condition. This will be achieved by expanding the current wintering barn facilities on WOL and WTL from 900 stalls to 1250 and improving farm profitability by grazing an additional 160 dairy cows across the two dairy farms by bringing support land previously used for winter grazing and silage production into the dairy platform.

42 Paddocks previously used by WTL will be transferred to WOL, while the support land will be moved into WTL dairy platform area. This keeps stocking rates between the two farms the same.

43 Detailed information on the inputs used in the OVERSEER® modelling and changes that have occurred year on year and between current and proposed scenarios are covered in the following reports and for brevity are not included in this brief of evidence:

– Nutrient Budgets/Analysis - Woldwide 1, 2, SH96 & Marcel Block (Supplementary Report – Horner Block) – Overseer FM Ver 6.3.2– 14/09/19

– Nutrient Budgets/Analysis Woldwide Runoff (Supplementary Report) Version 3 – 05/09/19

WOL, WTL, Support Land Results

44 The results of the baseline nutrient budgets prepared for WOL, WTL and the Support Land (SH96 & Marcel) are shown in Table 2 below (OVERSEER®FM version 6.3.2):

	13/14*	14/15	15/16	16/17	Average
Total N Loss	19489	23347	19440	20747	20756
N Loss/ha	41 (15)	47	39	41	42
Total P Loss	352	381	368	363	366
P Loss/ha	0.7 (0.2)	0.8	0.7	0.7	0.7
Pasture Grown Kg/DM/ha/ yr (Dairy	15,207	15,700	15,212	16,081	15,550

Table 2 – Nutrient Losses and Pasture Production WOL, WTL & Support Block

* See Paragraph 14 and Section 7.1 & 10.1 of the Nutrient Budgets/Analysis Report

45 The results of the proposed nutrient budget prepared for WOL & WTL (incorporating the support land into WTL) and the changes in nutrient losses are shown in Table 3 below (OVERSEER®FM version 6.3.2):

	Proposed Dairy Unit	% Change from Pre-Expansion Average
Total N Loss (kg)	19378	-6.6
N Loss/ha (kg)	39	-
Total P Loss (kg)	358 (344)*	-2.2 (-6.0)*
P loss/ha (kg)	0.7	-
Pasture Grown Kg/DM/ha/yr	15,944	-

Table 2 – Proposed Nutrient Losses and Pasture Production WOL & WTL (incl Support Land)

* Figures in brackets are total phosphorus reductions including mitigations calculated outside of OVERSEER® - See paragraphs 50-53.

46 Using OVERSEER®, nutrient budgets have been produced comparing nutrient losses from four seasons under the current farming system against those from the proposed system. OVERSEER® predicts that nitrogen loss will decrease by 6.6% and phosphorus by 2.2%.

47 The key reasons for the reductions in nitrogen are:

- Removal of winter and summer crop
- Removal of cows wintered outside on crop or grass
- Expansion of the size and use of the wintering barn facilities
- More efficient use of nitrogen fertiliser

48 The key reasons for the reductions in phosphorus are:

- Decrease in winter crop area
- Maintaining Olsen P at a target level of 30
- Expansion in the size and use of the wintering barn facilities (less wintering)

49 Additional mitigation measures for phosphorus have also been calculated outside of OVERSEER®, due to the limitations OVERSEER® has in being able to spatially recognise some farm landscape features, such as waterways and critical source areas.

50 The core of the Overseer sub-model is based on the work of McDowell et al (2005)[3], which estimates phosphorus losses due to run-off up to second order streams (a stream with two tributaries) from a grazed-pastoral system. Run-off includes the combined losses from surface and sub-surface flows, but excludes deep drainage to groundwater and mass movement. At block level OVERSEER® accounts for general topography attributing a higher phosphorus loss risk with increased slope, however it is unable to define specific areas of risk within a block, such as critical source areas. Due to this limitation the model can't account for specific mitigations to deal with those higher risk areas.

51 A key assumption in the OVERSEER® phosphorus sub-model is that there is a connection between a phosphorus source and a second order stream. On properties with no waterways or on a flat farm with minimal critical source areas this assumption may not hold true. In addition to this, OVERSEER® automatically estimates that there will be phosphorus loss from lanes to waterways. It assumes that all

[3] McDowell, R.W., Monaghan, R.M., Wheeler, D. (2005). *Modelling phosphorus losses from pastoral farming systems in New Zealand*. New Zealand Journal of Agricultural Research 48: 131-141.

excreted phosphorus ends up as dung and that 30% of the phosphorus deposited on lanes is lost to water with the remaining 70% expected to remain on the lane or return to the adjacent paddock. This is a significant assumption and a major component of modelled phosphorus loss, reported as part of “other sources” in the OVERSEER® model.

52 Taking into account the mechanics of the OVERSEER® phosphorus sub-model, proposed mitigations that isolate a source of phosphorus from a waterway or reduce the amount of phosphorus getting to a waterway through specific landscape features will result in additional reductions in phosphorus above those calculated in OVERSEER®. Details of these mitigations for WOL, WTL and WRL are contained in the following reports attached to the Farm Environmental Management Plans:

- Woldwide 1 & 2 Phosphorus Mitigation Plan Version 3 – 04/09/19.
- Woldwide Runoff Phosphorus Mitigation Plan Version 2 – 05/09/19.

53 When specific phosphorus mitigations measures relating to lanes (mitigation of 13.1kg P/year) and the management of critical source areas (mitigation of 1.2kg P/year) are calculated outside of OVERSEER® the predicted total reduction in phosphorus as a result of implementing the proposed farming system is 22kg P/year or 6%.

54 For completeness, nutrient losses from the Marcel Block, which is not currently being used for dairying are presented in Table 3 below. When compared to the predicted per/ha losses from the new farming system there is a significant reduction in nitrogen losses on Marcel Block and no change to the per/ha phosphorus losses.

Marcel only (44ha)	13/14	14/15	15/16	16/17	Average
Total N Loss	3220	2684	1871	2082	2464
N Loss Ha					56
Total P Loss	9.8+(21)=30.8	10+(21.7)=31.7	8.25+(21)=29.25	8.3+(21.9)=30.2	30.5
P loss ha					0.7

Table 3 – Nutrient Losses – Marcel Block – Figures in brackets are the relative proportion of other sources phosphorus losses.

Horner Block Results

55 The results of the baseline nutrient budget and proposed nutrient budget prepared for Horner Block are shown in Table 4 below (OVERSEER®FM version 6.3.2):

	Total Current	Total Proposed	Per/ha Current	Per/ha Proposed	% Change
Nitrogen Loss (kg/N)	3155	3107	20	19	-1.5
Phosphorus Loss (Kg/P)	24	22	0.1	0.1	-8
Pasture Production (kg/DM)	17000		17000		

Table 4 – Current and Proposed Nutrient Losses Horner Block

56 Using OVERSEER®, nutrient budgets have been produced comparing nutrient losses from the 2017-18 season against those from the proposed system. OVERSEER® predicts that nitrogen loss will decrease by 1.5% and phosphorus by 8%.

57 The only change between the current and proposed scenarios on the Horner Block is the substitution of solid fertiliser with effluent slurry fertiliser from the WOL and WTL. This is applied in five applications of 15m^3/ha compared to three applications of 17m^3/ha currently. The change to applying less more often is likely to account for the small changes in nitrogen and phosphorus losses between the current and proposed scenarios.

58 It is acknowledged that the application of nitrogen from effluent slurry in the 2017-18 current file was 166kg/ha/year, which is slightly above the 150kg/ha/year limit allowed for in the farms discharge consent (due to a miscalculation in the slurry loading rates during 2017-18). This is likely to have little impact on the overall losses predicted by OVERSEER® for the 2017-18 season, however I have run a scenario

in OVERSEER® that keeps all inputs to the Horner Block the same but substitutes 16kg/N/ha from slurry with 16kg/N/ha from Urea (which would have been permitted). This actually increased the 2017-18 nitrogen loss from 3155kg/N/yr to 3260kg/N/yr.

59 The intended purpose of the nutrient budgets for the Horner Block were to show that the cut and carry operation has very low overall nutrient losses and the changes to WOL and WTL do not change this. This is within the context that the current 17-18 season nutrient budget represents a conservative approach to modelling the existing nitrogen and phosphorus losses on the Horner Block. Prior to the 2017-18 season the Horner Block was also used for the winter grazing of young stock (R1's). This land use would significantly lift the current average nutrient losses on Horner Block. On this basis, maintaining the status quo will likely result in a sizable reduction in nitrogen and phosphorus losses compared to land uses that have occurred in recent times and could legally still occur now.

Woldwide Runoff (WRL) Results

60 The results of the baseline nutrient budgets and proposed nutrient budget prepared for WRL are shown in Table 5 below (OVERSEER®FM version 6.3.1):

	16/17	17/18	Average	Proposed	% Change
Total N Loss (kg)	26134	19931	23033	22603	-1.9
N Loss/ha (kg)	29	22	26	25	
Total P Loss (kg)	500	532	516	489 (454)*	-5.2 (-12)*
P Loss/ha (kg)	0.6	0.6	0.6	0.5	
Pasture Grown (kg/DM/ha /yr)	12639	11024	11832	13282	

Table 5 – Current and Proposed Nutrient Losses Woldwide Runoff

* Figures in brackets are total phosphorus reductions including mitigations calculated outside of OVERSEER® - See paragraphs 50-52.

61 Using OVERSEER®, nutrient budgets have been produced comparing nutrient losses from the 16/17 and 17/18 seasons against

those from the proposed system. OVERSEER® predicts that nitrogen loss will decrease by 1.9% and phosphorus by 5.2%.

62 The key reasons for the small reduction in nitrogen are:

- Reduction in cows wintered on crop compared to the 2016/17 season.
- Additional land (12ha) planted in trees
- More efficient use of nitrogen fertiliser

63 The key reasons for the reductions in phosphorus are:

- Additional land (12ha) planted in trees
- Reducing larger applications of phosphorus fertiliser
- Reduction in cows wintered on crop compared to the 2016/17 season.

64 When specific phosphorus mitigations measures relating to unfenced waterways (mitigation of 19.7kg P/year) and the management of critical source areas (mitigation of 15kg P/year) are calculated outside of OVERSEER® the predicted total reduction in phosphorus as a result of implementing the proposed farming system is 62kg P/year or 12%.

65 As noted in paragraphs 15-18, the section of the 2016-17 nutrient budget that relates to the Merriburn block has been based on a conservative estimate of the land use that was likely to be occurring. Stock data estimates were provided by a former farm manager with the crop and supplement requirements to fed stock over winter being determined by the Dairy NZ crop calculator.

66 In order to support the winter grazing assumptions made for the Merriburn Block aerial imagery (Google Earth) was used to look at areas of the farm that were under cultivation. The most recent image of the farm prior to it being leased to WRL is December 2015. The areas cultivated at this time were placed onto a farm map (attached in the Woldwide Runoff Nutrient Budget/Analysis Report – Appendix 3) showing paddocks and their subsequent size. The area under cultivation was approximately 120ha. Assuming half of this area was returning to grass (which is conservative as some paddocks would be

double cropped) then 60ha would have been utilised for winter grazing. This can be compared to the 58ha under winter crop in the Merriburn Block in the 2016/17 Nutrient Budget.

67 Conservative fertiliser inputs and baleage production figures were also used in forming the 2016-17 nutrient budget. Full details are available in the following report:

- Nutrient Budgets/Analysis Woldwide Runoff (Supplementary Report) Version 3 – 05/09/19.

COMMENTS ON REPORTING OFFICERS POSITION

250kg/ha Nitrogen Loading from Effluent Slurry

68 References have been made throughout the Section 42A report to the proposed nitrogen loading rates from slurry on the Horner Block and that this is significantly higher than the good management practice guideline of 150kg/N/ha/yr. No consideration has been given to the origins of the guideline or the actual nutrient requirements of the pasture.

69 A key aspect not covered in the Section 42A report or the evidence of Ms Lovett is the effluent guideline of 150kg/N/ha/yr is only applicable to dairy farms, i.e. a farm where stock are also grazing the pasture and delivering nutrients back into the pastural system via urine and dung. This recycling of nutrients makes a sizable contribution to the soil/pasture nutrient pool returning around 300kg/N/ha/yr (Jarvis et al, 1995[4]).

70 The Horner Block is a cut and carry block and therefore nutrients in pasture that are normally ingested by animals and returned to the soil pasture system as urine and dung are being exported in silage and feed to animals in the wintering facilities. In a cut and carry system this nutrient needs to be replaced. This can either be done with solid imported fertilisers (which come with additional costs both economically and environmentally, i.e. green house gas emissions)

[4] Jarvis, S.C., Scholefield, D., Pain, B., 1995. Nitrogen cycling in grazing systems. In: Bacon, P.E. (Ed.), Nitrogen Fertilization in the Environment. Marcel Dekker, New York.

or by simply returning the nutrients captured in effluent from the wintering barns back to the Horner Block.

71 Unlike the patchy return of nutrient to the soil/pasture system from a dairy cow, where upwards of 30% of the applied nitrogen is lost from the soil root zone, slurry on the Horner Block is applied at a low depth, evenly and at a rate of only 50kg/N/ha/yr per application (compared to 500-1000kg/N/ha/yr in a cow urine patch).

72 While there can be nutrient losses to water resulting from the spreading of effluent, the loss figure of 2-20% of nitrogen and phosphorus applied as FDE quoted by Ms Lovett is from a 2004 literature review by Houlbrooke et al. At that time most effluent was spread directly to land with little consideration given to soil moisture conditions. Since 2004 there has been a significant investment in effluent infrastructure across the dairy industry whereby most farms can now defer effluent irrigation to times when soil conditions are suitable. On this basis the figures quoted are likely to be exacerbated and actual losses when low depth, deferred irrigation techniques are used are likely to be at the lower end of the 2-20% scale.

73 Further discussion on the 250kg/N/ha loading rate from slurry on the Horner Block is provided by Anthony Roberts in his statement of evidence.

Nitrogen Loading Rates – Effluent vs Non-Effluent Blocks

74 Comments in the Section 42A report and the evidence of Nicole Phillips refers to good farming practice not being achieved as a result of total N applications on the effluent block being higher than on the non-effluent block.

75 It is good farming practice to make allowances for nutrients provided via the application of dairy effluent by reducing solid fertiliser inputs on effluent areas, however I have not witnessed a situation where nitrogen loadings on the effluent and non-effluent blocks are identical.

76 Generally total modelled nutrient inputs on effluent blocks will be higher to account for the variability in effluent nutrient concentrations

and spreading variances. In my opinion this does not constitute poor practice.

Modelling Concerns

77 Concerns have been raised in the Section 42A report that not providing budgets for the 2017-18 and 2018-19 season for WOL, WTL and the Support Land place a far greater level of uncertainty on the modelled results reflecting actual losses from the proposed activity. It is difficult to see any justification for this conclusion as the lack of budgets for 2017-18 and 2018-19 don't impact on the modelling results obtained from 2013/14 to 2016/17. These four nutrient budgets provide a very comprehensive overview of the losses occurring from the current authorised farming operation.

78 The reasons for not supplying a 2017/18 nutrient budget are outlined in the Nutrient Budgets/Analysis Report for WOL, WTL, SH96 and Marcel Block and relate to cow numbers for the 2017/18 season exceeded the maximum number allowed under the farms discharge permit. This was largely as a result of having extra stock reared in anticipation of obtaining resource consent last year, This never eventuated. While modelling the 2017/18 season is possible it is deemed to be inappropriate as it is likely to inflate the farms current nutrient loss averages.

79 A 2018/19 nutrient budget has not been supplied as the application was submitted prior to the end of the season and the relevant end of season data was not available.

80 Reference has been made in the Section 42A report that additional cows will be added to WOL and as such nutrient losses will increase in this area relative to the rest of the farm. The report further states that the way the proposed scenario has been modelled in OVERSEER® shows the additional cows over the whole of WOL and WTL (incorporating the support land) when they will only be added to WOL. While this is partly correct in that additional cows will be added onto WOL, what hasn't been articulated is WOL's land area has increased to incorporate land previously used by WTL. This would become available as a result of WTL expanding into the support land (SH96 & Marcel). The overall stocking rate is similar on both farms

and hence there is no benefit in modelling WOL and WTL separately as all other inputs are also identical.

81 Concerns have been raised that modelling on the SH96 and Marcel Blocks incorporates intensive winter grazing, which is not part of the existing environment. This could be correct if the 2017 land use consent had been implemented, however to the best of my knowledge this has not occurred from an operational or legal perspective. This issue is dealt with more comprehensively in legal submissions by Mr van der Wal.

82 There is some confusion in the Section 42A report pertaining to the versions of OVERSEER® used to produce the baseline nutrient budgets versus the proposed nutrient budgets. To clarify all modelling (including all baseline budgets) for WOL,WTL, SH96, Marcel and Horner Block have been completed in OVERSEER® FM Ver 6.3.2 (released 9th September 2019). Modelling of the baseline and proposed nutrient budgets for WRO have been completed in OVERSEER® FM Ver 6.3.1. On this basis modelling is comparable between baseline files and proposed files in all instances.

Braxton Soils

83 Comments are made in the Section 42A report about the ability of OVERSEER® to accurately model the potential nutrient losses due to the nature of the shrink/swell soils on the property.

84 This may be accurate in terms of the total losses and kg/ha losses predicted from the OVERSEER® modelling (as it relates to Braxton soils) but the relative increases or decreases in nutrient losses between scenarios is still valid and carries important weight in the context of Policy 15 and 16 of the pSWLP.

85 This is because the existing scenario and the proposed scenario were both modelled using the same version of OVERSEER® with the same “bias”. Because the focus is on finding the difference between those scenarios, as long as the bias is the same, it makes no difference for the validity of the comparison. It is similar to finding the difference in weight between two objects, using scales that slightly under-read. As long as the same scales under-reading by the same

extent are used, the difference will remain accurate and not be undermined by the under-reading.

86 Ms Mears in paragraph 44 of her evidence raises concerns that the mitigation proposed by the applicant to avoid applying effluent to cracked soils will result in an increase in the calculated nitrogen loading rate in other areas. Ms Mears states in an extreme case 75ha of Braxton soil may need to be avoided on the Horner Block, increasing the likelihood of an increased nutrient loading rate on the remaining areas.

87 It is acknowledged that there is a small risk this could occur in an extreme weather event; however this would only be for a limited part of the dairy season and dry conditions would limit the volumes of dairy effluent being generated (significant portion of dairy effluent is generated from rainfall onto hardstanding areas). Effluent generated in the wintering barns would be partially spread by the time dry conditions resulted in soil cracking, freeing up capacity in the effluent storage pond to store effluent until conditions improved heading into autumn. The overall risk of significantly increasing nutrient loading rates in other areas of the Horner Block due to soil cracking is low and is able to be effectively managed.

<u>Good Management Practices</u>

88 Table 6.1.12 in the Council's Sec 42a report refers to mitigations that have been proposed by the applicant but the officer has concerns with. Ms Grant has dismissed many of the mitigations as being illegal activities or things that should already be occurring as part of good farming practice. I have provided comments below where the proposed mitigations are within my field of expertise.

89 *More Efficient Use of Fertiliser*

89.1 I agree with Ms Grant that the efficient use of fertiliser is not a mitigation, for example, where significant quantities of fertiliser are being applied, yet pasture production is low, changes to rectify this would not be classified as a mitigation. This is not the case for the Woldwide properties. The mitigation being proposed was *more* efficient use of fertiliser,

it was not intended to imply that the current use of fertiliser on the farm does not meet good farming practice but to strive for even greater efficiencies.

90 *Olsen P Levels*

90.1 Currently Olsen P levels are targeted to sit at the upper end of the optimum range for a high producing dairy farm i.e. 40. As WOL and WTL are high producing dairy farm (within the top 25% for the supply area) this would be classified as good farming practice. Due to the variability in soil testing results there will always be paddocks over and under the optimum Olsen P target.

90.2 The mitigation being proposed is to reduce the target Olsen P levels to 30, which is going above good farming practice as this target is the lowest recommended for a high producing dairy farm.

CONCLUSION

91 OVERSEER® modelling of the WOL, WTL and Support Land predict losses of nitrogen and phosphorus to decrease when compared to modelling undertaken for the proposed farming system. When additional mitigations for phosphorus are applied outside of OVERSEER® total phosphorus losses are predicted to decrease by 6%. Nitrogen loss is predicted to decrease by 6.6% by implementing the new farming system.

92 OVEREER® modelling for the Horner Block was intended to show that the cut and carry operation has very low overall nutrient losses and the changes to WOL and WTL do not impact on this. The modelling undertaken confirms this, with little change in nitrogen (slight decrease) losses and a 2kg (8%) reduction in phosphorus loss. This is within the context that prior to the 2017-18 season the Horner Block was also use for the winter grazing of young stock (R1's). This land use would significantly lift the current average nutrient losses, meaning retaining the status quo will likely result in a sizable reduction in nitrogen and phosphorus losses compared to land uses that have occurred in recent times.

93 OVERSEER® modelling undertaken for WRO predicts losses of nitrogen and phosphorus to decrease when compared to modelling undertaken for the proposed farming system. When additional mitigations for phosphorus are applied outside of OVERSEER® total phosphorus losses are predicted to decrease by 12%. Nitrogen loss is predicted to decrease by 1.9% between the current average and the proposed scenario.

94 The main reasons there is no increase in nutrient loss between the existing and proposed scenarios on WOL, WTL and the Support Land is due to the removal of winter and summer grazing of crops and the expansion in the size and use of the wintering barn facilities on WOL and WTL.

95 The guideline of 150kg/N/ha/yr supplied from dairy effluent is relevant where stock are grazing the land and thus returning nutrients to the soil/pasture via dung and urine. In a cut and carry system, which occurs on the Horner Block, no recycling of nutrients occurs from animals and thus large quantities of nutrients are lost from the system when supplements are made and transported to be the wintering facilities. Applying slurry from the wintering facilities to the Horner Block is simply returning these nutrients to the land in a more efficient manner than that achieved by a grazing dairy cow. Evidence has been presented to show five applications of 50kg/N/ha via dairy slurry (250kg/N/ha/yr) is not in conflict with good management practices.

96 The block losses and kg/ha losses relating to Braxton soils, predicted from the OVERSEER® modelling, could be inaccurate due to the shrink/swell properties of some these soils. However, because the existing and proposed scenario modelling used the same approach, if there is any inaccuracy it will be uniform for both scenarios. This means that the relative increases or decreases in nutrient losses between scenarios are still valid.

Dated 16 September 2019

Cain Duncan