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.

Statement of evidence of **Timothy Michael Baker** for the Director-General of Conservation

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STATEMENT OF EVIDENCE OF TIMOTHY MICHAEL BAKER

QUALIFICATIONS AND EXPERIENCE

1 My full name is Timothy Michael Baker. I hold the position of Associate Hydrogeologist at Jacobs New Zealand Ltd. I have been in this position since January 2013. I have a total of 17 years' experience in the field of hydrogeology and water resources.

2 I hold a Bachelor of Science (BSc) in Geography and Environmental Science (2000) and a Master of Science Degree with Honours in Physical Geography (2003) from Victoria University of Wellington.

3 I am also a member of the Hydrological Society of New Zealand.

4 I have acted as an Expert Witness in groundwater related consent hearings in New Zealand for the past seven years. I have provided expertise in the fields of hydrogeology, groundwater quality and environmental monitoring plan design to a range of local and central Government clients including the Department of Conservation and numerous regional councils across New Zealand.

5 Of particular relevance for this hearing was my involvement 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 (the Department) and was involved in the refinement of the Groundwater Monitoring and Contingency Plan (GMCP) established for those consents.

6 I am presenting this evidence for the Director-General of Conservation in relation to hydrogeological evidence addressing the potential effects on water resources across the Aupōuri Peninsula.

CODE OF CONDUCT

7 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.

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

9 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

SCOPE OF EVIDENCE

10 My evidence will deal with the following:

- An overview of surface waterbodies on the Aupōuri Peninsula and their likely degree of connectivity to groundwater.

- The modelled impacts on surface waterbodies and review of the assessment of effects on these waterbodies.

- Recommendations for further refinement of the assessment of effects.

OVERVIEW OF THE CONSENT APPLICATION

11 Between February 2018 and August 2019 Northland Regional Council (NRC) received 24 individual applications for new groundwater takes from the deep shell bed of the Aupōuri Aquifer. These takes are proposed for the irrigation of Avocado crops and other horticultural/cropping activities.

12 A numerical groundwater model for the Aupōuri Aquifer was developed by Williamson Water and Land Advisory (WWLA) and completed in October 2018. The model was used as the basis for the AEE section in a number of the assessments for applications that were lodged after its completion.

13 After reviewing the information presented in the individual applications, NRC issued a s92(1) request for further information. Further information was then provided by WWLA and WSP Opus.

14 A LIDAR survey commissioned by NRC in 2019 indicated that the land surface elevation data used in the 2018 groundwater model were erroneous. The improved data were used to update the model, resulting in an improved model calibration, reducing Root Mean Square Error (RMSE, a measure of the goodness of fit between modelled and observed groundwater levels) from 1.89 m to 1.31 m.

15 Revised modelling was presented in February 2020 assessing the cumulative hydrological effects of all 24 takes. NRC has broadly based their s42A assessment on this revised modelling, and the accompanying AEE, prepared by WWLA.

16 The volume of water sought by the Applicants ranges from 70 to 10,705 m3/day (4,800 to 776,000 m3/year). Cumulatively, these applications would increase the allocation of the Aupōuri aquifer from approximately 50% to over 80% (noting that sub-aquifer allocations range from 40 to 101 % based on proposed natural Resource Plan (pRNP) allocation limits).

AUPŌURI AQUIFER

17 The Aupōuri Aquifer (as modelled) covers a land area of approximately 53,500 ha extending along the whole length of Ninety Mile Beach on the west coast, and from Kōkōta (The Sandspit) to Waimanoni on the east coast. It also includes the low-lying land between Waimanoni and Ahipara.

18 The conceptual geological and hydrogeological setting of the Aupōuri Peninsula has been extensively described in the Applicants' Factual Technical Report – Modelling (WWA, 2020) using information obtained from a number of historical reports including Northland Regional Council (1991) and Lincoln Agritech (2015), in addition to more recent borehole logs and survey data associated with the AAWUG applications (data predominantly obtained by WWLA).

19 This model conceptualisation is broadly of two dominant aquifer systems comprising:

a. The upper fine-grained sand aquifer, interspersed with sporadic iron pan, peat, lignite, silt, gravel and shell beds that become more compact with distance from the coast.

b. An extensive lower layer containing coarse shell fragments commonly referred to as the shellbeds. (This is the target layer for each of the 24 takes.)

20 WWLA (2020) report that while there is no laterally continuous confining layer, the occurrence of low-permeability layers within the sand deposits (e.g. iron pan, brown (organic) sand, silt and peat) that vary in depth and thickness, collectively provide a degree of confinement to the shellbed aquifer. As a result, the shellbed is characterised as a semi-confined aquifer that exhibits varying degrees of hydraulic connection to the overlying sand deposits depending on the local geological setting (e.g. depth and lateral continuity of low permeability layers within the sand deposits at a local scale).

21 Understanding the degree of connection between the deep and shallow aquifer, and the uncertainty around the spatial changes in this connection, is important when assessing the potential effects on surface waterbodies.

22 Overall, at a regional scale (i.e. the extent of the groundwater model) the interpretation of the geology is largely consistent between reports and I concur with the general conceptualisation adopted for these applications.

SURFACE WATER FEATURES PRESENT AT AUPŌURI

23 I understand the Department administers 5244 ha of conservation land on the Aupōuri Peninsula. The Department has responsibility to manage this land for conservation purposes (as well as managing other natural and historic resources for conservation purposes). As such, the Department is concerned about potential effects on groundwater dependent features that could be present in the area such as wetlands, lakes and streams. The ecological value and importance of these features is described, in general terms, in the evidence of Dr West.

24 The general functioning of these systems with respect to hydrology is described briefly below.

25 At least 35 dune lakes exist across the modelled study area.[1] These lakes typically occur in areas of large dunes along the central spine of the Aupōuri Peninsula, west of Ngataki in the north, and between Waipārera and Sweetwater. The lakes range in size from 1 ha to 108 ha.

26 Dune lakes typically form in interdunal hollows where rainfall runoff is impeded by the topography of the dunes and drainage into the ground is restricted by accumulations of low permeability sediment. Over time, these sediments can form into iron pans. Typically, these lakes are perched above the underlying groundwater table, although they may have outflows that are associated with localised unconfined groundwater systems.

27 The Aupōuri Peninsula is home to over 40 mapped wetlands, as described in the evidence of Dr West.[2] Like dune lakes, wetlands have typically formed within interdunal depressions where, over time, the deposition of sediment fines onto the lake beds has led to the development of iron pans under acidic conditions. These pans are generally observed at the interface between the sand aquifer and the overlying peat (Hicks, 2001). These iron pans have very low permeability, and as a result the wetlands are often described as being hydraulically disconnected from the underlying groundwater system based on assumptions of laterally continuous iron pans (Hicks, 2001).

28 However, unlike the dune lakes which are found on the larger and higher dunes, wetlands are often located in lower lying coastal zones, where there is less elevation difference between the shallow unconfined groundwater system and the wetland water levels. In these areas, the potential for a wetland to have a degree of hydraulic connection to the shallow groundwater table is higher.

29 Other surface water features in the Aupōuri area include streams and farm drains. A stream can be disconnected or connected to groundwater, depending on the underlying geology. Connected streams may either gain groundwater or lose water to ground.

30 NRC provided the Department with summary maps of currently consented surface water takes in the Aupōuri Aquifer area. The maps show that there are in excess of 100 surface water takes between 0 and 250 L/s across the model domain. The mapping suggests that there are currently two streams located in the area of predicted cumulative drawdown that are over allocated. These are Waihopo Stream in the north, and a tidally affected Stream at Paparore.

31 While some potentially affected streams and drains have been identified in some of the original application documents (but not all), no updated information was presented in the revised AEE or in the s42A report about the flows and functionality of individual streams in

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[1] Brydon Hughes s42A report. Source: Freshwater Environments of New Zealand Database.

[2] D West evidence for the Director-General of Conservation at [11].

the area. In my experience, when assessing effects on streams for a groundwater resource consent it is usual to assess the effects on minimum flows, and then if affected, the effects on flow variability in individual waterbodies.

32 Mr Hughes in his s42A report states that anecdotal evidence suggests that flow in many drains is likely to be maintained by the drainage of perched groundwater tables (the reason the drains were originally installed). Other streams have been noted in WWLA (2020a) to be ephemeral. These are general statements, and while they may be correct, are not necessarily reflective of all surface waterbodies.

ASSESSMENT APPROACH

33 The individual AEEs typically used modelled data to inform the assessment of effects. This is because in most cases the applicants are yet to drill their production bores.

34 In my experience, assessments of effects are normally supported by data obtained from aquifer testing, pump testing and measurement of effects on neighbouring bores as a result of testing the proposed abstraction well.

35 For most of these applications, aquifer parameters from neighbouring wells, and existing pump testing information, has been used to inform the individual assessments.

36 This is approach is unusual, however I acknowledge that it is not without precedent. It assumes that the new wells will behave and have similar effects to existing wells. This may be the case, but it should be proven through testing of the wells post-installation.

CURENT ASSESSMENT OF SURFACE WATER CONNECTION

37 To inform the AEE, WWLA (2020) have modelled three scenarios:

a. Scenario 1 Naturalised – the calibration model with no groundwater pumping included in the simulation.

b. Scenario 2: Proposed Extraction – includes all current and proposed groundwater totalling 14.4 million m3/year.

c. Scenario 3: Low Permeability-Proposed Extraction – Groundwater extraction is the same as in Scenario 2 with horizontal hydraulic conductivity of Model Layer 2 decreased to 1x10-7 m/s to simulate a hard pan extending over the model area.

Predicted Drawdown

38 Scenario 2 is used to for the assessment of drawdown because it is the only calibrated scenario, and it represents a greater potential impact on surface water drains [and other features] compared to Scenario 3 (WWLA, 2020a).

39 The model has simulated drawdown (presented with drawdown contours) in the shallow and deep aquifers. For the purposes of my evidence, I have focussed on the shallow drawdown as this it most likely to have the potential for effects on surface water features.

40 Figure A1 (attached) shows the cumulative drawdown of all takes (both currently consented and the 24 proposed) relative to the naturalised (pre-pumping predicted drawdown).

41 Figure A2 (attached) shows the drawdown predicted as a result of just the 24 proposed takes. This drawdown is relative to the currently consented takes.

42 Figures A1 and A2 both show that drawdown is not uniform across the model domain. Drawdown is focussed near areas with more groundwater takes, and areas where more drains/streams are represented in the model. The area with the most drawdown (0.5 m or greater) are between Ngataki and Pukenui in the north, and between Ahipara and Sweetwater in the south. The cumulative drawdown is simulated at up to 2 m and the additional drawdown relative to a 'consented baseline' is up to 1 m.

Effects of Surface Water Flows

43 Surface water effects are assessed in the AEE by comparing the annual minimum flow in the model's drain cells (Scenario 2) to the naturalised annual minimum flow (Scenario 1). This indicates a decrease of 4.3% in minimum flows as a result of the take. WWLA state that this is below the NRC threshold in the proposed Regional Plan for Northland (pRPN).

44 The pNRP (Table 24, Policy H.4.1) guidance sets the minimum flows of rivers to between 80 and 100% of the 7-day mean annual low flow, depending on the rivers' management unit classification (Outstanding/Coastal/Small/Large).

45 Also noted in the AEE is that many streams are ephemeral so are exempt from minimum flow restrictions.

46 This assessment has not spatially differentiated the effects on individual waterways, rather it is a global water balance approach. It is feasible that the 4% reductions in minimum flow predicted could be greater in some waterbodies, and lower in others depending where the waterbody is located relative to predicted drawdown and geological conditions. It is difficult to assess the effects at an individual water body scale using this approach.

47 In my experience, when preparing an AEE for a groundwater take, the Applicant would clearly identify individual waterbodies in the area around the take where drawdown might be expected. This has been done in some of the individual applications, however the assessments pre-date the model revision in 2020 and do not appear to have been updated.

48 Other evidence of groundwater contribution to streams does exist, but the source of the groundwater (shallow/deep) has not been identified. Radon samples were collected in accordance with the MWWUG GMCP conditions in 2019. The results from this indicate that there is groundwater contribution at site 'Salles Downstream' and 'Okohine Stream'. The Radon concentrations at these sites were higher than other drain and wetland results, and not reflective of background conditions. This indicates that it is feasible that streams in the modelled area could be affected by groundwater takes and therefore require identification.

49 Overall, further work is needed to explain the variability (if any) of flow reductions across the modelled area and to demonstrate the location of, or absence of, water bodies that may be linked to groundwater.

Effects on Wetlands

50 The assessment of effects on wetlands is addressed by the Applicant using an the analysis of predicted effects on drain flows(discussed in my paragraphs 38-41 above). Overall, the AEE concludes that that as the predicted reduction in annual minimum flow is low (4.3%) then the effects on wetlands would be expected to be less than minor. As discussed above, further explanation of the spatial variability in flow reduction is required in order to be able to develop an informed position on this conclusion.

51 The effects on wetlands are expanded on in further detail by Brydon Hughes in the s42A report. In his report, Mr Hughes presents an analysis of water level data collected in and around the Kaimaumau wetland over the past year as part of the MWWUG GMCP.

52 Mr Hughes concludes that although the monitoring period is short (particularly for the MWWUG sites), based on available data there are no clear indications of any substantial hydraulic connection between the Kaimaumau Wetland and the underlying Aupōuri Aquifer (based on data from the MWWUG monitoring sites).

53 Mr Hughes assessment does not address any other wetlands in the modelled area. Over 40 other wetlands mapped by the Department are presented on Figure 1 of Mr West's Evidence.

54 A further assessment of the Kaimaumau GMCP data has been completed by WWLA (2020c) using a modelled lake water balance approach. The conclusions drawn in WWLA (2020c) are substantially the same as Mr Hughes. The evidence of Mr Blyth for the Department addresses this report and raises some questions about the modelling approach.

55 I note that the conclusions regarding groundwater connectivity are based on only 9 months of monitoring data. The MWWUG GMCP is a long-term adaptive monitoring programme designed to measure the effects of a Staged Implementation of the groundwater abstractions over a period of 9 years. Given the low abstraction

rates of use in this Stage 1-year potential effects may not have propagated into the wetland yet.

Effects on Dune Lakes

56 The Applicant does not implicitly address the effects on dune lakes in the revised assessment. Rather it would appear that based on the assumption that all dune lakes are disconnected from groundwater, no assessment has been carried out. This requires clarification.

57 It is noted that in some of the original applications, effects on individual water bodies were assessed. One example is the Elbury Holdings Limited application (August 2018) in which up to 0.105 m drawdown on Lake Rotoroa is predicted. A revised assessment based on the 2019 model updates has not been presented.

58 The effects on dune lakes are covered in further detail Brydon Hughes in the s42A report. In his report, Mr Hughes compares the bed elevation of recorded dune lakes to the modelled shallow groundwater surface. In general, most lakes are several metres above the water table suggesting they are unlikely to be affected by changes in level resulting from the proposed abstraction. However, there are some lakes (FENZ ID 23660, 23671, 24454, 24459, 24460) that have a difference of less than 2 m. The location of these lakes are plotted on Figures A1 and A2.

59 The predicted drawdown in the shallow aquifer beneath these lakes is 0.1 m. Mr Hughes assesses this as unlikely to have any significant effect on these lakes. In my opinion further information on the values and functioning of these identified lakes is warranted to determine if they should be included in a GMCP. Lake 23671 appears to be connected to a stream or drain and is close to two proposed wells.

60 A number of dune lakes are located in and around the Sweetwater area, where the greatest drawdowns in the shallow aquifer are located. Monitoring of shallow and deep groundwater, lake and wetland water levels has been undertaken as part of the existing Sweetwater Farms Consent since 2013. To date, no discernible effects on shallow groundwater/wetland levels have been observed as a result of the consented pumping from the shellbed aquifer, although it is understood that only a portion of the 180 L/s allocation for the station is being used.

61 Continued monitoring in and around the Sweetwater area is warranted given the increase in abstraction volumes and locations.

PROPOSED MONITORING

62 At the time of preparing this evidence the Department's technical specialists are still completing a review of the GMCPs.

63 From a hydrological perspective, I believe it is important that the GMCPs provide for a robust analysis and documentation of

baseline conditions. This includes the identification of groundwater dependent features that may not have been surveyed to date current groundwater, lake and stream hydrology.

CONCLUSIONS

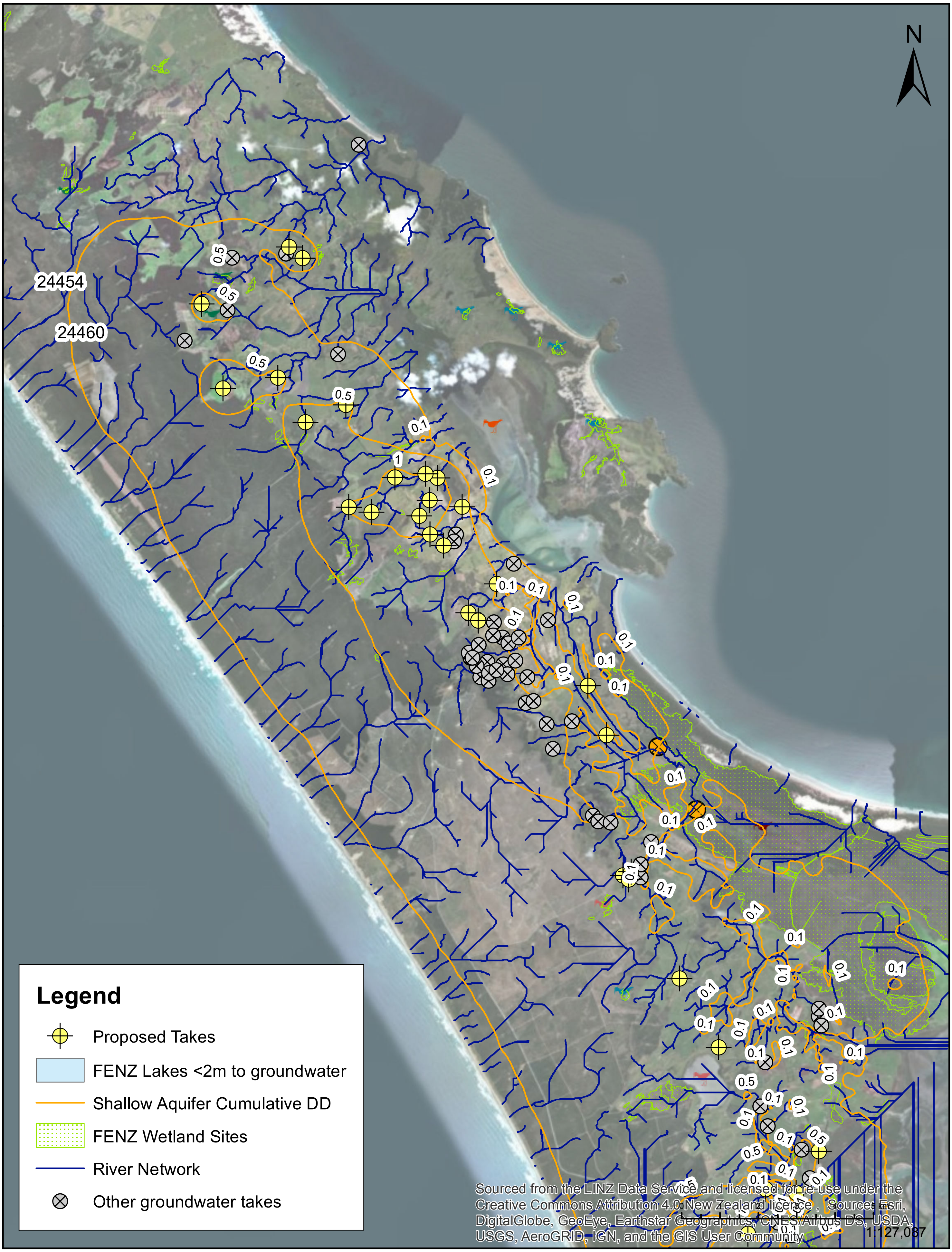
64 A regional scale model developed by WWLA has been used to assess the effects of the 24 proposed abstractions from the Aupōuri Aquifer. New LIDAR data allowed this model to be revised in late 2019 that has resulted in an improved calibration. The model appears to be a useful tool for assessing effects (drawdown, saline intrusion risk) and groundwater allocation at a regional scale. A peer review of the model was done for NRC by Mr Brydon Hughes of LWP and has concluded the same.

65 The revised model has been used to assess the impacts on surface flows at a regional scale and predicts an overall reduction of 4.3% in annual minimum flows. However, the assessment does not apportion the reduction to specific waterbodies, nor does it account for the likely spatial variability in the predicted reduction (some areas may have higher reductions, some lower).

66 Some (11 out of 24) of the individual applications have identified drains, streams or surface water bodies that are close to each of the proposed takes. An assessment of impact on these identified waterbodies is in some cases presented but is based on modelling data from the original model, not the revised model. It is unclear whether the conclusions presented in the 2018/early 2019 applications is still relevant. Further and updated information on the effects on individual water bodies is required.

67 The GMCPs proposed are useful plans, and the staged abstraction approach is strongly supported. This staged approach needs to be informed by useful and relevant data. At this stage, it is not clear whether there are additional surface water bodies that should be added to the plans.

68 The AEEs presented for most applications are based on modelled data and have not included data obtained from aquifer and pump testing of the proposed abstraction bore. This is because in most cases the bores are yet to be drilled. The assessment assumes that all of the new bores will have aquifer properties similar to existing bores. To ensure that the AEE and assumptions in the modelling regarding pumping response is accurate, I recommend a condition requiring aquifer testing be included in any consent granted. This testing should demonstrate that the assessments presented in these applications are still valid, prior to take(s) commencing.



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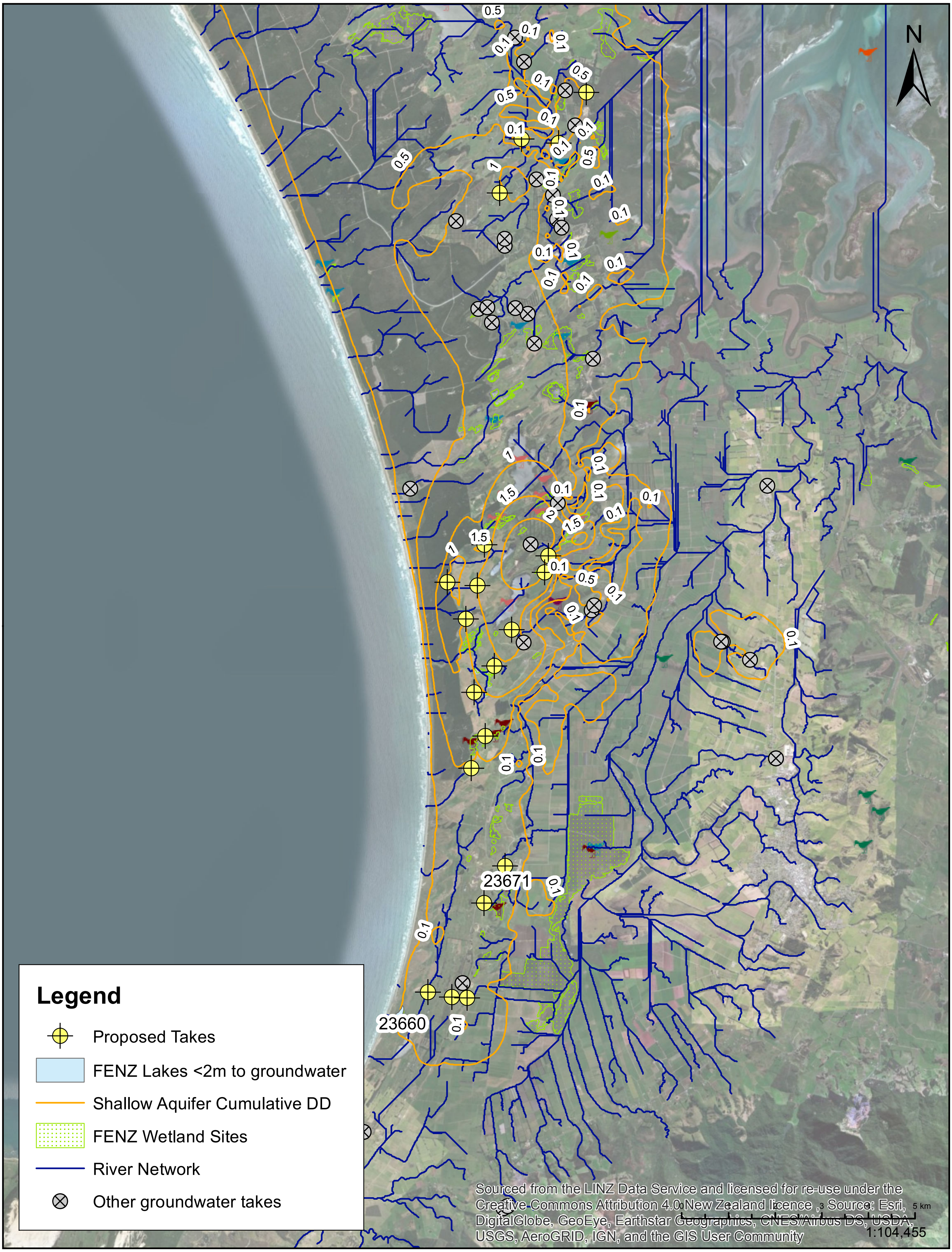
Aupouri Cumulative Drawdown (north)

JACOBS

Carlaw Park
12-16 Nicholls Lane
Parnell, Auckland
Tel +64 9 928 5500
Fax +64 9 928 5501

FIGURE A1

Date: 21/08/2020



Aupouri Cumulative Drawdown (south)

JACOBS®

Carlaw Park
12-16 Nicholls Lane
Parnell, Auckland
Tel +64 9 928 5500
Fax +64 9 928 5501

FIGURE A2

Date: 21/08/2020

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