In the matter of:	Clauses 6 and 8 of Schedule 1 – Resource Management Act 1991 – Submissions on publicly notified plan change and variation – Proposed Plan Change 1 and Variation 1 to Waikato Regional Plan – Waikato and Waipā River Catchments
And:	**Wairakei Pastoral Ltd**
	Submitter
And:	**Waikato Regional Council**
	Local Authority

STATEMENT OF EVIDENCE OF DR MARTIN WILLIAM NEALE

Block 2 Hearing Topics

Dated: 3 May 2019

STATEMENT OF EVIDENCE OF MARTIN WILLIAM NEALE

SUMMARY

1 Key points from Block 1 include:

1.1 I agree with the premise that parts of the Waikato and Waipā Rivers are degraded, and that a revised management framework is needed to meet the NPS-FM and the Vision and Strategy.

1.2 Multiple lines of evidence indicate that the algal growth in the river is more strongly controlled by P than N, including analysis of WRC monitoring data and nutrient manipulation experiments. Based on this body of evidence, I consider it appropriate that efforts to manage algal biomass in the Waikato River should focus most on managing P.

1.3 I consider the terminology used in PC1 and the Block 1 Section 42A Report to be confusing and inconsistent with the NPS-FM. In particular, the numbers in Table 3.11-1 are 'freshwater objectives' as described by the NPS-FM, not targets or limits. To be consistent with the NPSFM, I recommend that all references to the numbers in Table 3.11-1 be changed to 'objective(s)'.

1.4 Table 3.11-1 is a cornerstone of PC1 as it sets short-term and long-term water quality objectives for the Waikato and Waipa Rivers and their tributaries, and long-term freshwater objectives for the lakes FMUs. Given this, it is important that these objectives are determined in a transparent and scientifically credible manner.

1.5 However, I identified several issues in my evidence and the uncertainty they create means Table 3.11-1, as a key provision in PC1, is not currently fit for purpose and should not be used in this manner until the issues I have raised have been addressed or clarified. I am hopeful that some of these issues may be addressed through the expert conferencing process now underway.

2 Key points for Block 2 include:

2.1 I have concerns that the current methods and rules in PC1 will not achieve Objectives 1 and 3. These objectives represent the key outcomes sought for the health and wellbeing of the Waikato and Waipā Rivers and are therefore critical to the Vision and Strategy.

2.2 Objective 1 seeks the long-term restoration and protection of water quality. I recognise that this objective represents a long-term outcome, and that all the tools needed to achieve the long-term restoration may not exist now. However, the fundamental intervention logic of PC1 remains problematic for achieving this objective because of:

(a) A focus on nitrogen compared with phosphorus (and sediment); and

(b) A misinterpretation of the 'load to come'

I consider it appropriate that meeting Objective 1 requires more comprehensive management of P and sediment at a catchment scale, including explicit management of TP at all sites.

2.3 Similar issues exist with achieving Objective 3; including:

(a) A short-term load to come from recent land use change.

(b) Riparian setbacks that (as currently provided for) are too narrow to provide meaningful benefits.

(c) Increases in sediment discharges (potentially) arising from riparian management.

(d) The proposed timing of rules implementation.

2.4 Due to the shortcomings of the PC1 modelling approaches, WPL has invested in the development of a dynamic decision support tool (**RDST**) to aid in the management of part of the upper FMU.

2.5 Testing of management scenarios with the RDST indicates that there are more flexible land management approaches, than the provisions of PC1, that could lead to superior water quality outcomes. This is in part a result of the large-scale implementation of mitigation activities across the Wairakei Estate, but this approach could nevertheless be applied at different scales with positive outcomes.

BLOCK 2 HEARING TOPICS

1 My name is **Martin William Neale**. I have the qualifications and experience recorded in my statement of evidence filed in relation to the Block 1 Hearing Topics.

2 My statement of evidence has been prepared in accordance with the Code of Conduct for Expert Witnesses set out in Section 7 of the Environment Court of New Zealand Practice Note 2014.

TOPIC C1. DIFFUSE DISCHARGE MANAGEMENT

3 I agree with the premise that parts of the Waikato and Waipā Rivers are degraded, and that a revised management framework is needed to meet the requirements of the Vision and Strategy and the National Policy Statement for Freshwater Management (**NPS-FM**) as amended in 2017. However, I have concerns about the approach of Plan Change 1 (**PC1**) and the intervention logic of the proposed management.

4 The high-level approach in PC1 attempts to manage four key contaminants in the catchment (nitrogen (**N**), phosphorus (**P**), sediment and microbial pathogens). However, in practice PC1 focuses on the management of N, which is problematic for several reasons.

5 Multiple lines of evidence indicate that the algal growth in the river is more strongly controlled by P than N, including analysis of Waikato Regional Council (**WRC**) monitoring data and nutrient manipulation experiments. Based on this body of evidence, I consider it appropriate that efforts to manage algal biomass in the Waikato River should focus most on managing P.

6 The focus on N in PC1 may produce little change in any of the other contaminants discharged to the river, whilst coming at a significant economic and social cost to implement (Block 1 Section 42A Report, para 129). Such an outcome would (in my view) fail to meet the desired Vision and Strategy outcomes.

7 Table 3.11-1 is a cornerstone of PC1 as it sets short-term and long-term freshwater objectives for the Waikato and Waipā Rivers and their tributaries, and long-term freshwater objectives for the lakes FMUs. Given this, it is important that the freshwater objectives are determined in a transparent and scientifically credible manner.

8 Conceptually, the way that the freshwater objectives in Table 3.11-1 have been developed appears logical and credible: the PC1 supporting documents inform us that the current state has been

determined from WRC monitoring data; the long-term freshwater objectives are determined by an NPS-FM guided process using the NOF methodology and the short-term freshwater objectives are based on 10% of the difference between these two benchmarks. However, I have several concerns about the assessment of the current state and the derivation of the freshwater objectives contained in Table 3.11-1 that were fully described in my Block 1 evidence.

9 Given the issues I describe in my Block 1 evidence, and the uncertainty they create, Table 3.11-1, which is a key provision in PC1, is not currently fit for purpose and should not be used in this manner until the issues I have raised have been addressed or clarified. I am hopeful that some of these issues may be addressed through the expert conferencing process currently underway.

TOPIC C1.2 POLICIES 1 AND 2 AND THE OVERALL RULE FRAMEWORK

10 I have concerns that the current methods and rules in PC1 will not achieve Objectives 1 and 3. These objectives represent the key outcomes sought for the health and wellbeing of the Waikato and Waipā Rivers and are therefore critical to the Vision and Strategy.

Objective 1

11 Objective 1 seeks the long-term restoration and protection of water quality. I recognise that this objective represents a long-term outcome, and that all the tools needed to achieve the long-term restoration may not exist now. However, the fundamental intervention logic of PC1 remains problematic for achieving this objective.

12 The focus of PC1 on managing N to achieve ecological outcomes (i.e. lower algal growth) in the catchment remains a significant issue.

13 At a high level, it has long been recognised by the scientific community that P is more important in limiting primary production (i.e. algae and plant growth) in freshwater than N (OECD, 1982), and this is supported by more recent global reviews of the issue (Guildford & Hecky, 2000; Schindler et al, 2016).

14 In addition, this finding has been confirmed in long-term studies attempting to restore the freshwater ecology of lakes in North America. For example, Schindler et al (2008) carried out a 37-year study where the nutrients in a lake were controlled. For 16 years of this study, N was reduced in relation to P, but algal blooms continued, particularly toxic cyanobacteria blooms, despite the lake showing seasonal signs of N limitation (indicated by TN: TP ratios).

15 Despite this finding, TN: TP ratios can be helpful to indicate the relative importance of the two nutrients. A review of nutrient ratios in New Zealand lakes found that these ratios indicated P limitation more frequently (53%) compared with N limitation (14%)(Abell et al, 2010). This review recognised that lake management in New Zealand had previously focussed on N and argued for greater focus on P to achieve improvements in ecological status.

16 Similarly, in the PC1 process, multiple lines of evidence were available that indicate that overall, P is the most important nutrient controlling algal biomass in the Waikato River. For example;

16.1 Nutrients and algal biomass all increase with distance downstream from Taupo Gates and there is therefore a correlation amongst these three variables. However, at an individual site level, there is a strong positive relationship between TP and chlorophyll a, whereas the relationship between TN and chlorophyll a is weak.

16.2 Long-term trend analysis of WRC's monitoring data shows TP and chlorophyll a have decreased, whilst TN has increased, indicating that TP is limiting algal biomass (Verburg, 2016).

16.3 Modelling of the relationship between nutrients and algal biomass indicated that TP contributed more (69%) to chlorophyll a concentration than TN (16%) (Yalden & Elliott, 2015).

16.4 In addition, bioassays, in which algal response to nutrient manipulations were investigated, have documented much greater changes in algal biomass with P additions or reductions, than N (Gibbs et al., 2014; Gibbs & Croker, 2015).

17 Given this abundance of scientific information indicating that P is relatively more important than N for achieving ecological outcomes in the catchment, the focus on N in PC1 is surprising and inconsistent with current scientific understanding.

18 From a perspective of achieving the health and wellbeing of the Waikato and Waipa Rivers, the greater emphasis on N is problematic because traditional actions to reduce N (measured by N leaching in OVERSEER) are unlikely to achieve any meaningful reductions in P (and the other two contaminants) due to their different delivery pathways to the river[1]. Such an outcome would (in my view) likely fail to meet the desired Vision and Strategy outcomes.

[1] Nitrogen is typically transported through the soil and groundwater, whereas sediment, phosphorus and microbial contaminants are typically transported via surface run off.

19 As stated at the Block 1 hearing, I do not consider that efforts to manage N should be removed altogether, rather the balance is skewed too far towards N. To achieve the desired Vision and Strategy outcomes the provisions in PC1 need to place greater weight on P to reduce algal growth in the main river.

20 Furthermore, a recent paper assessing the key stressors for the catchment (Pingram et al, 2019) indicated that TP, along with sediment and habitat quality, were the stressors most closely linked to poor ecological condition (indicated by macroinvertebrate and fish communities). This paper identified that management actions targeted at improving these three measures (TP, sediment and habitat) across the whole catchment (not just the main river) are most likely to achieve improvement in ecological condition.

21 As a result of this whole body of evidence, I consider it appropriate that meeting Objective 1 requires more comprehensive management of P and sediment at a catchment scale, including explicit management of TP at all sites consistent with my Block 1 evidence (para 39).

Objective 3

22 In my view Objective 3 will likely not be met for several reasons:

22.1 There is a short-term load to come of N that is a consequence of land use change not yet fully captured in the WRC water quality monitoring data. This load to come is likely to result in small increases in N concentrations in the catchment through to around 2025 before levelling off (described in detail by Mr Williamson). I consider that this load to come is already visible in the updated current state data presented to the Panel by Dr Scarsbrook in Block 1.

22.2 The riparian setbacks specified in Schedule 1 (1, 3 or 5 metres) are well below the distances considered to have meaningful effects on stream outcomes. For example:

(a) Setbacks of 10 meters appear appropriate for sediment trapping (Liu et al, 2008; Zhang et al, 2010);

(b) Setbacks in excess of 20 meters are required for nutrient removal (Zhang et al, 2010; Sweeney & Newbold, 2014);

(c) Setbacks of 30 meters are required to provide for healthy macroinvertebrate and fish communities (Sweeney & Newbold, 2014).

It should be noted that the study (Holmes et al, 2016) used to support the minimum 5m setback in the Section 42A Report (para 773) is based on a wadeable spring fed stream and the authors caution against applying this figure to rain fed streams. The authors expect that wider fenced riparian areas would be required for more erosive (i.e. rain-fed) streams.

22.3 Multiple studies have shown that riparian planting and restoration leads to a short-to-medium term increase in sediment release. Davies-Colley (1997) first reported that Waikato streams in pasture were narrower than those with forested riparian areas. He hypothesised that pasture grasses encroaching on stream channels had caused this phenomenon by trapping sediments and that restoring riparian corridors could cause the sediment to be released. This change in channel shape and associated sediment release after riparian re-forestation has since been documented as lasting at least four decades (McBride et al, 2010). Parkyn et al (2005) created a model to describe this for Auckland streams, and identified that the net benefit for sediment load occurred around 36 years after fencing and planting. They cautioned that significant sediment yield from bank stored sediment can be expected, peaking around 25 years after restoration.

23 The difficulty with achieving Objective 3 arises from the lags (both negative and positive) that are inherent in ecological systems. I support the need for meaningful riparian setbacks and restoration, but it should be done with the knowledge that the benefits of these actions might not eventuate for several decades. Therefore, meeting some of the short-term freshwater objectives in Table 3.11-1 will be highly unlikely as some water quality measures will get worse before they get better (even if appropriate management is put in place).

24 The most effective short-term riparian mitigation measures are therefore stock exclusion and leaving existing vegetation in situ, with strategic riparian planting over the medium to long term. Setback distance (as noted above) is critical for the success of riparian mitigation, and setbacks more than 5m are likely to be most effective. These actions should be commenced as soon as possible.

Ruahuwai Decision Support Tool

25 The evidence presented on behalf of Wairakei Pastoral Limited (**WPL**) in Block 1 by Mr Williamson, Dr Cresswell and Dr Jordan raised substantial concerns about the modelling work carried out to inform PC1.

26 The shortcomings of the PC1 modelling led WPL to invest in the development of a model suite (collectively known as the Ruahuwai Decision Support Tool (**RDST**)) that has greater utility than that undertaken for PC1 (the details of which are covered in the Block 2 evidence of Mr Conland, Mr Williamson, Dr Cresswell and Dr Jordan).

27 Hence, my evidence does not cover the technical details of the RDST modelling, rather it considers how such a model can be used to inform and improve the management of the catchment. The model can also be used to underpin an adaptive management approach to the catchment, which is described further by Mr Conland.

28 The RDST model predicts the contaminants targeted by PC1 – N (TN, NO3), P (TP), sediment and E.coli - and chlorophyll a (as an indicator of algal biomass). The RDST makes direct predictions of several measures (e.g. annual and seasonal summary statistics) of three of the contaminants (N, P and E. coli). The predictions for chlorophyll a were calculated using the TN and TP predictions from the model using the equations described by Verberg (2016).

29 Mr Williamson describes the calibration steps for the RDST in his evidence and the findings of that assessment provides confidence that the model may be used for the purpose described here. That is, I use the outputs of the model to assess the efficacy of the potential management approaches for the Wairakei Estate for achieving the long-term freshwater objectives in PC1 (noting of course that they may change after expert conferencing).

30 Mr Conland and Mr Williamson describe in their Block 2 evidence all the model scenarios that have been tested with the RDST, whereas I use the predictions from the following four scenarios in my assessment;

30.1 Scenario 1: the ‘do nothing’ scenario, which represents the existing land use at the time of PC1 notification in 2016 and continues with no mitigations or FEPs developed in the catchment.

30.2 Scenario -1: the ‘stop farming’ scenario, which represents all land (except native forest, roads, built, and river land uses) being changed to plantation forest. In this situation geothermal inputs and point sources such as Contact Energy’s power station are still included. Inflow from Lake Taupo remains unchanged.

30.3 Scenario 4: the ‘PC1’ scenario, which represents all farms in the catchment having FEPs and all farms are limited to the

75^{th} Percentile as proposed in the planning provisions notified under PC1.

30.4 Scenario 6: the ‘vulnerable land’ scenario, which represents all farms in the catchment having FEPs and where farming on vulnerable land is avoided or mitigated according to the level of risk at the farm location.

31 The first two scenarios essentially ‘book-end’ the extremes of the options available, from do nothing (or ‘business as usual’), to stopping all farming. In practice, both are unrealistic outcomes, but they provide context for the management scenarios.

32 The other two scenarios (numbers 4 and 6) provide an assessment of potential management options, including the PC1 provisions as notified and a scenario developed for the RDST which includes FEPs for all farms and targeted management of the sensitive, or critical source areas for contamination.

33 This assessment has been carried out for three sites closest to the Wairakei Estate on the Waikato River (Ohaaki, Tahorakuri and Ohakuri). The spatial coverage is determined by the sites most affected by the Estate’s activities, but will also have flow on downstream benefits. The models are run to 2064 (as described in Mr Williamson’s evidence), and the water quality outcomes discussed below are based on that timeframe.

34 It is noteworthy that for the majority of parameters at these sites the notified PC1 freshwater objectives are the same as the current state of water quality (PC1 Table 3.11.1). Therefore, to meet the freshwater objectives in PC1 at these locations generally requires the protection or maintenance of existing water quality. The exception is:

34.1 TN at Ohakuri - current state of 211 mg/m^3 compared with a short-term target of 206 mg/m^3 and a long-term target of 160 mg/m^3.

35 As would be expected the water quality outcomes predicted are better for Scenario -1 (stop farming) than for Scenario 1 (do nothing). However, the differences between these scenarios are relatively small for some of the parameters, with most of the predicted results in the same attribute band. This is not unexpected as these sites are all close to the Lake Taupo outflow and this discharge will have a dominant effect on water quality in this area, with a lesser effect from land use.

36 For the other two management scenarios, the water quality predictions are intermediate between Scenario 1 and 2. The numeric values are consistently lower for Scenario 6 (FEPs and

targeted mitigation) than for Scenario 4 (PC1 provisions), although the results from the two scenarios are all in the same band (Table 1).

37 The better water quality outcomes from Scenario 6 is a key finding as it indicates that freshwater outcomes can be achieved under an alternative management framework. In this case, one that provides for some land use flexibility, whilst meeting (or exceeding in some cases) the water quality outcomes predicted to eventuate from a more restrictive management framework (i.e. PC1 provisions). This is in part a result of the large-scale implementation of mitigation activities across the Wairakei Estate. To the best of my knowledge, such a comprehensive programme of mitigation activities has not been undertaken in such a coherent manner across such a large catchment in New Zealand.

38 Whilst each of the mitigation activities has a credible intervention logic, proven track record and predicted environmental benefit, there remains some uncertainty in managing such complex natural ecosystems. In addition, WPL is unable to control all factors in the catchment (e.g. other landowners' activities and natural environmental conditions).

39 Therefore, I consider the use of an Adaptive Management approach is the most appropriate way to manage the effects of land use. Importantly, Adaptive Management is focussed more on achieving management objectives, rather than the methods to achieve these objectives. For example, if the Waikato River meets the community's objectives, supports healthy populations of native flora and fauna and is free from harmful algal blooms, we would care little about the concentrations of nutrients in the water, nor the constraints on land use change (both key issues in PC1).

Table 1: Modelled water quality data for WPL sites from selected scenarios. See para 30 for scenario details.

Parameter	Model Scenario			
	Scenario 1 (Do nothing)	Scenario 2 (Stop farming)	Scenario 4 (PC1 provisions)	Scenario 6 (FEP & mitigations)
Waikato River @ Ohaaki				
Chl a (median)	1.5	1.2	1.4	1.4
Chl a (maximum)	8.4	2.4	6.3	6.2
TN median	160	120	150	150
TP median	11	11	11	11
Nitrate (median)	0.046	0.035	0.044	0.044
Nitrate (95^{th} %ile)	0.056	0.043	0.053	0.053
Ammonia (median)	0.006	0.004	0.006	0.006
Ammonia (maximum)	0.009	0.006	0.008	0.008
E. coli (95^{th} %ile)	9	9	9	9
Waikato River @ Ohakuri				
Chl a (median)	2.7	1.7	2.4	2.3
Chl a (maximum)	16	3.7	12	10
TN median	210	96	180	170
TP median	18	15	17	16
Nitrate (median)	0.081	0.037	0.070	0.063
Nitrate (95^{th} %ile)	0.130	0.046	0.110	0.095
Ammonia (median)	0.005	0.002	0.004	0.004
Ammonia (maximum)	0.013	0.003	0.011	0.009
E. coli (95^{th} %ile)	14	7	11	10
Waikato River @ Tahorakuri				
Chl a (median)	4	2.5	3.6	3.4
Chl a (maximum)	21	5.7	16	14
TN median	320	140	270	250
TP median	22	19	21	21
Nitrate (median)	0.140	0.063	0.12	0.11
Nitrate (95^{th} %ile)	0.280	0.077	0.25	0.2
Ammonia (median)	0.010	0.004	0.008	0.0076
Ammonia (maximum)	0.021	0.005	0.019	0.015
E. coli (95^{th} %ile)	69	37	55	48

CONCLUSIONS

40 The RDST has been used to run scenarios to assess the water quality effects of the potential management actions for the Ruahuwai sub-catchment. The model predictions have consistently indicated that the relevant water quality parameters would improve or remain stable following implementation of FEPs and the proposed mitigations in the Ruahuwai sub-catchment. This information indicates that the management approach proposed by WPL may contribute to the restoration of water quality within the Waikato River.

41 The first 10-years are nevertheless critical for the success of PC1 and the long-term 80-year strategy, and the key dates that trigger resource consents and FEPs should be brought forward as recommended by Mr Ford and Mr McKay in their Block 2 evidence

42 I have concerns that the current methods and rules in PC1 will not achieve Objectives 1 and 3. These objectives represent the key outcomes sought for the health and wellbeing of the Waikato and Waipā Rivers and are therefore critical to meeting the Vision and Strategy.

43 The focus of PC1 on managing N to achieve ecological outcomes (i.e. lower algal growth) in the catchment remains a significant issue. This focus is despite a significant body of science indicating managing P is likely to provide for better outcomes in freshwater quality. As a result of this body of evidence, along with a recent paper on the key stressors in the Waikato catchment, I consider it appropriate that meeting Objective 1 requires more comprehensive management of P and sediment at a catchment scale, including explicit management of TP at all sites

44 Furthermore, problems with achieving Objective 3 arise from the lags (both negative and positive) that are inherent in ecological systems. I support the need for meaningful riparian setbacks and restoration, but it should be done with the knowledge that the benefits of these actions might not eventuate for several decades. Therefore, meeting some of the short-term freshwater objectives in Table 3.11-1 will be highly unlikely as some water quality measures will get worse before they get better. In my view these issues increase the urgency for taking action under PC1 as quickly as possible (within tighter timeframes). They would not justify any delay in acting.

45 Several WPL experts have described the shortcomings of the PC1 modelling, which led WPL to invest in the development of the RDST, that has greater utility than the modelling undertaken for PC1.

46 The testing of management scenarios with the RDST indicates that there are more flexible land management approaches than the provisions of PC1 that could lead to superior water quality outcomes. This is in part a result of the large-scale implementation of mitigation activities across the Wairakei Estate.

Dr Martin Neale

Puhoi Stour Limited

3 May 2019

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