BEFORE THE ENVIRONMENT COURT	**ENV-2021-WLG-000020**
AT WELLINGTON	**ENV-2021-WLG-000021**
I MUA I TE KŌTI TAIAO	**ENV-2021-WLG-000022**
I TE WHANGANUI-Ā-TARA ROHE	**ENV-2021-WLG-000023**

IN THE MATTER	of the Resource Management Act 1991 (**RMA** or **the Act**)
AND	
IN THE MATTER	of appeals under Clause 14(1) of the First Schedule of the Act in relation to a decision of Manawatū-Whanganui Regional Council on Proposed Plan Change 2 to the Horizons One Plan
BETWEEN	**TE RUNANGA O RAUKAWA** **Appellant** **ANDREW DAY** **Appellant** **WELLINGTON FISH AND GAME COUNCIL** **Appellant** **NGĀTI TURANGA** **Appellant**
AND	**MANAWATŪ-WHANGANUI REGIONAL COUNCIL** **Respondent**

STATEMENT OF EVIDENCE OF ANDREW BARBER (FEP AND SEDIMENT MANAGEMENT) ON BEHALF OF HORTICULTURE NEW ZEALAND

13 October 2023

HOLM | MAJUREY

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INTRODUCTION

Qualifications and experience

1. My name is Andrew John Barber. I am a Director of Agrilink NZ and work as an Agricultural Engineering Consultant based in Auckland. I have a Bachelor of Horticulture (Tech) with first class honours from Massey University.

2. I have spent 25 years as a consultant in the agricultural industry, specialising in resource use optimisation. This includes resource use benchmarking in the form of national and individualised reporting to growers comparing their performance to regional and national benchmarks.

3. In my 29 years as a consultant, of relevance to my evidence, I have helped develop vegetable industry soil and erosion management guidelines, individual cultivated property erosion and sediment control plans, NZGAP's Environmental Management System (**EMS**) through their Farm Environment Plan (FEP) templates and provide nitrogen management support.

4. I am the Programme Manager for the industry-led Sustainable Vegetable Systems (**SVS**) project. This is a 4-year joint industry and MPI project that is delivering a nitrogen management decision support tool. The SVS tool prepares crop and paddock specific nitrogen budgets that are integrated with soil nitrogen testing.

5. I was Project Manager on the Franklin Sustainability Project and provided technical advice on managing soil erosion on cultivated land. This was a multi-stakeholder project that ran between 1996 and 2004 which, while having a broad goal of improving the overall sustainability of outdoor vegetable production in the Franklin region, had a clear focus on keeping soil on the paddock and mitigating any effects of off-site discharges. The project directly involved the growers, Horticulture New Zealand, the Ministry for the Environment, the Ministry for Primary Industries (**MPI**), Auckland Council, Waikato Regional Council, and the Franklin District Council.

6. I managed and conducted research for the MPI Sustainable Farming Fund (**SFF**) project Don't Muddy the Water (**DMTW**). This

project has quantified the efficiency of Sediment Retention Ponds (**SRP**) and vegetated buffers on vegetable properties. It has also developed an erosion and sediment control app, Erosion & Sediment Control Plans, and is currently linking this through to NZ Good Agricultural Practice (**NZGAP**) Farm Environment Plans (**FEP**) (https://www.newzealandgap.co.nz/).

7. In 2014 I updated the Erosion and Sediment Control Guidelines for Vegetable Production. The DMTW Project was based largely on quantifying the efficiency of the SRP design in these guidelines.

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.

Involvement in project

9. I have been engaged by Horticulture New Zealand and Potatoes New Zealand to contribute to the Farm System Experts – Commercial Vegetable Growing group.

10. The primary outcome being the development of the Nitrogen Risk Assessment Tool (**NRAT**): Commercial Vegetable Growing. Part of the development process included testing the NRAT with vegetable growers in Levin.

Scope of evidence

11. My evidence provides a description of the NRAT developed through expert conferencing and subsequent grower testing and iterations.

12. I discuss how the two most significant practice changes that will drive down nitrogen leaching are the use of nitrogen budgets and soil nitrogen testing – both of these measures are in the NRAT and the practices can be implemented through the industry developed SVS decision support tool.

13. In this evidence I describe how practice change is driven through the NRAT. Specifically, this will determine the level of nitrogen leaching risk and then through the need to achieve a score prescribed in the NRAT's Nitrogen Leaching Risk Limits table, the process directs growers to the most appropriate practices that are proportionate to the level of risk.

14. My evidence demonstrates that, by using NZGAPs FEP and an industry developed Dashboard, FEPs will identify practice change, then capture, document, and track actions over time. My evidence discusses that this will result in a transparent assurance and reporting programme.

EXPERT CONFERENCING AND JOINT WITNESS STATEMENTS

15. I have been involved in the development of the Nitrogen Risk Assessment Tool: Commercial Vegetable Growing, in conjunction with experts Dr Anne-Maree Jolly from WSP for Manawatū-Whanganui Regional Council (**Horizons**), Stuart Ford from Horticulture New Zealand, and Dr Brent Clothier from Plant and Food Research.

INDUSTRY FRAMEWORK SUPPORTING GROWERS TO ADOPT GOOD PRACTICES IN FRESHWATER FARM PLANS

16. I support the requirement under Rule 14-1 that a Nutrient Management Plan must demonstrate that either the nitrogen leaching loss or the nitrogen leaching risk limits, evidenced through the NRAT, are met. I support the amendments proposed by Dr Drury, to better align the definition a Nutrient Management Plan to provide for the alternative methods.

17. I support the definition of a Nutrient Management Plan that recognises that the Nutrient Management Plan can be developed as a component of a certified Freshwater Farm Plan (**FWFP**), which takes a multi-contaminant approach to managing diffuse discharges.

18. As outlined in Michelle Sands evidence, the recent amendment to the RMA Section 217 KA provides a pathway for Regional Councils

to approve industry organisation to provide certification or audit services for Freshwater Farm Plans.

19. As described in Michelle Sands evidence, it is HortNZ's expectation that the NZGAP will be approved by Horizons to deliver FWFP certification and audit based on the NZGAP EMS system. Having worked with growers from right around the country in the EMS space, there is a consistent theme of regulatory uncertainty and consequently human nature has meant that practice implementation has been slower than may have otherwise been the case. It will be more efficient if the FWFP certification pathway for Nutrient Management Plans and the process for approval through third party audited industry schemes like NZGAP is established by Horizons before PC2 becomes fully operative.

20. In my evidence I use the term Farm Environment Plan (**FEP**) to describe the farm plans currently used by growers. The horticulture industry has developed an extremely robust process that takes growers from problem recognition through to third party audited FEPs. It is my expectation that these FEPs and the Nutrient Management Plans within them would meet the requirements of Nutrient Management Plans within PC2, and would form the foundation of a certified Freshwater Farm Plan under part 9A of the RMA.

JOINING THE DOTS – A SYSTEMS APPROACH

21. I support the emphasis of the implementation of Good and Best Management Practices (**GMP** and **BMP**) in the PC2 policy framework.

22. NZGAP's EMS is practice and action focused. The implementation of identified new or improved practices are time-bound and become the focus of subsequent audits.

23. FEPs do not occur in isolation. They are a crucial element of a whole system approach. FEPs are underpinned by research, solution development, Codes of Practice, and dissemination. Crucially they provide a structured process to plan, document, and implement Good and Best Management Practice which is verified via independent audits.

24. The first step towards improved practice is problem recognition. Without recognition, and consequently motivation to change, there is confrontation and reduced effectiveness of what becomes begrudgingly applied measures. The industry has developed a framework called Joining the Dots, that goes from problem recognition, through solution development, FEPs, implementation, assurance, and reporting.

25. The NZGAP EMS has developed a FEP Template. There are five management areas, with multiple subsections:

a) Property Plan (map);

b) Soil;

c) Nutrients;

d) Water and Irrigation; and

e) Mahinga Kai and Biodiversity.

26. The FEP process for each management area is the same:

a) Assess the environmental risks;

b) Identify GMPs (and BMPs if applicable) currently completed;

c) Identify GMPs (and BMPs if applicable) yet to be completed and set target dates for completion;

d) Make progress towards GMP (and BMP if applicable); and

e) Actions and improvements are assessed during each EMS audit.

27. The FEP Template has been developed and refined over the past few years. One of the biggest benefits is that it documents the timeline for the implementation of GMPs and BMPs. It collates the suite of practices and if a practice is not being used it requires a justification for a 'No' response or a timeframe for its implementation. Likewise, where practices are being used the grower must provide evidence of such. Metrics that establish the current level of BMPs and GMPs, as well as the planned actions over the next 5 years is included later in my evidence as Dashboards.

INDUSTRY RESEARCH TO SUPPORT APPROPRIATE NUTRIENT MANAGEMENT

28. I support amendments to Method 5-13, that reduces the emphasis on Overseer as a nutrient management model and establishes a process for the identification and evaluation of other nutrient management models and tools. It is my expectation that the CVG NRAT will be recognised as appropriate for the calculation of the risk of on-farm nutrient losses.

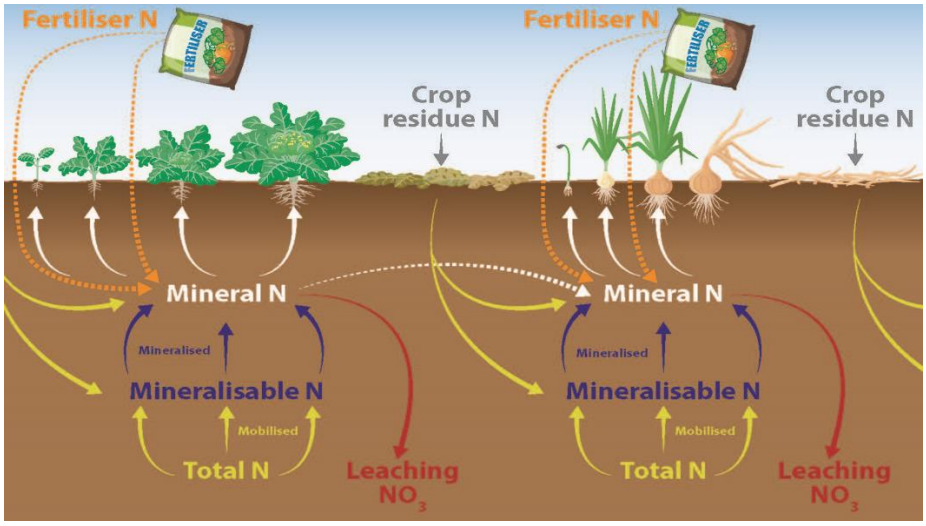
29. In July 2020 MPI and the vegetable industry (Potatoes NZ, Vegetables NZ, Vegetable Research and Innovation, and HortNZ) began the SVS project that runs through to June 2024.

30. The outcomes of SVS will be a greater understanding of nitrogen flows and management, that in turn will reduce the risk of nitrogen leaching. This will help growers improve their nitrogen use efficiency through the adoption of Good and/or Best Management Practices.

31. To achieve its primary outcome, SVS has developed a nitrogen fertiliser decision support tool. The SVS tool turns the invisible visible, through modelling crop nitrogen uptake and soil mineral nitrogen levels. In the tool these dynamic changes are graphically displayed as both changes over time and in a nitrogen budget consisting of inputs and outputs (see below).

32. SVS takes a whole system approach, rather than looking at a crop in isolation. This is because the performance of a crop is impacted upon by the practices prior (i.e., the previous crop or fallow period) and decisions on future crops may mitigate the effects of a current crop.

33. Vegetable cropping is incredibly dynamic and understanding the different forms of nitrogen and how they flow through the system is very complicated, as shown in the diagram below.

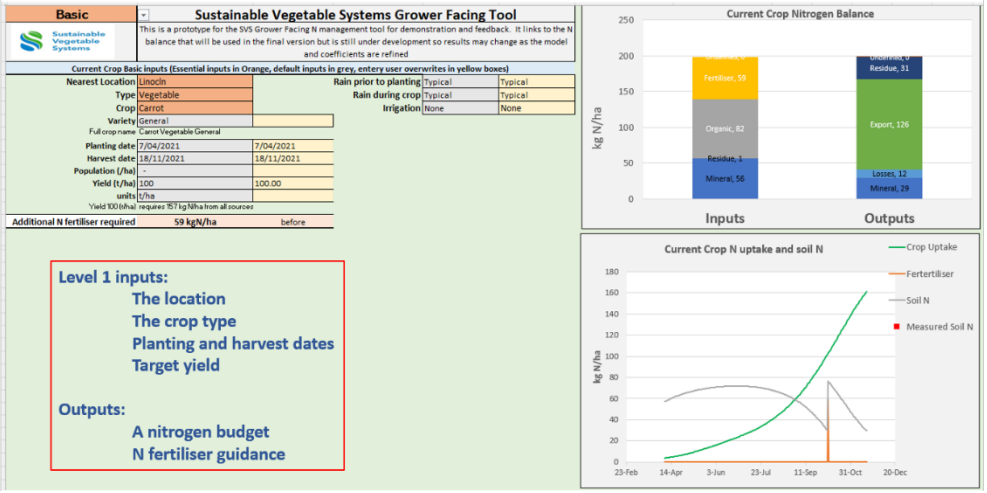


34. Fertiliser is just one nitrogen source, others include existing mineral nitrogen, mineralisation from the total soil nitrogen pool, and organic matter (crop residues, cover crops, and compost).

35. SVS has developed a nitrogen fertiliser decision support tool that incorporates the latest research conducted by Plant and Food Research with a focus on fertiliser decision makers. The tool has three levels, with entry level requiring just four inputs: location, crop type, planting and harvest dates, and target yield. Using the best industry research and knowledge, fertiliser nitrogen guidance is provided along with a budget and modelled soil mineral nitrogen levels over the life of the crop.

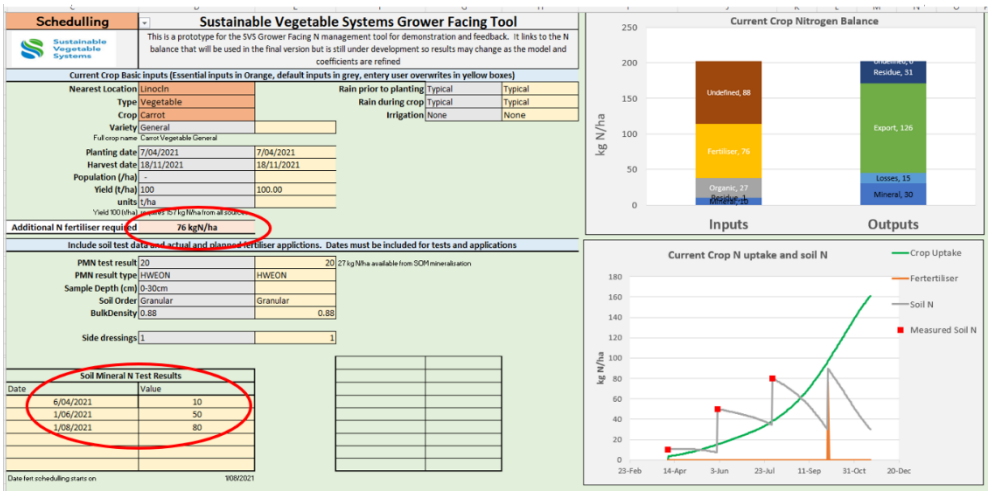
36. Practice change is difficult, so barriers must be minimised. That is what Level 1 achieves. However, the tool is yet to be demonstrated where someone doesn't say, "oh but …". It is the "oh but" that takes the enquiring mind down a path of using the more sophisticated levels of the tool. This leads to overriding a series of defaults. Level 2,

the integration of soil testing, and Level 3 paddock crop history and planning.



37. One of the issues with Overseer was a lack of confidence in the vegetable model. While the SVS tool must also use a crop and soil model, it integrates this with soil testing. I am yet to meet a grower who would accept a modelled number over a measured one. This is where Level 2, soil testing really powers the tool into a hands-on everyday nitrogen fertiliser decision support tool. The SVS tool is not something that is begrudgingly used for compliance reasons and then put away on the shelf awaiting dusting off when the next auditor turns up.

38. The example below shows a slightly higher fertiliser guidance than the default Level 1; 76 kgN/ha of fertiliser (below) compared to 59 kgN/ha (above). This is based on brining soil testing into the tool. In this instance the change in guidance has been caused by a combination of starting with less mineral nitrogen (10 kgN/ha compared to the default 60 kgN/ha) therefore requiring more fertiliser to achieve the target yield. This is partially counterbalanced by higher than modelled soil mineral N levels through the life of the crop (grey vertical lines resetting the soil mineral N levels following testing – red squares).



39. Nitrogen budgeting, along with integrated nitrogen soil testing, are two of the most fundamental practice changes that will lead to improved nitrogen optimisation and consequently less nitrogen leaching. These practices are included in the NRAT.

NITROGEN RISK ASSESSMENT TOOL

40. I support the CVG NRAT.

41. The NRAT for Commercial Vegetable Growing (**CVG**) was developed during Expert Conferencing. It was subsequently modified following testing with growers and further discussion amongst the experts. On further reflection I have suggested some small changes to the crop rotation definition, shown in bold (not yet updated in the attachment).

> *Crop Rotation the systematic planting of different crops in sequence over multiple years within the same growing space, or across changing* ***l****and parcels,* ***which can*** *include a pasture phase* ***or fallow period****. This process helps maintain* ***soil structure and*** *nutrients, reduce****s*** *soil erosion, and* ***reduces*** ~~*prevents*~~ *plant pests and diseases.*

42. Grower testing produced a wide range of results, with the scenarios described in more detail below. The intended outcome of the NRAT is to drive practice change proportionate to the level of risk. This has been well tested and demonstrated.

43. The NRAT is split into two main components, nitrogen fertiliser practices and soil health. The level of risk is largely established through the fertiliser application rate; a combination of the annual

and per application rates. The points for each practice are calculated by multiplying the points in each band by the proportion of the Productive Area that the practice band applies to.

44. The level of risk is then increased or mitigated using four fertiliser management practices and two soil health practices.

45. The two fundamental practices that will drive down nitrogen leaching is the use of a nitrogen budget and soil nitrogen testing. Through the Sustainable Vegetable Systems (**SVS**) project, the industry and MPI has developed a nitrogen decision support tool that prepares a nitrogen budget that integrates with soil nitrogen testing. This is a significant step forward, and through its adoption by the CVG makes the two key mitigations in the NRAT practical and achievable.

46. SVS has delivered a nitrogen management support tool. The intention is that growers use the tool for developing their Nutrient Management Plans, and then track the modelled soil mineral nitrogen levels through soil testing. A forward-looking model is essential, but ground truthed actual mineral nitrogen levels provide a reset and adjust the future nitrogen fertiliser guidance. While the budget accounts for leaching in a reasonably simplistic way, the tool does not have a sufficiently robust nitrogen leaching output that can be used for regulatory purposes.

47. The proposed NRAT is attached to my evidence and described in the evidence of Dr Jolly. For the purposes of the testing described below I have assumed that the growers require an upper point value of 60. This is determined through the Nitrogen Leaching Risk Limits table, with the limit selected based on the operation's biophysical conditions (Profile Available Water, and rainfall).

MANAGING BIOPHYSICAL RISK THROUGH THE CVG RISK SCORE CARD

48. Biophysical risk is accounted for based on the upper limit score as shown in the table Nitrogen Leaching Risk Limits for Commercial Vegetable Growing. Based on 12 categories using a range of Profile Available Water and annual rainfall, scores range between 72, where the nitrogen leaching risk is the lowest (low rainfall and high-Profile Available Water) through to 44, where the nitrogen leaching

risk is the highest (high rainfall and low-Profile Available Water). Consequently, to achieve a low score more mitigations are required. Most likely this will involve additional soil mineral nitrogen testing to help further guide fertiliser decision making.

MANAGING CROP ROTATION THROUGH THE CVG NITROGEN RISK ASSESSMENT TOOL

49. I support the definition for crop rotation proposed by Dr Drury and for baseline area. The NRAT method has been designed to support crop rotation and to manage any changes in localised risk that could occur with crop rotation.

50. As outlined in the evidence of Michelle Sands, crop rotation is essential for maintaining soil and plant health, and to achieve crop rotations CVG occurs across changing properties.

51. As discussed above the SVS research will reduce grower-managed diffuse nitrogen discharge risks associated with the complexity of CVG rotations, managing multiple nitrogen sources, including from crop residue, total soil nitrogen, and fertiliser.

52. The NRAT enables growers to manage the risks of their growing operations at a crop scale and accounting for changing parcels of land, as discussed below.

53. The NRAT includes a definition for Productive Area that accounts for crop rotation across different land parcels:

> *"The area denominator in 1(a) and 1(b) is an operation's total productive vegetable growing area. This includes both owned and leased land. While the total land area cannot increase under an existing consent, the location of leased land may change from year to year. The level of risk on the swapped lease land must be assessed and must not increase the overall risk level."*

54. Nitrogen flows through commercial vegetable production systems are extremely dynamic. The interaction of continually changing crops in rotation, the large diversity of crops, seasonal variability, and market demands amongst a myriad of other factors makes vegetable nitrogen management very complex.

55. The SVS project has conducted almost 4 years of nitrogen trials and monitored the nitrogen flows on nine commercial sites around the

country. The project has culminated in the development of a nitrogen decision support tool that makes the invisible visible through a research based, ground truthed nitrogen budget.

56. The SVS tool integrates a nitrogen budget with soil nitrogen testing to support nitrogen fertiliser decision making.

57. The SVS tool delivers the two most significant management practice changes, a nitrogen budget and integrated soil nitrogen testing, that will optimise nitrogen use and therefore lower nitrogen leaching.

58. Risk assessments are the foundation of the NZGAP FEP and are throughout many of the industries Codes of Practice. The proposed NRAT is a component of this assessment, where the NRAT ranks the level of risk, and then directs the user towards the appropriate mitigations commensurate with the level of risk.

59. The environment only sees the effects of practice change not numerical models. FEPs, risk assessments, Codes of Practice, soil testing, and decision support tools like the SVS tool, will reduce environmental effects through practice change and will meet the requirements of PC2

NITROGEN RISK ASSESSMENT TOOL TESTING

60. During development of the NRAT, four growers farming 1040 Ha of CVG, with a productive area of 866 Ha, were taken through the process. Based on their current practices, scores were -58, 106, 144, and 189. Three of the 4 operations scored greater than 60 and therefore needed to make practice changes to drive down their score and consequently, once those practice changes are implemented, reduce nitrogen leaching. The operation with the lowest score (-58) had already extensively implemented BMP.

61. The operation with the second-lowest score is a reasonably low intensity operation, with half of the Productive Area receiving less than 100 kgN/ha, and the rest between 100–150 kgN/ha. Implementing nitrogen budgeting across the whole operation lowered their score to 56. Had they been in a more venerable catchment (lower Profile Available Water and higher rainfall) and

required a score of 44, this operation would need to implement annual soil nitrogen testing across a quarter of their operation. The NRAT has driven practice change for a reasonably low nitrogen intensity grower to implement budgeting and potentially annual soil nitrogen testing. The process of budgeting which leads to great understanding about nitrogen flows, in my opinion and evidenced through the work done in SVS, will reduce fertiliser application rates and changing application timing. Consequently, this will improve nitrogen utilisation and reduce leaching.

62. The operation with the highest current score (189) was applying between 100 to 200 kgN/ha. To achieve a score of 60 the operation would need to implement a combination of nitrogen budgeting and soil nitrogen testing prior to each crop. To achieve a score of less than 44, soil nitrogen testing would need to be increased to prior to half of all nitrogen fertiliser applications.

ESTIMATING THE EFFECTIVENESS OF THE NITROGEN RISK ASSESSMENT TOOL

63. As outlined in the evidence Stuart Ford, Horizons engaged Dan Bloomer to undertake detailed modelling of the CVG rotations in the Horowhenua FMU. As part of this modelling, pre and post 2019 scenarios were tested with the post 2019 scenario representing the implementation of GMPs and BMPs. As explained in the evidence of Gill Holmes, the combined estimated reduction in nitrogen load for the WaiopheuFMU predicted using the Bloomer modelling was estimated at 34%.

64. My expertise is not in Overseer modelling. As explained in Stuart Ford's evidence, the estimates of percentage reduction are influenced by the modelling assumptions.

65. What I can say with confidence is that it is the adoption of practices that reduce the risk of nitrogen leaching and other contaminant losses. In my opinion the NRAT offers growers a useful tool for supporting their nitrogen fertiliser decisions, and for CVG is more closely related to the practices they adopt than Overseer modelling, and therefore in my opinion is at least as likely to support the uptake of GMPs and BMPs for CVG than Overseer modelling.

66. Following my testing of the SVS tool with growers, I am confident that the NRAT supports growers to have a better understanding and data on which to base fertiliser application decisions. Consequently, in my opinion, a 35% reduction in nitrogen loss is achievable through the implementation of these GMPs and BMPs that the NRAT will direct growers towards.

UPTAKE OF FARM ENVIRONMENT PLANS

67. Farm Environment Plans provide the mechanism for capturing current practice and tracking change. In the Region, 1442 Ha of CVG has a FEP with the NZGAP EMS.

68. One of the outcomes from the preparation and reviewing of FEPs is being able to track and show practice change over time. In 2020 nine FEPs were completed and audited. In 2023, through NZGAP and HortNZ's Growing Change programme, these operations were revisited and their FEPs updated. HortNZ and NZGAP have developed a Dashboard to track and communicate progress.

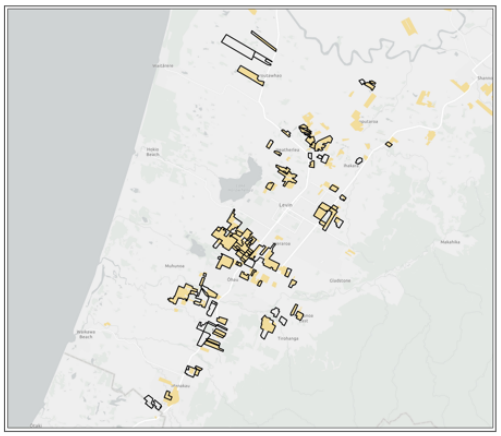
NZGAP Environment Management System (EMS) - Horowhenua Growers

Same site change - 2020 to 2023

1 Summary

	2020	2023	Change
Completed Farm Environment Plans (FEPs)	9	9	0%
Total horticulture area in Horizons (ha)	3,647	3,647	0%
Total area with completed FEP (ha)	1,449	1,442	0%
Proportion of Horizons horticulture covered (%)	40%	40%	0%
Total **owned** area with completed FEP (ha)	1,145	1,151	0%
Total **leased** area with completed FEP (ha)	303	291	-4%
Proportion of area with completed maps (%)	100%	100%	0%
Proportion of responses at GMP (%)*	82%	86%	4%
Proportion of responses at BMP (%)*	59%	62%	5%
Total number of Non-Compliances	11	Awaiting audit	-

*excluding 'Not Applicable' responses



Map of Horowhenua Region. Black outline show horticultural land with completed EMS FEP, yellow areas show short-rotation cropland from Horizons council data.

69. At a high level there has been a 4% increase in GMPs and a 5% increase in BMPs between 2020 and 2023. Ultimately an FEP is about the identification and implementation of actions. In 2020 41 actions

were identified, of which by 2023 29 had been implemented. A further 11 actions were identified as new or ongoing.

NZGAP Environment Management System (EMS) - Horowhenua Growers

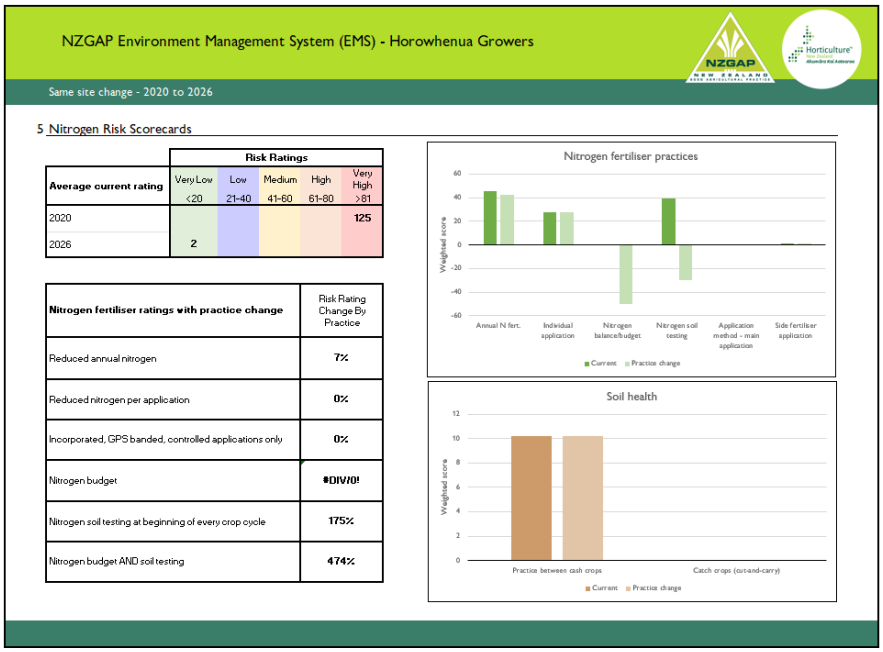
Same site change - 2019 to 2023

4 Horowhenua growers - Action Plans

	2020	2023		
Total number of planned actions	41	18	Completed actions as of 2023	29
Average planned actions per operation	5	2	Average completed actions per operation	3

Examples of recorded actions	Number of operations	Number of completed actions	Number of planned or ongoing actions
Installation of buffer strips	2	4	0
Complete Nitrogen Risk Assessment Tool (NRAT)	7	7	0
Investigate or continue to use Nitrate quick test	5	3	3
Machinery calibration (irrigator, fert spreader, etc.)	2	3	0
Improved record keeping	5	4	1
Participation in trials (Fertiliser efficiency trials, biologicals, etc.)	5	4	3
Native planting	1	1	1
Other erosion and sediment control measures	4	3	3

70. The NRAT and its associated practices provides a good demonstration of the Dashboard. The average score in 2020 was 125 (calculated retrospectively). With the implementation of the proposed practice changes this will drop to 2. The Dashboard shows that while there is a small expectation of reduced fertiliser use, the implementation of nitrogen budgets and soil testing are the main changes. In my opinion, while there was only a small expectation by the growers of reduced fertiliser use, the reality will be lower fertiliser use. Improved knowledge and testing must, and has, led to lower fertiliser use as demonstrated through SVS cases studies.



CONCLUSIONS AND RECOMENDATIONS

71. I support the definition of a Nutrient Management Plan that recognises that a NRAT is a component of a Nutrient Management Plan, which in turn sits within a certified Freshwater Farm Plan (**FWFP**).

72. FWFP's are built upon risk assessments. The expert's collaborative development of the Nitrogen Risk Assessment Tool reflects and strengthens this approach for nitrogen within the NZGAP EMS. The outcome of completing the risk assessment is a set of mitigations (GMP and BMP's) that are proportionate to the level of risk. In my opinion, a 35% reduction in nitrogen leaching is achievable through the implementation of these GMPs and BMPs that the NRAT will direct growers towards.

73. It will be efficient for the implementation of PC2 if the FWFP certification pathway for Nutrient Management Plans and the process of approval through independent third party audited industry schemes like NZGAP is established by Horizons before PC2 becomes fully operative. This removes regulatory uncertainty and directs all efforts to practice implementation, which is ultimately the only thing that the environment sees.

74. Through the Sustainable Vegetable Systems project the industry has developed a nitrogen decision support tool. This tool significantly improves the understanding of nitrogen flows within an extremely complicated vegetable growing system and integrates nitrogen budgets with soil nitrogen testing. In my opinion these two key mitigations will improve nitrogen optimisation and consequently lower nitrogen leaching.

Andrew Barber

13 October 2023

ATTACHMENT: NITROGEN RISK ASSESSMENT TOOL

Nitrogen Risk Assessment Tool: Commercial Vegetable Growing

Nitrogen Fertiliser Practices

(a) Nitrogen fertiliser annual application rate
(b) Nitrogen fertiliser application rate per application (individual)
(c) Nitrogen balance/budget
(d) Nitrogen soil testing
(e) Crop establishment fertiliser application method
(f) Side fertiliser application method

2. Soil Health

(a) Practices between crops
(b) Catch crops (cut-and-carry)

1. Nitrogen Fertiliser Practices

(a) Nitrogen fertiliser annual application rate	Points	Proportion of area (%)
N fertiliser: <100 kgN/ha	0	
N fertiliser: 100-150 kgN/ha	30	
N fertiliser: 151-200 kgN/ha	60	
N fertiliser: 201-250 kgN/ha	90	
N fertiliser: 251-300 kgN/ha	150	
N fertiliser: 301-400 kgN/ha	200	
N fertiliser: >400 kgN/ha	250	
Subtotal (column 2 x 3)		

(b) Nitrogen fertiliser application rate per application (individual)	Points	Proportion of area (%)
N fertiliser: <25 kgN/ha	-30	
N fertiliser: 25-50 kgN/ha	0	
N fertiliser: 51-75 kgN/ha	30	
N fertiliser: 76-100 kgN/ha	60	
N fertiliser: >100 kgN/ha	90	
Subtotal (column 2 x 3)		

(c) Nitrogen balance/budget	Points	Proportion of area (%)
Yes	-50	
No	0	
Subtotal (column 2 x 3)		

(d) Nitrogen soil testing	Points	Proportion of area (%)
Before every nitrogen fertiliser application	-50	
At the beginning of each crop within the crop rotation	-30	
One a year	0	
Never	50	
Subtotal (column 2 x 3)		

(e) Crop establishment fertiliser application method	Points	Proportion of area (%)
Incorporated, GPS banded, controlled application	-20	
Surface, GPS banded, controlled application	-15	
Incorporated, banded	-10	
Surface, banded	-5	
Surface broadcast, incorporated	10	
Surface broadcast	20	
Subtotal (column 2 x 3)		

(f) Side fertiliser application method	Points	Proportion of area (%)
GPS banded, controlled application	-15	
Banded	-5	
Broadcast	20	
Subtotal (column 2 x 3)		

TOTAL POINTS. Nitrogen Fertiliser Practices	

2. Soil Health

(a) Practices between vegetable crops within the crop rotation	Points	Proportion of area (%) [1]
Cover crop	-30	
Fallow < 4 weeks	0	
Fallow 4 – 12 weeks	25	
Fallow > 12 weeks	50	
Subtotal (column 2 x 3)		

1. Note the sum of the area for fallow periods will equal 100%, plus the area planted in cover crops, i.e., if cover crops are planted the sum of the area is greater than 100%.

(b) Catch crops (cut-and-carry)	Points	Proportion of area (%)
Yes	-20	
No	0	
Subtotal (column 2 x 3)		

TOTAL POINTS. Soil Health	

TOTAL POINTS. Nitrogen Fertiliser Practices + Soil Health	

Nitrogen Leaching Risk Limits for Commercial Vegetable Growing (for Variations in Soil and Drainage) as determined by the combined points for the two-management practices, Nitrogen Fertiliser and Soil Health.

Points Limit	Profile Available Water		
	151 - 350 mm	**61 - 150 mm**	**0 - 60 mm**
Rainfall 1 <1000 mm/year	72	72	52
Rainfall 2 1000 – 1300 mm/year	72	60	48
Rainfall 3 1300 – 1600 mm/year	60	52	44
Rainfall 4 >1600 mm/year	60	48	44

Definitions

Calculation of Subtotal. The subtotals for each practice category are calculated by multiplying the practice score (column 2) by the proportion of the area that the practice applies to (column 3). Then summing the points. For example, if 50% of the area has a nitrogen soil test at the beginning of each crop cycle and 50% of the area is tested once a year the subtotal is -30 x 0.5 + 0 x 0.5 = 15

(d) Nitrogen soil testing	Points	Proportion of area (%)
Before every nitrogen fertiliser application	-50	
At the beginning of each crop cycle	-30	50%
One a year	0	50%
Never	50	
Subtotal (column 2 x 3)	**15**	

Proportion of area (%). The proportion of the area that a practice is applied to. This will always total 100%, except for the Soil Health question (1) Practices between crops, where the sum of the fallow periods will equal 100% plus the proportion of the area that are planted in cover crops.

Risk Rating. The subtotals are summed to determine the overall Risk Rating for both of the farm management practices; (1) Nitrogen fertiliser practice and (2) Soil health.

Productive Area. The area denominator in 1(a) and 1(b) is an operation's total productive vegetable growing area. This includes both owned and leased land.

Productive area is all the area within the boundaries of the productive vegetable growing area. This includes the total area where the crop is grown, including wheel tracks and beds that are not cropped, as well as headlands and races. Productive area does not include the land occupied by buildings. Productive vegetable growing area does not include areas that cannot be cropped such as bush blocks, nor does it include pasture grown for greater than 2 years.

Baseline Commercial Growing Area cannot increase under an existing consent, the location of leased land may change from year to year. The level of risk on the swapped lease land must be assessed and must not increase the overall risk level. **Baseline Commercial Growing Area** means the aggregated area of land^ utilised for commercial vegetable production in the 2012/2013 growing season and includes all land^ under the control (owned or leased) of a single grower or enterprise.

Baseline Growing Period means the 2012/2013 growing season.

Crop Rotation is the systematic planting of different crops in sequence over multiple years within the same growing space, or across changing land parcels, and often includes a pasture phase. This process helps maintain nutrients in the soil, reduce soil erosion, and prevents plant diseases and pests.

Enterprise means one or more parcels of land^ held in single or multiple ownership to support the principle land^ use, or land^ on which the land^ use is reliant, which constitutes a single operating unit for the purposes of management.

Nitrogen fertiliser annual application rate 1(a). This is the total quantity of elemental nitrogen fertiliser applied per year divided by the productive area. This should be split into the different rate bands based on the proportion of productive area (i.e., 50% at 100 – 150 kgN/ha and 50% at 151 – 200 kgN/ha). This is not a whole operation average.

Nitrogen fertiliser application rate per application (individual) 1(b). This is the amount of elemental nitrogen applied per hectare for a single application. This should be split into the different rate bands based on the proportion of productive area where rates vary between crops. This is not a whole operation average.

Catch crop: A catch crop is any crop that is grown with the primary objective of catching excess nitrogen in soils that otherwise may be lost through leaching. At harvest this crop is exported off farm. Examples include maize and grass grown for silage or hay.

Cover crop: A cover crop is any crop that is grown with the primary objective of catching excess nitrogen in soils that otherwise may be lost through leaching. Before the planting of the next vegetable crop the cover crop is mulched and/or incorporated into the soil.

Fallow: A period of time after crop harvest where the soil remains bare.

Nitrogen soil testing (mineral N): the use of soil mineral N testing. E.g., Quick N test or laboratory based mineral N.

Nitrogen balance/budget: A decision support tool to help a grower understand the inputs and outputs of nitrogen for a crop growing system. Nitrogen outputs are balanced against nitrogen inputs in a graph or table, categorised by source or destination. Nitrogen budgets assist growers with appropriate nitrogen fertiliser recommendations.

Crop establishment fertiliser application methods:

Surface: the application of fertiliser which remains on top of the soil, either banded or broadcast.

Incorporated: the fertiliser is applied into the soil at the time of application.

GPS banded: the placement of fertiliser in continuous narrow ribbons, usually at specific distances from the seeds or plants, recorded using GPS.

Banded: the placement of fertiliser in continuous narrow ribbons, usually at specific distances from the seeds or plants.

Broadcast: The spreading of fertiliser evenly over a large area. The fertiliser then remains on the soil surface to break down.

Controlled application: Controlled application rate of fertiliser is a method of applying fertiliser in a precise and targeted manner using an electronic rate controller that, maintains or adjusts rates during spreading irrespective of speed.

ATTACHMENT: NZGAP DASHBOARD

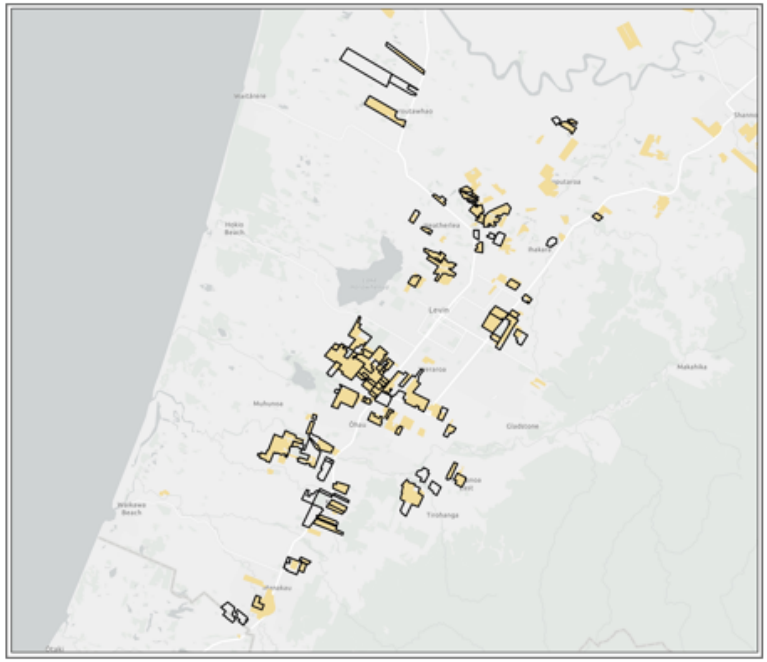
NZGAP Environment Management System (EMS) - Horowhenua Growers

Same site change - 2020 to 2023

1 Summary

	2020	2023	Change
Completed Farm Environment Plans (FEPs)	9	9	0%
Total horticulture area in Horizons (ha)	3,647	3,647	0%
Total area with completed FEP (ha)	1,449	1,442	0%
Proportion of Horizons horticulture covered (%)	40%	40%	0%
Total **owned** area with completed FEP (ha)	1,145	1,151	0%
Total **leased** area with completed FEP (ha)	303	291	-4%
Proportion of area with completed maps (%)	100%	100%	0%
Proportion of responses at GMP (%)*	82%	86%	4%
Proportion of responses at BMP (%)*	59%	62%	5%
Total number of Non-Compliances	11	Awaiting audit	-

*excluding 'Not Applicable' responses



Map of Horowhenua Region. Black outline show horticultural land with completed EMS FEP, yellow areas show short-rotation cropland from Horizons council data.

NZGAP Environment Management System (EMS) - Horowhenua Growers

Same site change - 2019 to 2023

4 Horowhenua growers - Action Plans

	2020	2023
Total number of planned actions	41	18
Average planned actions per operation	5	2

Completed actions as of 2023	29
Average completed actions per operation	3

Examples of recorded actions	Number of operations	Number of completed actions	Number of planned or ongoing actions
Installation of buffer strips	2	4	0
Complete Nitrogen Risk Assessment Tool (NRAT)	7	7	0
Investigate or continue to use Nitrate quick test	5	3	3
Machinery calibration (irrigator, fert spreader, etc.)	2	3	0
Improved record keeping	5	4	1
Participation in trials (Fertiliser efficiency trials, biologicals, etc.)	5	4	3
Native planting	1	1	1
Other erosion and sediment control measures	4	3	3

NZGAP Environment Management System (EMS) - Horowhenua Growers

Same site change - 2020 to 2026

5 Nitrogen Risk Assessment Tool (NRAT)

Average current rating	Risk Ratings				
	Very Low	Low	Medium	High	Very High
	<20	21-40	41-60	61-80	>81
2020					**125**
2026	**2**				

Nitrogen fertiliser ratings with practice change	Risk Rating Change By Practice
Reduced annual nitrogen	**7%**
Reduced nitrogen per application	**0%**
Incorporated, GPS banded, controlled applications only	**0%**
Nitrogen budget	**Infinite**
Nitrogen soil testing at beginning of every crop cycle	**175%**
Nitrogen budget AND soil testing	**474%**