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 **David William West** for the Director-General of Conservation

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STATEMENT OF EVIDENCE OF DAVID WILLIAM WEST

QUALIFICATIONS AND EXPERIENCE

1 My full name is **David William West**. I am a Freshwater Science Advisor Freshwater based in the Whangārei office of the Department Of Conservation.

2 I hold a Bachelor of Science (BSc), Master of Science Degree with Honours in Freshwater Ecology (1989) and a PhD Freshwater Ecotoxicology (2007) from the University of Waikato.

3 I have over 30 years experience in freshwater ecology and have undertaken assessments, research and monitoring in streams, rivers, lakes and wetlands throughout New Zealand. I led a monitoring pilot of Northland streams, rivers, wetlands and lakes in 2014. Since 2014 I have carried out monitoring of the Kaimaumau-Motutangi wetland and carried out restoration and assessments of other Northland freshwaters. I am familiar with other streams, rivers, wetlands and lakes in the area to which these proceedings relate.

4 I am presenting this evidence for the Director-General of Conservation (DoC) in relation to freshwater ecological evidence addressing the potential effects on freshwater ecosystems and species across the Aupōuri Aquifer.

CODE OF CONDUCT

5 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.

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

7 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

8 My evidence will cover the following:

- Wetlands.
- Ephemeral wetlands.
- Springs.

- Streams.
- Lakes & ponds.
- Threatened freshwater species

Wetlands

9 Within the area affected by these applications the Kaimaumau-Motutangi wetland complex is the largest (2931 ha) and is the largest wetland in the Northland region. It contains a high diversity of coastal and inland wetlands and is a nationally significant site for the protection of New Zealand's natural heritage.

10 Kaimaumau-Motutangi was the second most significant wetland in Northland in a 2011 assessment by Wildland Consultants (2011) for the Northland Regional Council.

11 There are over 40 other wetlands mapped in the affected area in FENZ (Ausseil et al 2008) (Figure 1.). It is unknown if these are a complete extent. Later and more detailed work in other regions has revealed that FENZ wetland mapping underestimates wetland extent and current wetland extent can be reduced by wetland drainage-removal (Robertson et al 2018). FENZ mapping also cannot consistently delineate seasonally dependent wetlands i.e. ephemeral wetlands (Ausseil et al 2011).

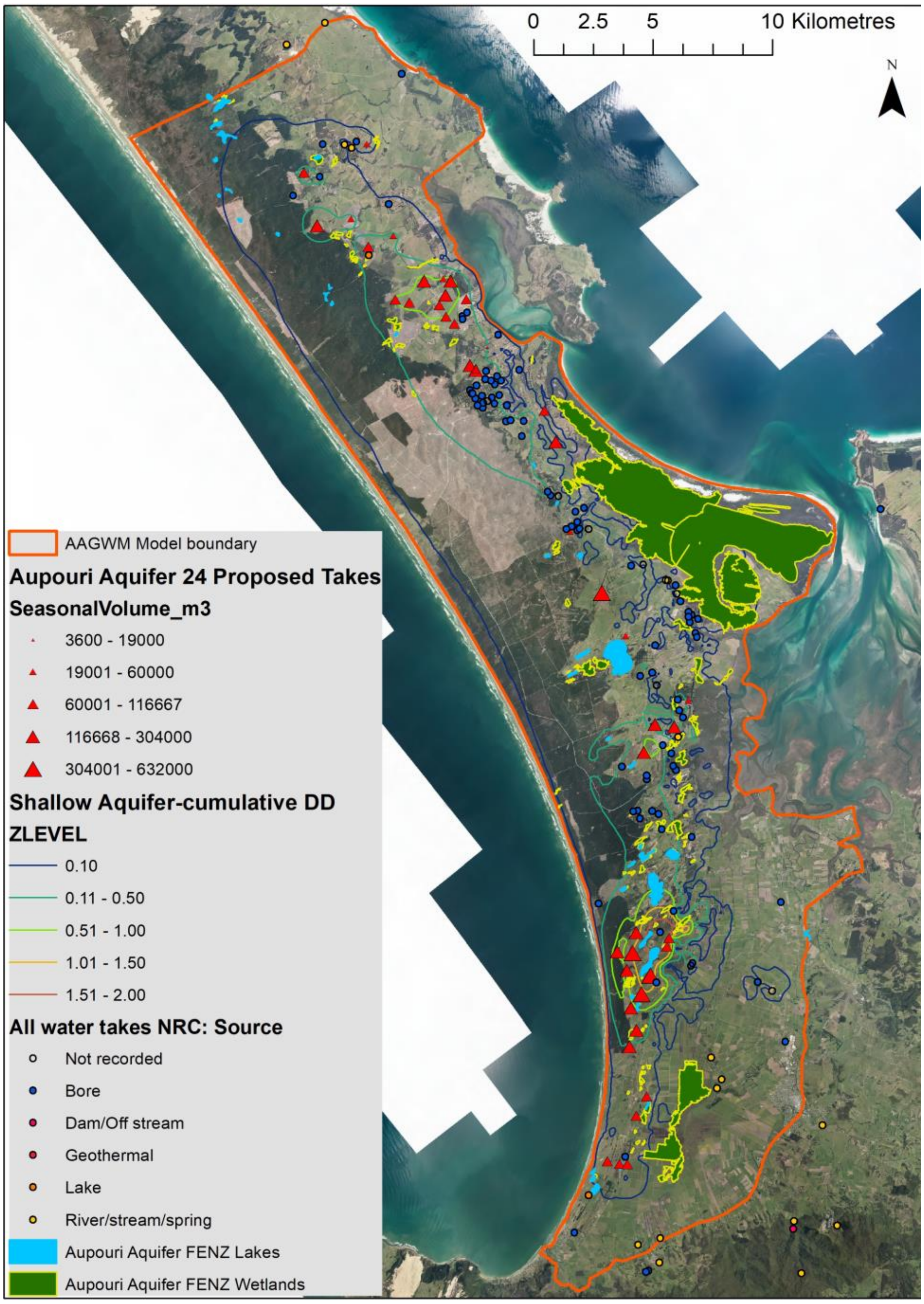

Figure 1. Wetlands and lakes mapped in the aquifer area in relation to take locations, volumes and predicted groundwater drawdown levels.

12 The primary driver of wetland ecosystem function and composition is hydrological regime (Mitsch and Gosselink 2007). Alterations to wetland water levels can lead to irreversible changes in ecohydrological functioning and cause the loss of indigenous ecosystems and species (e.g. Blyth 2011).

13 As seen in the now dryer parts of the Kaimaumau-Motutangi, declining water levels due to drainage, water diversion or groundwater extraction can lead to increased dominance of dryland species (i.e. invasive fire prone wattle (Boffa Miskell 2018), loss of habitat for threatened species and a reduction in wetland condition and extent. The potential increase in exchange between

groundwater and surface water due to extensive drainage undertaken in preparation for planting avocados (Figure 2.) also increases risks that alterations in groundwater levels can influence surface water levels.

14 Wetlands provide provisioning, regulating, habitat, and cultural ecosystem services that all are reduced with reductions in natural water levels and frequency. Drainage particularly reduces carbon stored in peat wetlands (Clarkson et al 2013).

15 I attach as Appendix 1 to my evidence, the Statement of Evidence of my colleague Dr Robertson for the Motutangi-Waiharara Water Users Group (MWWUG) resource consent applications. Dr Robertson's evidence further sets out the ecological significance of the Kaimaumau-Motutangi wetland, including by reference to the significance criteria in Appendix 5 of the Northland Regional Policy Statement. I agree with Dr Robertson's statements.

16 The scope of the current applications are more widely dispersed. A large number of (often unmapped) waterbodies, in addition to the Kaimaumau-Motutangi wetland, could potentially be affected. Increasingly dry summers and droughts, forecast dry periods and intensification of landuse in the Region, add to concern expressed in my evidence (supported by Mr Baker's evidence) that the potential adverse effects on these waterbodies have not been adequately assessed.

17 Williamson Water & Land Advisory Limited (WWLA) have provided an 'overarching' AEE. Other subregion AEEs have been provided, such as WSP Opus AEE for Te Aupōuri Commercial Development Ltd. The Te Aupōuri AEE has some assessment of specific surface waterbodies that could be affected by takes especially stream flows. However it is unclear if WSP-Opus has used the updated WWLA groundwater model in assessments, referred to by Mr Baker.[1] It is my understanding that they did not. Despite this, the overarching WWLA AEE states the proposed groundwater takes "*do not pose significant risk in terms of surface water depletion*".[2]

[1] Revised modelling presented in February 2020.
[2] WWLA AEE page 37 last paragraph.

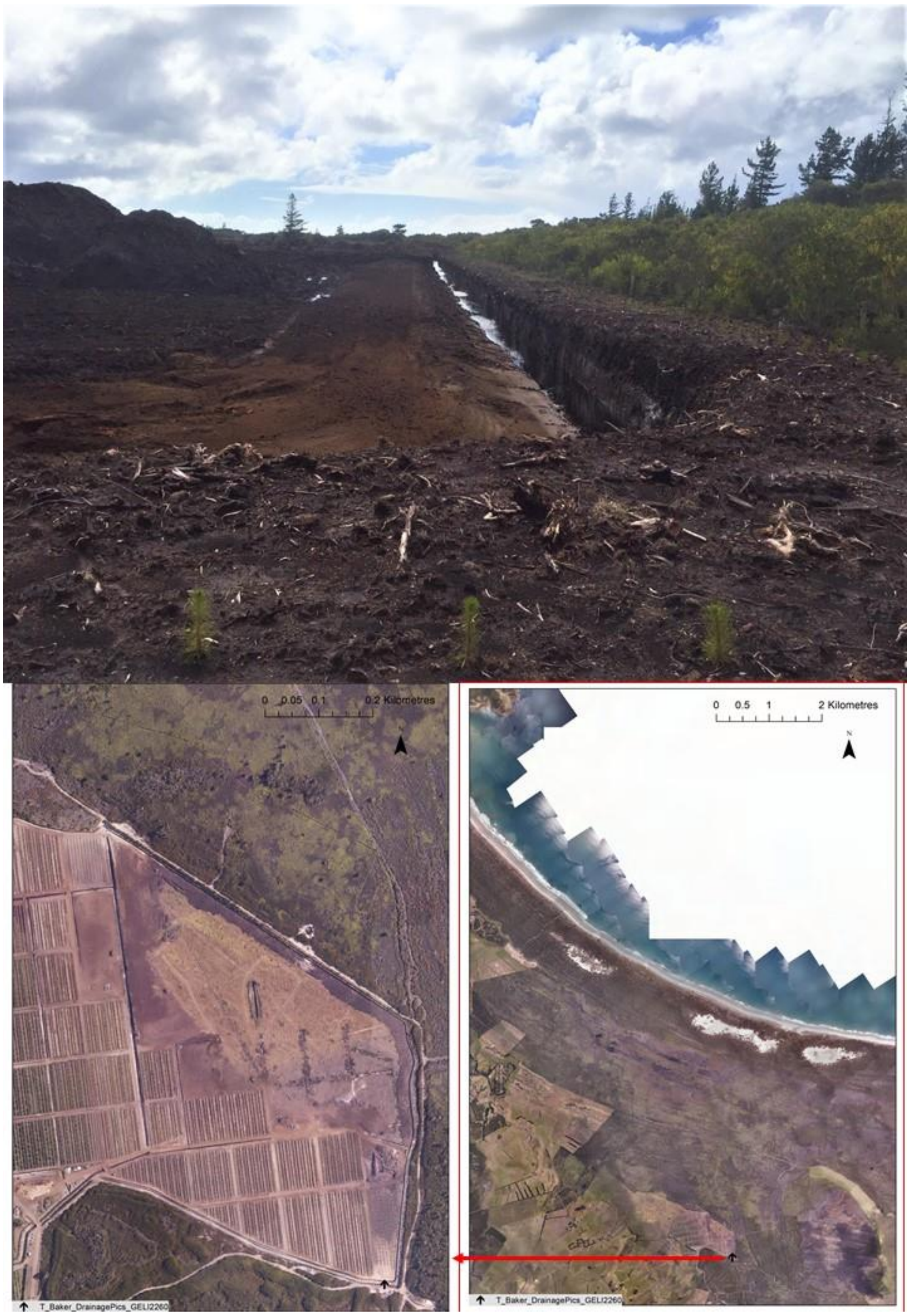

Figure 2. A 2018 example of extensive development and drainage already occurring in the aquifer area adjacent to the highly significant Kaimaumau-Motutangi wetland.

Ephemeral wetlands and turfs

18 Currently unassessed by the Applicants and largely unmapped are those wetlands that are visibly wet for only part of the year. Some types of ephemeral wetlands and turfs such as dune slacks, or depressions can be fed by groundwater from a considerable distance inland (Johnson & Rogers 2003). These types of wetlands will occur on coastal margins of the Aupōuri aquifer and could be at higher risk of impact from reductions in groundwater levels. The

flora and fauna of these unique and vulnerable ecosystems are adapted to the fluctuation in hydrology of each particular location (below I refer in particular to the Black mudfish a species At Risk, Dunn et al 2018)

19 In my opinion it is inappropriate to dismiss any effects on these types of waterbodies and species based on coarse regional predictions of groundwater level changes.

Springs

20 As with ephemeral wetlands springs, except large ones, are rarely mapped or assessed in New Zealand. Being at the interface of three distinct ecosystems, groundwater, surface water and terrestrial; alterations of all three can have significant effects on spring habitat and integrity (Barquin & Scarsbrook 2007).

21 The purity of the water from springs make them immensely important for drinking water, wai tapu and unique fauna. High levels of local endemism indicate that springs are important centres of genetic diversity and radiation for poorly-dispersing taxa (Scarsbrook et al 2007).

22 As groundwater dependant ecosystems springs may be the first places where any effects of groundwater level reductions will be seen.

23 The applications do not consider or map springs as sensitive receiving waterbodies. Groundwater springs and seepages were recorded in the Kaimaumau wetland (Hicks et al 2001) demonstrating that upwards movement of groundwater through gaps in successive hardpans is possible. These upwellings-springs can supplement even predominately surface water features.

Streams

24 Aupōuri Stream and river reaches mapped in a Digital River Network sourced from NIWA in 2017 show that over half of the reaches are 1st order i.e. small with correspondingly small discharges. Instream function and ecosystem health may be impacted in these small (and often ephemeral streams) with even small reductions in water supply. Small streams have a critical influence on downstream portions of the river network by altering sediment and nutrients flows, providing habitat and refuge for diverse aquatic and riparian organisms and creating migration corridors (Wohl 2017).

25 Summer low flows in streams are often maintained by groundwater inputs, so a larger than expected effect could be seen especially in summer drought conditions such as Northland has been experiencing.

26 A few applications for example WSP Opus AEE for Te Aupōuri Commercial Development Ltd and Lincoln Agritech for P & G Enterprises attempt to assess possible reductions in stream flow

due to groundwater drawdown and effects on minimum flow. Mr Baker considers the adequacy of these assessments in his paragraph [47].

Lakes and ponds

27 Thirty eight Freshwater Ecosystems of New Zealand (FENZ) lakes fall within the Aupōuri Aquifer Groundwater Model boundary. The 34 classified are aeolian or dune lakes.

28 Northland is renowned for its dune lakes and NRC has put extensive effort into monitoring and identifying priority management actions for them (Champion 2012, Champion 2014).

29 The Sweetwater lakes have been identified as Outstanding Natural Features in the Proposed Regional Plan and Lake Rotoroa is in the top 10% of Northland Biodiversity Ranking - Lake Ranks.

30 Warm lowland lakes such as dune lakes are generally the most impacted by land intensification but due historically less intensive development, Northland Dune Lakes represent a large proportion of good water quality New Zealand lakes (Champion 2012). The three key threats listed by Champion 2012 are biosecurity, eutrophication and water level change.

31 It is concerning that one of Northland’s most significant dune lakes Lake Rotoroa is in the middle of the highest predicted drawn-down areas.

Threatened species

32 Almost all of the remaining northernmost populations of the At Risk (Dunn et al 2018) Black mudfish occur within the bounds of the Aupōuri aquifer.

33 Mudfish are adapted to occupy ephemeral habitats that dry out during summer (Ling & Gleeson 2001). If those habitats disappear and there are not higher water level events in winter-spring that fish can use to colonise new ephemeral habitats then populations will be lost.

34 The At Risk fish, inanga, longfin eel (Tuna) and giant bully also occur throughout Aupōuri streams, lakes and wetlands (NZFFD accessed 27 March 2020).

35 Many threatened plants occur in turf communities and even small alterations in drying and wetting regimes can change whole turf communities (Johnson & Rogers 2003). Wetland monitoring undertaken by Wildlands[3] identified threatened plants (de Lange et al 2018) including, *Lycopodiella serpentina* (Threatened-Nationally Vulnerable) and*Fimbristylis velata* (Threatened-Naturally Uncommon).

[3] Wildlands Contract Report Number 5289 attached to the evidence of Mr Williamson pages 49-124.

CONCLUSION

36 As I list above there are several ecosystems and species that rely on ephemeral conditions or groundwater supplements. The effects on these sensitive ecosystems and species have not been mapped in most of the application AEEs.

37 While a low average reduction in surface water flows is predicted across the aquifer, as stated in the evidence of Mr Baker, local reductions that take into account updated (February 2020) modelling have largely been omitted. There may be larger effects in some areas such as Sweetwater that have large predicted groundwater drawdown and may contain small sensitive unmapped freshwater bodies and significant dune lakes.

38 The Northland Regional Council has new information from LiDAR and mapping of wetness that could be used to map the sensitive ecosystems listed above. Once those places are mapped effects on them can be assessed. At a minimum I consider monitoring must be put in place to see if reductions in groundwater manifest as impacts in these places and for resident species.

39 It is difficult to provide complete comment on the adaptive management regime proposed, until better mapping of surface waters I outline above is undertaken.

40 In respect of the proposal to incorporate the Northern and South-Western group of takes within the MWWUG GMCP, and the proposals for some amendments to that GMCP outlined in the evidence of M Letica, DOC has not been provided with formal notice in writing by NRC that it wishes to amend the GMCP in that respect. If that process were to be undertaken, the Director-General of Conservation would have 20 working days to provide a response and 30 working days to provide a report detailing any reasons for disagreement with the change.

Appendix 1: Evidence of Dr H Robertson for DOC dated 23 November 2018 given in Environment Court proceedings ENV-2018-AKL-000121 & 000126

References

Ausseil AG, Gerbeaux P, Chadderton WL, Stephens T, Brown D, Leathwick J. 2008. Wetland ecosystems of national importance for biodiversity. Landcare Research Contract Report LC0708/158. Prepared for Department of Conservation, Wellington, NZ

Ausseil, A.-G. E., Chadderton, W., Gerbeaux, P., Stephens, R. T., & Leathwick, J. R. 2011. Applying systematic conservation planning principles to palustrine and inland saline wetlands of New Zealand. Freshwater Biology, 56(1), 142-161.

Barquín, J., & Scarsbrook, M. 2007. Management and conservation strategies for coldwater springs. Aquatic Conservation: Marine and Freshwater Ecosystems, 18(5), 580-591. doi:10.1002/aqc.884

Blyth J.M. 2011. Ecohydrological characterisation of Whangamarino wetland. MSc dissertation, University of Waikato, Hamilton

Boffa Miskell Limited. (2018). Kaimaumau-Motutangi Wetland Mapping: Methods, Wetland and Vegetation Descriptions and Constraints. 46p.

Champion, P. 2012. Northland Lakes Strategy. NIWA Client Report No: HAM2012-121.

Champion, P. 2014. Northland Lakes Strategy Part II, update and implementation strategy NIWA Client Report: HAM2014-038.

Clarkson, B. R., Ausseil, A.-G. E., & Gerbeaux, P. 2013. Wetland Ecosystem Services. In J. Dymond (Ed.), Economic value of landbased ecosystems in New Zealand: Patterson and Cole.

de Lange, P. J., Rolfe, J., Barkla, J., Courtney, S. P., Champion, P. D., Perrie, L. R., . . . Ladley, K. 2018. Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series no. 22. http://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs22entire.pdf

Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., . . . Rolfe, J. R. 2018. Conservation status of New Zealand freshwater fishes, 2017 New Zealand Threat Classification Series no. 24. https://www.doc.govt.nz/Documents/science-and-technical/nztcs24entire.pdf

Hicks, D. L., Campbell, J., & Atkinson, I. A. E. 2001. Options for managing the Kaimaumau Wetland, Northland, New Zealand. Science for conservation 230. Wellington, N.Z., Department of Conservation: 88p. no. 155. https://www.doc.govt.nz/globalassets/documents/science-and-technical/SFC155.pdf

Johnson, P., & Rogers, G. 2003. Ephemeral wetlands and their turfs in New Zealand Science for conservation 230. Wellington, N.Z., Department of Conservation: 88p.

Ling, N., & Gleeson, D. M. 2001. A new species of mudfish, Neochanna (Teleostei: Galaxiidae), from northern New Zealand. Journal of the

Royal Society of New Zealand, 31(2), 385-392.
doi:10.1080/03014223.2001.9517660

Mitsch WJ, Gosselink JG. 2007. Wetlands. Hoboken. ed: John Wiley & Sons, Inc.

Robertson, H. A., Ausseil, A-G, Rance, B., Betts, H., Pomeroy, E. 2018. Loss of wetlands since 1990 in Southland, New Zealand. New Zealand Journal of Ecology 43(1): 3355.

Scarsbrook, M., Barquín, J, Gray, Duncan. New Zealand coldwater springs and their biodiversity. Science for conservation 278. Wellington, N.Z., Department of Conservation: 72p.

Wildland Consultants 2011. Ranking of Top Wetlands in the Northland Region, Stage 4 Ranking of 304 wetlands. Contract report No 2489 for Northland Regional Council.

Wohl, E. 2017. The significance of small streams. Frontiers of Earth Science, 11(3), 447-456. doi:10.1007/s11707-017-0647-y.

BEFORE THE ENVIRONMENT COURT **ENV-2018-AKL-000121 & 000126**

IN THE MATTER OF the Resource Management Act 1991

And

IN THE MATTER OF an appeal under section 120 of the Act

BETWEEN A BURGOYNE / TE TAUMATUA O NGATI KURI RESEARCH UNIT (ENV-2018-AKL-000121)

DIRECTOR-GENERAL OF CONSERVATION (ENV-2018-AKL-000126)

Appellants

AND NORTHLAND REGIONAL COUNCIL

Respondent

AND MOTUTANGI-WAIHARARA WATER USERS GROUP

Applicant

STATEMENT OF EVIDENCE OF HUGH ALLISTER ROBERTSON ON BEHALF OF THE DIRECTOR-GENERAL OF CONSERVATION

23 November 2018

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1. INTRODUCTION

1.1 My name is Hugh Allister Robertson. I hold the position of Principal Science Advisor-Freshwater in the Aquatic Unit of the Department of Conservation. I have been in this position since October 2008. I am the scientific lead for the Department's Arawai Kākāriki wetland restoration programme.

1.2 I have a PhD in wetland ecology from Deakin University, Melbourne, Australia (2007), and a BSc Hons (first class) from Otago University (1999).

1.3 My PhD thesis was entitled 'Environmental Water Requirements of Isolated Floodplain Wetlands' and investigated the consequences of altered hydrology on the ecological functioning of important wetland systems.

1.4 I have 18 years of experience in the field of freshwater ecology in New Zealand and Australia, in both a research and wetland management capacity. This includes expert knowledge of the ecohydrological functioning of a number of nationally significant wetlands in New Zealand.

1.5 Prior to working for the Department of Conservation I worked for the NSW Department of Environment and Climate Change (2006-2008) where I was responsible for providing technical input to catchment water sharing plans. I worked for the regional government in South Australia (2005-2006) determining the environmental water requirements (water allocation) to maintain the ecological values of wetlands.

1.6 I was appointed New Zealand's National Science & Technical (STRP) Focal Point for the Ramsar Convention on Wetlands in 2008. In this role I provide scientific advice to the NZ Government on the status of wetlands of international importance and the sustainable management of wetlands.

1.7 I am a member of the New Zealand Freshwater Sciences Society and the Society of Wetland Scientists.

1.8 I am presenting this evidence for the Director-General of Conservation in relation to: (1) the potential ecological effects on the Kaimaumau wetland as a result of groundwater extraction and (2) the technical adequacy of the revised Groundwater and Monitoring Contingency Plan (that resulted from expert caucusing) and draft consent conditions to address these effects.

1.9 I have visited Kaimaumau-Motutangi Wetland on several occasions over the past two years. The purpose of these visits included: to undertake detailed helicopter-based wetland habitat and vegetation mapping, field work to maintain hydrological monitoring equipment, and to assess significant indigenous vegetation and habitats.

2. CODE OF CONDUCT

2.1 I confirm that I have read the code of conduct for expert witnesses as contained in the Environment Court's Practice Note 2014. I have complied with the practice note when preparing my written statement of evidence, and will do so when I give oral evidence before the Court.

2.2 The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence to follow.

2.3 Unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

3. SCOPE

3.1 I have been asked to provide evidence in relation to the following matters:

(a) the ecological / biodiversity values present at Kaimaumau-Motutangi wetland and the ecological significance of the wetland

(b) the potential for groundwater to be contributing to the surface water levels in the wetland and the anticipated adverse effects of a reduction in water level on the wetland

(c) the extent that the revised Groundwater and Monitoring Contingency Plan (GMCP), and associated consent conditions, adequately address concerns in relation to potential adverse effects on Kaimaumau-Motutangi

3.2 The key documents I have used in preparing this evidence are:

(a) Agreed Statement of Facts (ASF) agreed to by NRC, MWWUG and DOC.

(b) The Joint Witness Statement (JWS) including a revised GMCP agreed by all technical experts involved in conferencing on 20 September 2018

(c) Consent conditions presented in the Hearing Decision Report

(d) Appendix 5 of the Northland Regional Policy Statement (*Areas of significant indigenous vegetation and significant habitats of indigenous fauna in terrestrial, freshwater and marine environments*)

(e) New Zealand Coastal Policy Statement 2010

3.3 I have relied on the evidence of Mr Tim Baker in relation to the potential connectivity of the deep and shallow aquifer at Kaimaumau-Motutangi wetland.

3.4 I have relied on parts of Mr Jon Williamson's evidence, in particular, the new survey (mapping) of the extent of low-lying wetland habitat in relation to groundwater levels.

4. EXECUTIVE SUMMARY

4.1 Kaimaumau-Motutangi wetland is the largest (2931 ha) wetland in the Northland region. It contains a high diversity of coastal and inland wetlands and is a nationally significant site for the protection of New Zealand's natural heritage.

4.2 The principal matter of my technical concern was that the Groundwater Monitoring and Continency Plan (GMCP) presented in the Hearing Decision Report was inadequate. Specifically, the GMCP did not provide sufficient monitoring or investigation to ensure the consented groundwater takes had no more than minor adverse effects on the hydrological functioning of Kaimaumau-Motutangi wetland.

4.3 There is a critical area of the Kaimaumau-Motutangi wetland that is at higher risk of being impacted by groundwater extraction. This area is low-lying (closer to groundwater) and is characterised by a very stable wetland water level (typically 10-15cm variation) that indicates a continuous source of surface-water or groundwater. No monitoring or investigation was proposed for this ecologically significant wetland area in the Hearing Decision Report.

4.4 Following technical expert conferencing on 20 September 2018, the parties continued to liaise in an attempt to reach agreement on outstanding matters. As a result, the GMCP has been revised to provide further monitoring and investigation within the Kaimaumau-Motutangi wetland. The monitoring is focused on the wetland area considered most at risk of being impacted by groundwater extraction.

4.5 Subject to two clarifications, I am comfortable that the revised GMCP will provide monitoring, reporting and contingency actions to adequately protect the significant values of Kaimaumau wetland. I consider that some clarification is necessary to avoid confusion of (1) the specific analysis and reporting requirements under 3.2.3, and (2) more specific definition of what is meant by a reduction of 50% water take under 4.2 of the revised GMCP.

5. ECOLOGICAL SIGNIFICANCE OF KAIMAUMAU-MOTUTANGI WETLAND

5.1 Kaimaumau-Motutangi wetland is the largest wetland in the Northland region with a wetland area of 2931 ha, based on the Freshwaters of New Zealand (FENZ) geospatial data on the extent of wetlands (Figure 1). I have personally visited Kaimaumau-Motutangi Wetland on several occasions, including during helicopter-based aerial mapping, and I consider the FENZ mapping to be a good representation of wetland extent.

5.2 In my opinion previous reports that the wetland complex is only ~1850 ha (e.g. Wildland Consultants 2011) are incorrect.

Figure 1. Wetland extent at Kaimaumau-Motutangi. Taken from the Freshwaters of New Zealand (FENZ) national geospatial data on the extent of wetlands.

5.3 A significant portion of the wetland complex is administered by the Department of Conservation (DOC) as public conservation land (Figure 2) as Scientific Reserve (955 ha) and Conservation Area (1503 ha). The remaining wetland is predominately located with Māori owned land.

5.4 Kaimaumau-Motutangi wetland contains extensive areas of significant indigenous vegetation and habitat and is nationally and regionally significant for the conservation of natural heritage (DOC 2014). The ecological significance of wetland is high considering its large size (2931 ha) and given that in a national context only 10% of historical wetlands remain in New Zealand and in Northland only 5% of the historical extent of wetlands remain (Ausseil et al. 2008).

Figure 2. Extent of the Kaimaumau-Motutangi wetland administered as public conservation land. 1 = Kaimaumau Scientific Reserve, 2 = East Beach Conservation Areas, 3 = Lake Waikaramu Conservation Area.

5.5 The wetland is characterised by extensive freshwater and coastal wetlands, dunes and shrubland vegetation. It contains nationally rare ecosystems (Williams et al. 2007) such as gumland, ephemeral wetlands and dune slacks, and intact ecological sequences from inland freshwater wetlands through to coastal wetlands, dunes and estuarine habitats (DOC 2014).

5.6 An assessment of wetland significance in Northland undertaken by Wildland Consultants (2011) for the Northland Regional Council determined that Kaimaumau-Motutangi was the 2nd most significant wetland in Northland based on its ecological values.

5.7 In my opinion, Kaimaumau-Motutangi wetland, when assessed at the wetland complex scale, meets all four high-level criteria for significant indigenous vegetation and habitat as defined in Appendix 5 of the Northland Regional Policy Statement[1] (*Areas of significant indigenous vegetation and significant habitats of indigenous fauna in terrestrial, freshwater and marine environments*). The specific criteria that apply at the whole wetland scale are presented in Table 1.

Table 1.

Criteria from Appendix 5 of the Northland Regional Policy Statement	**Kaimaumau-Motutangi Wetland**
1. Representativeness (a) Regardless of its size, the *ecological site* is largely indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity at the relevant and recognised ecological classification and scale to which the *ecological site* belongs: i. If the *ecological site* comprises largely indigenous vegetation types; and ii. Is typical of what would have existed circa 1840; or iii. Is represented by faunal assemblages in most of the guilds expected for the habitat type; or	1a - achieved
(b) The *ecological site* i. Is a large example of indigenous vegetation or habitat of indigenous fauna, or ii. Contains a combination of landform and indigenous vegetation and habitat of indigenous fauna, that is considered to be a good example of its type at the relevant and recognised ecological classification and scale.	1b - achieved
2. Rarity / distinctiveness (a) The *ecological site* comprises indigenous ecosystems or indigenous vegetation types that: i. Are either Acutely or Chronically Threatened land environments associated with LENZ Level 4; or ii. Excluding wetlands, are now less than 20% of their original extent; or iii. Excluding *man made wetlands*, are examples of the wetland classes that either otherwise trigger Appendix 5 criteria or exceed any of the following area thresholds (boundaries defined by Landcare delineation tool);	2a - achieved

[1] Note: Under the Northland RPS a site is significant if it only meets one of the criteria.

a) Saltmarsh greater than 0.5 hectare in area; or b) Shallow water (lake margins and rivers) greater than 0.5 hectare in area; or c) Swamp greater than 0.4 hectare in area; or d) Bog greater than 0.2 hectare in area; or e) Wet Heathlands greater than 0.2 hectare in area; or f) Marsh; Fen; Ephemeral wetlands or Seepage / flush greater than 0.05 hectares in area.	
(b) Indigenous vegetation or habitat of indigenous fauna that supports one or more indigenous taxa that are threatened, at risk, data deficient or uncommon, either nationally or at the relevant ecological scale.	2b - achieved
(c) The *ecological site* contains indigenous vegetation or an indigenous taxon that is: i. Endemic to the Northland-Auckland region; or ii. At its distributional limit within the Northland region;	2c - achieved
(d) The *ecological site* contains indigenous vegetation or an association of indigenous taxa that: i. Is distinctive of a restricted occurrence; or ii. Is part of an *ecological unit* that occurs on an originally rare ecosystem or iii. Is an indigenous ecosystem and vegetation type that is naturally rare or has developed as a result of an unusual environmental factor(s) that occur or are likely to occur in Northland; or iv. Is an example of nationally or regionally rare habitat as recognised in the New Zealand Marine Protected Areas Policy.	2d - achieved
3. Diversity and pattern (a) Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of: i. Indigenous ecosystem or habitat types; or ii. Indigenous taxa;	3a - achieved
(b) Changes in taxon composition reflecting the existence of diverse natural features or ecological gradients; or	3b - achieved
(c) Intact ecological sequences.	3c - achieved
4. Ecological context (a) Indigenous vegetation or habitat of indigenous fauna is present that provides or contributes to an important ecological linkage or network, or provides an important buffering function; or	4a - achieved
(b) The *ecological site* plays an important hydrological, biological or ecological role in the natural functioning of riverine, lacustrine, palustrine, estuarine, plutonic (including karst), geothermal or marine system; or	4b - achieved
(c) The *ecological site* is an important habitat for critical life history stages of indigenous fauna including breeding / spawning, roosting, nesting, resting, feeding, moulting, refugia or migration staging point (as used seasonally, temporarily or permanently).	4c - achieved

5.8 In some discrete parts of the wetland not all criteria may apply, but overall the entire wetland complex can be assessed as ecologically significant based on the Appendix 5 criteria of the Northland RPS. This view is consistent with the evidence of Ms Martell Letica for the applicant (paragraph 6.7) who states that both the inner and outer wetland meet the RPS significance criteria.

5.9 In my opinion, the wetland is also internationally significant based on the criteria for designating sites of international importance under the Ramsar Convention (Denyer and Robertson 2016). In particular, it is one of the best examples of a representative wetland type in New Zealand (Ramsar Criterion 1) and provides significant habitat for a number of critically threatened species (Ramsar Criterion 2).

5.10 The wetland is unique in a national context due to the diversity of wetland types that are represented. There is a mosaic of landforms as described by Hicks et al. (2001) transitioning from the estuarine habitats, across coastal dunes to extensive coastal and inland freshwater wetlands sitting in depressions adjacent to sand ridges and often underlain by an iron pan. The wetlands vary from peat 'bogs' typically at slightly higher elevation that are rainfed, to fen and swamp wetland types that have standing water above the ground surface (Figure 3).

5.11 The varied landforms and wetland types correspond with a non-uniform hydrological environment that supports a high diversity of vegetation communities. Dominant indigenous wetland vegetation includes *Empodisma robustum*, *Machaerina teretifolia* and other *Machaerina* species, *Schoenus brevifolius*, *Schoenus tendo, Typha orientalis, Leptospermum scoparium and Apodasmia similis.*

Figure 3. Photograph of wetland habitat in the Kaimaumau-Motutangi wetland complex.

5.12 The wetland contains a very high richness of threatened and rare plant species, including several species listed as 'nationally critical' and 'nationally endangered' (Hicks et al. 2001, DOC 2014). This includes *Calochilus herbaceous, Phylloglossum* *drumondii, Thelymitra* "ahipara" and *Utricularia australis* all of which are ‘nationally critical’ threatened plant species, and *Todea Barbara* and *Lycopodium serpentinum* which are ‘nationally endangered’.

5.13 The intact ecological sequences and diversity of wetland habitats at Kaimaumau-Motutangi provide significant habitat for threatened fauna species (DOC 2014). This includes a relatively large population (pers. obs) of Australasian bittern *Botaurus poiciloptilus* which is ‘nationally critical’. Northland mudfish *Neochanna heleios* which is ‘nationally vulnerable’ and several ‘at risk-declining’ wetland fauna occur at the wetland.

5.14 During an aerial survey that I participated in during 2018, numerous (<4) Australasian Bittern were observed within standing water in the wetland. This confirmed the open water habitat, in association with indigenous wetland plants adapted to growing in permanently wet areas (e.g. *Machaerina* spp. Typha orientalis), provide important habitat for nationally threatened bird species.

5.15 A relatively large area of the Kaimaumau-Motutangi Wetland complex is mapped as occurring within the coastal environment by the Regional Policy Statement for Northland (Figure 4).

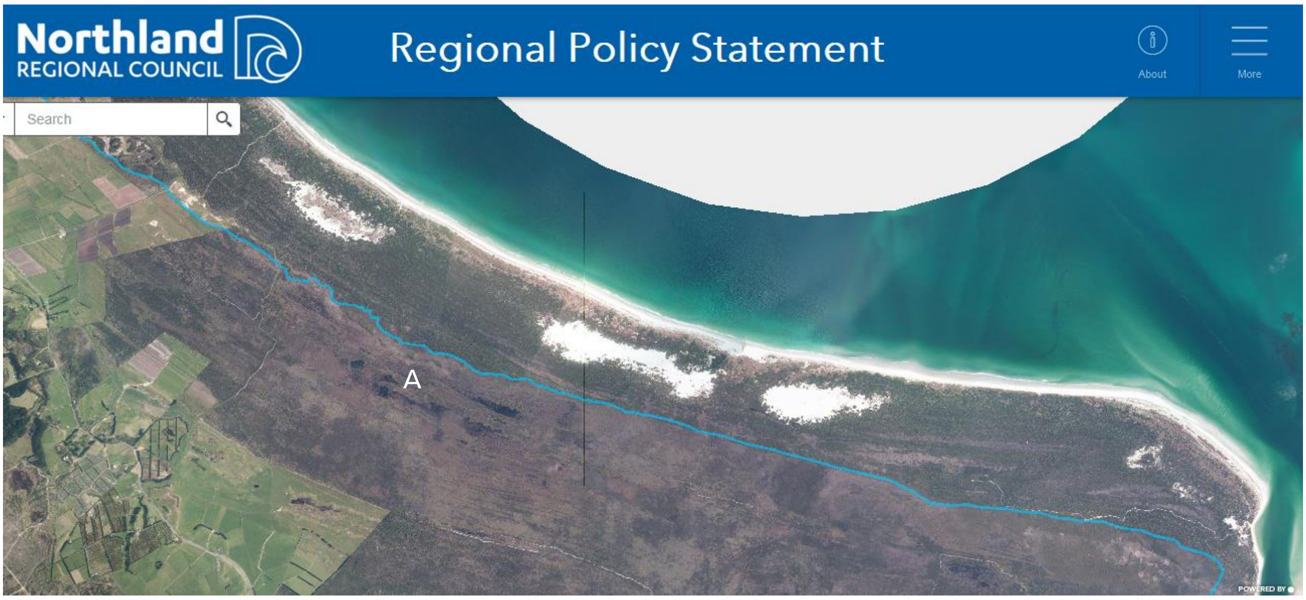

Figure 4. Delineation of the coastal environment (north of the blue line) at Kaimaumau-Motutangi Wetland as per the Regional Policy Statement for Northland. Map sourced from Northland Regional Council (21 November 2018). ‘A’ identifies the extensive low-lying wetland area south of the coastal dunes.

5.16 Although the coastal environment boundary captures extensive dune and coastal wetland habitat, in my opinion, it under-estimates the extent of the Kaimaumau-Motutangi wetland that is influenced by coastal processes.

5.17 In particular, there are extensive low-lying wetlands to the south of the large coastal dunes (‘A’ in Figure 4). A photograph of this part of the wetland is also shown in Figure 5 below.

5.18 The formation of this low-lying wetland area is directly related to the presence of coastal foredunes, as described by Hicks et al. (2001). The dunes also continue to have a direct role in defining the extent and hydrology of this low-lying zone. That is, water storage and movement is influenced by the landward edge of the coastal foredunes, forming a boundary of the wetland. In my opinion, this confirms the significant influence of coastal processes at location ‘A’. In addition, as a result of further monitoring done by the Applicant post the hearing (refer to Section 3 of Mr Williamson’s evidence and para 7.4 of Mr Baker’s evidence) new data suggested there is a potential for the northern part of the wetland, at location A in the coastal environment, to be hydraulically connected to the groundwater aquifer.

5.19 Policy 1 of the New Zealand Coastal Policy Statement states that the coastal environment includes, under 2(c), *areas where coastal processes, influences or qualities are significant, including coastal lakes, lagoons, tidal estuaries, saltmarshes, coastal wetlands, and the margins of these.*

5.20 Coastal processes are a key feature of the Kaimaumau-Motutangi wetland and have driven the geomorphological formation of the wetland complex (Hicks et al. 2001). Under current hydrological conditions, both freshwater and estuarine wetlands remain strongly influenced by coastal processes.

5.21 The wetland meets at least 8 criteria of Policy 11 of the New Zealand Coastal Policy Statement (at least 3 from Policy 11(a) and 5 from Policy 11(b)), as summarised in Table 2. Assessment of these criteria was based on the coastal environment boundary shown in Figure 4, however the assessment would equally apply across all wetland habitats influenced by coastal processes at Kaimaumau-Motutangi.

Table 2.

Policy 11 Criteria relating to the protection of indigenous biological diversity (biodiversity) in the coastal environment	**Kaimaumau-Motutangi Wetland**
(a) avoid adverse effects of activities on:	

(i) indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;	Present
(ii) taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened;	
(iii) indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare;	Present
(iv) habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare;	
(v) areas containing nationally significant examples of indigenous community types; and	
(vi) areas set aside for full or partial protection of indigenous biological diversity under other legislation; and	Present
(b) avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on:	
(i) areas of predominantly indigenous vegetation in the coastal environment;	Present
(ii) habitats in the coastal environment that are important during the vulnerable life stages of indigenous species;	Present
(iii) indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh;	Present
(iv) habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes;	Potentially present
(v) habitats, including areas and routes, important to migratory species; and	Present
(vi) ecological corridors, and areas important for linking or maintaining biological values identified under this policy.	Present

6. ASSESSMENT OF POTENTIAL EFFECTS ON WETLAND HYDROLOGY AND ECOLOGY

6.1 The primary driver of wetland ecosystem function and composition is their hydrological regime (Mitsch and Gosselink 2007). Modifications to wetland water levels can lead to irreversible changes in ecohydrological functioning and cause the loss of indigenous ecosystems and species (e.g. Blyth 2011). Declining water levels in wetlands, due to drainage, water diversion or groundwater extraction leads to increased dominance of dryland species, loss of habitat for threatened species and an overall decline in ecological integrity.

6.2 The Agreed Statement of Facts states (in paragraph 23) that '*a decline in water levels within a wetland can have an ecological impact if the magnitude of decline exceeds the tolerance of the flora and fauna adapted to living in the wetland habitat*.'

6.3 The principal matter of concern is that the consented groundwater takes may over time result in a drawdown of the wetland water level and as a result have an impact on the hydrological functioning of Kaimaumau-Motutangi wetland, and lead to a decline in indigenous biodiversity and ecological integrity.

6.4 In my opinion, if there was a change in the median annual water level of $\geq$0.1m, and a decline of seasonal water levels (median, and minimum water levels of >0.1m) this will cause significant negative adverse effects on the wetland.

6.5 Research on wetland plant responses to hydrological conditions also has found that changes in average water levels (~10 cm) could promote a shift from plant assemblages dominated by natives to those dominated by invasive or alien taxa (Magee & Kentula 2005)

6.6 The potential effects on wetland hydrology that were estimated from modelling and presented in the applicants AEE were:

(1) a reduction in mean annual low-flow discharge by a maximum of 7%, and 5-year low-flow discharge by 11%, and

(2) an estimated drawdown in the shallow unconfined aquifer of up to 0.2m-0.6m, including the shallow unconfined aquifer at Kaimaumau wetland.

6.7 It is acknowledged that the model indicates the Kaimaumau Scientific Reserve (under Scenario 2 of the modelling) is estimated to only have up to 0.1m drawdown of the shallow aquifer (Figure 4, evidence of Mr Williamson).

6.8 It is also acknowledged, as stated in the evidence of Mr Baker, that the '*drawdown relationship would be influenced by the degree of connectivity between the wetland and the underlying sand aquifer. In most areas, it is likely that the wetland is perched above the underlying sand aquifer and the connectivity is limited. However, in lower lying areas, and in areas where the iron pan and/or peat is discontinuous, the degree of connectivity may be higher'.*

6.9 Kaimaumau-Motutangi wetland supports a range of wetland types. Extensive areas are peat 'bog' and hydrologically function as rainfed wetlands (Hicks et al. 2001) with little if any anticipated connection with groundwater. However, the wetland also contains other wetland types, including fen and swamp wetland types that by definition (Johnson and Gerbeaux 2004) are characterised by water sources that include surface water run-off and/or groundwater.

6.10 I agree with the evidence of Mr Jon Williamson, Mr Brydon Hughes and Mr Tim Baker that the higher elevation peat bog wetland to the southwest of Kaimaumau-Motutangi has a very low risk of being impacted from groundwater extraction. These wetlands are predominantly rainfed and perched above the shallow groundwater, i.e. disconnected from underlying groundwater.

6.11 However, a critical area of the Kaimaumau-Motutangi wetland is the large low-lying wetland habitat that has permanent and relatively stable water levels (Figure 5). The permanent open water supports wetland plant species associated with a fen or swamp wetland type, such as *Typha orientalis*.

6.12 The key technical concern that provided part of the basis for the Director-General of Conservation's appeal was that this wetland area (Figure 5) is at much greater risk of being adversely impacted as a result of groundwater extraction.

Figure 5. Wetland habitat in Kaimaumau Scientific Reserve characterised by permanent inundation above the ground and relatively stable water levels.

6.13 The concern about this wetland area (Figure 5) was based on two key factors:

(a) the lower elevation of the wetland habitat, and therefore increased probability of it being connected with groundwater

(b) the observed stable water levels near to the site (Figure 6) indicating a relatively continuous input of surface water and/or groundwater

6.14 The key observation from water level monitoring (Figure 6) is that the wetland water level is very stable. For much of the year the water table is fluctuating 0.10 to 0.15m. This type of hydrograph would typically occur if there is a continuous supply of surface water and/or groundwater that maintains a constant water balance.

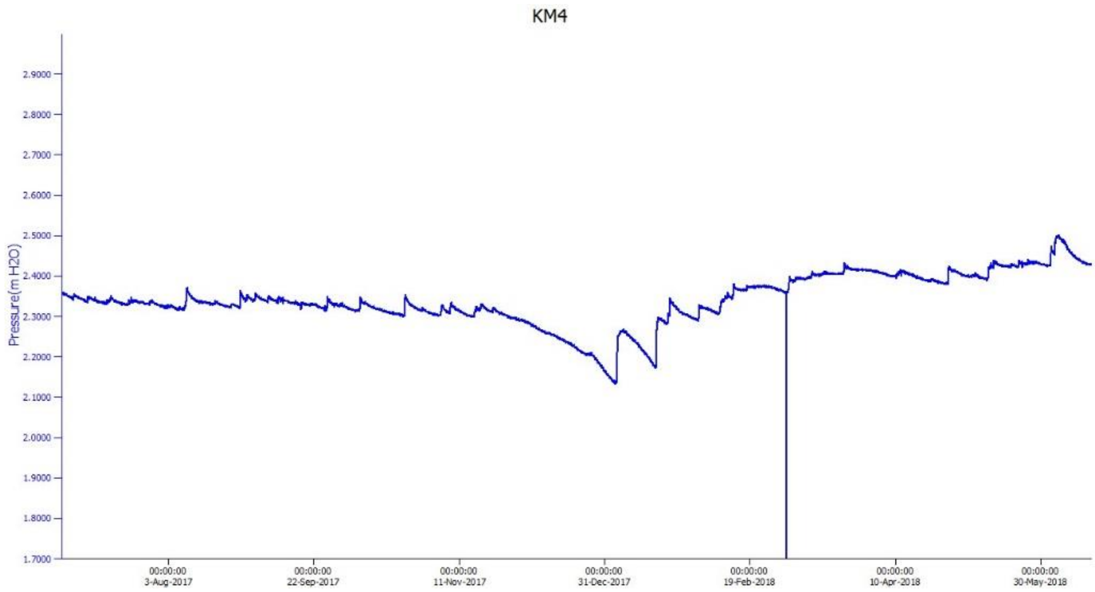

Figure 6. Hydrograph showing the variation in wetland water levels from August 2017 to May 2018 at a DOC monitoring site located to the east of site depicted in Figure 5.

6.15 In contrast, the evidence of Mr Williamson suggests the wetland water levels can vary 0.65 – 1.50m, in reference to the report by Hicks et al. 2001. While this may be the case for other areas of Kaimaumau wetland, the data presented in Figure 6 illustrates that water level variation is not uniform across the wetland.

6.16 In this wetland type a decline in the water level of 0.1m would have significant adverse ecological effects in my opinion. That is, leading to a reduced extent of shallow water, and leading to a shift in species composition favouring species that are more adapted to shallow inundation (e.g. Robertson & James 2007).

6.17 Notably, the area shown in Figure 5 directly aligns with the low-elevation wetland area highlighted in the evidence of Mr Williamson (Figure 7). Mr Williamson's evidence, Mr Baker's evidence and my own technical assessment identify this region as the zone of highest risk from groundwater extraction.

6.18 Mr Williamson states (paragraphs 3.6-3.8) that there is less certainty in this northern part of the wetland that the surface water is disconnected from groundwater. This is due to '*fewer boreholes being available and the results obtained not showing such a clear difference in water levels*.'

Figure 7. Reproduced Figure 3 of the evidence presented by Mr Jon Williamson. Low-lying wetland habitat is shown in blue-light blue-green. 'A' indicates the location of the low-lying wetland that is also shown in Figure 4.

6.19 Mr Williamson's analysis also indicates that groundwater levels in this area were '*approximately 0.7 m to 1 m higher (from two bores) than the lowest wetland levels in the Scientific Reserve Area'*. This reinforces concerns that the low-lying area of wetland may not be perched, but is instead potentially connected with groundwater.

6.20 Based on this information, it was agreed by the technical experts that further monitoring should occur in the northern section of the wetland to adequately address concerns about potential adverse effects on wetland hydrology due to groundwater extraction.

6.21 The monitoring agreed by the experts will, in my opinion, reduce the reliance on hydrogeological modelling of water level drawdown impacts to estimate potential adverse effects on wetland hydrology.

7. ASSESSMENT OF REVISED GMCP AND ASSOCIATED CONSENT CONDITIONS

7.1 The Agreed Statement of Facts prepared prior to the expert conferencing states (in paragraph 24) that '*there is some uncertainty about connectivity between the Aupōuri aquifer and surface water bodies. To account for this, the decision has imposed some monitoring within the consent conditions'*.

7.2 I support the use of monitoring in situations where there is uncertainty about the actual effects of a proposed development on significant ecological areas.

7.3 The principal matter of my technical concern was that the Groundwater Monitoring and Continency Plan (GMCP) presented in the Hearing Decision Report was inadequate. Specifically, the GMCP did not provide sufficient monitoring or investigation to ensure the consented groundwater takes had no more than minor adverse effects on the hydrological functioning of Kaimaumau-Motutangi wetland.

7.4 The revised GMCP, as agreed at expert conferencing, however has made a number of specific improvements. These are:

(a) A requirement for monitoring wetland water levels in the area of highest risk from groundwater drawdown

(b) A requirement for radon sampling to provide data on groundwater inputs to the wetland

(c) An improved methodology in 3.2.3 for evaluating the groundwater-wetland connectivity, including analysis prior to proceeding to the next stage of development and involvement of a qualified wetland ecologist in assessing potential adverse effects on the wetland as part of 3.2.3

(d) Improved definition of trigger levels, and the establishment of a baseline (reference) against which trigger levels will be assessed

(e) Definition of root stock water

7.5 Subject to some residual concerns I outline below, overall, I am comfortable that the revised GMCP provides a much more focused monitoring and assessment process to detect and evaluate the potential adverse effects of groundwater extraction on wetland hydrology and ecology. The changes to the GMCP satisfy my concerns that potential adverse effects from groundwater extraction may occur undetected due the absence of adequate monitoring and analysis.

7.6 I note Mr Brydon Hughes also confirms that the agreed changes to the GMCP provide a '*practicable means to address concerns' in relation to the potential effects of the proposed abstraction on the Kaimaumau wetland*.'

7.7 Upon a further review of the revised GMCP, I do note however, three sections that would benefit from minor amendment, these are:

(a) Provide for a more specific definition of what a 50% reduction in water under 4.2 (b) relates to. I note that the evidence of Mr Baker recommends a proposed definition of the 50% reduction.

(b) Clarification that the analysis and reporting required under 3.2.3, in terms of interpreting wetland water level drawdown effects, will involve both a hydrologist and wetland ecologist.

(c) Clarification that the report required under 3.2.3 will be prepared on each occasion prior to moving to next stage of development. This is inferred in the statement that '*this information will also be considered as part of the review and approval of the staged development process outlined in Section 2.4*. But it is not clearly stated that a report examining the effects on groundwater drawdown on wetland water levels is required for each stage of development. I consider this a necessary requirement.

8. CONCLUSION

8.1 Kaimaumau-Motutangi wetland is the largest (2931 ha) wetland in the Northland region. It contains a high diversity of coastal and inland wetlands and is a nationally significant site for the protection of New Zealand's natural heritage.

8.2 The principal matter of my technical concern was that the Groundwater Monitoring and Continency Plan (GMCP) presented in the Hearing Decision Report was inadequate. Specifically, the GMCP did not provide sufficient monitoring or investigation to ensure the consented groundwater takes had no more than minor adverse effects on the hydrological functioning of Kaimaumau-Motutangi wetland.

8.3 There is a critical area of the Kaimaumau-Motutangi wetland that is at higher risk of being impacted by groundwater extraction. This area is low-lying (closer to groundwater) and is characterised by a very stable wetland water level (typically 10-15cm variation) that indicates a permanent source of surface-water or groundwater.

No monitoring or investigation was proposed for this ecologically significant wetland area in the Hearing Decision Report.

8.4 Following technical expert conferencing on 20 September 2018 the GMCP has been revised to provide further monitoring and investigation within the Kaimaumau-Motutangi wetland. The monitoring is focused on the wetland area considered most at risk of being impacted by groundwater extraction.

8.5 I am comfortable that the revised GMCP will provide monitoring, reporting and contingency actions to adequately protect the significant values of Kaimaumau wetland, while noting that some clarification of the monitoring assessment in 3.2.3 is considered necessary.

Hugh Allister Roberston

23 November 2018

REFERENCES

Ausseil AG, Gerbeaux P, Chadderton WL, Stephens T, Brown D, Leathwick J (2008). Wetland ecosystems of national importance for biodiversity. Landcare Research Contract Report LC0708/158. Prepared for Department of Conservation, Wellington, NZ

Blyth J.M (2011). Ecohydrological characterisation of Whangamarino wetland. MSc dissertation, University of Waikato, Hamilton

Denyer K, Robertson H. (2016). National guidelines for the assessment of potential Ramsar wetlands in New Zealand. Department of Conservation.

DOC 2014. Conservation Management Strategy. Northland 2014-2024, Volume 1. Operative 29 September 2014, Department of Conservation.

Hicks DL, Campbell DJ Atkinson IAE (2001). Options for managing the Kaimaumau wetland, Northland, New Zealand. Department of Conservation, Wellington

Johnson P, Gerbeaux P (2004). Wetland Types in New Zealand. Department of Conservation and Ministry for the Environment, Wellington.

Magee TK, Kentula, ME (2005). Response of wetland plant species to hydrologic conditions. Wetlands Ecology and Management, 13(2), pp.163-181.

Mitsch WJ, Gosselink JG (2007). Wetlands. Hoboken. ed: John Wiley & Sons, Inc.

Robertson HA, James KR (2007). Plant establishment from the seed bank of a degraded floodplain wetland: a comparison of two alternative management scenarios. Plant Ecology, 188: 145-164.

Wildland Consultants (2011). Ranking of Top Wetlands in the Northland Region, Stage 4 Ranking of 304 wetlands. Contract report No 2489 for Northland Regional Council.

Williams PA, Wiser S, Clarkson B, Stanley MC (2007). New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. New Zealand Journal of Ecology 31:119-128.