IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	Southland Proposed Water and Land Plan
BETWEEN	DairyNZ Limited
AND	Southland Regional Council (Environment Southland)

STATEMENT OF PRIMARY EVIDENCE OF JUSTIN KITTO FOR DAIRYNZ LIMITED

15 MAY 2017

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1. INTRODUCTION

1.1 My full name is Justin Allan Kitto.

1.2 I have been employed by DairyNZ as a Water Quality Specialist since 2012. I hold the degrees of Bachelor of Science (Geography) (Hons) and Master of Environmental Science (Freshwater Ecology) (Hons). I have more than eight years of national experience in freshwater science, specifically freshwater ecology and water quality.

1.3 In my current role I provide technical expertise on water quality issues relating to dairy farming. Prior to this role I was employed by the Otago Regional Council as an Environmental Scientist (Water Quality). During this period I was responsible for a number of water quality and stream ecology investigations and authored a number of technical reports.

1.4 For the last four years I have been tasked with assisting DairyNZ and local levy payers to understand the water quality issues in Southland, including current state, trend, pressures and potential causes of degradation and responses. In carrying out these duties I have visited all state of environment monitoring sites, attended several catchment groups, participated in Environment Southland technical workshops related to surface water quality, led analysis of water quality information and assisted in field surveys for a habitat mapping exercise in the Waituna catchment. I also represent DairyNZ on the Waituna Working Group.

2. CODE OF CONDUCT

2.1 I have been authorised to provide expert evidence on behalf of DairyNZ.

2.2 In preparing this evidence I have read the Expert Witness Code of Conduct set out in the Environment Court Practice Note 2014. I have complied with the Code in preparing this evidence and I agree to comply with it. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

2.3 In preparing this evidence I have read and am familiar with the proposed Water and Land Regional Plan, the Section 42 (“s42a”) report as well as the following key documents:

- Kitto and Hodson (2016) Water Quality State and Trends for Southland. Poster prepared for New Zealand Freshwater Sciences Society Conference. Invercargill, December 2016.
- Hodson et al. (2017) Water Quality in Southland: Current State and Trend. Environment Southland. Publication number 2017-04.
- Hodson and Akbaripasand (2016) State and Trends of Macroinvertebrate Community health in Southland. Poster prepared for New Zealand Freshwater Sciences Society Conference. Invercargill, December 2016.
- Hodson (2016) Cultivation setback distances. Environment Southland Memo prepared for Claire Jordan, 19/12/16.

3. SCOPE OF EVIDENCE

3.1 I limit my evidence to an assessment of issues relating to Southland's water quality state and trend, buffer widths and physiographic zones.

3.2 Specifically, I provide an assessment of current state and trends in river water quality and ecosystem health as reported by the National Objectives Framework (NOF), to demonstrate that water quality concerns can be managed in the interim through a "holding the line" approach, until further science is available to underpin the setting of water quality limits through Freshwater Management Unit (FMU) processes. I discuss the suitability of the proposed buffer widths to minimise sediment loss from disturbed land to ensure that the proposed rules meet their intended objective. I also address the suitability of the physiographic approach as a risk management tool as I have concerns about its use beyond steering good management practices and the implications for future limit setting.

3.3 My evidence is structured as follows:

a) Current state of Southland water quality and ecosystem health
b) Trends in Southland water quality
c) Buffer widths
d) Physiographic approach as a risk management tool
e) Appendix E of the proposed Water and Land Plan.

4. EXECUTIVE SUMMARY

4.1 In lieu of community defined water quality values, I have assessed current water quality state in Southland against the NOF. This assessment has illustrated that for both nitrate and ammonia toxicity, all State of Environment sites are compliant with the national bottom line. However, for periphyton, eight of the 30 monitored sites are modelled to fail the national bottom line. Only 11% of sites currently fail the national bottom line for secondary contact recreation.

4.2 Water quality trend analysis suggests that for many parameters (clarity, phosphorus, ammoniacal nitrogen and *E.coli*) the dominant trend is indeterminate. For nitrate-nitrite-nitrogen, almost half of monitored sites featured an increasing trend over the last ten years. However, analysis between 2012-2016 demonstrate an increasing proportion of indeterminate trends.

4.3 Overall, water quality state and trends analysis indicates localised hotspots for certain attributes, but there is no evidence to suggest a widespread pattern of ongoing water quality deterioration. This supports the 'holding the line' approach of the Plan.

4.4 Scientific review of buffer widths has demonstrated varied effectiveness for removing sediment over a wide range of set-back widths. There is limited robust evidence to suggest that a 20-metre riparian margin is significantly more effective than a 10 metre riparian margin. Evidence suggests that most sediment attenuation of overland runoff will be within the first 5 metres of a grass filter strip. I therefore do not believe that the proposed buffer widths of 20 metres are necessary to achieve the desired outcome.

4.5 At a conceptual level, the Physiographic Zones (PZ) appear appropriate as a method of categorising risk, identifying suitable good management practices and acting as a 'drafting gate' for consenting thresholds. However, the Physiographic approach does not take into consideration the amount of contaminant lost via different pathways, contaminant fate or the effects on receiving environments or community values. Therefore, I believe that additional science is required to underpin the further use of the physiographic zones beyond a conceptual risk framework to the limit setting process.

4.6 Appendix E of the proposed Water and Land Plan defines water quality standards. Some of these standards are not consistent with similar attributes in the National Objectives Framework.

5. CURRENT STATE

5.1 The current state of Southland's waterways has been assessed and reported by Kitto and Hodson (2016) and Hodson et al. (2017) based on the NOF, using the national bottom lines of NOF attributes as an indicator of unacceptable water quality. This approach was applied in the absence of community-defined values from which to define FMU-specific bottom-lines or measures of "unacceptable" water quality.

5.2 Three attributes relate to riverine ecosystem health as defined in the NOF; nitrate toxicity, ammonia toxicity and periphyton biomass. Periphyton objectives are also intended to consider the need for more conservative (relative to nitrate toxicity) nutrient-based targets should nutrient limitation be the most effective mechanism for regulating peak algal biomass. Macroinvertebrates are not included as an attribute in the NOF. Nevertheless, macroinvertebrates are widely accepted to represent a long-term, more integrative measure of ecosystem health than physicochemistry. Central Government has recently indicated their desire to include macroinvertebrates as a measure linked to reporting on ecosystem health within the NOF (Ministry for Environment, 2017).

5.3 The NOF also defines a faecal bacterial attribute (*E.coli*) for human health. The NOF attribute for human health currently has two different compliance statistics; one for primary contact recreation (95^{th}% MPN/100 ml) and another for secondary contact recreation (median MPN/100 ml). Changes have been proposed to revise these to four measures of *E.coli* by the Clean Water proposed revisions to the NOF (Ministry for Environment, 2017). For the purpose of this evidence I will only summarise water quality for secondary contact recreation based on the existing standards.

5.4 The results of a water quality state analysis (summarised in Table 1 in Kitto and Hodson (2016)[1]) conducted by Kitto and Hodson (2016) for the period 2009-2014 and by Hodson et al. (2017) for the period 2012-2016 indicate that in Southland, ecosystem health and water quality state is generally of a high standard (A or B band) for nitrate toxicity and ammonia toxicity, as well as other attributes across a wide range of sites. Specifically:

I. No sites failed the national bottom line for nitrate toxicity for the period 2009-2014 (Kitto and Hodson, 2016). In the latter, 52% of sites were in the A-band while 20% of sites were in the C-band. Updated results for 2012-2016 demonstrated that 54% of sites fall into the A-band while 16% of sites were in the C-band, indicating modest general improvement for the nitrate attribute (Hodson et al. 2017).

[1] Kitto and Hodson (2016 et al) summarised nitrate toxicity, periphyton and macroinvertebrate scores for the period 2009-2014. Hodson et al. (2017) updated the nitrate toxicity results and added in ammonia toxicity results for the period January 2012- December 2016. Macroinvertebrate data and periphyton data was not updated in the Hodson et al. (2017) report.

II. For ammoniacal nitrogen toxicity, no sites failed the national bottom line over the period 2012-2016. 60% of sites were in the A-band and 7% were in the C-band (Hodson et al. 2017).

III. For periphyton (30 sites), there is almost an equal distribution over the four bands. Eight sites failed the national bottom-line. Note, that for periphyton reporting, data collection frequency was limited to that required for NOF assessment. Instead a modelling approach by Snelder et al. (2013) was utilised for reporting algal biomass across 30 sites in Southland.

IV. For macroinvertebrate health, the Macroinvertebrate Community Index (MCI) was used. The breakpoints described by Stark and Maxted (2007) were used to define degradation condition. It was assumed by Kitto and Hodson (2016) that the four categories described by Stark and Maxted (2017) could be assigned the same A – D banding as used in the NOF. From this, the largest number of sites were in the C category (38%), followed by B (26%), A (22%) and D (14%) (Kitto and Hodson, 2016). More individual sites were considered to be in worse condition by Hodson and Akbaripasand (2016), who found that 9% of sites were in the D-category. The difference in the proportion of D-band sites between the two documents is due to Hodson and Akbaripasand (2016) considering additional monitoring stations that did not have a corresponding water quality monitoring station compared to Kitto and Hodson (2016).

V. For human health attributes at a regional scale, 86% (62 sites) are in the A or B Band for secondary contact recreation and five sites fail the national bottom-line. Of these five sites, two fail into the Aparima Freshwater Management Unit (FMU), two in the Oreti FMU and one in the Mataura FMU.

5.5 Of the four NOF attributes for rivers (nitrate toxicity, ammonia toxicity, periphyton biomass and *E.coli* for secondary contact recreation), only a small proportion of sites failed the national bottom line (≤ D band) for secondary contact recreation (7%) although over a quarter would be expected to fail for periphyton (27%). However, the periphyton results are based on modelled rather than actual data.

5.6 While most sites are categorised as being in the A or B band for nitrate toxicity, it is important to recognise that the toxicity attribute is not intended to manage for instream plant growth. Nitrogen is one of many factors that can influence plant growth in rivers. However, the importance of nitrogen relative to other controlling factors, and the exact thresholds at which an adverse effect might arise are poorly understood in Southland. Hence, it is not possible to categorise Southlands rivers for the effects of nutrients on periphyton. Nitrate toxicity is unlikely to be of widespread concern for aquatic fauna in Southland and no sites are expected to have mortality associated with nitrate levels.

5.7 Macroinvertebrate community health indices are currently not assigned attribute status in the NOF. Instead, they are valuable measures of ecosystem health, for which current state and trends in MCI scores indicate ongoing degradation outweighs improvement. Given that MCI links to land use are complex and cannot be simply explained, there are likely to be site-specific reasons for degraded MCI scores (e.g., a wide array of direct and indirect effects of land use or instream environment influencing MCI score; (McKergow et al. 2016)). However, emerging evidence suggests that habitat, and inparticular, fine sediment is likely the strongest and most widespread driver of macroinvertebrate community health (Greenwood et al*.* 2011; Burdon et al*.* 2013).

6. CURRENT TRENDS

6.1 Hodson et al. (2017) conducted a recent trend analysis on water quality data for three time periods using standardised analysis techniques. The three time periods were: January 2000 – December 2016; January 2007 – December 2016 and; January 2012 – December 2016. In addition to this, Hodson and Akbaripasand (2016) conducted trend analysis on macroinvertebrate data for the time period 1997 - 2014.

6.2 The results of this trend analysis suggest that:

I. For NNN, the proportion of sites with an indeterminate trend increased as the time period has reduced (i.e., no change between 2012 and 2016). The proportion of sites with an increasing (worsening) trend has decreased as the time periods have shortened and become more recent. The largest proportion of sites with an increasing trend was for the longest period of 2000-2016 (49% of 41 sites compared to 4% of 49 sites in 2012-2016).

II. For ammoniacal nitrogen most sites (83%) had no detectable trend for 2012-2016. However, for 2007-2016 the most dominant trend category was for a decreasing trend (59% of sites). The remainder of sites recorded an indeterminate trend. This potentially indicates a reduction in improvement and greater maintenance of ammoniacal nitrogen state and/or reduced magnitude of change (i.e., making it harder to statistically detect a trend above natural variation).

III. For dissolved reactive phosphorus (DRP), total phosphorus (TP), clarity and *E.coli*, the trends have predominantly been indeterminate (not significantly increasing or decreasing) across all three time periods. As the length of time analysed was reduced, the proportion of sites with a decreasing trend also decreased. However, the mid-length interval of 2007-2016 recorded the largest proportion of sites with an increasing (worsening) DRP trend. For total phosphorus (TP), there was an almost equal split between indeterminate trends and decreasing (improving) trends for the periods 2000-2016 and 2007-2016 suggesting little change in trends over the recent past or more present day condition. Almost all sites had an indeterminate trend for the shortest analytical period (2012-2016) for DRP, TP, clarity and *E.coli*.

IV. Faecal bacterial trends were mainly indeterminate (94%) with the shortest analytical period of 2012-2016 with only 6% of sites experiencing a recent increase (degradation). For the remaining two analytical periods, there was a very marginal change between the proportion of samples that were classified as indeterminate and increasing (e.g., 10% and 6% of sites experiencing an increase for the 2007-2016 and 2012-2016 periods, respectively).

V. Clarity measurements had largely indeterminate trends for all three analytical periods, with improvements outweighing declines across all three intervals. Worsening clarity was only detected in the 2000-2016 period.

VI. MCI scores degraded over the period 1997-2014 at 28% of the monitored stations with no detectable trend at the remaining sites. No sites had an improving trend (Hodson and Akbaripasand, 2016).

6.3 Overall, and in the context of NOF attributes, the results of trend analysis vary over a range of time-frames, with localised hotspots for certain attributes but not an overall, widespread picture of ongoing water quality deterioration. Trends for *E.coli*, phosphorus and clarity are predominately indeterminate while NH_4H trends were dominated by indeterminate or decreasing trends.

6.4 For NNN, the dominant trend (49% of sites) over the longer time period of 2000 to 2016 was for increasing concentrations. However, more recent time-series data suggest a reduction in number of sites of increasing concentration and an increase in the number of locations with indeterminate trends. While the exact cause of this general improvement more recently is unclear this could indicate either:

I. That increasing NNN trends have levelled off in response to (a) a reduction in the rate of landuse intensification through conversions, potentially in combination with (b) ground water lag times reaching equilibrium, or (c) an increase in the uptake of on-farm good management practices, or

II. The magnitude of increase has reduced and/or background natural variation has increased resulting in trends which are less detectable through the statistical methods applied.

6.5 The uncertainty around what is driving the apparent stabilisation of increasing N trends across many sites requires further assessment as new monitoring data comes to hand. At the same time the state and trend results suggest that ecosystem health and human health (in the context of the NOF) is not heavily degraded, or changing rapidly. Therefore, I consider it is acceptable that the Water and Land Plan has a 'holding the line' approach until such a time that community defined values are identified and more accurate technical work can be conducted to identify appropriate environmental limits.

7. BUFFER WIDTHS

7.1 DairyNZ's primary submission raised concerns around the proposed buffer widths in Rule 23. There were concerns about the science that was used to define different buffer widths and concern that the buffer widths were too large in some locations, and insufficient in other parts of the landscape where loss of sediment is more likely.

7.2 Rule 23 in the proposed Water and Land Plan required setbacks of 3 m for slopes less than 4°, 10 m for slopes between 4° and 16° and 20 m for slopes greater than 16°. In response to submissions, the s42a report has recommended a modification of the proposed buffer width requirements to 5 m for up to a 9° slope and 20 m buffer for a slope steeper than 9°. The s42a report clarifies that Rule 23 is intended to manage primarily for risks of sediment run-off to waterways.

7.3 While I support the objective and recognise the importance of managing the negative impacts of fine sediment, the selection of the current setback distances is arbitrary and not underpinned by robust evidence. To illustrate this point, I review the state of knowledge and guidance in New Zealand about setback distances for minimising the overland runoff of fine sediment below.

I. Collier et al. (1995) used a model to assess the effectives of sediment removal across a range of slopes and buffer widths. The inputs into this model included soil type, at least ten years of rainfall data and a range of slope angles, slope lengths and buffer widths. The model considered all possible combinations of these factors. The modelling approach found a range of buffer widths based on different slope lengths and angles for different soils. Despite this, the authors stressed that determining setback without a measure of soil drainage would be inappropriate and result in erroneous estimates of attenuation potential.

II. Parkyn (2005) conducted a review into riparian effectiveness on overland and subsurface contaminant loss to water. This review considered a range of studies from New Zealand and overseas with the summary from these studies demonstrating that buffers were able to remove between 53 and 98% of contaminants over a buffer range of 4.6 to 27 meters, noting that most studies indicated effectiveness at attenuating suspended solids fell rapidly with distance beyond the first 1-2 m (e.g. Smith 1989; Dillaha et al. 1989). However, the study did not note an optimal buffer width for any given slope angle.

III. More recently, McKergow et al. (2008) established the most refined state of knowledge on riparian management effects upon waterway contaminants. This review emphasised few consistent findings across riparian studies but that for equivalent reductions in overland runoff of sediment greater setbacks are needed on heavier soils, steeper slopes and higher rates of precipitation or length of paddock feeding a riparian margin. However, they found that specific setback distances could not be set with much confidence for quantitative reductions in fine sediment loss.

7.4 These documents have demonstrated that buffer widths can reduce overland contaminant loss to varying degrees. Combined, all three reviews also emphasise that there is limited robust evidence to determine that a 20 m riparian margin is significantly more effective than a 10 m riparian margin, but instead, most riparian attenuation of overland runoff will be within the first 5 m of a grass filter strip. For instance, Parkyn (2005) cites an international review that demonstrated riparian margins <5 m width attenuated suspended solids by 74% (Dillaha et al. 1989), whilst McKergow et al. (2008) demonstrated that grass filters of 3 m could attenuate 65% of suspended solids in the Bay of Plenty.

7.5 Based on this evidence I believe the proposed buffer widths are likely to be considerably wider than necessary for achieving effective sediment reduction for parts of the landscape where it is needed most.

7.6 In addition to the above findings, both Collier et al. (1995) and Parkyn (2005), along with other studies (for example Smith, 1989; McKergow et al. 2008), have acknowledged or demonstrated that overland removal rates are effective when there is uniform sheet wash across the land. However, these authors have acknowledged that flow is more likely to converge in certain locations where the overland flow will have higher velocities, more water depth and higher sediment concentrations, thus overwhelming the ability of the buffer to attenuate sediment. With these issues in mind, McKergow et al. (2008) recommended that the appropriateness of buffer widths should be considered with respect to landscape suitability (for example practicality of implementing measures and convergence zones), the timing of runoff relative to the seasonal vigour and density of grass filters and the effectiveness of other mitigation options such as sediment retention basins.

8. PHYSIOGRAPHIC ZONES

8.1 Environment Southland has developed the Physiographic Zone (PZ) approach which is based on a variety of interacting factors to divide Southland into nine zones representing different levels of risk for contaminant loss pathways.

8.2 At the conceptual level I agree that defining different PZ to understand and manage environmental risk and apply different good management practices is a sound approach. In principle, I support the adoption of this risk approach to manage water quality where there is clear scientific evidence linking contaminant loading and land management practises to impacts on ecosystem and human health which should be based on community values.

8.3 However, this approach has not quantified the magnitude of any risk, the amount of contaminant emanating from these zones, how they interact with other zones and the resulting effects on downstream receiving environments with respect to impacts on water ecosystem and human health and community values.

8.4 Consequently, I support the PZ approach as a 'drafting gate' for consenting activity requirements whereby the PZs are used as a conceptual risk framework to underpin the selection of appropriate good management practises relative to risk, and to prioritise areas where farm environment plans should focus on first.

8.5 Moving towards limit setting, I believe there is insufficient certainty to support application of the current physiographic approach to set zone-specific contaminant limits. A comprehensive understanding of contaminant load, fate and transport within each zone, and the effects on water quality values is required to fully support use of the physiographic approach to underpin the limit setting process.

8.6 Based on the physiographic science published to date, there is limited ability to replicate current patterns in water quality. I believe there is insufficient evidence to fully support the differentiation of nine distinct zones for surface water quality management. There is a general lack of data to validate the approach, with some important zones not being represented in the existing datasets. Further validation of the physiographic approach is required to fully support use of the conceptual risk framework to further underpin limit setting policies beyond holding the line.

9. APPENDIX E- WATER QUALITY STANDARDS

9.1 The proposed Water and Land Plan contains Appendix E which includes water quality standards that must be maintained and will be referred to when granting consent.

9.2 Some of these standards are now included in the NOF. However, there are differences in the terminology between both documents. For example, for periphyton, Appendix E refers to biomass of filamentous algae, diatoms and cyanobacteria while the NOF does not differentiate between these forms of algae. My understanding of the Environment Southland monitoring program for periphyton is that it measures total biomass (chlorophyll *a*) but does not collect data in a manner that is consistent with assessing against the Appendix E standards. The standards should be modified to reflect total biomass.

9.3 Constructed wetlands, sedimentation ponds and other treatment systems, which represent ideal mitigation tools to treat farm runoff and improve downstream water quality. These systems temporarily store contaminant-rich water prior to treatment and may therefore exceed the water quality standards proposed in Appendix E. I believe the proposed standards should exclude standing waters within treatment systems, and instead only apply to point source discharges or system outflows after reasonable mixing.

10. APPENDICES

Table 1: Summary of the proportion of sites compliant with different National Objective Framework (NOF) attributes and bandings. All parameters except macroinvertebrates are a part of NOF. NA applies to attributes that were not considered in the relevant document. For Hodson et al. (2017), results from Environment Southland and NIWA stations were added together before calculating proportions.

	Kitto and Hodson (2016)					Hodson et al. (2017)				
NOF Band	Nitrate toxicity	Ammonia toxicity	Secondary contact recreation	Macroinvertebrates	Periphyton	Nitrate toxicity	Ammonia toxicity	Secondary contact recreation	Macroinvertebrates	Periphyton
A	53	NA	57	22	23	60	67	55	NA	NA
B	27	NA	30	26	27	35	36	38	NA	NA
C	20	NA	6	38	23	16	7	7	NA	NA
D	0	NA	7	14	27	0	0	11	NA	NA
Total sites	70	NA	70	50	30	55	55	55	NA	NA

Table 2: Summary of trend analysis results from Hodson et al. (2017). Data is displayed as the proportion of sites that were analysed. Trend results from Environment Southland and NIWA monitoring stations have been added together before proportions were calculated.

Time period	Trend direction	Clarity (m)	*Escherichia coil* (*E.coli*) (cfu/100ml)	Nitrate+nitrite-nitrogen (NNN) (mg/l)	Total Nitrogen (TN) (mg/l)	Ammoniacal nitrogen (NH4) (mg/l)	Organic nitrogen (ON) (mg/l)	Dissolved reactive phosphorus (DRP) (mg/l)	Total phosphorus (TP) (mg/l)
2012-2016	Indeterminate	78	94	78	85	83	80	89	98
	Decrease	22	0	18	15	17	0	3	0
	Increase	0	6	4	0	0	20	8	2
2007-2016	Indeterminate	78	86	65	71	41	71	73	65
	Decrease	22	3	22	6	59	0	10	33
	Increase	0	10	13	23	0	29	18	4
2000-2016	Indeterminate	69	85	46	55	47	74	52	63
	Decrease	14	7	5	5	47	9	48	37
	Increase	17	9	49	40	5	17	0	0

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