WORKSHOP ITEM:	SUBJECT MATTER: **Estimating the "plausible worst case" increase in nitrogen load from a new way of permitting "normal dryland farming", that would need to be offset by decreases elsewhere in order to stay within the Hurunui Waiau River Regional Plan (HWRRP) nitrogen load limit**
AUTHOR: Ned Norton	DATE: 16 March 2018

Purpose of this paper

This paper responds to a request for more clarity around the estimates of increase in Hurunui catchment nitrogen (N) load associated with the possible new way of permitting "normal dryland farming" currently being considered by the Hurunui Waiau Zone Committee.

This request has come from the group that met to discuss the subject of "*Fixing the 10% rule and offsetting the load to come from dryland farming"* on Monday 12 March 2018, 11-12.30pm, Kereru Room, Environment Canterbury[1].

Background

The background to this request is complex and has been a topic of discussion at most HWZC meetings over more than twelve months. Most recently and directly relevant are the presentations and associated discussion at the Science Stakeholders Group (SSG) meeting on Wednesday 7 March (3pm-6.30pm, St Johns Hall, Amberley), titled:

i) *What is the risk of increase to the area of winter grazing of forage crops if "normal dryland farming" is permitted?* (Norton 2018a)

ii) *What is the "plausible worst case" increase in N load from permitting "normal dryland farming" – and thus what tonnage needs offsetting to stay within the Hurunui catchment N load limit?* (Norton 2018b)

The second of these presentations considered multiple lines of evidence and then used two independent methods to provide two parallel estimates of the plausible worst case increase in N load as follows:

- Method 1 involved the use of a GIS-based analysis of source N losses (i.e., lost from the root zone) at catchment and sub-catchment scales predicted to arise under a pre-defined "plausible worst case" scenario amount of winter grazing of forage crops. The method is described in a Memo by Ognjen Mojsilovic (2018) that was attached to a paper presented by Norton (2018c) to the public workshop held at Hurunui District Council Chambers in Amberley on 29 January 2018.
- Method 2 involved the use of an in-river N load calculator provided in Excel spreadsheet form together with a method description Memo by Peter Brown (2017)

[1] Attendees were Lisa Jenkins, Ian (Whit) Whitehouse, Andrew Parrish, David Just, Ned Norton, Ben Ensor, Josh Brown, Andrew Barton, Bianca Sullivan Chris Pile, Christina Robb, Rhys Narbey, Lauren Phillips, Helen Marr.

for use in the collaborative SSG process. This method predicts changes in in-river N load at State Highway 1 (SH1) and the Hurunui mouth under user-defined scenarios by drawing on information in Brown (2014) and Brown (2015). A subsequent step is used to convert the in-river N load estimates to source N load estimates based on proportional relative change to the consented source N loads held by the major irrigation schemes.

Summary of key messages

Three specific items are addressed in this paper:

1. A small revision to the N load estimated by "Method 2" as presented in the second SSG presentation of 7 March 2018 noted above:

   - The revised Method 2 estimate of "plausible worst case" N load increase from the possible new way of permitting normal dryland farming is 38 t-N/yr of source N load, while the Method 1 estimate remains at 70 t-N/yr of source N load.

2. Comments on justification for selecting one of the two N load calculation methods over the other (i.e., whether to use Method 1 or 2):

   - While both methods have their strengths and weaknesses and could be justified, it is suggested that using Method 2 would be a pragmatic way forward in the circumstances for discussions around offsetting the N losses in this catchment, for the reasons detailed later in the paper.

   - Key among the reasons is that Method 2 is based on in-river load estimates and the HWRRP Schedule 1 in-river load limit and is directly relevant and relatable to the nutrient management system used by the Amuri Irrigation Company (AIC).

3. In response to the question of estimating the N load presumed associated with the existing HWRRP "10% rule" for dryland farming, which under a planning argument might partly or fully offset the estimated increase in N load under the possible new way of permitting normal dryland farming:

   - It is estimated if all dryland farmers above and below Mandamus increased their baseline (2013) N losses by 10% this would lead to an in-river N load increase of 14 t-N/yr. Under the planning argument, that 14 t-N/yr would be on top of the HWRRP Schedule 1 load limit of 963 t-N/yr, giving a new total of 977 t-N/yr. The 14 t-N/yr in-river load increase is equivalent to a source load of 30t-N/yr using Method 2.

   - If such a planning argument was accepted, and achieving a "zero sum game" meant achieving the 977 t-N/yr in-river load rather than the Schedule 1 load limit of 963 t-N/yr, then only 8 of the 38 t-N/yr source load identified under item 1 above would need to be found (e.g., relinquished by irrigation schemes).

   - Allowing for 977 t-N/yr in-river load is a 27% increase on the 2005-2011 average annual load and this constitutes an incrementally higher risk for not achieving the

HWRRP periphyton and other related outcomes, than the 25% increase defined by the HWRRP Schedule 1 load limit. This is a risk for all irrigated and dryland users in the catchment.

- If the goal is to achieve the HWRRP Schedule 1 N load limit of 963 t-N/yr then the full 38 t-N/yr of source N load identified under item 1 above needs to be offset by relinquishing load from irrigated users and/or mitigations to otherwise generate headroom (e.g., by pumping high N concentration water from spring-fed tributaries such as St Leonards Drain for irrigation instead of using lower N concentration Hurunui water).

Method

I have addressed these matters by meeting with Josh Brown, whose technical work surveying Hurunui District Landcare Group dryland farms and other relevant information contributes significantly to the methods for assessing N increases from normal dryland farming. Josh attended the meeting on Monday 12 March, heard the request for more clarity, and worked with me to address that request. I am familiar with the methods used by Ognjen Mojsilovic contained in the SSG presentations mentioned above and I have discussed them with him. I have also checked that my use of Peter Brown's Hurunui in-river N load calculator is appropriate by discussion with him. I sent a draft of this paper to Josh Brown to allow for revisions so that we could report agreement on the responses given below.

Item 1: A small revision to the N load estimated by "Method 2" as presented in the second SSG presentation of 7 March 2018

The "Method 2" that I presented to the SSG used the Hurunui River in-river N load calculator provided by Peter Brown (2017). I entered a 14% assumed increase in dryland farming contribution, taken from the report by Josh Brown (2018), for both upstream and downstream of Mandamus. Group discussion at the SSG workshop and subsequently with Josh Brown suggests that a lower figure of 10% would be more appropriate for the plausible worst case increase above Mandamus. I note that a figure of 10% above Mandamus and 14% below Mandamus is also consistent in proportion to the estimated N losses for dryland above and below Mandamus by Mojsilovic (2018), which I used for "Method 1". When this change is entered into the calculator the Method 2 estimated N load needing offset reduces as follows:

- From 20 t-N/yr to 18 t-N/yr of in-river N load;
- Which is equivalent to 38 t-N/yr of source N load (instead of the previously presented 43 t-N/yr; e.g., 4% x AIC's 956 t-N/yr).

This revised result and conclusion are shown on revised versions of the final two slides of my 7 March 2018 SSG presentation (Figures 1 and 2).

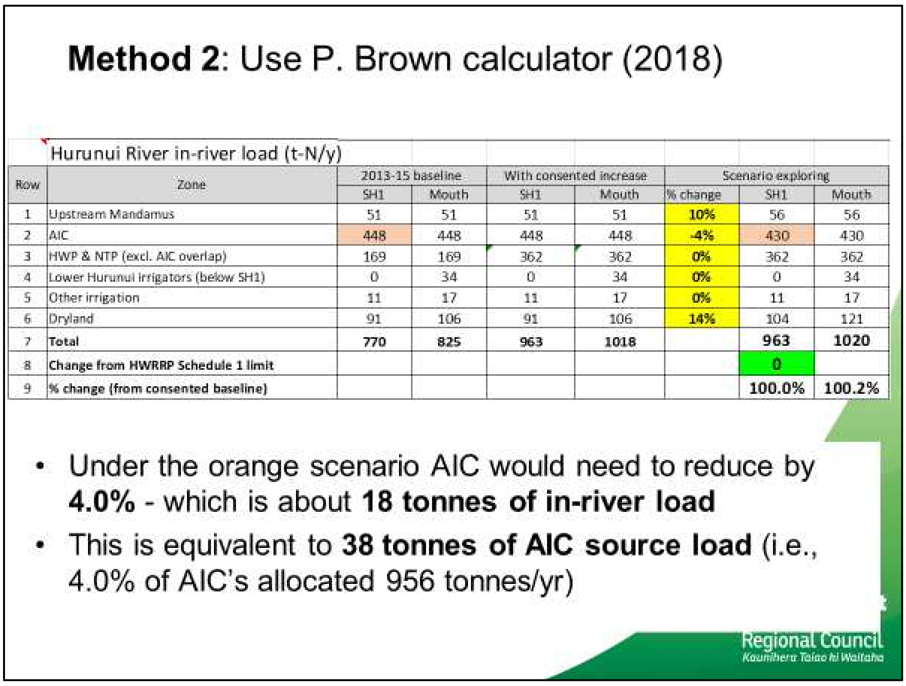

Figure 1: Revised version of slide no. 13 in the Norton 7 March 2018 SSG presentation.

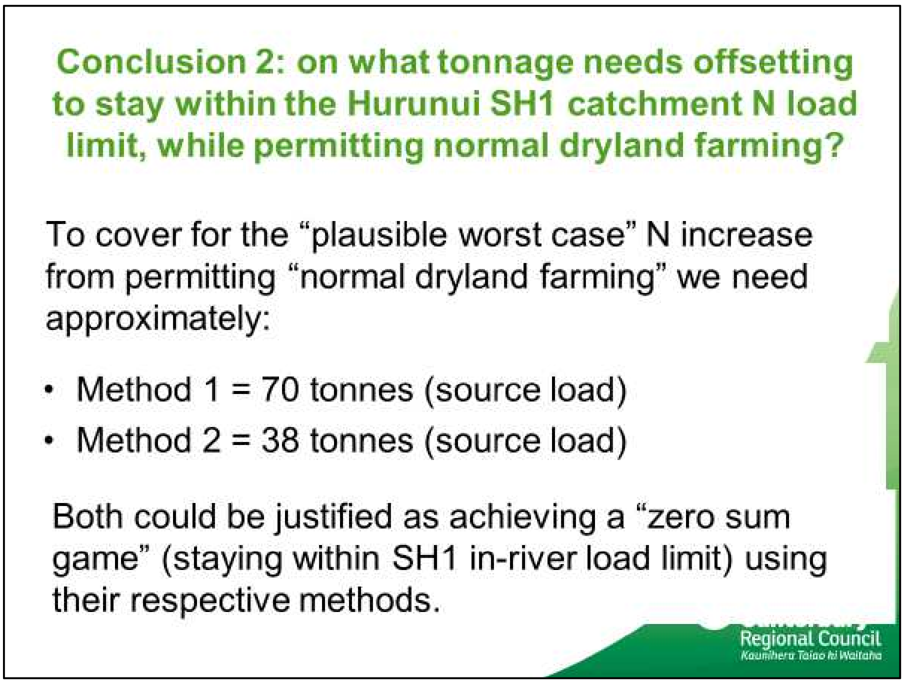

Figure 2: Revised version of slide no. 14 in the Norton 7 March 2018 SSG presentation.

Item 2: Comments on justification for selecting one of the two N load calculation methods over the other (i.e., whether to use Method 1 or 2)

Methods 1 and 2 use different methods to independently arrive at estimates of 38 and 70 t-N/yr of source N load respectively. While these estimates at first appear quite different to each-other when the focus is on considering how to offset them, from my perspective as Technical Lead they are comfortingly similar as parallel estimates of permitted dryland increase (i.e., same order of magnitude) when considered in the context of AIC's consented source N load of 956 t-N/yr and HWP's consented source N load of 1270 t-N/yr, with a total catchment source N load of over 2000 t-N/yr.

While both methods have their strengths and weaknesses it is suggested that using Method 2 would be a pragmatic way forward in the circumstances for offsetting discussions in this catchment on the following basis:

- The Method 2 calculator is based primarily on in-river load estimates, by sub-catchment and farming zone, and on the HWRRP Schedule 1 in-river load limit of 963 t-N/yr. Equivalent source N loads are calculated in a secondary step by taking the relevant percentage change in in-river load and expressing the same percentage change as a fraction of the irrigation scheme's (e.g., AIC) consented source N load.

- The method is thus directly relevant and relatable to the system used by the schemes in this catchment (AIC, HWP, NTP) which are by far the dominant current and likely future N emitters.

- The method has been in use for some time (e.g., P. Brown 2015), is familiar to both irrigated and dryland as well as environmental stakeholders and appears to have achieved a level of comfort through its use in SSG workshops.

Item 3: A response to the question of estimating the N load presumed associated with the existing HWRRP "10% rule" for dryland farming, which under a planning argument might partly or fully offset the estimated increase in N load under the possible new way of permitting normal dryland farming

This question was put to me by the group that met on 12 March 2018 and it explores a different interpretation of the basis for achieving what has previously been referred to in Hurunui ZC and SSG discussions as a "zero sum game".

To date the technical team has applied the concept of "zero sum game" to mean that permitting normal dryland farming needs to be done while staying within the HWRRP Schedule 1 N load limit of 963 t-N/yr – this being the 2005-2011 average annual load (770 t-N/yr) plus allowance for a 25% increase as laid out in the HWRRP. The technical team has understood that the balance of the 25% increase has been allocated by consent to the irrigation schemes (AIC, HWP and NTP) leaving no allowance for any increase by others in the catchment. Indeed this is the basis reflected in the Method 2 calculator (e.g., used by P. Brown since at least 2015) which is shown below in Figure 3 in its "neutral" Excel spreadsheet form (i.e., with only consented increases, and no permitted increases – summing to the HWRRP load limit of 963 t-N/yr).

Hurunui River in-river load (t-N/y)

Row	Zone	2013-15 baseline		With consented increase		Scenario exploring		
		SH1	Mouth	SH1	Mouth	% change	SH1	Mouth
1	Upstream Mandamus	51	51	51	51	0%	51	51
2	AIC	448	448	448	448	0%	448	448
3	HWP & NTP (excl. AIC overlap)	169	169	362	362	0%	362	362
4	Lower Hurunui irrigators (below SH1)	0	34	0	34	0%	0	34
5	Other irrigation	11	17	11	17	0%	11	17
6	Dryland	91	106	91	106	0%	91	106
7	**Total**	**770**	**825**	**963**	**1018**		**963**	**1018**
8	**Change from HWRRP Schedule 1 limit**						**0**	
9	**% change (from consented baseline)**						**100.0%**	**100.0%**

Yellow cells may be changed

Notes:
1. Per hectare losses by land use class are the average of the upper and lower bounds presented in Brown (2015) "Hurunui River nutrient modelling: impact of dryland intensification". Memorandum dated 10 March 2015 from Peter Brown to the Hurunui Waiau and Jed Nutrient Working Group.
2. Baseline values scaled by 0.95 to match 770 t-N/y HWRRP baseline load.
3. Assumes HWP's & NTP's command area in-river load is the 2013 baseline plus 193 t-N/y (193 t-N/y is a 25% increase on 770 t-N/y).
4. About 20% of existing irrigation [above SH1] is outside of AIC's command area. Their baseline load is included in line 3, since they lie within HWP's command area. This irrigation accounts for about 93t-N/y in-river, or 26% of the 362 t-N/y in-river load.
5. "Other irrigation" (line 5) is irrigation that falls outside AIC , HWP & 'Lower Hurunui Irrigators' zones. It is primarily from irrigated land along the Hurunui and Waitohi mainstems.
6. 'Lower Hurunui Irrigators ' zone covers most of the irrigable land below SH1.

Figure 3: Hurunui River in-river N load Excel spreadsheet calculator (P. Brown 2017) – in "neutral" form.

The question from the group at the 12 March 2018 meeting contemplates a planning argument that others in the Hurunui catchment (i.e., those other than AIC, HWP and NTP) are still entitled to increase their baseline (2013) N loss by up to 10% under the existing HWRRP "10% rule". The Method 2 calculator can be used to estimate an in-river N load increase of 14 t-N/yr if all dryland farmers above and below Mandamus did this. That 14 t-N/yr would be on top of the HWRRP Schedule 1 load limit of 963 t-N/yr, giving a new total of 977 t-N/yr as shown in the version of the calculator in Figure 4. The 14 t-N/yr in-river load increase is equivalent to a source load of 30t-N/yr (i.e., 3.1% of AIC's consented 956 t-N/yr).

Hurunui River in-river load (t-N/y)

Row	Zone	2013-15 baseline		With consented increase		Scenario exploring		
		SH1	Mouth	SH1	Mouth	% change	SH1	Mouth
1	Upstream Mandamus	51	51	51	51	10%	56	56
2	AIC	448	448	448	448	0%	448	448
3	HWP & NTP (excl. AIC overlap)	169	169	362	362	0%	362	362
4	Lower Hurunui irrigators (below SH1)	0	34	0	34	0%	0	34
5	Other irrigation	11	17	11	17	0%	11	17
6	Dryland	91	106	91	106	10%	100	117
7	**Total**	**770**	**825**	**963**	**1018**		**977**	**1034**
8	**Change from HWRRP Schedule 1 limit**						**14**	
9	**% change (from consented baseline)**						**101.5%**	**101.5%**

Yellow cells may be changed

Notes:
1. Per hectare losses by land use class are the average of the upper and lower bounds presented in Brown (2015) "Hurunui River nutrient modelling: impact of dryland intensification". Memorandum dated 10 March 2015 from Peter Brown to the Hurunui Waiau and Jed Nutrient Working Group.
2. Baseline values scaled by 0.95 to match 770 t-N/y HWRRP baseline load.
3. Assumes HWP's & NTP's command area in-river load is the 2013 baseline plus 193 t-N/y (193 t-N/y is a 25% increase on 770 t-N/y).
4. About 20% of existing irrigation [above SH1] is outside of AIC's command area. Their baseline load is included in line 3, since they lie within HWP's command area. This irrigation accounts for about 93t-N/y in-river, or 26% of the 362 t-N/y in-river load.
5. "Other irrigation" (line 5) is irrigation that falls outside AIC , HWP & 'Lower Hurunui Irrigators' zones. It is primarily from irrigated land along the Hurunui and Waitohi mainstems.
6. 'Lower Hurunui Irrigators ' zone covers most of the irrigable land below SH1.

Figure 4: Hurunui River in-river N load Excel spreadsheet calculator (P, Brown 2017) – showing a scenario where all dryland farmers above and below Mandamus increase their 2013 baseline N losses by 10%.

If such a planning argument was accepted and achieving a “zero sum game” meant achieving the 977 t-N/yr in-river load rather than the Schedule 1 load limit of 963 t-N/yr, then only 8 of the 38 t-N/yr source load identified under item 1 above would need to be found to offset increases under the new way of permitting normal dryland farming (e.g., relinquished by irrigation schemes).

Allowing for 977 t-N/yr in-river load is a 27% increase on the 2005-2011 average annual load and this constitutes an incrementally higher risk for not achieving the HWRRP periphyton and other related outcomes, than the 25% increase defined by the HWRRP Schedule 1 load limit. This is a risk for all irrigated and dryland users in the catchment.

If the goal is to achieve the HWRRP Schedule 1 N load limit of 963 t-N/yr then the full 38 t-N/yr of source N load identified under item 1 above needs to be offset by relinquishing load from irrigated users and/or mitigations to otherwise generate headroom (e.g., by pumping high N concentration water from spring-fed tributaries such as St Leonards Drain for irrigation instead of lower N concentration Hurunui water).

References

Brown, J. (2018). “Likely trends for dryland farming as a permitted activity in the Hurunui and Waiau Zone: In the context of water quality discussions”. On behalf of Hurunui District Landcare Group. Prepared for Environment Canterbury, February 2018; 49p. “

Brown, P. (2017). “Hurunui and Waiau catchment nutrient calculators”. Memorandum dated 6 November 2017. Prepared for Ned Norton and the Hurunui Science Stakeholders Working Group.

Brown, P. (2015). “Hurunui River nutrient modelling: impact of dryland intensification”. Memorandum dated 15 March 2015. Prepared for the Hurunui, Waiau and Jed Nutrient Working Group.

Brown, P. (2014). “Statement of evidence of P Brown for Ngai Tahu Properties consent application CRC144606”, 20 May 2014”

Mojsilovic, O. (2018). “Modelling changes in Hurunui and Waiau catchment root zone nitrogen losses from hypothetical scenarios of permitted winter forage development. Memorandum dated 25 January 2018. Prepared for Environment Canterbury. 3p.

Norton, N. (2018a). What is the risk of increase to the area of winter grazing of forage crops if “normal dryland farming” is permitted? Presentation to the Hurunui Science Stakeholders Group workshop hosted by the Hurunui Waiau Zone Committee, St Johns Hall, Amberley, 7 March 2018. Prepared for Environment Canterbury

Norton, N. (2018b). What is the “plausible worst case” increase in N load from permitting “normal dryland farming” – and thus what tonnage needs offsetting to stay within the Hurunui catchment N load limit? Presentation to the Hurunui Science Stakeholders

Group workshop hosted by the Hurunui Waiau Zone Committee, St Johns Hall, Amberley, 7 March 2018. Prepared for Environment Canterbury

Norton, N. (2018c). “What do we know about future nutrient losses in the Waiau catchment from both irrigated and dryland development, and under different assumed amounts of permitted winter grazing of forage crops?”. Agenda paper presented to a public workshop hosted by the Hurunui Waiau Zone Committee and Science Stakeholders Group, Hurunui District Council Chambers, Amberley, 29 January 2018. Prepared for Environment Canterbury. 7p.