BEFORE THE HEARINGS PANEL

IN THE MATTER	of the Resource Management Act 1991 ('the Act')
AND	
IN THE MATTER	of Proposed Plan Change 9 to the Hawke's Bay Regional Resource Management Plan

STATEMENT OF SUPPLEMENTARY EVIDENCE OF PAWEL RAKOWSKI FOR HAWKE'S BAY REGIONAL COUNCIL

4 June 2021

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1. INTRODUCTION

1.1 My name is Pawel Rakowski.

1.2 My qualifications and experience are as set out in my Reply Evidence dated 19 May 2021.

1.3 I reconfirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note dated 1 December 2014.

2. PURPOSE AND SCOPE OF EVIDENCE

2.1 My evidence is in response to the question raised by one of the Commissioners: "Are there parts of the Heretaunga Aquifer System that could be managed separately?"

2.2 I understand that this question relates to whether it is possible to manage groundwater abstraction from the Heretaunga Aquifer System to avoid impacts on surface water flows (rivers, streams and springs), by dividing the aquifer area into discrete areas with different allocation management strategies.

2.3 In my professional option, there is very limited scope for delineation of separate management zones. My opinion is based on modelling work and available geological and hydrological data, as reported by Rakowski (2018 and 2019) and Rakowski & Knowling (2018). The brief justification for my opinion is presented below.

3. KEY FACTS AND ASSUMPTIONS RELIED ON

3.1 Along with documents and evidence listed in section 2.1 of my Reply Evidence, in preparing this evidence I have reviewed the following:

a) Rakowski P. (2019) *Heretaunga Aquifer Stream Depletion Assessment: Stochastic stream depletion distribution, zone delineation and response function methodology*. HBRC publication No. 5029, February 2019.[1]

4. GEOLOGICAL AND HYDROLOGICAL DATA

4.1 The Heretaunga Aquifer System consists of highly transmissive sand and gravel deposits. High hydraulic transmissivity means that the pumping impact can be transmitted many kilometres away from the pumping point.

4.2 Groundwater pumping (in particular irrigation takes) is distributed across the aquifer, making it difficult to delineate a boundary of any management zone based on pumping activity.

4.3 There is no evidence of hydraulic boundaries within the aquifer that can justify delineation of zones (with the possible exception of peripheral aquifers, e.g. on Ngaruroro River terraces upstream of Maraekakaho).

4.4 Hydrological data (surveyed river losses and spring gains, well surveys and water quality data) confirm that water is transported and mixed throughout the aquifer.

4.5 In general, it is very difficult or impossible to measure stream depletion directly, therefore modelling may be the only practical way to estimate stream depletion.

4.6 Numerical modelling is particularly useful as it allows for assessment of a cumulative impact, which is typically impossible using analytical methods. Therefore, I have drawn upon my numerical modelling work to answer the question about managing impacts of groundwater abstraction on streamflow.

5. STREAM DEPLETION ZONES

5.1 Modelling work described in the Heretaunga Aquifer Stream Depletion Assessment Report (Rakowski, 2019) is most relevant to the stated question.

[1] Available for download at https://www.hbrc.govt.nz/documents-and-forms/details/11346. Last accessed 1 June 2021.

5.2 The primary objective of that study was to identify the spatial distribution of stream depletion in the Heretaunga Aquifer System, to explore potential groundwater management zones.

5.3 The study allowed for delineation of three zones of Stream Depletion Potential[2], with the intention that these could be used for management purposes. The results (Figure 1) identified:

(a) Zone 1 (very high stream depletion potential) located close to losing sections of rivers and streams, making it a potential candidate for a management zone.

(b) Zone 2 (zone of relatively high stream depletion potential) encompasses most of the Heretaunga Aquifer, which makes it challenging for managing stream depletion via reduction of abstraction.

(c) Zone 3 (zone of relatively low stream depletion potential) could potentially be managed separately from the more connected Zone 2 area. However, due to uncertainty with the modelling in most of Zone 3, surface water bodies in Zone 3 cannot be confidently regarded as less connected to groundwater than those in Zone 2. Therefore I do not recommend to manage Zone 3 separately.

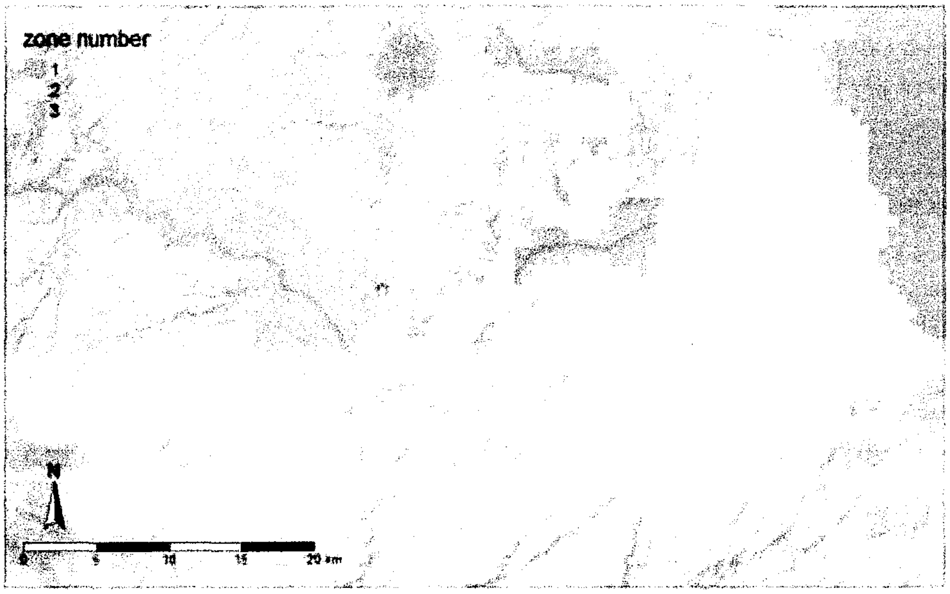

Figure 1 Stream Depletion Zones. Zone 1 - >90% depletion after 7 days pumping, Zone 2 - >60% depletion after 150 days pumping, Zone 3 <60% depletion after 150 days pumping.

[2] Stream Depletion Potential is used to delineate Stream Depletion Zones and was referred to as Stream Depletion Ratio in Rakowski (2019).

5.4 However, stream depletion zones are only relevant as an indication of a "potential" for stream depletion in a given location. If a given area has a high stream depletion potential, but there is no pumping from this area or if pumping is very low, the overall effect on river flow will also be low. On the other hand, a very high pumping rate from an area with a low stream depletion potential may result in a high level of stream depletion. Because of that, an additional map was developed to visualise the "true" stream depletion[3] based on actual groundwater pumping rates and distribution (Figure 2).

5.5 The results of the study indicated that the "true" stream depletion effect is distributed across the entire Heretaunga Aquifer and it is not possible to delineate any zones of high "true" stream depletion effect. This is because generation of stream depletion is not limited to any discrete zones around streams but is caused by combined abstractions that are distributed across the entire aquifer.

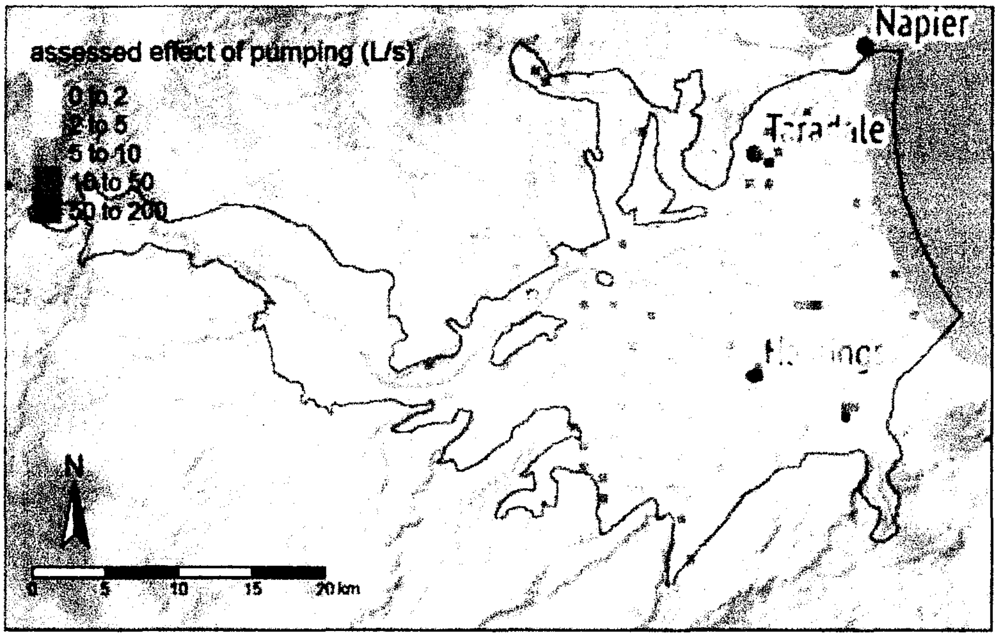

Figure 2 Distribution of "true" pumping effect (taking in to account Stream Depletion Potential and pumping distribution and rate) on "global" stream depletion.

5.6 The result indicates that individual abstractions can simultaneously impact multiple surface water features, which may be located many kilometres away. This would make it difficult to delineate allocation management zones.

[3] This "true" stream depletion is referred to as Assessed Stream Depletion in Rakowski (2019)

6. MODELLING OF STREAM DEPLETION EFFECT

6.1 Modelling scenarios (as reported in Rakowski, 2018) indicated that:

(a) Stream depletion is a result of a cumulative pumping effect from abstraction across the entire Heretaunga Aquifer System, rather than local effects from nearby abstractions.

(b) Managing stream depletion using abstraction bans in "Zone 1" (Figure 1 - zone identified as high stream depletion potential) has a very limited benefit for mitigating stream depletion. For example, only 40 L/s reduction of stream depletion is achieved for the Ngaruroro River after cessation of pumping in Zone 1 (green line in Figure 3), whereas total stream depletion can be at least 800 L/s during very dry periods. This strategy would also put the burden of protection from stream depletion on a limited number of users in Zone 1 that are subject to bans, when most of the depletion is generally a result of a cumulative abstraction outside of Zone 1.

(c) Restricting abstraction outside of Zone 1 during periods of low flow would take too long for stream flows to recover.

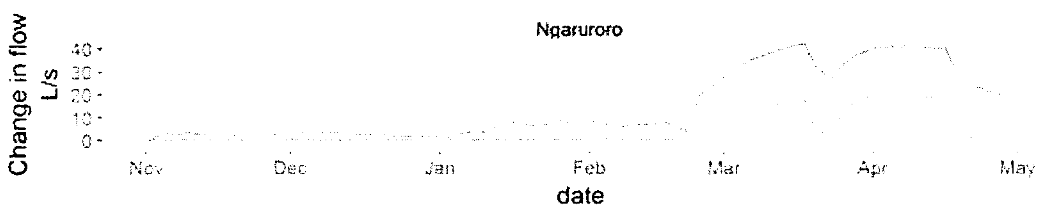

Figure 3 Ngaruroro River flow recovery after a groundwater pumping ban in Zone 1 (green line). (The red line shows river flow recovery after pumping ban in the zone that is currently used to manage directly connected groundwater takes)

(d) Reducing the entire allocation would have some benefit for some streams, but a very large reduction of abstraction would be required to avoid most of the depletion of surface water bodies (e.g. for the Ngaruroro). Figure 4 shows that the Ngaruroro River is depleted by about 800L/s and to avoid 600 L/s of this depletion would require complete and permanent cessation of irrigation pumping everywhere in Heretaunga Aquifer, which would be impractical.

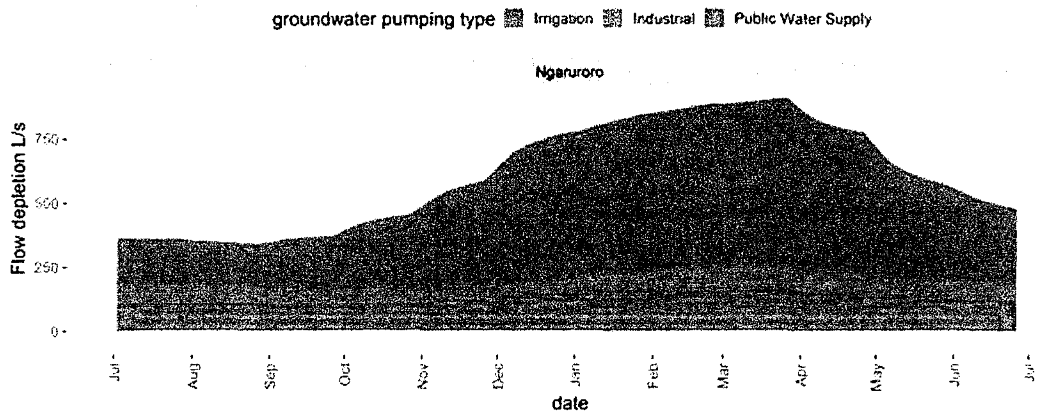

Figure 4 Flow depletion per user type in the 2012-2013 irrigation year for the Ngaruroro River at Fernhill.

(e) Modelling has demonstrated that stream flow enhancement from groundwater is feasible for remedying or mitigating the cumulative effects of groundwater abstraction throughout the Heretaunga Plains. Major losing rivers, such as the Ngaruroro River, are an exception due to the prohibitively large volumes of water which could not be augmented using groundwater. An alternative mitigation solution, such as a storage scheme, would be required to remedy stream depletion of the Ngaruroro River.

7. UNCERTAINTY

7.1 Despite large volumes of available geological and hydrological data that enabled good model calibration, there is still some residual uncertainty. This is a common issue in all groundwater models. In particular, there is uncertainty related to the conceptual setting in several areas, such as the peripheral parts of the Aquifer System, including the Paritua/Karewarewa and Moteo Valley areas. Despite this uncertainty, in my opinion there is enough evidence to indicate relatively high connection to the rest of the Heretaunga Aquifer System, even though the exact nature of connection (and therefore the exact degree of stream depletion) may be uncertain.

8. CONCLUSIONS

8.1 In the Heretaunga Plains, individual abstractions can simultaneously impact multiple surface water features which may be located many kilometres away. In my opinion, because of the wide distribution of stream depletion effect due to high transmissivity of the Heretaunga aquifer, delineation of allocation management zones is impractical and groundwater should be managed as a single system.

8.2 An exception to this may be groundwater bores in Zone 1 that are considered to be directly connected to surface water bodies. Those abstractions can be managed by restricting abstraction during periods of low flow, but this would only avoid a limited amount of the stream depletion effect. For example, the Ngaruroro River is depleted by about 800L/s and cessation of groundwater abstraction within Zone 1 would mitigate stream depletion by only 40L/s. To avoid 600 L/s of this depletion would require complete and permanent cessation of irrigation pumping everywhere in the Heretaunga Aquifer, which would be impractical.

8.3 While avoiding the effects of groundwater abstraction is not realistic due to the highly transmissive aquifer system, the effects may instead be remedied or mitigated at local scales.

References

Rakowski P. (2018) *Heretaunga Aquifer Groundwater Model Scenarios Report*. HBRC publication No. 5018.

Rakowski P. (2019) *Heretaunga Aquifer Stream Depletion Assessment: Stochastic stream depletion distribution, zone delineation and response function methodology*. HBRC publication No. 5029.

Rakowski P. and Knowling M. (2018) *Heretaunga Aquifer Groundwater Model Development Report*. HBRC publication No. 4997.

Pawel Rakowski
4 June 2021