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 FOUR LIMITED & WOLDWIDE FIVE LIMITED

Applicants

BRIEF OF EVIDENCE OF MARK CRAWFORD

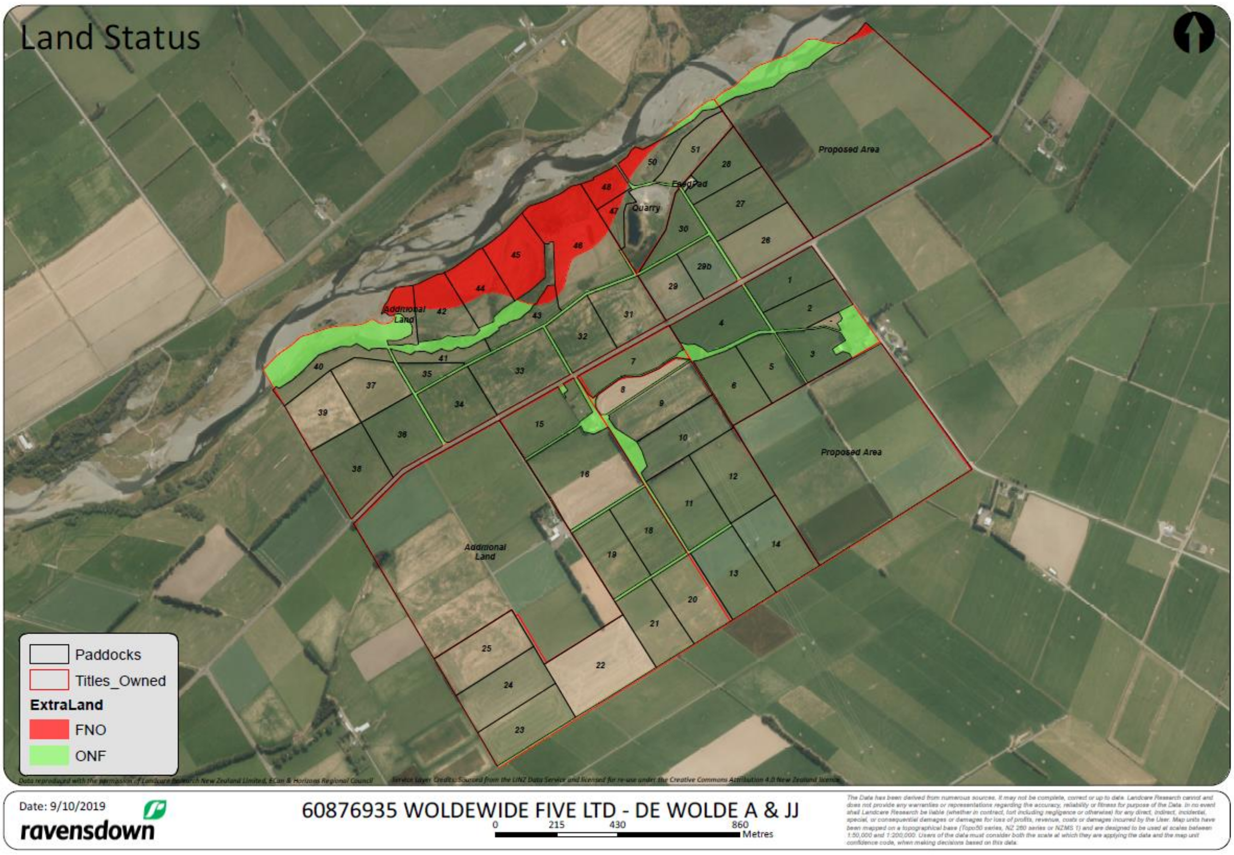
Addendum – Clarifications sought by Commissioners

18 October 2019

PURPOSE OF REPORT

1 This addendum has been prepared in response to a request by commissioners to provide additional evidence in a minute issued on 11th October 2019:

CONFIRMATION THAT THE ACTIVE RIVERBED AREA (CLEAR IN GOOGLE SATELLITE IMAGES) THAT IS IN WOLDWIDE FIVE TITLE HAS NOT BEEN INCLUDED IN OVERSEER MODELLING



1 Crop Area Paddocks number 40 to 48, this equates to a modelled area of 28.1 ha.

1.1 Of the Upukeroroa soils on the river margins within and outside title; Total area is GIS calculated at 56.2 ha; 15.9 ha is Farmed not owned (red), 29.7 ha is farmed titled and 10.6 ha is owned but not in paddocks (green), including river margin.

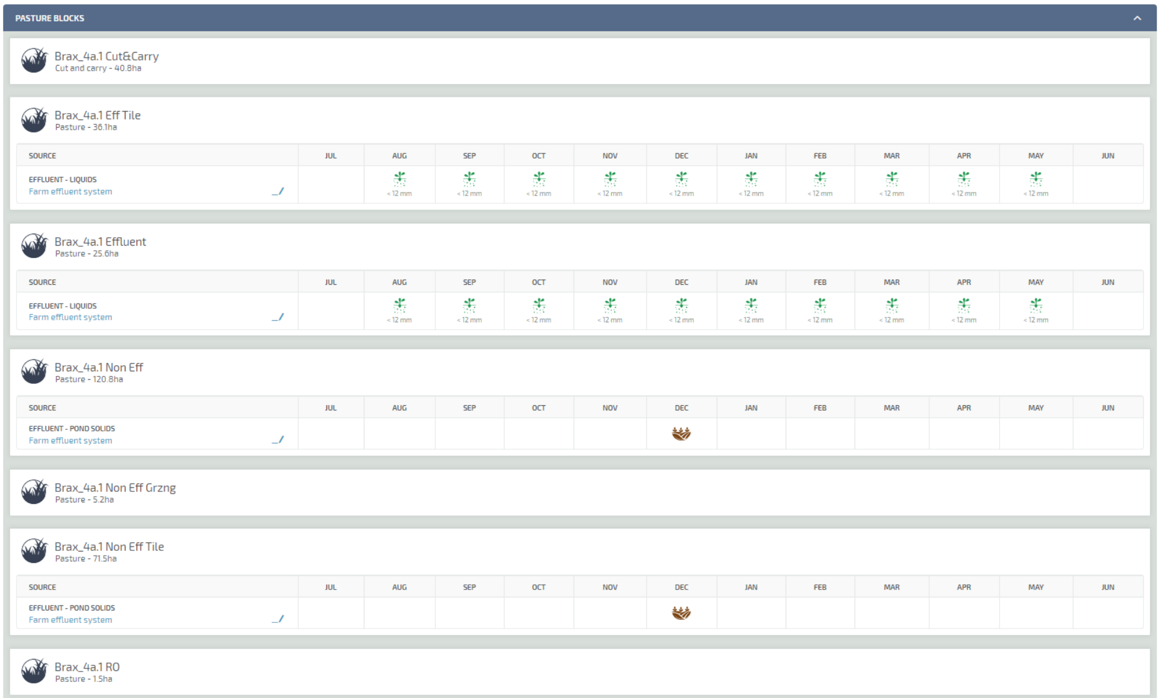
1.2 What was modelled was Upukeroroa 42.4 (29.7+15.9=45.6 less estimated 3.2 ha quarry and feed pads equate to 42.4 ha paddock, of which 28.1 ha is cropped. The other 10.6 ha is in other not farmed areas. This soil is modelled at a total of 56 ha, and any difference in areas to above is the rounding of areas and the estimations in riparian and other areas plus the quarry.

1.3 There is a very high level of agreement between the areas used for modelling and the GIS areas shown above.

1.4 No active riverbed has been modelled, all land is accounted for in titled paddock area or riparian land. According to the planner, it is likely that the majority of this land is administered by LINZ. A portion of this land includes an 8 ha area of land with the legal description "M919 Island in Aparima river opposite lots 13/14". The de Woldes pay rates on this land to the Southland District Council.

CONFIRMATION THAT FOR BOTH WW4 & WW5 THAT THE OVERSEER MODELLING OF FDE EFFLUENT AND BARN SLURRY IS CONSISTENT WITH THE AREAS SPECIFIED IN THE ORIGINAL APPLICATION; CONFIRMATION OF THE SOURCE OF INFORMATION USED TO ESTIMATE THE NPKS RATING FOR THE IMPORTED SLURRY DAIRY ORGANIC FERTILISER.

2 Effluent blocks have been modelled as blocks receiving FDE liquid effluent. As per written farm interview notes, where the effluent blocks are showing FDE liquid dairy shed effluent being sprayed from August to May (as per farmer discussions) in modelled picture from OVERSEER FM below;



2.1 Dairy shed solids are also shown to be spread on non-effluent areas, which is perfectly normal practice in dairy farming and in Southland and is an agreed best practice as per study by Houlbrooke (2008) for Horizons Regional Council (excerpt below).

6.4.3 Management of solids

If FDE is to be stored in ponds, then effluent solids become part of the effluent management programme. Without stirring, sediment will sink to the bottom of a pond and form a nutrient rich sludge that will need to be periodically cleaned out (Longhurst et al. 2000). The frequency of such an operation is dependent upon both the pond and herd size and typically occurs every 2-5 years. The emptied sludge should be land applied to an area not already receiving FDE via irrigation. If a single pond system is with a plastic liner is employed without prior solids separation then contractors should take care when emptying the pond. Under this circumstance a layer of material (probably clay) should be placed on top of the plastic liner to help prevent the potential for liner damage. Some farms keep their FDE ponds well stirred (via mechanical means) so as to prevent the build up of sediment sludge and therefore regularly irrigate it combined in solution with the liquid FDE (Photo 7). Such an operation can be achieved with most travelling irrigators and the larall system when fitted with a self-cleaning screen at the pump. However, K-Line, with its small (4 mm) nozzle size, requires some degree of solid separation to avoid nozzle blockages. Screw press solid separators are commercially available in New Zealand (photo 8) but come at a high cost (section 4.3). A cheaper alternative known as a 'sludge bed' system has recently been developed in Southland. The sludge bed separates sediment from the liquid effluent in order to provide FDE suitable for application using K-Line irrigation systems. Sludge beds contain a solids reservoir in front of a slatted wooden wall that gravity feeds liquid effluent to a storage pond (Photos 9 & 10). The liquid effluent is suitable for application through K-Line systems or any other irrigation system should the operator wish to separate out the sediment and liquid components of FDE.

Report prepared for Horizons Regional Council February 2008
Best practice management of Farm Dairy Effluent in the Manawatu-Wanganui region 34

2.2 As it is normal practice to spread solid effluent from dairy sheds to areas not receiving liquid FDE, then it is equally good practice for winter barn slurry to be spread in a similar manner, especially to areas where feed has been cut (harvested) and then carried to the barn to be fed. This is to return nutrients that have been carted to the barn.

2.3 The normal protocol in Overseer modelling is to refer to the blocks that receive FDE effluent as effluent blocks and other blocks as non-effluent blocks or the word "effluent" is not used in the block description. The reporting officers appear to have assumed that a block referred to as a non-effluent block means that it can't receive either dairy shed solid and wintering barn slurry. Figures 1 and 2 in the original applications for WW4 and WW5 have been checked against the blocks identified in the Overseer modelling to receive slurry effluent and I am satisfied that the areas match.

The following four diagrams illustrate this.

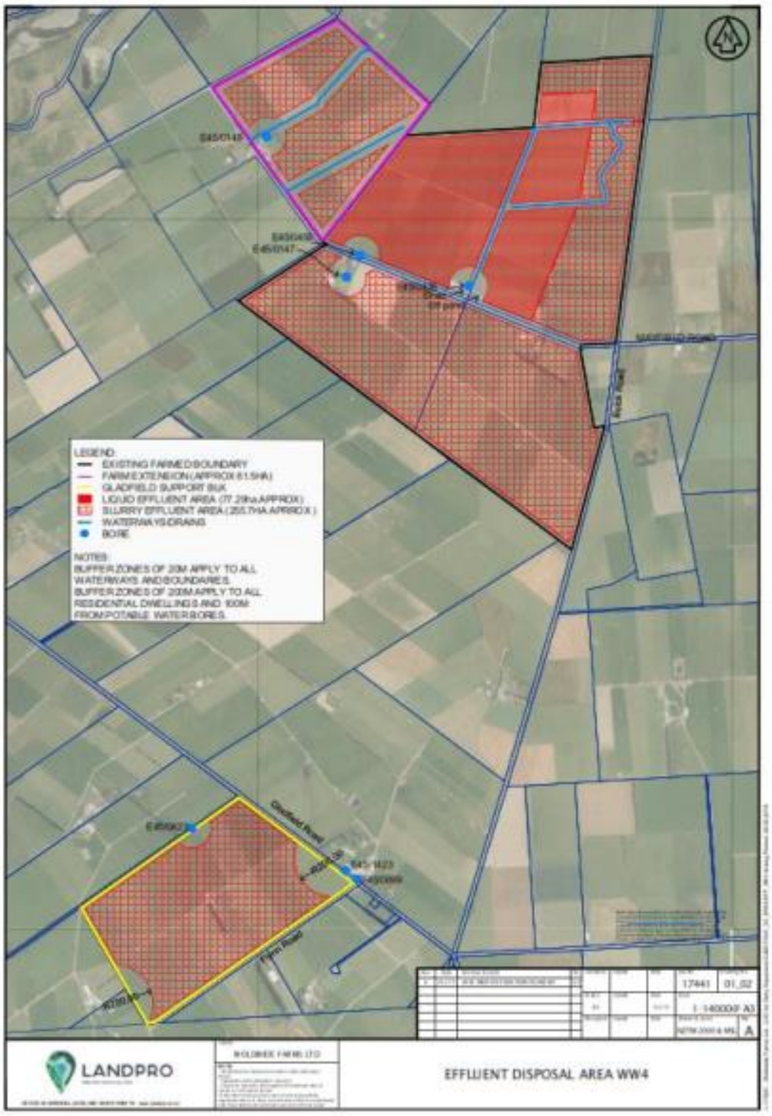
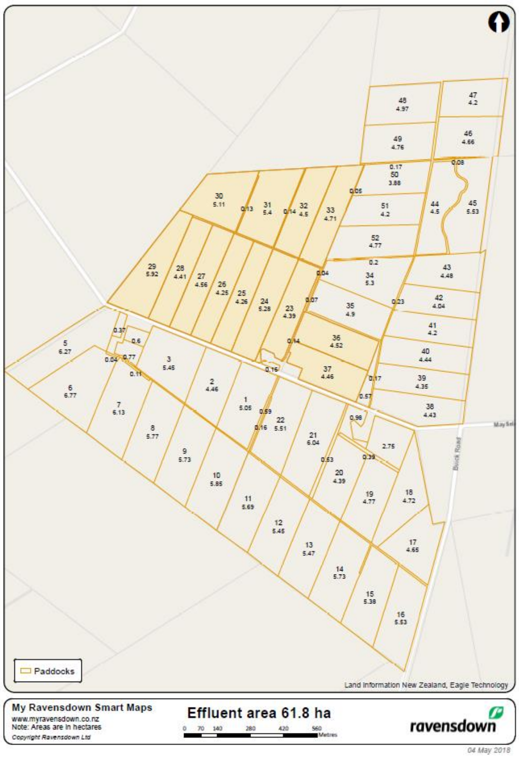


Figure 1: Proposed farm boundary and effluent discharge area for WW4

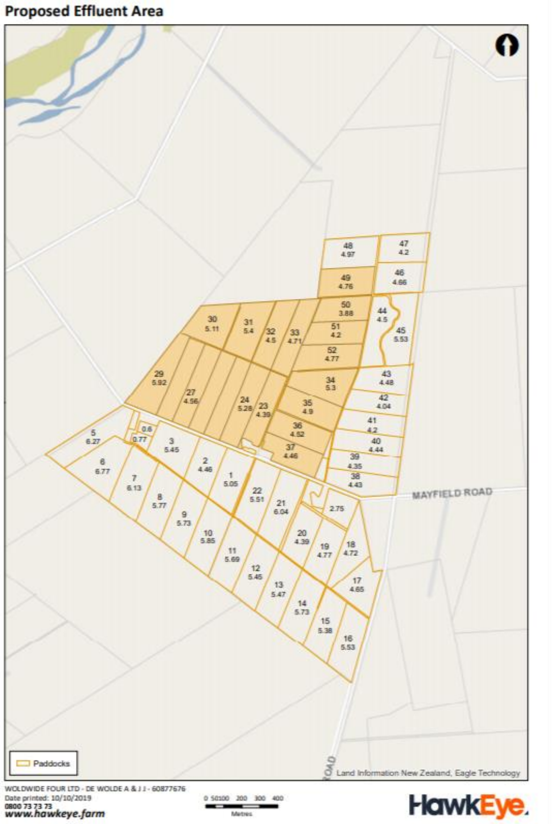
WW4: Current System, modelled 61.7 ha at 92 % area receiving ***FDE liquid*** = 57 ha



This is the same modelled for phase 1.

The proposed area is modelled 84.8 ha less 8 % adjustment re areas no receiving liquid effluent, equates to 78 ha. (GIS calculated is 89.6 ha or 82.4 ha, a 4.4 ha difference, adjusting effluent area upwards and decreasing non effluent down

Proposed Effluent Area



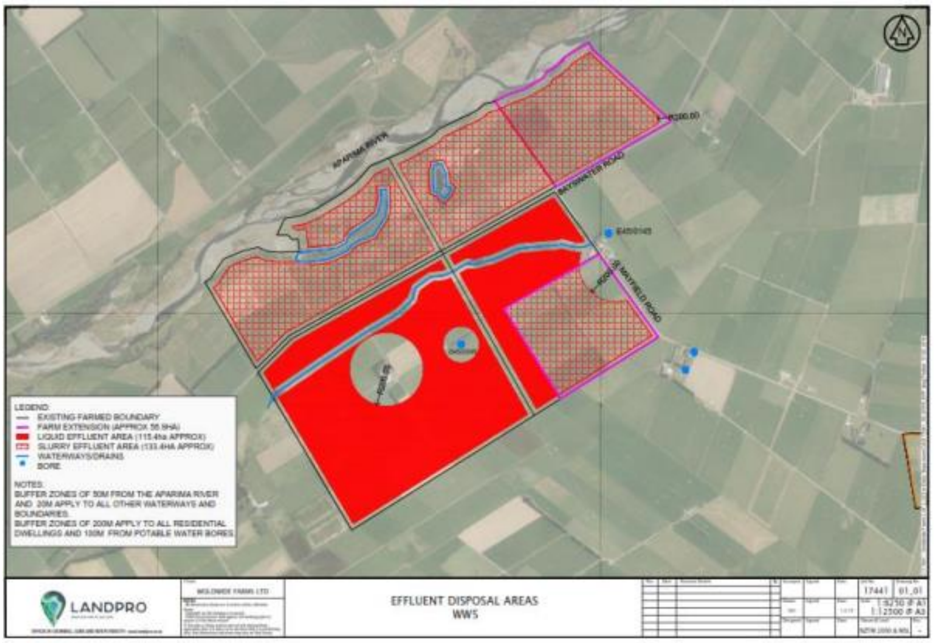
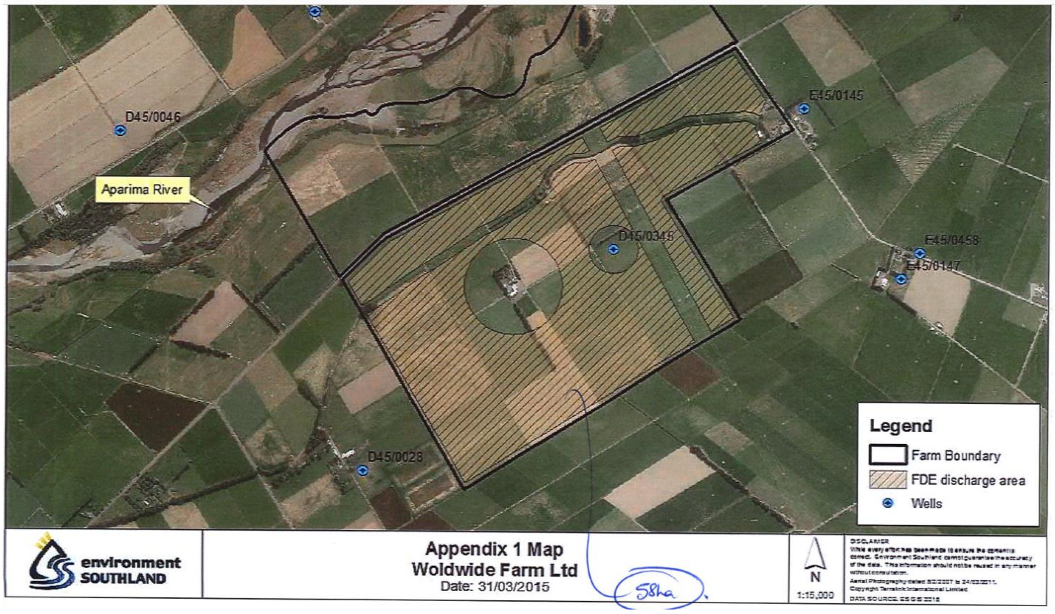


Figure 2: Proposed dairy farm boundary and effluent discharge area for WW5

WW5 areas: Current system modelled as per allowed/directed discharge area as per map, area as in report; total area 130.1 ha (86.4 ha plus 44.3 ha collies block and less 0.3 ha other non-paddock area= 130.1 ha)actual, less 14 % of areas not receiving liquid area (set backs etc.) to equate to 112 ha which was sought for consent (and shown in maps). Note GIS area will include non-productive areas so is slightly higher at 133.04 ha)

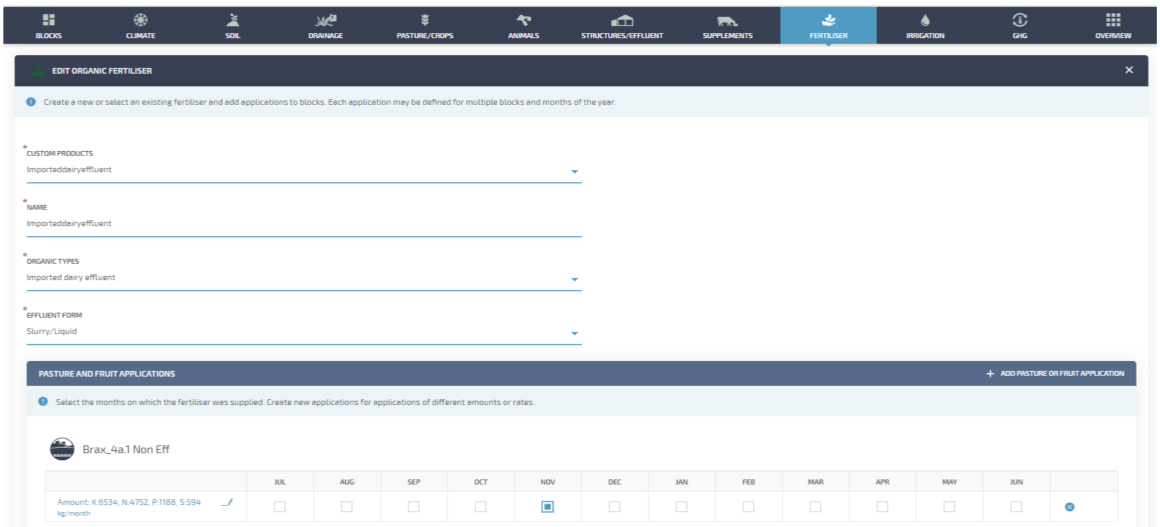


2.4 Where the winter barn slurry was applied can be evidenced by the summary of fertiliser use and fertility which also was requested by Ms Phillips for clarity. The following tables illustrate the where the addition of winter barn slurry is modelled and how applications were calculated.

2.5 As detailed in both written reports accompanying the budgets and entered as evidence and in the hearing papers, the following shows the nutrient concentration of the barn slurry as supplied by the planner from Dairy Green and used for Woldwide 1 & 2 budgets.

The nutrient concentration of wintering barn effluent is higher than dairy shed effluent due to lack of dilution and the housing of cows in the barns for up 24 hours per day. The nutrient content of pond effluent (slurry) was tested as part of a 2011 AgResearch study "Characterising dairy manures and slurries – Case study 15." The nutrient content of slurry at the applicant's pond was measured at:3,200 g/m³ N; 800 g/m³ P; 4,400 g/m3 K; 400 g/m³ S. Applying 15.2 m³/hectare applies slurry effluent at a depth of 1.5 mm. Discharging slurry effluent at 15.2 m³/hectare applies:49 kg of N; 12 kg of P; 69 kg of K; and 6 kg of S

2.6 It has been calculated that the barn slurry from WW4 would equal 5,112 m³ of slurry based on 50 Litres of slurry per cow per month from figures supplied by Abe De Wolde. The Braxton Non effluent area is 97.7 ha, and with 48.64 kg N/ha applied in slurry (49 rounded).this equates to 48.64*97.7 ha or 4,752 kg N/month applied or 49 kg N/ha applied as per entry in OVERSEER FM snipped below



2.7 The following tables illustrate where the barn slurry was modelled this way;

Soil Fertility as stated in evidence

System type Soil fertility levels	Current System WW4 (combined) P_K_S	Current System WW5 (combined) P_K_S	Final System. WW4 P_K_S	Final System WW5 P_K_S
Effluent Blocks Non effluent Blocks Cut and carry block Upukeroroa	38-10-10 50-13-10 31-7-11 n/a	29-12-12 21-11-12 n/a 27-23-8	38-10-10 50-13-10 31-7-11 n/a	29-12-12 21-11-12 n/a 27-23-8

WW4 Fertiliser Current averaged System modelled

Non Effluent block: All blocks

Month	Fertiliser	NPKS nutrient rating (kg/ha)
August	Ammo 31	43-0-0-12
September	Urea	18-0-0-0
October	Urea	23-0-0-0
November	Potash Superphosphate and FlexiN	25-14-19-17
December	Urea	23-0-0-0
January	Potash Superphosphate and FlexiN	25-14-19-17
February	Urea	23-0-0-0
March	Urea	23-0-0-0
April	Urea (liquid)	18-0-0-0
TOTAL		222-28-38-46

Effluent block: All blocks

Month	Fertiliser	NPKS nutrient rating (kg/ha)
August	Ammo 31	43-0-0-12
September	Urea	18-0-0-0
October	Urea	18-0-0-0
November	Superphosphate and FlexiN	25-13-0-16
January	Urea	23-0-0-0
March	Urea	23-0-0-0
April	Urea (liquid)	18-0-0-0
TOTAL		169-13-0-28

Gladfield Support Block (Run Off)

Month	Fertiliser	NPKS nutrient rating (kg/ha)
October	Crop DAP & Ammo 36 & KCl	71-15-22-10
December	Crop DAP & Ammo sulphate & KCl	57-15-22-10
January	Urea and KCl (Pot. Chloride)	60-0-60-0
March	Crop DAP & Ammo sulphate & KCl	31-7-37-8
TOTAL		219-37-141-28

WW4 Proposed (Barn) System modelled:

Non Effluent block Braxton (Tuatapere in brackets where different) and Braxton Tiled:

Month	Fertiliser	NPKS nutrient rating (kg/ha) Non tiled	NPKS nutrient rating (kg/ha) Tiled
August	Ammo 31	43-0-0-12	43-0-0-12
September	Urea	35-0-0-0	35-0-0-0
October	Urea	35-0-0-0	35-0-0-0
November	Barn slurry	43-11-57-5 (49-12-67-6)	
November	Potash Superphosphate and FlexiN		34-14-19-17
December	Urea		35-0-0-0
December	Barn slurry	(49-12-67-6)	
January	Potash Superphosphate and FlexiN	25-14-19-17 (nil)	34-14-19-17
February	Urea	23-0-0-0	23-0-0-0
March	Urea	23-0-0-0	23-0-0-0
April	Urea (liquid)	18-0-0-0	18-0-0-0
TOTAL		244-25-76-34 (274-24-134-24)	279-28-38-46
Dairy shed Solids		23-12-10-6	Nil

Effluent block Tile (non tile in brackets where different):

Month	Fertiliser	NPKS nutrient rating (kg/ha)
August	Ammo 31	43-0-0-12
September	Urea	35-0-0-0 (23-0-0-0)
October	Urea	35-0-0-0 (23-0-0-0)
November	Superphosphate and FlexiN	25-13-0-16
January	Urea	25-13-0-16
March	Urea	23-0-0-0
April	Urea (liquid)	9-0-0-0
TOTAL		194-26-0-44 (171-26-0-44)
Dairy shed Effluent (FDE)		91-6-104-6 (136-9-156-10)

Gladfield Support Block (RO)

Month	Fertiliser	NPKS nutrient rating (kg/ha)
October	Crop 15 & Ammo 36 & KCl	50-30-60-32
December	Crop DAP & Ammo sulphate & KCl	31-7-37-8
December	Barn slurry	103-18-100-9
January	Barn slurry	79-12-67-6
March	Crop DAP & Ammo sulphate & KCl	31-7-37-8
TOTAL		293-74-301-63

WW5 Fertiliser Current averaged System modelled

Non Effluent block: (All blocks)

Month	Fertiliser	NPKS nutrient rating (kg/ha)
August	Ammo 36	43-0-0-12
September	Urea	18-0-0-0
October	Urea	28-0-0-0
November	Urea	23-0-0-0
December	Potash Superphosphate and FlexiN	21-55-30-66
December	Organic dairy effluent (solid)	18-12-10-4
January	Urea	28-0-0-0
February	Urea	23-0-0-0
March	Urea (liquid)	18-0-0-0
Total Nutrients		219-68-40-82*

Effluent block: (All blocks)

Month	Fertiliser	NPKS nutrient rating (kg/ha)
August	Ammo 36	43-0-0-12
September	Urea	18-0-0-0
October	Urea	28-0-0-0
November	Urea	23-0-0-0
December	Potash Superphosphate and FlexiN	21-55-30-66
December	Organic dairy effluent (solid)	18-12-10-4
February	Urea	23-0-0-0
March	Urea (liquid)	18-0-0-0
Total Nutrients		192-67-41-82*

WW5 Proposed (Barn) System modelled:

Non Effluent block Braxton, Tuatapere and Upukeroroa:

Month	Fertiliser	NPKS nutrient rating (kg/ha) Braxton	NPKS nutrient rating (kg/ha) Tuatapere	NPKS nutrient rating (kg/ha) Upuk.
August	Ammo 31	43-0-0-12	43-0-0-12	43-0-0-12
September	Urea	35-0-0-0	35-0-0-0	23-0-0-0
October	Urea	30-0-0-0	30-0-0-0	23-0-0-0
November	Barn slurry	49-12-67-6	49-12-67-6	23-0-0-0
November	Urea	12-0-0-0	nil	
December	Cropmaster 20 or Soluble fertiliser	19-10-0-9		25-18-50-28
December	Barn slurry	24-6-33-3	24-6-33-3	
January	WW3 effluent import		13-9-8-3	
	Soluble fertiliser		19-4-11-14	
February	Urea	23-0-0-0	23-0-0-0	
March	Urea	23-0-0-0	23-0-0-0	23-0-0-0
April	Urea (liquid)	18-0-0-0	18-0-0-0	9-0-0-0
TOTAL		275-28-100-33	277-32-119-38	169-18-50-40
Dairy shed Solids		18-9-9-5	18-9-9-5	Nil

Effluent block Braxton and Tuatapere Non tile and Braxton tiled:

Month	Fertiliser	NPKS nutrient rating (kg/ha) Braxton	NPKS nutrient rating (kg/ha) Tuatapere	NPKS nutrient rating (kg/ha) Braxton tiled
August	Ammo 31	43-0-0-12	43-0-0-12	43-0-0-12
September	Urea	23-0-0-0	23-0-0-0	35-0-0-0
October	Urea	23-0-0-0)	23-0-0-0	350-0-0)
November	Barn slurry	49-12-67-6	49-12-67-6	
November	Urea			35-0-0-0
December	Barn slurry	24-6-33-3	24-6-33-3	
December	Soluble fertiliser			23-12-0-14
January	WW3 effluent imported	18-12-11-4	18-12-11-4	18-12-11-4
March	Urea	23-0-0-0	23-0-0-0	23-0-0-0
April	Urea (liquid)	9-0-0-0	9-0-0-0	9-0-0-0
TOTAL		212-31-111-25	212-31-111-25	219-24-11-30
Dairy shed Effluent (FDE)		71-4-87-5	79-5-97-6	55-3-68-4

3 In discussion of effluent modelled, if all the WW3 effluent is being deposited on the Horner Block and now there is no need to adjust for any effluent going onto WW5, one would delete the organic dairy slurry with no change in Urea as this was not originally changed from the current budget excluding the slurry, given it was minor. The relativity between budgets (current and proposed) would still be the same. This was done for the Current System and the budget showed the following results:

System type	Current System (WW3 effluent applied)	Current System (no WW3 effluent applied)
Nitrogen leaching loss to water (kg N/ha) Total N lost kg/farm	57 14,862	56 14,654
Nitrogen Conversion efficiency % (N in products/N inputs) *	26	27
Phosphorus run off to water (kg P/ha) Total P lost kg/farm	0.8 211	0.8 211
N fertiliser applied WW 3 effluent applied	158 14	158 nil

A BRIEF SUMMARY OF THE ADDITIONAL PHASE 1 WW4 MITIGATION UNDERTAKEN TO DEMONSTRATE P LOSS REDUCTION WITH PHASE 1. THIS WILL INCLUDE APPROPRIATE MITIGATION REFERENCES

4 The initial scenario or transitional stage whereby the cow numbers were increased to the maximum specified (850) in the existing discharge permit, to account for the additional land. Concerns were raised about the small increase in P loss for the WW4 Phase 1 period. As a consequence, cow numbers have been reduced for this Phase 1 period and P fertiliser applications reduced to ensure that during the Phase 1 period there would also be a reduction in P loss to water.

4.1 The combined result of these changes is to change the Phase 1 P increase of a 1.5% increase to a decrease of 0.6 % (including the 18/19 baseline year). The details behind these changes are explained below, in the same format as prior evidence.

(a) The transitional stage still increased the platform by the 63.3 ha part parcel of Cochrans block as per point 13 (by adding 23.5 ha of Tuatapere soils as well as more Braxton), thereby giving a total area 412.6 ha with 399.5 ha effective.

(b) The stock system modelled was based on 835 cows calved with 815 cows peak milked, producing 415,650 kg Milk solids equating to 510 kg milk solids/cow or 1,288 kg MS/total grazed. ha. The overall stocking rate was 9,940 rsu equating to 24.1 rsu/total ha or 2.0 cows/total ha. Replacement heifers (185) are grazed off-farm from weaning until they come back to winter on the support block as explained in past evidence. The dairy cows are also wintered on crop on the support block as set out in past evidence.

(c) This modelled system still has a requirement for 24 ha of crop, all on the Gladfield block, modelled as a two-year cropping rotation (third year as young grass) with average yields of 25 T DM/ha. The rest of the support block was cut and carried to the dairy block (12.2 T DM/ha, 480 T DM used, and 50 T DM stored). A further 775 Tonnes (T) of Dry Matter (DM) in supplement were imported (grain, brewers distilled grain, molasses and PKE) to be fed to dairy cows through the milking shed and on the pastoral blocks. In this model there was no baleage purchased as more pasture was available.

(d) The fertiliser amounts modelled were reduced to total fertiliser nitrogen modelled averaged at 176 kg N/ha/year. This was due to the lowered pastoral productivity and with a lower application across the effluent area due to the greater amount of nutrients from effluent to the same area.

4.2 Key differences between the two systems are;

(a) Fertiliser use

Tables 1:

Fertiliser use (kg/ha/year)	Current System	Initial Proposed (Consent) System.
Effluent	Total N applied 169 kg.	Total N applied 137 kg.
Non-Effluent	Total N applied 222 kg.	Total N applied 194 kg.
Fodder Crop	same	same
Support block	same	same
Annual N use (kg N/ha)	195	176
Annual Fertiliser P use (kg P/ha)	Effluent block: 13 Non effluent: 28 Cut and Carry: 37 Total Farm: 26	Effluent block: 6 Non effluent: 18 Cut and Carry: 37 Total Farm: 19

(b) Supplement use

Supplement use	Current System	Proposed (Consent) System. Adjusted
Pastoral	1248 T DM in total imported or 4,815 effective platform. Note also 395 T DM silage is made on the support block and fed out on dairy pastoral blocks including 30 T DM from storage included in above imported figure.	775 T DM in total imported or 2,413 effective platform. Note also 395 T DM silage is made on the support block and fed out on dairy pastoral blocks but 50 T DM is stored and not used and not included in above imported figure
Fodder Crop	same	same

(c) Wintering system and pasture production

Wintering System	Current System	Proposed (Consent) System.
Pastoral	The dairy cows are on farm platform on Gladfield support block on crop plus in calf heifers wintered on Gladfield support block	The dairy cows are on farm on Gladfield support block on crop plus in calf heifers wintered on support block
Fodder Crop	same	same
Pasture Production (kg DM/ha/year) *	15456	14247 (reduced due to lower stocking over greater areas as described below.
Productivity: Stocking SU/ha Milk solid sold (kg/ha effective)	9,578 s.u* equivalent to 28.4 s.u/ha effective or 3.1 cows/ha milking platform (27.4 s.u/ha total or 2.3 cows/ha total) 1,583/ha effective milking platform (1,574/ha total grazed)	9,940 s.u* equivalent to 24.9 s.u/ha effective or 2.6 cows/ha milking platform (24.1 s.u/ha total or 2.0 cows/ha total) 1,294/ha effective platform (1,288/ha total grazed)

* Estimated by OVERSEER FM®

(d) Effluent System

Effluent System	Current System	Proposed (Consent) System.
Modelled input	Holding Pond system after stone trap and applied via K Line pods. Application depth at < 10 mm per application (modelled < 12 mm) from August to May (spray infrequently as not modelling June or July to receive effluent 119 kg N/ha/year liquid over 57 ha (61.7 @ 92%)	Same system, over the same area, however with greater numbers of cows the volume has increased leading to the higher figure below; 123 kg N/ha/year liquid over 57 ha (61.7 ha@92%)

* Estimated by OVERSEER FM®

4.3 All soil information, climate and topography are the same between the two different scenarios

Table 2: The outputs generated by OVERSEER FM® for the two systems

System type	**Current System (combined)**	**Current System (combined incl 18/19 season)**	**Proposed (Consent) System. Adjusted**
Nitrogen leaching loss to water (kg N/ha) Total N lost kg/farm	29 11,978	29 12,017	28 11,674 (2.5% or 2.9% reduction)
Nitrogen Conversion efficiency % (N in products/N inputs) *	28	28	28
Phosphorus run off to water (kg P/ha) Total P lost kg/farm	0.8 343	0.8 344	0.8 342 (0.3% or 0.6% decrease)

* Dairy farm only

4.4 The Nitrogen loss is slightly reduced with the revised interim with the proposed scenario when compared to the current system, a similar level from 29 kg N/ha/year (11,978/412.6 or 12017/412.6=29.0) to 28 kg /N/ha/year rounded (11,674/412.6=28.3). This is largely due to the decreased pastoral productivity and reduced risk of urine patch losses.

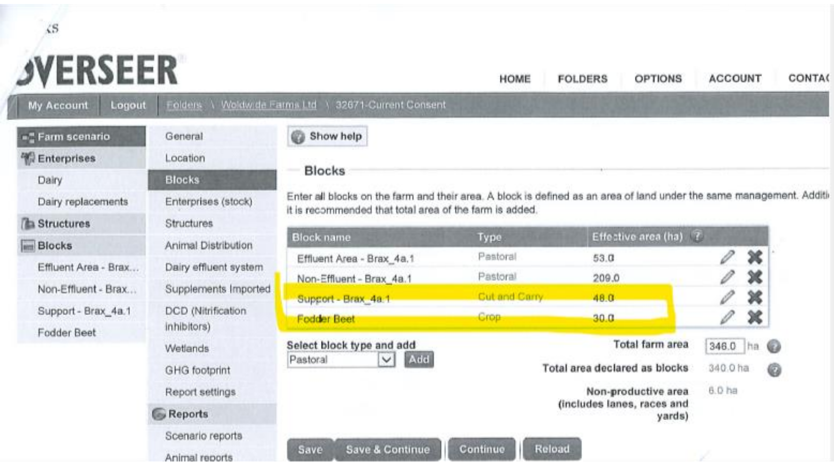
4.5 The Phosphorus loss from run off is maintained at 0.8 kg P/ha/year, reflecting a similar level of P loss risk between the two systems. A small decrease is now achieved when comparing the average current scenario including the 18/19 season and the revised phase 1 scenario, a 2 kg P/year decline or 0.6% reduction.

4.6 Nitrogen efficiency is the same at 28 % from both systems, reflecting little change in risk from the various Nitrogen sources/inputs into the farm system.

4.7 The proposed system is being managed less intensively when comparing the amount of product sold per ha and the amount of pasture required supporting each venture (Table 1c). The risks associated with both farming systems arise from the cropping programme, the high animal productivity and artificial drainage systems.

A BRIEF SUMMARY OF THE EVIDENCE USED AND METHOD FOR MODELLING IWG ON THE GLADFIELD BLOCK

5 There is significant evidence that the Gladfield block has been used for IWG, as well as the grass paddocks cut and carried. Mr de Wolde identified 24 ha of the 78 ha Gladfield block was being cropped in the 18/19 year (my notes), and the previous budget done by the fertiliser Agri manager has identified 30 ha of crop on the Gladfield block. The use of either Gladfield or the WW4 paddocks for IWG in the phase 1 on conversion will not have any significant effect on nutrient loss estimates (if a paddock for IWG is swapped) as they are all the same soil type, Braxton soils. Detailed notes used to assist in developing the block inputs are copied below;



A BRIEF SUMMARY OF THE EVIDENCE USED AND METHOD FOR MODELLING IWG ON THE COCHRANS BLOCKS FOR BOTH WW4 AND WW5

6 Winter grazing of WW5: Evidence that at the farmer meeting the farmer has identified 28 to 30 ha of the Upukeroroa block is being cropped (my notes) and drawing by farmer. This area was used for the modelling of the current averaged system 15/16 and 16/17 seasons. The 18/19 modelling continued with this practice for both winter 18 and winter 19. A change was made for the winter of 2019, as per written evidence of Mr de Wolde which was not modelled. The difference between the winter area grazed elsewhere on a different soil type but the same area and the use of the Upukeroroa soils as dairy pastures (instead of crop) would not be significant in my opinion to warrant further modelling for the 19 winter use

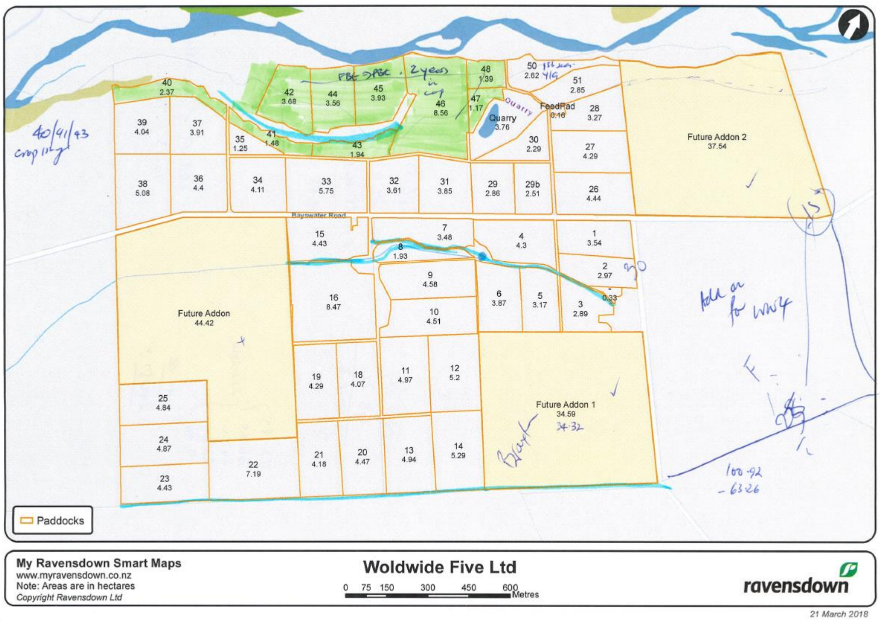


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Table 10. Crops

Mark on map where grown

Crop type	Area (ha)	yield (TDM/ha)	Previous year crop?*	Month Sown	Cultivation Method	Fert sowing and rate (kg/ha)	Fert (month/rate)	Effluent applied?/ when	Irrigation applied?/ when	Months grazed	Stock type
	30	28		Oct	Cult.	—	—	no.	no	May — J/J/A	2nd Dy cows 16 Rs

*if last year rotation was different take notes

Notes: Post 20-25. P/B → P/Beet (3 yrs) – P/Beet

SOME BRIEF COMMENTARY AND A TABLE TO OUTLINE THE OUTCOME OF MODELLING THE ADDITION OF THE WW4 COCHRAN BLOCK TO WW5 TO PRODUCE AN APARIMA RIVER CATCHMENT CURRENT VS PROPOSED NUTRIENT LOSS ASSESSMENT.

7 In the addendum evidence provided it referenced tables to add further clarity to both the applicants and witness evidence. The commissioners asked for this to be made clearer, which has been done and is now included as an attachment. These tables (Tables 1 and 1(a)) demonstrate that the reductions in the N and P loss to water for the WW5 proposal is able to compensate for the addition of the WW4 Cochrans block losses. Also it should be noted that on a specific catchment basis the losses from WW4 would drop by these same amounts.

ADDITIONAL CLARIFICATIONS

8 There are two additional matters where the s42A officers seem to continue to disagree with my evidence. I provide the following additional clarifications which I trust will be helpful in showing that they their disagreement is not well founded and that my conclusions should stand.

9 In relation to 28.4 (d) in my original evidence I believe that the attached table 1 (to this addendum) will provide some additional detail that helps resolve any issues as to that paragraph. This table outlines how each block changes between the current average system and the proposed system for both farms. It shows that the Nitrogen losses do increase on the sheep block, for both Woldwide farms, but the P losses on one farm reduces substantially (from 19 to 11) thus the information about what happens to the nutrient concentrations on the sheep block is not fully explained. In addition, as noted, the N loss on the dairy blocks decrease providing an overall decline, this being the more complete picture in explaining effects.

10 Finally, I wish to resolve any concerns that might have arisen out of paragraph 1.17 of the S42A Hearing Report, which states that; "*the increased stocking rate and associated feed demand through pasture or supplementation has the potential to increase the nitrogen surplus in the soil…".* I continue to disagree with that and refer to the third table (table 2) that I have provided. It actually demonstrates that both N surplus decreases and N efficiency increases, measures which allow one to surmise that the risk of N loss is reduced with the addition of the winter barns. I believe that considering this information ought to confirm that this observation in the s42A report was unfounded.

CONCLUSIONS

11 The OVERSEER FM® (6.3.2/2.8.3.1) models the farm systems as close and reasonable as practicable to the actual farm systems, in a consistent and conservative manner following best practice.

11.1 The clarifications both confirm the results robustly model the contaminant loss differences between the current, transitional (phase 1) and proposed farm systems for the additional mitigations for WW4 phase 1 and the of losses from WW4 to the Aparima catchment.

11.2 This addendum provides the confirmation of the appropriateness and validity of the input data (arising, it seems for S42A Hearing Report paragraph 5.13.15) that it is understood the Commissioners hoped caucusing would achieve.

Mark Crawford

Dated 18 October 2019

Tables to Support Addendum Evidence dated 18th October 2019.

Table 1: Block Comparison between Dairy and Sheep Blocks for Current and Proposed Scenarios (Pre additional P mitigation):

Woldwide Four (includes 18/19 year)

Blocks	**Current Scenario N**		**Proposed Scenario N**		**Difference (kg N/year)**	**Current Scenario P**		**Proposed Scenario P**		**Difference (kg P/year)**
	Area (ha)	**N loss (kg N/year)**	**Area (ha)**	**N loss (kg N/year)**		**Area (ha)**	**P loss (kg P/year)**	**Area (ha)**	**P loss (kg P/year)**	
Dairy Blocks	266.0	8,104	266.0	5,398	5398-8079=**2,706**	266.0	115	266.0	100	100-115=**15**
Dairy Blocks integrated with Sheep Blocks	71.5	2,354	71.5	1,735	**619**	71.5	37	71.5	37	**0**
Sheep Blocks	62.0	1,104	62.0	934+1,092=2,026	922	62.0	20	62.0	20+3=23	3
Total	**399.5**	**11,562**	**399.5**	**9,159**	**2,403**	**399.5**	**172**	**399.5**	**160**	**12**
Other Losses	11.8 1.3 13.1	Dairy 441 Sheep 14 Total 455	13.1	568	113	11.8 1.3 13.1	Dairy 166 Sheep 6 Total 172	13.1	210	38
Total	**412.6**	**12,017**	**412.6**	**9,727**	**2,290**	**412.6**	**344**	**412.6**	**370**	**26**
Overseer Check(reported)	412.6	12,017	412.6	9,727	9,727-12,017=**2,290**	412.6	344	412.6	371	371-344=27 rounding error)

Woldwide Five

Blocks	**Current Scenario N**		**Proposed Scenario N**		**Difference (kg N/year)**	**Current Scenario P**		**Proposed Scenario P**		**Difference (kg P/year)**
	Area (ha)	**N loss (kg N/year)**	**Area (ha)**	**N loss (kg N/year)**		**Area (ha)**	**P loss (kg P/year)**	**Area (ha)**	**P loss (kg P/year)**	

Dairy Blocks	164.8	10,153	164.8	7,112	7112-10153=3,041	164.8	71	164.8	51	51-71=20
Dairy Blocks integrated with Sheep Blocks	76.4	4,642	76.4	62+3381+811=4,254	388	76.4	12	76.4	0.5+6.9+3.6= 11	1
Sheep Blocks	70.1	1,354	70.1	879+1552+315=2,746	1,392	70.1	19	70.1	6.5+3.1+1.4=11	8
Total	**311.3**	**16,149**	**311.3**	**14,112**	**2,037**	**311.3**	**102**	**311.3**	**73**	**29**
Other Losses	21.4 2.9 24.3	Dairy 411 Sheep 31 Total 442	24.3	566	124	21.4 2.9 24.3	Dairy 135 Sheep 12 Total 147	24.3	175	28
Total	**335.6**	**16,591**	**335.6**	**14,678**	**1,913**	**335.6**	**249**	**335.6**	**248**	**1**
Overseer Check(reported)	335.6	16,591	335.6	14,678	14,678-16,591=1,913	335.6	249	335.6	248	248-249=(1)

Note: Red is decrease, black increase. Sheep losses in isolation don't account for changes in dairy blocks, nor does looking at N give a true picture of all contaminant losses. Please note that the totals for P do not include further P mitigation calculations.

Using Woldwide 4 as example; Cochrans Block addition comes to 62 ha in paddocks (with 1.3 ha non productive = 63.3 ha total and as reported in evidence). The N loss as a sheep block is 1,104 kg N/year adding the other losses of 1.3 ha this equals 1,104+14=1,118 kg N/year added this summed figure to the dairy unit N loss of 10,458+441=10,899 equates to 12,017 kg N/year (10,899+1118). The same maths gives the Phosphate losses for WW4 at 371 kg P/year (Sheep block is 20 kg P/year; plus other losses of 6 kg/year=26 kg P/year added to dairy unit P loss of 152+166=318 equates to 344 kg P/year).

The difference between the proposed and current is in the difference column, with a net decline in N losses of 2,290 kg N/year (which equates to the difference in total loss figures reported of 12,017 and 9,727).i.e. the net loss of 2,706 plus 619 less the N gain on the sheep block of 922 gives a net decline overall of 2,403 kg N/year. Add the net gain in other losses of 113, this equates to a Net loss of 2,290, which equals the difference in Overseer reported figures. This is the same for the P loss columns with a small rounding error creating the single unit difference.

Two items of note need to be made and clarity was asked for by the commissioners:

1. One cannot look in isolation at only the N loss on the sheep block and ignore the reduced losses of N on the dairy blocks. There is a net overall reduction. Also, the P losses on the sheep block decline for WW5 (8 kg/year decline) and only increase 3 kg P/year for WW4. Thus, the total contaminant story needs to be considered. Further P mitigations reduce any gain in P above into net losses, which is as in evidence is from additional other losses.
2. The loss from the Aparima catchment which includes the Cochrans block from WW4. This can be done by adding the difference on losses from this block in WW4 and adding them to the difference on blocks for WW5. The reduced losses in N can compensate for the added losses from the sheep portion of WW4. The P loss is

increased by 17 kg P/year. The additional mitigations will be able to cater for this increase, given that the barn mitigations would include portions of this sheep block in prior calculations. Also, the per ha amount is very small at 17 kg P/year/398.9 ha or 0.04 kg P/ha/year

Block	**Current Scenario N WW4**		**Proposed Scenario N WW4**		**Difference (kg N/year)**	**Current Scenario P WW4**	**Proposed Scenario P WW4**	**Difference (kg P/year)**
	Area (ha)	**N loss (kg N/year)**	**Area (ha)**	**N loss (kg N/year)**	**N loss (kg N/year)**	**P loss (kg P/year)**	**P loss (kg P/year)**	**P loss (kg P/year)**
Sheep Block WW4	62.0	1,104	62.0	2,026	922	20	23	3
Sheep Block Other	1.3	14	1.3	(1.3/13.1)=0.099% 0.099%*568=56	42	6	0.099%*210=21	15
Total	**63.3**	**1,118**	**63.3**	**2,082**	**964**	**26**	**44**	**18**
WW5	**335.6**	**16,591**	**335.6**	**14,678**	**1,913**	**249**	**248**	**1**
Total	**398.9**	**17,709**	**398.9**	**16,760**	**949 (1,913-964)**	**275**	**292**	**17 (18-1)**
Check					**949(16760-17709)**			**17 (292-275)**

2 *Table 1(a): Influence of WW4 Cochrans block on WW5 and Aparima catchment:*

Note. All P loss figures are pre additional P mitigations

Table 2: Metrics for Nitrogen surplus:

Metric	WW4: Current (and combined)	18/19 season	Proposed Scenario	Sheep Current Year	WW5: Current (and combined)	18/19 season	Proposed Scenario
N Surplus (kg/ha)	232 (284)	243	217 (23.6 % reduction)	113	244 (305)	268	259 (15.1 % reduction)
Nitrogen conversion efficiency (%)	28	27	48	17	26	29	47

This was in support of Mr de Wolde's evidence regarding improved nitrogen efficiency and reduced Nitrogen surpluses in the soil.

Metrics for additional Nutrient Budget (18/19): Likely Effect in relation to current scenario/baseline average.

Woldwide Four & Five:

Metric	WW4: Current Scenario Actual average Data used	WW4 Average data now incl 18/19 season	Likely Effect	WW5: Current Scenario Actual average data used	WW5 Average data now incl 18/19 season average	Likely Effect
No of cows wintered	810	805	Dec.	533	601	Inc
No of cows peak milked	775	778	Inc	513	573	Inc
Milk solids produced	410452	411242	Inc	249340	296445	Inc
Nitrogen used	195	200	Inc	212	207	Dec
Silage used	253 plus 480 Gladfield	220	Inc	330	90 plus	Dec
Molasses	66	59	Inc	49	68	Inc/Same
Barkley	520	530	Dec	402	401	Inc/Same
PKE	409 (total 995)	402 (total 991)	Inc	161 (total 612)	159 (total 608)	Inc/Similar

Note: These are the actual indices used in modelling and how the addition of 18/19 season data changes these averages and the likely effect in N losses. It is the contention that the additional budgets would not provide any further clarity to aid in decision making, given that they will likely change the results one way, further increases are very likely. Note also, for WW5 the numbers used were extrapolated from this actual data with the addition of the Collies block. However given the similarities between the averaging figures the figures used in the current scenario for WW5 would have resulted in losses greater to that which has been modelled already (i.e. conservatively)

Metrics for Average N loss 18/19 season included

Metric	WW4: Current Scenario averaged (actual)	WW4: Year End 18/19 actual	WW4: Current Scenario averaged (combined with sheep block)	WW4: Current Scenario averaged plus 18/19 (combined with sheep block)	WW4: Proposed Scenario
N loss (kg/year)	10,860	10,900	11,978	12,017	9,727
P loss (kg/year)	318	319	343	344	371
Milk solids produced Kg	410,452	415,192	n/a	n/a	570,000
Cows peak milked:	775	771	n/a	n/a	1000

Metric	WW5: Current Scenario averaged incl. Collies block	WW5: Year End 18/19 actual incl. Collies block	WW5: Current Scenario averaged (combined with sheep block)	WW5: Current Scenario averaged plus 18/19 (combined with sheep block)	WW5: Proposed Scenario
N loss (kg/year)	14,862	15,205	16,247	16,590	14,678
P loss (kg/year)	211	217	243	249	248
Milk solids produced Kg	314,081(adjusted)	390,655 (actual used)	n/a	n/a	535000
Cows peak milked:	665 (adjusted)	698 (actual used)	n/a	n/a	930

* Includes non OverseerFM modelling of P loss mitigation. Refer to Cain Duncan evidence

Woldwide Four Phase 1			
	Current Farm System	**Proposed Farm system**	**Reduction**
N (kg/yr)	12,017	11,898	1.0 %
P (kg/yr)	344	349	-1.5 % (increase)
Woldwide Four Final			
	Current Total Farm System	**Proposed Total Farm system**	**Reduction**
N (kg/yr)	12,017	9,727	18.8
P (kg/yr)	344	342* (371)	0.6
Woldwide Five Phase 1			
	Current Farm System	**Proposed Farm system**	**Reduction**
N (kg/yr)	16,590	16,047	3.3 %
P (kg/yr)	249	233	6.4 %

Woldwide Five Final			
	Current Total Farm System	**Proposed Total Farm system**	**Reduction**
N (kg/yr)	16,590	14,678	11.5 %
P (kg/yr)	249	227*(248)	8.8%

* Includes non OverseerFM modelling of P loss mitigation. Refer to Cain Duncan evidence

Tables explained:

The current farm losses without the added year of 18/19 are titled WW4 or 5 Current scenarios averaged(actual). These were given in evidence at the hearing. A request was made to include the 18/19 season, as to give more certainty to the modelling. In both cases the results were increased losses, and the results added to the view that conservative modelling had been done in the current averaged actual models for both farms.

The actual results for the year end 18/19 are in the second column. When the 18/19 year is added (pro rata) to the current averaged actual budgets the result is then added to the sheep block, which does not change. The new combined result is the fourth column and can be compared to the previous combined result prior to the adding of the 18/19 season which is in the third column, and which was reported in the evidence already given.

The fourth column, the new combined averaged result including 18/19 season is now include in the blue table as reported in M Freeman evidence.

The fifth and final column is the final proposal which has not changed.

Mark Crawford

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