BEFORE COMMISSIONERS APPOINTED
BY THE WAIKATO REGIONAL COUNCIL

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

EXECUTIVE SUMMARY OF TIMOTHY JASON COX
26 MARCH 2019

FLETCHER VAUTIER MOORE
LAWYERS
PO BOX 3029
RICHMOND 7050

Telephone: (03) 543 8301
Facsimile: (03) 543 8302
Email: cthomsen@fvm.co.nz
Solicitor: CP Thomsen

BACKGROUND

1. My full name is Timothy Jason Cox.

2. I am a water resources engineer and scientist, specializing in water quality and hydrologic modelling.

3. I am currently employed by Streamlined Environmental and the USA consulting firm CDM Smith.

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

SCOPE OF EVIDENCE

5. I have been requested by Beef + Lamb New Zealand to provide expert evidence on catchment modelling of landuse and water quality as it relates to the modelling underpinning the proposed Waikato Regional Plan Change 1 (WRPC1). My focus is on nutrients.

6. My over-arching goal in presenting this evidence is to advance the discussion and science with respect to understanding the source and fate of nutrients in the basin, investigating the potential for mitigation, and setting appropriate policy.

7. My summary today will generally follow this outline: first, I will describe some concerns that I have with the modelling that has been performed to-date by the Healthy Rivers technical team; second, I will briefly describe some of the new modelling work that I have performed and insights gained from that work; and lastly I will provide recommendations for addressing the concerns that I do have.

EXECUTIVE SUMMARY

8. As you know, numerical modelling was used to support policy development and the recommendations of the Collaborative Stakeholder Group as part of the Healthy Rivers planning process. A catchment model was constructed by the technical team to simulate nutrient load generation and transport in the Waikato River basin. I will hereafter refer to this as the "NIWA" model. The model was used to quantify sources and relative contributions of nutrient load in the basin and to perform predictive

simulations. This catchment model was coupled with a separate economics optimisation model for basin predictive modelling.

9. Although the developed models appear to be useful decision support tools, and were developed with substantial resources and expertise, I have concerns with how the models were parameterised and/or applied (or not applied, as the case may be). I will now outline my primary concerns:

9.1 The models, and modelling process, are lacking in transparency. There is insufficient detail in the modelling reports, in my opinion, for stakeholders to fully understand critical steps in the modelling process. More importantly, the models themselves, and the supporting datasets, have not been made available to the public. In my opinion, this does not follow best practice for such an important study.

9.2 Despite noted significant uncertainties in many of the key model input parameters, the models are not supported by uncertainty or sensitivity analyses of any kind. Consequently, the robustness of the model calibration and predictive power is unknown at this point. This potentially impacts model credibility and acceptance among stakeholders.

9.3 With the significant resources spent on developing these models, it seems they were underused. The models do not appear to have been directly used to support, or develop, policy decision making by the CSG. Rather, the policy appears to have been used to inform the modelling. The models could be used, for example, to identify and develop cost-effective mitigation strategies and identify spatial priorities for mitigation: a road map of sorts for achieving the stated goals. They could also be used to demonstrate relative source distributions of nutrient load at key instream locations, which would help to clearly and fully understand the drivers of water quality impairment in the basin. Lastly, the models could, and should, be used to set realistic, feasible, and spatially-variable water quality targets throughout the basin and to establish appropriate timeframes for achieving the targets.

9.4 The models appear to be using outdated landuse and export coefficient information. This may be skewing results significantly and lowers my confidence in both model output and other inputs (for example, calibrated attenuation coefficients). More on this momentarily. Note that the term “export coefficient” is a modelling term used here to describe the nutrient leaching rates, on a per unit area basis, assumed in the model for a given landuse type.

9.5 Much of the model parameterisation is based on a coarse calibration process, which has not been fully detailed in the reports. It does not appear that this process effectively isolated key model parameters (e.g. exports vs. attenuation). Nor was there any sort of verification exercise performed with the model.

10. To address some of these concerns, and to advance our understanding of the problem and of potential solutions, I developed a new model to simulate water quality in the basin. This model replicates the NIWA model to the extent possible, based on available information. Note that the development of a new model was necessitated by the fact that the NIWA model itself was unavailable. I used my model to investigate alternative policy scenarios. I also used the model to analyse various baseline input parameters and assumptions and to assess the impacts of these assumptions on model projections – in other words sensitivity and uncertainty analyses.

11. I will now describe a few of the key results of that modelling work.

12. My modelling results show that diffuse losses from dairy land represent the single largest contributor to instream nitrogen load throughout the basin. For example, at the Port Waikato and Waingaro Road stations, which are the downstream most locations in the Waikato and Waipa basins, respectively, combined dairy and dairy support activities are responsible for approximately 60% of the modelled instream nitrogen load. This is despite the fact that dairy land represents only 29% and 34% of the total basin drainage areas, respectively. I don’t believe that this information was clearly presented in the Healthy Rivers reporting to-date.

13. Point sources represent the largest category of contributors to the total nitrogen load at uppermost Waikato basin sites: Ohaaki and Ohakuri (approximately 65 and 35%, respectively).

14. Next, using data from published studies, my modelling results demonstrate a cost-effective mitigation strategy generally prioritising dairy mitigation over dry stock mitigation, as the former achieves greater reductions in nitrogen export for the same mitigation action and cost. Note that I make no suggestion here of how those mitigation costs should be allocated.

15. The land use layer used in the NIWA catchment model appears to be, at best, uncertain and, at worst, significantly inaccurate. An independently obtained land use layer for the basin, for the same time period (2012), shows significant differences when compared to the land use layer used in the NIWA model. In general, this data indicates more dairy land, and less forestry and dry stock land in the basin, than included in the NIWA modelling. Differences between the two datasets are largest in the upper basin. Due to the differences in landuse apportionment, simulated nitrogen concentrations at key river locations are approximately 40 – 55% higher using the updated landuse layer, compared to the same results using the NIWA landuse layer. These differences lower my confidence in the NIWA modelling results and suggest that both the contribution of dairy to current river nutrient loads, and catchment attenuation rates, may be significantly underestimated in the NIWA model.

16. Further on the topic of land use, I have reviewed 2018 land use data. This data shows, when compared to 2012 data from the same source, that land use has intensified significantly in the basin, even over the past 6 years, with extensive conversion from dry stock to dairy farming. This is particularly pronounced in the upper sub-catchments. This information raises the question of whether the NIWA model is an accurate representation of "current" conditions.

17. Pastoral farm nitrogen export coefficients assumed in the NIWA model are based on an outdated version of OVERSEER and are likely underestimated. Not surprisingly, my modelling demonstrates significant sensitivity of key model outputs to the range of uncertainty associated with farm export coefficients, again reducing my confidence in the NIWA modelling results.

As I just noted about the landuse discrepancies, an important implication here is that the model attenuation rates may have been underestimated during the NIWA model calibration exercise due to these types of errors at the export level.

18. As a consequence of what I've just described, model calculations used to support decision-making may be inaccurate to the point of being misleading for decision-makers.

19. Lastly, my modelling results highlight the fact that the required level of diffuse source mitigation to achieve the 80-year water quality goals is substantial, particularly without a commensurate reduction in point source loads. Many parts of the catchment require full afforestation (or mitigation of some sort down to natural background export levels) to achieve those goals. More specifically, the modelling identifies that upper basin long-term instream nitrogen outcomes in particular may be overly constraining. Without significant point source load reductions, nearly 100% afforestation would be required of all pastoral farm lands to achieve the targets.

20. Now moving on to my recommendations. In my opinion, additional modelling work should be performed with a focus on quantifying, and potentially reducing, model uncertainty, particularly in the areas of export coefficients and nutrient attenuation. I recommend that additional calibration and/or verification exercises be performed, potentially at a sub-catchment scale, to isolate export and attenuation rates and reduce model uncertainty. Additionally, in line with the recommendations of the Parliamentary Commissioner for the Environment's recent report (December of 2018), focused on regulatory models, I recommend that formal uncertainty and/or sensitivity analyses be conducted with the NIWA model. This will, in my opinion, greatly improve model credibility, defensibility, and acceptance, and may identify important areas for model improvement.

21. In line with PCE recommendations on transparency, from that same report, I recommend that both the NIWA catchment model and the supporting economics optimisation model, and all supporting data and parameterisation work, be made publicly available.

22. Lastly, it is my opinion that the models developed by the NIWA team to support the Healthy Rivers study were not used enough to either a.) investigate a range of cost-effective and practical strategies to achieve water quality goals in the basin (that “road map” that I mentioned earlier), or b.) establish achievable, and appropriately spatially variable, water quality targets for both the short and long-term. I recommend that, subject to the improvements in baseline modelling that I just described, the models be further applied to firm up policy and planning going forward.

DATED this 26th day of March 2019

Tim Cox