BEFORE COMMISSIONERS APPOINTED
BY THE WAIKATO REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the First Schedule to the Act
AND	
IN THE MATTER	of Waikato Regional Plan Change 1- Waikato and Waipā River Catchments and Variation 1 to Plan Change 1
AND	
IN THE MATTER	of submissions under clause 6 First Schedule
BY	**BEEF + LAMB NEW ZEALAND LIMITED** **Submitter**

BRIEF OF EVDIENCE OF RICHARD PARKES
3 May 2019

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BACKGROUND

1. My name is Richard Parkes.

2. My area of expertise is in Sustainable Agriculture, Farm Systems, Extension and Education. I have over 20 years' experience specialising in agriculture systems and soil conservation and nutrient management.

3. I gave evidence for Beef + Lamb New Zealand Ltd (B+LNZ) as part of its case on the hearing stream 1 (HS1) topics. In my HS1 evidence, dated 15 February 2019, I set out my qualifications, current employment and employment history and professional affiliations. I confirm those details remain current.

4. In addition, I am currently member of the Good Farming Practice Governance Group (GFP GG). The GFP GG developed the Good Farming Practice Action Plan for Water Quality 2018.

5. In preparing this evidence I have reviewed:

   (a) The reports and statements of evidence of other experts giving evidence relevant to my area of expertise, including:

      (i) Ms Alison Dewes;

      (ii) Dr Jane Chrystal;

      (iii) Mr Simon Stokes;

      (iv) Dr Alec Mackay;

      (v) Mr Richmond Beetham;

   (b) The Council Officers' section 42A report;

   (c) Plan Change 1 and Variation 1; and

   (d) The section 32 report.

6. I reconfirm that I have read the Code of Conduct for Expert Witnesses in the Environment Court's 2014 Practice Note and agree to comply with it. I

confirm that the opinions I have expressed represent my true and complete professional opinions. The matters addressed by my evidence are within my field of professional expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

7. I have been asked by B+LNZ to prepare evidence in relation to the sheep and beef sector generally and the implications of Plan Change 1 and Variation 1 (PC1) to the sector in the Waikato.

8. I am aware of the directions of the Hearing Panel to allocate blocks of time for particular topics. This brief of evidence relates primarily to hearing stream 2 (HS 2) and builds on from the evidence provided for HS1. Specifically, this brief of evidence focuses on the approach to managing agricultural land uses through PC1 and in particular sheep and beef farming systems.

9. I consider methods that, in my opinion, are more likely to achieve freshwater ecological health while sustaining communities. Those methods have the following characteristics in common:

    (a) They are tailored to the farm and its natural resources;

    (b) Enable flexibility, adaptation and innovation by the farmer and the sector;

    (c) They seek to engage farmers and provide a sense of ownership of the solutions, including understanding the issues and linking practice change to outcomes; and

    (d) Are spatially appropriate to allow for local solutions (on-farm and sub-catchment) to regional problems.

10. I describe and introduce land and environment plans, which are the basis of the farm environment plans contemplated by PC1. I also discuss the use of land use capability mapping in those plans.

11. I have also been asked to consider stock exclusion from water bodies, setbacks and restrictions (based on slope) on cultivation and how FEPs can assist the application of these mitigations.

EXECUTIVE SUMMARY

12. The New Zealand sheep and beef industry has evolved through many cycles of challenge and recovery over the last few decades as a result of changes in domestic policy, international markets, and environmental conditions including climate change. The sector's ability to adapt has been dependent on its flexibility. Flexibility allows innovation to occur and builds resilience within the sector.

13. As a result of this adaption, to environmental conditions, changes in climate, markets, and personal aspirations, the sheep and beef sector has developed into a highly diverse industry. This is in relation to spatial and temporal variation in both landscape characteristics and in farm systems and processes.

14. Key points in relation contaminant and loss pathways from the Sheep and Beef Sector

    (a) Key potential water contaminants for the sheep and beef sector are sediment, P and faecal pathogens, although the risk of losses from sheep and beef farms of these contaminants are not higher than other pastoral land uses;

    (b) Overland flow is the primary contaminant transport pathway associated with sheep and beef farming, although the nature and scale of this loss are highly variable throughout the region;

    (c) Nitrogen loss to water is proportionally much less of a concern for the sheep and beef sector; and

    (d) The majority of contaminant losses for sheep and beef farms occur over short time scales and/or from small areas of the farm where areas of high contaminant sources and rapid transport processes coincide (CSAs).

15. Tailored Land Environment Plans (LEP) enable farmers to understand their natural resources and the farms natural capital and to identify risk and prioritise actions across their property for the purpose of maintaining and enhancing their natural resources including soil, water quality, and biodiversity. This approach allows for the complexity and dynamic nature of the farming landscape by supporting active management of livestock and water at the farm and paddock scale. With mitigations being targeted at the environmental issues/ including freshwater ecosystem impacts of concern in a catchment.

16. As part of a specific Farm Environment Plan farm scale (1:10,000) scale Land Use Capability (LUC) mapping should be undertaken. This assessment is undertaken regardless of land use and is used to ascertain the lands capability for use, while taking into account it's physical limitations and its versatility for sustained production (Lynn et al.,2009).

17. Farmers learn from people they trust, each other and seeing theory implemented and working on the ground. Farmers have low trust in the environmental information coming out of regional councils hence there is immense opportunity for councils to leverage off industry organisations that have farmer trust and networks.

18. Fencing of small streams on hill country farms (greater than 15 degrees slope) is often technically challenging and cost prohibitive (Daigneault et al., 2017; Ministry for Primary Industries, 2013). Where fencing is technically challenging and or prohibitively expensive a range of less costly strategies are often available. These strategies may also be beneficial and act as insurance against the failure of fencing to mitigate contaminant losses (McDowell et al., 2017). Such strategies include tailored farm environment planning including the identification and management of critical source areas. As set out in my evidence for HS1 and the evidence of Dr Dada, overland flow is the predominate pathway for losses of pathogens from land to freshwater in the hill country.

19. A specific farm environment plan would allow the livestock owner to identify risk and prioritise actions across their property for the purpose of maintaining and enhancing water quality. It would allow for the complexity

and dynamic nature of the farming landscape by supporting active management of livestock and water at the farm and paddock scale.

20. The Good Farming Practice (GFP) Action plan is a voluntary commitment and like the 21 GFPs it contains, it was not developed for the purpose of becoming regulation. Good Farming Practice (GFP) are intended to be an evolving suit of practical measures, and as such I do not support their inclusion through regulation in a way that is prescriptive and reduces the role of innovation and on farm adaption. The B+LNZ LEP programme will both deliver and drive the evolution of the Agreed National Good Farming Practice Principles for the Sheep and Beef Sector.

21. Riparian margins used for mitigating the loss of particulate contaminants have different treatment efficiencies according to the land slope, vegetative cover, seasonality and intensity and volume of rainfall, and soil drainage properties. Annual and seasonal variations in rainfall affect both the amount and timing of surface runoff and mobilised particulate material and hence, the efficiency of buffer strips, as does slope. The slope will govern the buffer strip width required for a given trapping efficiency. As such riparian buffer zones are more appropriately established through tailored LEPs which take into account the geology of the landscape, the activity being undertaken, and the sensitivity of receiving environments. A blanket setback as proposed through PC1 will not be effective at addressing environmental concerns especially in more diverse landscapes.

TAILORED LAND ENVIRONMENT PLANNING

22. One size fits all farm plans fail to cater to the heterogeneity found in sheep and beef farming. The diversity across Waikato's sheep and beef farms means that a tailored and farm-specific approach is the most effective and efficient way to manage the potential effects associated with pastoral farming. As such, I support the PC1 approach of adopting tailored farm environment planning as a key tool within its management framework, though have some concern around the structure and contents of the plan.

23. As introduced in my HS1 evidence, Land Environment Plans (LEP) or Farm Environment Plans (FEP) (I use this term interchangeably) offer a tailored approach to understanding and categorising a farm's natural capital assets

(geology, topography, soils, climate, biodiversity, and water resources), and identifying and managing environmental risks. Such plans are also critical in ensuring that decisions are prioritised in line with business, family, social and cultural goals. In my experience, if developed by the farmer, with support where required, these plans can result in "issue and solution" ownership and ultimately optimal use of natural resources on that property. They are flexible and allow farmers to respond to environment, social and economic externalities effecting their farms.

24. Farm plans were financially supported by Central Government up until 1987. Following the removal of government grant assistance some regions stopped farm plan programs and others modified their approaches resulting in a lack of national consistency in farm planning.

25. Historically in New Zealand farm plans only dealt with soil erosion but since 1987, where they remain, they have become more holistic, encompassing a broader range of topics including biosecurity, biodiversity, nutrient management, riparian management, biodiversity or conservation management, flood protection, heritage values, and economic matters. For example, the Horizons Regional Council's Sustainable Land Use Initiative (SLUI) plans include a farm business component to identify the initial economic viability of the property and the subsequent effect of the programme of works on the resultant economic viability of the property.

26. The B+LNZ Land and Environment Plan (LEP) programme is aimed at addressing both the patchy coverage and lack of consistency in farm environment planning in New Zealand for the sheep and beef sector. The programme recognised the range of environmental vulnerabilities in diverse landscapes and the complexity of sheep and beef farming sectors and farm systems, and looked to New Zealand's vast experience in soil conservation and land management to develop the programme. In my opinion such programs and approaches to farm planning should form the foundation on which any management approach adopted by regional councils and other agencies to achieve sustainable land management for red meat farming should be based.

27. B+LNZ supported by leading agricultural experts in red meat systems and whole farm system planning, has co developed a Waikato FEP template and

guidelines for the Sheep and Beef sector with consultation with WRC (Appendix 1). This is based on B+LNZ LEP II type plans. A brief summary of the process and its roll out are provided:

a) LEP workshops have been delivered in the region since 2015;

b) PC 6 in Taupo highlighted to WRC that there was a gap in the support WRC was offering to sheep and beef farmers, who were basically being advised to complete an OVERSEER budget, but not much more;

c) B+LNZ established LEP workshops to fill this gap. Completing an Overseer nutrient budget formed part of an LEP 3.

d) LEP workshops took a farm systems approach which made the Overseer budget sit in context. The LEP process helped identify better input data and supported farmers in making knowledge linkages between management decisions and nutrient management;

e) WRC supported the engagement with farmers but were concerned at the time it took to get farmers through the LEP 1-3 process (3-4 years)

f) In response B+LNZ and WRC developed a Waikato specific FEP template (Appendix 1) based on the B+LNZ LEP templates. The WRC FEP is roughly equivalent to an LEP 2.

g) Pilot Workshops were run with farmers and since then another another 42 FEP workshop along with 31 LEP workshops have been run;

h) WRC supported the FEP and LEP workshops and wanted to see large numbers of farmers put through them, but these were limited by financial constraints;

i) WRC then developed “Risk and Mitigations Workshops’, in order to fast track the process. These workshops were intended to be a precursor to the FEP workshop, similar to a B+LNZ LEP 1, and enable farmers to come up to speed on the basics of Farm Environment Planning for those farmers that as yet had had no exposure. These

workshops were contracted out directly by WRC and to the best of my knowledge only three workshops have been delivered so far;

j) Since September 2013, 249 sheep and beef farmers have attended B+LNZ LEP workshops in the Waikato and since December 2016, 194 sheep and beef farmers have attended B+LNZ Waikato FEP workshops.

28. WRC requirements are under a constant state of change. Current requirements are that the minimum qualification for doing an FEP for a farmer is CNMZ (Certified Nutrient Management Advisor) certification. This is not appropriate nor required for sheep and beef farmers whose primary environmental vulnerabilities relate to the form and function of their landscape, overland flow pathways and contaminants which are lost to freshwater via these pathways. Management of diverse landscapes and farming systems required a completely different skill set for a consultant, than simply nutrient management. Farm advisors working with the red meat sector require farm systems expertise including soil conservation and LUC mapping.

29. As set out in my evidence, tailored LEP, rather than prescriptive standards types of approaches, are the most effective approach to farm environment planning for the red meat sector. I set this out in further detail below under Land and Environment Plans.

Good Farming Practice Action Plan 2018

30. The Action Plan's purpose is to accelerate the uptake of good farming practices for improving water quality, to measure and demonstrate this uptake, to assess the impact and benefit of those farming practices, and to communicate progress to the wider public.

31. The Action plan was developed by a Governance Group composed of senior representatives of primary sectors, regional councils and the Water Directorate (Ministry for the Environment and Primary Industries).

32. The Action plan is a voluntary commitment and like the 21 GFP it contains was not developed for the purpose of becoming regulation. PC1's Schedule 1 Requirement for Farm Environment Plans in it's Glossary – Definitions

states that: Good Farming Practice (GFP) – means the 21 industry-agreed National Good Farming Practice Principals (Good Farming Practice – Action for Water Quality 2018). Schedule 1 will require that farmers be audited against these GFP.

33. The Governance Group committed to supporting positive behaviour change and adopting an approach of continual improvement. GFP are intended to be an evolving suit of practical measures. As such I do not support them being applied through a prescriptive manner as is being proposed by WRC. The B+LNZ LEP programme will both deliver and drive the evolution of the Agreed National Good Farming Practice Principles for the Sheep and Beef Sector.

What is a Land and Environment Plan (LEP)?

34. An LEP is a tool that guides farmers through a recorded assessment of a farm's natural capital assets such as geology, soil, water, and climate, and assists farmers to understand the vulnerabilities and opportunities provided by these natural assets. An LEP helps farmers to develop a written plan outlining how these natural capital assets will be sustainably managed. It involves a stock-take of land, soil and water resources, an assessment of production opportunities and environmental risks, and recording what actions are going to be undertaken, where they are being targeted, and when they will be implemented. A strong focus of the LEP is to assist farmers to make the knowledge connections between their underlying natural assets, and how their farming systems and enterprise can be optimised to fit the capability of the land.

35. The key environmental issues actively identified and managed through LEPs include those contaminants which can flow overland to be discharged to surface waterbodies, such as phosphorus, sediment, and pathogens, as well as identifying areas of the farm which may be susceptible to erosion and nitrogen losses. The LEP can also help identify areas of the farm which have high biodiversity values such as native vegetation, or other values such as cultural values.

36. A well prepared LEP captures stewardship and sustainability in relation to the farming enterprise. It provides an understanding of the natural resources

on a farm and allows all those involved with the farm business to understand the plan to manage them for the long term.

37. The benefits of a LEP include:

(a) Providing a stock take of a farm's natural capital assets such as soil, geology, climate, biodiversity, and freshwater resources along with on farm Land Use Capability mapping (1: 5,000 to 1: 10,000);

(b) Identifying land management units and their strengths and limitations;

(c) Helping identify areas where resources are not being fully utilised and production opportunities are being lost;

(d) Identifying sensitive habitats and critical source areas;

(e) Identifying improvements in farming practice that will enhance production, future-proof the business and foster access to environmentally discerning markets;

(f) Providing evidence for on-farm sustainable practices to consumers, regulators and others;

(g) If actions and timeframes for their achievement are written down, they are more likely to be completed;

(h) The potential to add value to a farm;

(i) Integration with farm business plans;

(j) Helping to meet regional council requirements to manage threats to water quality.

38. A foundation of the LEP programme is that a farmer can produce an LEP Level 1 or 2 for their own property. Professional one-on-one support from a farm advisor or consultant is required to prepare a LEP Level 3.

39. B+LNZ has produced workbooks, and hosts facilitated workshops, to support farmers to do this. The process is well described in a B+LNZ video:

beeflambnz.com/knowledge-hub/video/land-and-environment-plans-overview

40. The workbook and workshop guide farmers through the process of identifying on-farm environmental risks, with industry Good Management Practice (GMP) guides used to assist farmers to determine the most appropriate responses to address those risks.

41. There are three levels of LEP (in increasing order of sophistication):

(a) LEP Level 1 is an introduction to farm environmental planning that sets out how to manage a farm's natural resources. LEP Level 1 guides the farmer through an assessment of their farm's environmental risks and land management opportunities. It involves a stocktake of land, soil and water resources, and results in the development of a personalised, written plan—identifying actions to be undertaken, where they might be targeted, and when they will be implemented.

(b) The key difference between a LEP Level 1 and Level 2 is the identification of Land Management Units (LMU) on a farm map, which are used to tailor land and farm systems management on a property, and the inclusion of a basic nutrient budget. The key steps involved are:

(i) Stocktake of a farm's land and soil resources;

(ii) Development of LMU;

(iii) Use LMUs as a basis for nutrient budgeting, strength and weakness analysis, and productive potential assessment;

(iv) Identification of critical source areas and mitigation actions;

(v) Summarising opportunities for optimising sustainable farming as a three-year response plan.

(vi) An LEP Level 3 builds on a LEP Level 2. The steps involved are similar to those for a LEP Level 2, but with a greater emphasis

on specifications and methods used by professional farm planners, including:

a) An accurate and up-to-date paddock-scale map showing features relevant to land and environmental management;

b) A paddock-scale inventory describing the land resource according to published standards for either soil mapping or Land Use Capability (LUC);

c) Overseer® farm nutrient budget prepared by a qualified operator;

d) A “Works Programme” prepared with input from a resource management specialist;

e) Achievements are recorded and changes in freshwater quality, soil condition and natural biodiversity are monitored at least three-yearly.

42. Level 3 plans represents the current gold standard in tailored farm environment planning, and have largely been up taken by the sector’s farmer leaders and earlier adopters. While B+LNZ does not keep formal records of the coverage of LEP 3, we estimate that there are around 840 LEP 3 or equivalent plans nationally representing roughly 8% of sheep and beef farms.

43. The level 3 plans have been used to support extension through demonstrating how the use of farm environment planning can enhance environmental outcomes, optimize the farm system and increase profitability. There are a number of cases where individual farmers have championed this approach and have supported farmers around them to attend farm plan workshops.

44. B+LNZ ran a project in the Southern Lakes Region where three farmers around Lake Wanaka were supported to develop a level 3 farm plan and extension events were run to outline how those plans had enhanced each individual farm business. As a result of that project 18 other farmers around the Lake are working with a consultant to develop their own plans and

sharing challenges and opportunities presented through that process with their peers.

45. In addition to these projects there are a number of other farm environment plans that are equivalent to the LEP level 3. In the Horizons region over 700 sustainable land use whole farm plans covering over 525,000 ha, were developed and are being implemented and around 30 Whanganui catchment Strategy Plans covering around 18,000 ha (Upper Whanganui, Ohura catchment).

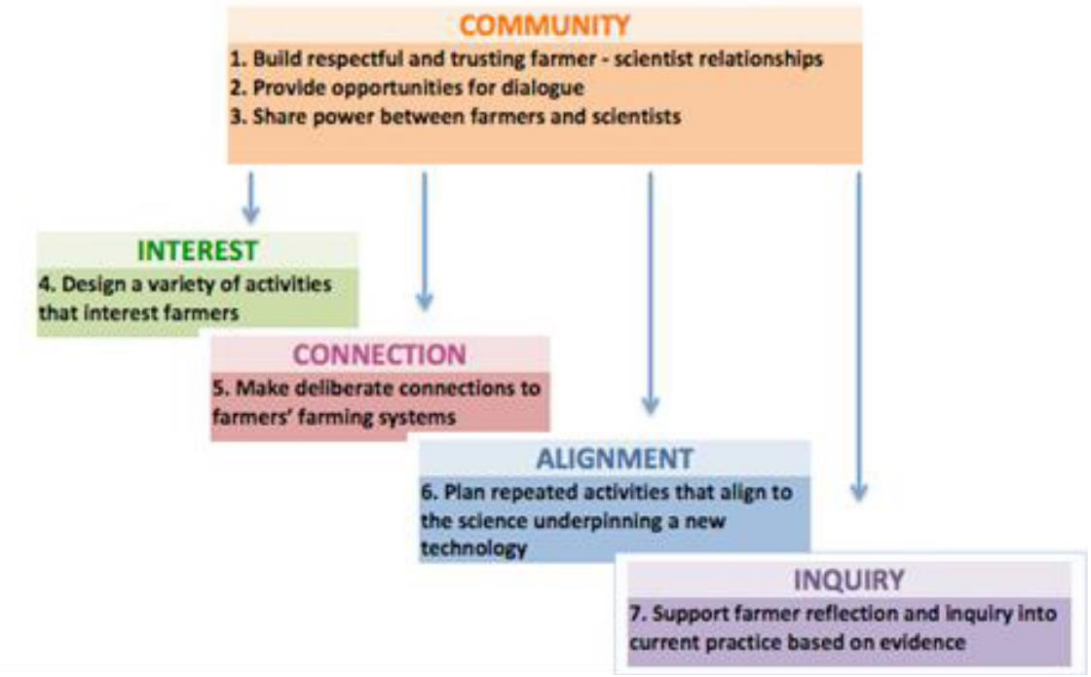
46. Landcorp/Pamu Farms have developed 64 LEP level 3 equivalent plans across their sheep and beef farms.

How Farmers Learn

47. Overwhelmingly farmers learn from those they trust and predominantly this is from each other or those that they have had a longstanding relationship with (Wood et al. 2014). For sheep and beef farmers this in the environment space was provided prior to the formation of regional councils by central government via their local Soil Conservator or where in the country regional councils have opted to retain soil conservation function by the Land Management Office (LMO). The success in this role being the relationship developed with the farmer. Over a number of years' farmers would learn collaboratively with the LMO about managing their farms natural resource through the implantation and annual review of 10 year works programmes outlined in LUC based farm plans.

48. Sewell et al., 2014 identified five critical success factors and seven educational principals required for promoting farmer learning (Figure 1). These factors and principals develop trust with the farmer and provide the opportunity for farmers to be an active and respected participant in enquiry. This framework shares al lot of similarity with the traditional function of the soil conservator or LMO.

Figure 1: Success factors and educational principles for promoting farmer learning.



49. In the absence of a soil conservation function or where the value in such investment is not seen there has been a tendency in New Zealand to switch to prescribed command and control change process where central agencies and in the water quality space regional councils have started to rely on hierarchical autoreactive change models that produce knowledge irrespective of local circumstances. These command and control change processes fail to empower learning (Wood et al. 2014[b]).

50. When faced with command and control environments the conversation is based on deficit, what is wrong, what is not working, who is to blame. This conversation threatens individual's self-image with people responding in three possible ways:

    (a) Ignoring the problem

    (b) Challenging the evidence

    (c) Resolving the conflict.

51. The harder or more negative the information the more likely people are ignore or deny it but conversely when the message focuses more on the

positive i.e. what have we got, what are the strengths and opportunities, much like an LUC based farm plan then change is more likely to adopted (Department of The Prime Minister and Cabinet 2019).

52. As we know in New Zealand local government tasked with both sustainably managing natural resources but unfortunately farmers lack trust in the advice on environmental performance provided by local governments (Brown et al. 2016). Brown et al. 2016 go onto sight empirical evidence that indicates that New Zealand farmers are more likely to adopt new practices after seeing them successfully demonstrated. The conclusion they then then draw is that 'local government would do well to partner with those of have tried the practices themselves and those with large farmer networks". B+LNZ have established a number of demonstration farms for this purpose. There are currently three B+LNZ Environment Demonstration Farms in the Waikato Region.

53. In work undertaken by the Department of Agriculture, Forestry and Fisheries in Queensland looking at the benefit-cost of addressing rural diffuse pollution with an integrated farm extension framework and published in the Extension Farming Systems Journal they present an argument that increased public investment in voluntary extension programs that target high risk agricultural sub-catchments is an economic efficient intervention to reduce rural diffuse pollution. Their study showed that a voluntary extension approach supported by incentives and investment in on farm trials, demonstration sites and including farmers as active participants in learning would have a positive internal rate of return of 13.4% from the ongoing investment by government with a benefit cost ration of 1.61 (Stockwell et al. 2012).

LAND USE CAPABILITY MAPPING

54. As stated above an LEP 3 represents the gold standard in tailored farm environment planning and as such LUC mapping is central.

55. LUC classification was developed for assessing the capacity of land for long term sustainable production. The LUC classification system is defined as "*[a] systematic arrangement of different kinds of land according to those properties that determine its capacity for long-term sustained production"*

(Lynn et al.,2009). Capability is used to refer to the sustainability of productive use or uses after taking into account the physical limitations of the land.

56. New Zealand Land Use Capability system (LUC), as detailed in Mr Stokes evidence, provides an established method for assessing characteristics of the natural capital of the landscape, as it recognises that not all land is the same and provides a system for assessing the opportunities and limitations provided by a parcel of land.

57. The LUC classification follows a national standard set in the Land Use Capability Handbook. The standards are regionally defined in regional land use capability extended legends and described in regional classification bulletins.

58. LUC mapping provides a valuable land use data base that can be used to make informed decisions regarding future use and management of land. LUC mapping at (at farm scale of approximately 1:10,000) is the accepted scale for undertaking farm and land management planning.

59. It is important to understand that the scale of the mapping determines its ultimate use. LUC mapping carried out at 1:50,000 is ideal for regional planning purposes but is not suitable for detailed farm planning. An LUC map at the farm scale provides detailed facts on rock type, soils, slope, erosion and vegetation as well as an assessment of the long term capability of the land for productive use.

60. Todd, M.D., 2018 illustrates the importance of farm scale LUC mapping. The pictures below are both the same landscape but in the second picture LUC is shown from NZRI at 1:50,000 plus. In the first picture we see farm scale LUC as mapped in a SLUI farm plan.

Figure 2: Farm Scale and Regional Scale LUC mapping

This picture shows **farm scale** Land Use Capability units mapped in the SLUI farm plan. It confirms that farm scale mapping is essential in order to get recommended land actions that are consistent with the mapped LUC and will produce results that make sense on the ground.

This picture shows **regional scale** New Zealand Land Resource Inventory (NZLRI) Land Use Capability Units for a severely eroding farm.

61. This example has important implications for modelling the effect of any land use actions on sediment reductions. According to Dymond et al 2014:

(a) 7e8 has a sediment discharge in the order of 20,000 Tonnes/km^2 /year;

(b) 7e1 has a sediment discharge in the order of 4,000 Tonnes/km^2 /year;

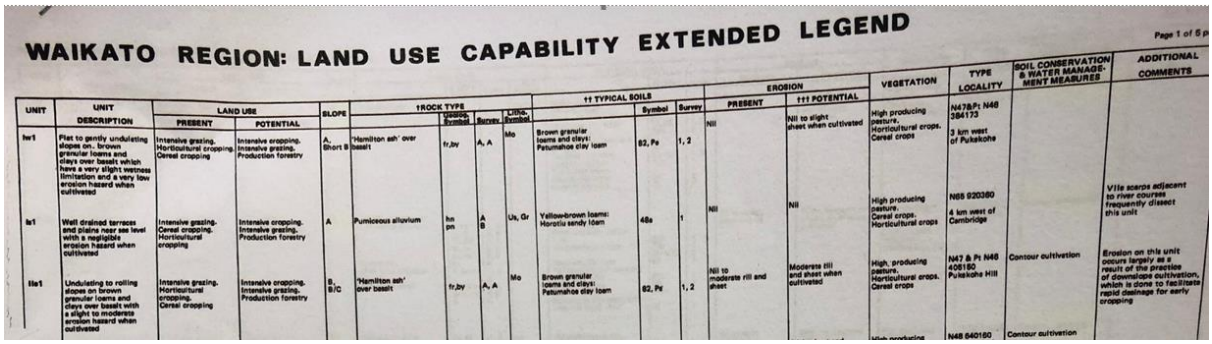
(c) 6e10 has a sediment discharge in the order of 6,500 Tonnes/km^2 /year;

(d) 6e7 has a sediment discharge in the order of 750 Tonnes/km^2 /year;

62. These differences are significant. For instance, at the regional scale the farthest ridgeline is identified as 6e7, whereas the farm-scale mapping shows it as 7e8. This is a difference in sediment discharge of 19,250 tonnes/km^2/year.

63. The Waikato Region LUC Extended Legend (Figure 1) includes land use suitability, main limitations, and management responses. LUC can be used to not only understand natural capital stocks but also to inform land use, farm systems, and management.

Figure 3. Waikato Region: Land Use Capability Extended Legend



WAIKATO REGION: LAND USE CAPABILITY EXTENDED LEGEND

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UNIT	UNIT DESCRIPTION	LAND USE		SLOPE	†ROCK TYPE				†† TYPICAL SOILS			EROSION		VEGETATION	TYPE LOCALITY	SOIL CONSERVATION & WATER MANAGEMENT MEASURES	ADDITIONAL COMMENTS
		PRESENT	POTENTIAL			Lithol. Symbol	Survey	Lithol. Symbol		Symbol	Survey	PRESENT	††† POTENTIAL				
1e1	Flat to gently undulating slopes on.. brown granular loams and clays over basalt which have a very slight wetness limitation and a very low erosion hazard when cultivated	Intensive grazing. Horticultural cropping. Cereal cropping	Intensive cropping. Intensive grazing. Production forestry	A. Short S	'Hamilton ash' over basalt	fr,bv	A, A	Mo	Brown granular loams and clays: Patumahoe clay loam	82, Pe	1, 2	Nil	Nil to slight sheet when cultivated	High producing pasture. Horticultural crops. Cereal crops	N67&Pt N48 384173 3 km west of Pukekohe		
1e1	Well drained terraces and plains near sea level with a negligible erosion hazard when cultivated	Intensive grazing. Cereal cropping. Horticultural cropping	Intensive cropping. Intensive grazing. Production forestry	A	Pumiceous alluvium	hn pn	A B	Us, Gr	Yellowbrown loams: Horotiu sandy loam	48a	1	Nil	Nil	High producing pasture. Cereal crops. Horticultural crops	N65 920380 4 km west of Cambridge		Vile scarps adjacent to river courses frequently dissect this unit
IIIe1	Undulating to rolling slopes on brown granular loams and clays over basalt with a slight to moderate erosion hazard when cultivated	Intensive grazing. Horticultural cropping. Cereal cropping	Intensive cropping. Intensive grazing. Production forestry	B, B/C	'Hamilton ash' over basalt	fr,bv	A, A	Mo	Brown granular loams and clays: Patumahoe clay loam	82, Pe	1, 2	Nil to moderate rill and sheet	Moderate III and sheet when cultivated	High producing pasture. Horticultural crops. Cereal crops	N47 & Pt N48 405180 Pukekohe Hill	Contour cultivation	Erosion on this unit occurs largely as a result of the practice of downslope cultivation, which is done to facilitate rapid drainage for early cropping
															N48 640180	Contour cultivation	

64. It is helpful for farmers to have a good land use database when managing the land. LUC support farmers to gain a good understanding of their natural capital and how it will influence their management decisions. I consider LUC is an appropriate way for PC1 to underpin tailored and robust approaches to farm environment planning, as well as subcatchment management which was discussed in my evidence in chief (paras 68, 77, and 87). The use of

LUC is considered further in Mr Stokes and Dr McKay's evidence, and I support their conclusions.

LIVESTOCK EXCLUSION, CULTIVATION, SLOPE AND SETBACKS

65. Mitigation methods are mostly based on natural processes to remove targeted contaminants and fall into three classes (McDowell et al., 2013):

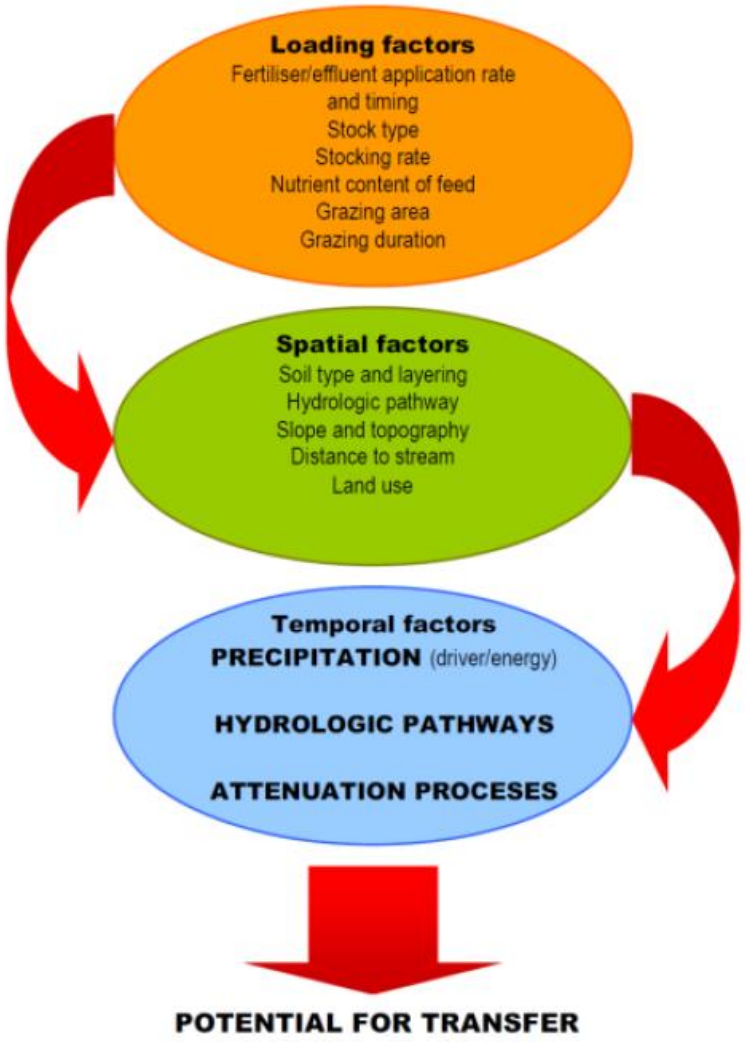
    (a) Land-based treatment of contaminants at source, often referred to as 'mitigation in the field';

    (b) Interception of contaminants along hydrological pathways often referred to as 'edge of field';

    (c) Bottom-of-catchment methods that treat contaminants within receiving waters.

66. How each mitigation method performs will vary according to its location, the contaminant load, time and natural physical features of the landscape (Figure 1). For example, riparian margins used for mitigating the loss of particulate contaminants have different treatment efficiencies according to the land slope, vegetative cover, seasonality and intensity and volume of rainfall, and soil drainage properties (Collins et al., 2005). Annual and seasonal variations in rainfall affect both the amount and timing of surface runoff and mobilised particulate material and hence, the efficiency of buffer strips (McDowell et al., 2013). The slope will govern the buffer strip width required for a given trapping efficiency. Hence if a constant 5m setback vegetated buffer strip was regulated then its efficiency for removing sediment, particulate P and *E. coli*, would vary as the slope of the land varies (Collier et al., 1995).

Figure 4: Controls governing pollutant transfer from pasture (from McKergow et al., 2007a)



67. Riparian margins wider than 3-5 m may have limited benefit for sediment mitigation because any filtering that was likely to occur has already occurred by this stage (Basher et al., 2016) but having said this if E. coli is a targeted contaminant then this may not be the case. The efficacy of stream fencing in reducing sediment loss will vary according to the relative contribution of stream bank erosion to sediment in a catchment, land slope and soil type (Dorner et al.,2018). Compared to sediment lost from streambank erosion, or on flat land, sediment generated from overland flow across farm land is likely to bypass riparian areas with virtually no sediment being captured when it is generated from larger rainfall events, or where slope is increased (Dormer et al., 2018). As such the establishment of pre-determined riparian setback areas through regulation such as proposed in PC1 are likely to have

limited utility. The extent of the riparian setback should be determined in relation to slope and soil type. Setbacks could be calculated according to the following formula (x meters) plus 0.65 X the slope (Barling & More, 1994). With slope being taken from the Land Resource Inventory (LRI) or LUC unit description in the extended legend, to aid determination in the field and reduce subjectivity. For example, if we take the 1m baseline minimum set back then at 15^{o} the setback would be 1 + (0.65 X 15) = 10.75m and for 20^{o} 1 + (0.65 X 20) = 13. In the hill country for example gully retirement in areas which are at risk of erosion would be more effective than riparian setback areas. These are best determined through tailored farm environment planning, which takes into account geology, rainfall, and risk of contaminant losses from the activity.

68. Riparian fencing, however provides an opportunity to decrease stream bank sediment loss (McKergow et al., 2007; Newbold, 2014), without the need for a farmer to make significant changes to their farm system (Doole et al., 2018), as well as stopping direct deposition of faecal matter from livestock standing in waterbodies. Hence the popularity of riparian fencing in programmes both regulatory and non-regulatory aimed at improving water quality in New Zealand for more intensive land uses and in flat to rolling terrain (Dormer et al., 2018).

69. According to Land Air and Water Aotearoa stream order is a measure of stream or river size defined by the degree of branching in a drainage system. For example, a first-order stream has no tributaries, while a second-order stream has at least two first-order tributaries. A third-order stream must have at least 2 second-order tributaries.

70. Additionally, according to NIWA the River Environment Classification (REC) is a database of catchment spatial attributes, summarised for every segment in New Zealand's network of rivers. The attributes were compiled for the purposes of river classification, while the river network description has been used to underpin models.

71. In work published by McDowell et al. 2017 they modelled the significance of catchment characteristics (e.g. climate, topography, geology, and cover) as captured by the REC and stream order in order to estimate contamination yield. On average the yields of all contaminants increased with increasing

stream order in catchments dominated by agricultural land use. Loads from low order small streams (<1m wide 30 cm deep surrounded by pastoral land use) accounted for an average of 77% of the national load, or put another way, fencing off higher order streams from livestock misses 77% of national contamination load. According to McDowell et al. 2017 this meant that to substantially reduce contaminant losses other mitigations should be investigated in small streams, particularly where fencing of larger streams has lower efficacy.

72. Fencing of small streams on hill country farms (greater than 15 degrees slope) is often technically challenging and cost prohibitive (Daigneault et al., 2017; Ministry for Primary Industries, 2013). Where fencing is technically challenging and or prohibitively expensive a range of less costly strategies are often available. These strategies may also be beneficial and act as insurance against the failure of fencing to mitigate contaminant losses (McDowell et al., 2017). An example of the failure of fencing would be an ephemeral flow path (e.g. swale) transporting faecal matter from a livestock camp into a higher order stream via overland flow.

73. As I concluded in my HS1 evidence, targeting mitigations to areas that account for the majority of farm losses is more cost effective as often these losses come from a minority of the farm's area (i.e. critical source areas, CSAs) (McDowell et al. 2014). Improved knowledge and delineation of CSAs will improve the cost effectiveness of mitigation measures; the development of tools such as MitAgator^{TM} will support this (McDowell et al. 2015).

74. A specific farm environment plan would allow the livestock owner to identify risk and prioritise actions across their property for the purpose of maintaining and enhancing water quality. It would allow for the complexity and dynamic nature of the farming landscape by supporting active management of livestock and water at the farm and paddock scale. With mitigations being target at contaminant of concern in a catchment. This may include a combination of permanent and temporary fencing based on risk and management. For example, temporary fencing could be used to exclude livestock from swales and ephemeral flow paths while they are transporting surface water. Other effective management approaches to reducing the risk

of stock accessing waterbodies include provision of shade and shelter away from waterbodies, water reticulation, and stock management approaches such as how stock are mustered or the types of stock kept in specific paddocks.

75. Land Use Capability assessment provides a useful tool to determine the predominate slope of a parcel of land, its stock holding capacity, as well as its limitations including for cultivation. As I have already noted above, as part of a specific FEP farm scale (1:10,000) plan, LUC mapping should be undertaken. This assessment is undertaken regardless of land use and is used to ascertain the lands capability for use, while taking into account it's physical limitations and its versatility for sustained production (Lynn et al.,2009). In most cases pasture harvested from various LUC classes is typically closely correlated to the natural carrying capacity and the subsequent suitability of the land to carry a certain stocking rate.

76. The LUC Extended Legend for the Waikato Region identifies present and potential land use, slope and soil conservation and water management measures for each LUC unit.

77. For an LUC unit the slope angle is measured from the horizontal in degrees and the dominant slope within the map unit area is recorded as one of the following seven slope groups (table 1). In the field dominant slopes are measured by hand-held Abney level or clinometer, or estimated by eye (Lynn et al.,2009). The use of Digital Elevation Mapping such as LIDAR can be used to generate slope maps. From personal experience when using this technology is still important to focus on the dominant slope class to avoid unnecessary complexity.

Table 1: Land Use Capability Slope Thresholds

Slope	Slope angle (degrees)	Description	Typical examples
A	0-3^{o}	Flat to gently undulating	Flats, terraces
B	4-7^{o}	Undulating	Terraces, fans
C	8-15^{o}	Rolling	Downlands, fans

Slope	Slope angle (degrees)	Description	Typical examples
D	16-20º	Strongly rolling	Downlands, hill country
E	21-25º	Moderately steep	Hill country
F	26-35º	Steep	Hill country and steeplands
G	>35º	Very steep	Steeplands, cliffs

78. In the LUC Extended Legend for the Waikato Region only six LUC units with a slope class above C (8-15º) have 'potential' for 'occasional cropping'. These are 4e1, 4e2, 4e3, 4e4, 4e5 and 4e6. All of these LUC units can be found on slopes up to slope class D (16-20º). All these LUC units require 'Contour Cultivation' and if the extended legend were to be revised would require minimum tillage. According to the explanatory notes for cultivation for cropping in the LUC Hand book (Lynn et al.,2009) when renewing pasture, it is common practice is to sow a forage crop and re-sow in pasture after the forage crop has been fed off. This is not sufficient to justify the land being classed as suitable for cultivation for cropping. 'Suitable for cropping' means, that under good management the land is capable of growing at least one of the common field crops normally grown in that region without any permanent adverse soil affect. 'Cultivation for cropping' and arable' use implies that the land is capable of producing on of these crops at least once every 4 or 5 years.

79. As such cultivation on hill country farms should be able to be undertaken with low risk to the environment, where it is undertaken in accordance with farm scale LUC mapping and tailored FEP as long as appropriate soil conservation measures have been implemented (this could include appropriate stream buffers or setbacks), this assessment could be made by the Land Management Officer from the Regional Council or other qualified soil conservation practitioner.

RECOMMENDATIONS

80. Farm specific environment plans incorporating farm scale LUC and CSA management are the vehicle to implement the Agreed National Good Farming Practice Principals (Appendix 2) for the sheep and beef industry. This approach enables farmers/land managers to implement GFP actions specific to their farm that report against these broad national GFP principals or outcome statements.

81. The strategic grazing of winter fodder crops. Orchiston et al.2013 hypothesised that loses of sediment, phosphorus and E. coli could be considerably reduced through the protection of the CSA which accounted for less than 2.5% of total paddock area. As illustrated in Appendix 3 in the control catchment cows were strip grazed from the bottom of the paddock and moved up slope with unrestricted access to the CSA. In the treatment the cows were strip-grazed from the top of the paddock and moved downslope, with restricted access to the CSA. This trial demonstrated that by simply changing gazing management 80-90% reductions in sediment and phosphorus loss were achieved in the paddock receiving the strategic grazing treatment (Orchiston et al.2013).

82. It is my recommendation that FEPs including farm scale LUC maps along with a revised LUC Extended Legend for the Waikato Region be used to ascertain the land's capability for sustained use and to identify soil conservation and other mitigation measures to manage the land within the capability limits of its natural capital. The farm's LUC map can be used identify areas suitable for cropping, match management considerations and plan stock exclusion/management around waterways, including the identification and management of stock crossing point. FEPs based on LUC match land use to land capability. The FEP then identifies a programme of work custom made for the property. Critical areas such as very steep slopes, waterways, wetlands and highly erodible areas are identified, delineated and a programme of management put in place to remediate present erosion and reduce the potential for future problems.

R Parkes
3 May 2019

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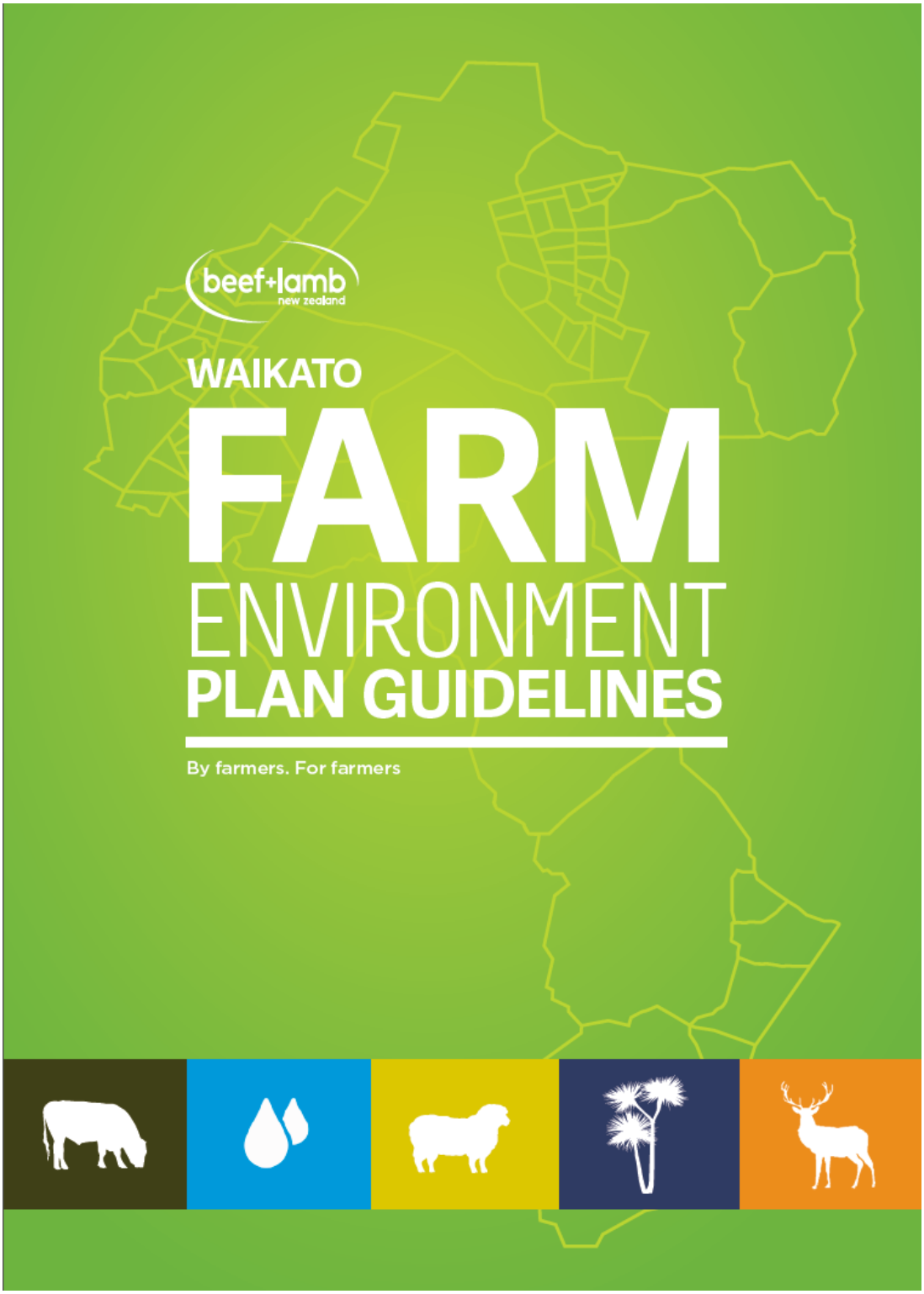
APPENDIX 1: BEEF + LAMB NEW ZEALAND FARM ENVIRONMENT PLAN GUIDELINES FOR THE WAIKATO REGION AND DRYSTOCK MENU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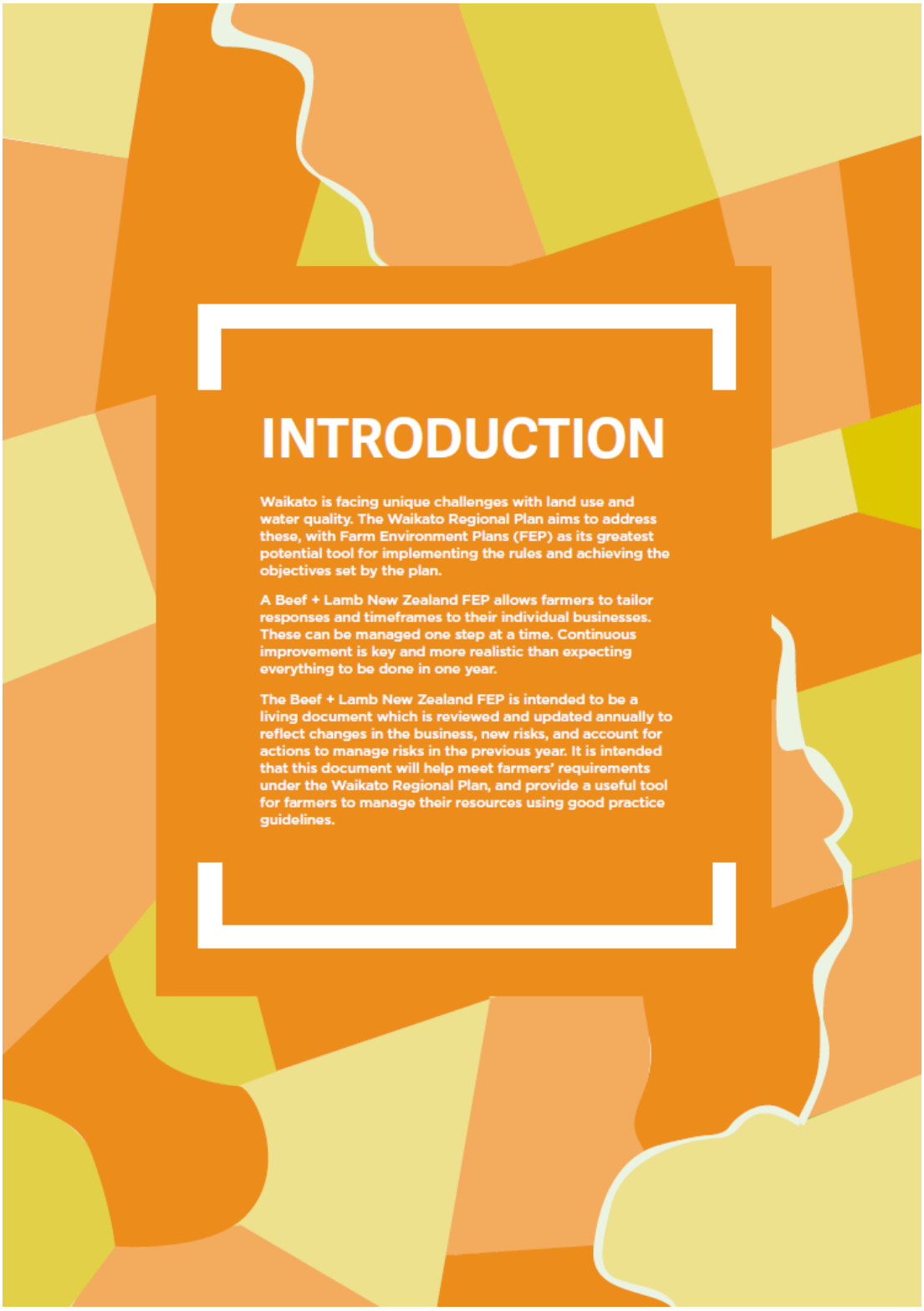
WAIKATO
FARM
ENVIRONMENT
PLAN GUIDELINES
By farmers. For farmers



INTRODUCTION

Waikato is facing unique challenges with land use and water quality. The Waikato Regional Plan aims to address these, with Farm Environment Plans (FEP) as its greatest potential tool for implementing the rules and achieving the objectives set by the plan.

A Beef + Lamb New Zealand FEP allows farmers to tailor responses and timeframes to their individual businesses. These can be managed one step at a time. Continuous improvement is key and more realistic than expecting everything to be done in one year.

The Beef + Lamb New Zealand FEP is intended to be a living document which is reviewed and updated annually to reflect changes in the business, new risks, and account for actions to manage risks in the previous year. It is intended that this document will help meet farmers' requirements under the Waikato Regional Plan, and provide a useful tool for farmers to manage their resources using good practice guidelines.

STEPS

ONE
PREPARE FARM MAP

TWO
DEFINE AND DESCRIBE LMUs

THREE
IDENTIFY STRENGTHS AND WEAKNESSES FOR EACH LMU

FOUR
REVIEW NUTRIENT BUDGET INFORMATION

FIVE
LIST ENVIRONMENTAL OBJECTIVES AND OUTLINE CURRENT PRACTICES

SIX
IDENTIFY NEW ACTIONS BASED ON IDENTIFIED RISKS

SEVEN
IMPLEMENT, MONITOR AND REVIEW

GUIDELINES

WAIKATO FARM ENVIRONMENT PLAN

Note: One Farm Environment Plan (FEP) is needed per property or farming enterprise which may include a number of properties in common ownership. If you own more than one property in the same catchment then one FEP may be enough—check this with the Waikato Regional Council.

This guide provides a step-wise approach for the preparation of Waikato Farm Environment Plans (FEPs).

It has been developed to help Waikato farmers complete an FEP which satisfies the requirements of Waikato Regional Council (WRC).

An FEP is a way to demonstrate good management to the regional council, but also identify opportunities for efficiency gains within your business. It shows the wider community that farmers are good caretakers of the land and records the unique aspects of your property for future management.

An FEP is good for your business as well as the environment.

To complete this FEP you will need:

- An aerial photo or farm map
- A recent nutrient budget (completed using OVERSEER®).
- The information required to complete the workbook.

INSTRUCTIONS

This guide includes:

- WRC defined environmental objectives
- A list of common good management practices
- Examples of LMUs (Land Management Units), a map, descriptions, strengths and weaknesses.

By completing this Waikato FEP and implementing your plan you will be joining the growing number of farmers future-proofing their business.

This FEP should be completed at a Beef + Lamb New Zealand (B+LNZ) workshop or with support from a farm advisor, regional council representative or other technical advisor. A trained facilitator and WRC staff, will be available at workshops to answer your questions and help you prepare your FEP. To meet the requirements of WRC, your FEP must be approved by a Certified Farm Environment Planner.

ONE
PREPARE A FARM MAP

Create a farm map that shows sites of interest for farm environment planning.

Obtain an aerial photo (copy)

Many farmers already have an aerial photo or an orthophoto of their farm. These can be obtained online (e.g. Google Earth), from commercial suppliers, rural practitioners or WRC. Photography outlets, printers, copy centres and desktop publishers can provide large format copies and resizing.

Orthophotos are strongly recommended because they have been digitally corrected to remove distortions caused by camera tilt, lens curvature and terrain unevenness.

Make at least three copies of the farm photo. Minimum size should be A3 (297 x 420 mm), but bigger is better for farm mapping. Spanning the farm photo across two or three A3 size pages achieves a detailed but manageable scale.

Increasingly there is electronic mapping or planning packages available so you can create your map on your computer, including separate layers for different items, e.g. waterways, fences, pipelines.

Colour maps or aerial photos are needed, rather than black and white.

Map relevant features (required)

1. Mark in a north arrow and give the map a name (e.g. Smith's Farm Map).
2. Map features of interest. These can be natural (e.g. wetlands, waterways) or constructed (e.g. buildings, tracks).
3. Minimum features to map include:
   - The boundaries of the property;
   - The locations of the main land uses that occur on the property;
   - The locations of existing and future actions to manage contaminant loss;
   - Any internal property boundaries that relate to risks and actions described in this plan;
   - The location of continually flowing rivers, streams, drains and permanent lakes, ponds and wetlands;
   - The location of riparian vegetation and fences adjacent to water bodies; and
   - The location of critical source areas for contaminants.
4. Use symbols, lines, hatching and colour to differentiate features.
5. Create a legend that lists and describes what each map symbol represents.

Additional features for consideration (optional)

- Shelterbelts
- Bores
- Conservation trees
- Detention dams and other structures
- Dumps
- Prevailing wind direction
- Archaeological sites
- Chemical storage sheds
- Runoff points to water (dips, yards, tracks)
- Power pylons, pipelines, easements
- Cultural sites
- Pest or weed control areas.

The endpoint of this step is a **farm map** for your FEP.

TWO
LAND MANAGEMENT UNITS

Land Management Units (LMUs) are areas of land that can be farmed or managed in a similar way because of underlying physical similarities.

They can represent a static snapshot of how land is currently used, or an insight into how land could be used if all physical opportunities were realised.

Designing new Land Management Units involves:

1. Grouping similar land types
2. Evaluating strengths and weaknesses
3. Developing a resource chart.

If a part of the farm is managed uniquely then it should be a separate unit.

Your LMUs should be the same as the blocks used in your OVERSEER nutrient budget.

How well matched is the current system?

Can land management be changed to better the land resource?

Can the land resource be developed to improve land use?

What are the opportunities? What are the limitations?

LMUs represent farming's interaction with the physical landscape. The idea is to better clarify what you have (the land resource) so it can be better matched with what you need (a productive sustainable farming system).

DESIGN LAND MANAGEMENT UNITS

Create a map of Land Management Units (LMUs).

Group similar land types into LMUs

Aim to aggregate the many different land types into a more manageable set of LMUs.

Many small areas can be grouped as one LMU (e.g. patches of bush).

For the remainder, consider each land type individually. What makes it different? Does it have favourable qualities? Unfavourable qualities? Can it be grouped with other similar land types?

You may already have different management blocks, e.g. lambing block, beef unit block, cropping block, back country block. Map these existing management blocks against your Land Resource Map (either on a second copy, or on the one already prepared if it is not too cluttered).

LMUs are meant to be practical so use existing fence lines to define unit boundaries (unless you identify an opportunity that requires changes to fence lines). Other factors to consider when drafting LMUs are listed opposite.

LMUs may be based on OVERSEER topography classes, e.g:

- Flat (0-7°)
- Easy (8-15°)
- Rolling (16-25°)
- Steep (>25°)

Other considerations for the design of LMUs

- Riparian zones
- Soil type/soil order
- Natural drainage
- Dryness
- Iron or clay pans
- Changes in geology
- Soil depth
- Erosion—existing and at risk areas
- Aspect
- Stoniness
- Flooding frequency
- Elevation
- Contour and slope
- Workability
- Soil texture (e.g. clayey, sandy, etc.)
- Areas at different stages of development
- Erosion management areas
- Wetlands
- Fragile soils
- Pugging management areas
- Weed or pest control areas
- Stock risk areas (gorges, tomos)
- Fertiliser policy
- Irrigation (separated by type)
- Climate
- Accessibility
- Distance from services and facilities.

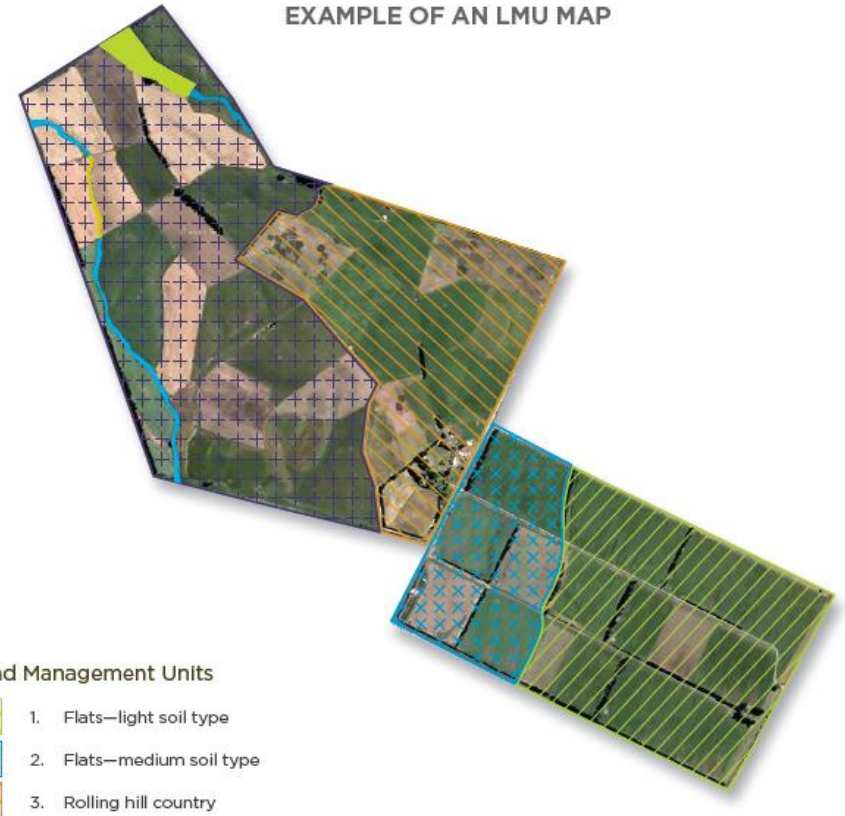
The endpoint of this step is a **map of the LMUs** on your farm.

LAND AND SOIL INFORMATION

Some farms already have detailed land resource maps. This may be a soil map, or a Land Resource Inventory (LRI) and Land Use Capability (LUC) map surveyed by a regional council or catchment board. Detailed Waikato soil information is available at **smap.landcareresearch.co.nz/home.**

SMap soil factsheets also include OVERSEER input information for soil types.

EXAMPLE OF AN LMU MAP



Land Management Units

1. Flats—light soil type
2. Flats—medium soil type
3. Rolling hill country
4. Dryland rolling hill
5. Forestry
6. Fenced riparian areas
7. Unfenced riparian areas

THREE
STRENGTHS & WEAKNESSES

Evaluate the strengths and weaknesses of each LMU.

List strengths and weaknesses of each LMU

What is defined as a strength or weakness depends on the management purpose being considered. For example, stoniness may be a weakness in terms of higher for nitrogen leaching loss, but it may represent a strength for winter grazing (to avoid pugging).

Think about strengths and weaknesses for each block for nutrient loss, livestock access to waterways, irrigation management (if applicable), as well as other factors.

Record strengths and weaknesses under the appropriate headings in the resource chart on pages 4 and 5 of your workbook. Include environmental risks related to nutrient, soil, and waterway management. As you work through the table you may identify opportunities that require LMUs to be modified. Examples of possible strengths and weaknesses are listed below.

Examples of possible strengths

- Free draining
- Deep topsoil
- Good soil moisture-holding ability
- High natural fertility
- Good soil structure
- Balanced soil texture (e.g. loam)
- Resistant to pugging
- Well aerated
- Optimum fertility
- Optimum pH
- Flat land
- Naturally sheltered
- Warm aspect
- Stable (no erosion)
- New pasture
- Good pasture quality
- Shelter—maybe good lambing or fawning blocks
- Artificially drained
- Low insect risk
- Low in weeds
- Good stock access to water
- Good machinery access.

Examples of possible weaknesses

- Poorly drained
- Shallow topsoil
- Poor soil moisture-holding ability
- Low natural fertility
- Poor soil structure
- Susceptible to pugging or compaction
- High water table
- High nutrient leaching
- High runoff risk
- Excessive stoniness
- Hot dry aspect
- Wet cold aspect
- Drought prone
- Erosion prone
- Flooding risk
- Low quality pasture
- Excessively steep
- Exposed
- Weed or pest problems
- Poor stock access to water
- Poor machinery access
- Inefficient irrigation system.

RESOURCE CHART

Describe and record the characteristics, strengths, and weaknesses of each LMU.

Describe the physical characteristics of each LMU.

Prepare a resource chart. An example is provided on the next page.

Refer back to the farm resource map to describe physical characteristics of each LMU.

Based on the resources, strengths and weaknesses identified, are there any opportunities or constraints in the current management blocks that could be changed to better use your land? Consider adding these to the Action Plan on page 16 of the workbook.

Example of a resource chart (not related to LMU map on page 5)

LMU	DESCRIPTION	STRENGTHS	WEAKNESSES	USES AND MANAGEMENT
		Medium water holding capacity		
		Free draining	Susceptible to grass grub	
		Uniform soil type	New grass every four years	
		Some shelter (west)	Can be wind prone	
		High P retention	Susceptible to N leaching	
		Good access	Drought prone/looses moisture	Dairy support
A1+A2	**Main block**	Good infrastructure	High P retention	Pasture
		Medium water holding capacity		
		Free draining		
		Uniform soil type		
		Some shelter (west)	Susceptible to grass grub	
		High P retention	Can be wind prone	
		Good access	Susceptible to N leaching	
		Good infrastructure warm early country	Drought prone/looses moisture	
		Minimal frosts	High P retention	
				Dairy support
B	**Lucerne**	50% Better than grass—can yield up to 22 tonne	Variation in yield 12-22 tonne	Lucerne
				Dairy support
		Warm—sheltered	Winter wet	Pasture
C	**River flats**	Low P retention	Isolated	Some cattle wintering
			Pugging with cattle in winter	
		Heavy soil—holds moisture	Seasonal surface water	Pasture
D	**Water race**	Low P retention	Long narrow block	Dairy support

FOUR
NUTRIENT BUDGET

Quantify farm nutrient balances using Land Management Units.

OVERSEER nutrient budgets are a standard component of good management practice in modern farming, ensuring continuous improvement through efficient fertiliser use and helping minimise nutrient losses from the farm.

Most farmers in Waikato need to use OVERSEER for nutrient budgeting and to understand what your modelled Nitrogen loss is. The dates you need to model vary between catchments.

Waikato Regional Council can provide specific information relevant to your catchment that sets out what Nitrogen requirements apply to your property.

Fertiliser representatives and some farm advisors can prepare nutrient budgets using OVERSEER.

It is important to have someone who is trained and certified in operating OVERSEER to ensure the results are valuable.

Your nutrient budget should be updated annually. The information it provides is key to understanding your nutrient management risks and opportunities.

Appendix two outlines the record keeping requirements that will ensure the completion of your nutrient budget is relatively straight forward.

Review the nutrient budget

1. Is nutrient loss from specific LMUs a risk which is not currently well managed? It is important to recognise that even if average farm nutrient loss is low, there may be blocks where it is high. These "hotspots" are common and if they are managed to the best of your ability then this should be explained in the following sections.
2. Is your nutrient budget up to date and do you meet the WRC nutrient loss requirements for your area?

Depending on how you answered the two questions above, there may be some actions to include in the following sections.

The endpoint of this step is your most current **OVERSEER nutrient budget.**

FIVE
ENVIRONMENTAL OBJECTIVES

Demonstrate how you will manage environmental risks.

FEPs need to contain a set of actions that describe how environmental risks are managed within a business, including changes that will be made where necessary.

This section looks at meeting objectives for managing farm environmental risks.

You should use the following objectives here as the basis for meeting WRC's requirements.

Objectives

1. **Nutrient management:** To maximise nutrient use efficiency while minimising nutrient losses to water in order to meet specified nutrient allowances.
2. **Soil management:** To maintain or improve the physical and biological condition of soils in order to minimise the movement of sediment, phosphorus and other contaminants to waterways.
3. **Wetlands and riparian management and stock exclusion:** To manage wetland and waterway margins to avoid damage to the bed and margins of a water body, avoid direct input of nutrients, and to maximise riparian margin nutrient filtering.
4. **Land use and grazing management:** To manage and assess the appropriate land use and grazing management for specific areas on farm in order to maintain and improve the physical and biological condition of soils and minimise the diffuse discharges of contaminants.
5. **Irrigation management:** To operate irrigation systems (if applicable) that are capable of applying water efficiently and management that ensures actual use of water is monitored and is efficient.
6. **Biodiversity:** To maintain and enhance on farm biodiversity.
7. **Pest management:** To coordinate an effective pest management strategy.
8. **Offal pits, silage and effluent, runoff from stock yards, tracks, races and rubbish dumps:** To manage the number and location of these sources to minimise risk to health and water quality.
9. **Critical Source Areas management:** To identify and manage the critical source areas from which N, P, sediment and pathogens are lost.
10. **Any objective which is specific to the farm.**

Note: if collected animal effluent is part of your farm system—e.g. imported dairy or pig farm effluent—this will need to be included in your FEP with an objective to minimise environmental impacts of its use. Current management will need to be described and risks identified (e.g. runoff, leaching). WRC staff and workshop facilitators can assist with this if it is relevant to your farm.

Now complete the Environmental Objectives table starting on page 6 of your workbook.

The objectives need to be listed first, then under each one record the practices you employ to help you meet it and the evidence you could show to demonstrate this to an auditor.

Appendix one lists a large range of good management practices—use this for ideas. Examples of ways to demonstrate good practices range from visible evidence on farm to record keeping.

Every farm will have different issues and practices—if there is something relevant that you do to manage a risk which is not listed in the appendix, it should still be recorded.

The endpoint of this step is a completed table of **written objectives**—as listed above or modified for your local situation—with a list of current, relevant, good management practices under each objective.

EXAMPLE

Objective one—Maximise nutrient use efficiency while minimising nutrient losses (specifically nitrogen and phosphorus) to water in order to meet specified nutrient allowances.

What practices help you achieve objective one?	How can you demonstrate this?
All fertilisers are applied in lower risk months (no N or applied in May–July, and no P applied June–September).	Farm diary records fertiliser application dates, rates, soil temperature and rainfall.
Fertiliser policy is based on fertiliser representative's advice, informed by annual OVERSEER nutrient budget and two yearly soil testing to transects.	Proof of placement maps retained for all fertiliser applications in last five years.
We leave a minimum 5m wide uncultivated margin along streams in winter feed paddocks. When grazing we fence this with a single hot-wire to prevent cattle access and maintain the vegetated strip.	Annual nutrient budgets and fertiliser recommendations retained.
Soil temperature is above 7°C and rising, and pasture is at least 25mm high (1000kg DM/Ha) before nitrogen is applied.	
Certified contractor used for all fertiliser application, with calibrated equipment and GPS technology. No fertiliser applied directly into waterways.	

Some common examples of practices to achieve the objectives include:

- OVERSEER nutrient budget prepared for farm and for each LMU—reviewed annually.
- Nutrient budget used in assessment of options for minimising nutrient loss and maximising nutrient efficiency.
- Technical advisor used to determine nutrient management policies.
- Stock excluded from all waterways and wetlands in accordance with WRC requirements.
- Culverts or bridges at stock crossings.
- Key sites (critical source areas) for phosphorus and sediment losses identified on map.
- Alternative sources of stock water in each paddock (e.g. reticulated water in troughs).
- Olsen-P maintained at optimum levels.
- No super-phosphate application in high-risk months (June–September).
- No May, June, July applications of N fertilisers.
- Nutrient allocation zone N loss limits meet local rules.
- Excessive N-fertiliser rates avoided (>50kg N/application or >150kg N/ha/yr (on pasture).
- Equipment used for fertiliser application is suitably calibrated.
- N applied when soil temperature above 7°C and rising.
- Stock moved off wet soils in winter.
- Soil testing/plant analysis programme.
- Afforestation of erosion prone areas or use of poplar/willow poles for erosion control.
- Stock class matched to soil type and land capability.
- Direct drilling or minimum tillage used in preference to conventional cultivation.
- Wider riparian buffers provided at low points to filter any run-off.
- Risks of leachate from silage pits identified and managed.
- Rubbish dumps and offal pits located in areas where there is no risk of groundwater contamination.
- Weather forecasts and soil temperature monitored and used in irrigation decision making.
- Soil moisture monitored and used for irrigation decision making.

See a longer list in appendix one for further ideas.

Note: these do not apply to every farm situation but should offer a prompt.

SIX
ACTION PLAN

You have recorded the good things you do in a way that will help you demonstrate good management.

This step is where you record the issues or opportunities you have identified to further improve your business. This may include changes to Land Management Units identified in section two.

This list of actions will be different for every farm; depending on your system, current practices and degree of environmental challenge. You might only have a short list of additional responses or you might have identified a number of opportunities to improve.

Use appendix one again for ideas. Note that good practices can be highly catchment and farm specific in terms of their relevance and practicality.

It is likely your progress will be measured against this list in the future through an independent farm plan audit—so make sure the listed actions are realistic.

It is important not to try and do everything in one year. Completing an FEP is an achievement in itself. The actions identified should be prioritised and handled as the business capability allows.

Consider actions listed in appendix one and use the action plan template provided in your workbook to draw up a list of additional actions. An example is shown below.

Review opportunities and environmental issues identified at each preceding step.

Consider your nutrient budget—specifically N and P loss to water and whether there is opportunity to reduce these. Is your nutrient budget up to date?

Ensure responses are SMART (**S**pecific, **M**easurable, **A**chievable, **R**elevant and **T**ime-bound). This means using the list in appendix one for ideas but modifying what you write for your own operation to make it specific. Appendix four shows examples of specific responses.

Please refer to the Drystock Farm Menu in your toolkit for ideas on environmental management.

EXAMPLE—ACTIONS IDENTIFIED

Issue/risk	Significance (L/M/H)	Response	Timeframe	Responsibility	Additional benefits
Phosphorus loss and soil damage in winter feed paddocks.		Shift breaks towards streams instead of away from to maximise the runoff filtering benefit of the crop. Leave a vegetated buffer strip next to waterways in all winter feed paddocks—3m minimum width.	Starting with next Autumn sowing and ongoing after that—review the following year.	Manager	Help prevent soil compaction. Captures nutrients and minimises nutrient loss to water.
Ongoing problem with soil erosion on back hill.		Phone Regional Council for advice on which variety and order poles for next year. From next year, plant 40 poplar poles on back hill annually for three years.	2014-2017	Manager	Shade and shelter for stock.

SEVEN
IMPLEMENT, MONITOR & REVIEW

Congratulations on designing a Farm Environment Plan specific for your farm.

Implement each response according to your timeline:

- Monitor and record all your achievements
- Remember to review and reassess each year.

Once your plan is complete, sign the document on page 22 of the workbook.

APPENDIX ONE

Note: these do not apply to every farm situation but should offer prompts

NUTRIENT BUDGETING

- OVERSEER nutrient budget prepared for farm and for each LMU/block
- Nutrient budget reviewed annually and revised if necessary
- Nutrient budget used in assessment of options for minimising nutrient loss and maximising nutrient use efficiency
- Use of technical advisor to determine nutrient management policies.

PHOSPHORUS AND SEDIMENT LOSS

- Stock excluded from at-risk streams with fences or other methods
- Culverts or bridges at stock crossings
- Key sites for phosphorus and sediment losses identified
- Alternative sources of stock water in each paddock (e.g. reticulated water in troughs)
- Consider strategic vegetated-buffer areas where runoff converges
- Vegetated riparian buffer strips maintained around waterways (intensely farmed areas)
- Olsen-P maintained at optimum levels
- No direct application of P-fertiliser application into waterways
- Use slow release P-fertiliser
- No super-phosphate application in high-risk months (June–September)
- No over-grazing of pastures prone to drying out
- Phosphate fertiliser application rates consistent with nutrient budget rates
- Fertiliser application rates based on advisor's recommendations
- Regular soil tests (specify frequency) undertaken as aid to determining P needs
- Plant analysis undertaken as aid to fertiliser needs
- Equipment used for fertiliser application is suitably calibrated
- Maximum fertiliser application rates set
- GPS technology used for precise application of all P fertiliser
- Cattle grazed on and off fodder block
- Straw bales placed in low spots to adsorb runoff from fodder crop block
- Strip next to riparian margins grazed last when break feeding winter feed crops
- Ensure runoff from areas of high animal concentration (e.g. yards, frequently used tracks and stock camps) is discharged onto land rather than into waterways
- Move troughs and gateways away from areas of high water flow
- Manage or retire bogs and swampy areas
- Provide deer wallows away from waterways
- Cultivate along contours rather than up and down slope where slope >3 degrees.

RUBBISH, OFFAL AND SILAGE

- Offal pits located in areas where there is no risk of contamination of groundwater
- Offal pits covered and or fenced—think of child safety and vermin
- Composting used for dead stock disposal
- Risks of leachate from silage pits identified and managed
- No runoff of leachate from silage pits to waterways including drains
- Farm rubbish dumps located in an area where there is no risk of contamination of groundwater.

NITROGEN LOSS

- No May, June, July applications of N fertilisers
- Nutrient allocation Zone N loss limits met (see WRC information sheet for local rules)
- No N fertiliser applications when heavy rain is forecast
- Avoid excessive N-fertiliser rates (>50 kg N/application or >150 kg N/ha/yr (on pasture; crops may be higher))
- Ensure other nutrients are non-limiting (maximise N-uptake opportunity)
- Undertake a comprehensive nutrient analysis using OVERSEER Nutrient Budgets
- N fertiliser application rates based on Advisor's recommendations
- N fertiliser application. rates based on industry crop models
- Deep soil N tests used as basis of N applications to crops
- Plant analysis used as tool to determine N application rates
- Equipment used for N application is suitably calibrated
- N application rates set to match growth cycle of pasture or crop
- Pasture is at least 25mm high (1000kg DM/Ha) before nitrogen is applied
- N applied when soil temperature above 7^{0}C and rising
- N is not applied when soils are at field capacity as measured using soil moisture equipment
- N is not applied to severely compacted soils
- Cultivation practices and timing adjusted to minimise N losses
- GPS technology used for precise application of all N fertiliser spread
- When feeding winter fodder crops, stock stood off block for at least four hours
- Crop rotation designed to utilise residual nitrogen in soil, e.g. cereals following fodder crops.

SOIL AND EROSION MANAGEMENT

- Move stock off wet soils in winter
- Soil testing/plant analysis programme
- Heavy machinery restricted to specified pathways
- Regular checks for soil compaction undertaken for high risk soils
- Crop residue retained to improve soil structure
- Significant soil compaction managed through soil aeration
- Differences in soil susceptibility to compaction recognised and managed to minimise damage
- Space planted poplar poles on hill slopes at appropriate densities
- Retirement from grazing of severely erosion prone areas, particularly those with marginal production value
- Afforestation of erosion prone areas
- Use of containment structures for certain erosion types (e.g. debris dams)
- Strategic tree planting to protect key infrastructure from erosion (fences, tracks, buildings, public roads)
- Design or locate tracks, fences, etc. in a way that minimises the risk of erosion damage
- Engage a regional council advisor/officer or similar specialist for advice on erosion and soil management
- Stabilisation planting such as flaxes, small trees, willows to prevent stream bank erosion
- Contour fencing
- Reducing weight of stock on erodible country (e.g. replacing cattle with sheep or moving to a younger stock class)
- Direct drilling or minimum tillage used in preference to conventional cultivation in high erosion risk situations
- Regular checks for erosion from channelled runoff, (i.e. from wheel ruts, tracks etc.), and fast remedial action
- Eroding areas on the property identified and appropriate management applied
- Deer mobs separated to reduce pacing and erosion on fence lines
- Fence lines/corners planted to reduce deer pacing behaviour and erosion
- Areas of stream bank erosion are identified and controlled.

WATERWAYS AND BIODIVERSITY

- Refer to the B+LNZ factsheet on stock exclusion from waterways and the WRC information sheet on stock exclusion requirements
- Stock excluded from all waterways and wetlands in accordance with WRC rules
- Culverts or bridges at stock crossings
- Alternative sources of stock water in each paddock (e.g. troughs)
- Vegetated riparian buffer strips around waterways
- Approaches to stock crossings are managed to avoid runoff to waterways
- Drain cleaning is undertaken in a manner that minimises sediment losses
- Riparian margins are of sufficient width to adequately filter run-off
- Wider riparian buffers provided at low points to filter any run-off
- Minimum or no-till cultivation techniques used when high risk of run-off from cultivated blocks
- Runoff from stock tracks and races directed away from waterways or filtered through riparian buffers
- Riparian planting programme planned/implemented
- Permanently/frequently wet areas within paddocks are managed to avoid contamination from stock or fertiliser
- Legally protected wetlands on farm identified and protected
- Legally protected areas of indigenous biodiversity on farm identified and protected
- Weeds and pests within protected areas are managed
- Enhancement programme in place for identified areas of indigenous biodiversity
- Reticulate stock water.

IRRIGATION

New irrigation

- System designed with site specific knowledge of soil, climate and crop needs
- Independent evaluation of irrigation design undertaken before development
- System meets flow meter, flow rate, volume and area irrigated requirements
- All new irrigation infrastructure is installed in accordance with Installation Code of Practice for Piped Irrigation Systems (Irrigation New Zealand, January 2012)
- Post installation checks of application rate and distribution uniformity undertaken
- Commissioning tests show that system performs to desired specifications for: system capacity, application depth, intensity and uniformity and return interval.

Existing Irrigation

- Soil moisture assessed—detail method and frequency
- Decision rules used (i.e. no irrigation after 10mm rain etc.)
- Rainfall forecasts and soil temperature monitored and used in decision making
- Deficit irrigation used within soil moisture trigger points
- Crop irrigation scheduling model used
- Spray line shifts made to suitable plan (e.g. GPS on bike; follow map)
- Application to non-target areas is minimised
- System closed down if runoff and/or ponding occurs
- Rotation adjusted according to soil moisture status and rainfall
- Daily checks for excessive runoff/ponding and other irrigation problems
- Annual audit of system completed to identify efficiency improvements
- Audit upgrades identified in work plan with timelines for completion
- Application depth and uniformity checks pre-season, and through season
- Wetted width widened on outer spans on long pivots or on slopes
- System evaluation by certified evaluator 5-yearly
- Program to remedy problems in 5-yearly evaluation implemented
- Annual water use checklist completed
- Variable rate irrigation used to maximise water use efficiency.

APPENDIX TWO
RECORD KEEPING FOR NUTRIENT BUDGETING

Good record keeping makes use of OVERSEER simpler and ensures more accurate results.

Waikato Regional Council requires you to keep the following information:

- Identification of the land area of the farm
- A map or aerial photograph showing the different blocks within the farm/LMUs
- Annual stocking rate (numbers, types and classes) including a breakdown by stock class for each month
- A description of the farm management practices used on each block including (where applicable):
  - (i) Ground cover—pasture, crops, non-grazed areas (including forestry, riparian and tree areas)
  - (ii) Stock management—lambing/calving/fawning dates and percentages, any purchases and sales and associated dates, types and age of stock
  - (iii) Fertiliser management practices—types, quantities, timing, location and rates of application and details of varying procedures for different blocks
  - (iv) Winter management of cattle grazed off—including the use of feed pads, grazing off or standoff pads
  - (v) Crop management practices—area cultivated, method of cultivation, crop types, rotations, timing of sowing and harvesting, resulting use of crop, where and when it is fed out on farm or when it is exported and where to
  - (vi) Supplementary feed brought onto the farm—feed type, annual tonnage, dry matter content, feed quality, nitrogen content
  - (vii) Use of nitrification inhibitors and any other verifiable nitrogen leaching inhibitors.

  Note: Where any of the matters (i) to (vii) have not been implemented on a particular block then that should be stated.
- Copies of annual accounts to verify the above information
- Farm animal effluent, pig farm effluent, feed pad and stand-off pad effluent management including:
  - (i) Area of land used for irrigation
  - (ii) Annual nitrogen loading rate and nitrogen load rate per application
  - (iii) Instantaneous application rate
  - (v) Clean water irrigation in terms of areas irrigated, rates of water applied and irrigation systems used
- Copies of invoices or receipts for purchases of stock, fertiliser, supplements imported or exported.

APPENDIX THREE
OPTIMUM SOIL TEST VALUES

Target soil test ranges for New Zealand sheep and beef farms (New Zealand Fertiliser Manufacturers' Research Association Inc. and New Zealand Pastoral Agriculture Research Institute Ltd, 1994)

Soil Test	Ash	Sedimentary	Pumice	Peat
Target Olsen-P	20-30	20-30	35-45	35-45
Target soil test K	7-10	5-8	7-10	5-7
Sulphate-S	10-12	10-12	10-12	10-12
Organic-S	15-20	15-20	15-20	15-20
Target soil test Mg (pasture)	8-10	8-10	8-10	8-10
Ideal soil test Mg (animal)	25-30	25-30	25-30	25-30
pH	5.8-6.0	5.8-6.0	5.8-6.0	5.0-5.5 (0-75mm) undeveloped 4.5-5.0 (75-150mm)

APPENDIX FOUR
EXAMPLES OF POSSIBLE SPECIFIC RESPONSES

MAINTENANCE OF EXISTING WORKS

- Replace 10 missing space-planted poplars on slip-prone slope in Big Hill paddock.
- Annual silviculture for the conservation tree block and two forestry blocks.
- Check fences and repair if necessary on two wetlands, the bush block and the river fences every six months.
- Annual check on the silt build up in the drains, four dams and the six silt traps. Bi-annually clear silt out and distribute back on to paddocks—rotate which paddocks receive it.
- In late summer, early autumn check all tracks and repair as necessary. Also check the two runoff diversion walls and repair any damage.

HILL COUNTRY EROSION

- Retire shady face reverting to scrub in Flax paddock. Afforest slip on Rough paddock to prevent further erosion.
- Space plant 50 poplars and 30 willows to stabilise hill faces above Main river.
- Space plant 20 poplars above main access track in Paddock 1 to protect it from future erosion. Plant a wood lot behind woolshed to stabilise bank and prevent damage to shed.
- Assess all tracks and other infrastructure in next 12 months to determine if any additional planting is required to protect it.
- Ensure all new infrastructures (e.g. tracks), including the new fence in Back paddock, are not going to cause any extra erosion by considering contour and soil type.
- Explore opportunities for drainage in the spring of Number 3 paddock.

WATER QUALITY

- Over the next 12 months, put up a one-wire electric along Main creek to keep cattle out. In the next three months, put up a stock-proof fence around the wetland area.
- In next six months scope out a water reticulation system for the five back paddocks. Implement over following six months.
- Complete 10km of fencing in riparian areas on either side of Main river.
- Fence the two runoff convergence zones (e.g. headwaters) on Main creek and Dog Burn.
- Ensure the fertiliser company and farm manager understand the avoidance of superphosphate applications if rain is forecast.
- Install four dams in Number 4 paddock and three in Number 6 paddock for trapping sediment.
- Investigate low solubility types of P-fertiliser before next application due and determine if this will work for the farm. If it will, work out if it is an affordable option.
- Install culvert in Bog paddock and a bridge over Dog Burn to prevent stock accessing waterways.
- Look at soil test results and determine if Olsen-P levels are at or below the optimum—maintain them.
- Speak to top-dressing pilot to ensure he is not applying fertiliser directly to water bodies.
- Adjust super phosphate plan to apply in April rather than June, July, August or September.
- Adjust fertiliser plan to reduce N-application rates from 170kg N/ha/year to below 150kg N/ha/year*
- Ensure the annual N-based fertiliser is applied in autumn and spring if necessary, but not winter.
- Site offal holes, dumps, septic tanks, dips away from water and leaching-sensitive areas.

** NB. Urine patches rather than N-fertiliser are the key source of N-leaching in most pastoral systems.*

WIND EROSION

- Assess cultivation practices and where possible move to conservation tillage on Back Flats where crop is used.
- Plant a shelter belt on River-Flat paddock. Carry out an annual check in autumn and repair any damage as required.
- Investigate plant species to stabilise the sand country in paddocks 7, 8 and 9. Consider if there are containment structures that may also help. Implement if suitable.

PUGGING AND COMPACTION

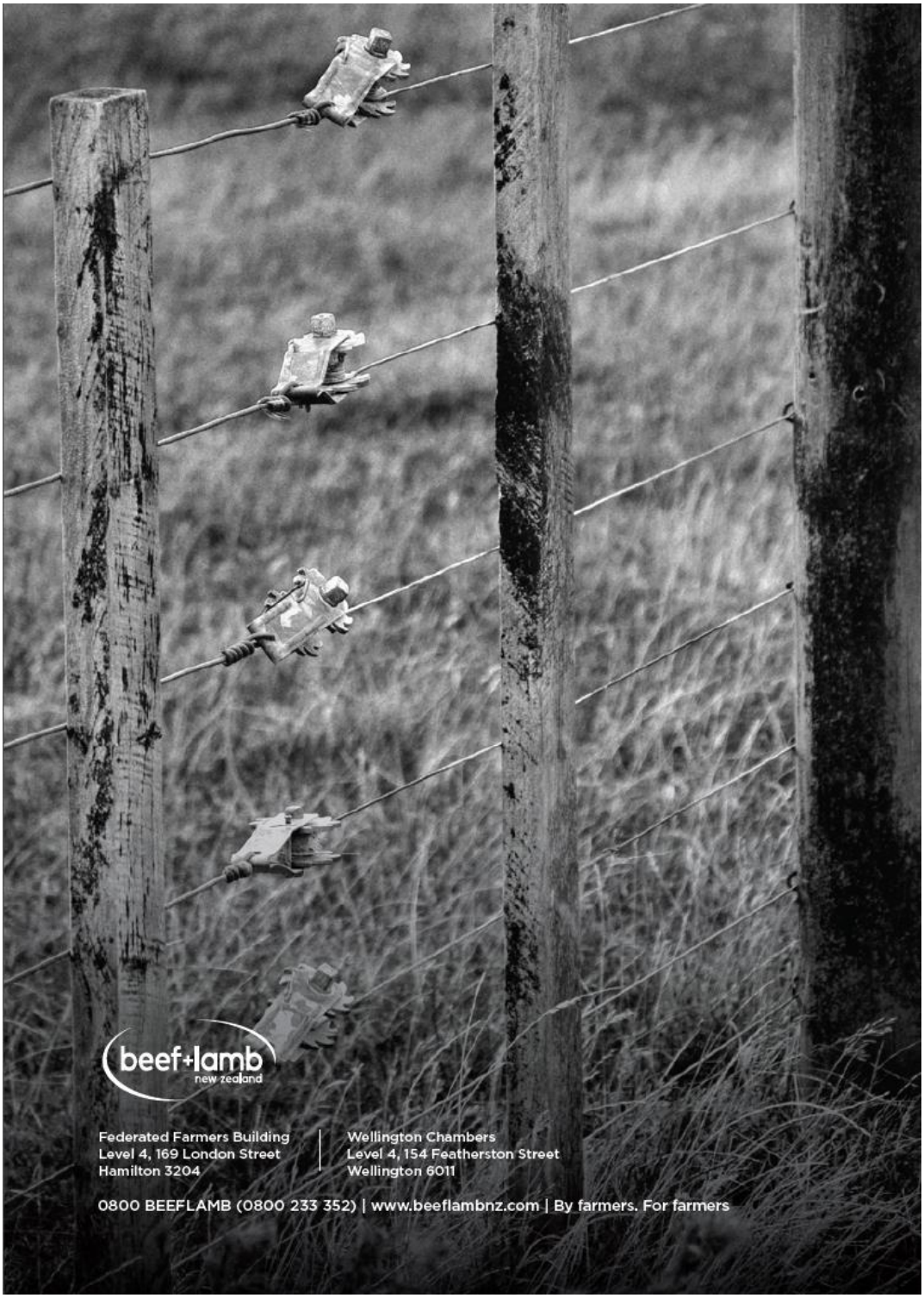
- Identify the high-risk paddocks when wet, and the low-risk paddocks when wet. Outline a policy to move stock prior to the high-risk paddocks getting wet and inform all staff of the policy.
- Install drainage in Number 2 and Boggy paddocks. Check drainage is functioning annually and repair any damage if necessary.
- Establish policy on soil conditions for cultivation. Policy will outline no cultivation when at-risk soils are wet and shiny (i.e. plastic).
- Develop and outline grazing policy residuals to all staff to ensure over-grazing is not occurring.

SEEK LOCAL OR EXPERT ADVICE

- Regional council officers
- Farm consultants/advisors
- B+LNZ Environment Extension Manager
- Workshop facilitator
- Fertiliser reps
- Universities and research
- Neighbours.

SEEK ADDITIONAL INFORMATION

- www.beeflambnz.com
- www.landcare.org.nz
- Regional councils
- Rural newspapers
- Field days, conferences or workshops
- Libraries.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Menu

Practices to improve water quality

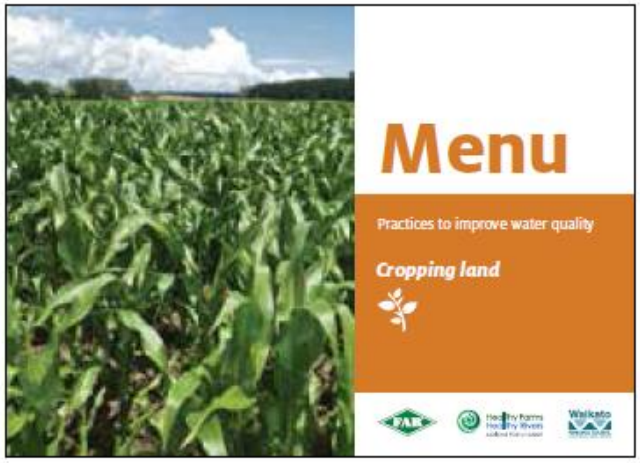
Drystock farms

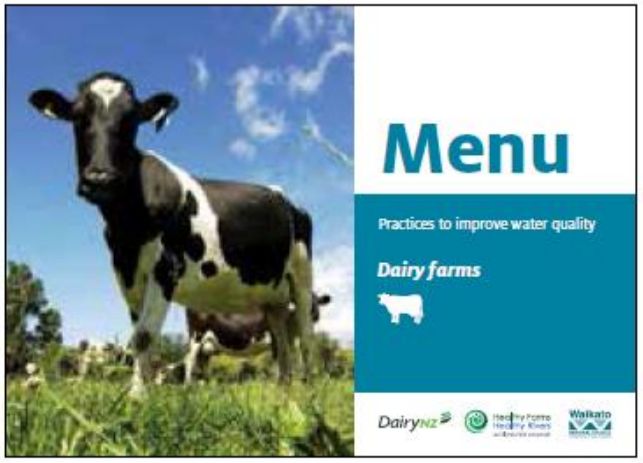
beef+lamb new zealand

Healthy Farms Healthy Rivers
ACTIONS FOR CHANGE

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

Also available at www.waikatoregion.govt.nz/menus





This menu has been developed by Waikato Regional Council and the Upper Waikato Primary Sector Partnership, a group of representatives from agricultural industry organisations working in the Upper Waikato catchment. The group aims to work together to help farmers improve nutrient efficiency and reduce losses.

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DairyNZ

AGFIRST

Fonterra Dairy for life

agri-nutrients Ballance

Headlands minimal footprint - optimal profit

FAR

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Thank you to the farmers of the Waikato for their involvement in this menu.

Peer reviewed by Bob Wilcock, NIWA

August 2013
Revised late 2015

Menu of practices to improve water quality: drystock farms

About this menu

This menu provides a range of practices for drystock farms, mainly hill country sheep, beef and deer, to improve nutrient management and reduce impacts on water quality. It is designed to help identify the best options for your individual circumstances. The practices listed are generally a step ahead of current regulatory expectations. They will also help you to better meet future sustainability challenges.

The menu should be used in conjunction with your consultant or you Land and Environment Plan.

The starting point for using this menu is a nutrient budget and a land environment plan which includes farm goals, management approaches and feed supply. These tools will help identify the water quality improvement practices that best fit your farm, taking into account flow on effects on feed budgets and other farm policies. Looking at the big picture will help ensure changes in one area do not create deficits or unbudgeted costs in another.

What's the issue?

Farmers, iwi, industry, local government and others have already done much to improve water quality, and continue to do so. However, more is needed to meet community desires for fresh water.

Water quality varies across the Waikato region from excellent to poor. This is largely due to variations in land use type and intensity, and also due to geology. In less developed parts of the region conditions are excellent and there have been few signs of deterioration. But water quality is poorer in intensively-farmed areas. In some areas, urban and other non-agricultural point sources also contribute to poor water quality.

In waterways across the region, slowly but steadily rising levels of nitrogen over the last 20 years are cause for concern. Nitrogen in groundwater can take decades to emerge into surface water, and this indicator of water quality will worsen before it improves. Levels of micro-organisms are moderate to high, but stable. Sediment levels are high in places, and phosphorus levels vary.

Water quality benefits

To help determine the most effective water quality improvement practices for your farm, each practice's likely water quality benefits are rated. The ratings are based on latest research and indicate likely effectiveness in reducing the amount of nitrogen (N), phosphorus (P), sediment and micro-organisms entering waterways.

Topography and management regimes vary from farm to farm, as do the need for and effectiveness of each practice listed in the menu. The ratings are an indicative best estimate and assume generally accepted industry good practice is followed.

Likely water quality benefits: estimated reduction (at whole farm scale) in contaminant reaching waterways

	Nitrogen (N)	Phosphorus (P)	Sediment	Micro-organisms
Low L	Less than 10%	Less than 20%		
Medium M	From 10 to 25%	From 20 to 50%		
High H	More than 25%	More than 50%		

Farm business impacts

Each practice's potential cost and economic benefit to the farm business are also rated. Individual farm circumstances will influence costs and benefits. However, this menu can help you identify a short list of practices for the farm management team (and consultant if you use one) to consider in more detail. Many of the practices' cost ratings are different to their benefit ratings. For example, a low cost practice may provide a high farm benefit. Also, some of the benefits may take some time to be realised.

Potential impact on farm business

	Cost	Benefit
Low $	Limited input of farmer time and expenditure. Limited practice change required.	Little change to farm profit as a result of this practice, or may require small changes to farm infrastructure.
Medium $$	Moderate input of farmer time and expenditure. Some practice change required.	Practice likely to result in a moderate increase in profitability or improved management.
High $$$	Significant input of farmer time and significant expenditure. Significant practice change required.	Very profitable practice or results in improved management e.g. large reduction in farm operational costs.

To copy mitigations into your farm environment plan go to **www.farmmenus.org.nz**.

Tell us what you think and register for updates

This menu reflects current knowledge and future editions will be produced as knowledge develops. We value your feedback, so if you have any concerns or suggestions, please contact a Waikato Regional Council Agricultural Advisor on freephone 0800 800 401 or info@waikatoregion.govt.nz.
To automatically receive future editions of this menu, please register at www.waikatoregion.govt.nz/menus.

Drystock farms

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Whole farm planning	Undertake a Land and Environment Plan (LEP) to understand farm resources and risks	Preparation of the farm plan will identify water quality risks. Likely water quality benefits of different practices depend on land classes, management challenges and practices used to manage risks on farm.				$ - $$	$$$	Involves assessment of farm resources, stocking policies and farm business risks – see www.beeflambnz.com/farm/tools-resources/land-and-environment-planning-toolkit/ for more information. A good starting point that will help clarify the most useful practices to consider. Should include industry good practices and a risk assessment of current practices.
	Match land use to land capability	L	M	M	L	$$	$$	Graze sheep on steeper paddocks and restrict cows to easier slopes if possible. Consider afforestation (native, plantation or pole planting) as an alternative, especially where there is a high risk of erosion.
Nutrient management	Do a whole farm nutrient budget	Likely water quality benefits will depend on the range of practices used to manage nutrients as a result of nutrient budget recommendations.				$	$$	Farm consultant/advisor should use OVERSEER®[1] (use most recent version) to create a nutrient budget for the whole farm.[1]
	Apply N fertiliser in accordance with feed budget, climatic conditions and soil temperatures greater than 7°C	-	-	-	-	-	-	Refer to the Fertiliser Association's Code of Practice for Nutrient Management www.fertiliser.org.nz.
	Keep Olsen P at agronomic optimum (using soil testing)	-	H	-	-	$	$$$	Avoiding unnecessary application of P will reduce costs. Optimum level will depend on soil type. To minimise run off, apply P fertiliser when good soil moisture and no large rainfall events forecast. Consider use of lower solubility P fertiliser if soil conditions allow.

[1] The OVERSEER® nutrient budgeting programme assumes many 'low' rated practices are already in place. If these practices haven't been implemented, OVERSEER® is likely to underestimate nutrient losses. Adopting these practices over time may result in little change to your OVERSEER® nutrient budget even though you are achieving positive change on the ground.

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Managing nitrogen losses	Reduce number of old cattle (R3s) to reduce large urine spots	M	M	M	-	$	$$	Male stock also distribute urine more widely, so urine patches are less concentrated. Would also lower live weight on farm for winter wet periods with benefits for soil health and water quality.
	Increase sheep to cattle ratios to reduce large urine spots (and soil damage)	M	M	M	-	$$	$	Effectiveness depends on farm contour. Profitability of change depends on sheep vs beef schedules and capital stock sales required. Altering ratios may increase management challenge for pasture quality, with fewer cattle to manage long rank pasture.
Stock management	Increase lambing percentage	L	L	-	-	$$	$$$	May involve higher ewe live weights at mating and improved feeding at lambing. Lambing percentage can be increased by improved genetics and maintaining ewe condition through pregnancy and lactation.
	Increase rate of cattle finishing	M	L	-	-	$$	$$$	Minimises numbers of older cattle wintered on farm and reduces period of time on maintenance feed.
Stock management to reduce erosion and soil damage	Rotational grazing	L	M	M	M	$	$$	Keeping animals moving onto fresh pasture reduces stress and pacing when wet weather hits. Could also use break fencing to reduce soil damage during wet periods.
	Match stock management to land use capability	L	H	H	M	$$	$$	Preventative approach where heavy animal classes are run on flatter contour off the hills where possible. Requires information on land use capability (may be a cost). Requires contour fencing for greatest benefit.
	Graze wetter paddocks earlier in the winter rotation	-	M	M	L	$	$$	Requires forward planning. May not be possible if targeted paddocks are across the whole farm. Benefits will depend on soil type.

Drystock farms

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Stock management to reduce erosion and soil damage *(cont.)*	Strip graze towards waterways, rather than away from them	L	M	M	L	$	$	Applies to grazed paddocks in wet weather with overland flow that converges to form small channels of running water. Have as large a grass strip as possible between the winter grazed strip and the waterway, for as long as possible. Benefits will depend on fertility, slope and feed type. There may be local rules that set the minimum width.
	Separate deer mobs to reduce pacing on fencelines	L	M	H	M	$$ - $$$	$$	Can lower impacts but will not fully prevent damage. Refer to the NZ Deer Farmers' Landcare Manual for more information, available in hard copy from Deer Industry New Zealand.
Planting to reduce erosion	Plant spaced poplars or other poles on steep country	-	L	M	-	$$	$$	Fast growing poplar or willow poles effective on southern faces or erodible/wet slopes while still allowing grazing. Mixed agroforestry is drought tolerant and provides an alternate feed source.
	Plant deer fencelines to reduce pacing behaviour	L	M	H	M	$$ - $$$	$$	Can lower impacts but will not fully prevent damage. Refer to the NZ Deer Farmers' Landcare Manual for more information, available in hard copy from Deer Industry New Zealand.
	Afforestation of steep southern faces (above Land Use Capability 6e)	M	M	M	-	$$ - $$$	$ - $$	Protects areas of greatest erosion risk and replaces low growing slopes with long term productive investment. Best suited to areas with large weed burdens and minimal profitability. Profitability depends on forestry regime and market. Any afforestation plan should include a harvest plan to ensure all land is harvestable.

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Managing critical source areas - hotspots (high sediment, phosphorus or faecal loads coming from small areas of high run off)	Reduce run off from tracks, races and yards (using cut-offs and shaping)	L	M	M	M	$	$$	Cost and effectiveness depends on contour of farm (higher risk of soil loss on steeper land but will also require more work). Requires regular maintenance but can reduce water damage and long term track maintenance costs.
	Fence out dams, plant around margins and pipe water to troughs	L	M	L	L	$$	$$	Extends the life of the dam. Watch for faulty ballcocks and overflowing water. Planting around the dam will keep water cooler in summer, but do not plant on dam wall. Benefits will depend on water quality of dams, but can provide significant production gains.
	Fence and plant permanent wet and boggy areas and springs	L	L	L	L	$$	$$	Benefits will be proportional to the number and use made of springs. Co-benefits could include reduced stock losses and ease of mustering.
	Space planting of trees	L	M	M	M	$$	$$	Stabilises hill slopes and reduces erosion risk. Potential for drought fodder, depending on species planted. Co-benefits include shade and shelter.
	Fence and plant out unproductive steeper slopes	-	H	H	L	$$$	$$	Planted steeper slopes will slow water movement and reduce potential for erosion. Will reduce weed control and lower fertiliser expenditure.
	Direct stockyard run off to paddock	L	M	M	H	$	$$	To stop direct run off into streams and drains.
	Move water troughs and gateways away from areas of high water flow	L	M	M	M	$	$	These areas of concentrated stock use have high nutrient loads and reduced vegetative cover, so are higher risk for run off. Cost and effectiveness depends on contour of farm (higher risk of soil loss on steeper land but greater benefit).

Drystock farms

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Riparian management	Fence stock out of waterways	L	M	L	H	$ - $$	$$	Fencing could range from permanent 8 wire to temporary electric fencing during grazing periods, depending on individual farm needs and preferences. Two wire electric with sheep under grazing may be appropriate where exclusion of large stock is the priority. Provide a minimum setback of at least 3m. Fencing adds capital value, reduces stock losses and benefits animal health. Can also be used to improve subdivision and pasture utilisation. Costs include reticulated water.
	Put in culverts or bridges at regular stock crossings	L	M	H	H	$ - $$$	$$$	Cost will depend on whether culvert or bridge is required. Bridges also require resource consent. Improved crossings reduce stock and vehicle travel time.
	Improve on farm infrastructure to keep stock out of waterways (reticulate stock water, improve stock crossings, plant shade trees away from water)	L	M	M	H	$$ - $$$	$$	These improvements all add capital value to the farm and provide animal health and welfare benefits alongside water quality benefits. Important to locate new troughs away from areas of high water flow and high stock traffic e.g. gateways.
	Manage or retire bogs and swampy areas	M	H	M	M	$$	$$	Controlled summer grazing of swampy areas can be useful for keeping weeds down. Keeping stock out of swampy areas and wetlands will reduce stock losses and mustering time. If they are areas with high stock traffic and high water flows, excluding stock will be highly effective in reducing P losses to waterways.
	Provide deer wallows away from waterways	L	M	H	H	$$	$	May involve use of sediment traps or buffers to filter run off from wallows before it reaches waterways.

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Riparian management ***(cont.)***	Riparian planting	L M if swampy	M	M	M	$$$	$	Effectiveness improves with a grass margin to help filter run off, especially on steeper slopes. Effectiveness of planting depends on species. Ongoing weed and pest management is an added cost but reduces with time. Can improve bank stability, provide habitat for wildlife and instream shade for fish and insects.
	Sediment trap (an engineered structure to slow water flows, reduce energy, filter sediment and allow grass growth e.g. decanting dam, detainment bunds)	L	M	M	L	$$$	$ - $$$	Most useful where steady flow of run off to waterways during wet periods and sediment/P is an issue. Detainment bunds designed to allow ponding for no more than three days to maintain pasture. Require water storage of around 120m³/ha of draining catchment. Can be costly where not using existing structures. Requires sound engineering design and ongoing maintenance.
Cropping management	Reduce soil cultivation by adopting strip tillage or direct drilling	L	H	H	-	$	$$	Effective for reducing run off and soil loss, and improving soil quality and infiltration. Soils grazed over the winter may be compacted or pugged, requiring more cultivation or resulting in rough paddocks. Requires modified planter machinery to deliver good seed placement for even plant establishment. Additional expenditure might be required for insect pest control. FAR trials show a benefit of $200/ha to direct drilling if crop establishment costs and yields are similar.
	Cultivate along contours (rather than up and down the slope) where slopes greater than 3°	L	H	H	-	$	$$	Slows down run off and reduces erosion. Row orientation should follow contour. Avoid cropping on steep land.

Drystock farms

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Cropping management *(cont.)*	Establish autumn pastures early	M	L	L	-	$	$	May not be feasible if pasture establishment is limited by a lack of soil moisture. N benefit will be proportional to the area cultivated.
	Use low N crops	M	-	-	-	$	$	Fodder beet and radish have a low N content and will lower urinary N deposition. Benefit may not apply if stocking rate is increased.
	Use winter active crops	H	-	-	-	$	$	Winter active crops (oats, rape, Italian rye) may reduce N leached over winter.
	Maintain buffer strips on sloping cropping paddocks	-	H	H	M	$$	$	Reduces risk of soil loss from unexpected rain events on cultivated paddocks where there is a risk of erosion. Benefit will be proportional to area cultivated
	Actively manage grazing of winter crop areas to reduce risk of N leaching, run off, soil loss and compaction	L	M	M	M	$$	$$$	Graze from top to bottom of paddock contour. Avoid leaving stock on during wet periods, for long periods, or concentrated on small sections of the crop.
	Use placement tools e.g. GPS guidance, crop sensing, where possible	H	H	-	-	$$$	$$$	Delivers more precise nutrient inputs for expected crop yield. Likely to become more widely used as tractors are upgraded over time.
	Include grass buffer strips (2m or more) for cultivated land next to waterways	L	M	L	-	$$	$	Effective for filtering run off and reducing the risk of fertiliser loss during spreading. More benefit on greater slope but wider buffer required. May require weed management but can provide habitat for beneficial predatory insects, reducing need for pest control. Light grazing with sheep or young cattle during dry periods can be useful to manage weeds.

Management area	On farm practice	Likely water quality benefit				Potential impact on farm business		Factors to consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Irrigation water application	Measure and record soil moisture and rainfall to develop a soil water budget	-	-	-	-	$	$	There is value in collecting and using farm data to inform management decisions. Note local evapotranspiration data is needed to complete the water budget.
	Use water budget to schedule irrigation	Depends on irrigation type and farm system				$$	$$$	Water scheduling increases water efficiency. Benefits depend on current practice, soil type and farm system . Seek professional advice on water scheduling.
	Do not exceed soil water infiltration rate	Depends on irrigation type and farm system				$	$$	Benefits depend on current practice, soil type and farm system . Seek professional advice to avoid drainage.
	Maintain irrigation equipment	Depends on irrigation type				$$	$$	Check pipes are not leaking and nozzles are working well.
Farm training	Embed environmental management into farm practices by training and incentivising staff	-	-	-	-	$	$	Level of benefit will depend on staff members' experience in environmental practice.
	Encourage staff to attend Land and Environment Planning workshops	-	-	-	-	$	$$$	Level of benefit will depend on the staff members experience in environmental practice.

Please note: This document assumes generally accepted industry good practice is followed in all aspects of farm management.

Menu of practices to improve water quality: drystock farms

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APPENDIX 2: AGREED NATIONAL GOOD FARMING PRACTICE PRINCIPALS

AGREED NATIONAL GOOD FARMING PRACTICE PRINCIPLES

GENERAL PRINCIPLES	
1.	Identify the physical and biophysical characteristics of the farm system, assess the risk factors to water quality associated with the farm system, and manage appropriately
2.	Maintain accurate and auditable records of annual farm inputs, outputs and management practices
3.	Manage farming operations to minimise direct and indirect losses of sediment and nutrients to water, and maintain or enhance soil structure, where agronomically appropriate
NUTRIENTS	
4.	Monitor soil phosphorus levels and maintain them at or below the agronomic optimum for the farm system
5.	Manage the amount and timing of fertiliser inputs, taking account of all sources of nutrients, to match plant requirements and minimise risk of losses
6.	Store and load fertiliser to minimise risk of spillage, leaching and loss into waterbodies
7.	Ensure equipment for spreading fertilisers is well maintained and calibrated
8.	Store, transport and distribute feed to minimise wastage, leachate and soil damage
WATERWAYS	
9.	Identify risk of overland flow of sediment and faecal bacteria on the property and implement measures to minimise transport of these to waterbodies
10.	Locate and manage farm tracks, gateways, water troughs, self-feeding areas, stock camps, wallows and other sources of run-off to minimise risks to water quality
11.	Exclude stock from waterbodies to the extent that is compatible with land form, stock class and stock intensity. Where exclusion is not possible, mitigate impacts on waterways
LAND AND SOIL	
12.	Manage periods of exposed soil between crops / pasture to reduce risk of erosion, overland flow and leaching
13.	Manage or retire erosion-prone land to minimise soil losses through appropriate measures and practices[1]
14.	Select appropriate paddocks for intensive grazing, recognising and mitigating possible nutrient and sediment loss from critical source areas
15.	Manage grazing to minimise losses from critical source areas
EFFLUENT	
16.	Ensure the effluent system meets industry-specific Code of Practice or equivalent standard
17.	Have sufficient suitable storage available for farm effluent and wastewater
18.	Ensure equipment for spreading effluent and other organic manures is well maintained and calibrated
19.	Apply effluent to pasture and crops at depths, rates and times to match plant requirements and minimise risk to waterbodies
WATER AND IRRIGATION	
20.	Manage the amount and timing of irrigation inputs to meet plant demands and minimise risk of leaching and runoff
21.	Design, check and operate irrigation systems to minimise the amount of water needed to meet production objectives

1. *Implementing this principle may mean that Class 8 land is not actively farmed for arable, pastoral or commercial forestry land uses as this land is generally unsuitable for these uses as described in the Land Use Capability Handbook.*

These principles were updated from the 2015 Industry-Agreed Good Management Practices Relating to Water Quality. While first applied in Canterbury, they were developed to be applicable across all regions of New Zealand.

APPENDIX 3: STRATEGIC GRAZING OF WINTER FODDER CROPS

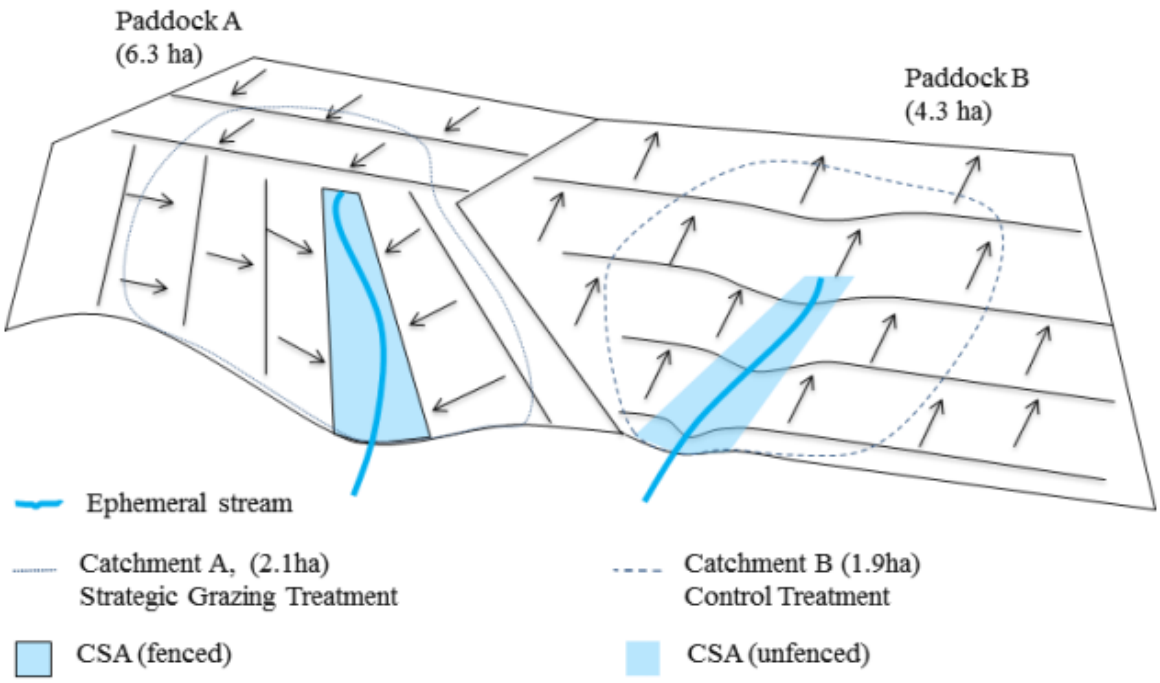

Figure 1. Paddock layout and treatments imposed in the 2012 winter season at Telford Farm. Arrows indicate the different grazing patterns and directions followed for each catchment.

(Source. Orchiston et al, 2013)