BEFORE THE NORTHLAND REGIONAL COUNCIL

under:	the Resource Management Act 1991
in the matter of:	Resource consent applications by the Te Aupōuri Commercial Development Ltd, Far North Avocados Ltd, P McLaughlin, NE Evans Trust & WJ Evans & J Evans, P & G. Enterprises (PJ & GW Marchant), MP Doody & DM Wedding, A Matthews, SE & LA Blucher, NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valadares & D Bryan (Property No 1), MV Evans (Property No 2), MV Evans (Property No 1), Tuscany Valley Avocados Ltd (M Bellette), NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valadares & D Bryan (Property No 2), Tiri Avocados Ltd, Valic NZ Ltd, Wataview Orchards (Green Charteris Family Trust), Mate Yelavich & Co Ltd, Robert Paul Campbell Trust, Elbury Holdings Ltd (C/-K J & F G King) for new groundwater takes from the Aupōuri aquifer subzones: Houhora, Motutangi and Waiharara and applications by Waikopu Avocados Ltd, Henderson Bay Avocados Ltd, Avokaha Ltd (c/- K Paterson & A Nicholson), KSL Ltd (c/- S Shine), Te Rarawa Farming Ltd and Te Make Farms Ltd for increased existing consented takes from the Aupōuri aquifer subzones: Houhora, Motutangi, Sweetwater and Ahipara.

Reply Evidence of
Timothy Michael Baker
for the Director-General of Conservation
11 June 2021

For the Director-General of Conservation:

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REPLY EVIDENCE OF TIMOTHY MICHAEL BAKER

QUALIFICATIONS AND EXPERIENCE

1 My full name is **Timothy Michael Baker**. I previously held the position of Associate Hydrogeologist at Jacobs New Zealand Ltd. I now hold the position of Principal Consultant, Hydrology & Hydrogeology at SLR Consulting NZ Ltd. Apart from that change my qualifications and experience are set out in my Evidence in Chief (EIC) dated 21 August 2020.

2 I was also involved in the Motutangi-Waiharara Waters Users Group (MWWUG) consent hearings and Environment Court appeals, in 2018 and 2019. I presented groundwater and hydrology evidence for the Department of Conservation (DOC) and was involved in the refinement of the Groundwater Monitoring and Contingency Plan (GMCP) established for those consents.

CODE OF CONDUCT

3 I have read and agree to comply with the Code of Conduct for Expert Witnesses produced by the Environment Court 2014 and have prepared my evidence in accordance with those rules. My qualifications as an expert are set out above.

4 I confirm that the issues addressed in this brief of evidence are within my area of expertise.

5 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I have specified where my opinion is based on limited or partial information and identified any assumptions, I have made in forming my opinions.

6 I participated in an expert conferencing session in September 2020 with Mr Brydon Hughes, Mr Jon Williamson and Dr West (AAWUG – Joint Statement - Expert Conferencing').[1]

Conceptual Setting and Position of Concern

7 I discussed the conceptual geological and hydrogeologcial setting of the Aupōuri Peninsula in my EIC.[2] The following additional comments preface this Reply statement and respond generally to differences between DOC experts and the Applicant's expert in JWS's, on the level of caution required.[3]

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[1] 'JWS 1'.

[2] Baker EIC at [17] – [22].

[3] E.g. JWS 4, 11 December 2020 'Requests for additional modelling and sampling' at Table 1, row 1 - Mr Blyth's comment (in response to Mr Williamson's comments), that it is possible groundwater inputs could make up a larger component of the Kaimaumau-Motutangi Wetland's water balance if modelling is considered at finer-grained scale(s).

8 The Aupōuri aquifer system has been described by both the Applicant[4] and Lincoln Agritech[5] as a leaky-confined aquifer system. This is because there is no regionally extensive confining layer but there are numerous low-permeability layers that vary in depth and thickness, which over multiple occurrences collectively provide a degree of confinement that lends to the development of vertical pressure gradients (WWLA, 2020).This is overlain by a more dynamic unconfined system.

9 The shellbed target zone of the Aupōuri Aquifer that the 24 takes are abstracting from can be described as a discharge-driven system rather than a recharge-driven system. Under natural conditions (i.e., no pumping) groundwater flow in the shell-beds is likely to be low and recharge from the overlying sediments would be approximate to the marine discharge.

10 Under natural (no-pumping) conditions, the unconfined aquifer system generally to be relatively independent of the leaky-confined system with little vertical flow, and most shallow groundwater migrating either horizontally toward the coast (within the shallow aquifer or as baseflow in streams/springs/wetlands), although positive pressure gradients toward the coast indicate potential for upwelling.

11 Pumping from the shellbed aquifer increases the volume of groundwater recharging into the deeper system from the overlying layers. The more pumping that occurs, the more vertical flow is induced (leakage). Over time this water drawn vertically must come from the shallow unconfined aquifer system. It is the effects of this impact on the shallow groundwater system, and its connectivity to groundwater dependent features that is of concern to the Department of Conservation.

Assessment of Stream Depletion effects

12 As stated in my EIC[6], modelling contained in the AEE predicted a project-wide 4.3% decrease in annual minimum flows because of the proposed groundwater takes. This decrease was not spatially defined and was based on a regional water balance approach.

13 Subsequently a revised Stream Depletion Assessment was presented in Mr Williamsons Supplementary Statement of Evidence (28 September 2020). This assessment used the Aupōuri Groundwater Flow Model to calculate the degree of stream depletion attributable to each bore.

14 The methodology used is described in the Supplementary Statement of Evidence. The methodology described is:

[4] Aupōuri Aquifer Groundwater Model. Factual Technical Report – Modelling. Williamson Water and Land Advisory, 2020.
[5] Aupōuri Aquifer Review Report 1056-1-R1. Lincoln Argitech, 2015.
[6] At [43].

a. The stream depletion effect that was attributable to each bore was back calculated from the total catchment stream depletion using NRC's cross boundary effects methodology.

b. Except for this analysis, catchment boundaries were substituted for sub-aquifer management boundaries.

c. The portion of each catchment's stream depletion attributed to individual bores was based on the radius of influence of a given bore and weighting to reflect differing rates of take.

15 I am uncertain of the accuracy and reliability of this assessment when it is dependent on streamflow and baseflow data that has been simulated by the model (as opposed to relying on measured and observed flow). It is my understanding that the groundwater model is not calibrated to any surface water baseflows, rather the post calibration model flow budget provides a surface water volume that is discharging to drains and wetlands. This has been modelled using assumptions of drain depth (drain boundaries) and connectivity to the underlying aquifer (conductance value) as described in Section 3.1.4 of the Model Development Report.

16 A concern would be, for example, if the model were to overestimate surface water discharges, then the percentage of streamflow depletion calculated by this approach could be higher than currently reported (or *vice versa*).

17 I am cognisant that the model development and calibration approach adopted is not unique, and in my understanding of groundwater modelling this is an acceptable approach. However, I am concerned that there is a lack of discussion of the residual uncertainty in relation to streamflow and baseflow.

18 Further highlighting the variability in streamflow depletion assessment methodologies are the results from analytical modelling undertaken in the application of P&G Enterprises. This assessment was undertaken by Lincoln Agritech Limited and is presented in Appendix A of that application.

19 It is noted that for the P&G Enterprises example, the production bore has not yet been drilled and all aquifer parameters used in the assessment were derived from nearby wells and available literature.

20 The P&G Enterprises approach uses the Hunt and Scott (2007) analytical solution. This is a two-aquifer analytical solution widely used for leaky aquifer streamflow depletion assessments across NZ.

21 The AEE presented streamflow depletion calculations for two nearby streams. For the Korakonui Stream depletion after 210 days was calculated as 2.6 L/s (66%) and on the Kaitakia Stream depletion was 3.7 L/s (94%). Based on this assessment, both takes would be classified as 'High' under Policy H.5 of the Proposed Regional Plan for Northland (assuming similar values after 150 days pumping).

22 Whilst acknowledging that the above analytical SFD assessment may err on the side of conservatism, I have looked at the potential impact of this depletion on stream flow:

a. The NRC Water Allocation Tool[7] provides estimates of 7-day MALF for both streams. The 7-day MALF for the final reach on Kaikatia is 9.2 L/s, the Stream Flow depletion or 'SFD' (~3.7 L/s) would correspond to 41% of MALF for final reach on Kaikatia Stream.

b. The 7-day MALF for the Korakonui Stream is 18.9 L/s, the calculated SFD (2.6 L/s) would correspond to 13% of MALF. Both of these rivers are within the Coastal rivers FMU (for water quantity); therefore, the proposed groundwater extraction could result in over-allocation for Kaikatia Stream (allocation limit = 30% of MALF, and minimum flow = 90% of MALF).[8]

23 Interestingly, the percentage of streamflow depletion calculated using the Aupōuri Aquifer Groundwater model was 0%. Further explanation from the Applicant of why the two assessments are so different is warranted.

24 Based on the NRC Allocation tool, there are other stream reaches across the Aupōuri Peninsula that are highly or fully allocated, and additional streamflow depletion may further degrade baseflow. These areas include the Awanui River (Reach ID 1003666) and the Okohine/Waiparera Streams (Reach ID 1002019).

25 In my opinion, the best solution (numerical or analytical) is a model that accurately represents the hydrogeological conditions around the bore in question. Often a well calibrated numerical model will provide a valid estimate of streamflow depletion, however if an analytical model can better represent the geological conditions observed from borehole logs and aquifer testing then it can also provide good data.

26 Given the above, I am concerned that the approach of assessing SFD effects without having drilled or tested the bores may underestimate SFD effects. A requirement to aquifer test the bore following drilling, and an exercise to confirm that the results of the aquifer test align with those in the model is warranted. This is a requirement of Policy H.5 (subclause 2).

27 Overall, the above paragraphs outline why I believe further a robust shallow groundwater, and surface water monitoring regime is warranted, and is informed by a sufficient degree of investigation into the connectivity of groundwater with springs, streams and wetlands, as described in the evidence of Dr West.

[7] Reach-scale hydrological estimates based on stream NRC's Water Allocation Tool
[8] Policies H.4.1 and H.4.3 Proposed Northland Regional Plan (I understand appeals on these policies have been resolved by Court Order).

Dividing GMCP management into three

28 The Applicant proposes to 'split' the proposed takes into 3 groupings for the purpose of separate GMCP's, as follows:

a. Northern: Other, Waihopo and (northern) Houhora sub-aquifers

b. Middle: Other, Paparore, Motutangi and Houhora sub-aquifers

c. South-western: Sweetwater and Ahipara sub-aquifers.

29 The groupings have been amended since the original s42A Report dated 31 August 2020.[9]

30 As stated in that s42A Report:[10]

> *"… the boundaries of the various sub-aquifers of the Aupōuri Aquifer management unit represent arbitrary sub-divisions of a laterally continuous aquifer system."*

31 I agree that these proposed groupings provide a practical way of monitoring and reporting on the effects over a large area. However, the cumulative effects on the aquifer are important and an overview/consolidation of the effects reported across all three GMCPs is required.

Proposed Monitoring regime

32 The Applicants have proposed monitoring locations for the Northern and South-Western Groups. For the Middle Group, the Applicants propose using the existing MWUUG locations plus one additional location at Paparore.

33 Since the adjournment of the hearing, DOC specialists and the Applicant have conferenced and identified wetland high-risk sites, referred to as Areas of Interest (AOI) that have been agreed to warrant further monitoring of potential effects, and as such have been incorporated into the GMCPs.

34 I was not directly involved in the identification of these AOI, nor with the delineation and monitoring procedure presented in the GMCP.

35 I have noted that the procedure outlined in the GMCP does not include monitoring of wetland water levels within the AOI and does not include the installation of any additional shallow groundwater monitoring sites close to the wetlands.

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[9] The Officers' originally recommended an amalgamated and amended MWWUG GMCP for the 'Middle Group' of takes as they are in an area that is considered to overlap with the takes that are subject to the existing MWWUG consents. I understand this is no longer preferred by the Applicant. The Applicant has split the 'Middle Group' of takes into a separate GMCP to that of the MWWUG consents but with a form of 'priority system' for the MWWUG consent-holders that I do not comment on.

[10] Report LWP 27 July 2020 attached to s42A Report dated 31 August 2020.

36 At a minimum, I believe that wetland levels within each of the AOI (that remain in the monitoring programme) should be monitored at a frequency no less than monthly, but ideally continuously (i.e., daily).

37 Additionally, each AOI remaining in the monitoring programme should have an unconfined aquifer monitoring well located close by. I have reviewed the locations of the AOI and the proposed monitoring locations as shown in the GMCPs and recommend the following shallow monitoring well additions:

a. A shallow unconfined monitoring well in the vicinity of AOI 'M'. This currently appears to be reliant on monitoring of the Motutangi Shallow well that is located ~3 km south of the AOI. The AOI is immediately adjacent to Production Well Bryan Estate-2.

b. A shallow unconfined monitoring well between AOI 'P' and AOI 'J' because there is no current shallow aquifer monitoring well in the immediate area.

c. A shallow unconfined monitoring well adjacent t AOI 'G' because this site is isolated from others and there is no current shallow aquifer monitoring well in the immediate area.

38 I have Appended a Map (Appendix 1) to this evidence showing the current and proposed shallow groundwater level monitoring, overlaid with the drawdown contours and the additional wells recommended above.

Should 'Stage 1' be allowed while gathering of baseline data occurs?

39 The MWUUG GCMP specified a process for establishment initial 'interim' trigger levels - an initial 12 to 15 month period of 'baseline' monitoring. During this time, cumulative abstraction by the MWWUG consent holders was limited to less than 25 percent of the full authorised volume. In the MWWUG consents hearing, DOC initially did not consider the takes should be allowed during the collecting of baseline information. This was resolved in the Environment Court hearings process and the Court imposed an 'interim' trigger level approach during 'Stage 1'.

40 Further, for the MWWUG takes, DOC initially requested a longer record (longer than 12-15 months) in order to understand natural fluctuations and isolate for unusual climactic events/seasonable variations. After conferencing, myself and Dr Hugh Robertson agreed that a lesser period would be acceptable on the basis that a synthesised record was available to supplement a data set of only 12 months i.e. reducing the risk of potential effects on the wetland not being measured due to lack of baseline data.

41 The current proposals are largely based upon the MWUUG approach, to which DOC had the above reservations.

42 Additional issues are raised for the current grouping of takes, given that for the new proposed bores, there are existing takes occurring from the MWWUG consents during which the Applicants propose to collect baseline data (during Stage 1).

43 Potential *increases* in Stage 1 'allocations' from 25%, further undermine the intended approach of collecting baseline information in order to reflect the natural environment, during Stage 1.[11]

44 In the Middle Group, interim trigger levels must be set at the Paparore Sentinel Bore prior to exercise of consents, located within the Paparore sub-aquifer unit (APP.04361.01.01, APP.040362.01.01, APP.040363.01.01.) For the Paparore Bore, 2.2.1 states:

> "The setting of trigger level values … will be undertaken during the first implementation stage after 12 months of monitoring data has been collected and within 15 months of the date of commencement of these consents. This approach recognises that:
>
> - There is historical monitoring data available for most parameters.
> - In some areas, no baseline data has been established by the consent holder(s) or any of the key stakeholders in the area; and that
> - The manifestation of any effects from the exercising of these consents will steadily progress with time in accordance with the stages of orchard developments and the age of the crop. The scale of abstraction during the baseline data collection period (i.e. 12 months following commencement of the consent) will not vary significantly from existing environment conditions."

45 In my opinion a longer dataset would provide for a more accurate indication of natural variability, both seasonally and climatically. Ideally, this baseline period would be prior to abstraction occurring, for obvious reasons.

Non-linear rate of change

46 Uptake by consent-holders is proposed to be permitted in four stages over seven years (unless the outcome of the Staged Implementation and Monitoring Programme Review shows that there should be a delay in moving to the next stage, or that the next stage should not occur). This differs from the staging over 9 years as in the MWUUG consents. Further, as stated above, the volumes are proposed to differ, in some sub-aquifers, from the MWUUG approach that was '25%' (Stage 1), 50% (Stage 2), 75% (Stage 3) to 100% (Stage 4).

[11] For example, for the Waihopo sub-aquifer which is proposed to be managed within the Northern GMCP, it is proposed that 53% of the total allocated volume be taken at Stage 1. It is indicated that this is due to the operating requirements - Te Aupōuri Commercial Development Ltd consent application requires full amount sought at commencement – refer note on page 8 Northern GMCP: "*The allocation from these bores is intended for a mixture of pasture and market gardening which will require the full amount of allocation dependent on the areas planted in each crop."*

47 In the MWUUG consents it was proposed that Stage 1 be approximately 'standardised' as 25% and Stage 1 was for one full irrigation season.[12] The Applicants consider that this is not suitable for consent holders and propose:

a. Amending the definition of "irrigation season" (2.1.1 'End of Stage 1') from:

"1 full irrigation season following date of commencement of the consents"

To:

"A period where all or part of abstraction of the Stage 1 annual volume is taken after commencement of the consent and after which a full 12 months of baseline monitoring data has been collected."

Ms Letica's evidence at [5.15]:

"The change has been proposed in recognition that the term 'full irrigation season', unless fully defined elsewhere, would have to be defined as having to have taken water from the 'full irrigation season' as applies to that particular crop. The change recognises that all or part of the volume set out as Stage 1 allocation may be taken during this time." (emphasis)

48 I note that a careful, staged implementation would enable an assessment of potential impact of shallow groundwater decline on the Kaimaumau-Motutangi Wetland after a full season. Whereas the above proposal would provide for a non-linear rate of change, including:

a. Potentially low abstraction rates of use in a Stage 1-year, e.g. where only a portion of the allocation is taken.

b. At the other extreme, an allowance for greater take at Stages 1 and 2 etc (greater than 25%, 50% for some consent-holders).

49 In summary, the rate of change will not be standardised due to the needs to consent-holders. Acknowledging that a true baseline (no abstraction) cannot be obtained, a benefit of the staged abstraction is that it provides for a period of time over which abstraction rates are gradually ramped up. I am concerned that a consent holder could simply turn on the pump to comply with taking 'part of the abstraction' when the orchard may not even be developed. This would allow 50% of take to be used in Stage-2, reducing the usefulness of the staged approach to provide for a low use period.

[12] DOC considered that critical to enable monitoring to be reviewed after the first full irrigation season (to inform the SIMPR or Staged Implementation and monitoring Programme Review).The SIMPR is commissioned by the Regional Council and can include recommendations regarding trigger levels and whether to proceed to the next stage.

50 As discussed under the above heading, larger takes than 25% at Stage 1 also undermine the gathering of baseline data on a 'naturalised' environment, upon which to set trigger levels.

The Setting of Trigger levels

51 Trigger levels for the existing MWUUG monitoring points are proposed to be included in the AWUG 'Middle Group' GMCP.

52 DOC has experienced the following issues with the setting of these trigger levels, under the regime which allows NRC to set the trigger levels after consultation with parties to the GMCP.

53 The MWUUG GMCP approach required that TL1 be defined as two standard deviations from the baseline data. The baseline is defined as 12 months of monitoring data plus a synthesised record developed from actual long-term data of a nearby bore. TL2 was three standard deviations from the baseline.

54 Due to the delays in the installation of monitoring sites caused by the appeals to the Environment Court, the data series used to develop the interim Trigger Levels (TLs) was limited to approximately July 2019 – November 2019 (in the case of some existing NRC bores, a longer record is available). DOC therefore accepted the interim trigger level could be set on a more limited dataset[13], provided that the GMCP methodology should be followed following completion of the first 12 months of data collection (3rd Quarter 2020).

55 DOC provided comment to NRC on the Water Level Monitoring and Trigger levels for the Kaimaumau Wetland. These comments included:

a. Data indicates a positive hydraulic gradient from the shallow aquifer to the wetland in the north, and in the south the wetland appears perched above the shallow groundwater. Given this, the northern site is likely to be the most important in assessing connectivity between the wetland and the underlying groundwater.

b. The data record continues to be limited, as are the potential effects of pumping to greater volumes.

56 Given the similarity in temporal trends between the southern and northern sites over the interim data period, LWP suggested that if TL1 in the South site is breached, then the Northland Regional Council (NRC) should fly and download the northern site to check trends. This recommendation has not been supported by DOC. However, LWP recommended (letter to Northland Regional Council 30 October 2020) that this approach be adopted regardless of DOC's concerns, stating:[14]

[13] The use of synthesised data as synthesising a record correlating to only 5 month of data would be difficult.
[14] Appendix 1(f) to the Legal submissions in reply, footnote to Table 5.

> "Due to access constraints at the northern site (helicopter access only) interim wetland water level triggers are proposed for the Kaimaumau Wetland – South monitoring site only. Available data indicates temporal response at both sites are virtually identical. If TL1 is exceeded at the Kaimaumau Wetland – South monitoring site, data will be collected form the Kaimaumau Wetland – North site to confirm trigger exceedance."

57 In setting the trigger levels after the 'interim period', trigger levels were amended to reflect data collected over the 2019-20 summer, which was an extreme drought event. DOC had provided comment opposing this, and opposing the approach of setting trigger levels below observed minimum groundwater levels.[15] Council's Compliance Manager subsequently authorised the Trigger Levels recommended in the LWP report.[16]

58 I understand that it remains DOCs view that an additional monitoring location is required in the Kaimaumau wetland, based on water level analysis produced by my colleague James Blyth. This analysis shows that levels at DOC sites KM3 and KM4 responded differently to sites Kaimaumau Wetland North and South during the 2019 drought event (they did not dry out).

59 In summary, the above points highlight the risk and often unintended consequences of establishing baseline data after commencement of pumping, and only for a short period of time. Ideally, baseline data should be collected prior to commencement of pumping, and for a period that provides for an indication of natural seasonal and climate variability.

60 The above issue of short baseline period and existing pumping is further exacerbated by there being little knowledge of historic shallow groundwater levels, particularly in the Middle and Northern zones because the NRC SOE Monitoring network is sparse to non-existent in areas (refer Appendix 1).

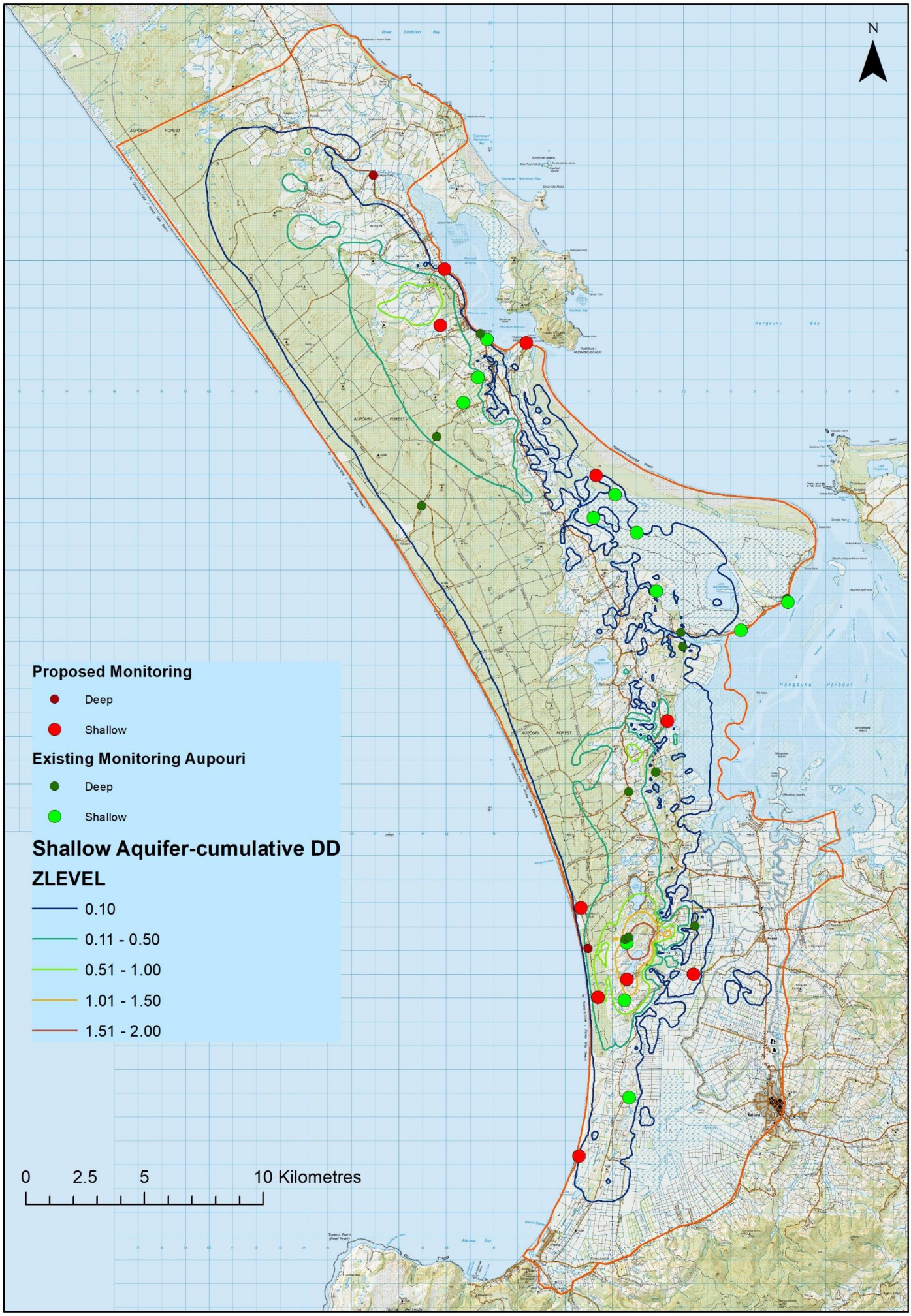
Timothy Michael Baker

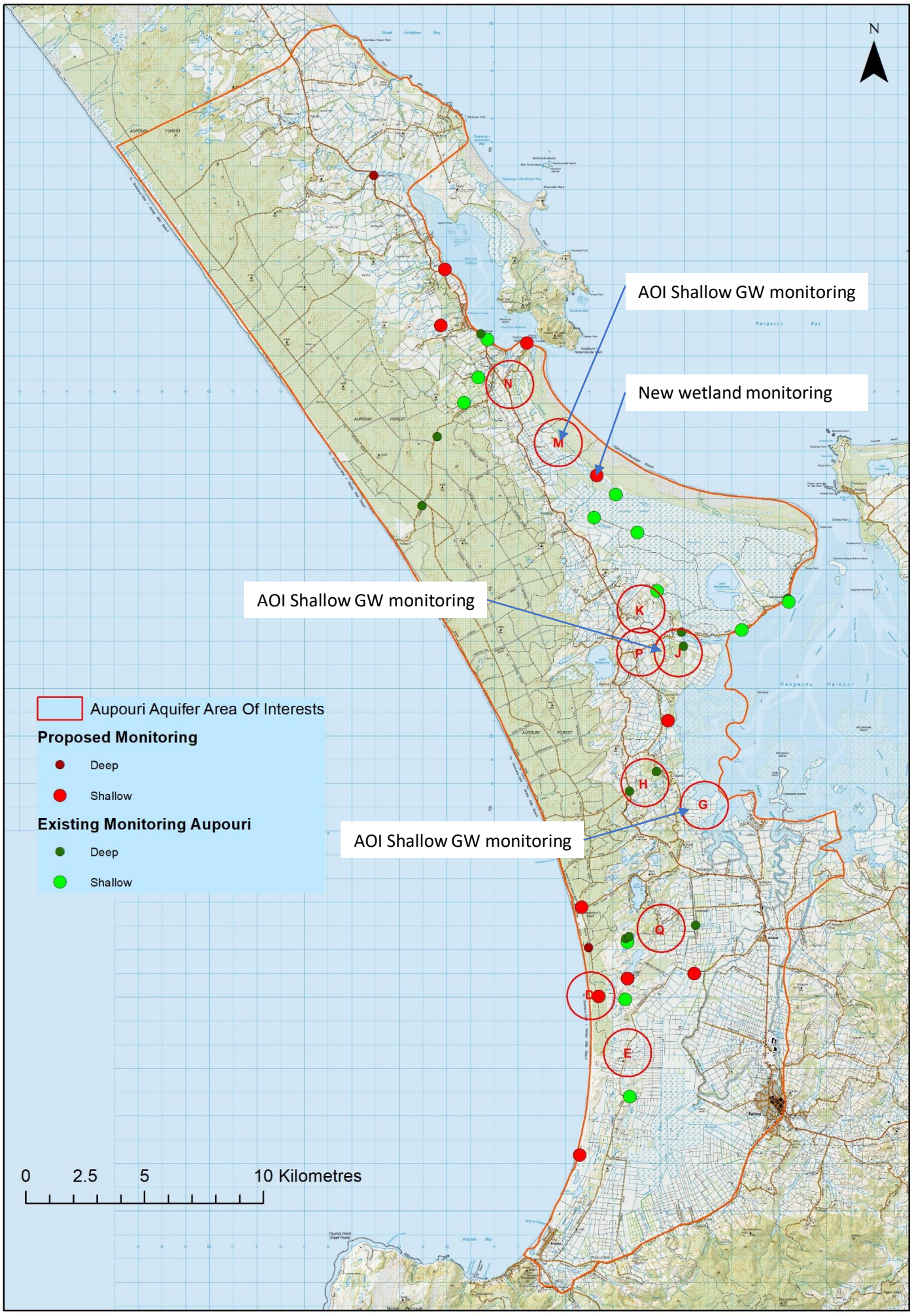
11 June 2021

[15] Refer letter dated 20 October 2020 from DOC to NRC (S Saville), attached to the Planning JWS as Appendix 2 to the *General Statement of Tom Christie and Herb Familton*.
[16] Appendix 1(f) to the Legal submissions in Reply refers.

Appendix 1 - Shallow Monitoring Map

T Baker Appendix 1: Shallow GW Monitoring Maps

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