Appendix 6

Nitrogen loads: scenarios used to model catchment outcomes

The intensification and nutrient reduction scenarios detailed below were the basis for further modelling work by Dr Biggs (summarised in his End of Hearing report, paragraph 14) to determine the instream benefits of various contaminant management approaches. The relative loads and how they were calculated for each of the nine scenarios are detailed in the text below. A summary of the loads of N and P for each scenario, and the related average concentrations are provided in Table 1.

Intensification scenarios[1]:

i. **Fonterra Year 1 load** – annual nitrogen load calculated from Year 1 of Fonterra's proposed N loss limits for Table 13.2.

- The load for this scenario was calculated from the evidence of Mr Willis, attachment 4, page 43 (Table 13.2, Year 1, Value A). The calculated catchment nitrogen load for this scenario in the upper Manawatu is 1,080 tonnes/year, assuming full intensification to the limits in the table. As documented in the Supplementary Evidence of Dr Roygard (page 33).

ii. **1,200 kg MS/ha load <u>and</u> LUC dairy expansion scenario** – combined annual nitrogen load calculated by Clothier *et al*. (2007). Nitrogen loss limits predicted from intensification of land currently in dairying (increasing production from an average of 1,000 to 1,200 kg MS/ha) and the annual N loss load predicted from expansion of dairying onto all LUC Class 3 or better land under current management practices.

- The load for this scenario was calculated from the findings of Clothier *et al.* (2007) that increasing the production from 1,000 to 1,200 kg MS/ha increased leaching losses from 31 kg/ha to 49 kg/ha. Dr Clothier's s42A report (paragraph 106) shows the in-river increase would be 132.381 tonnes over the current load of 744 tonnes/year (i.e. total load of 876.381 tonnes/year). For the LUC expansion, Dr Clothier modelled the increase in dairy farming from 16.3% of the catchment to 25% of the catchment through expansion onto further LUC class 1, 2 & 3 land. Dr Clothier (paragraph 107) shows the increase would be 132.555 tonnes over the current in-river load of 744 tonnes/year (i.e. 876.555 tonnes/year). To simulate the

[1] NB: for all of the intensification scenarios the phosphorus load was determined to be equal to the current state load from Roygard & McArthur (2008), as information for the accurate modelling of phosphorus loads was not available.

catchment load under the combined effect of these scenarios, a nitrogen load of 1,009 tonnes/year was determined (744 + 132.381 + 132.555).

iii. **1,200 kg MS/ha <u>or</u> LUC dairy expansion load** – annual nitrogen load calculated by Clothier *et al*. (2007). Nitrogen loss limits predicted from intensification of land currently in dairying (increasing production from an average of 1,000 to 1,200 kg MS/ha) *or* the annual N loss load predicted from expansion of dairying onto all LUC Class 3 or better land under current management practices. For either of these scenarios, the appropriate load to model is 877 tonnes/year.

iv. **Rule 13-1 Year 20 load** – annual nitrogen load calculated by Clothier *et al.* (2007) using full allocation of N loss limits proposed by the Rule 13-1 Year 20 requirements. This model assumes every hectare in the catchment is leaching at the full Year 20 loss rates of Table 13.2. The calculated catchment nitrogen load for this scenario in the upper Manawatu is 751 tonnes/year, assuming full intensification to the limits in the table. As documented in Dr Roygard's s42A report page 182.

v. **Current state** – measured annual nitrogen load based on the calculation method of Roygard & McArthur (2008). The current state catchment nitrogen load for this scenario in the upper Manawatu is 745 tonnes/year. As documented in Dr Roygard's s42A report page 182.

Nutrient reduction scenarios:

vi. **Rule 13-1 no land use change** – implementation of proposed Rule 13-1 Year 20 nitrogen loads for all existing intensive land uses depending on LUC class (dairy, cropping and horticulture).

- Nitrogen loads were estimated for current land use types and areas from Year 20 N losses in Table 13.2. Calculations were done using areas of current land area for each land use type identified by Clark & Roygard (2007) for zones Mana_1 to Mana_5. Loss rates for intensive land uses in the catchment used those specified in Table 13.2 in addition to loss rates of 4 kg/ha/year for forested catchment (native and exotic) and 7.8 kg/ha/year from sheep and beef farming (as per Table 4 Clothier *et al.,* 2007[2]). In-river nitrogen loads were calculated using the attenuation factor of 0.5 recommended by Dr Clothier. The calculated catchment

2 Page 14 of Clothier *et a*l. (2007) Table 4 identifies a loss rate of 3.9 kg/ha/year in-river for sheep and beef farming. The use of 7.8 kg/ha/year assumes an attenuation factor of 0.5.

nitrogen load for this scenario in the upper Manawatu is 536 tonnes/year as documented in Table 1 below.

- Phosphorus loads were calculated using the estimations of Parfitt *et al.* (2007) for the upper Manawatu of 1 tonne/year from stock exclusion on dairy farms, 1 tonne/year from removing crossings and getting races away from streams, and 2 tonnes/year from good effluent management. Point source best management practice (BMP) reduction of phosphorus of 3 tonnes/year and nitrogen of 8 tonnes/year were used from Roygard & McArthur (2008). A SLUI phosphorus reduction of 1 tonne/year was determined assuming 2.5% of priority farms in the catchment were to take up SLUI Whole Farm Plans[3]. This model assumes no change in land use type, area or intensity.

vii. **1/3 reduction** – annual load based on assumed 1/3 reduction from current state (both dairying and sheep and beef) using potential mitigation options as described by Clothier *et al.* (2007) for N, Parfitt *et al.* (2007) for P, and Roygard & McArthur (2008) for point source BMP reductions. This model assumes no change in land use or intensity. The calculated catchment nitrogen load for this scenario in the upper Manawatu is 502 tonnes/year (Roygard & McArthur 2008 page 127).

viii. **Standard load limit** – annual load calculated from POP standards for SIN (0.444 g/m^3) and DRP (0.010 g/m^3) using the calculation methods of Roygard & McArthur (2008). The calculated catchment nitrogen load for this scenario in the upper Manawatu is 358 tonnes/year (Dr Roygard's s42A report, page 182).

ix. **Ideal load** – annual load calculated from my recommended nutrient standards for SIN (0.110 g/m^3) and DRP (0.010 g/m^3) of Dr Biggs, using the load calculation methods of Roygard & McArthur (2008). The calculated catchment nitrogen load for this scenario in the upper Manawatu is 89 tonnes/year (Dr Roygard's s42A report, Evidence in Chief page 182)

3 Estimated from Parfitt *et al.* (2007) assumed reduction of 4 tonnes P / year from the implementation of SLUI Whole Farm Plans for 10% of the catchment's priority farms. The scenarios conservatively estimate 1 tonne/year from 2.5% of the catchment's top priority farms.

Table 1: Nutrient loads and concentrations for various intensification and nutrient reduction scenarios for the upper Manawatu River at Hopelands.

Intensification scenarios	**N load tonnes/year**	**N conc. g/m^3**	**P load[4] tonnes/year**	**P conc. g/m^3**
Fonterra Year 1	1,080	1.2841	21	0.0227
1,200 kg MS/ha load	991	1.1783	21	0.0227
LUC dairy expansion load	877.7	1.0436	21	0.0227
Rule 13-1 Year 20 load (full allocation of N losses Table 13.2)	755.1	0.8978	21	0.0227
Current state	745.1	0.8746	21	0.0227
Nutrient reduction scenarios	**N load tonnes/year**	**N conc. g/m^3**	**P load tonnes/year**	**P conc. g/m^3**
Rule 13-1 Year 20 load **no change** in current land use areas	536	0.6373	12.6	0.0141
1/3 reduction	490.1	0.5827	12	0.0134
Standard load limit	358	0.4257	8.1	0.0091
Ideal load	89	0.1058	8.1	0.0091

[4] Phosphorus loads for these scenarios cannot be accurately calculated because any reductions in phosphorus as a result of point-source or SLUI improvements may be offset by an unknown degree of increased phosphorus load from intensification. Because of the potential for no net benefit (or an increase) in P loads, we have opted to apply the current state phosphorus loads for the intensification scenarios.