IN THE MATTER OF the resource management Act 1991

AND

IN THE MATTER OF an application for a Notice of Requirement by New Zealand Transport Agency to the Palmerston North City Council, Manawatu District Council and Tararua District Council for EAHU A TŪRANGA MANAWATŪ TARARUA HIGHWAY.

ADDENDUM TO STATEMENT OF EVIDENCE OF ALEC DONALD MACKAY (EFFECTS ON BALLANTRAIE TRIAL SITE) ON BEHALF OF AGRESEARCH LIMITED
INTRODUCTION

1. My name is **ALEC DONALD MACKAY**.

2. I submitted a statement of expert evidence ("EIC") on the effects of the path of the proposed new road through the long-term phosphorus fertiliser and sheep grazing trial at Ballantrae, on behalf of AgResearch Limited dated 15th March 2019.

3. I have the qualifications and experience set out in my EIC.

4. I repeat the confirmation given in my EIC that I have read the ‘Code of Conduct’ for expert witnesses and that my evidence has been prepared in compliance with that Code.

5. In this addendum I use the same defined terms as in my EIC.

6. I have read the addendum to the evidence filed by Jeffrey Donald Morton on behalf of NZTA.

7. In this addendum to my EIC, I respond to the addendum of the expert evidence of Jeffery Donald Morton.
RESPONSE TO EXPERT EVIDENCE

The area of the trial site that will be permanently lost to the proposed new road during construction

8. In response to Dr Morton’s comments in his addendum the areas used by AgResearch to assess the effect the path of the proposed new road on areas, slopes, aspects and permanent frame sites were supplied by NZTA on the 22nd of February 2019 and again on the 1st of April 2019.

9. It was agreed in the joint statement of experts that the land acquired for construction by NZTA that also includes 25 of the permanent frame site, would be lost from the long-term farm systems trial, because of the effect of road construction and the uncertainty around its management. Land returned at the end of the construction period could not be reintegrated into the long-term farm systems trial but would only be available for small-scale component studies. This was also agreed to by most of the scientists in the joint witness statement.

10. It was agreed by the majority attending the expert conferencing that even if the effect of the proposed new road could be limited to the construction footprint provided by NZTA on the 22nd of February 2019 only, the integrity of the long-term farm systems trial would be lost, leaving areas of land with different histories for small component research. That would bring an end to this unique nationally significant long-term system trial and 44 years of continuous measurements.

Effect of the path of the proposed new road on the integrity of the long-term systems trial

11. The impact includes loss of land, in particular the disproportionate loss of the South West aspect, loss of permanent frame sites, change in hydrology, increased instability, access difficulties, uncertain effects on animal behaviours, the construction process itself and traffic once the road is constructed.

12. The loss of the South West Aspect is significant given its disproportionately greater contribution to forage supply in the summer-autumn period (Fig. 1, Lambert et al., 1983)1. Any changes to the existing configuration of land within the farmlets will

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change the dynamics of the systems, introducing a new variable that will negatively influence the ongoing performance of the systems.

Figure 1. Differences in herbage accumulation rates between NW and SW aspects. Values are calculated as percentage increase or decrease of NW rate cf. SW rate (Lambert et al., 1983)

13. The landscape in which the long-term systems trial is located is mapped as Land Use Capability (LUC) Classes 3 through to 8. A large part of the trial would be LUC subclasses 6e and 7e, with wetness a factor in the valley floors. In addition to the effect that road construction will have on the hydrology of the farmlets, by effectively putting a large drain through the farmlets (Appendix 1), it will also introduce an enormous amount of biophysical instability. This will increase the risk of erosion (i.e. slipping and slumping) and the loss of land and infrastructure from all four farmlets that make up the long-term systems trial.

**Level of research and investment**

14. The assertions by Dr Morton in the addendum to his EIC that there is no ongoing research is at odds with the evidence that I provided in my EIC. In brief more than half the research published has been since 1994, of which most are “new” pieces of research. There have been more post-graduate students involved in the study since 1988 than prior.

15. To obtain an estimate of the investment made in the long-term farm systems trial since 1975 into today’s dollars, the following would need to be included in the calculation:
   - Set up costs of the systems and supporting infrastructure;
• Annual management and maintenance of the farmlets ($75k per year);
• Annual technical input each year into practices, measurements, sampling and reporting, (0.5 FTE per year);
• Investment in analyses of soil, pastures, and animal samples ($75k per sampling event);
• Investment in science publications (153 science publications) and 96 other significant publications. That does not include NZ Grasslands Association Proceedings, FLRC or Animal Production Society (50 more?). Assuming $100k / publication, this would be in the vicinity of $25 million;
• Investment in post graduate students (35 theses). Assuming $150k / thesis, this would be in the vicinity of $5 million;

These estimated costs would put the total investment in the long-term system trial in excess of $40 million.

**Animal production measurements on the long-term systems trial have been continuous since 1975.**

16 Animal performance has been a key measure of interest from researchers/producers/industry in pastoral systems research. So much of the research conducted in similar fields is limited to measures of pasture growth and sometimes measures of pasture composition pasture quality are also included. Animal production is often inferred from these measures and hence value to producers and the industry. Extrapolating from pasture production to animal production breaks down because it is not easy to account for surpluses and deficits of feed, nor seasonal changes in animal demand. Systems trials very quickly identify these imbalances. It’s often much easier to demonstrate differences in pasture production than in animal production for these reasons.

17 Only rarely are animal growths and performance measured as part of component research studies. This is because of the resources and costs of including such measurements. Even rarer is the measurement of performance of livestock within closed systems. This is the case in the long-term systems study at Ballantrae and so one of the reasons for its uniqueness and value. Dr Morton in his EIC and again in his Addendum (paragraph 27 and 33) indicates that routine pasture growth measurements were stopped in 1988 and suggests these were the core measurements being made on the farmlets. They were important but not the core measure. The core measurements not just till 1988 but to the present day is animal performance.
Animal performance provide the ultimate measure of production. It reflects the amount of feed available throughout the year and also its quality and availability to animals. For example, the input of 125 or 375 kg SSP/ha/year increased annual pasture production by 40% and 63%, respectively, compared with the farmlet with no fertiliser in 2015/16 (Mackay et al., 2016). Critically the differences in sheep stocking rates were greater than the differences in pasture production, with the input of 125 or 375 kg SSP/ha/year resulting in increases of 50 and 120%, respectively, in animal stocking rates. The large apparent difference in the value of a fertiliser input when based on animal production rather than just pasture growth, reflects the fact a fertiliser input impacts beyond just pasture yield to include pasture botanical composition and nutritive value, which flows through and impacts on pasture utilisation, animal health and performance.

Annual animal production figures

This is one of the reasons why maintaining animal production records has been a core activity in the long-term system trial. It is also the key reason for the ongoing interest as a resource for both science and by industry.

Ongoing change in the behaviour and performance of the systems

The farmlets of the long-term farm systems are not a steady-state or in an equilibrium but continue to change at different time scales with respect to soil fertility, soil biology, pasture growth, species composition and animal performance, as indicated in my EIC. Further Dr Morton’s suggests in his addendum (paragraph 33) that the Olsen P levels in the HFHF systems appear to be stabilised, and narrowly uses this to suggest everything is known and nothing left requiring investigation. In theory soil P levels should be continuing to increase given the amount of fertiliser being applied is more than maintenance. This challenges current thinking, highlight the value of this long-term systems trials. The paper by Mackay and Costal (2016) suggests that the movement of large amounts of phosphorus down the profile, might explain in part why the Olsen P has not continued to increase (Fig.2). It identifies, yet again, an issue requiring new research. For example, if P is moving down the soil profile in an unexpected

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manner, does this have consequences for soil testing into the future, P losses mechanisms?3.

Figure 2. Changes in Olsen P levels (µg/ml) at 0-75 and 75-15 mm soil depths on low, medium and high slope areas on the farmlet that has had no fertiliser since 1980 (LFNF), received 125 kg/ha/year of superphosphate since 1980 (LFLF) or 375 kg/ha/year of superphosphate since 1980 (HFHF). Vertical lines are errors bars. (Mackay and Costall 2016)

Alec Mackay
2nd April 2019
