BEFORE THE NORTHLAND REGIONAL COUNCIL

under:	the Resource Management Act 1991
in the matter of:	Resource consent applications by the Motutangi-Waiharara Water Users Group for new groundwater takes from the Aupouri aquifer subzones: Houhora, Motutangi and Waiharara

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

(Groundwater)

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STATEMENT OF EVIDENCE OF TIMOTHY BAKER

INTRODUCTION

1 My full name is Timothy Michael Baker

2 I am employed by Jacobs New Zealand Ltd, an engineering and environmental consulting firm. I am contracted to provide groundwater expertise on resource consent application REQ-581172 to the Department of Conservation (DOC).

3 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.

4 I have 15 years' experience in the field of hydrogeology and water resources. I started my career at Wellington Regional Council and worked for them between 2002 and 2007, then Black & Veatch Limited and CH2M Hill (both Environmental Consultancies) in the UK between 2007 and 2012 and most recently joined Sinclair Knight Merz (now Jacobs) in 2013.

5 I have acted as an Expert Witness in groundwater related consent hearings in New Zealand for the past five years. I have provided expertise in the fields of hydrogeology, groundwater quality and environmental monitoring plan design to a range of local government clients including Greater Wellington Regional Council, Bay of Plenty Regional Council, Manawatu-Wanganui Regional Council and other organisations such as Horticulture New Zealand and Fonterra.

6 I am familiar with the Kaimaumau wetland to which these proceedings relate. My familiarity is based on conversations with Ms Shona Myers who is also presenting evidence for DOC and my colleagues at Jacobs, James Blyth and Gillian Holmes. James Blyth is responsible for the current water level monitoring programme within the wetland (and is presenting evidence) and Gillian Holmes has extensive experience in the hydrogeology of the Northland Region including having prepared the consent application for the Sweetwater Farms groundwater take west of Kaitaia.

7 At the time of writing this evidence I have not visited the wetland myself, however a field visit to verify my conceptualisation of the wetland is planned for the 26 March 2018.

CODE OF CONDUCT

8 I have read and agree to comply with the Code of Conduct for Expert Witnesses produced by the Environment Court and have

prepared my evidence in accordance with those rules. My qualifications as an expert are set out above.

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

10 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

11 My evidence will focus on several key areas of uncertainty and data gaps that in my opinion restrict the ability of the Applicant to adequately form a baseline assessment of the Kaimaumau Wetland. These are:

- The limited amount of baseline data (borehole logs, groundwater water level and surface water flow measurements, water quality information) that exists specifically in and around the Kaimaumau wetland and the uncertainty that may exist in the assessment of effects as a result of this limited data;
- The reliance on anecdotal evidence to support the conceptualisation that there is little to no hydraulic connectivity between the Kaimaumau Wetland and the underlying sand aquifer;
- The applicability of a regional scale model to answer questions of local scale effects;
- Interpretation of key data (Radon 222) to assess the degree of connectivity across a large wetland system;
- The spatial distribution of calibration points in the groundwater model and what effect this may have on the certainty of drawdown predictions in areas where there were no calibration points; and
- The inability of the currently drafted Groundwater Monitoring and Contingency Plan presented in the NRC Officers Report to monitor for potential changes in the hydrology of the wetland.

KAIMAUMAU WETLAND DESCRIPTION

12 The Kaimaumau/Motutangi wetland complex covers an area of some 1850 ha of which 955 ha is designated as Scientific Reserve and the remaining is Conservation area. Scientific Reserves afford the highest level of protection of all reserves managed under the Reserves Act 1977. The degree of protection and consequences for

planning based considerations is discussed in more detail in the evidence of Shona Myers.

13 The wetland is located on the Aupouri Peninsula and extends from just south of Houhoura Heads to the mouth of the Rangaunu Harbour, a distance of almost 10 km. It is the only freshwater wetland exceeding 1000 ha in Northland and is nationally recognised for its outstanding natural values, discussed further in the evidence of Shona Myers and Jacob Williams.

14 Locally, the wetland is the top ranking bog wetland in the Northland Region (Wildlands, 2011) based on a weighted ranking system that considers a total of eight attributes including size, threatened species, hydrological integrity and representativeness.

REGIONAL GEOLOGICAL & HYDROGEOLOGICAL SETTING

15 The conceptual geological and hydrogeological setting of the Aupouri Peninsula has been extensively described in the applicants Factual Technical Report – Modelling (WWA, 2017) using information described in a number of historical reports including Northland Regional Council (1991) and Lincoln Agritech (2015), in addition to more recent borehole logs associated with several of the proposed takes.

16 This conceptualisation is broadly of two dominant aquifer systems comprising:

- **a.** The upper fine grained sand aquifer, the is 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 the production wells that form part of the consent.

17 Groundwater within the shellbed aquifer is semi-confined due to the presence of low permeability layers within the overlying sand aquifer. As reported by Lincoln Agritech (2015) and WWA (2017) there is no clear hydraulic boundary between the shellbeds and the overlying sand aquifer. This is largely a result of there not being a continuous confining layer, but due to the variable presence of low permeability layers within the fine sands aquifer.

18 At surface, immediately above the upper sand aquifer are a number of dune lakes and coastal wetlands, including Lake Waiparera and the Kaimaumau-Moturangi wetland complex. In general, these surface features have evolved due to the presence of discontinuous low permeability horizons such as peat and/or iron pans that have

developed in the swales between dune ridges (WWA, 2017; Hughes & Reaburn, 2018). These features are anecdotally referred to as being perched above the unconfined aquifer, and in the case of Lake Waiparera this is little doubt of this, but on the lower elevation coastal plains where the Kaimauamau wetland is, actual scientific evidence of a perched system is lacking.

19 In my opinion, quantifying the degree of connectivity between these surface features, in particular the Kaimaumau Wetland and the underlying sand aquifer is critical in order to adequately assess the potential effects on the hydrology of the wetland. At present, I do not believe there is sufficient scientific evidence of the level of connectivity the wetland has with the underlying aquifer, largely due to a lack of geological data in this area. This is discussed further in paragraphs 25 through to 38 below.

20 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 this application. However, my concerns largely related to the application of the regional model to localised assessments of effect.

HYDROLOGY OF THE WETLAND AND CURRENT WORK PROGRAMME

21 There have been a very limited number of quantitative hydrological investigations on the Kaimaumau Wetland and as a result, knowledge of the hydrological regime within the wetland is limited.

22 Known investigations to date are largely summarised in the comprehensive report prepared for the Department of Conservation by Hicks et al in 2001. The investigations documented in this report are all historic, and very limited in scope.

23 Whilst the report is considered the most comprehensive completed on the wetland, it lacks actual monitoring data to support the hydrological assumptions made within it.

24 DOC are aware of this lack of quantitative data and commissioned a limited investigation into drain and wetland water levels in 2017 to aid restoration planning. The structure of this investigation, and early results are presented in the evidence of my colleague James Blyth.

HYDROGEOLGICAL SETTING OF THE WETLAND

25 The evolution and conceptual setting of the wetland relative to its surrounding landforms is well described in the Hicks (2001) report.

26 The elongated wetland has largely developed in the swales between parallel lines for coastal dunes, that increase with age as you move inland.

27 Over time, the deposition of sediment fines into the swales 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 wetland is often described as being hydraulically disconnected from the underlying groundwater system.

28 The dunes described above have in areas been dissected by former stream channels, and more recently man-made drains resulting in a wetland with a complex flow regime.

29 However, the above statement regarding the disconnection is very generalised, and it is acknowledged both in historical documentation and the current application that the iron pan is likely discontinuous and that there are areas where it may be absent. Unfortunately, the spatial extent and continuity of the pan has not been investigated or constrained by way of mapping.

30 Conditions that may lead to the iron pan being absent are described in Hicks (2001) as being erosion from the dissected stream channels within the wetland and artificial removal such as the creation of drainage within the wetland system. The following excerpt describes it well:

   a. *"It* [the peat] *forms a barrier to water movement through the peat and sand. Rainwater on the peat must flow sideways through it, until it reaches a place where the hardpan is breached (for instance one of the buried stream valleys) or stops (for instance the landward edge of the coastal foredunes).*

31 In addition to the above points, it is considered that the iron pan thins with proximity to the coast as the dunes here are younger and have had less time to develop a pan. Hicks (2001) reports that the younger coastal parabolic dunes (Pinaki sand) have a loose subsoil where the iron pan is absent. Beneath these younger dunes, Hicks (2001) postulates that sub-surface flow may be possible on the coastal side of the Moututangi, Waihuahua and Otiaia catchments.

32 The wetland has five sub-catchments, each with distinct surface outlet. There has been little to no work in quantifying the inflows and outflows from these sub-catchments and as a result the current understanding of the wetlands hydrological behaviour is largely

conceptual and based on anecdotal evidence. This is discussed in detail in the evidence of James Blyth.

33 In my opinion, without quantified flow and level data for the wetland, it is not possible to develop a baseline against which to compare the effects of the proposed abstraction.

34 To assess the effects of the proposed abstraction on the wetland the Applicant has taken two approaches. Firstly, the effects on wetland drain flows were estimated using data obtained from the flow budget for each time step of their groundwater model. Secondly, the effects on standing water levels in the wetland were estimated from the magnitude of drawdown calculated in the shallow unconfined aquifer for various model predictive scenarios.

35 The assessments of effects on the wetland suggest that the proposed abstraction has the ability to reduce mean-annual low flow discharge by a maximum of 7% and 5-year low-flow discharge by 11%. In relation to drawdown of water levels, the modelling predicts drawdown of between 0.2 and 0.6 m across the wetland.

36 Drawdowns of 0.2m and 0.6m are relatively significant in terms of wetland systems and should not be considered minor. These levels will have adverse effects on wetland processes (refer evidence of James Blyth and Shona Myers). Further, given the uncertainty in hydrological assessments I have outlined, the drawdown may be even greater than outlined in the applicant’s assessment.

37 WWA (2017) claim that the model construction (no hydraulic separation between the shallow aquifer and the wetland) results in estimates of drawdown and flow reduction that are conservative. In my opinion, whist I understand the basis for this conservatism, the lack of quantitative baseline data around the hydrology and hydrogeology of the wetland outweighs any conservatism as a method of minimising monitoring or further investigation on the wetland.

38 These uncertainties, and lack of baseline information, must be acknowledged in an assessment of potential effects, and in my opinion the proposed monitoring does not address this uncertainty in any way.

GROUNDWATER MODEL UNCERTAINTY

39 The groundwater model appears to represent the regional (i.e. whole of model domain) hydrogeological setting adequately given the spatial limited data available for the construction and calibration. The peer review undertaken by Mr Brydon Hughes of the Land and Water People (2017) largely supports this too. However, there are

several areas of uncertainty and/or limitations in the model that need careful consideration specifically with respect to the effects on the Kaimaumau Wetland.

40 Firstly, the model has been calibrated using groundwater heads from a total of 17 piezometers, all of which are located in the northern half of the model domain (Figure 1). There are no water level records in or around the Kaimaumau wetland, nor even in the southern half of the model domain.

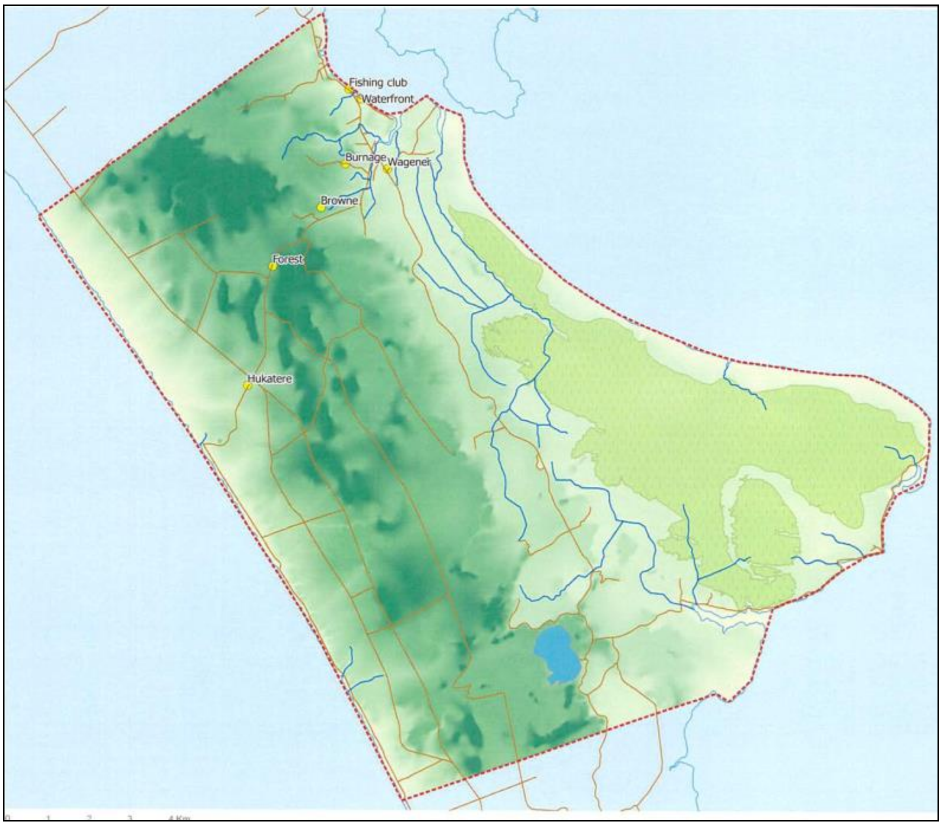

Figure 1. Location of calibration piezometers relative to the Kaimaumau wetland. Source: WWA, 2017.

41 In addition to the 17 calibration sites, at the request of the peer-reviewer, the simulated heads in the model were compared to spot data collected as manual water level measurements during the WWA aquifer tests. The difference between these values ranged from -0.4 m to 4.1 m. An additional four piezometers (at two locations) just south of the model domain were checked and had differences in simulated vs measured head of between -0.6 and 1.9 m.

42 There was no calibration to groundwater fluxes in the model. As such, there is uncertainty in the ability of the model to predict

accurate and reliable drainage fluxes (which have been used in the AEE to calculate specific discharge) in and around the wetland.

43 The Modelling report states that some of the head difference may be due to inaccuracies in the DEM used to reference groundwater levels. I cannot comment further on this except to say that the two head differences of >3 m plus the inaccuracies in the DEM highlight that there are some inherent uncertainties in the model predictions.

44 So whilst a ‘good’ (WWA, 2017) calibration was achieved at the end of the transient calibration process, the poor spatial distribution of the calibration points increases the level of uncertainty in the ability of the model to predict accurate groundwater response in and around the wetland.

45 In my opinion, the collection of a groundwater level time series for both shallow and deep groundwater in at least two locations in proximity to the wetland should have been undertaken as part of the modelling exercise.

46 As noted both in the modelling report and in the peer review, the discontinuous and irregular nature of the iron pan and other layers of low permeability are challenging to represent accurately in the groundwater model. This is compounded by the fact that there is little to no actual mapping of the extent and nature of iron pans both beneath and in proximity to the wetland.

47 As a result of this, the model is limited with regard to its ability to predict vertical leakage and associated groundwater drawdown. This is acknowledged by WWA in the modelling report, who state that the model likely exaggerates the effects of the proposed abstraction on groundwater levels in the shallow aquifer and at surface, however given the uncertainty in the geology underlying the wetland the opposite could be true.

48 Lastly, the modelled flux indicates a substantial shallow coastal discharge. It is unclear from the WWA modelling report how this coastal flux was determined and this does require further explanation. This is important because if the coastal flux was less than currently predicted, then the potential for surface expressions of groundwater along the coast, such as into the Kaimaumau wetland could be higher (i.e. a discharge wetland).

49 In summary, the ability of the model to accurately predicted changes in groundwater level at a scale that may affect the wetland (i.e. +/- 0.5 m) is limited due to the lack of baseline information in and around the wetland and resulting model limitations/ uncertainty.

50 In my opinion, whist the uncertainty is acknowledged, the monitoring proposed to protect the wetland from effects does not adequately reflect this.

INTERPRETATION OF RADON

51 As stated in the application, in order to characterise the potential interaction between deeper groundwater and the wetland, the applicant undertook a survey of radon concentrations in surface water at several locations within the wetland (see Figure 2 below).

Figure 2: Radon-222 sampling sites. Source: WWA, 2017.

52 Radon (Rn-222) is generated from the decay or uranium which is ubiquitous in almost all rocks and soils, resulting in the release of radon from uranium bearing minerals in groundwater[1]. It has a very short half-life of 3.8 days, so when groundwater emerges (whether in a spring flow or as a result of pumping) the concentration will reduce rapidly (i.e. by 50% in 3.8 days) as a result of degassing. As such, the measurement of radon in surface water is a useful tool to indicate where groundwater may be contributing to flow in a surface water body.

[1] GNS Science. Web Reference accessed 08/03/18: https://www.gns.cri.nz/Home/Services/Laboratories-Facilities/Tritium-and-Water-Dating-Laboratory/Introduction-to-Water-Dating-and-Tracer-Analysis/Radon

53 GNS Science (who carry out Radon analysis in NZ) typically use a Radon concentration of >0.5 BqL^{-1} as an indicator of groundwater contribution[2].

54 Concentrations measured by WWA ranged from 0.1 to 2.6 BqL^{-1} and of the eight surface water samples collected, five had concentrations >0.5 BqL^{-1}. Based on the GNS interpretation guidance, all five of these sites exhibit some degree of groundwater contribution.

55 The Salles stream samples indicate a groundwater contribution between the 'Salles Drain' and 'Salles Downstream' sites and the both the Seymour Drain and Selwyn Drain also indicate groundwater contribution.

56 In my opinion the results actually indicate a strong potential for groundwater contribution into the drains and/or surface channels of the wetland that requires further investigation.

57 Unfortunately, the survey did not extend into the centre of the wetland or assess Te Kahuna Stream which is a significant outflow on the coastal side of the wetland. In my opinion, a more extensive survey, including a downstream transect along the Seymour Drain into Motutangi Stream would be very useful for assessing groundwater contribution into the centre of the wetland.

VOLUME OF WATER TAKE

58 The DOC submission identified that the proposed abstraction from the Motutangi groundwater management zone, in combination with the existing consented groundwater abstraction for this zone, would exceed the allocation limit as stated in Policy D.4.17 of the Proposed Regional Plan for Northland. This statement was made based on the information provided in Table 3 of the consent application peer review report (LWP, 2017).

59 It now appears that the total abstraction for the Motutangi groundwater management zone was incorrectly calculated in Table 3, with one third of the proposed abstraction for Mapua Avocados Limited being located within the neighbouring Houhora groundwater management zone (this application consists of a combined groundwater take from three separate bores).

60 The groundwater allocation status for the three zones in question have now been revised, with analysis tables being provided within the Officers Report (Table 5) and the evidence of Jon Williamson (Table 2). It should be noted that there are two main differences

[2] Heather Martindale, GNS Science Groundwater Geochemist. Pers. Comm. 12/03/18.

between the two tables, one being the proposed abstraction volumes and the other being the current allocation status. However, these differences aside, the calculated total allocation from the Motutangi groundwater management zone would be below the specified allocation limit, if the application was granted. As such, I agree that the proposed abstraction is a Discretionary Activity, not a Non-Complying Activity as specified in the DOC submission.

61 Based on my assessment, however, in my opinion, the hydrological effects of this discretionary activity on Kaimaumau Wetland have not been adequately addressed.

SUMMARY

62 In summary I believe that the evidence I have presented above discuss a number of points relevant to the assessment of effects of the proposed abstraction on the Kaimaumau wetland. The key points can be summarised as:

a. Use of a regional scale model to assess effects at a local scale

b. Use of a quantitative assessment of drawdown and reduction of flows based on anecdotal and uncalibrated data

c. A poor distribution of calibration heads

d. A lack of hydrological and hydrogeological data in and around the nationally significant Kaimaumau wetland, resulting in the inability to assess and report on baseline conditions

e. A lack of proposed monitoring of groundwater water levels and drain/stream flows in and around the wetland

63 When combined, the above points make it difficult to have confidence in the presumption that effects of the proposed abstraction is less than minor.

64 In summary, because of the absence of baseline data, the level of uncertainty in the groundwater modelling with regards to the wetland is too high for an adaptive management approach. As such, I recommend the consent should be declined.

Timothy Baker
19 March 2018

REFERENCES

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