BEFORE INDEPENDENT HEARING COMMISSIONERS

AT NAPIER AND WAIPAWA

I MUA NGĀ KAIKŌMIHANA WHAKAWĀ MOTUHAKE

KI AHURIRI & WAIPAWA

IN THE MATTER	**of the Resource Management Act 1991**
AND	
IN THE MATTER	**of the hearing of submissions on applications for take and use of Tranche 2 groundwater, Ruataniwha Basin**

STATEMENT OF EVIDENCE OF DR VAUGHAN KEESING
ON BEHALF OF TRANCHE 2 APPLICANTS

(AQUATIC ECOLOGY)

31 OCTOBER 2022

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1. EXECUTIVE SUMMARY

1.1 This evidence is a revised assessment and conclusion of my initial ecological assessment following further model verification between Hawke's Bay Regional Council (**HBRC**) and the applicant's expert groundwater modeller (Aqualinc) resulting in a new "typical" summer drawdown model output; and following caucusing between HBRC's expert ecological consultant and myself. It reflects agreements and differences caused by those two processes.

1.2 In assessing the potential for effects to small streams in the Ruataniwha Basin, Hawke's Bay, 38 locations were visited representing around 26 streams which had reaches or tributaries near or within predicted drawdown areas. The drawdown areas were initially modelled with worst case drawdown situations over 20 years but that has been updated since my initial effects report (Bml, Keesing 2022) with a typical later summer drawdown modelled response related to the proposed deep aquifer water abstraction for irrigation.

1.3 The reaches surveyed were measured for depth profiles and flow patterns through cross sections relating to each of three typical hydrological habitat types present i.e., runs, riffles and pools. Wider riparian and instream factors (macrophyte, algae etc.) and other features related to aquatic habitat were recorded that indicated the condition of the aquatic communities. No fish or aquatic benthic macroinvertebrate sampling was undertaken with reliance for that data on HBRC survey work some years previously and state of the environment monitoring (SOE) which does not include all the small streams. Farmer knowledge was sought during the surveys to assist in determining (especially in the losing reaches west of SH50) which streams generally remained with surface water year-round and which did not. I am also reliant on the work of Ms Alexandra Johansen for that expert local flow information.

1.4 These data allowed an assessment of instream ecological condition, habitat quality, permeance of surface water and ecological value. The depth data in particular allowed examination of the resultant effects of the predicted drawdowns. Some adjustments to the drawdown predictions were then made for certain streams based on my acquired knowledge of the stream's nature relative to groundwater and substrate condition.

1.5 The Ruataniwha basin is a highly modified and well used alluvial plain which has had intensive farm modification for over 100 years. There is almost no remnant wetland, forest or stream feature in this landscape.

1.6 Of all the streams assessed the new typical summer drawdown has most potential impact to the central Kahahakuri system that runs through Spring Hill and a little north of the township of Ongaonga until its perennial reach somewhere east of Plantation Road. Several of the very small, poor quality centre valley tributaries to the Ongaonga Stream between Ngarara Road and the Tukituki River are also numerically affected, but these have very poor quality conditions minimising the level of adverse effect that can be done to them.

1.7 In essence, as a broad conclusion, I am confident that no stream within the basin potentially affected by the deep aquifer abstraction will, because of existing intermittent nature, or sufficiency of water, and robust aquatic community, be likely to be adversely affected by the proposal in more than a minor way. That effect, should it occur would also highly likely be reversable through modifications to the take regime.

1.8 I also surveyed a range of wetlands across the Basin to determine their status (RMA wetland or natural wetland) and their potential vulnerability to change because of the potential drawdown. The great majority of wetlands identified were constructed features (and so not natural wetlands). Those potentially more natural were typically in the gaining reaches (eastern basin) and are very deep wetlands which will not be adversely affected.

1.9 I also surveyed Inglis Bush to determine the nature of the forest community and to determine if water stress was a current issue. I found the forest to be typical of river terrace forests (totara-kahikatea-titoki) once common in the Basin and with several other examples still present in the landscape west and north, but it is not a wetland or swamp forest. No adverse effects of the proposal are likely to the forest and its functioning. There is also a small ponded potential wetland at its southern edge and near the outer limit of expected drawdown. While this potential wetland may experience a shift in the level of water, it is (as I understand it) a product of land use and has those experiences already, and any wetland flora and fauna will, in my opinion, adapt appropriately such that no value reflected in the National Policy Statement for Freshwater Management 2020 (2020a) (NPS FM) will diminish.

2. INTRODUCTION

2.1 My name is Vaughan Francis Keesing.

2.2 I am a Senior Ecologist and Partner with the consulting firm of Boffa Miskell Limited.

2.3 I have been a consulting ecologist for the last 25 years. My qualifications include a B.Sc. (Hons, 1st) in Zoology and a Ph.D. in Ecology, both from Massey University, as well as a certificate in Research Statistics.

2.4 My skills lie in community ecology. I have specialist skills in the areas of limnology (the study of inland waters, including wetlands), entomology, zoology, and botany, and I have worked extensively in freshwater and terrestrial habitats.

2.5 During that time I have undertaken a wide range of ecological surveys of natural and semi-natural sites. I have provided assessments of values and significance of sites for many councils and private clients, as well as assessing ecological effects of a range of activities on those sites.

2.6 This work has included assessments across a range of projects and habitat types, such as:

(a) determining significant wetlands (as part of exercises in the West Coast Region and Ashburton to identify Significant Natural Areas (SNAs) and in Rangitikei as part of its Protected Natural Areas Programme);

(b) bush significance assessments (over 150 Franklin District Conservation lots, 50 Western Bay of Plenty lots, and many more across New Zealand);

(c) large-scale roading projects involving wetland assessment, stream diversions, stream recreation, and stream loss and devising proposals to offset stream and wetland effects (e.g., MacKays to Peka Peka Expressway and Transmission Gully);

(d) wind farms (e.g., Haurapaki, West Wind, Hurunui, Mill Creek, and Hauāuru mā raki) and hydroelectric schemes (e.g., Arnold, Wairau, and Coleridge);

(e) over 20 large-scale subdivisions (e.g., Omaha South (Darby Partners), Long Bay (Landco), Pegasus Bay (Infinity Co), and Ravenswood (Infinity));

(f) plan changes and Structure plans (e.g., Porters Ski Field expansion, Pukerua Bay Northern Growth Area (Porirua)); and

(g) most relevant to this hearing because it involved assessments of effects of water level changes to ecosystems is the work I have undertaken for the following:

   (i) Hurunui irrigation project (Hurunui),

   (ii) Waitohi irrigation water diversion and dams (Hurunui),

   (iii) Wakamoekau community water storage (Masterton);

   (iv) Ngaruroro WCO (Napier),

   (v) Conway minimum flow regime (North Canterbury),

   (vi) North Christchurch stream minimum flow assessments,

(vii) Wairau hydroelectric power scheme (Blenheim).

Code of Conduct

2.7 Although this is a Council hearing, I have read the Environment Court's Code of Conduct for Expert Witnesses and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this statement of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of Evidence

2.8 For this project I have surveyed the water take basin (the Ruataniwha Basin) for natural wetlands and smaller streams in and around the modelled water drawdown areas in order to describe their condition and sensitivity to potential groundwater changes causing surface water changes.

2.9 My evidence will address the following matters:

(a) Small streams: presence, condition, historic faunal data, instream habitat depth metrics, sensitivity to change.

(b) Wetlands: presence, condition, qualification under the NPS FM, sensitivity to change.

(c) Inglis Bush: type of forest, sensitivity to groundwater change.

2.10 Where appropriate and relevant, my evidence will reference and rely on the evidence of Mr Julian Weir (Aqualinc), whose opinion I agree with.

3. THE RUATANIWHA BASIN: OVERVIEW

3.1 The Ruataniwha Basin in the central Hawke's Bay is a river created gravel basin some 1.5-2 million years old following uplift of the Ruahine Ranges and constrained eastward by a series of low limestone hills (the Turiri Range), and north by the extension of Wakarara Range out of the Ruahine Ranges.

3.2 The Ruahine Ranges westward provide the rain from the heads of the catchments of the Waipawa, Tukituki, Makaretu, Mangaonuku and Turipo (the larger braided rivers of the Basin).

3.3 Many of the smaller tributaries arise from hill springs east of the main ranges and have less reliable flows year-round. All rivers and streams which flow over the basin, merge into the Waipawa and Tukituki Rivers at its eastern edge, around 10 km east of Waipawa and Waipukurau towns.

3.4 The Ruataniwha aquifer is a multi-layered alluvial system comprising a relatively shallow unconfined layer, and several deeper confined aquifers.

The "Small" Streams

3.5 The basin has a range of smaller tributaries to the Waipawa, Tukituki, Makaretu, Mangaonuku and Turipo Rivers. It was these smaller streams I focused on for my assessment.

3.6 It is assumed that the very large rivers are mostly independent of the predicted groundwater change and assessment by Aqualinc (Mr Wier) indicated a strong absence of effect.

3.7 I used the initial worst case prediction drawdown contours produced by Aqualinc (Mr Weir's) overlaid on an NZ 250 topographic map to locate the streams in or near the predicted drawdown areas and targeted those areas for investigation.

3.8 These I reasoned were the streams most likely to be influenced by the proposed deep aquifer water harvest.

3.9 I surveyed all these streams over 1 week (week of the 18th April 2022).

3.10 38 locations representing around 26 stream/tributaries were visited and the streams and locations are listed in Appendix 1 and the map of locations in Appendix 2.

3.11 I note that while I waited to undertake my survey until a time when the HBRC monitored larger rivers were flowing at their typical levels for that time of the year, my survey follows on the back of an accepted wet summer and that is likely to have meant that the small streams at survey were running with more water than they would following a more typical dryer summer.

Wetlands

3.12 On the 4th of November 2021 I visited from north to south all of the locally known wetland areas, guided by two local farmers. At each wetland I noted the species and proportional cover, water sources and discharges and general condition. This allowed me to consider the wetlands under the MfE 2020 Wetland Delineation Protocols (Ministry for the Environment, 2020b) and NPS FM (2020) exclusions.

4. RESULTS OF ASSESSMENT

Wetlands

4.1 I inspected 16 wetland features on the 4th of November 2021 and also recorded two others in my week long site visit in 2022.

4.2 Since my survey I have also been made aware of a HBRC initiative to begin to locate natural wetlands (as required by the new NPS FM (2020)). A map was supplied by the Council reviewer (Ms Drummond) produced by Mr Nick Singers. That map indicates that there are more wetlands than I have identified, but that map is much wider than my scope. I have talked to the author of that wetland mapping and have been informed that the map is an indication using aerial photography of where natural wetland is likely to be, not a ground-truthed certainty, but a first cut for verification. My map, produced from a site visit and local knowledge and within the drawdown areas, and Mr Singers' are sufficiently similar that I am confident no natural wetland, which is not excluded by being created, has been missed.

4.3 Twelve of the features I surveyed were human created "duck ponds". Each had been dug out, the sides and islands formed, and a range of exotic trees and harakeke planted. Most were around 20-30 years of age.

4.4 These areas are in low points of farms and may once have been natural wetlands or at least swampy pasture, but today they are planted exotic-dominated shallow ponds with rough edges of tall fescue and Yorkshire fog, lotus, creeping butter cup and weeds with occasional *Carex secta* and *Juncus edgariae* and *J. effusus* under willow with a dense or sparse canopy. Aquatic flora was generally limited to duck weed (*Lemna disperma*), *Azolla rubra* and pond weeds (*Potamogeton crispus, P. cheesemanii*).

4.5 One of the pond features (Rob Wilson Pond) had shallow wet edges that held some Carex and abundant Eleocharis (*E. acuta*) (indigenous wetland species) amongst mercer grass and Yorkshire fog. This was the most "natural" wetland edge visited.

4.6 I also saw many small stock ponds throughout the landscape which while having Azolla and duck weed and even occasional edges of harakeke or Carex are not natural wetlands (being excluded by the exceptions in the NPS FM (2020), and the current NPS FM exposure draft).

4.7 I consider that the 12 "duck ponds" are also excluded from being natural wetlands by exclusion 3.21(1) natural wetlands (a) of the 2020 NPS FM – i.e. constructed wetlands, and also by exclusion 3.21(1) natural wetland (b) of the exposure draft NPS FM 2022 (Ministry for the Environment, 2022).

4.8 Given the status and condition of the features recorded, effects, if any, of a drawdown in surface water need not be considered in terms of adverse effects or effects that would require avoidance, remedy or mitigation.

4.9 The remaining six wetlands I located were not duck ponds or other purposefully created wetland features. There is a willow wetland feature between Tikokino Road and Makaroro Road; a seepage feature with herbaceous vegetation along the stop bank of the southern side of the Waipawa River; a swale-like feature at the end of Parson Road with raupo; and three wetlands (willow and carex) associated with Black Creek which is one of the many tributaries that flow into the lower Kahahakuri Stream and then the Tukituki River near Waipukurau.

4.10 These largely induced (but still natural) exotic dominated willow wetlands are generally in the gaining reach of the basin, which is to say the area where groundwater re-surfaces and where the streams and wetlands are the deepest. These features I consider highly unlikely to be affected by any drawdown because of the depth of water present within them.

Small streams

4.11 In regard to the water sources, springs are less common in the west. They are generally in the east (Baalousha, 2012), so the western small streams are very much rain driven and so vulnerable to seasonal drying and do not have much stability. Indeed the landowners of the small streams west of SH50 related to me that for as much as 9 months of the year these small streams are surface dry. The reaches in the east are persistent and often deep. In my assessment I considered streams west of SH50 to be in the losing reach, streams east of Burnside-Plantation Roads to be gaining, and in between a transition (neutral).

4.12 The small waterways throughout the Ruataniwha Basin are generally in poor ecological condition. While most retain a “hard” bottom, they generally lack good riparian cover and diversity (willow in the main or pasture) and most, in the central and especially the west of the basin, suffer substantive summer low flow and even surface depletion. All have experienced a range of farming activity inputs over the last 150 years and few have had previous edge protection or buffers to farming activities.

4.13 The benthic invertebrate fauna remains marginally good (but not everywhere) but tilting to poor, and fish fauna, while representative in the bigger systems and including some At Risk species (such as dwarf galaxiid), are reduced to 3 or 4 species in the smaller tributaries.

4.14 The values at large in the small streams can be considered low (and moderate where Threatened and At Risk fish species populations persist).

4.15 The small streams have likely been diminishing in quality over the last 20 years as suggested by comparison between the MCI indices of 2003 and more recent scores (Data from HBRC studies and state of the environment monitoring). This most likely means a relatively simple and insensitive fauna and my observations of the small streams character bears that out.

4.16 All of the small streams I surveyed are characteristic habitats of tolerant, robust, and simple fauna, insensitive to flow variation (or other perturbations).

The Kahahakuri system

4.17 In the following, because the Kahahakuri system is the one stream predicted to be the most affected, I present a series of photographs that show the typical state of the stream from Spring Hill (at McLeod Road bridge) downstream to Plantation Road. This "state" is typical of the small streams south too.

4.18 I found that the important features were, little to no riparian cover, the edges were farmed pasture with related effects, and the stream systems are shallow and small and dry on the surface in places.

4.19 The southern tributary held more water, in that it was not surface dry, but again the edges were unprotected, in pasture, stock pugged and damaged, with heavy long green filamentous algae and macrophyte, generally indicative of poor quality but abundant aquatic communities and so reasonable longfin eel (tuna) habitat.

Photo 1 The Kahahakuri main branch at McLeod Road Bridge

Photo 2 The main branch at Caldwell Road

Photo 3 Main branch at Chesterman's Bridge SH50

Photo 4 Main branch at Plantation Road

Photo 5 True right (south) branch downstream of SH50

Photo 6 South branch upstream of Plantation Road

5. POTENTIAL GROUNDWATER DRAWDOWN RELATED ADVERSE EFFECTS.

5.1 The effect on ecological features of the proposed tranche 2 deep groundwater harvest is the potential to reduce the amount of surface water in the streams and wetlands within a predicted drawdown area to the point where the aquatic instream flora and fauna are adversely affected and change above and beyond that which is seasonally normal.

5.2 Aqualinc (Mr Weir) has developed predictions for effects to the larger rivers and has modelled shallow groundwater drawdown contours showing changes in shallow groundwater depth related to groundwater harvest over the basin related to the expected bore sites. He initially modelled a worst case scenario described to me as an accumulation of the effect over 20 years of the activity in operation. I used this effect in my initial AEE. Then, since his caucusing with HBRC where the groundwater experts reached agreement on the model (as revised to address some identified issues), he has developed a typical summer drawdown using March 2001 as the typical condition.

5.3 I used these predictions to understand where effects might occur and the severity of those effects.

5.4 In terms of river flows, Mr Weir's modelling shows the average and 7-day **minimum** annual low flow (MALF) change very little for the Tukipo or Mangaonuku, to the point where Mr Weir concluded no noticeable effect would be present to average or low flow statistics. From an ecological perspective (and while I have not considered the larger rivers/streams) it is reasonable to say that it is unlikely that this difference could cause any change to any species or habitat condition in those rivers.

5.5 In terms of the groundwater modelling, I consider that there must be a lag time from take to expression of that take on the surface given the depth and possibly differential permeability of the interceding layers. I understand that this lag time is not considered in the model. The relevance is that "effects" to the amount of water may not manifest themselves until perhaps autumn when rainfall will be greater. This is an unknown but makes the assessment more conservative.

5.6 If accurate it will mean that the season of effect moves more into the wetter autumn rather than late summer.

5.7 The drawdown effect to groundwater must also be variable across the basin even within the modelled drawdown contours as it is dependent on the specific underlying soils and their permeability. I already know that the northern Pettit Valley Stream (one of the better quality systems) has a papa bed along at least some of its length and this separates the bed water from the groundwater.

5.8 My assessment should therefore be seen as a generalised worst case assessment.

5.9 I initially weighted (based on my site observations) the drawdown based on locations. I suggested in my AEE that drawdown west of SH50 should be 100% of the predicted as it is a losing part of the basin – surface flows are lost to groundwater. I suggested that the drawdown east of a line between Takapau and Ruataniwha should be 25% of the predicted as this is the gaining part of the basin and the effect and lag the least impacting. And centrally (in the neutral zone (see Appendix 3)) I considered, with incorporation of a lag time and different permeability, a 50% surface water difference of the predicted shallow groundwater change to be a fair numerical figure to work with.

5.10 My revised assessment based on the new modelled typical scenario did not then also weight the amount of draw down as did my AEE and the drawdown affects assessed here (and at caucusing) are “raw”.

5.11 I took this assessment drawdown refinement and compared the measured instream water depths of my survey. That assessment data I present in the following table is one of my primary assessment tools (Table 1).

Table 1. Depth measures and predicted drawdown leading to the estimated aquatic habitat feature depth change in the small streams of the basin. Green indicates remaining positive depth, red a surface dry condition and orange a substantive depth decrease.

Stream	Habitat	Reach	original worst case Model prediction mm	new 1 March (average summer) & 13 mm/yr take (mm)	Average depth (mm) of stream	First, worst case, water depth result (mm)	Typical[1] summer water depth result (mm)
Mangamate Stream	Riffle	100%	200	80	72	-128	-8
	Run		200	80	140	-60	60
	Pool		200	80	600	400	520
Mangamate Creek Rd tributary	Riffle	losing	200	30	56	-144	26
	Run		200	30	254	54	224
	Pool		200	30	400	200	370
Lower Mangamate Stream	Riffle	losing	200	80	230	30	150
Richardson's Bridge tributary	Run	losing	200	80	297	97	217
	Pool		200	80	575	375	495
Mangamauku Stream	Riffle	losing	200	80	130	-70	50
	Run		200	80	188	-12	108
Mangamauku @ Wharetoka	Run	neutral	200	80	260	60	180
Mangaoho @ Tikokino	Run	losing	200	170	220	20	50
Mangaoho @ Rathbone	Run	losing	200	170	327	127	157
	Riffle		200	170	100	-100	-70
Mangaoho @ Butler Rd	Run	neutral	200	50	706	506	656
	Riffle		200	50	121	-79	71
Two-mile Stream above SH50	Run	losing	600	140	90	-510	-50
	Pool		600	140	400	-200	260
Two-mile Creek @ Butler Rd	Run	neutral	300	110	280	-20	170
Kahahakuri – Spring Hill Reserve tributary	Run	losing	300	280	56	-244	-224
Kahahakuri – McLeod Rd bridge	Run	losing	700	340	717	17	377
	Riffle		700	340	70	-630	-270
	Pool		700	340	800	100	460
Kahahakuri –- Chesterman's Bridge	Run	losing	500	260	0	0	0
	Riffle		500	260	0	0	0
	Pool		500	260	0	0	0
Kahahakuri north – Plantation Road Bridge	Run	neutral	300	240	0	0	0
Kahahakuri @ SH50	Run	losing	400	240	188	-212	-52
Kahahakuri @ Plantation Rd	Run	neutral	300	240	224	-76	-16
Ongaonga Stream	Run	losing	400	190	700	300	510

[1] The new typical model output comes from a recalibration of the model and is not the same model as was used to produce the original "worst" case scenario.

Stream	Habitat	Reach	original worst case Model prediction mm	new 1 March (average summer) & 13 mm/yr take (mm)	Average depth (mm) of stream	First, worst case, water depth result (mm)	Typical[1] summer water depth result (mm)
	Pool		400	190	600	200	410
Ongaonga valley central tributary	Run	losing	300	180	100	-200	-80
	pool		300	180	400	100	220
Ongaonga valley south (Tahunga)	Run	losing	300	210	116	-184	-94
	Riffle		300	210	92	-208	-118
	Pool		300	210	318	18	108
Pettit Valley north tributary	Run	losing	200	270	303	103	33
	Riffle		200	270	110	-90	-160
	Pool		200	270	403	203	133
Pettit Valley central tributary	Run	losing	200	210	80	-120	-130
	Riffle		200	210	122	-78	-88
	Pool		200	210	560	360	350
Pettit Valley South tributary	Run	losing	200	170	110	-90	-60
	pool		200	170	370	170	200
Blackburn Valley north tributary	Run	losing	200	150	140	-60	-10
	Riffle		200	150	100	-100	-50
Blackburn Valley central tributary	Run	losing	200	150	144	-56	-6
Blackburn southern tributary	Run	losing	0	150	346	346	196
	Riffle		0	150	59	59	-91
	Pool		0	150	395	395	245
Main stem Blackburn Stream	Run	losing	0	180	280	280	100
	Riffle		0	180	110	110	-70
	Pool		0	180	615	615	435
Tukipo Ashcott @ Burnside Rd	Run	Neutral	200	50	0	0	-50
Tukipo Ashcott @ Ashcott Rd	Run	Neutral	0	10	900	900	890
Tukipo-Ashly farm tributary	Run	Neutral	200	40	550	350	510
Tukipo – Mangatewai	Run	Neutral	300	40	381	81	341
	Riffle		300	40	161	-139	121
Tukipo – Mangapohio	Run	Neutral	300	30	247	-53	217
Black stream – Parson's branch	Run	Gaining	300	160	526	226	366
	Pool		300	160	505	205	345
Black stream Woodbrock	Run	Gaining	300	160	520	220	360
	Pool		300	160	530	230	370
Black stream @ Fairfield Rd	Run	Gaining	300	160	200	-100	40

5.12 The green areas of the table are where there will remain surface waters in the various habitats, almost always in the pools, and often in the runs and more rarely in the riffles. An important consideration is to not follow the percentage change but to understand if there is sufficient water depth to allow all the existing life to be sustained. For example at the Kahahakuri - McLeod Rd bridge a depth change of ca 717 to 377mm will appear to be a near 50% decrease, but because the life in the pool was predominantly midge, mosquito, worm, amphipod, snail and water boatman, that 377mm is as good as the 700mm in sustaining the populations at viable levels. Even eel would continue, even if with added stress, to be sustained in that scenario.

5.13 No colour is where the stream habitats were dry at survey (even in the wet summer conditions).

5.14 The gaining reaches of the basin, those generally deeper streams such as the Tukipo catchment, Black Stream, Waipawamate Stream, lower Kahahakuri Stream, are unlikely to be adversely affected by the possible groundwater drawdown as predicted by the model. Each will retain more than sufficient water as surface water to allow all the species and communities present currently to persist without compromise when the water takes are in operation.

5.15 Those streams in the "neutral zone" (see Appendix 3) are not sufficiently drawn down and are sufficiently deep as to not be adversely affected in any ecologically meaningful way.

5.16 Unsurprising, it is some of the losing reach streams (those west of SH50) that show the greatest potential for drying.

5.17 Losses to below surface were

- riffle at Mangamate
- riffle at Mangaoho @ Rathbone
- Two-mile Creek above SH50 – run

- Kahahakuri along its reach in general – although without impact to the main stem below the Cladwell Road intersect
- The small central valley tributaries (6) between Ngaruru Road and the Tukituki River

5.18 There are three general types of streams in the losing reach:

(a) wide gravel northern streams set in wide gorge-like formations (Mangamate, Mangamauku, Mangaoho);

(b) small narrow intermittent valley streams with short, small catchments (Ongaonga Valley streams, Pettit and Blackburn Valley streams, Two-mile Creek, Creek Road); and

(c) larger perennial streams (Ongaonga, Pettit Valley north and lower Blackburn main stem).

5.19 These last three are larger likely perennial flowing systems (at least in the areas I surveyed, acknowledging that local knowledge has them drying in a range of their reaches annually) that reach back up into the foothills for their sources (or have a great many tributaries such as the main stem lower Blackburn) and have substantial water and are more than likely to retain much of their riffle habitat (not that they have much riffle habitat being mostly run). They are not likely to suffer substantive loss to the point where any habitat feature is dry and pools in the main are unaffected.

5.20 The most significant drawdowns are in the Kahahakuri system and west of SH50 in the Ongaonga, Pettit and Blackburn Valley central tributaries. These represent two forms of stream (as described above), the single thread valley bottom streams of limited flow with small catchments, and the larger 3rd to 4th order perennial larger deeper streams fed by numerous tributaries with substantive bank height.

5.21 I discuss these streams in the following section.

Mangamate / Mangamauku

5.22 The northern cobble systems have been recorded as having poor and very poor quality macroinvertebrate communities and seasonal surface flow restrictions or outright long reaches of surface drying (Hawke's Bay Regional Council, 2003). There is a small range of fish (NIWA Freshwater fish database).

5.23 The risk in terms of low flow effects to quality systems is largely absent.

5.24 These streams are seasonal drying systems, and the aquatic fauna has adapted to this change and responds seasonally by moving into the gravels, into the hyporheic zone (Woessner, 2017), and / or moving laterally into permanent pools or lower reaches that sustain surface water (i.e., out of the intermittent sections). Those that typically move into the hyporheic zone can persist 'chasing' the water down for months to several meters deep. There are permeant dwellers in this deeper habitat zone also – the Stygofauna (Boulton et al., 1998; Stubbington, 2012; Winterbourn & Wright-Stow, 2002) which are unlikely to be affected.

5.25 Fish also move away from declining depth and find water resources in stable pools or move upstream or downstream of typical drying reaches and / or many are able to move (up to several meters deep) into the hyporheic zone (Kawanishi et al., 2013) and take seasonal refuge there.

5.1 If drying is to occur more than is typical (and that now seems unlikely with the typical model now run (Mr Weir, Aqualinc)) it is likely that those hyporheic migration behaviours will start a little earlier and go on a little longer, only this will not only be related to the proposed deep water take but it will also be the expected response to the growing climate change issues. The extension of the predicted drying is, I am told, roughly 3 days earlier and 3 days longer i.e. 6 days in a year of additional drying. This is a minor change.

5.2 I am of the opinion that any such change caused by the tranche 2 deep water harvest will not "inconvenience" the fauna such that their "fitness" is affected.

5.3 In short, the logic to me appears reasonable that the streams here on perched beds will respond as they currently do with increasing regularity towards longer dryer summer periods related to climate change more than the possible drawdown effect and the fauna will manage based on their current normal seasonal behaviours.

5.4 I assess that it is likely that the magnitude of effect (the drawdown change) will be negligible (if at all) and to a low value system (based on condition); the result being a very low level of effect (EIANZ Guidelines (Roper-Lindsay et al., 2018)). A very low level of effect (if at all any effect) is a "less than minor corresponding RMA level of effect". Such an effect should not require mitigation or offset.

Kahahakuri upper tributaries (Spring Hill and McLeod's)

5.5 The small tributaries of the wider Kahahakuri Steam are shallow and other than the reach within the remnant Springhill Reserve, are of a quality and value reflective of low flow, intermittent systems in unbuffered past0ral farmland with corresponding seasonal nutrient, sediment and stock access issues. These challenges over 100 years have meant that the aquatic fauna is limited, tolerant and very robust. The main stem (northern branch) is, even following a wet summer, dry at the surface for a substantive reach – Plantation Road upstream to at least SH50. It already has significant surface flow issues to the point where the proposal cannot make it poorer. Upstream the tributaries are likely to experience an additional 5-6 days of surface dry conditions. This will add some stress but will not change the assemblage's persistence. The effect I consider to be low (EIANZ Guidelines 2018), that is, a minor shift away from existing baseline conditions with the underlying character, composition and attributes of the existing baseline condition retained.

5.6 The southern smaller branch has greater flow, but not better aquatic instream condition. Nevertheless, it will experience earlier (3 days) onset of drying and it will experience greater drying and those reaches not always dry will be dry. This will not however have much detrimental effect on natural indigenous representative macroinvertebrate communities or fish communities.

Pettit Valley North system

5.7 This is arguably the best stream in the Ongaonga-Blackburn Valley system. It runs near and south of Pettit Valley Road. It has greater habitat variability than the Ongaonga Stream, within some native riparian vegetation and a reasonable substrate. It is not as robust or large as the lower Blackburn or Ongaonga Stream – there is a level of greater flow vulnerability.

5.8 This stream has better aquatic condition and values than the other intermittent systems nearby. The stream is also partially or largely on a papa bed which makes it impermeable and (as with the Mangamate) perched above the shallow groundwater aquifer. That means it does not respond directly and along the bed to changing groundwater.

5.9 The only direct effect might be to the feeder springs but currently the project hydrologist (Mr Weir, Aqualinc) considers that this stream area, despite the drawdown model predictions, will not be affected in terms of loss of surface water. Therefore, I see it unlikely to be adversely affected.

Ongaonga Valley, Pettit Valley, Blackburn Valley, Creek Road Mangamate tributary

5.10 These tributaries are all small narrow (<1m), shallow, meandering valley floor intermittent streams with limited catchments from generally one source not far into the foothills.

Photo 7 Ongaonga central valley tributary

5.11 All the small valley tributaries south to the Tukituki are predominantly without riparian woody vegetation and are almost entirely within the pastoral system, without defining banks and the shallow runs are normally partially or fully vegetated in Yorkshire fog and Glyceria fluitans.

5.12 Given the substrate, flow variability, vegetation cover type (grass) and likely water quality, it is unlikely these streams support fish species (other than occasional longfin eel) and likely that they have a simple and abundant low Macroinvertebrate community indices (MCI) community. These communities are both very resistant and resilient and already suffer seasonal drying.

5.13 I consider that these tributaries are of sufficiently poor quality and are such robust communities adapted to variable flow conditions, that adverse effects of the predicted drawdown, although of the more extreme of the predicted drawdowns in the wider project, will not suffer any measurable aquatic community decline or value or conditional change because they are dryer for longer (potentially an additional week a year).

5.14 The overarching level of effect across the basin, I consider, is likely to be very low, sufficiently low that adverse effects will be hard to monitor, and I consider that such a level of adverse effect should not require any form of effects management.

5.15 I appreciate that this opinion is not shared by, Ms Drummond, the HBRC's consultant ecologist, and I discuss this further below.

6. INGLIS BUSH

6.1 There has been debate surrounding Inglis Bush and wetland and the potential for effects. Initially I understood the debate to be about the forest and its evident dieback of the canopy kahikatea and that that related to historic water race conditions. After expert conferencing I appreciate that there was a small wetland at the south end that could be of issue.

6.2 I first note that the issues around Inglis Bush have been on-going for at least 30 years, with Mr Jim Watt of Landcare research providing a detailed assessment in 1997 (Watt, 1997) of the likely impact of the Ashcott water race on the bush (an issue raised by Forest and Bird to DOC in 1994). He concluded the race was not the cause of kahikatea dieback, but that the droughts which were worse and compounded since 1950's were.

6.3 In saying this, clearly there have been a range of modifications in regard to water around and in the forest. One main one was the Ashcott water race (constructed in 1965-66) which used to take water from the Tukituki through the forest in a dug channel and emerged near a wetland before passing on to Ashcott. The channel was dry on my site visit and I understand, and can see, that it is not used for the transport of water any longer.

6.4 Mr Watt also concluded that there is a trend (in 1997) of tawa and titoki prominence in the canopy as the pioneer kahikatea reach over-maturity and die off with a canopy change to then include totara and matai (with the tawa and titoki).

Photo 8 From MWH 2011 (Tukituki Catchment Terrestrial Ecological Characterisation prepared for HBRC Dec. 2011). Orange arrow points to southern small wetland area.

6.5 I walked (with a local guide, Mr Van Der Burg) through the reserve forest from the northern west corner centrally to near the southern eastern corner. I traced and noted the old northern boundary fence and the 1-2m terrace riser at the fence (the line observable on the aerial photo above as a distinct colour change right to left), beyond which I was informed was open pasture a short time earlier and was outside of the bush reserve.

6.6 The lower terrace was largely willow, fallen timber, and a range of weeds (blackberry) and early colonisers.

6.7 Inside the reserve the dominant canopy numerically was titoki. There were large trees of totara, kahikatea, matai and tawa but the dominant canopy species is titoki. In relatively closed canopy areas, the under canopy is relatively open and contains mahoe, pigeonwood, small leaved milk tree, Coprosma rotundifolia, kawakawa, konono, tawa saplings, titoki saplings, kahikatea saplings, rewarewa saplings, shield fern, thread fern, hen and chicken fern, and shining spleenwort.

6.8 The kahikatea which are emergent of the titoki canopy are very large and old, the diameter at breast height (DBH) of the largest being over 2m. The MWH 2011 report (Forbes et al., 2011) references Grant 1996 (a book "Hawke's Bay Forests of Yesterday") with the age of the oldest kahikatea being over 340 years old. It seems reasonable to me that those trees at around 400 years old (Smale, 1984) and most of the way through their likely 500-600-year life span (Hinds & Reid, 1957). It is reasonable to expect these old trees to be showing signs of poor health and decline including sections of canopy dieback and dropping branches. These conditions are observable in the canopy kahikatea in Inglis Bush.

6.9 The forest is not a wetland forest, but is a typical river alluvial terrace forest, once common down most of the rivers in the basin and adapted to growing on light soils and river gravels with alluvial materials. While there were wetter swamp forest areas in the Ruataniwha Basin these were usually in the valley central areas further east.

6.10 The future, based on saplings of Inglis Bush forest, is titoki, tawa, matai and totara (i.e. I concur with the earlier Watt Landcare report). It is relatively independent of the deep and shallow groundwater, with the forest's roots running very deep in the old river gravels and the plants present capable of managing large-scale groundwater variation seasonally.

6.11 In my survey I did not encounter any flows or springs in the bush or feeding the southern wetland.

6.12 The southern potential wetland, in my opinion, is a product of water retention from a storage type modification. I will be visiting this feature prior to the hearing to confirm my current opinions. I Because at writing I say this because of the shape and very straight south-eastern face and land demarcations seen on the 2006 aerial (Google). I agreed in expert conferencing that I had not seen this area and that a drawdown was possible, but because in a 1943 aerial photograph (attainable from the web site "Retrolens") there is no sign that such a wetland existed I suspect that it is not a natural wetland. In any respect if a drawdown was to occur such that the general reservoir and associated wetland was affected by drying that caused a vegetation change, the most likely effect would be a shift in the wetland "inwards" i.e., as the pond shallowed the vegetation assemblage would move into the shallowing water while retreating at the outer edges. There would be a net neutral effect.

Photo 9 Google 2006.

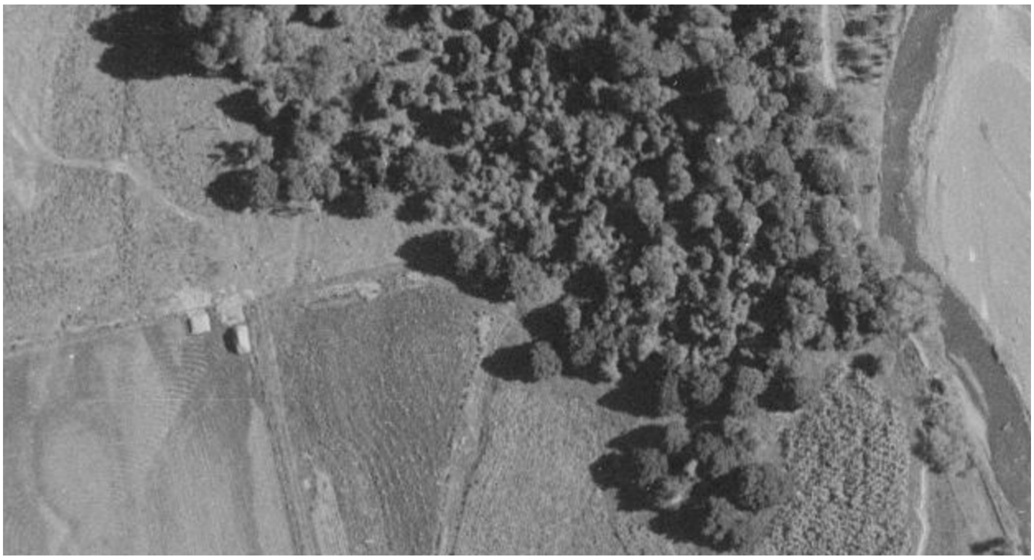

Photo 10 1942 – Inglis Bush southern half and lower picture is a close up of the "wetland" area.

7. CONCLUSION

Small streams

7.1 In my opinion the changes occur to streams already experiencing considerable periods of surface dry and the change will be sufficiently minor and small that no measurable effects are likely. This is because of a current seasonal lack in flow, the retention of inter run meander bend pools, coupled with a very tolerant and low-quality suite of aquatic instream fauna, and generally no or limited number of fish (longfin eel which retreat seasonally).

7.2 Lower eastern streams are too deep and with soft muds and macrophytes that are too deep to be affected even by higher level drawdown predictions.

7.3 There may be, in some riffle habitats in the losing reaches of the basin (west of SH50) were there will be an exaggeration of the usual seasonal drying effects (up to 6 additional days and less deep surface water presence), but this is not a new or high magnitude change. The effect of a more prolonged surface dry situation will be a deeper and/or longer migration for species into the hyporheic zone. This will not cause the loss of or decline in the aquatic communities.

Wetlands

7.4 The great majority of wetland features on the plains are either stock ponds or duck ponds. These constructed features are excluded from the definition of natural wetland in the NPS FM (2020)

7.5 Those few (three areas) natural wetlands (the Black Creek complex, Waipawa stop bank and Tikokino Road) are still induced systems of exotic nature and small size and are insensitive generally to seasonal surface water and shallow groundwater change, by and large because they are in the gaining reach around Parson Road.

Inglis Bush

7.6 The Inglis Bush is a quality river terrace forest of titoki and tawa with emergent kahikatea, totara and matai. It is not a swamp or wetland forest and will not be affected in any measurable way by deep aquifer water takes. The changes occurring currently are related to tree age. The small wetland in the south, while having reputed values, is likely retained by the impoundment of water where historically there was no wetland and any drawdown effect, if sufficient to cause change, should be a repositioning of the wetland vegetation not a loss.

8. RECOMMENDATIONS BY S 42A REPORT AND RESPONSE

8.1 Ms Drummond (PDP) is the HBRC freshwater ecology reviewer and has reviewed the surface water aspects for HBRC and has passed comment in regard to the small streams and wetland effects ecological assessment which I produced.

8.2 It was Ms Drummond and I who have subsequently caucused and produced a joint witness statement (18 October 2022) on freshwater ecology.

8.3 In that joint statement we agreed on a range of matters and had “disagreement” only on a few.

8.4 We agreed that many of the small streams have a simplistic aquatic fauna adapted to impacted conditions and are robust to change.

8.5 We also agreed that there is only limited data on the aquatic communities, including fish communities, of the small streams within the affected area. The opinion as to the assemblages and their quality is based on the survey observation of the habitat available, the HBRC surveys of similar nearby streams, and experience of sampling in streams of the observed condition.

8.6 We agree that the new typical summer model shows a less adverse condition than the first worst case model.

8.7 We also agree by and large that the streams within the drawdown effect (as shown in the modelling) will have a reduced amount of surface water during abstraction, but what the real magnitude of change will be remains uncertain.

8.8 We agree that the effects will be more pronounced in some streams than others and that the drawdown, that now naturally occurs, will be exacerbated.

8.9 In respect to the impact of these changes, in essence Ms Drummond does not consider that sufficient evidence has been provided to support an assessment of an absence of dramatic change in the habitats affected.

8.10 I understand her thinking to be that Table 1 shows reductions and drying of riffles and runs in many stream reaches and large drawdown of refugia habitat (pools), at least in terms of percentage change. This is even though she agrees that the aquatic communities present are simple and robust to change.

8.11 Her rationale, as per the joint statement, is that without details on the current ecological values at the specific sites, including fish presence and migration pathways, she considers that it cannot be said that dramatic changes will not occur.

8.12 I do not share that opinion in that the conditions of the aquatic habitat and likely values present are such that based on a widely accepted correlated faunal value of poor, farmed, small, intermittent stream systems, enough information is available, through my survey and HBRC surveys, that the risk of an incorrect value or an adverse effect to any system of indigenous value or representative value is very low and that change in general will also be small, minor, and possibly not even sufficiently large as to be able to be monitored.

8.13 The difference in magnitude of effect and so risk seems to lie in the amount of specific site related data, even while we agree that many of the affected streams are simple, robust, communities resistant to change.

8.14 While we agree that the new modelled change portrays a less adverse situation, Ms Drummond still considers that the depth change predictions (both original and new) are underestimated as the average depths measured in March 2022 were not characteristic of seasonal low flows.

8.15 I still consider the measures made when they were made are sufficiently informative of the season to see the pattern and magnitude of change likely. I note also that even with the wet summer there were a range of stream reaches especially in the Kahahakuri system that were surface dry and it is those reaches that are predicted to be the driest. It is my evidence that where a reach is generally dry or dry for weeks or months on end, not days, a further 5-7 days of drying (as predicted) will not change the faunal communities already capable of lasting in that system or their functions.

8.16 We agreed this point in the joint statement but then reflected that the knowledge of just how long these small streams remained surface dry and with what frequency is not "known" and that my assumptions (above and beyond my 1 week of observations) are based in discussions with the landowners and with Ms Johansen (see section 6 of her evidence and site photographs), not in a formal water level measure regime. That said it is clear that these streams, especially west of SH 50, are very dry for long periods virtually every year.

8.17 In discussing the hyporheic zone we agreed that where the surface water is drawn to below the surface, the hyporheic zone will be drawn down also, more than it is currently. We also agreed that hyporheic zone communities in the western hill-fed areas are likely of better condition than those in the lowland area, and that impacts to the hyporheic zone will be lower than that in the surface water environment, with only areas where surface drying occurs being impacted.

8.18 We importantly agreed that there could be changes to the hyporheic zone where surface drying occurs, but this will be low level and is not likely to result in a significant adverse effect.

8.19 In terms of wetlands, we agreed that the wetlands identified (by the Applicant's survey) are mostly created wetlands for recreation and amenity (duck shooting) and can be excluded via the NPS FM exclusions. We further agreed that there is a low likelihood that any natural wetlands were missed in the Applicant's assessment of the modelled drawdown area.

8.20 In regard to Inglis Bush we agree that the forest is not a wetland forest and will be being affected by a range of issues including age, natural succession, pests, water stress, surrounding land use influences etc.

8.21 We discussed the southern small wetland and determined that it is within the wider potential drawdown area even while not under the mapped contour lines of drawdown in Mr Weir's report. I determined to visit the site prior to the hearing.

8.22 I am respectfully of the opinion that Ms Drummond's analysis falls on the very conservative side because she does not benefit from the detailed instream work that I undertook. As she states, there is insufficient detailed evidence on the specific sites for her to draw a conclusion.

8.23 Most importantly, while I realised that the current conditions of the majority of the small waterways were severely compromised with a dry adapted aquatic community and therefore very robust and tolerant, Ms Drummond, on the other hand, considers the poor condition and resilient communities as therefore without tolerance to further change and requires no further stressors but instead restoration.

8.24 We both agree that mitigation or instream assistance to these small intermittent systems of a nature that might reduce the potential effect is problematic and potentially unachievable, noting that riparian revegetation would likely cause greater intermittency rather than cure it.

8.25 If there is to be mitigation or offset (and we are perhaps not on the same page on that) it depends to a degree on the planning framework, then we are in agreement that it should be as an offset and focus on a reach of perennial stream that will potentially suffer drawdown and that requires other assistance and so better secure enhanced instream habitat and fish passage etc.

8.26 In terms of the augmentation, this has not been put forward as ecological mitigation. At conferencing we discussed (and agree) that augmentation should not be undertaken in ephemeral or strongly intermittent reaches where it was to change that condition (the pattern of water habitat).

8.27 If augmentation to a stream was to be to a strongly intermittent or ephemeral reach but did not change the pattern of flow because the discharge was subsumed to the ground water within a short distance then this would not be of concern to me in regard to the effect Ms Drummond and I were concerned about -i.e. turning an ephemeral system into an intermittent system.

8.28 We also agreed that any augmented water from the deep aquifer must be quality checked before being discharged to a surface waterbody.

8.29 Given the above I recommend an augmentation management plan be developed so as to be sure that it occurs in sensible locations and appropriate rates and times.

8.30 Lastly, we agreed that one way to reduce uncertainty would be to install some water level monitoring devices into some of the potentially drawn down streams (I recommend the Kahahakuri at McLeod's Road bridge, the Pettit north at Pettit Valley Road, the Ongaonga at SH50 and the Mangaoho at Rathbones bridge (SH50)) to measure water level change before and after abstraction is undertaken.

8.31 In summary, I have reviewed Ms Drummond's review report and we have caucused and while there remain some differences, primarily around risk, and quantity of specific stream detailed biotic information, I do not consider changes need to be made to my assessment as set out earlier in this evidence or my conclusions.

Final Conclusion

8.32 I am of the opinion that the adverse freshwater ecological effects which may occur, and the level of those changes, are small (such that they may be determined to be less than minor), will be largely too small to measure with any accuracy in terms of macroinvertebrate or fish communities and are ultimately reversable through the removal or reduction in the take programme should the consent be granted.

Dr Vaughan Keesing

31 October 2022

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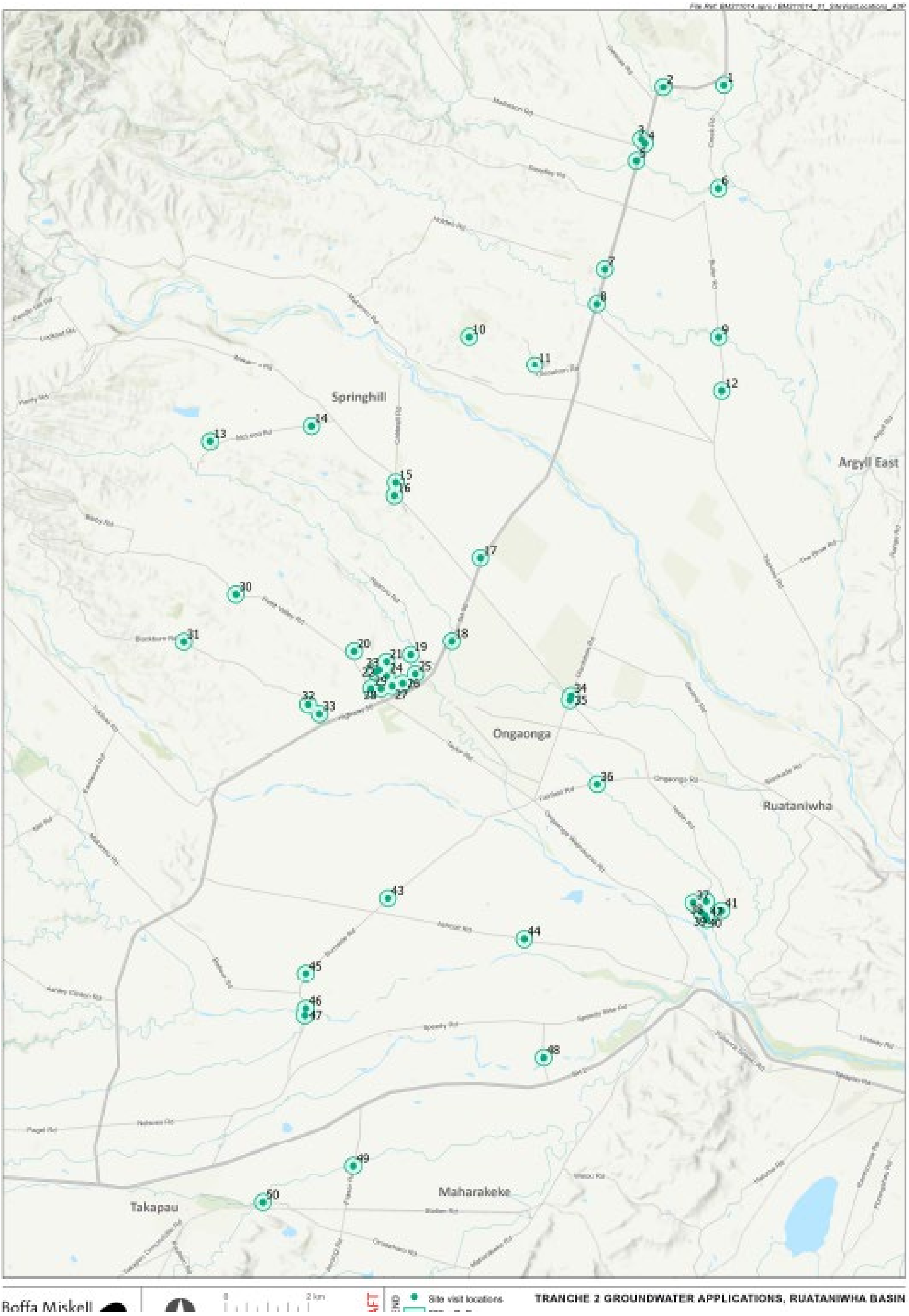
Appendix 1 -Stream survey sites

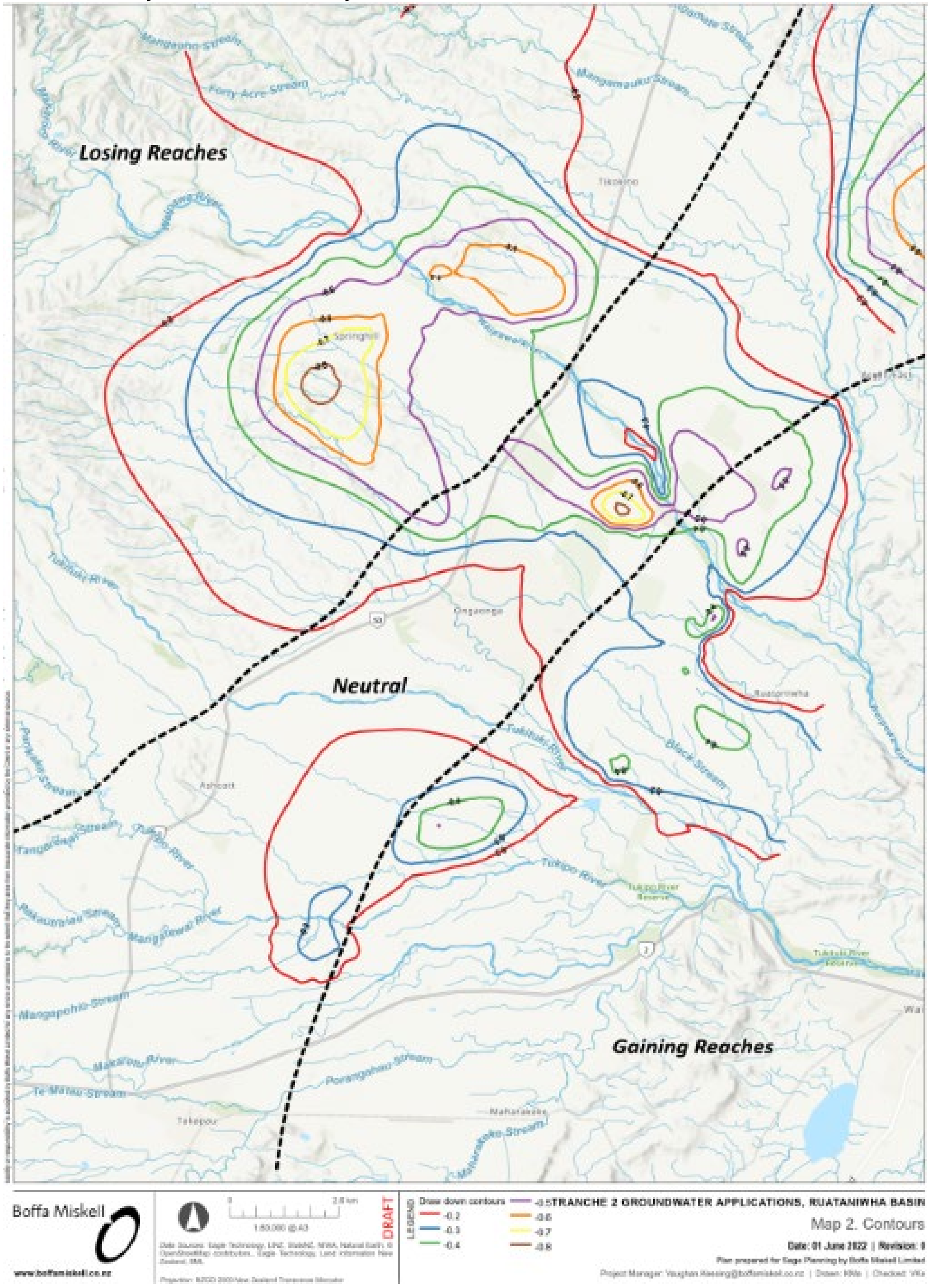
The stream name (where there is one) is given and the sites and extent of stream potentially affected is show on map 1.

Site name	**Site**
Mangamate Creek road	1
Mangamate	2
Richardson's Bridge tributary	3
Richardson's Bridge tributary	4
Mangamauku Stream	5
Mangamauku- @ Wharetoka	6
Mangaoho @ Tikokino	7
Mangaoho @ Rathbone	8
Mangaoho @ Butler Rd	9
Two-mile stream QEII	10
Two-mile stream above SH50	11
Two-mile Creek @ Butler Rd	12
Kahahakuri - Spring Hill reserve tributary	13
Kahahakuri - McLeod Rd bridge	14
Kahahakuri - McLeod Rd bridge	15
Kahahakuri - McLeod Rd bridge	16
Kahahakuri - Chesterman's Bridge	17
Kahahakuri @ SH50	18
Ongaonga Stream	19
Ongaonga valley south (Tahunga)	20
Ongaonga valley central tributary	21
Ongaonga valley central tributary	22
Ongaonga valley central tributary	23
Ongaonga valley central tributary	24
Ongaonga valley central tributary	25
Main stem Blackburn Stream	26
Main stem Blackburn Stream	27
Main stem Blackburn Stream	28
Main stem Blackburn Stream	29
Pettit north valley tributary	30
Pettit valley central tributary	31
Blackburn valley north tributary	32
Blackburn valley central tributary	33
Kahahakuri nth - Plantation Road Bridge	34
Kahahakuri @ Plantation Rd	35
Kahahakuri @ Plantation Rd	36
Black Stream Woodbrock	37

Appendix 2. Site inspection location map



Appendix 3 – Drawn down modelled contours and gaining, neutral and loosing zones initially used to make my assessment.



Appendix 4 – Concluding Stream effects maps