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To the Hearings Panel, Plan Change 1 (“Healthy Rivers”)

Following the presentation of my primary evidence for Block 2 of Plan Change 1 (dated Wednesday 22nd May 2019), the Commissioners requested three items of additional information.

1. To provide the complete reference for ‘Sherriff et al. 2016’;
2. To quantify the additional area to be removed from production by landowners should fence setbacks be increased:
    a. From 1 m to 5 m; or
    b. From 3 m to 5 m; and
3. To quantify the area of land to be removed from production should stock exclusion from intermittent watercourses be included in PC1.

This memo serves to provide this information to the best of my ability in the time available.

1. Complete reference - ‘Sherriff et al. 2016’

Sherriff, S. C., Rowan, J. S., Fenton, O., Jordan, P., Melland, A. R., Mellander, P.-E. and hUallacháin, D. Ó. (2016) 'Storm Event Suspended Sediment-Discharge Hysteresis and Controls in Agricultural Watersheds: Implications for Watershed Scale Sediment Management', *Environmental Science & Technology,* 50(4), 1769-1778.

2. Increasing setback distances

The estimates provided here regarding the area of land to be removed from production associated with increasing setback distances, have been aligned with stream lengths (for orders 1 to 7, excluding intermittent watercourses) detailed within the Evidence submitted by Paul Frederick le Miere on behalf of Federated Farmers for Block 3, submitted 5th July 2019 (with ID #74191). My rationale for doing this is to facilitate ease of direct comparison.

Both myself and Mr le Miere acknowledge the inherent difficulty of accurately calculating the lengths of waterways to be affected by PC1’s policies and rules. No accurate Geographic Information System (GIS) layer(s) exist in New Zealand that detail precisely the location and lengths of small streams, particularly intermittent watercourses and first order streams. The most widely used and accurate GIS layer available is the River Environment Classification version 2.4 (REC2) produced and maintained by NIWA[1]. However, being based on a 30 m digital elevation model and 20 m contours, the spatial

[1] REC2 www.niwa.co.nz/freshwater-and-estuaries/management-tools/river-environment-classification-0

resolution is not fine enough to consistently and accurately capture small watercourses, as shown in Figure 1.

Figure 1. REC2 mapped watercourses shown in blue alongside Robertson Road south of Otorohanga, approximately 1000 m upstream of the Waipa River. Unmapped lengths of both permanent and intermittent watercourses are shown in white. Note that some of these are artificial drains through wetland areas.

In addition, the following matters should be borne in mind when assessing the costs in the Tables below (which are likely to be an over-estimate):

i. The analyses assume all watercourse require fencing and do not take into account the exceptions provided within the PC1 planning framework (for example, the types of stock to be excluded; the presence of natural barriers; provision for temporary fencing);
ii. The large majority of watercourses flowing through dairy-farmed land have already been fenced off, the data for which is held by Fonterra and DairyNZ and not readily available for inclusion/exclusion in my analyses;
iii. Those watercourses currently not fenced on dairy farms will, on the whole, be intermittent *artificial* watercourses, which will not be mapped in the REC2 (or any) GIS layer, and therefore cannot presently be accurately estimated; and
iv. The analyses for <u>All</u> farms include both dairy and dry stock land uses (Table 1).

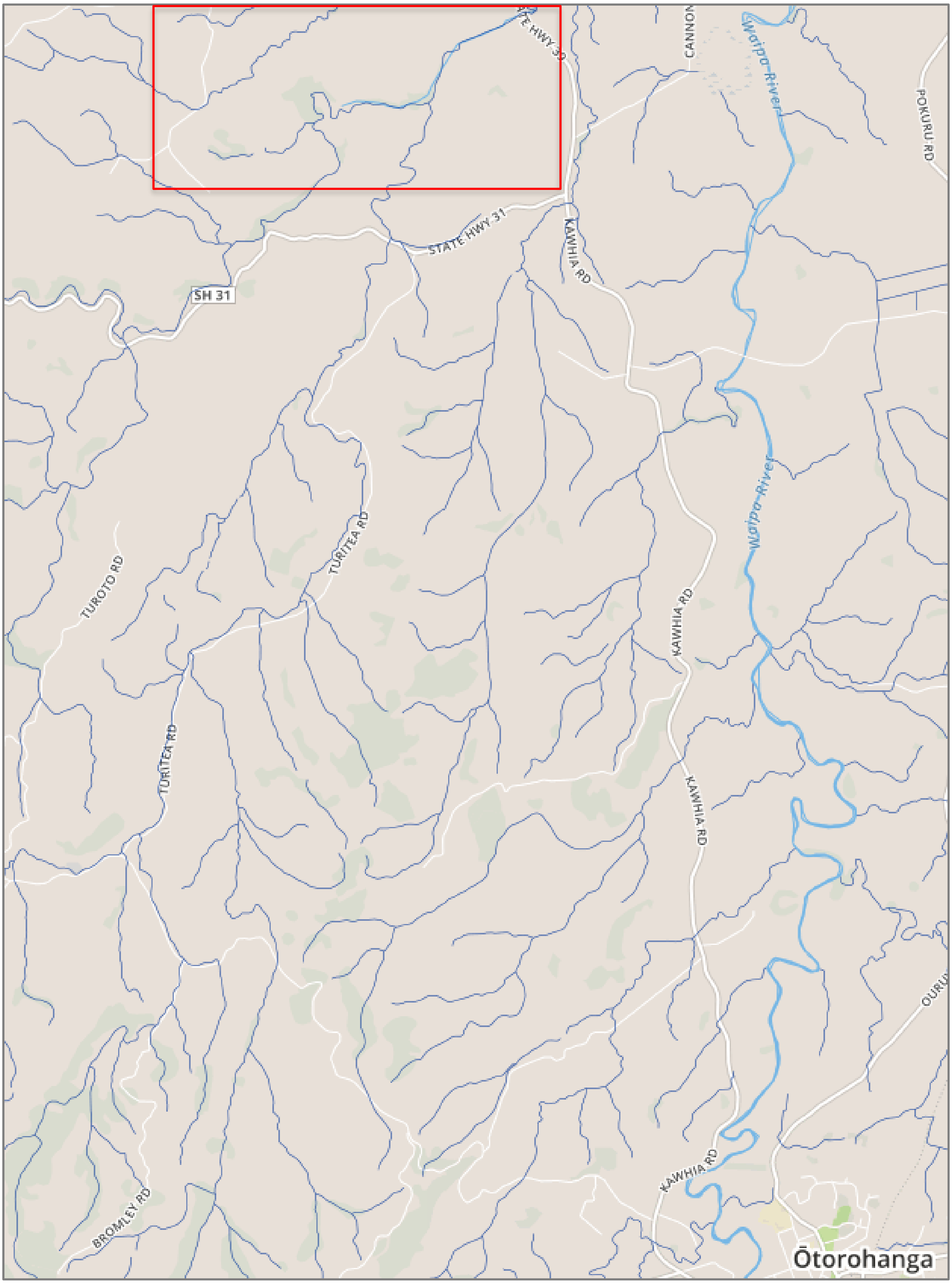

Figure 2. Location of REC2 watercourses map (red box) shown in Figure 1, relative to Otorohanga and the Waipa River.

Tables 1 and 2 present the estimated areas of land (all farms and dry stock, respectively) affected by increasing setback distances, as well as approximate costs associated with fencing and loss of land from production. Two fencing costs per meter have been used to reflect the less expensive post and hotwire fences commonly used on dairy farms, and the more costly post and batten fences used on dry stock farms. Costs are based on those recommended by the Waikato Regional Council, on their webpage entitled 'Planting and fencing waterways calculation sheet'[2]. For all farms (Table 1, including both dairy and dry stock) fencing costs have been estimated at $9.15/m, an average between dairy fencing (3-wire, 2 electric, at $2.25/m) and dry stock fencing (8-wire and batten, at $16/m). This is a highly conservative estimation for all farms given the much lower cost of fencing for dairy farms (as stated). However, this average has been included so that comparisons can be made with Mr le Miere's evidence (which similarly includes a coarse estimate of fencing costs, at $10/m). Daigneault et al. (2017) include comparable fencing costs in their economic model of New Zealand's riparian restoration strategy (low cost at $2/m, medium at $8/m, and high at $16/m). Note, the dry stock fencing option chosen also assumes *sheep* are to be excluded from watercourses, which present PC1 rules do not require. If only cattle are considered, fencing costs may be 50-75% less.

The land values used were obtained from the Real Estate Institute of New Zealand (REINZ) rural media release[3] detailing the median prices per hectare for farms sold in the three months to June 2019, categorised as 'All farms' ($22,044), and 'Grazing farms', i.e. dry stock, ($10,881). Riparian land values are estimated as one third of these values, reflecting the much-reduced productivity of these areas.

Finally, the length of intermittent watercourses has been calculated as an additional 30 % of the length of first order streams. Again, this is conservative. It may be that the actual length of intermittent watercourses is less (unknown). However, in lieu of detailed GIS map work, this seems a reasonable method of estimating such an otherwise unquantified value.

The approximate ***additional area*** of land required for retirement (excluding intermittent watercourses) due to increasing setback distances from:

i.	1 to 5 m, for all farms	= c. 9,397 ha
ii.	3 to 5 m, for all farms	= c. 4,698 ha
iii.	1 to 5 m, for dry stock farms	= c. 3,657 ha
iv.	3 to 5 m, for dry stock farms	= c. 1,828 ha

The approximate ***additional costs*** associated with riparian land removed from production (excluding intermittent watercourses) due to increasing setback distances only from:

i.	1 to 5 m, for all farms (at riparian land value c. $6,600/ha)	= c. $62,018,880
ii.	3 to 5 m, for all farms (at riparian land value c. $6,600/ha)	= c. $31,009,440
iii.	1 to 5 m, for dry stock farms (at riparian land value c. $3,000/ha)	= c. $10,970,400
iv.	3 to 5 m, for dry stock farms (at riparian land value c. $3,000/ha)	= c. $5,485,200

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[2] Accessed 21st July 2019 https://www.waikatoregion.govt.nz/Environment/Natural-resources/Land-and-soil/Managing-Land-and-Soil/Managing-farm-runoff/Planting-and-fencing-waterways-calculation-sheet/
[3] Accessed 17th July 2019 from https://www.reinz.co.nz/public-archive-2019

Table 1. Estimated land areas (ha) and associated costs ($NZ) for fencing setbacks of 1, 3, and 5 m for stock exclusion from intermittent (0.3 order) and permanent (orders 1 to 7) watercourses running through All farms (dairy and dry stock inclusive) within the PC1 area. Values in BOLD highlight those understood to be of particular interest to the Commissioners

Stream order	Length of waterway (m)	Length of waterway (km)	Area 1 m setback (ha)	Area 3 m setback (ha)	Area 5 m setback (ha)	Fencing @ $9.15/m	**1 m setback**		**3 m setback**		**5 m setback**	
							All farms land value @ $22k/ha	Riparian land value @ $6.6k/ha	All farms land value @ $22k/ha	Riparian land value @ $6.6k/ha	All farms land value @ $22k/ha	Riparian land value @ $6.6k/ha
0.3	1833000	1833	**366.6**	1099.8	**1833**	**$33,543,900**	$8,065,200	**$2,419,560**	$24,195,600	**$7,258,680**	$40,326,000	**$12,097,800**
1	6110000	6110	1222	3666	6110	$111,813,000	$26,884,000	$8,065,200	$80,652,000	$24,195,600	$134,420,000	$40,326,000
2	3021000	3021	604.2	1812.6	3021	$55,284,300	$13,292,400	$3,987,720	$39,877,200	$11,963,160	$66,462,000	$19,938,600
3	1644000	1644	328.8	986.4	1644	$30,085,200	$7,233,600	$2,170,080	$21,700,800	$6,510,240	$36,168,000	$10,850,400
4	648000	648	129.6	388.8	648	$11,858,400	$2,851,200	$855,360	$8,553,600	$2,566,080	$14,256,000	$4,276,800
5	252000	252	50.4	151.2	252	$4,611,600	$1,108,800	$332,640	$3,326,400	$997,920	$5,544,000	$1,663,200
6	31000	31	6.2	18.6	31	$567,300	$136,400	$40,920	$409,200	$122,760	$682,000	$204,600
7	40000	40	8	24	40	$732,000	$176,000	$52,800	$528,000	$158,400	$880,000	$264,000
Subtotal *(excluding intermittent watercourses)*		11746	2349.2	7047.6	11746	**$214,951,800**	$51,682,400	**$15,504,720**	$155,047,200	$46,514,160	$258,412,000	**$77,523,600**
TOTAL		14245	3693.4	11080.2	18467	**$248,495,700**	$59,747,600	**$17,924,280**	$179,242,800	$53,772,840	$298,738,000	**$89,621,400**

Table 2. Estimated land areas (ha) and associated costs ($NZ) for fencing setbacks of 1, 3, and 5 m for stock exclusion from intermittent (0.3 order) and permanent (orders 1 to 7) watercourses running through dry stock farms within the PC1 area. Values in BOLD highlight those understood to be of particular interest to the Commissioners

Stream order	Length of waterway (m)	Length of waterway (km)	Area 1 m setback (ha)	Area 3 m setback (ha)	Area 5 m setback (ha)	Fencing @ $16/m	**1 m setback**		**3 m setback**		**5 m setback**	
							Dry stock land value @ $10k/ha	Riparian land value @ $3k/ha	Dry stock land value @ $10k/ha	Riparian land value @ $3k/ha	Dry stock land value @ $10k/ha	Riparian land value @ $3k/ha
0.3	750000	750	**150**	450	**750**	**$24,000,000**	$1,500,000	**$450,000**	$4,500,000	**$1,350,000**	$7,500,000	**$2,250,000**
1	2500000	2500	500	1500	2500	$80,000,000	$5,000,000	$1500000	$15,000,000	$4,500,000	$25,000,000	$7,500,000
2	1100000	1100	220	660	1100	$35,200,000	$2,200,000	$660000	$6,600,000	$1,980,000	$11,000,000	$3,300,000
3	650000	650	130	390	650	$20,800,000	$1,300,000	$390000	$3,900,000	$1,170,000	$6,500,000	$1,950,000
4	225000	225	45	135	225	$7,200,000	$450,000	$135000	$1,350,000	$405,000	$2,250,000	$675,000
5	80000	80	16	48	80	$2,560,000	$160,000	$48000	$480,000	$144,000	$800,000	$240,000
6	10000	10	2	6	10	$320,000	$20,000	$6000	$60,000	$18,000	$100,000	$30,000
7	6000	6	1.2	3.6	6	$192,000	$12,000	$3600	$36,000	$10,800	$60,000	$18,000
Subtotal *(excluding intermittent watercourses)*		4571	914.2	2742.6	4571	**$146,272,000**	$9,142,000	**$2,742,600**	$27,426,000	**$8,227,800**	$45,710,000	**$13,713,000**
TOTAL		5321	1064.2	3192.6	5321	**$170,272,000**	$10,642,000	**$3,192,600**	$31,926,000	**$9,577,800**	$53,210,000	**$15,963,000**

3. Stock exclusion from intermittent watercourses

The approximate ***additional area*** of riparian land required for retirement due to stock exclusion from intermittent watercourses with **1 m** setback distances:

i. For all farms (c. 1833 km of watercourse) = c. 367 ha
ii. For dry stock farms (c. 750 km of watercourse) = c. 150 ha

The approximate ***additional costs*** associated with fencing and riparian land removed from production due to stock exclusion from intermittent watercourses with **1 m** setback distances:

iii. For all farms (riparian land value at $6,600/ha) = c. $2,419,560
iv. For all farms (fencing cost at $9.15/m) = c. $33,543,900
v. For dry stock farms (riparian land value at $3,000/ha) = c. $450,000
vi. For dry stock farms (fencing cost at $16/m) = c. $24,000,000

The approximate ***additional area*** of riparian land required for retirement due to stock exclusion from intermittent watercourses with **5 m** setback distances:

vii. For all farms (c. 1833 km of watercourse) = c. 1833 ha
viii. For dry stock farms (c. 750 km of watercourse) = c. 750 ha

The approximate ***additional costs*** associated with riparian land removed from production due to stock exclusion from intermittent watercourses with **5 m** setback distances:

ix. For all farms (riparian land value at $6,600/ha) = c. $12,097,800
x. For dry stock farms (riparian land value at $3,000/ha) = c. $2,250,000

Please refer to previous Tables 1 and 2 for additional data comparisons. Furthermore, Daigneault et al. (2017) summarise the findings of a detailed economic land use model analysing the *benefits* and *costs* of stock exclusion (fencing) and riparian planting in New Zealand, to which the Hearings Panel are directed should such information be of benefit to their decision making.

References

Daigneault, A. J., Eppink, F. V. and Lee, W. G. (2017) 'A national riparian restoration programme in New Zealand: Is it value for money?', *Journal of Environmental Management,* **187**, 166-177.

DATED this 24th day of July 2019

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