IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Lake Rotorua Nutrient Management – **PROPOSED PLAN CHANGE 10** to the Bay of Plenty Regional Water and Land Plan

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STATEMENT OF EVIDENCE OF ALASTAIR CHARLES MACCORMICK ON BEHALF OF THE BAY OF PLENTY REGIONAL COUNCIL

Evidence topic: OVERSEER® and Proposed Plan Change 10; the Use of Reference Files.

Contents:

Qualifications and Experience

1. My full name is **Alastair Charles MacCormick**. I am employed by Bay of Plenty Regional Council as a Senior Lakes Technical Officer, a position I have held at various levels for 10 years.

2. Prior to this I worked as an agricultural pilot conducting spraying and fertiliser spreading operations on cropping and pastoral systems in Australia.

3. I have the following qualifications: BSc, Intermediate Sustainable Nutrient Management in New Zealand Agriculture, Advanced Sustainable Nutrient Management in New Zealand Agriculture. I have particular technical expertise in the use of OVERSEER® Nutrient Budgets (OVERSEER®)[1], a farm nutrient computer model developed to help farmers understand and manage the nutrient movements on their farms in order to optimise production and reduce nutrient loss (Watkins et al., 2015). I am a member of the OVERSEER® User Advisory Group, the OVERSEER® Working Group and was a member of the OVERSEER® Data Input Standards Stakeholder Advisory Group. Membership of these groups is focused on those with practical expertise in the use of OVERSEER®.

4. My role as a Lakes Technical Officer in the Council has evolved over time. Initially I was tasked with the implementation of a series of rules in the Operative Regional Water and Land Plan commonly termed "Rule 11". This work required the benchmarking of properties using a model to estimate the nitrogen and phosphorus losses from the property[2]. As a result of this work I have used OVERSEER® extensively in the Rotorua Lakes catchments and am familiar with issues around its use in Rotorua. Benchmarking also required the development of systems to capture, update and analyse the information that was created or collected through this process. It is this information that forms the basis of the PC10 nitrogen allocations.

5. My position has focused on providing advice and data analysis to the council planners during the development of PC10. In this role I have contributed to Stakeholder Advisory Group (StAG[3]) and I have also provided benchmarking information to consultants and scientists for the purpose of analysis. In conjunction with Dr Kit Rutherford I developed the catchment discharge coefficients for use in the

[1] See evidence of Mr Park ("Park 2017") for a detailed explanation of OVERSEER®.
[2] See evidence of Mr Lamb explaining Rule 11 and the benchmarking process.
[3] See evidence of Mr Lamb explaining StAG.

2016 ROTAN update (ROTAN-Annual). This is explained in Dr Rutherford's evidence ("Rutherford 2016").

6. I am authorised to provide this evidence by the Regional Council.

7. I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014 and I agree to comply with it. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where I state I am relying on the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from my expressed opinion.

Scope of Evidence and Summary

8. My evidence covers the technical aspects of the PC10 allocation methodology. It begins by explaining how the base allocations were developed then describes how those allocations are reduced to achieve the catchment targets. It then goes on to explain how the allocations are adjusted with OVERSEER® version changes. Throughout I provide my opinion on the technical robustness of the use of OVERSEER® in PC10, concluding that it provides a technically robust approach that responds to the dual needs of certainty and flexibility. In response to submissions, I review both the reference file performance and a revised 6.2.3 based allocation system. I conclude that the new reference file methodology set out in the evidence of Mr Matheson (Matheson 2017), filed concurrently with this evidence, is preferable to the earlier version; and that the proposed 6.2.3 allocation system is not preferable. My reasons for this are explained in the evidence below.

9. It should be read with the evidence on the use of OVERSEER® and reference files in the evidence of Mr Park (Park 2017) and the overall explanation about the approach to nitrogen management provided in the evidence of Mr Lamb (Lamb 2017).

PC10 Allocation Methodology

Benchmarking

10. Nutrient benchmarking is a requirement of a series of rules (commonly termed "rule 11") in the Regional Water and Land Plan. It applies to five of the Rotorua lakes: Rotorua, Rotoiti, Rotoehu, Ōkāreka and Ōkaro. Benchmarking involved collecting farm management and biophysical information from individual farms and entering it into the OVERSEER® nutrient budgeting model, in order to predict nitrogen and

phosphorus loss from the farm to water. Not all of the properties complied with their required benchmarking. Benchmarking of Rotorua properties started in 2007 using OVERSEER® 5.4.3 and continued until the end of 2015. Larger properties were prioritised although some smaller properties were benchmarked when requested. Of the properties benchmarked most were benchmarked under rule 11C.

11. The spatial extent of Lake Rotorua benchmarking was limited by the Lake Rotorua surface catchment as defined by the 2006 LiDAR[4] and the regional boundary- whichever is the lesser extent (Figure 1). Where properties spanned two Rule 11 catchments the entire property may have had a benchmark. Properties that extend beyond the Rule 11 boundary generally had the entire property run through the OVERSEER® model, with only the area within the boundary subject to Rule 11.

12. Benchmarked properties are shown in Figure 1. In general, the majority of smaller properties were not benchmarked and most properties between the regional or surface water boundary and groundwater extents will not have been run through OVERSEER® as part of the benchmarking process.

13. Council's approach to benchmarking was to develop the best possible estimates of nutrient losses given the available data at the time. Bio-physical data was taken from GIS sources (LiDAR, S-map[5], NIWA 1971-2001 mean rainfall, aerial photography) and farm data was sourced from the farmer. Where available, farm data was verified against records. The availability of farm data (or the farmer) meant that some benchmarks are based on very detailed and verified information and some benchmarks are based on partial data and/or recollection. The benchmark is therefore the "best estimate".

14. The majority of dairy farmers in the catchment initially did not cooperate with benchmarking and negotiated in 2011 to be benchmarked by a third party (not Council) and to provide a summary of their farm information along with their N and P discharges[6]. For these properties, Council did not hold the OVERSEER® files and was not able to update the benchmarked discharges as new versions of OVERSEER® were released. Most of these properties have since provided their original benchmark OVERSEER® files. All drystock and forested properties targeted for benchmarking

[4] 'LiDAR' stands for Light Detection and Ranging, used to provide accurate topographical maps.

[5] 'S-map is a new digital soil spatial information system for New Zealand. It is being created as part of the government-funded Spatial Information programme run by Landcare Research.' (from: *https://smap.landcareresearch.co.nz/abouthttps://smap.landcareresearch.co.nz/about*)

[6] This was the 'Collective Benchmarking Protocol', finalised in a letter (8/8/2011) from Eddie Grogan (BOPRC GM Water Management) to the Chair of Lake Rotorua Primary Producer's Collective

(i.e. generally larger properties) were benchmarked by Council staff or contractors with OVERSEER® files and data records held by Council from the outset.

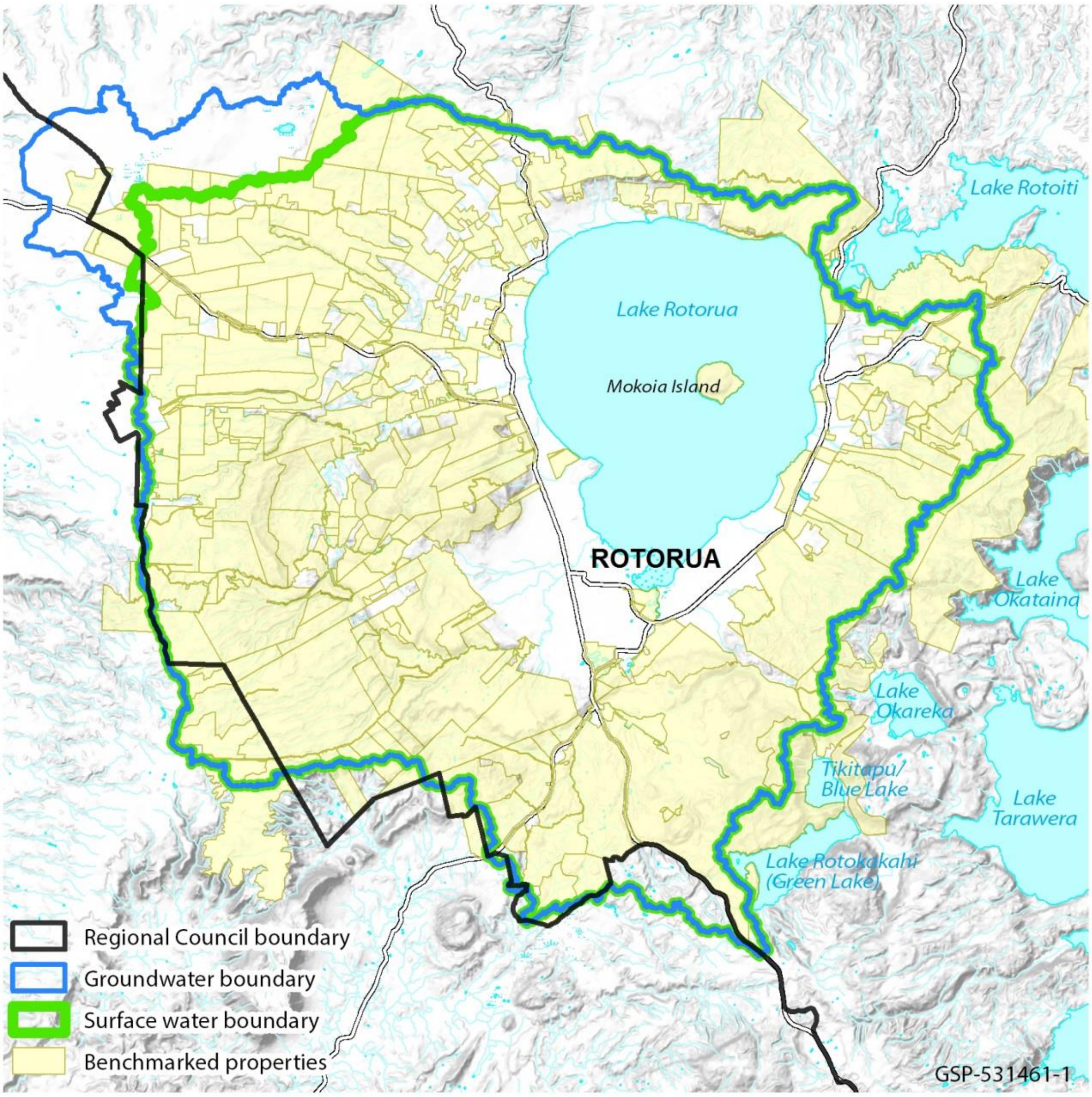

Figure 1. Benchmarked properties within the Lake Rotorua groundwater boundary.

15. The benchmarked discharges for each property are stored in a database and updated with each OVERSEER® version by re-running the OVERSEER® file. The reasons for regular OVERSEER® updates are described below in paragraph 17 (see also: Mr Park's evidence, para 32; Freeman et al., (2016), Chapter 6). The properties where Council do not hold the OVERSEER® files are not updated. The progressive change in OVERSEER® and the adoption of the OVERSEER® Best Practice Data Input Standards (BPDIS) has required the addition of and/or the changing of some data in the files in order to maintain their relevance to the original farm systems. Where this has been necessary it has been done by reference to the original data collected or by

making assumptions about practices that were typical of the period and area. Examples are shown in Table 1.

Table 1. Examples of the changes that have been required to maintain the benchmarking files.

Type of change	Previous OVERSEER® versions	Current OVERSEER® version	Actions required
Additional data requirements	OVERSEER® 5.4 used annual fertiliser inputs with a high-risk period.	Monthly fertiliser inputs.	Inspect original data/make assumptions.
	Friesian-Jersey cross not available in beef calendar.	Friesian-Jersey cross available.	Inspect original data/make assumptions.
Errors/bugs fixes	Fodder parent block not specified.	Parent block/s specified. When importing, all pastoral blocks are assumed to be the parent block.	Inspect original file and align new files with the originals.
	In OVERSEER® 6.1.3 animal ME requirements were sometimes exceeded requiring work arounds.	This bug has been corrected so the original data successfully runs the file.	Files had to be individually manipulated in order to run then returned to their original configuration when the bugs were fixed.
Changes to the biophysical data	Soils type entered from National Soils Database using S-Map and user judgement.	Soils data loaded directly from S-Map in accordance with the BPDIS.	Soils data needs to be regularly checked and updated (with each version change) in 1100 blocks.
	Weather data obtained through GIS analysis of rainfall, latitude and altitude combined with user interpretation of OVERSEER® maps for annual PET, seasonal PET and seasonal variation in rainfall.	Obtained through OVERSEER® climate tool using latitudes and longitudes of each block.	The weather data for 1100 blocks has needed to be re-entered into the files several times as the methods of entering data has changed.

16. While the continual updating of the individual farms benchmarking OVERSEER® files through versions is technically possible, it is likely that over time the files will diverge from the original farm system. The process of updating the files can only be undertaken once the new OVERSEER® version has been released. In recent years this has resulted in significant delays in updating the benchmark file outputs as issues are identified and appropriate changes to the files are made. Because the changes are often farm specific, verifying that they are fair and reasonable requires the individual attention of an experienced OVERSEER® user with knowledge of the original farm system. This knowledge is not always available.

OVERSEER® updates

17. Whilst the continuous changes made to the OVERSEER® model make it difficult to manage in the regulatory environment, they have also resulted in an improved ability to model Rotorua farm systems. Examples of significant improvements to the model are:

    (a) The change from rainfall driven N leaching to drainage driven N leaching (OVERSEER® technical note 5, August 2012);

    (b) The use of S-Map data to define soil physical properties;

    (c) The ability to capture differential monthly animal grazing;

    (d) Improved ability to measure losses from fodder crop blocks;

    (e) Additional block types such as trees, house, wetlands and cut and carry;

    (f) Improved features such as effluent treatment options, pads and shelters, increased supplement removal and DCDs.

18. As new science is incorporated, the ability of OVERSEER® to represent Rotorua biophysical conditions and farming practice will improve, giving a better indication of the effects of farming in the catchment. This continual development and improvement of the model is key to maintaining its relevance to constantly evolving science and farm practice.

19. The predicted discharges from the benchmarked OVERSEER® files were relatively stable in OVERSEER® 5.4 but underwent a step change with the update to OVERSEER® 6. This step change was largely due to the recalibration of the drainage model. In OVERSEER® 6, the adoption of S-Map data and various bug fixes has also resulted in further significant change. The average N discharge from dairy blocks has doubled between OVERSEER® 5.4 and OVERSEER® 6.2.0. Drystock block discharges have increased by about 75%.

20. Different OVERSEER® versions can give different N leaching predictions even though the model inputs remain the same. Therefore, both the allocation and the farm performance need to be predicted using the same version of OVERSEER® in order to avoid an erroneous representation of the farms nitrogen losses relative to its allocation. The reference file method in combination with five year NMPs is designed

to provide periods where the farmer is ‘shielded’ from the effects of frequent version changes whilst also allowing for the periodic incorporation of new science within OVERSEER®.

PC10 nitrogen allocations

21. Nitrogen has been provisionally allocated to all rural land in the catchment based on the benchmarked OVERSEER® 6.2.0 discharges and the 2001-2004 land use. During benchmarking each OVERSEER® block was identified as one of 18 different land use categories (Table 2). This land use and OVERSEER® 6.2.0 discharge is recorded against each block polygon in Council’s GIS system. Under PC10 these land uses are further grouped into six categories/sectors.

Table 2. Benchmarked land uses and their PC10 sector.

Benchmarked land use	**PC10 land use sector**
Pastoral drystock	Drystock
Pastoral dairy support	
Crop	
Cut and carry	
Fruit crop	
Fodder dairy support	
Fodder drystock	
Pastoral dairy	Dairy
Pastoral effluent	
Fodder (dairy)	
Trees -bush and scrub	Bush and scrub
Riparian	
Wetland	
Trees forestry	Plantation forestry
Grazed trees	Grazed trees
House	House
Urban open space	N/A
Non-productive	Non-productive

22. All non-benchmarked land has also been categorised as one of the six PC10 land use sectors based on reviewing 2002/2003 aerial photography and recorded in a GIS layer. Combining the benchmark GIS layer with the non-benchmarked land use layer enables a sector map of the entire catchment to be assembled (Figure 2).

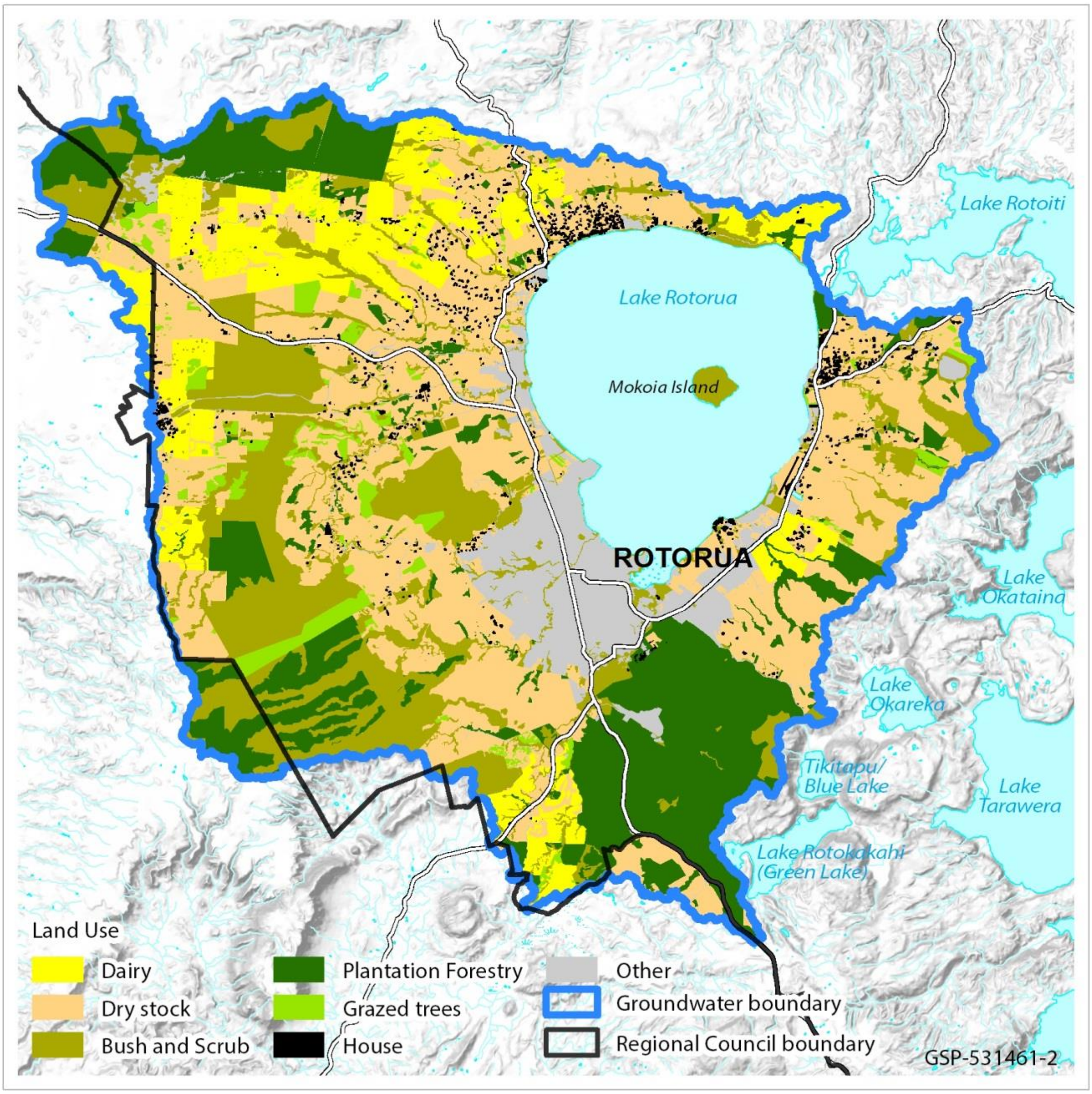

Figure 2. Sectors within the Rotorua groundwater catchment.

23. All rural land within the catchment was then assigned an OVERSEER® 6.2.0 nitrogen discharge as follows:

(a) Benchmarked land where we hold the OVERSEER® file was assigned the OVERSEER® 6.2.0 discharge.

(b) Benchmarked land where we don't hold the benchmark file was assigned an estimated 6.2.0 discharge based on multiplying the 5.4.11 block discharge by the average OVERSEER® shift for that land use e.g. if a dairy block in 5.4.11 had a discharge of 40 kg N/ha/yr and the average dairy discharge doubled between 5.4.11 and 6.2.0, the assigned 6.2.0 discharge is 80 kg N/ha/yr.

(c) Non benchmarked land received the average discharge for the relevant land use sector.

24. An example calculation is shown in Table 3 below.

Table 3. Example showing how 6.2.0 discharges are calculated for blocks without 6.2.0 OVERSEER® files.

Land use	Benchmarked in OVERSEER® 5.4.	Benchmarks predicted by OVERSEER® 6.2.0	Average shift	Benchmarks calculated using average increase	Benchmarks based on average
Dairy	**40**	**90**	**200%**		
Dairy	**60**	**110**			
Dairy	**40**	*...multiplied by average shift (200%)=*		***80***	
Dairy	**60**	*...multiplied by average shift (200%)=*		***120***	
Dairy	*average of all dairy benchmarks (predicted and estimated)=*				***100***

25. The result of the above process is that all rural land in the catchment is divided into spatially defined blocks. Each block is assigned a PC10 land use sector and either has an actual OVERSEER® 6.2.0 discharge, a calculated 6.2.0 equivalent discharge or an average sector 6.2.0 equivalent discharge. The cumulative areas of each sector and how the discharge was calculated are shown in Table 4 below.

Table 4. Areas of actual 6.2.0 benchmarks, calculated 6.2.0 benchmarks and average 6.2.0 benchmarks for each sector within the Rotorua groundwater catchment.

	Area (ha)		
Land Use Sector	**Actual Benchmarks in 6.2.0**	**Calculated 6.2.0 equivalent**	**Average 6.2.0 equivalent**
Dairy	3511	1175	315
Drystock	10907	341	4613
Grazed trees	1213	133	0
Plantation forestry	7033	34	2096
Bush and Scrub	7559	162	2273
House	92	2	303

26. Schedule LR One gives scope for derived benchmarks to be altered where there is evidence of substantial change.

27. Derived benchmarks can also be established where the property was not previously managed by Rule 11.

Calculating the reduction targets and block allocations

28. The allocation methodology is structured to achieve proportionally the same level of total sector nitrogen loss reduction as proposed in the Integrated Framework[7]. To do this the total sector nitrogen load is multiplied by the percentage sector reductions to give the sector reductions and sustainable load (Table 5).

Table 5. Calculation of the dairy and drystock sector reductions and sustainable loads.

Sector	OVERSEER® 6.2.0 load (tN/yr)	Reduction (%)	Reduction (tN/yr)	2032 Sustainable load (6.2.0 tN/yr)
Dairy	501	35.3%	177	324
Drystock	505	17.2%	87	418

29. The 2032 pNDA is then distributed amongst all blocks in the catchment based on their sector, the blocks OVERSEER® 6.2.0 nitrogen discharge, standard sector percentage reduction and ranges set by StAG in July 2015. The ranges consist of an upper and lower limit for each sector and the standard sector percentage reduction is the reduction applicable to a block with a near average OVERSEER® 6.2.0 nitrogen allocation. There are numerous combinations of ranges and standard sector reductions that achieve each sectors sustainable load. The combination shown in Table 6 was presented to StAG in August 2014 after trialling and considering multiple combinations in earlier meetings. In essence this combination was preferred by the majority of StAG members although no formal StAG vote was taken.

Table 6. Standard sector reductions and range bounds for each sector.

	Dairy	Drystock
Standard sector percentage reduction (%)	31.3	20
Lower nitrogen discharge allowance range boundary (kg N/ha/yr)	54.6	18
Upper nitrogen discharge allowance range boundary (kg N/ha/yr)	72.8	54.6

30. In words, the equations to calculate the block provisional Nitrogen Discharge Allowance (pNDA) are as follows:

(a) If the block OVERSEER® 6.2.0 per hectare nitrogen discharge is reduced by the standard sector percentage reduction and the result is more than the upper limit, then the block allocation shall be reduced to the upper limit;

[7] Explained in the evidence of Lamb, 2017.

(b) If the block OVERSEER® 6.2.0 per hectare nitrogen discharge is reduced by the standard sector percentage reduction and the result is between the upper and lower limits, then the block allocation is the result;

(c) If the block OVERSEER® 6.2.0 per hectare nitrogen discharge is reduced by the standard sector percentage reduction and the result is less than the lower limit, then the block allocation is the lower limit.

31. A chart of the dairy block start point allocations and corresponding 2032 pNDAs is shown in Figure 3. The dairy 2017 start point block allocations range from 20 kg N/ha/yr to 10616 kg N/ha/yr; the pNDAs range from 54.6 to 72.8 kg N/ha/yr. Note the y axis has been truncated for display purposes. The last block has an excessive discharge due to a large amount of effluent being applied to a very small area.

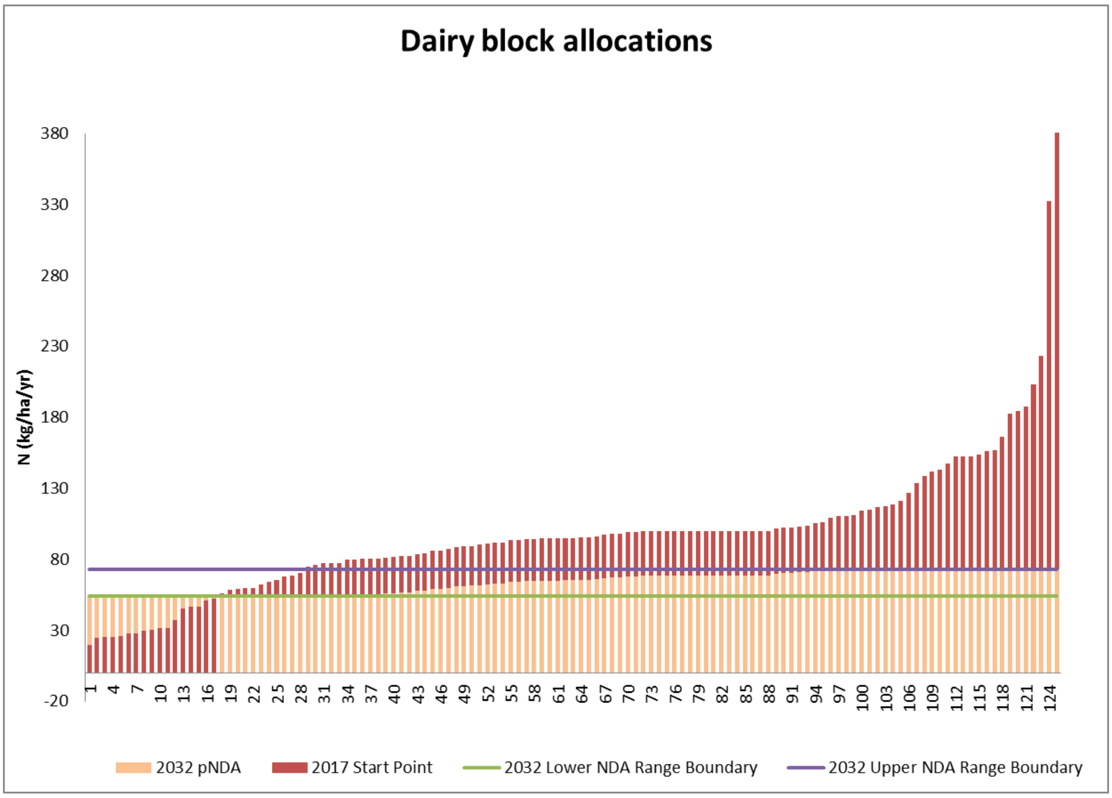

Figure 3. Dairy block start point allocations and pNDAs after application of the range boundaries and standard sector reduction (OVERSEER® 6.2.0 N loss values).

32. Similarly, the drystock block start point allocations and corresponding 2032 pNDA are shown in Figure 4. The drystock 2017 start points range from 4 to 222 kg N/ha/yr. The pNDAs range from 18 to 54.6 kg N/ha/yr.

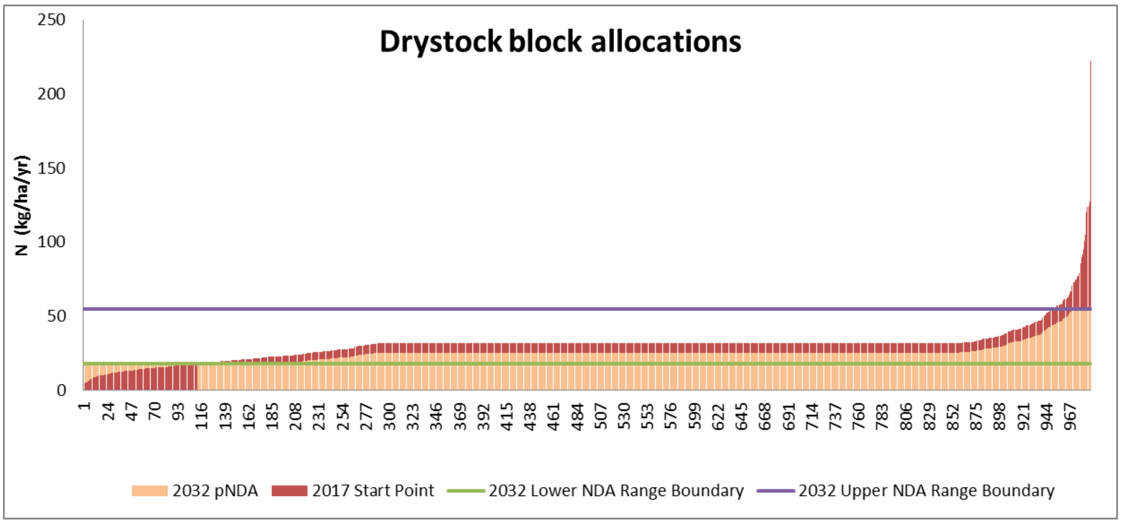

Figure 4. Drystock block start point allocations and pNDAs after application of the range boundaries and standard sector reduction (OVERSEER® 6.2.0 N loss values).

33. Table 6 of Schedule LR One describes the standard sector reductions as 31.3% for dairy and 20% for drystock yet the required total sector contributions from the Integrated Framework are 35.3% and 17.2% respectively. The reason for the different rates is that not all blocks are being required to reduce by the same amount. In the case of dairy, the nitrogen load being removed above the upper boundary exceeds the nitrogen load being added below the lower bound, hence the standard sector percentage reduction can be less than the required sector contribution whilst still meeting the reduction target.

34. In the case of drystock, the nitrogen load added below the lower bound is greater than the nitrogen load removed above the upper bound and so the standard sector percentage reduction must be greater than the sector contribution in order to meet the drystock reduction target. The relatively large number of drystock blocks with derived benchmarks and pNDAs is apparent in Figure 4 in the mid-part of the graph where adjacent columns have the same N loss rate, approximately between X-axis numbers 300 to 852 (note that most of these blocks are small – see Table 4 for the area breakdown).

Managing OVERSEER® version change using reference files

35. The 'reference file' method in PC10's Schedule 5 is designed to manage OVERSEER® version updates. These software updates occur typically twice per year to reflect improved science, incorporation of new features and bug fixes.

36. There are five reference files covering the five land uses that form the basis of the nitrogen allocation scheme in PC10's Schedule LR One. These land uses are: drystock; dairy; plantation forestry; native bush/scrub; house block (i.e. rural houses with on-site waste treatment). Losses from grazed trees are referenced against the drystock reference file.

37. The drystock and dairy reference files (as notified) are described in detail in Perrin Ag Consultants Ltd report 'Methodology for creation of NDA reference files and stocking rate table Version 2 (February 2016)', and the evidence of Mr Matheson explaining the methodology behind the creation of the sector reference files. For the purpose of my evidence, I note that the key features of the drystock and dairy reference files (as per the notified PC10) are:

(a) 100 ha hypothetical farms with a single land use.

(b) A block structure based on the proportion of each soil type used in the benchmarking OVERSEER® files. For example, there are 26 soils across all drystock benchmarked blocks. A Mamaku loamy sand (Mku_1a.1) comprises 11.4% of all benchmarked drystock land and is therefore represented by an 11.4 ha block within the 100 ha drystock reference file.

(c) The other bio-physical attributes of each block are based on area weighted averages from the benchmarked blocks in each sector. These attributes are rainfall, potential evapo-transpiration (PET) and slope.

(d) A farm management regime that:

(i) Meets the average sector 2032 N loss;

(ii) Has variable pasture production between blocks;

(iii) Provides for stock and silage (conserved pasture) movement between blocks;

(iv) Is economically viable i.e. profitable.

38. The detail of how reference files work is in Schedule LR Five. An abbreviated and more conceptual description follows below.

39. As described above, each blocks nitrogen allocation is based on the benchmarked or derived benchmark loss using OVERSEER® 6.2.0, the land use sector and the reduction and range criteria listed in Table LR 6.

40. The reference files for the five land use sectors were run in OVERSEER® version 6.2.0 to give five corresponding nitrogen loss rates. These reference file nitrogen loss rates were then compared with the start point and the pNDA loss rates for every actual block with the corresponding land use. These comparisons are expressed as percentages of the reference file nitrogen loss. Managed Reduction Targets (MRT) were then calculated based on Table LR 7. The percentage values are the critical numbers as these remain fixed over time i.e. the percentages do not change as OVERSEER® is updated.

41. As new OVERSEER® versions are released, the five reference files are re-run using the latest version. The revised reference file loss rates are then multiplied by the start point, MRTs and pNDA (for each block) in order to calculate revised allocations for the new OVERSEER® version.

42. As farming enterprises evolve and the management and/or areas differ from those used to define the allocation, the new farm map is superimposed over the block GIS allocation layer to calculate the new property total pNDA.

43. The amount that the modelled nitrogen loss changes for any individual farm as a result of an OVERSEER® version update is unlikely to be exactly the same as the reference files because the dairy or drystock component on a real farm will not be exactly equivalent to the 100 ha reference file ‘farm’. These differences in relative nitrogen loss shifts are unavoidable within the reference file system as it is designed in PC10.

Maintaining the allocation integrity with time

44. Maintaining the integrity of the allocation system over time is essential to protecting individual rights to discharge and achieving the water quality targets. Listed below are five aspects of the proposed rules that achieve this:

    (a) Fixing the allocation to a single version of OVERSEER®. This provides certainty that the blocks allocation relative to other blocks within the sector will be maintained through OVERSEER® version changes and that allocations are constant and transparent providing certainty for decision making.

(b) Maintaining like with like when comparing a farm's allocation with its performance. This is achieved through the use of reference files and standardised biophysical data accessed from OVERSEER® and the council's GIS system.

(c) Maintaining a spatially fixed allocation map that is independent of property boundaries or ownership. This ensures that the allocations on land cannot be changed as a result of sales, leases or subdivisions without direction from the owner. Methods are being developed to allow the redistribution of nitrogen around a property (i.e. between blocks) so that areas of land can be sold or leased with more or less nitrogen than originally allocated. Any changes will need to be offset within the same property unless there has been a trade with another property.

(d) Standardising how OVERSEER® is used. Different users of OVERSEER® can produce outputs for the same property that vary considerably. This may be due to the file being created for different purposes, the use of different farm information or different data entry options within OVERSEER®. Identifying the purpose of an OVERSEER® file is being discussed within national forums and may become a feature of OVERSEER® in the future. Standardising how OVERSEER® is used is addressed through the BPDIS. Further refinement is provided in BOPRC's Data Input Protocols for the Rotorua catchment.

(e) Five year science reviews described in Method 2 (LR M2).

Responses to Submissions

Review of reference file performance

45. The reference file system is a new approach to managing OVERSEER® version change in the regulatory environment. As such it was not possible to test its performance until several version changes had occurred after the initial pNDA allocation in OVERSEER® 6.2.0.

46. With the first new release of OVERSEER® after allocation it was found that the drystock reference file did not run successfully and would not predict a total farm nitrogen loss. Investigations by AgResearch revealed this was due to a software bug when the timing of feeding supplements is specified by the user. It was likely this 'bug' existed in OVERSEER® 6.2.0 with the implication that the reference files were likely to be over estimating nitrogen discharges. This was resolved by adjusting the reference

files so that supplement timing was not specified. These files are described in Perrin Ag Consultants Ltd report 'Methodology for creation of NDA reference files and stocking rate table Version 2' (February 2016). These files have been successfully transitioned through each version of OVERSEER® up to 6.2.3.

47. Several submissions were received recommending that the reference files should be more representative of current farm systems. (See section 42A report).

48. To test the reference file performance, the reference file total N loss in versions 6.2.0, 6.2.1, 6.2.2 and 6.2.3 was compared on a percentage basis against the average sector benchmark. This comparison showed that the drystock reference file tracked the benchmarks reasonably closely (Figure 5), whereas the dairy reference files did not (Figure 6). Where the reference file plot tracks above the benchmark average plot, this represents a relative increase in block allocations and an erosion of the catchment reductions. Where it tracks below there is an erosion of block allocations and an over-achievement of the catchment targets.

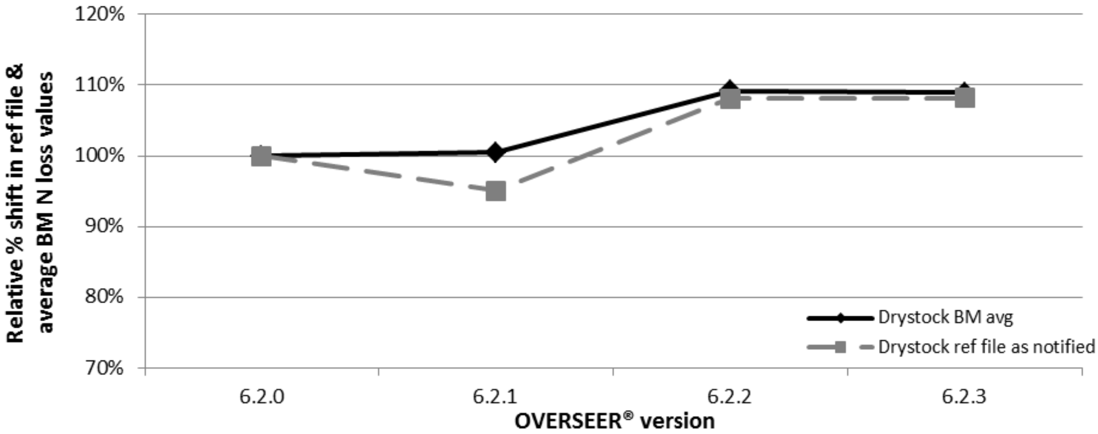

Figure 5. Comparison of the drystock reference file against the area weighted average drystock discharge from the benchmarking files.

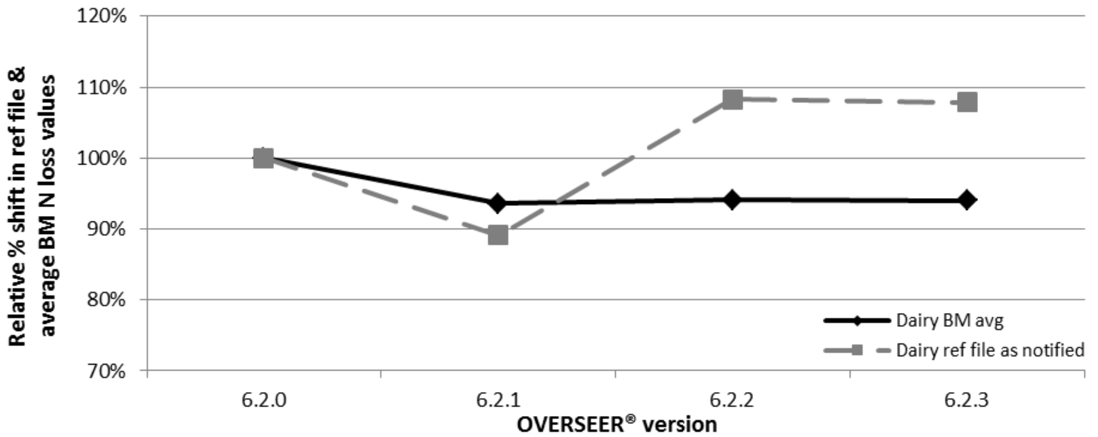

Figure 6. Comparison of the dairy reference file against the area weighted average dairy discharge from the benchmarking files.

49. Mr Matheson from Perrin Ag Consultants Ltd was asked to create a 'current' farm system reference file. This file along with the existing reference file was compared against benchmarks through versions 6.2.0, 6.2.1, 6.2.2 and 6.2.3 (Figure 7). The 'current' reference file performed similarly to the PC10 notified version.

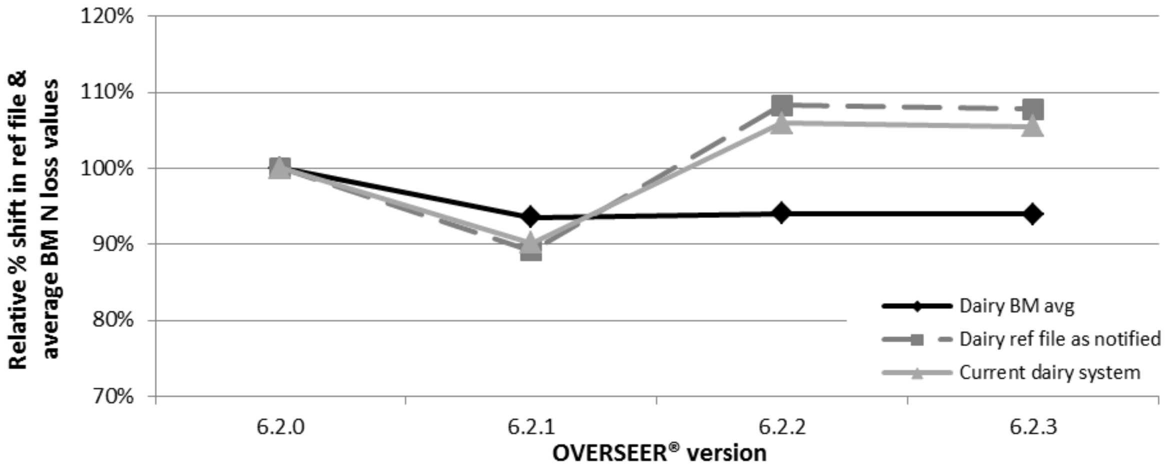

Figure 7. Comparison of a 'current' dairy reference file against the area weighted average dairy discharge from the benchmarking files and the dairy reference file as notified.

50. A meeting was held with submitters on the 15 September 2016 to discuss this issue. The consensus view of submitters was that the reference files should track the benchmarks as closely as possible (see also Park 2017).

51. Further investigations revealed that the divergence from the benchmark average resulted from a bug in how OVERSEER® was calculating the background losses on effluent blocks. This only occurred when effluent was applied to part of the block. In the dairy reference file, in order to apply effluent to all soil types in the catchment, 35% of each block received effluent. However, in the benchmark files, typically 100% of the effluent block receives effluent. Therefore only the reference files were affected. Subsequently, the following has been posted on the OVERSEER® website:

> "When the '% of area receiving effluent' is less than 100%, N leaching from the background model is being overestimated, with the size of the error dependent on the proportion of area (increases as % of area receiving effluent increases) and the block initial conditions. This does not affect the urine N leaching value."

52. To resolve the effluent bug, three alternative approaches were investigated:

(a) Altering the existing reference file block structure to split each block into a main block and effluent block. This allows 100% of the block area to receive effluent and avoids the bug. This approach is a structural change to the file and results in no changes to the farm system.

(b) Altering the "current file" block structure to split each block into a main block and effluent block in the same manner as described above.

(c) Construction of a revised dairy and drystock reference file that as closely as possible represent average benchmarking files and realistic farm systems. The details of this approach are described by Mr Matheson in 'Methodology for and output from further revision of reference files, December 2016'.

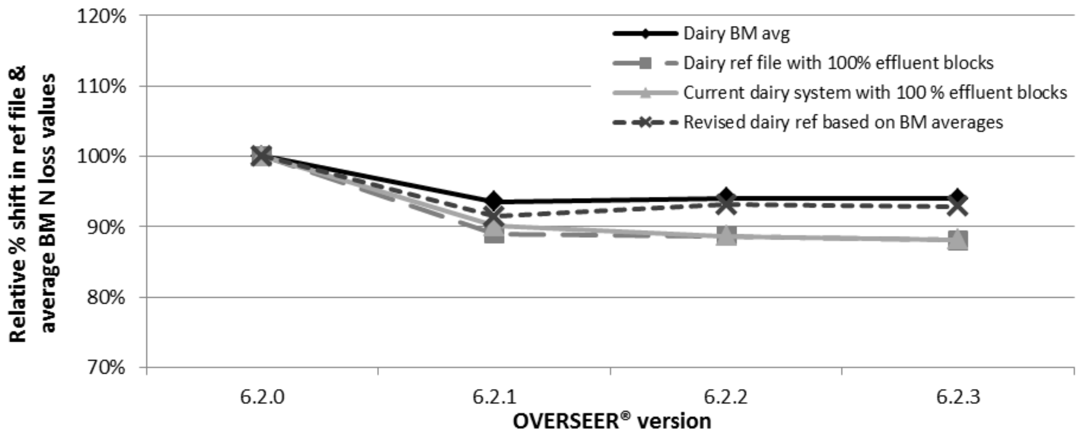

Figure 8. Comparison of three alternative dairy reference files with the area weighted average dairy discharge.

53. The results of these approaches for the dairy reference file are shown in Figure 8. Both the notified reference file and the current reference file (both altered to avoid the effluent block bug) track below the benchmark average by up to 6%. The dairy reference file based on benchmark averages tracks within 3% of the benchmark average.

54. Figure 9 shows the results for the different drystock reference file approaches. Both the existing drystock reference file and the revised reference file based on benchmarking data track similarly with very close alignment in versions 6.2.2 and 6.2.3. In version 6.2.1 the reference files predict a lower discharge by around 6%.

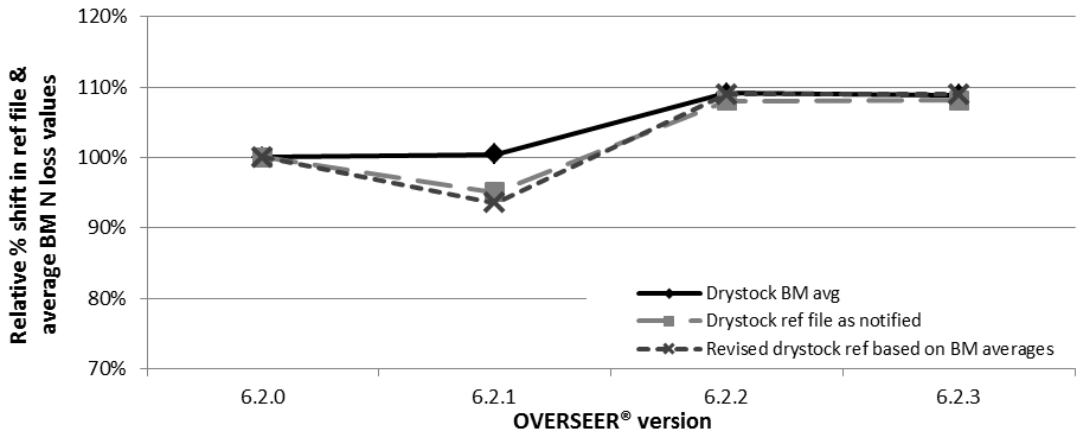

Figure 9. Comparison of the drystock reference file based on benchmarking averages with the drystock ref file as notified and the area weighted average drystock discharge.

55. In all plots there appears to be a divergence between the reference files and average benchmark discharges in version 6.2.1. The reason for this has not been investigated.

56. Overall the revised reference files, based on benchmark averages, show the closest alignment with the average benchmark discharges.

57. It should be noted that the transition of OVERSEER® files from version to version has elements of uncertainty. This uncertainty is likely to be affecting the calculation of the average benchmark discharges. These uncertainties result from:

(a) The failure of a file to run in a particular version requiring the use of work-arounds or resulting in missing data;

(b) The populating of new fields in OVERSEER® requiring the use of OVERSEER® defaults, best estimates or interpretation of the original benchmarking data collected;

(c) The benchmarking files that have not been supplied;

(d) Inconsistencies between users when transitioning files from one version to the next.

58. As a result, I believe that other than variations resulting from software bugs, the variations in reference file nitrogen discharges (relative to the benchmarking averages) are likely to be lessened by adoption of the revised dairy and drystock reference files described in Mr Matheson's evidence (Perrin Ag Consultants Ltd, 2016).

Updating the allocation to OVERSEER® 6.2.3

59. Submissions have sought that the nitrogen allocation be anchored in a more recent version of OVERSEER® than 6.2.0 (as notified).

60. To test the effect of this option, the benchmark files were transitioned into OVERSEER® 6.2.3 and NDAs recalculated using the Schedule One allocation methodology. For the 6.2.0 allocation, the upper bound, lower bound and standard sector reductions were set by consultation with StAG. As this process was not available the bounds were altered by the average sector change in the benchmarking files then the standard reduction percentage was manipulated until the 2032 target sector load was reached (Table 7).

Table 7. Standard sector reductions and range bounds used to create an allocation based in OVERSEER® 6.2.3.

	Dairy	Drystock
Standard sector percentage reduction (%)	30.4	17.8
Lower nitrogen discharge allowance range boundary (kg N/ha/yr)	51.3	19.6
Upper nitrogen discharge allowance range boundary (kg N/ha/yr)	68.4	59.5

61. Aside from the version change and the potential for different N predictions that result, the key difference in the 6.2.3 allocation data is that any changes that have occurred since the 6.2.0 allocation was completed can be incorporated into the calculations. These include some changes to benchmarks, data corrections and a number of dairy properties that have since supplied their benchmarking files.

62. This 6.2.3 based allocation was then compared to the current allocation in 6.2.3 equivalents (i.e. using existing 6.2.0 percentage allocations multiplied by the reference file output in 6.2.3) using:

(a) The reference files as notified <u>however,</u> to enable a meaningful comparison the existing dairy reference file has been substituted for the related file modified to include 100% effluent blocks. In my opinion this provides the best estimate of how the notified dairy reference file will perform once the effluent bug is resolved (paragraphs 63-66).

(b) The revised reference files (Perrin Ag Consultants Ltd, 2016) based on average benchmarking data (paragraphs 67-72).

63. The change to property allocations is shown in Figure 10. Each bar represents a benchmarked property. The first two bars on the left of the graph represent the change on non-benchmarked properties.

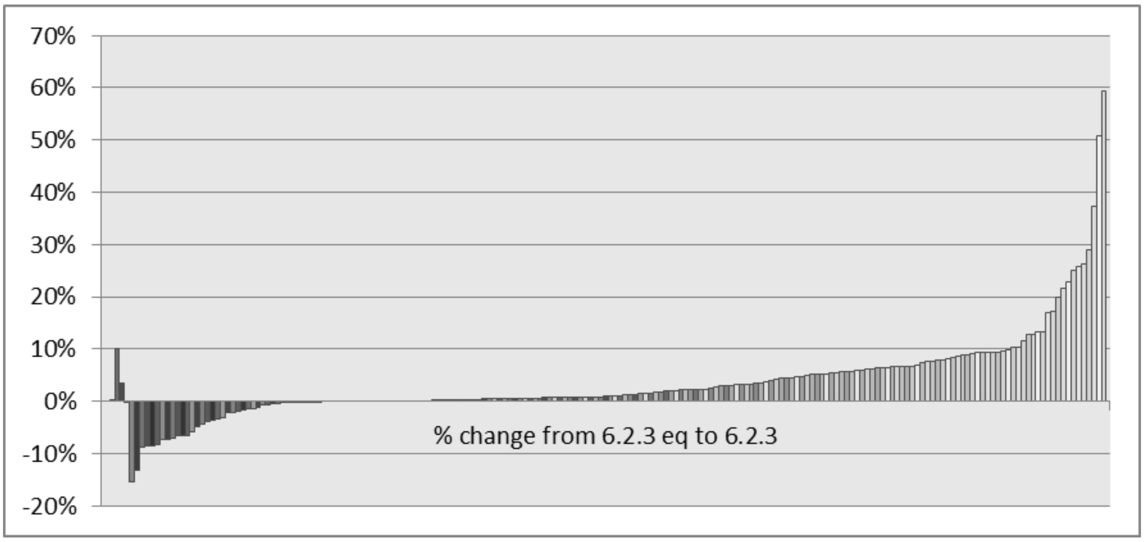

Figure 10. Change in property NDAs resulting from adopting a 6.2.3 based allocation compared to the current 6.2.0 allocation using the existing reference files modified to include 100% effluent blocks.

64. Using an allocation anchored in 6.2.3 results in 29 benchmarked properties getting a reduced allocation, 42 properties allocations not changing and 123 properties getting an increased allocation. On average, the dairy allocation increases by 9% and the drystock allocation increases by 2%. Non-benchmarked dairy and drystock land increase by 10% and 3% respectively.

65. The largest changes in allocation on properties are a result of the predicted nitrogen losses from land with low stocking rates increasing significantly in version 6.2.3 compared to 6.2.0, especially from grazed tree blocks. In addition, there has been an increase in losses from cropping blocks between versions which is significant where cropping blocks form a larger proportion of the property. There was no identifiable trend evident from properties that had a significant reduction in nitrogen allocation.

66. For each sector the reduction percentages (dairy 35.3%, drystock 17.2%) are still maintained. The reduction in pastoral nitrogen load from rules under a 6.2.3 allocation is 25.6% compared to 26.2% achieved by a 6.2.0 allocation and a 26.6% reduction achieved using ROTAN loads and areas. The erosion in reductions results from the relative change in sector loads and the fixed sector percentage reductions. Changes in sector loads result from a combination of changes to sector area as data is revised and changes to average discharges due to OVERSEER® version changes. This effect is demonstrated in Table 8 where it can be seen that although the total load and the

sector percentage reductions are the same for the two allocations, the percentage reduction in allocation 2 is 4% less than allocation 1. This is an unavoidable artefact of having fixed percentage reductions and variable sector loads.

Table 8. Demonstration of why the total reductions achieved varies between different allocation platforms.

	Allocation 1			Allocation 2		
	Load (tN)	Percentage reduction	Total reduction from sector (tN)	Load (tN)	Percentage reduction	Total reduction from sector (tN)
Dairy	600	35	212	400	35	141
Drystock	400	17	69	600	17	103
Totals	**1000**	**28**	**281**	**1000**	**24**	**244**

67. The allocation comparison (described in paragraphs 63-66) was repeated using the revised reference files based on benchmarking averages.

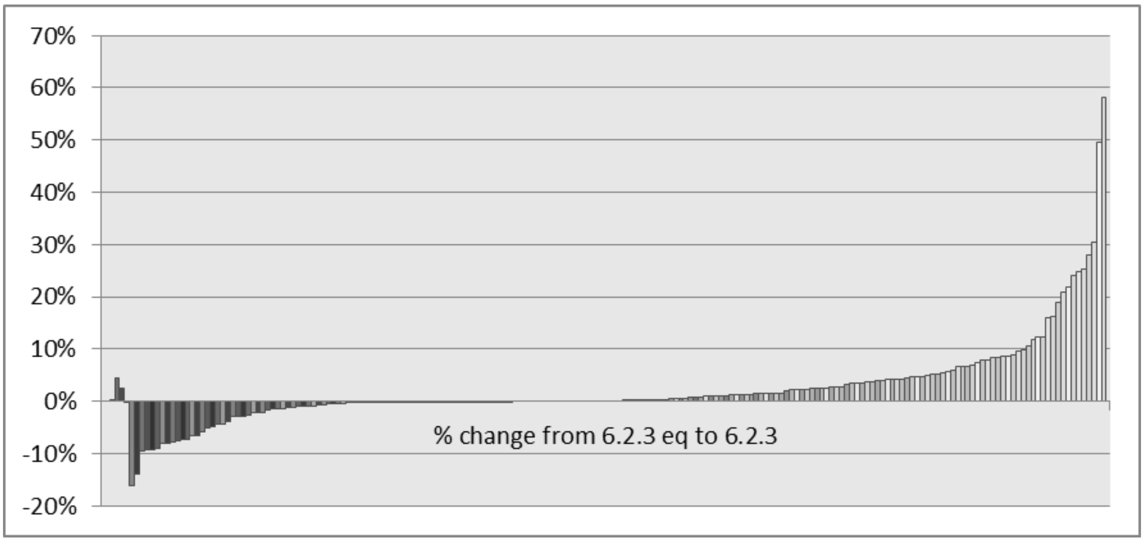

Figure 11. Change in property allocations resulting from adopting a 6.2.3 based allocation compared to the current 6.2.0 allocation using the revised reference files based on benchmarking averages.

68. The change to property allocations is shown in Figure 11. Each bar represents a benchmarked property. The first two bars on the left of the graph represent the change on non-benchmarked properties.

69. Comparing an allocation anchored in 6.2.3 with the 6.2.0 allocation using the revised reference files results in 40 benchmarked properties getting a reduced allocation, 69 properties allocations not changing and 85 properties getting an increased allocation. On average, the dairy allocation increases by 3.1% and the drystock allocation increases by 1.1%. Non benchmarked dairy and drystock land increase by 4.4% and 2.6% respectively.

70. The percentage increases in this scenario are less than in the first comparison because using the reference files based on benchmarks results in an increased 6.2.0 allocation compared to the current reference files. This can be seen in Figure 8.

71. As with the comparison using the current reference files the largest increases in allocations occurred on properties with low stocking rates and no trends from properties with significantly reduced allocations were identified.

72. The effects on the catchment targets are the same as described in paragraph 66 as these calculations are independent of the reference files.

Conclusion

73. In my opinion the reference file methodology provides the best method to manage the allocations in the Rotorua catchment given the proposed rule structure. The basis for my opinion is:

    (a) "Bugs" are as likely to occur in individual farm allocation files as they are in the reference files.

    (b) Because there are only five reference files, Council's ability to identify and manage "bugs" is better than if there were hundreds of individual OVERSEER® files defining allocations in the catchment.

    (c) Allocations are likely to fluctuate less under the reference file methodology as allocations are anchored in a single version.

74. With regard to the reference files used to define allocations I recommend that the revised reference files described in the Perrin Ag Consultants Ltd, (2016) report 'Methodology for and output from further revision of NDA reference files, December 2016" are adopted. The basis for my opinion is:

    (a) The underpinning principle behind the proposed rules is that farm allocations are reduced from benchmark levels to a lower level and that the revised reference files are most likely to track the benchmark averages in the future.

    (b) Of the options assessed these reference files have tracked the average benchmarks best.

    (c) The structure of these files is most likely to result in any bugs being common between the reference file and the farm performance file thereby maintaining "like with like" comparisons. This is in contrast to the current reference file strategy that aims to avoid "bugs" through the use of a simple farm system.

75. I recommend maintaining the current 6.2.0 based allocation for the following reasons:

(a) A 6.2.3 allocation results in a reduction in the amount of nitrogen being removed from the catchment (about 6 tN).

(b) For farmer decision making certainty, allocation needs to be a fixed to a single version rather than being constantly re-evaluated which will invariably benefit some and disadvantage others. The notified allocation ranges and standard reductions were tested through the StAG community forum. Ideally if a new allocation version were to be adopted, the ranges and resulting allocations would be tested in the same manner.

(c) Provisional NDAs have been provided to many landowners in order to help them understand the significance of PC10 on their farm enterprise. Changing those will likely result in disruption and confusion with minimal benefit.

(d) The majority of increases in allocations largely occur on very low intensity blocks. This change appears to have occurred between versions 6.2.1 and 6.2.2. I am uncertain whether this is an intended change in nitrogen leaching predictions and have logged a job with OVERSEER® requesting it be investigated. If this change is reversed it is likely that the overall relative change in allocations will be minor, however there would still be shifts in allocations between properties.

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Date: 17 January 2017

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