BEFORE THE ENVIRONMENT COURT **ENV-2020-AKL-00087**

AT AUCKLAND

I MUA I TE KŌTI TAIAO

I TĀMAKI MAKAURAU ROHE

IN THE MATTER of the Resource Management Act 1991 (**RMA** or **the Act**)

AND

IN THE MATTER of the Proposed Plan Change 1 to the Waikato Regional Plan

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STATEMENT OF EVIDENCE OF STUART GRAHAM EASTON (WATER QUALITY) ON BEHALF OF HORTICULTURE NEW ZEALAND

28 JULY 2023

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EXECUTIVE SUMMARY

1. There has been no net-increase in cultivated land area since 2008. Providing flexibility for growers to rotate crops at the Freshwater Management Unit (**FMU**) scale would be representative of the current situation and is unlikely to create any more than a negligible change in contaminant load at the sub-catchment or FMU scale.

2. To provide for population growth and land lost to urbanisation, 1,877 ha of additional Commercial Vegetable Production (**CVP**) is required.

3. The area limits in Table 1 of Rule 3.11.4. 8 are not an appropriate use of the NIWA model information because they are based on fixed numerical limits from Overseer, applied at the sub-catchment scale.

4. I have used the NIWA model information to estimate the CVP expansion areas that could be accommodated with no more than 1% in sub-catchment nitrogen (**N**) load, but excluding those sub-catchments identified as N-priority in Table 3.11.2. This analysis indicates the Plan Change could accommodate 1,446 ha of CVP with very minor increases in sub-catchment (max 1%), FMU (max 0.2%) and catchment (total 0.4%) nitrogen load.

5. Approximately 55% of current CVP is on LUC I and II, with the remainder on LUC III or above. There is 65,000 ha of dairy land on LUC III, some of which is expected to be suitable for CVP expansion. In my opinion, allowing CVP to expand onto LUC III would not create a greater water quality risk, because the CVP expansion is subject to a consent specific analysis and water quality risk is mostly influenced by change in land use intensity, not capability.

6. I do not support the area limits in Rule 3.11.4.8 Table 1 or the corrections proposed by Urlwyn Treblico to Rule 3.11.4.8 Table

1 because: the areas rely on Overseer leaching models in a way that is not supported by the Overseer review; the areas are arbitrarily limited to sub-catchments in the Waikato District; and in my opinion, the NIWA model information is not of sufficient accuracy to support the use of the estimated areas in regulation.

7. I have recalculated the area required to ensure that CVP expansion is provided for. This additional area would result in a net increase of 0.5% in catchment nitrogen load. I consider the water quality impacts to be minor.

INTRODUCTION

Qualifications and experience

1. My full name is Stuart Graham Easton.

2. I am employed by Taylor Collaborations Limited, an environmental consulting firm. I am contracted to provide water quality expertise on the Proposed Waikato Regional Plan Change 1 – Waikato and Waipā River Catchments (**PC1**) to Horticulture New Zealand (**HortNZ**).

3. I hold a Bachelor of Science (BSc) in Environmental Science (2009) and a Master of Geographic Information Science Degree (2015) from Victoria University of Wellington.

4. I have 9 years' experience in the field of water resource science.

5. Amongst other modelling experience, I have built or contributed to the development of water quality models in Australia for the Victoria Department of Environment, Land, Water and Planning, and in New Zealand for Greater Wellington Regional Council, to support the implementation of the NPSFM as part of the Ruamāhanga, te Awarua-o-Porirua, te Whanganui-a-Tara, and Kāpiti whaitua processes.

6. I have a family background in horticulture, specifically apple growing, and have worked in multiple roles for Easton Apples Ltd between 2004 and 2012. I am familiar with horticultural systems and processes.

7. My evidence is prepared on behalf of HortNZ. I have contributed to technical work in support of HortNZ through the PC1 process, including undertaking some of the technical assessments outlined in Jacobs (2017) and (2018), submitted with HortNZ's submissions on PC1.

Expert Witness Code of Conduct

8. I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Practice Note dated 1 January 2023. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Purpose and scope of evidence

9. HortNZ has requested that I answer the following questions:

   (a) Would providing for crop rotation at the FMU scale result in greater water quality risks compared with providing for rotation at the sub-catchment scale?

   (b) What is the anticipated need for expansion of commercial vegetable production in the Waikato Region, up to 2030?

   (c) What is the appropriate regulatory application of the NIWA modelling?

   (d) How would you analyse the potential for CVP expansion provided for under Policy 5?

   (e) Would allowing CVP to expand on to LUC I, II and III have greater water quality risks than limiting CVP expansion onto LUC I and II only?

10. I also provide a rebuttal to the proposal for Rule 3.11.4.8 contained in the evidence of Urlwyn Treblico.

11. To answer the questions above, I have used the NIWA model spreadsheet and GIS layer information (as in my previous analysis for Block 3) to make high-level assessments of potential future changes in relative N-loading. The

assessments do not account for attenuation processes or point sources and do not attempt to replicate the NIWA model in its entirety. FMUs are based on the model sub-catchment GIS information, with no separate consideration of the Lakes FMUs (which are largely within the Lower Waikato FMU). The Whangamarino catchment has been estimated from Map 3.11-3.[1] NIWA have edited the land use areas in the spreadsheet information from the GIS layer information (e.g. to account for Dairy Support as a separate land use and to increase the CVP area in the Whakapipi catchment from what was mapped). Out of necessity I have used the GIS information for spatial analysis and the spreadsheet information for N-loading analysis in this evidence.

QUESTION 1: CROP ROTATION AT THE FMU SCALE

12. My assessment is that providing flexibility for growers to rotate crops at the FMU scale would be representative of the current situation and is unlikely to create any more than a negligible change in contaminant load compared to rotation at the sub-catchment scale.

13. I have assessed the pattern of land use change at sub-catchment and FMU scale and it appears that there has been relatively minor flux in cultivated land area (which includes CVP) and no net increase in area since 2008. Some new land areas have been cultivated since 2008, and some areas have been retired out of CVP. Urbanisation is the main driver of land use change out of CVP, which is presumed to then drive a change in location of cultivated areas.

14. I have estimated that 328 ha of cultivated land has been replaced by urban land use since 2008 (across the Waikato catchment and the Pukekohe Specified Vegetable Growing Area [**SVGA**]), and the area of CVP zoned for future

[1] This has necessitated splitting the Waikato at Mercer sub-catchment.

urbanisation in the Waikato is 97 ha, focused in the Whakapipi and Port Waikato catchments. The impact of this 97 ha moving elsewhere within the FMU is estimated to result in a net reduction in N load within the Lower Waikato FMU.

15. If growers can rotate areas at the FMU scale, it would provide growers the flexibility to replace this land, potentially not within the same sub-catchment.

16. I expect that providing for crop rotation (outside of replacing CVP lost to urbanisation) at the FMU scale would result in no net change in N load at FMU or sub-catchment scale over medium to long time scales because the total area of CVP does not change. Over shorter time scales the intensity of production may change, however the time-averaged N loading from CVP (which accounts for all rotation types) does not change.

17. My expectation based on the pattern of change of cultivated land is that new CVP land that is consented under HortNZ proposed Rule 3.11.4.8 would follow the same pattern of existing CVP and its location would be stable as new CVP land into the future – although the businesses that use that new CVP land may change over time as part of their rotation practices.

18. My analysis indicates that at the sub-catchment and FMU scale CVP area and location are relatively static. It is at the business level where the rotations are dynamic. The dynamism at a business level has no measurable impact on the loads contributed at the sub-catchment or FMU level, where the changes largely cancel each other out.

Analysis on FMU compared with sub-catchment rotation limits

19. In the following assessment, cultivated land (including but not limited to CVP) change over time is quantified using The

Landcover Database (LCDB, version 5.0)[2] and LUCAS[3] spatial information.[4]

20. Table 1 (LCDB) and Table 2 (LUCAS) show that there was expansion of cultivated land up until 2008, with limited net-change or a small decrease in area in all FMUs in the 10 years from 2008 to 2018. No sub-catchment shows a net increase in area in either dataset since 2008. This suggests that the total cultivated area, and therefore CVP area, is currently static. The Auckland portion of the Pukekohe Specified Vegetable Growing Area (SVGA) has been included in the analysis for completeness as growers often operate on both the Auckland and Waikato sides (the Waikato side of the SVGA is part of the Lower Waikato FMU).

Table 1 LCDB area (ha) and net change for 'Short-rotation cropland

FMU	Area 2018	Area 2012	Area 2008	Area 2001	Area 1996	% change from previous year			
						2018	2012	2008	2001
Waipā	1339	1378	1390	1382	1117	-3%	-1%	1%	24%
Upper Waikato	2244	2244	2244	2060	1983	0%	0%	9%	4%
Lower Waikato	7767	7825	7835	7488	7098	-1%	0%	5%	5%
Central Waikato	1288	1306	1307	1119	1066	-1%	0%	17%	5%
Auckland (Pukekohe SVGA)	5792	5877	5890	5655	5539	-1%	0%	4%	2%

2 https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/ Accessed 31/05/2023.

3 https://data.mfe.govt.nz/layer/52375-lucas-nz-land-use-map-1990-2008-2012-2016-v011/ Accessed 31/05/2023.

4 LCDB and LUCAS map cultivated land which includes but is not limited to CVP. See paragraphs 30 and 31.

Table 2 LUCAS area (ha) and net change for 'Cropland – Annual'

FMU	Area 2016	Area 2012	Area 2008	Area 1990	% change from previous year		
					2016	2012	2008
Waipā	1299	1299	1302	1046	0%	0%	24%
Upper Waikato	2292	2292	2292	1997	0%	0%	15%
Lower Waikato	7761	7769	7752	6994	0%	0%	11%
Central Waikato	1304	1330	1334	1089	-2%	0%	23%
Auckland (Pukekohe SVGA)	5910	5955	5959	5630	-1%	0%	6%

21. While this analysis suggests that the overall cultivated area has not changed since 2008, within that area we expect individual growers and blocks to move (rotations).

22. Table 3 shows the flux in cultivated land within the Healthy Rivers FMUs and the Auckland SVGA (defined as 'short-rotation cropland' in the LCDB). Very little flux is evident since 2008. Of the 442 ha of cultivated land that has changed to a different land-use since 2008, 328 ha (74%) has been urbanised (re-classified as "Built-up Area (settlement)" in the LCDB).

Table 3 LCDB short-rotation cropland flux since 2008 (ha)

FMU	2018		2012		2008	
	Into cropland	Out of cropland	Into cropland	Out of cropland	Into cropland	Out of cropland
Waipā	0	39	0	12	8	0
Upper Waikato	0	0	0	0	193	8
Lower Waikato	4	62	0	10	422	75
Central Waikato	11	28	0	2	198	10
Auckland (Pukekohe SVGA)	0	85	8	21	326	91

23. To estimate the future area of CVP likely to be lost to urbanisation, I have analysed the Auckland Unitary Plan[5] and Waikato District Council spatial plan and aerial imagery:[6]

    (a) In Auckland (Pukekohe SVGA), there is 468 ha currently in CVP that are zoned Future Urban, Residential, or Countryside Living;

    (b) In Waikato, there is 97 ha in CVP that is currently zoned as Rural and has been assigned Residential as the Future Zone.

24. All CVP area lost to urban expansion is within the Pukekohe SVGA north of the Waikato River. The impact of 'rotating' 97 ha of CVP lost to urbanisation is dependent on the land use that the rotating CVP replaces. If the land use that is ultimately replaced (i.e. that the CVP replaced by urbanisation then replaces) has a higher N loss rate than urban (12.0 kg/ha/year in the NIWA model), then a net reduction in N load will be achieved. I estimate that based on the configuration of suitable CVP land (LUC I & II land currently in pasture) the rotation of 97 ha would result in a net reduction of 1,060 kg/N/year for the Lower Waikato FMU (-0.03%).

25. While HortNZ holds incomplete grower area information, enterprises that have mapped their growing area as part of the NZGAP Environmental Management System (**EMS**) add-on can provide an understanding of the change in area at an individual grower level. Figure 1 shows the area mapped by three enterprises in 2016 and 2019. Black boundaries show the blocks mapped in 2016 and 2019 ("static"), red boundaries show the blocks mapped in 2019 only ("new"), and the yellow blocks mapped in 2016 but not in 2019 ("former"). Grower #1

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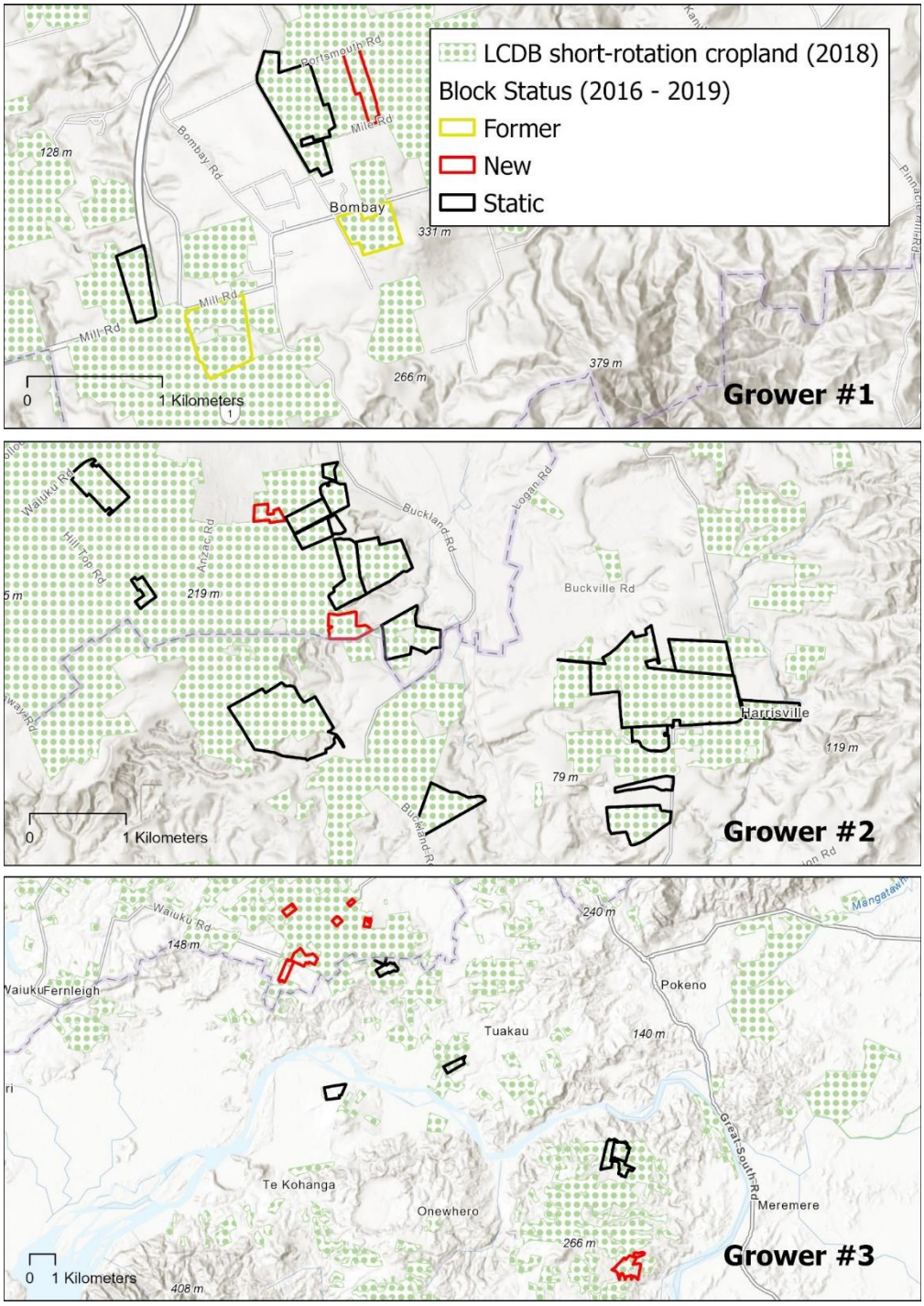
5 https://data-aucklandcouncil.opendata.arcgis.com/content/unitary-plan-base-zone-layer-file/about: accessed 5/06/2023.

6 https://data.waikatodistrict.govt.nz/layer/95686-proposed-zones/: accessed 2/06/2023.

has contracted slightly, grower #2 has expanded slightly, and grower #3 has expanded by almost 100%. For all three growers, the 'new' blocks since 2016 are on existing CVP land resulting in no net change in total growing area.

Figure 1 Change in growing area for three enterprises. Grower #1 and Grower #2 maps show only a subset of total grower blocks. All blocks not shown here are "static".



QUESTION 2: ANTICIPATED CVP EXPANSION TO 2030

26. For the combined Auckland and Waikato regions, 1,409 ha is required to meet population growth and 468 ha of current CVP is predicted to be lost to future urban development in Auckland (which is not expected to be able to be provided for within Auckland), giving **1,877 ha** total provisional CVP growth required.

Analysis to support CVP expansion estimation

27. My analysis is based on an assumption that the current CVP area would need to expand in proportion to the projected population growth. The calculations supporting this analysis are described in the sections below.

28. Consideration for the Auckland region is given as the Pukekohe hub lies across both regions. There is limited opportunity for new CVP in the Auckland region, and CVP expansion to provide for population growth and land lost to urban development in both regions is expected to extend southwards into the Waikato.

Cultivated Vegetable Production area

29. Estimates vary as to the area of CVP within the Healthy Rivers catchments and within the Pukekohe Hub. The NIWA Healthy Rivers modelling[7] estimates the total CVP area in the Waikato River catchment as approximately 6,240 ha.[8]

30. Other information sources include LCDB and LUCAS, which estimate there are approximately 12,650 ha of short-rotation (LCDB) or annual (LUCAS) cropland in the catchments, however these classifications include all cropping systems that

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[7] Annette Semadeni-Davies, Sandy Elliott, Sharleen Yalden Modelling Nutrient Loads in the Waikato and Waipā River Catchments Development of catchment-scale models (Waikato Regional Council, Technical Report 2018/63, September 2015).

[8] NIWA Healthy Rivers modelling GIS data. This is slightly different to the spreadsheet information provided by NIWA where manual adjustments were made (6,104 ha).

comprise a period of bare ground such as extensive arable and seed cropping systems or cropping for animal consumption (e.g. fodder crops or winter grazing paddocks). Non-CVP cropping systems are classified (amongst other land covers) as Miscellaneous in the NIWA modelling. It is therefore difficult to make a direct comparison between the NIWA and national GIS layers' categories at the regional scale.

31. Within the Pukekohe SVGA as outlined in the NPSFM 2020,[9] it is expected that the majority of the area mapped as short-rotation or annual-cropland in the LCDB and LUCAS is CVP. Those layers estimate approximately 8,500 ha of annual cropland/CVP is in the Pukekohe SVGA (8,408 ha in LCDB [2018] and 8,568 ha in LUCAS [2016]). The Waikato side of the SVGA contains approximately 30% (2,616 ha - LCDB) of the total SVGA CVP area, with the remaining area (~5,792 ha - LCDB) in Auckland. By comparison, the NIWA modelling estimates there are 1,836 ha of CVP on the Waikato side of the Pukekohe SVGA, which is likely an underestimation of CVP area.

32. In the following assessment, I have therefore used the LCDB estimates for within the Pukekohe SVGA (including the area in the Waikato), and the NIWA GIS information for the remaining area.

33. Using LCDB information for within the Pukekohe SVGA (8,408 ha), and NIWA modelling GIS information for the remaining healthy rivers catchments (4,404 ha, where a greater proportion of LCDB short-rotation cropland is expected to be non-CVP systems), the total CVP area in the combined Pukekohe SVGA and Waikato River catchment is **12,812 ha**, and in the Waikato River catchments is **7,020 ha**.

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[9] SVGA area is north of the Waikato River. This definition does not include significant growing areas south of the Waikato River around Pukekawa and Onewhero.

Expansion footprint for population growth Auckland and Waikato

34. For Waikato, the Statistics New Zealand medium population growth scenario from 2018 to 2030 is 18%, and for Auckland and Waikato combined the medium population growth scenario is 11%.[10]

35. The estimated increase in CVP area required to meet population growth is 1,409 ha (11% of 12,812 ha) for Auckland and Waikato. For Waikato only, the increase in CVP area required to meet population growth is 1,264 ha (18% of 7,020 ha).[11]

36. There is 468 ha predicted to be lost to urban expansion in Auckland, and 97 ha in Waikato (see paragraph 20).

37. The area of expansion predicted to meet population demand is greater than any change (increase or decrease) in cultivated area mapped by the LCDB since 2008 (Table 1) – it is therefore unlikely to occur. As outlined in the evidence of Michelle Sands and Stuart Ford the expansion of CVP is driven by domestic demand for fresh vegetables, and the cost and complexity of establishing new CVP area.

38. Table 4 estimates the N-loading impact of 1,877 ha of CVP expansion to account for population growth in Auckland and the Waikato and land lost to urbanisation in Auckland using the NIWA water quality model information. The CVP area has been distributed following the same pattern as the existing CVP land, but with no expansion distributed into the Whangamarino. The N loading impact is predicted to be a 0.5% increase in load at the catchment scale.

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[10] https://www.stats.govt.nz/information-releases/subnational-population-projections-2018base2048-update/. Accessed 28/05/2023. 2030 population projections estimated as the average of 2028 and 2032.

[11] Using LCDB estimates for within the Pukekohe hub and NIWA model GIS information for remaining area.

Table 4 Distribution of Provisional CVP area by existing distribution

FMU	Existing CVP area (ha)*	Proportional distribution (excluding Whangamarino)	Provisional CVP Area (ha)	Additional Load (t/N/year)	Proportion change (FMU N load)
Lower Waikato	3579	66%	1241	53	1.7%
Waipa	734	14%	254	10	0.2%
Central Waikato	612	11%	212	10	1.1%
Upper Waikato	490	9%	170	6	0.1%
Whangamarino	689	0%	0	0	0.0%
Total Catchment	6104	100%	1877	80	0.5%
* The areas in Table 4 are taken from the NIWA model spreadsheet information					

QUESTION 3: THE NIWA MODEL

39. In my opinion, the NIWA water quality model is fit for purpose for use as a regional-scale tool to assess current and future water quality catchment loads and state.

40. While suitable for its designed-for regional scale analysis, in my opinion the model architecture and sources of uncertainty make the model unsuitable for water quality assessment at below sub-catchment scale (i.e. farm scale) where variability in geography, hydrology, and farm system will not be sufficiently accounted for by the average annual nutrient loss rates. The model should be used cautiously at the sub-catchment scale, due to variability in sub-catchment sizes, categorisation of land uses, and accuracy of the land-use mapping.

41. As outlined in the Evidence of Stuart Ford, the Overseer review states that Overseer should not be relied on in regulation to set fixed numeric limits.

42. The area limits in the Rule 3.11.4.8 in the decision and the amended area limits in Urlwyn Treblico's evidence are based on the Overseer leaching estimates within the NIWA model,

for example 66kg/ha for CVP. The area limits are taken from analysis that I conducted for Block 3. The intention of that analysis was to estimate the total area of provisional CVP expansion that may be provided for within an increase in N load (1%) using the best available information at the time. This point is further addressed under *Rebuttal of Urlwyn Treblico*.

43. In my opinion, the area limits in Rule 3.11.4. 8 are not an appropriate use of the NIWA model information because they are based on fixed numerical limits from Overseer, applied at the sub-catchment scale.

The NIWA model & description of contaminant loss assumptions

44. My understanding of the NIWA model is based on spreadsheets and GIS layers provided by NIWA during Block 3 and the modelling report.[12]

45. The NIWA model is relatively simple, based on annual average nutrient loss rates derived from Overseer and CLUES associated with different land uses. Attenuation factors are applied at the catchment scale to calibrate the combined nutrient loads to estimated mean annual loads.

46. In the modelling report various sources of model uncertainty are recognised, including that the Overseer inputs may lead to under or over-estimation of source nutrient yields, spatial error, and error associated with calibration and point-source data.

47. It is apparent that the CVP area in the NIWA model information is likely an under-estimate of the actual area (see *Analysis to support CVP expansion estimation*). Similarly, it is recognised that the Overseer estimates are likely to underestimate N loads for CVP and other land uses (as per

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[12] Annette Semadeni-Davies, Sandy Elliott, Sharleen Yalden Modelling Nutrient Loads in the Waikato and Waipā River Catchments Development of catchment-scale models (Waikato Regional Council, Technical Report 2018/63, September 2015).

Stuart Ford's evidence). Under-estimation of N loading for all land uses is apparent in the very low attenuation factors used for most catchments to achieve model calibration.

48. However, because CVP areas are generally very small, any increase in area or modelled N loading rate for CVP would result in minimal overall load increases. Furthermore, the model architecture means that increasing contaminant loads would simply result in increased attenuation rates to match the same total load calculated from in-stream sampling.

49. Table 5 summarises N loading for the modelled land uses at FMU scale. Table 5 does not account for any rule provisions or incorporation of best management practice or mitigations (e.g. it does not account for reductions in leaching that will be driven by PC1). Table 5 shows that horticulture produces the lowest total N load of the modelled land uses across the total Healthy Rivers FMUs (3% of total N load).

Table 5 FMU N loads (t/N/year) and FMU proportion in parentheses

FMU	Dairy	Forest	Hortic-ulture	MISC	Dairy support	Sheep and beef	Urban
Lower Waikato	1480 (48%)	30 (1%)	236 (8%)	119 (4%)	280 (9%)	883 (28%)	84 (3%)
Waipā	2981 (61%)	49 (1%)	48 (1%)	170 (3%)	426 (9%)	1126 (23%)	96 (2%)
Central Waikato	447 (49%)	2 (0%)	40 (4%)	15 (2%)	67 (7%)	218 (24%)	126 (14%)
Upper Waikato	3111 (52%)	571 (10%)	32 (1%)	172 (3%)	519 (9%)	1472 (25%)	88 (1%)
Whanga marino	239 (31%)	25 (3%)	41 (5%)	58 (8%)	70 (9%)	321 (42%)	18 (2%)
Total	8257 (53%)	678 (4%)	397 (3%)	535 (3%)	1362 (9%)	4019 (26%)	413 (3%)

QUESTION 4: CVP EXPANSION UNDER POLICY 5

50. I have used the NIWA model information to estimate the CVP expansion areas that could be accommodated with no more than 1% in sub-catchment N load, but excluding those sub-catchments identified as N priority in Table 3.11.2. This analysis indicates PC1 could accommodate 1,446 ha of CVP with very

minor increases in sub-catchment (max 1%), FMU (max 0.2%) and catchment (total 0.4%) nitrogen load.

51. As outlined in paragraph 37, the water quality analysis I have undertaken using the NIWA model is appropriate for nitrogen load analysis at the sub-catchment, FMU and catchment scale to inform policy analysis. However, as outlined in paragraph 41 it is not appropriate for the setting of numerical (either area or load-based) limits.

52. A 1% increase in sub-catchment N load was a scenario proposed by Mr Baker in his Block 3 evidence and is discussed in Ms Holmes evidence.[13] In my opinion a 1% increase in sub-catchment N load is reflective of a minor increase in load that may be compensated for by a reduction in diffuse losses from other contaminants.

Analysis to support CVP expansion provided for under Policy 5

53. The following assessments seek to understand the implications of removing Rule 3.11.4.8 Table 1 by summarising potential N loading impacts of CVP expansion at the FMU and sub-catchment scale.

54. Table 6 shows the estimated change in N loading at the FMU scale under a CVP expansion scenario to allow for population growth. This modelling exercise restricts CVP expansion to a maximum of a 1% increase in N load at the sub-catchment scale and does not include the N-priority sub-catchments given in Table 3.11-2 or sub-catchments within a lake FMU.[14] CVP expansion is modelled to replace either Dairy, Dairy Support, or Sheep and Beef, based on the area weighted average of these land uses on LUC I & II land in each sub-catchment.

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[13] Statement of Evidence of Gillian Holmes, dated 28 July 2023, paragraph 63. See Statement of Evidence of Tim Baker, Block 3, dated 9 July 2019.

[14] Sub-catchments have not been split where part of them falls within a lake FMU.

55. Table 6 shows that at the FMU scale, 1,446 ha of provisional CVP area is provided for with an 0.4% increase in total N load. This is sufficient to account for population growth (1,409 ha, see paragraph 26). However, the area is not enough to provide for population growth and area lost to urban expansion in Auckland (1,877 ha).

56. Of the 1,446 ha identified in Table 6, 960 ha (66%) is within sub-catchments identified as *E. coli* and/or Sediment and/or P priority, but not N priority (the remaining area is in sub-catchments which have no current state water quality data). In these sub-catchments I expect that the nitrogen load increase associated with CVP expansion may be readily compensated for by a reduction in diffuse losses from other contaminants; for example the NIWA modelling estimates CVP produces less *E. coli* than pastoral land-uses, and modelling for Block 3 showed a net reduction in sediment losses for CVP under Best Management Practice in comparison to pasture, as explained my paragraph 77.

Table 6 Predicted change in N load at FMU scale for CVP expansion (limited to maximum 1% increase in sub-catchment load, N-priority sub-catchments and lakes FMU sub-catchments excluded

FMU	Existing CVP area (ha)	Additional Area (ha)	Existing Total N load (t/year)	Additional Load (t/year)	Proportion change
Lower Waikato	3579	284	3112	13	0.4%
Waipā	734	688	4896	28	0.6%
Central Waikato	612	100	915	5	0.5%
Upper Waikato	490	266	5965	10	0.2%
Whangamarino	689	107	772	6	0.7%
Total	6104	1446	15661	62	0.4%

QUESTION 5: CVP EXPANSION ONTO LUC I, II, AND III

57. In my opinion allowing CVP to expand onto LUC III would not create a greater water quality risk, because the CVP expansion is subject to a consent specific analysis and water quality risk is mostly influenced by change in land use intensity, not capability.

Analysis to support LUC I, II, III water quality risk assessment

58. The limitation of CVP expansion to LUC I and II relates the analysis I undertook for Block 3, described under *Rebuttal of Urlwyn Treblico* below. In that analysis I assumed CVP expansion would occur on LUC I and II only as part of my modelling assumptions to determine the most likely land that CVP would expand on to.

59. The Land Resource Information System (LRIS) Data Dictionary describes Land Use Capability (LUC) III as: [15]

> *Land with moderate limitations for arable use, but suitable for cultivated crops, pasture or forestry.*

60. LUC mapping is possible at various spatial scales. The LUC mapping used both here and in my previous analysis (NZLRI)[16] is at 1:50,000 scale which is appropriate for sub-catchment and above assessment but is not detailed enough to determine suitability of a given land parcel for CVP.

61. Table 7 summarises the LUC of the NIWA water quality model GIS information. Of the 6,240 ha of existing CVP in the region approximately 55% is on LUC I and II. LUC III and above is suitable for CVP in some cases.

62. The main determinant of the water quality effect of CVP expansion is related to the previous land use and the net difference in N load.

63. It is not always the case that higher N leaching land uses are located on LUC I and II, for example fruit production is commonly found on LUC I and II and has relatively low N leaching. Table 7 shows that there is significant areas of low N leaching land-use (e.g. Misc., Sheep & Beef) on LUC I & II land and also significant areas of higher N leaching (i.e. Dairy) on

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15 https://lris.scinfo.org.nz/layer/48076-nzlri-land-use-capability-2021/attachments/9162/

16 https://lris.scinfo.org.nz/layer/48076-nzlri-land-use-capability-2021/

LUC IV+. LUC III supports all land uses; 21% of Dairy farming is on LUC III which is almost 65,000 ha.

64. Given the assessment required for CVP expansion is consent specific, it will be more achievable to meet the requirements of Policy 5 if the previous land use was relatively intense, such as dairy farming.

65. At least some of this 65,000 ha of dairy land on LUC III is likely to be suitable for CVP expansion, and it is likely possible to demonstrate that CVP expansion subject to policy 3 and 5 could occur on some of this land.

Table 7 Land Use Capability (LUC) of the NIWA model GIS information (ha, LUC value in proportion of land use in parentheses)

Land use	LUC				Total
	1	2	3	4+	
Horticulture	874 (14%)	2552 (41%)	1155 (19%)	1659 (27%)	6240
MISC	3190 (2%)	10169 (5%)	11072 (5%)	180944 (88%)	205376
S&B	6168 (2%)	42101 (11%)	52887 (14%)	265408 (72%)	366564
Forestry	99 (0%)	644 (0%)	18264 (11%)	149986 (89%)	168993
Urban	2590 (10%)	7261 (27%)	6501 (24%)	10522 (39%)	26874
Dairy	8004 (3%)	90824 (30%)	64986 (21%)	140545 (46%)	304359

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66. The area limits in Rule 3.11.4.8 Table 1 and the corrections proposed by Urlwyn Treblico are based on the calculations I undertook to support Tim Baker as part of my Block 3 evidence.[17]

67. I no longer support the area limits in Rule 3.11.4.8 Table 1, or the corrections proposed by Urlwyn Treblico to Rule 3.11.4.8 Table 1 for three reasons:

[17] The Hearing Panel's Recommendation Report, paragraphs 1600-1630.

(a) The areas rely on Overseer leaching models in a way that is not supported by the Overseer review. As outlined in the evidence of Stuart Ford, the Overseer review states that Overseer should not be relied on in regulation to set fixed numeric limits.

(b) The Block 3 analysis I undertook limited the potential CVP expansion to the Waikato District. Later analysis I undertook for the HortNZ appeal showed that 1,968 ha of expansion could occur with water effects consistent with those accepted by the Decision. Limiting my original analysis to the Waikato District was not driven by water quality; it was simply an assumption in the original methodology driven by data availability.

(c) The analysis limits sub-catchment N load increase to 1% at the sub-catchment level which is heavily influenced by the NIWA model sub-catchment delineation, land use categorisation, and spatial mapping. In my opinion, the NIWA model information is not of sufficient accuracy to support the use of the estimated areas in regulation.

Background to analysis and appropriate use of the analysis

68. The area limits in Rule 3.11.4.8 Table 1 are based on the calculations I undertook to support my Block 3 evidence and the Block 3 evidence of Tim Baker.

69. I used the NIWA Water Quality model information (Nitrogen, Phosphorus and E.coli) and the Don't Muddy the Water (Sediment) model information to demonstrate the potential contaminant load changes associated with CVP expansion.

70. My modelling included assumptions about where CVP expansion could occur:

(a) In the Waikato District and zoned as 'Rural' in the proposed Waikato District Plan;

(b) On LUC I and II land;

(c) Existing land use is Dairy, Forestry, Miscellaneous, or Sheep & Beef (i.e. not Urban or Horticulture); and

(d) Excluded certain catchments identified by Tim Baker.

71. The nitrogen load calculation was therefore dependent on the Overseer leaching assumptions, the categorisation of land use, the configuration of land use (i.e. spatial mapping accuracy), and the sub-catchment delineation of the NIWA model information.

72. The method for the modelling was:

(a) Calculate the spatially-weighted average contaminant loss rate for the existing land use(s) in each sub-catchment on LUC I and II land;

(b) Subtract the contaminant loss rate calculated in (a) from the loss rate for CVP to get the 'marginal' loss rate in t/ha/year expected from a conversion to CVP;

(c) For Nitrogen, calculate the area provided that would result in a 1% increase in N load (1% of the existing sub-catchment N load divided by the marginal loss rate derived in (b)).

73. Should leaching assumptions, mapping accuracy, or the categorisation of land use change (i.e. with improved mapping, or through a model update as addressed in the Overseer review), the CVP area provided for within a 1% N load increase would also change.

74. Leaching assumptions and mapping accuracy of the NIWA model are shown to be inaccurate (paragraphs 45 and 29).

The categorisation of land use is also an important consideration; catchments with a higher proportion of less intensive land use (e.g. 'Misc' which includes arable cropping as well as native bush) would be able to assimilate less provisional CVP area than sub-catchments with a higher proportion of intensive land use (e.g. Dairy). In reality, the expansion of CVP would likely replace a single land use and a sub-catchment specific assessment would be required to assess the relative change in N-loading rate.

75. The NIWA model sub-catchment delineation serves to reduce CVP expansion in small sub-catchments (e.g. Whakapipi, Ohaeroa) which produce less run-off (and therefore load), and generally exhibit higher contaminant concentrations as there is less dilution from non-productive land. Small catchments will also generally have lower attenuation rates as contaminants spend less time within the catchment. The variation in sub-catchment size is great (e.g. Waikato at Mercer Bridge is more than 22 times the size of the neighbouring Ohaeroa catchment). This is related to where monitoring has taken place (as used for model calibration), however in my opinion precludes sub-catchment based area limitations using the current sub-catchment delineation.

76. In my opinion, while suitable for use to inform water quality assessment, the NIWA model information is not of sufficient accuracy to support, in regulation, the estimated areas provided for within a 1% increase in sub-catchment N load.

77. The results of this modelling showed:[18]

    (a) Nitrogen – 1,129 ha of CVP could be accommodated within suitable sub-catchments (as determined by Tim

[18] Differences in provisional CVP area for each contaminant are due to different areas in the underlying spatial data sets (NIWA model information for N and E. coli, and the NZEEM erosion layer for sediment).

Baker) with no more than 1% increase in annual Nitrogen load in any sub-catchment.[19]

(b) E.coli – 1,160 of CVP could be accommodated within suitable sub-catchments (as determined by Tim Baker) with a decrease of -0.2% % decrease in annual *E. coli* load at the Waikato catchment scale.

(c) Sediment – 1,024 ha of CVP could be accommodated with an estimated annual sediment load reduction of 226 tons at the Waikato catchment scale.

78. The 1% sub-catchment nitrogen expansion area limits were adopted in the Decision, but the Decision reduced the areas where expansion could occur by a further 11 sub-catchments, but still with all potential expansion areas being limited to the Waikato District. The result was to reduce the CVP expansion total area from 1,129 Ha in my Block 3 evidence to 389 ha in the Decision Version (the changes proposed to Rule Table 3.11.4.8 by Urlwyn Treblico are a copy of the areas presented in my Block 3 evidence for the sub-catchments in the Decision Version).

79. To support HortNZ's appeal, I undertook calculations assuming the CVP expansion was not limited to the Waikato District and could occur anywhere the Waikato River catchment – except for those sub-catchments identified in the Decision as inappropriate for CVP expansion. This necessitated removing the requirement for provisional CVP to be on rurally-zoned land which slightly changed the results for some catchments.

80. The results of this modelling showed that 1,968 Ha could be accommodated within suitable sub-catchments in the Waikato River Catchment, with no more than 1% nitrogen

[19] The Hearing Panel's Recommendation Report, paragraphs 1621 and 1622.

load increase at the sub-catchment level and no more than 0.5% increase at an FMU level. From a water quality perspective, this outcome is very similar to the water quality outcome in the Decision and Urlwyn Treblico's amendments to Rule 3.11.4.8 Table 1 but applied to more sub-catchments.

81. The Overseer review's findings were released in August 2021. The panel concluded OverseerFM is unlikely to be a reliable tool for predicting either relative or absolute nutrient loss estimates from farms.[20] The panel stated, "*we do not have confidence that Overseer's modelled outputs tell us whether changes in farm management reduce or increase the losses of nutrients, or what the magnitude or error of these losses might be*". MfE released a response to the review[21] which included updated advice from a technical advisory group that "*OverseerFM output numbers should not be used as absolute numbers*". This advice built on earlier work that had recommended "*Regional plan provisions and resource consent conditions should take account of the potential implications of Overseer version change by avoiding the use of fixed numerical limits for nutrient losses*".[22]

82. The area limits I calculated in my Block 3 evidence and for the HortNZ appeal depend on the Overseer leaching assumptions in the NIWA model. These area limits are effectively fixed numeric limits for nutrient losses.

83. The areas relate to an assumed nitrogen load limit of 1% per sub-catchment, and that load limit is calculated using Overseer leaching assumptions. As discussed in Stuart Ford's evidence, the Overseer modelling that informed the

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20 Overseer whole-model review - Assessment of the model approach

21 Responding to the Overseer model redevelopment review

22 41145-Report-on-appropriate-use-of-Overseer-in-regulation- (mpi.govt.nz).

catchment modelling is uncertain, and he does not consider it suitable for regulating consent-level decision-making.

84. I consider my updated analysis suitable for use to inform water quality assessment, and I have used this method to inform my evidence for this hearing. However, when my analysis is used in Rule 3.11.4.8 the areas are fixed numeric nutrient loss limits and are not an appropriate use of Overseer in Regulation. My updated analysis shows that the CVP area required to meet population growth demands may be provided for with minor predicted changes in water quality with minor increases and decreases in contaminants.

Stuart Graham Easton

28 July 2023