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 Waipa River Catchments

And: **Wairakei Pastoral Ltd**

Submitter

And: **Waikato Regional Council**

Local Authority

STATEMENT OF EVIDENCE OF NICHOLAS ASHLEY CONLAND

Block 2 Hearing Topics

Dated: 3 May 2019

STATEMENT OF EVIDENCE OF NICHOLAS ASHLEY CONLAND

SUMMARY

1. The key points from my Block 2 evidence are:

2. I have prepared scenarios on the RDST to examine the proposed provisions in PC1 and compared these with alternative scenarios which reflect the alternatives proposed by WPL. The scenarios are tests of the environmental conditions which occur when a set of actions are undertaken in a sub-catchment.

3. In the scenarios I ask:

    3.1. What is the benefit of the Farm Environment Plan? (This is Scenario 2)

    3.2. What is the difference between GFP and BFP? (This is Scenario 3)

    3.3. What is the benefit of the 75th percentile? (This is Scenario 4)

    3.4. Does LUC manage land use effects? (This is Scenario 5)

    3.5. Does protection of Vulnerable Land manage land use effects? (This is Scenario 6)

    3.6. Does Vulnerable Land provide for land use flexibility? (This is Scenario 7)

4. The scenario results are compared with two 'bookend' scenarios which provide a range between 'Doing Nothing' and 'Stop Farming' the difference between these two scenarios show the range for total mitigations in the sub-catchments and represents the anthropogenic load. These are illustrated in **Table 1**.

5. The PC1 provisions are examined in Scenario 2; the Scenario 3 and Scenario 4 results show that in most sub-catchments properties and enterprises completing an FEP with BFP have the largest improvement in the FWO levels expressed as a load for TN and TP.

6. The WPL alternative provisions are examined in Scenario 5; the Scenario 6 and Scenario 7 results show that in most sub-catchments properties and enterprises completing an FEP with mitigations on Vulnerable Land have a greater improvement than the PC1 provisions in the FWO levels expressed as a load for TN and TP.

7. The WPL alternative Scenario 6 also shows that LUC resource limits on land use activity has the largest improvement in the FWO levels expressed as a load for TN and TP.

8. The WPL alternative Scenario 7 also shows that land use flexibility is provided for properties and enterprises completing an FEP with mitigations on Vulnerable Land. This analysis provides for Te Ture Whenua and settlement land.

9. I have examined the provisions of PC1 from the perspective farming properties, enterprises and sub-catchment entities for regional plan implementation by WRC. As a result of my analysis I recommend that PC1 provisions are amended so that:

    9.1. Policy provisions for land use change include criteria for Vulnerable Land; DST use; Table 3.11-1 FWO and Loads for TN and TP as Limits and Targets; Sub-catchment Plans and Adaptive Management.

    9.2. Farming Activity rules have conditions which require an FEP that performs to the Table 3.11-1 FWO; and avoid Vulnerable Land.

    9.3. A farming activity rule that manages property subdivision and mergers.

    9.4. A farming activity rule for land use change that has two pathways depending on whether loads and FWO can be achieved.

    9.5. All reference to the 75th percentile is deleted, and Schedule B is simplified to focus on assessing changes in land use intensity from a benchmark period.

10. Schedule 1 (Block 3) should contain direction for:

    10.1. Direction for mitigations actions to target changes in attribute levels to achieve the FWO.

    10.2. Vulnerable Land criteria.

    10.3. Adaptive Management.

    10.4. Catchment Management.

    10.5. Guidance for compliance with NRP

    10.6. Guidance for GFP and BFP.

16. Using these two sets of analyses I have examined options which will best provide for Objective 3 and the Vision and Strategy in the first 10 years of the plan.

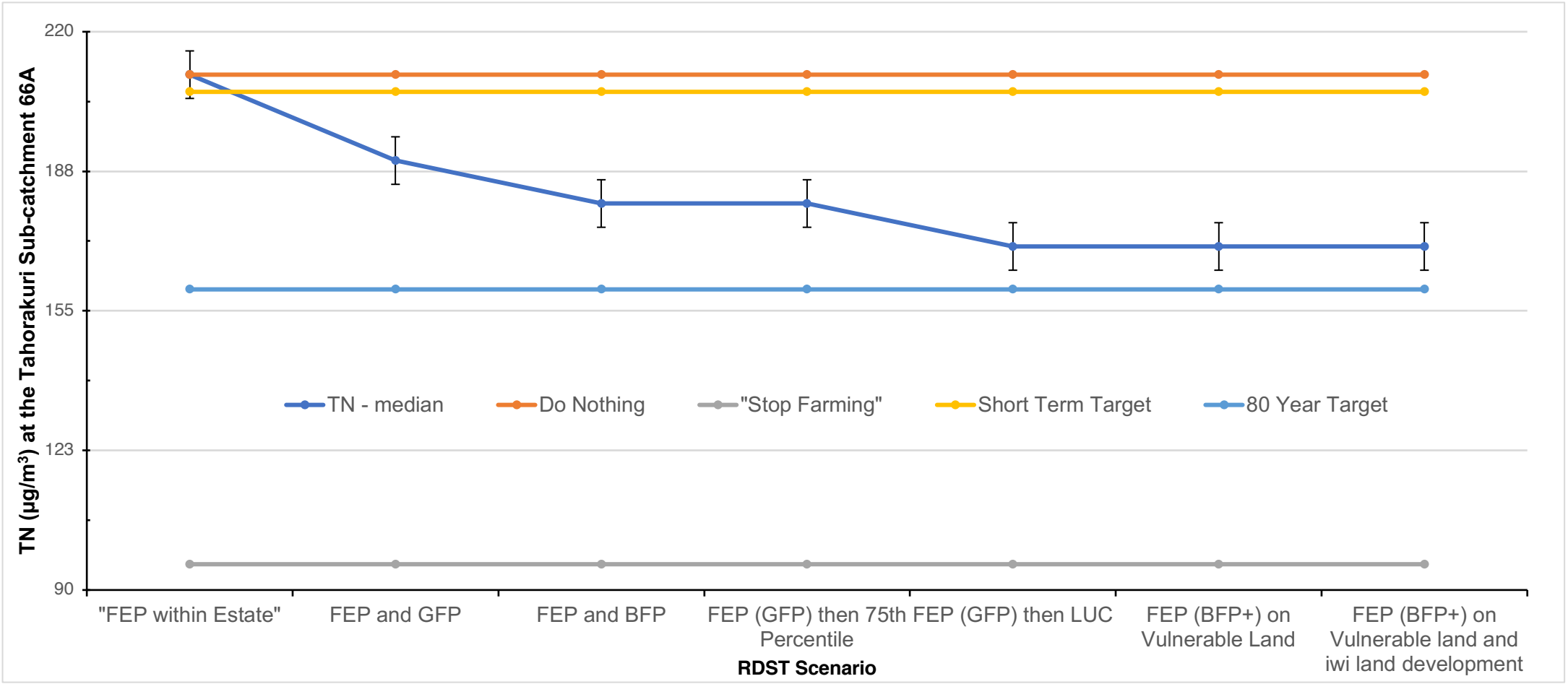

Figure 1 : Assessment of Plan Provisions relative to Objective 1 and Objective 3 at Tahorakuri Sub-Catchment 66A

BLOCK 2 HEARING TOPICS

1. My name is Nicholas (**Nic**) Conland. I have the qualifications and experience recorded in my supplementary evidence filed in relation to the Block 1 Hearing statement of evidence and 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.

3. My evidence addresses the Part C topics from the perspective of the regional plan implementation in the areas of my expertise.

4. In particular I have focused on the provisions and the related activities which drive behavior change in the first 10 years of Plan Change 1 (**PC1**) to meet Objective 3. These are Table 3.11-1, the Farm Environment Plans, and the 75th percentile.

5. I developed the Ruahuwai Decision Support Tool (**RDST**) scenarios for Wairakei Pastoral Limited (**WPL**) to test the efficiency and effectiveness of these PC1 provisions and the reasonably practicable alternatives considered as rational options by WPL.

TOPIC C1 – DIFFUSE DISCHARGE MANAGEMENT

Role of Table 3.11-1

6. The role of Table 3.11-1 in providing both numeric freshwater objectives (**FWO**) and a temporal and spatial direction for achieving the Vision and Strategy is key to the successful implementation of PC1.

7. The attributes are best identified as numeric FWO in line with the NPS-FM to represent the desired states for water quality in each of the sub-catchments. The attributes in Table 3.11-1 operate as performance measures for the Vision and Strategy and loads (proposed in submissions by WPL, Beef and Lamb and Horticulture New Zealand (**HortNZ**)) operate as limits (or targets) to manage resource use.

8. In my supplementary evidence I analysed the role of loads to support the implementation of PC1.

9. The inclusion of appropriate NPS-FM limits and targets as a "load" to limit the level of resource use in the catchment is an appropriate mechanism to guide resource managers to meet the Vision and Strategy and achieve Objectives 1 and 3 in PC1.

10. The proposed loads (tonnes/year) for Total Nitrogen (**TN**) and Total Phosphorus (**TP**) represent the total resource use in a sub-catchment relative to the FWO for Chlorophyll a, TN, and TP levels.

11. The proposed loads also (as limits/targets) provide a criteria for determining the ability of a sub-catchment to assimilate land use changes relative to FWO in Table 3.11-1 and the Vision and Strategy. The ability of collective mitigations within a sub-catchment to reduce loads (to limits) is examined in the scenarios later in my evidence.

12. Farm Environment Plan (**FEP**) preparation will need to address the FWO in Table 3.11-1 directly through individual and collective mitigation actions which seek to achieve changes in attribute levels to achieve the FWO. Where each sub-catchment will have a different spatial and temporal risk assessment to develop targeted FEP's at a Property, Enterprise, Sub-catchment and Sector Group scale.

13. In my experience with both regional plan development and plan implementation the inclusion of clear objectives which express the community aspirations for change and the desired state for their resources is essential. I recommend that PC1 is amended so that:

    1.1. Farming activity rules require an FEP that performs to the Table 3.11-1 FWO;

    1.2. Schedule 1 (FEPs) contains direction for mitigations actions to target changes in attribute levels to achieve the FWO.

Decision Support Tools for PC1

14. As part of my research for my Block 2 evidence I reviewed Dr Doole's evidence for Block 1 and re-read his Technical Leaders Group reports, because Dr Doole had undertaken a similar exercise to the RDST developing the TLG's Decision Support Tool (**DST**).

15. I read the following reports commissioned by the TLG for the Healthy Rivers Wai Ora (**HRWO**) Project:

    1.1. Report No. HR/TLG/2015-2016/4.2 - Evaluation of scenarios for water quality improvement in the Waikato and Waipa River catchments - Assessment of second set of scenarios 24 September 2015 (**Doole 2015**)

    1.2. Report No. HR/TLG/2016-2017/4.4 - Evaluation of scenarios for water quality improvement in the Waikato and Waipa River catchments Business-as-usual assessment (**Doole 2016**)

1.3. Report No. HR/TLG/2016-2017/4.5 - Simulation of the proposed policy mix for the Healthy Rivers Wai Ora process (**Doole June 2016**)

1.4. Report No. HR/TLG/2015-2016/4.6 - Description of mitigation options defined within the economic model for Healthy Rivers Wai Ora Project - Description of options and sensitivity analysis - (**Doole September 2015**)

1.5. Report No. HR/TLG/2015-2016/4.7 - General principles underlying the development of the Healthy Rivers Wai Ora (HRWO) economic model (**Doole November 2015**)

16. The reports provided some useful examples for how the HRWO DST scenarios were prepared and run. The RDST scenarios have followed similar principles for the adoption of mitigations and the approach to Good Farming Practice (**GFP**) and Best Farming Practice (**BFP**) (as defined by Mr Ford in his evidence).

17. I note from the TLG report 4.2 (Doole 2015)[1] that several conclusions are drawn from the evaluation of HRWO Scenario 1. These are:

> "(9) There is a step-change in the necessary level of adoption for mitigation practices, as the steps move above 25% in progress towards Scenario 1. In particular, this is observable in the targeted use of farm plans and broad-scale adoption of edge-of-field strategies.
>
> (10) Unconstrained land-use change allows a reduction in abatement cost, but requires substantial transformation of land use (around 50% of the catchment) in order to achieve these reductions.
>
> (11) Not defining limits for TN across the catchment (apart from maintenance of current state) has little effect on mitigation cost. A major reduction in TN occurs anyway to cost-effectively meet the simulated set of limits for the other contaminants, regardless of whether N itself is subject to limits or not. This arises from the fact that the most cost-effective strategies for phosphorus abatement (e.g. de-intensification, point source improvement, and edge-of-field strategies) have dual benefit for reducing both nitrogen and phosphorus losses."

[1] Evaluation of scenarios for water-quality improvement in the Waikato and Waipa River catchments

18. These conclusions are interesting especially the sensitivity analysis where the TN reductions were ignored but achieved by the other mitigation actions, also that unconstrained land use change led the HRWO DST to change land use type as a form of mitigation and subsequent cost off set.

19. It appears that this pathway in the HRWO DST optimisation, may have formed part of the constraint in the modelling that led to the moratorium approach in PC1.

20. In the scenarios I have prepared for the RDST, I analysed of a range of land use options. Including looking at a Land Use Capability (**LUC**) scenario. The other land use control I investigated was the sensitivity analysis of land with low vulnerability to nitrogen leaching.

21. The Mitigation Options report (HR/TLG/2015-2016/4.7) provides useful guidance for the performance of the mitigation actions in an FEP and especially the "edge of field" examples. I followed a similar approach with WPL's 5 protocols explained in my Block 1 evidence. Overall the HRWO DST scenarios apply a broad range of mitigations and I am confident with the consistency of approach between the two DST's parameterising of the scenarios.

22. While WPL has put resources into developing the RDST to provide support for decision making, PC1 currently requires the Chief Executive Officer (**CEO**) of Waikato Regional Council (**WRC**) to appoint an approval for an alternative DST. I see this as problematic as it implies an unconfined subjective decision on the usability of a DST without any qualification.

23. It is difficult to see how a rational application for use of a new model would be substantiated without some guidance in the PC1 provisions. I have read and considered the proposed schedule in the HortNZ submission which provides a substantial and useful outline for using a DST for PC1.

24. I have also read the Parliamentary Commissioner for the Environment's (**PCE**) report and recommendations for DST's within the context of the review of OVERSEER.

25. I have considerable experience with the assessment of effects under Schedule 4 of the RMA. The Schedule 4 approach is familiar to most RMA practitioners and relies on polices and rules defining the elements of the environmental assessment required such as the link between land use and the FWO in Table 3.11-1.

26. This approach is widely used and accepted for the assessment of effects on the environment (AEE) under a very broad range of rules in all regional plans. It is rare that a plan will stipulate the particular DST required by Council officers.

27. For example I have prepared numerous applications for air discharges which have used a range of air dispersion models (AERMOD, AUSPLUME, CALPUFF, etc…) depending on the source of the effects and the sensitivity of the receiving environment.

28. I have also prepared numerous applications for the use and take of water using a wide range of DST relating to diverse environments and uses such as: stormwater, groundwater; stream depleting groundwater; and surface water.

29. The same approach applies for construction discharges to water, geothermal, noise and traffic AEE's which are all provided for in a similar way under a Schedule 4 approach.

30. My preference is for effects criteria to be defined by a DST, I see merit in the approach suggested by HortNZ and the PCE report to include criteria for DST in the PC1 Schedule 1.

OVERSEER

33. I agree with Mr McCallum-Clarke's verbal evidence[2] that OVERSEER is useful for on farm comparative scenario testing and inter-farm comparisons are poor, also that absolute values from OVERSEER are problematic. The limitations with OVERSEER have been clearly outlined in the recent PCE report and are covered in the evidence of Dr Cresswell and Mr Ford.

34. I think this is simply expressed as good on one farm, poor comparing two.

35. My experience with OVERSEER has changed substantively over the last 6 years with less and less reliance on OVERSEER for any determination of effects and latterly as a proxy for land use productivity and intensity. The mitigations within OVERSEER are useful tools for scenario analysis, however the primary assumption that all farms are operating at GFP is not well understood and is likely impossible to ascertain.

36. My concerns with OVERSEER are primarily due to the steady state characteristics of OVERSEER operating long term climate data and producing annual average leaching losses. With the limitations of OVERSEER understood, its place within the plan provisions requires some analysis.

37. PC1 provisions referencing OVERSEER are:

Schedule B "The Nitrogen Reference Point"

1.1. Schedule B provides a guideline to prepare a comparable OVERSEER file in a format which collects data on farming productivity. The collected data provides WRC with a benchmark or grand parented value for productivity or land use intensity. The Nitrogen Reference Point (**NRP**) numbers recorded are facts relative to the version of OVERSEER and the productivity records included in the assessment. The NRP provides no explicit determination of effects on the environment and the NRP numbers are not comparable between farms due to the issue above.

75th percentile

1.2. The 75th percentile nitrogen leaching value is derived from NRP values from dairy farming properties and enterprises in each Freshwater Management Unit (**FMU**) and the 75th percentile provides a limit on resource use under the NPS FM. The 75th percentile is prepared when all NRP values are submitted and

[2] Section 42A Report Page 8 para 19: Page 13/14 para 49

the upper quartile of farming activity is reduced to the 75th percentile value. Due to the independence of each NRP value a comparison is not valid, as such the NRP values require compliance with the FEP to determine if farming activities are operating at GFP levels. Finally, the 75th percentile is biased more by biophysical attributes which are independent of effects than inefficient farming systems.

Schedule 1 – FEP's

1.3. The FEP requires all farms to understand their current land use intensity and evaluate the risks from biophysical location and potential effects on the environment. The FEP provides two mechanisms under PC1, firstly to schedule mitigations which lift all farms to GMP, secondly to schedule mitigations which target locations ('critical source areas') where farm activities are likely to have increased or actual environmental risk. The FEP provides a compliance relationship with WRC to ensure all farms are at GMP and complete mitigation actions. The NRP within a FEP provides a useful proxy to monitor farming activity through productivity data and a compliance relationship with WRC to monitor changes in land use intensity.

38. I have prepared data for OVERSEER at a farming and enterprise scale for PC1 over the last three years. There have been several version changes in OVERSEER which have shifted the NRP values. However, over this time there has been no significant change in farm productivity data (or observed water quality attributes).

39. I have considered the role for OVERSEER within PC1 and believe it has value within the FEP as part of the compliance relationship with WRC to determine changes in land use intensity. This provides WRC with a NRP within a FEP, as an individual farming property assessment (at that location) which can be referred back to in subsequent years to determine.

40. Where compliance could be based on changes in productivity which increase land use intensity. I recommend the following changes to the PC1 provisions:

    1.1. Schedule B is simplified to focus on assessing changes in land use intensity from a benchmark period.

    1.2. All reference to the 75th percentile is deleted.

    1.3. Schedule 1 is amended to improve the function of the NRP as a compliance mechanism to evaluate changes in land use intensity.

41. I have read the Section 42A Report, where the reporting officer in para 21 makes similar recommendations.

Ruahuwai Decision Support Tool and scenario modelling

42. As outlined in the Appendix 1 of my Block 1 evidence, the RDST was developed to inform land use and mitigation decisions in 2015. I led a team of developers to put together the design and architecture for the RDST and provide a conceptual biophysical model of the Ruahuwai Catchment.

43. Over the last four years the conceptual model has evolved as the scope for the model use has changed to look at the policy framework being considered by WRC in the Ruahuwai Catchment. The current technical specifications of the RDST are covered in the evidence of Mr Williamson. I have used the RDST to run numerous scenarios to look at possible optimisation solutions for the Ruahuwai Catchment which would also be suitable for the whole of the Waikato and Waipa River Catchments.

44. I have had a broad and long-term engagement with local and regional stakeholders and the RDST has been made available to other parties in the Ruahuwai Catchment to examine water quality outcomes. This includes iwi, Farm Enterprises (Landcorp, Ata Rangi, Southern Pastures Limited, Theland Farm Group), DairyNZ, Beef and Lamb, Miraka and WRC.

Four contaminants – nitrogen, phosphorus, E.coli, and sediment

45. The provisions in PC1 addressing diffuse discharge management and making reductions over time have been examined in my previous paragraphs. These are:

    1.1. Table 3.11-1;

    1.2. Schedule B 'The NRP';

    1.3. The 75th Percentile; and

    1.4. The FEP.

46. The success or otherwise of these provisions will be measured by the performance time frames in Objectives 3 and ultimately Objective 1. The question is – Will PC1 as drafted realise Objective 3 and ultimately Objective 1 conditions for Table 3.11-1? As I outlined above in **para 38** the NRP is not linked to effects within the sub-catchment or by association Table 3.11-1.

47. The 75th percentile which operates as a limit on resources is linked to effects on the environment but is not focused or targeted beyond the limitations of the NRP.

48. The FEP requires mitigation actions which need to be focused on environmental risks at the farming property, enterprise, sector and sub-catchment scale. The FEP also requires all farm practices to be at GMP or at an equivalent minimum level of uniform compliance. Lastly the FEP provides a tool to monitor the intensity of land use to ensure diffuse discharges are not increasing by changes in farm productivity.

49. The mitigation actions require FWO and Limits (or targets) to focus actions on the attributes which need the most work and to constrain resources within a sub-catchment. It is essential that a FEP is related to Table 3.11-1 to provide a staged transition to Objective 3 and Objective 1. In this conclusion I am conscious that the mitigation actions and the way in which they are focused is critical for the success of PC1.

50. The PC1 provisions need to be amended to provide criteria which focus the mitigation actions on particular land within a sub-catchment which is vulnerable to diffuse discharges.

RDST Senarios

51. When preparing the questions to examine the PC1 provisions and test alternatives for a DST I focused the analysis on mitigation actions which could test possible outcomes for the Vision and Strategy through achieving the Table 3.11-1 FWO and limits and targets.

52. The significant problem for implementation of the Vision and Strategy is to evaluate how the objectives in the Strategy can be achieved in the context of the RMA.

53. In preparing this evidence I have conceptualised a series of scenarios to evaluate and test the provisions in the proposed PC1 and some alternatives to test the efficiency and effectiveness of these options in terms of outcomes for water quality. The scenarios presented are based on the best data available and where possible follow the technical direction of the TLG and the provisions of the PC1 as notified.

54. All of the scenarios were run across the whole of the Ruahuwai Catchment which includes 10 (plus 66A Tahorakuri) of the sub-catchments in Table 3.11-1 and Table 3.11-2. The scenarios follow the sequence of land use options which first explore the existing situation at the time of notification (2016-2017) and the options being contemplated by the Ruahuwai Catchment community (2018-2019).

55. The RDST scenarios[3] are as follows:

Scenario 0 – **Calibration**

56. This represents the calibration conditions for the RDST using the calibrated model using the five transitional periods of land use change (1972, 2005, 2010, 2015, 2016/17).

Scenario 1 – **Do Nothing**

57. This represents a 'future' where the land use as existing at the time of PC1 notification (22 October 2016) continues with no mitigations or FEP's developed in the catchment.

Scenario -1 – **Stop Farming**

58. This represents a 'future' where all land (except native forest, roads, built, and river land uses) are 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 (e.g. Lake Taupo catchment remains developed).

Scenario 2 – **FEP and 'GFP' on all farms**

59. This represents a 'future' where all farms in the catchment prepared and completed a FEP. This is developed following the 5 protocols developed by WPL and GFP as considered determined by OVERSEER protocols (summarised in Mr Ford's evidence). This is consistent with the first 10 year actions considered by Dr Doole in (Doole G.J 2016a[4]).

Scenario 3 – **FEP and 'BFP' on all farms**

60. This represents a 'future' where the conditions in Scenario 2 exist, except all farms have undertaken a significant mitigation steps to BFP as developed by Mr Ford (in his evidence).

Scenario 4 – **FEP and 75th Percentile limits on all farms**

61. This represents a 'future' where the conditions in Scenarios 2 exist, except all farms are limited to the 75th Percentile as proposed in the planning provisions under PC1.

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[3] A full description of the scenarios is provided in Appendix 2 of my evidence.

[4] Graeme J. Doole (2016a), Description of mitigation options defined within the economic model for Healthy Rivers Wai Ora Project, Report No. HR/TLG/2015-2016/4.6

Scenario 5 – **FEP then LUC limits applied**

62. This represents a 'future' where the conditions in Scenarios 2 exist, except all the farms are limited to the Land Use Capability limits for productivity as developed by Mr Ford (n his evidence). The land use changes in intensity follow the direction provided by Dr Doole in his report (Doole 2016).

Scenario 6 – **FEP then mitigations on Vulnerable Land**

63. This represents a 'future' where farming on Vulnerable Land is avoided and mitigated in proportion to the level of nitrogen risk at the farming location.

Scenario 7 – **FEP then mitigations plus land use changes on Vulnerable Land**

64. This represents a 'future' where farming on Vulnerable Land is avoided and mitigated similar to Scenario 6 except on land with very low nitrogen risk. At these locations land use changes in terms of intensity following the direction provided by Dr Doole in (Doole 2016a).

65. The scenarios are fully described in **APPENDIX 1**.

Performance bookends for scenario's

66. The **Scenario 1** and **Scenario -1** provide 'bookends' for the range of options available to the catchment by respectively "Doing Nothing" and Stopping Farming. The purpose of these scenarios is to examine the possible scale for mitigations in each of the sub-catchments. The "Do nothing" load represents no action towards the Vision and Strategy and "Stop Farming" represents the background load in the sub-catchment.

67. The difference between these two scenarios provides a useful point of reference as a performance baseline when examining the range of scenarios. Where the closer the mitigations arrive to the background load, the more effect they are from a resource management perspective.

68. I do not consider the economic or environmental effectiveness or efficiency this is in the evidence of Dr Neale and Mr Ford respectively. The performance 'bookends' will be included in subsequent examinations of the scenarios in my evidence.

69. The following table illustrates the range between the two extreme options in the main Waikato River sub-catchments and the Pueto River.

Table 1 : Results table for loads looking at "bookends' or range between maximum and minimum mitigation actions (tonnes TN/year)

SC #	Evidence Scenario	Calibration	"Do Nothing"	"Stop Farming"	Range
73	**Waikato River @ Ohaaki**				
	TN - Annual Average	743.0	792.9	586.5	26%
	TP - Annual Average	72.6	74.3	56.4	24%
66B	**Waikato River @ Ohakuri**				
	TN - Annual Average	1457.1	1514.7	583.1	62%
	TP - Annual Average	169.4	172.3	95.0	45%
66A	**Waikato River @ Tahorakuri**				
	TN - Annual Average	1518.6	1591.8	700.6	56%
	TP - Annual Average	163.7	167.3	105.5	37%
74	**Pueto Stream**				
	TN - Annual Average	84.0	113.3	47.2	58%
	TP - Annual Average	14.0	14.2	12.9	9%

Existing Plan Provisions

70. The scenarios 2, 3 and 4 represent my interpretation of the PC1 outcomes (from provisions as notified) in the first 10 years to achieve Objective 3. In these scenarios I make the assumption that all properties over 20ha prepare a FEP and produce mitigation actions according to the five protocols presented in my Block 1 evidence. The protocol mitigations are equivalent to the mitigations described in the Doole 2016 report[5].

71. The application of the 75th percentile is described in Doole 2016 as.

> "A part of the proposed policy states that all dairy farmers with a leaching rate currently above the 75th percentile, assessed per Freshwater Management Unit (FMU), must reduce their nitrogen leaching level to that consistent with the 75th percentile by 2026. This restriction would also apply to any dry stock producer whose nitrogen-leaching level is above that proposed threshold."

72. The three scenario's respectively cover:

    1.1. Scenario 2 (FEP at GFP);

    1.2. Scenario 3 (FEP at BFP); and

    1.3. Scenario 4 (FEP below the 75th Percentile).

73. They assume an immediate adoption of FEP's and mitigations. As such the loads represent the final outcome for these actions. The time taken for the catchment to respond to these actions is estimated to be 5 to 15 years as is provided in the evidence of Mr Williamson.

74. The following **Figure 2** demonstrates the relative reductions of TN loads for each of these provisions in the Pueto Catchment, as expected where the FEP and the resource limiting 75th percentile are used the load is reduced by the largest proportion. I see negligible difference between the other FEP options as they employ the same mitigation actions.

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[5] Graeme J. Doole , John M. Quinn , Bob J. Wilcock , and Neale Hudson (June 2016), Simulation of the proposed policy mix for the Healthy Rivers Wai Ora process, Report No. HR/TLG/2016-2017/4.5

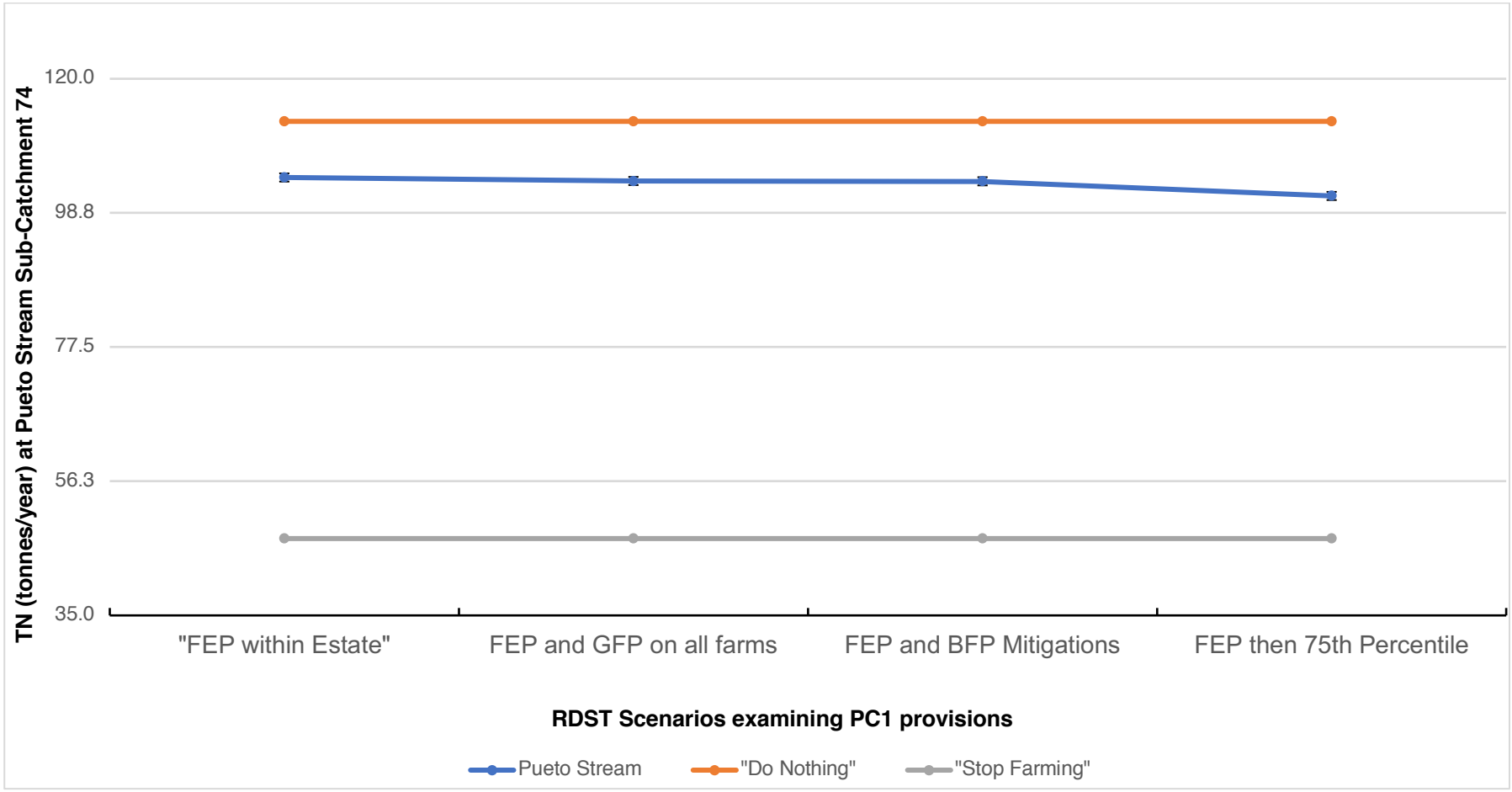

Figure 2: Examination of PC1 provisions for making TN (Tonnes/year) reductions at the Pueto Stream

Vulnerable Land

75. In my Block 1 evidence I introduced management approaches to avoid the risks of land use on vulnerable land. The next set of examinations look at the introduction of Vulnerable Land as both a limitation on resource use and direction for mitigation actions.

76. The idea of avoiding vulnerable land as critical source areas is not a new concept but requires both a definition to allow a Schedule 4 pathway under the RMA and an examination to evaluate its effectiveness relative to the existing PC1 proposal for the 75th percentile. I see 'Vulnerable Land' as a logical approach to avoiding biophysical sources of water contamination relating to the attributes in Table 3.11-1. If defined they represent land areas which could be excluded from intensive land use unless mitigation actions in an FEP avoid, or where appropriate remedy or mitigate discharges.

77. In PC1, changes to the provisions could include policy to direct the avoidance of vulnerable land and rules with conditions to avoid or where appropriate mitigate the effects of intensive land use on vulnerable land.

78. Subsequently, the Schedule 1 giving guidance for FEP preparation could also be amended to require an applicant to identify and avoid vulnerable land areas including:

    1.1. Erosion Prone Land (as set by WRC guidance[6]) - managing clarity and phosphorus release;

    1.2. Riparian margins (up to 15 metres as an average stream set back, and 5 metres as a minimum) - managing all four Table 3.11-1 attributes;

    1.3. Nitrogen Risk Areas (land with rapid groundwater travel (response) times based on proximity to a waterbody; soil and/or aquifer transmissivity) - managing the baseflow of nitrogen to the river; and

    1.4. Drainage land (Where shallow groundwater is directly connected to surface water through a drainage network) - managing the direct release of all four Table 3.11-1 attributes.

79. In the FEP, Vulnerable Land then becomes a key focus for mitigation, where land use cannot be avoided. Vulnerable Land is further explored in the evidence of Mr Williamson.

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[6] https://www.waikatoregion.govt.nz/Council/Policy-and-plans/Rules-and-regulation/Regional-Plan/Waikato-Regional-Plan/#download

80. The Vulnerable Land Scenario 6 starts with the same land use as scenarios 2, 3 and 4 required to undertake mitigations at Vulnerable Land locations.

81. Scenario 6 looks at the potential for using Vulnerable Land as a limit on resource use and as a guide for mitigation actions. In Scenario 6 mitigations actions are applied to existing land use according to the percentage nitrogen risk.

82. The **Figure 3** below illustrates the relative performance of the PC1 provisions and the alternative Vulnerable Land mitigation option examined across the scenarios.

83. The results demonstrate that for the first 10 years of PC1 implementation, mitigations guided by Vulnerable Land criteria will improve the outcome under both the FEP and the Vision and Strategy.

84. I suggest that this is the best and perhaps only way to achieve Objective 3 in regards to Table 3.11-1.

85. I recommend that PC1 provisions are amended so that:

    1.1. The 75th Percentile provisions are deleted.

    1.2. The farming activity rules contain conditions for avoiding Vulnerable Land.

    1.3. Schedule 1 includes the Vulnerable Land criteria set out in **para 78** above as risk assessment criteria.

86. The load reductions brought about through completed Vulnerable Land mitigations may also provide a useful guide for setting sub-catchment load levels.

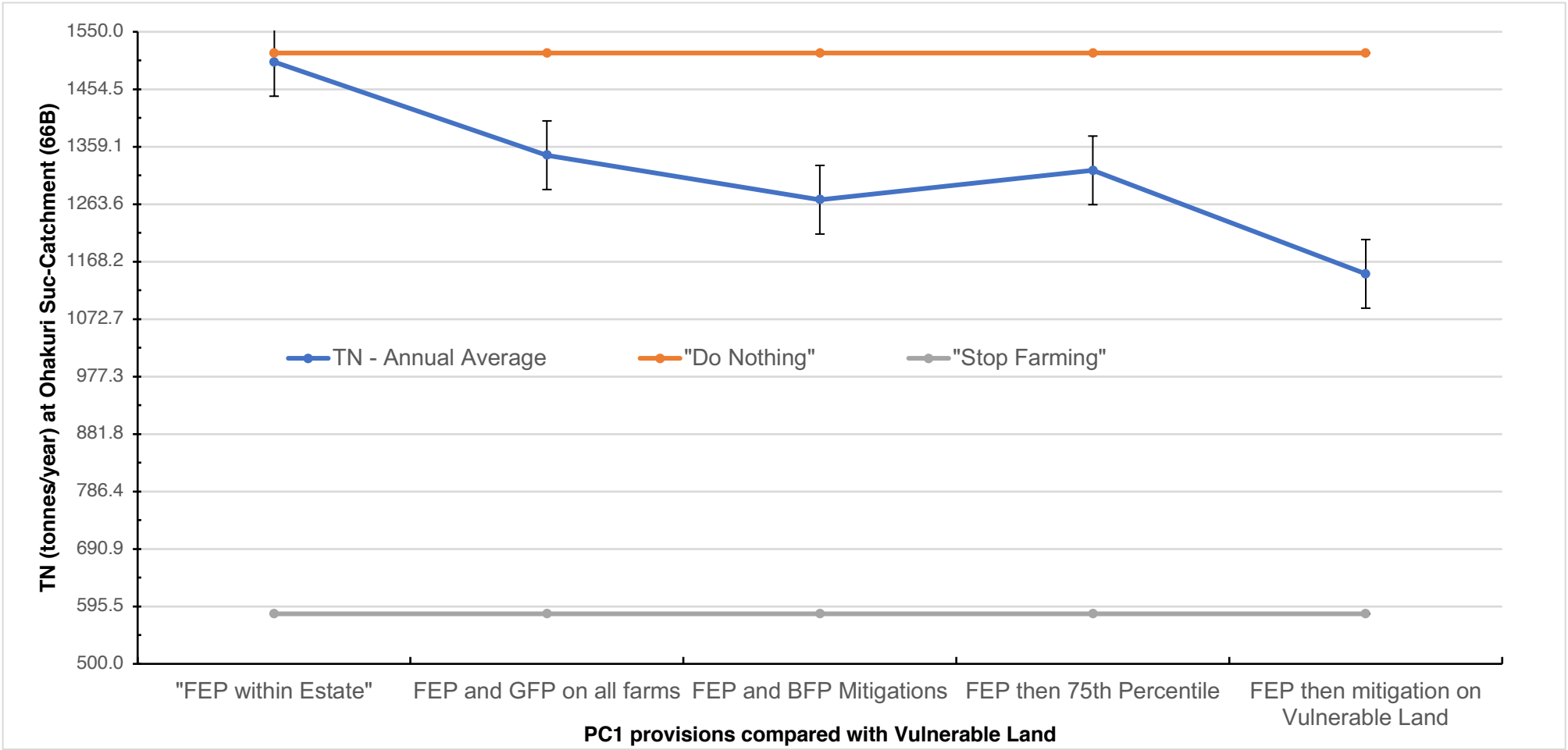

Figure 3 : Comparison of PC1 provisions for ‘Making Reductions’ at Ohakuri Sub-catchment 66B (tonnes TN/year)

Land use change

87. An important part of catchment management is the ability to optimise land use to return the best environmental and economic solution.

88. The 74 sub-catchments in Table 3.11-1 (plus Tahorakuri sub-catchment 66A) are generally not meeting their FWO and the proposed loads are exceeded meaning they are targets under the NPS FM.

89. The problem can be defined as :**Can land use change be undertaken in a sub-catchments where the FWO's or Load limits Table 3.11-1 are not met**? I have considered the options for land use change provisions in PC1 which are drafted in Policy as "Restricting land use change" and in Rule 3.11.5.7 as "Non-complying activity rule – Land use change".

90. These provisions seek to ensure that Objective's 1 and 3 are achieved through avoiding increases in land use change or intensity at the expense of the FWO in Table 3.11-1.

91. Scenarios 4, 5 and 7 look at the potential for land use flexibility, with different provisions as a limit on resource use and as a guide for mitigation actions. Where:

    1.1. Scenario 4 applies FEP's catchment wide and requires BFP with high levels of mitigation at the upper end of the cost mitigation curve;

    1.2. Scenario 5 applies LUC land uses based on the Doole 2016 rules for land use change, it also requires all properties to have a FEP; and

    1.3. Scenario 7 applies mitigations and changes land use according to the percentage nitrogen risk.

92. The results illustrated in the following Figure 4, show that both LUC and Vulnerable Land provide for some land use flexibility. The efficiency of Vulnerable Land at reducing the conceptual anthropogenic load is 23%, this compares with the catchment wide FEP requirements at 11% and includes significant land use flexibility in the sub-catchment.

93. The LUC scenario also provides for land use change, which during the first 10 years could provide for land use flexibility for farming activities which have completed their FEP. Mr Ford analyses the economic efficiency of LUC as a provision which limits resource use.

94. Depending on the scale or intensity of land use change it will require require catchment scale planning and a staged approach with adaptive management.

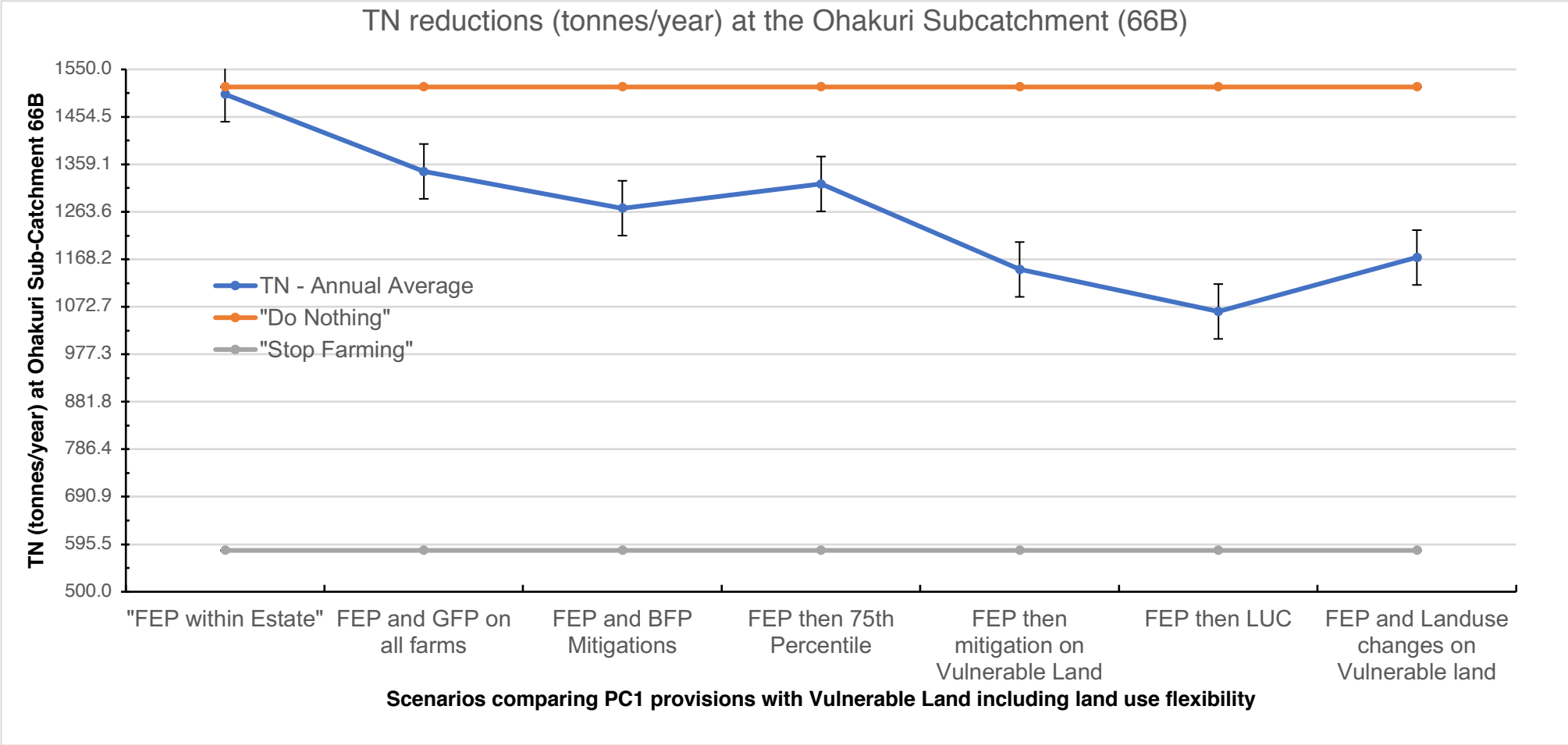

Figure 4 : Comparison of PC1 provisions for 'Restricting land use changes' at Ohakuri (tonnes TN/year)

Sub-catchment Approach

98. In the Waikato and Waipa River Catchments, water quality outcomes and values have been determined through the Vision and Strategy as incorporated into the proposed PC1 provisions and numerically within the FWO in Table 3.11-1.

99. By taking a sub-catchment approach, communities of interest will take a proactive, prioritised and integrated 'whole of sub-catchment' approach to managing each sub-catchment's land and water, identify specific issues and include actions to:

    1.1. Maintain and improve water quality;

    1.2. Conserve soil;

    1.3. Restore and protect important biodiversity habitats; and

    1.4. Meet the Vision and Strategy aspirations for the Waikato River.

100. A community of interest may form a legal entity to manage an enterprise; industry sector; or sub-catchment to provide clear guidance including management actions for the preparation of FEP at scale.

101. The following ten basic steps outline how a community of interest can successfully achieve positive changes in water quality outcomes by preparing a robust FEP to manage land at the sub-catchment scale:

    1.1. Identify and assess the current water quality and water quality issues at a sub-catchment level could be managed by the community to achieve the FWO in Table 3.11-1;

    1.2. Use a DST to measure, model, and predict changes in attribute levels in the sub-catchment relative to the land use activity from all individual properties and enterprises within the sub-catchment, and how they can be related to the sub-catchment loads within Table 3.11-1;

    1.3. Establish the principles for mitigation of input loads at the sub-catchment level through the development of a relationship between land use and the water quality attribute levels and loads for the sub-catchment in Table 3.11-1;

    1.4. Provide mitigation measures for the management of nitrogen, phosphorus, sediment and microbial pathogen losses in the sub-catchment to be managed by the community of interest;

    1.5. Provide direction for individual mitigation actions to ensure farming activities operate at GFP level or better and mitigation options in the previous step are completed;

1.6. Include a robust monitoring programme (real-time, reporting of attribute levels in a suitable digital format) designed to monitor the actual or potential environmental effects of catchment activities within the sub-catchment;

1.7. Use adaptive management to respond with mitigation actions to actual or potential adverse effects of farming activities or land use change on the environment observed in monitoring programme;

1.8. Seek independent validation for the predictive performance and accuracy of any DST;

1.9. Test predicted effects from any proposed land use changes in the sub-catchment in stages; and

1.10. Require annual monitoring and mitigation reports to be prepared by the community of interest and submitted to the WRC.

102. Depending on the spatial scale of the activity and the assessment of the actual and potential effects a community of interest can provide the economy of scale and the engagement with its members to prepare a FEP at the sub-catchment scale. A sub-catchment approach to mitigations can reveal targeted mitigations which benefit the sub-catchment management entity and the environment by providing a mechanism through time to meet the FWO and manage the resources within the sub-catchment load limit.

103. In this situation the predicted change in the sub-catchment load will provide WRC a criteria on which to base the authorisation with conditions that require adaptive management steps and protocol.

104. The sub-catchment load may be required to reduce over a 5 year period before further increases in intensity are allowed. This could be determined by a DST which provides predictions in load and strict monitoring to determine changes in measured load over time.

105. This flexibility can only be provided for where a sub-catchment is under its load limit for TP and TN or can demonstrate how this is achieved through agreed mitigations.

106. At a property scale within the sub-catchment plan criteria for individual land use changes which don't increase the overall intensity of land use could be permitted. The changes to Schedule B may provide for these criteria.

Buying and selling property

107. Most farming activities under PC1 (the existing management unit) will have a resource consent which has determined the current intensity of land use and have an FEP. Questions will arise in relation to farm succession or subdivision in terms of the impact of these events on an existing consent for farming activity.

108. In principle I believe criteria can be introduced which provide for a common process to address these issues. For example where there is:

    1.1. No net change in intensity determined through the combined FEP and productivity data; and an existing lawful FEP is being complied with; the net farm changes should be a controlled activity.

    1.2. A net change in intensity determined through the DST and the combined FEP. A new application for each separate parcel of land will be required under the normal consent pathway under PC1 rules.

109. These criteria will need to be developed into rules which manage how the combined conditions will apply and the apportionment of the mitigation actions.

110. Any changes in intensity which includes a risk to achieving FWO or loads will require a precautionary approach incorporating adaptive management.

Reductions - Role of Adaptive Management

116. To achieve the FWO for the health and wellbeing of the Waikato River (and the Vision and Strategy), management at a sub-catchment level is required.

117. To meaningfully reduce input loads and meet the FWO attribute levels, PC1 needs provisions to control the location and intensity of land use in a flexible and targeted way.

118. Practically a range of mitigation actions will be required, supported by an effective mechanism to reduce financial costs and environmental risks, reinforced where appropriate by DSTs.

119. Adaptive Management is an efficient and effective structure to ensure that mitigations and their predictions of effectiveness are focused. With mitigation actions not leading to unintended consequences for the environment or communities. Such consequences may lead to financial costs for a community and a loss of confidence in mitigation actions.

120. Adaptive Management uses predictive modelling to ask for outcomes of a 'possible' future by testing a range of hypothetical options for their relative impacts on the current state.

121. The purpose of an Adaptive Management approach is to allow a flexible approach to the management of natural resources and to let a learning cycle occur for each decision-making step.

122. An Adaptive Management process is then informed by the stepwise learning from changes in water quality (monitoring) against the predicted outcomes. This allows informed or guided decisions rather than random exercises. Adaptive Management helps communities make decisions about complex ecological systems and mitigation options rather than wait decades for final research results.

123. The following eight basic steps follow recent guidance from Court decisions for preparing an environmental management plan for a property, enterprise or a sub-catchment. I recommend the PC1 provisions include the following features of Adaptive Management (as amendments to Schedule 1):

    1.1. The existing environment is established by robust baseline monitoring;

    1.2. The extent of the environmental risk (including the consequences) is tested by the DSTs;

    1.3. Effects that might arise can be addressed by mitigations before they become irreversible;

1.4. FEP's provide for effective monitoring of adverse effects using appropriate indicators;

1.5. Thresholds are set for each of the indicators to trigger remedial action(s) before the effects become damaging to the environment;

1.6. Where land use change is undertaken, it is staged, and any FEP's require certain criteria to be met before the next stage can proceed;

1.7. Where sub-catchment wide mitigation is undertaken, it is staged, and FEP's require certain criteria to be met before any changes to catchment land use can proceed; and

1.8. Mitigation actions include a real ability to reverse (or retire) all or some of the changes to land in the catchment that have occurred if the water quality monitoring trends demonstrate criteria are not met.

124. The integration of Adaptive Management into the FEP is important to set the expectations of the farming activity practices across the property, enterprise and sub-catchment scales.

125. I recommend the PC1 provisions are amended so that:

1.1. A policy for the decision making on land use change is linked to a criteria based on:

(a) Table 3.11-1 FWO and Loads for TN and TP as Limits and Targets.

(b) Inclusion of a sub-catchment plan.

(c) Inclusion of adaptive management.

1.2. A farming activity rule is provided for sub-catchment entities

1.3. A rule for land use change includes two pathways depending on whether loads and FWO can be achieved.

1.4. A farming activity rule is provided for the splitting and merger of land within an FEP (or sub-catchment plan) for a farm, enterprise, sector group or sub-catchment.

Farm Environment Plans and Policy 2

147. In principle the FEP for an individual property, enterprise or a sub-catchment is a manual for sustainable farming practices and achieving the Vision and Strategy for the Waikato River. The purpose of the FEP Schedule is to provide a structure for FEPs to improve the health and wellbeing of the Waikato River. The FEP structure will assess the risk of diffuse discharges of sediment, nitrogen, phosphorus and microbial pathogens associated with land use activities and potential changes in land use.

148. The approach to preparing a FEP for an individual property will be similar to a FEP for an enterprise or a sub-catchment. The objectives are identical, and both require the link between assessments of environmental risk; what mitigations are required; and monitoring and reporting to feedback how effective the mitigations were.

149. The FEP requires the identification of mitigation actions for decreases in diffuse discharges from those attributes which are not meeting the FWO in Table 3.11-1. Central to the future management of the Waikato and Waipa Rivers, all farming activities and land use change and associated diffuse discharges will be undertaken in accordance with a FEP.

150. The scope for preparing a FEP for an enterprise or a sub-catchment will require more monitoring and reporting but the economies of scale should make it less time consuming overall. Either way a comprehensive understanding of the farming practices and the land use suitability is required.

151. Policy 2 is the primary provision for FEP in PC1, the notified version focuses on ‘taking a tailored approach to reducing diffuse discharges from farming activities’, the reporting officer in the Section 42A Report has attempted to focus the policy around the FEP development. While I think this is a step in the right direct there needs to be greater clarity for what is expected and ‘what success looks like’ for a well prepared and executed FEP.

152. Schedule 1 as drafted has guidance for how land is described to be either a property or an enterprise. Properties under PC1 are based on adjacent titles in the same ownership. In contrast an enterprise is managed by a legal person or entity that comprises non-contiguous titles across a wider spatial extent. An enterprise could also be located within a sub-catchment or across several sub-catchments.

153. As outlined above, PC1 needs to have provisions to ensure that normal changes in land management such as growth succession and lifestyle changes are managed efficiently.

154. The most important aspect of Schedule 1 within PC1 will be guidance on environmental risk assessment. Schedule 1 needs to include a nitrogen benchmark (or a productivity proxy) to monitor the relative intensity in land use through time. As I have identified in my discussions on: Table 3.11-1; Vulnerable Land; Sub-Catchment Planning; and Adaptive Management. Schedule 1 needs further detail to guide the FEP development to cover these topics.

155. I have considered the role of FEPs and consider that several key elements need to be included as directions in policy, conditions and matters of discretion in the PC1 rules to guide WRC decision making. These from my evidence are:

    1.1. Vulnerable Land;

    1.2. Assessment of land use intensity via a DST;

    1.3. Mitigations which are focused on achieving the FWO in the sub-catchment(s);

    1.4. Catchment management mitigations;

    1.5. Adaptive Management where the sub-catchment is over its target load or not meeting the FWO; and

    1.6. Guidance for GFP and BFP to ensure there is a uniform improvement in farm systems.

156. The success of PC1 will be in the expectations of Objective 3 (and eventually Objective 1) and this means that the implementation of FEPs must be put in place immediately (eg by 2020/2022) and provide enough risk assessment guidance to avoid unintended consequences. Environmental risk is best managed with well-practiced tools which align with the precautionary principles of the RMA avoiding or mitigating known sources of effects; management plans which have performance criteria and an Adaptive Management to encourage active participation in the management cycle.

TOPIC C2. CULTIVATION, SLOPE AND SETBACKS

160. I think the use of cultivation, slope and setbacks as proxies for managing land use intensity is duplication. This is better managed in a targeted and directed way through a comprehensive FEP.

161. The need for intensity triggers will promote opt out behaviour where people may believe that they are excluded from contributing to the Vision and Strategy. If a ‘bright line’ for intensity is required this could

be the 20ha proposed in the notified PC1, with exclusions added for intensive land use such as dairy farming or commercial vegetable production on Vulnerable Land.

TOPIC C3. STOCK EXCLUSION

162. In my Block 1 evidence I illustrated the scale and anticipated role of riparian margins and the immediate compliance with Schedule C.

163. I have investigated the benefits of riparian management across a range of landscapes. The current requirements for riparian and stock exclusion are in my opinion too narrow to result in the benefits observed in the literature[7]. In WPL's Protocol 1 the target for riparian margins is 15 metres. I have also used this as the mitigation standard in the scenarios modelling.

164. I also listened with interest to the Block 1 evidence provided by Mr van Duivenboden (Landcorp – Pamu) who illustrated the likely intervention of technology to make fencing of riparian no longer a cost obstacle.

TOPIC C5. MAORI TREATY SETTLENT LAND

165. As part of the investigation of the PC1 provisions I have looked at the relationship between the notified Policy 6 which requires enduring reductions (presumably to restore and protect) the FWO in Table 3.11-1 and the land use change rule which effectively constrains land use while farming activities improve with a FEP and GFP.

166. As part of this investigation I have also reviewed Policy 16 which provides for the development of iwi settlement land during the initial 10 years. To test this hypothesis I prepared a scenario which looks at the flexibility of use for Te Ture Whenua and settlement land. This was part of the Scenario 7 parameterisation which allows analysis of how this might be achieved.

167. As set out in the Scenario 7 description this approach provides flexibility (at the sub-catchment scale) where land with low vulnerability attributes is allowed (within the provisions of a FEP and GFP) to undertake land use changes. The changes in the scenario were guided by the direction from Dr Doole in his similar scenario and the LUC classes.

168. The resulting findings presented in the **Figure 6** : Investigation of landuse flexibility in Tahorakuri 66A below highlight that for the proposed Tahorakuri Sub-catchment (66A) the opportunity for the development of Te Ture Whenua and settlement land is a real

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[7] A Meta-Analysis on Nitrogen Retention by Buffer Zones – Oct 2018 (Elena Valkama,* Kirsi Usva, Merja Saarinen, and Jaana Uusi-Kämppä)

proposition within the constraints of a suitable catchment plan to manage the transition.

169. This scenario deliberately avoids a specific development option but illustrates that with a Vulnerable Land approach within the Tahorakuri sub-catchment 66A land use flexibility can be realised along with the Vision and Strategy objectives.

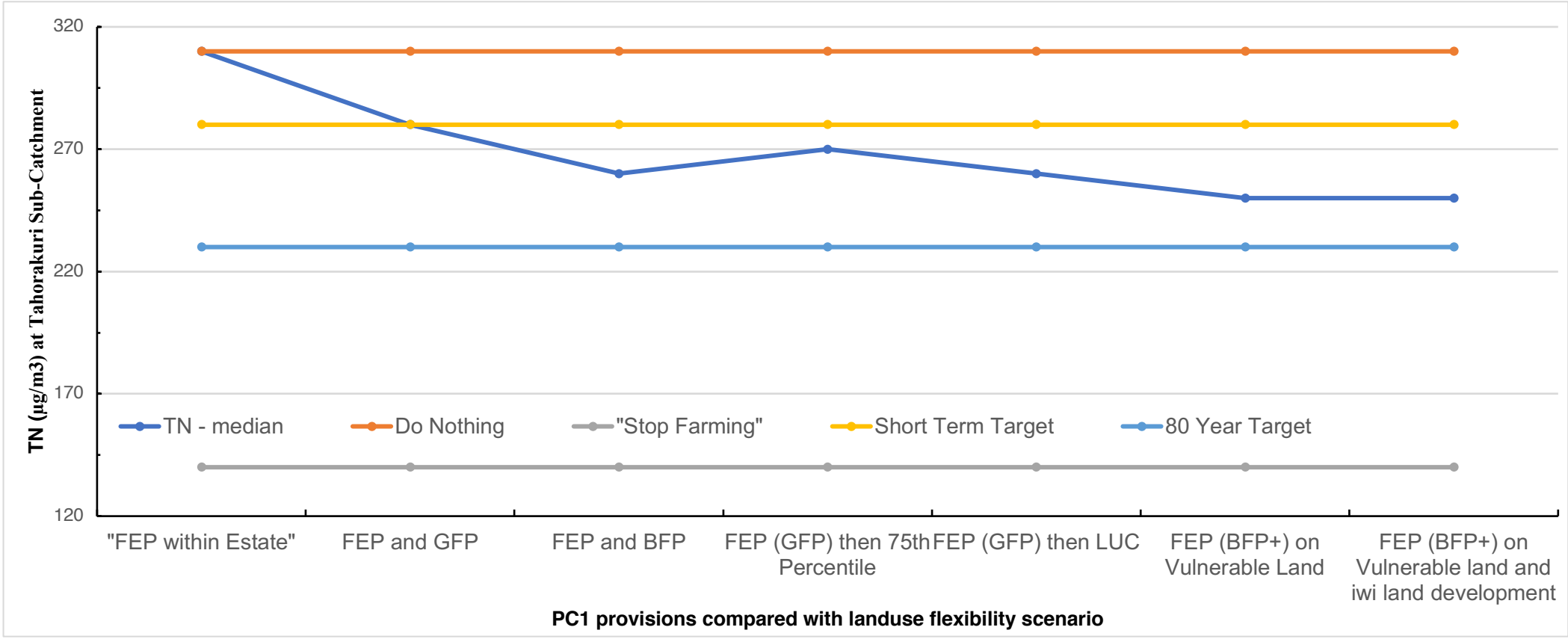

Figure 6: Investigation of land use flexibility in Tahorakuri SC 66A

CONCLUSIONS

170. I have prepared scenarios on the RDST to examine the proposed provisions in PC1 and compared these with alternative scenarios which reflect the alternatives proposed by WPL. The scenarios are tests of the environmental conditions which occur when a set of actions are undertaken in a sub-catchments.

17. I have examined the provisions of PC1 from the perspective farming properties, enterprises and sub-catchment entities for regional plan implementation by WRC.

18. Using these two sets of analyses I have examined options which will best provide for Objective 3 and the Vision and Strategy in the first 10 years of the plan.

Nicholas Ashley Conland

Taiao Natural Resource Management Limited

3rd May 2019

APPENDIX 1

RDST Scenarios

The following are descriptions for the RDST scenarios undertaken to examine the provisions as notified in PC1 and options considered by WPL.

The structure and specifications for the model are contained in the technical reports prepared by WWLA to describe the RDST.

This includes the calibration (Scenario 0) and the accuracy and precision of the DST.

Scenario 1 – Do Nothing

1. This represents a 'future' where the land use as existing at the time of the plan notification in 2016/17 continues with no mitigations or FEPs developed in the catchment.

2. The RDST is run with a land use map for land use in 2016/17. This was prepared by WPL from an initial AgriBase data set and then confirmed from aerial photography; Real Estate data; and site verification by vehicle.

3. The climate period is the NIWA gridded VCSN data from 1972 to 2018.

4. The data is reported for the coincident sampling periods based on WRC collected runs between 2010 to 2014.

5. No mitigations are applied for this scenario.

6. All land use, point source and background discharges are assumed to be static.

7. Figure 7 provides an image of the RDST - 2016/17 land use.

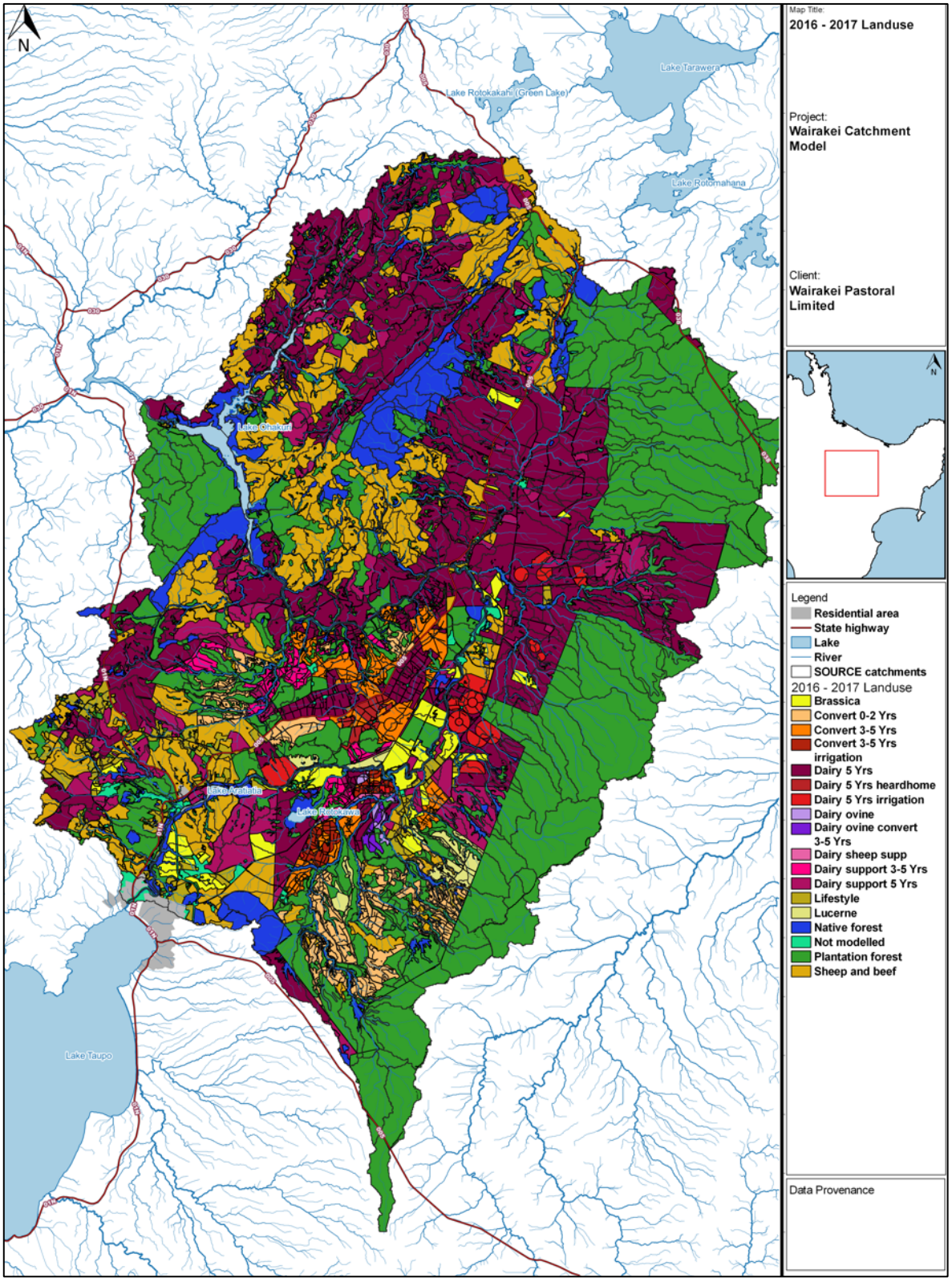

Figure 7 : RDST - 2016-2017 Land use inputs

Scenario -1 – Stop Farming

8. This represents a 'future' where all land (except native forest, roads, built, and river land uses) are changed to plantation forest.

9. The RDST is run with a land use map for land use in 2016/17. This was prepared by WPL from an initial AgriBase data set and then confirmed from aerial photography; Real Estate data; and site verification by vehicle.

10. The climate period is the NIWA gridded VCSN data from 1972 to 2018.

11. The data is reported for the coincident sampling periods based on WRC collected runs between 2011 to 2014.

12. No mitigations are applied for this scenario, geothermal inputs and point sources such as Contact Energy's power station are still included. Inflow from Lake Taupo remains unchanged (e.g. Lake Taupo catchment remains developed).

Scenario 2 – **FEP GFP on all properties, and enterprises**

13. This represents a 'future' where all properties and enterprises in the catchment prepared and completed a FEP. This is developed following the 5 protocols developed by WPL and GFP as considered determined by OVERSEER protocols.

14. GFP is defined for the RDST in Mr Ford's evidence.

15. This is consistent with the first 10 year actions considered by Dr Doole in (Doole G.J - 2016a).

16. The nitrogen OVERSEER related GMP mitigations are described in the Block 2 Evidence by Mr Ford and his report (TAG Dec 2018[8]).

17. The protocol mitigations are based on the mitigation protocols 1 to 5 described in my Block 1 EIC.

18. They are applied in the RDST as follows:

    1.1. The OVERSEER related mitigation reductions are applied to the APSIM daily time series for each land use type.

    1.2. The APSIM daily time series are applied at the MODFLOW 300m^2 grid across the catchment. These are illustrated in the RDST Technical Report Vol 4 **Figure 82**.

    1.3. The protocol mitigations are applied as the average mitigation practice (mitigation actions completed) in the Estate wide FEP:

        (a) Protocol 1 Riparian

        (b) Protocol 2 EPL.

        (c) Protocol 3 Gully Protection.

        (d) Protocol 4 Sediment Bunding.

        (e) Protocol 5 Wetland (not tested in RDST at this stage).

    1.4. Each protocol mitigation is applied in the model at a SOURCE Catchment scale (415 Hydrological catchments in RDST).

[8] S Ford, Wairakei Estate Nitrogen Mitigation Modelling using Overseer, The AgriBusiness Group (2018)

1.5. The mitigation reductions are applied to the quickflow and baseflow concentrations to each SOURCE catchment in the RDST.

1.6. The mitigations are illustrated in the RDST Technical Report Vol 4 **Figures 78 – 81**.

19. The combined mitigations (OVERSEER and Protocol) are summarised as a FEP for the purposes of the scenarios. All the scenarios assume a FEP has been completed.

20. The mitigations are assumed to take effect immediately.

21. The land use map for this scenario is 2018. This was prepared by starting with the 2016/17 map and updating the areas inside the Estate with new information from the WPL's FEP.

22. The climate period is the NIWA gridded VCSN data from 1972 to 2018.

23. The data is reported for the coincident sampling periods based on WRC collected runs between 2011 to 2014.

24. The following *Figure 8* shows the 2018 land use map

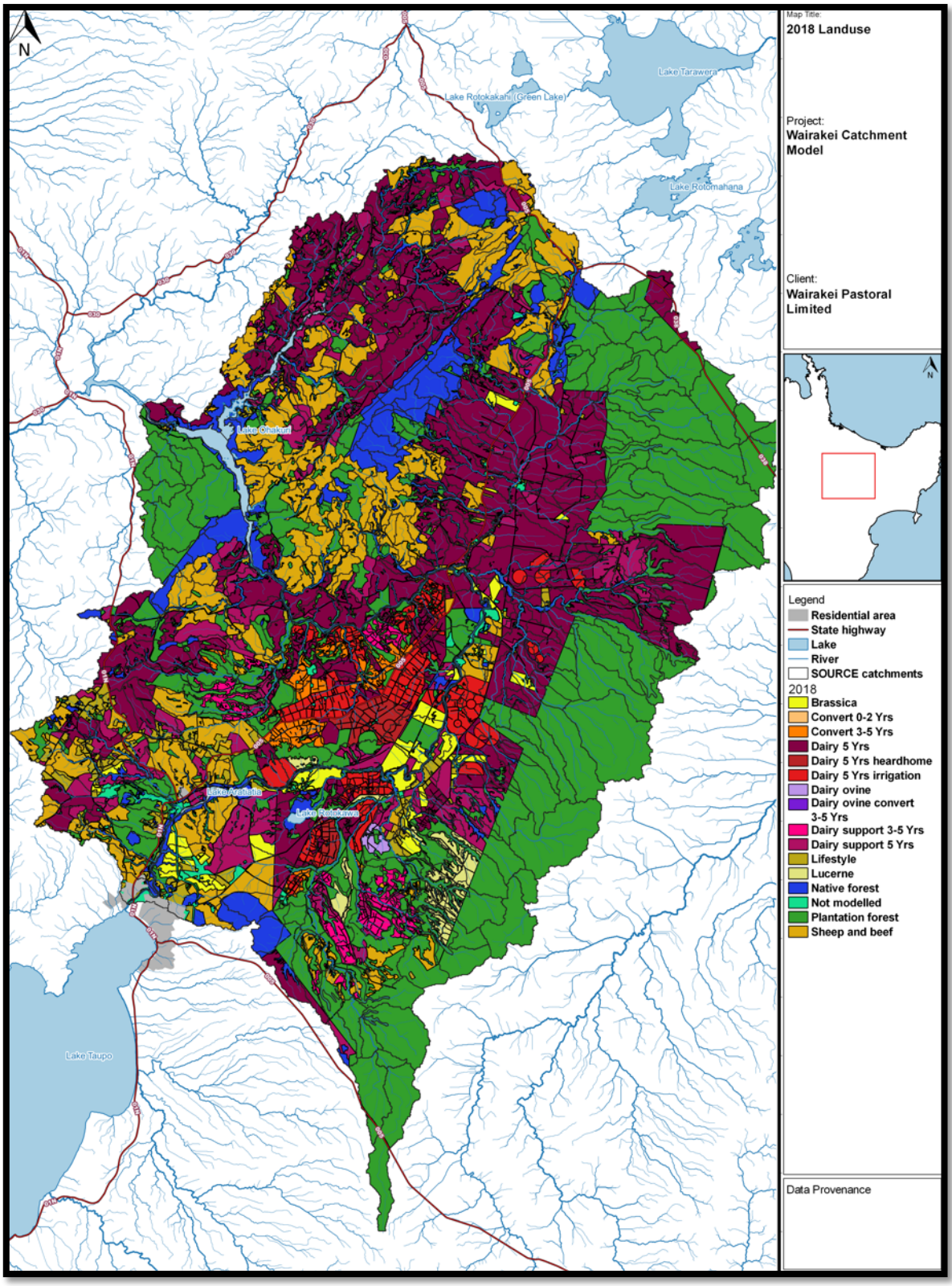

Figure 8 : RDST 2018 land use inputs

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Scenario 3 – **FEP and BFP on all properties and enterprises**

25. This represents a 'future' where the conditions in Scenario 2 exist, except all farming activities have undertaken a significant mitigation steps towards BFP as developed by Mr Ford (TAG Dec 2018).

26. The mitigations are only based on OVERSEER mitigations with infrastructure introduced to all farms in the catchment.

27. The OVERSEER related mitigation reductions are applied to the APSIM daily time series for each land use type.

28. The APSIM daily time series are applied at the MODFLOW 300m^2 grid across the catchment. These are illustrated in the RDST Technical Report Vol 4 **Figure 84**.

Scenario 4 – **FEP and 75th Percentile limits on all properties and enterprises**

29. This represents a 'future' where the conditions in Scenarios 2 exist, except all farms are limited to the 75th Percentile as proposed in the planning provisions under PC1.

30. Properties over 20ha were assessed for their property related NRP based on APSIM records. This produced 805 properties in the Ruahuwai catchment. The NRP values were list sorted to determine the 75th percentile. The properties in excess of this value were scaled to reduce their outputs to the 75th percentile resource limit. The 75th Percentile was ca. 77 Kg/Ha/year.

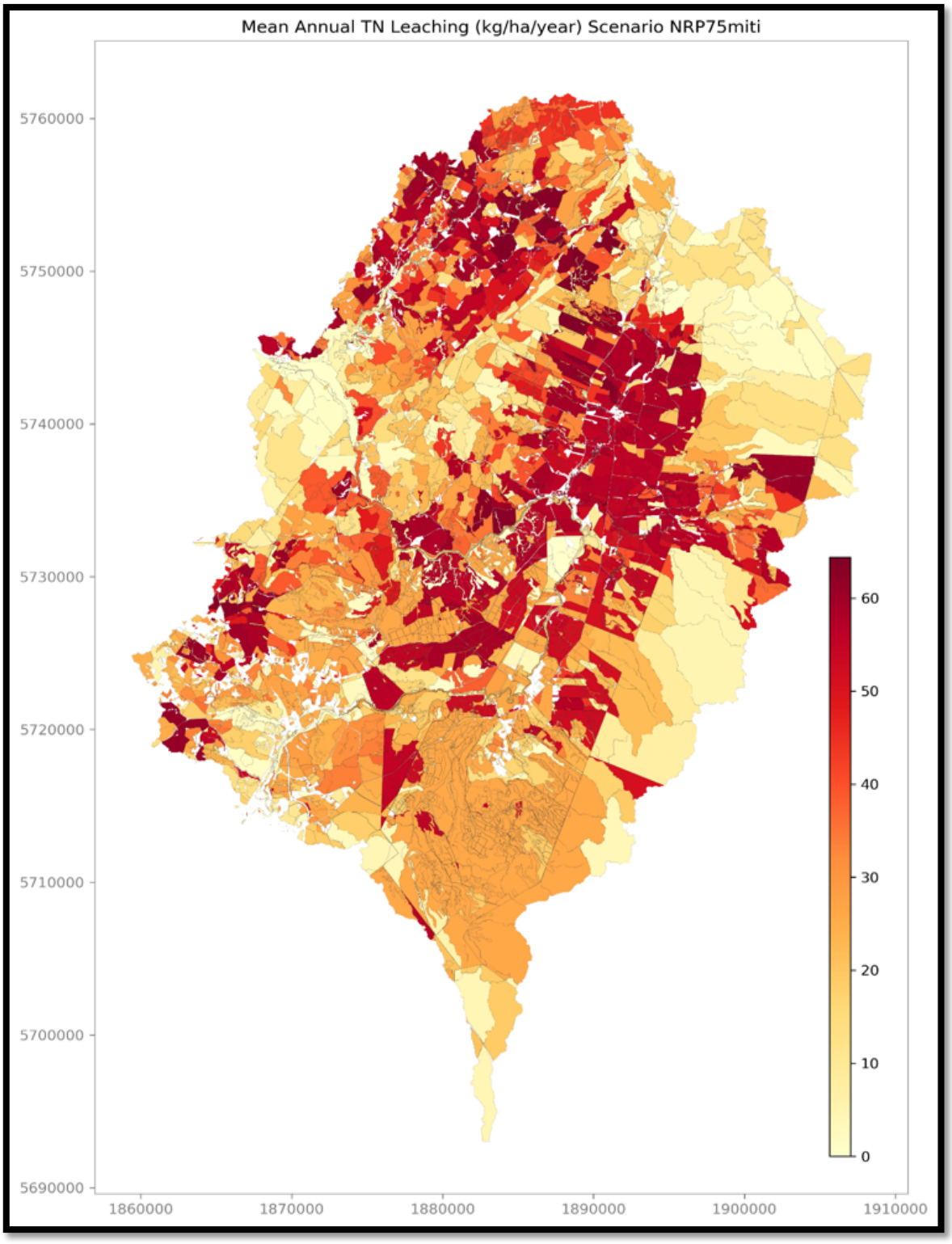

Figure 9 : N leaching from properties in NRP scenario

Scenario 5 – **FEP then LUC limits applied**

31. This represents a 'future' where the conditions in Scenario 2 exist, except all the properties and enterprises are limited to the Land Use Capability limits for productivity as developed by Mr Ford (in his evidence). The land use changes in intensity follow the direction provided by Dr Doole in the report Doole et al (2016).[9]

32. The LUC shapefile (LRI[10]) was intersected with the property boundary shapefile, and the area weighted average property LUC value is calculated.

33. A new input shape file was created by intersecting the property boundary shapefile with FEP areas shapefile. Note: the land use within the FEP zones remain unchanged if in forestry or Indigenous or if in farming is changed to forestry in this scenario.

34. The LUC property leaching rate was calculated from the area weighted LUC nitrogen leaching rate within each property boundary.

35. Assign the land use with the closest average N leaching rate based on the pre-defined leaching rate applicable for each LUC value set out in Table 2 : Ruahuwai LUC scores (TAG 2019).

36. For the purpose of this scenario, we assume a uniform land use within each property.

Table 2 : Ruahuwai LUC scores (TAG 2019)

LUC Class	I	II	III	IV	V	VI	VII	VIII
WPL	50	44	39	29	26	24	12	3

[9] This report was commissioned by the Technical Leaders Group for the Healthy Rivers Wai Ora Project Report No. HR/TLG/2016-2017/4.5

[10] https://lris.scinfo.org.nz/layer/48076-nzlri-land-use-capability/

37. Land use in the catchment is applied according to the Dr Doole's approach – where:

    1.1. Areas of land use capability (LUC) class 1–3 are assumed to be Dairy. The new dairy activities that are simulated by APSIM use existing APSIM Dairy model.

    1.2. Areas of LUC class 4-5 are assumed to be Dairy Support. The new dairy activities that are simulated by APSIM use existing APSIM Dairy Support model.

    1.3. Areas of LUC class 5–7 are assumed to be Dry Stock. The new dairy activities that are simulated by APSIM use existing APSIM Dry Stock model.

    1.4. Areas of LUC class 8 are assumed to be forestry. The new forestry activities that are simulated by APSIM use existing APSIM forestry model

38. This scenario has the same base conditions as scenario 2 with all farming activities managed by an FEP with mitigation actions.

39. The **Figure 10** provides an illustration of the LUC inputs.

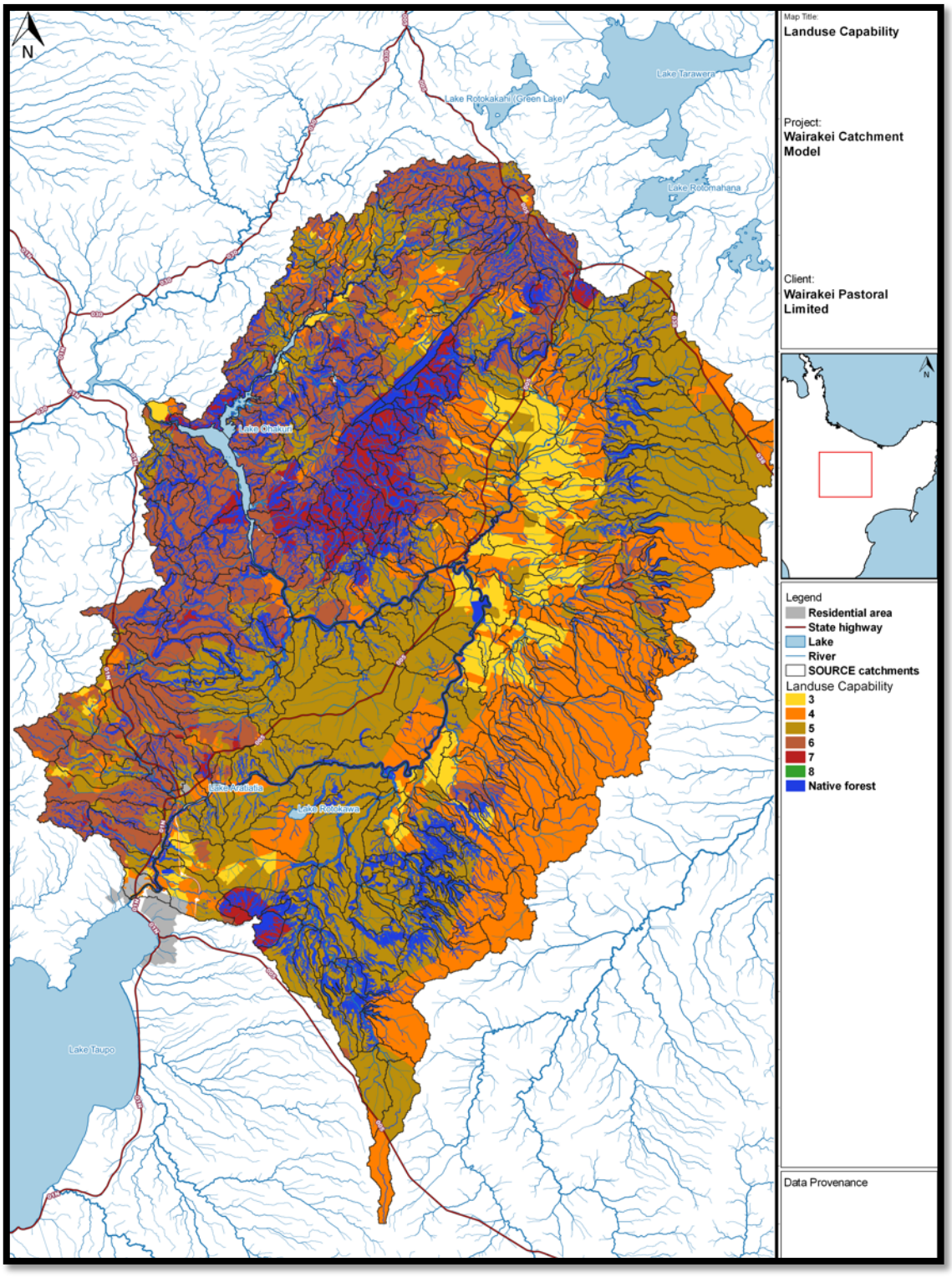

Figure 10 : RDST LUC inputs

Scenario 6 – **FEP then mitigations on Vulnerable Land**

40. This represents a 'future' where farming on Vulnerable Land is avoided and mitigated in proportion to the level of nitrogen risk at the farm location.

41. This scenario has the same base conditions as Scenario 2 with all farming activities managed by an FEP with mitigation actions.

42. A new input shape file was created by intersecting the 2018 land use shapefile with the FEP mitigation areas shapefile. Note: the land use within the FEP areas remain unchanged if in forestry or indigenous forest and if in farming is changed to forestry in this scenario.

43. The FEP adjusted land use shapefile (from above para) was intersected with the N Vulnerability shapefile to produce the final input file.

44. The nitrogen risk assessment (**NRA**) in described in the Block 2 evidence of Mr Williamson. The NRA is determined at the scale of the RDST grid which is 300m^2. This is illustrated in **Figure 11 :Nitrogen Risk Assessment grid in RDST**.

45. The property average N vulnerability score is calculated as an area weighted average within each property as the average % reduction. (excluding the FEP areas).

46. The mitigation for each property was assigned based on the where the property N vulnerability score falls within the bands in **Table 3**.

47. The mitigation actions in **Table 3** were applied to farming activity within each property.

48. The mitigation actions are described in the evidence of Mr Ford and Mr Williamson.

Table 3 : Nitrogen Risk Assessment, Reduction and Mitigation

NRA % Reduction	**Mitigation**
<50%	Regenerative Farming
50-70%	APSIM High
70-80%	APSIM Medium
80-95%	APSIM Low
>95%	APSIM Low

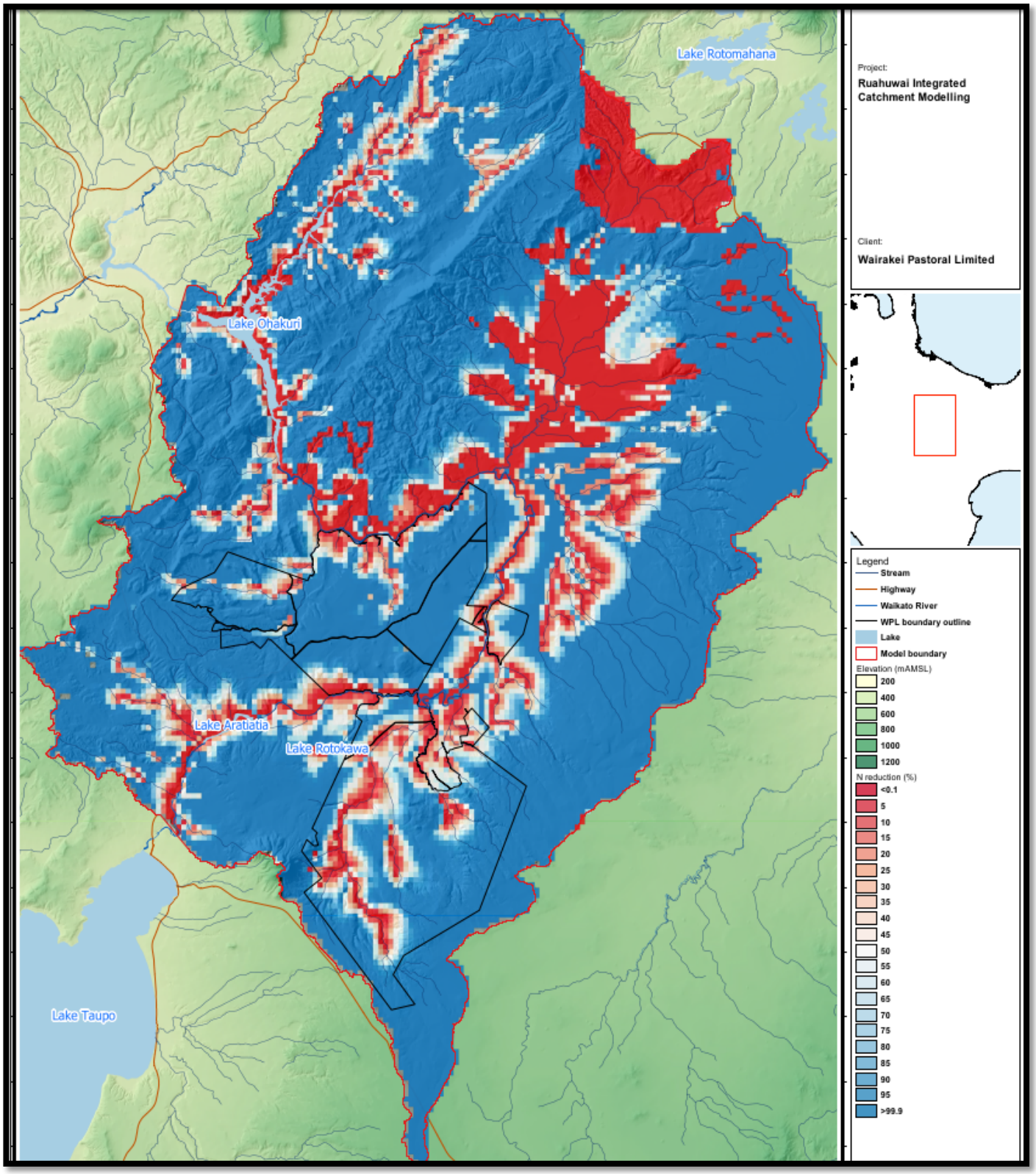

Figure 11 : Nitrogen Risk Assessment grid in RDST

Scenario 7 – **FEP then mitigations plus land use changes on Vulnerable Land**

49. This scenario represents a 'future' where farming on Vulnerable Land is avoided and mitigated similar to Scenario 6. Except on land with very low nitrogen risk. At these locations the land use changes in intensity follow the direction provided by Dr Doole in the report Doole et al (2016).[11]

50. This scenario has the same base conditions as Scenario 2 with all farming activities managed by an FEP with mitigation actions.

51. The initial input for this scenario is the property based shapefile for NRA from Scenario 6. However, where the property N vulnerability score falls within the bands in **Table 4: Nitrogen Vulnerability Mitigations** below, apply the corresponding mitigation and land use change relative to the property N vulnerability score.

52. The land use change is determined from the LUC property score from the LUC Scenario 5. The following table sets out the proposed mitigation and land use changes relative to the property N vulnerability score.

53. Where properties have low nitrogen vulnerability (>90% attenuation), the scenario assumes that land use change occurs similar to the LUC Scenario 5 and a land use change is applied.

54. For high nitrogen vulnerability properties (<10% nitrogen attenuation), land use change is applied to reduce the risk of leaching while seeking to optimise the productivity using the LUC property values.

55. The **Figure 12** provides an illustration of the modified 2018 land use map with the flexibility options provided in *Table 4: Nitrogen Vulnerability Mitigations*.

[11] This report was commissioned by the Technical Leaders Group for the Healthy Rivers Wai Ora Project Report No. HR/TLG/2016-2017/4.5

Table 4: Nitrogen Vulnerability Mitigations

NRA % Reduction	Mitigation or Land use change
<10%	• If LUC class 1-3 land use is changed to (APSIM high) Lucerne • If LUC class 4-5 land use is changed to Dry stock (Cow Salad) • If LUC class 6-8 land use is changed to Forestry
10-20%	Regenerative Farming
20-30%	Regenerative Farming
40-50%	Regenerative Farming
50-60%	APSIM High
70-80%	APSIM Medium
80-90%	APSIM Low
>90%	a. Areas of land use capability (LUC) class 1–3 are assumed to be dairy. The new dairy activities that are simulated by APSIM use existing APSIM Dairy model. b. Areas of LUC class 4-5 are assumed to be dairy support. The new dairy activities that are simulated by APSIM use existing APSIM Dairy Support model. c. Areas of LUC class 5–7 are assumed to be dry stock. The new dairy activities that are simulated by APSIM use existing APSIM Dry Stock model. d. Areas of LUC class 8 are assumed to be forestry. The new forestry activities that are simulated by APSIM use existing APSIM forestry model

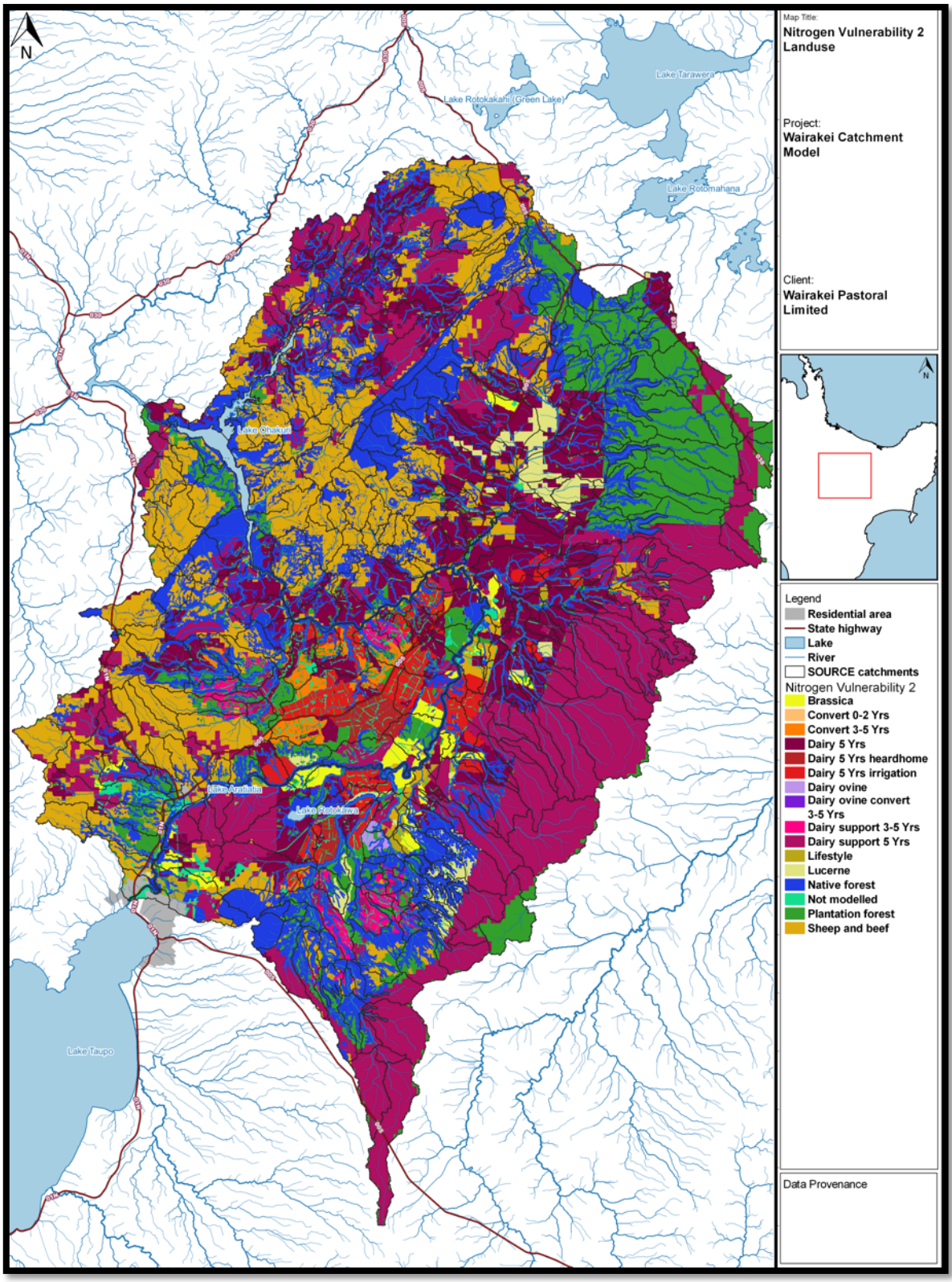

Figure 12 : Land use flexibility on low vulnerability land (inputs to RDST)