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memorandum

TO	Paul Barrett	FROM	Neil Thomas
	Hawke's Bay Regional Council	DATE	29 September 2021
RE	Tranche 2 Groundwater Consent Applications – Ruataniwha Basin		

1.0 Introduction

Pattle Delamore Partners Limited (PDP) has been engaged by Hawke's Bay Regional Council (HBRC) to assist with the technical review of a group of applications to take Tranche 2 groundwater from the Ruataniwha Basin. These applications propose to take deep groundwater (Tranche 2 groundwater defined in the decision on Plan Change 6 for the HBRC Regional Plan) from bores in the Ruataniwha Basin. The decision defining Tranche 2 groundwater also specifies that the water can only be allocated if the consent holder also augments surface water flows with the intention to ensure that stream depletion effects that could arise as a result of groundwater abstraction are mitigated.

Table 1 below summarises the optimised volumes of each consent application based on Aqualinc's model scenario 4 which considers the possibility of low flows still being affected by irrigation and augmentation in dry years (1 in 10 year). The original volumes applied for are different for some applications, as described further in this review.

Table 1: Summary of Tranche 2 consent applications volumes

Application Number/s	Applicant Name/s	Total Tranche 2 Volume (m^3/year)	Irrigation Volume (m^3/year)	Augmentation Volume (m^3/year)
WP140512T	Te Awahohonu Forest Trust (TAFT)	4,914,920	2,841,220	2,073,700
WP150016T	Springhill Dairies	1,005,213	588,313	416,900
WP150044T	Tuki Tuki Awa Ltd[1]	707,700	678,100	29,600
WP160193T	Plantation Road Dairies	3,751,225	2,418,225	1,333,000
WP140555Tb APP-124498	Papawai Partnership	1,475,517	1,010,817	464,700
WP170155T APP-124500	I & P Farming Limited	1,200,010	916,010	284,000
WP170166T	Buchanan Trust No.2	1,145,794	786,594	359,200
APP-125281	Purunui Trust	554,921	370,321	184,600

1. Some discrepancies with volumes listed in AEE and conditions

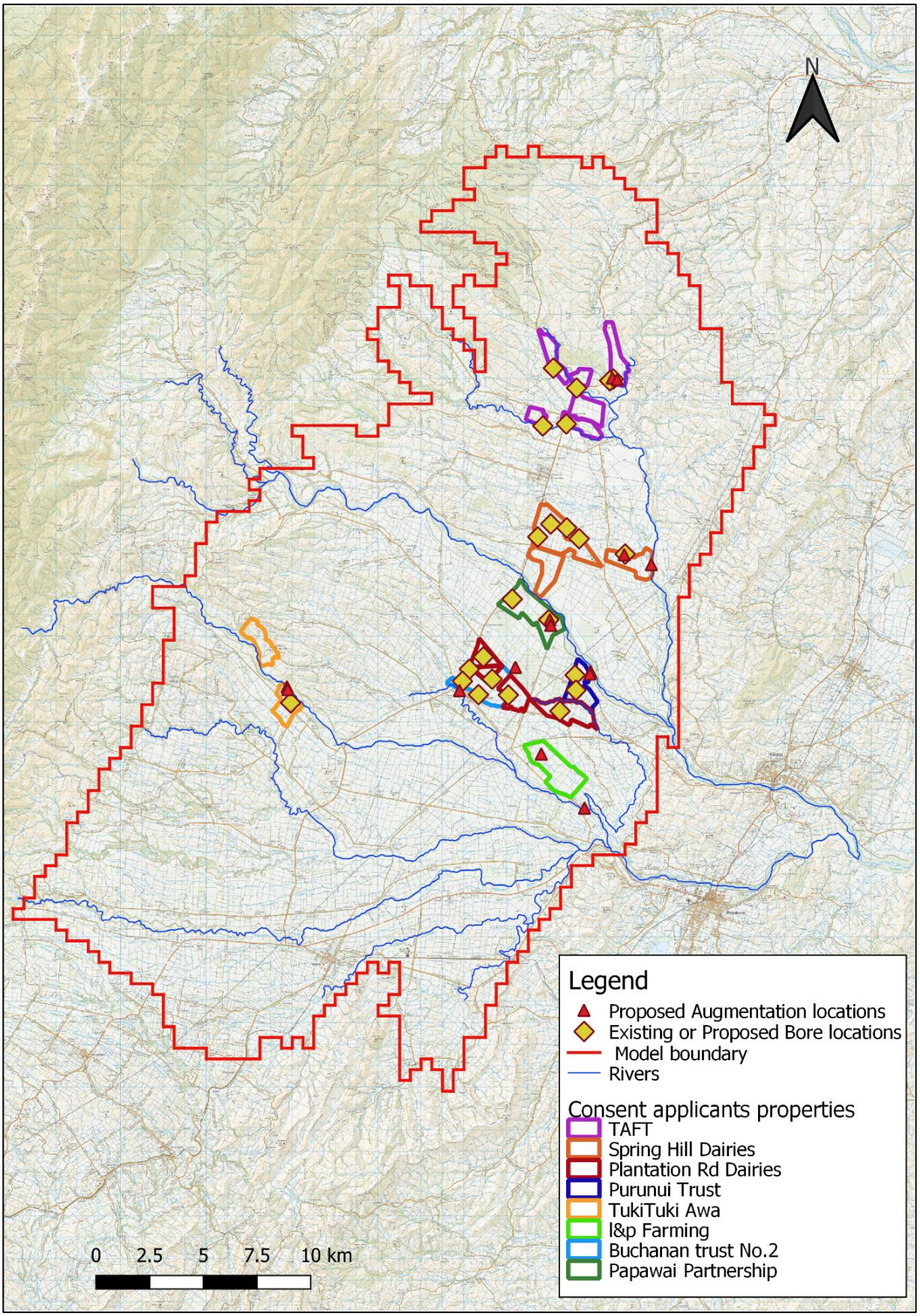

Figure 1: Tranche 2 applicants' properties, locations for groundwater irrigation bores, proposed augmentation takes and discharges and key rivers in the catchment. Red line shows previous HBRC model boundary.

2.0 Overview of information provided

2.1 Geological setting

At a broad scale, the geology of the Ruataniwha Basin can be split into two overall intervals, with a younger gravel formation overlying the older Salisbury Gravel formation to a maximum depth of around 200 m below ground surface (as described in Weir (2013)). However, the depth and thickness of the younger gravels is not well defined, and it is likely that the younger gravels grade into the deeper gravel formation without a distinct intervening surface.

Groundwater in the basin is recharged through rainfall, less any evapotranspiration, together with river seepage from the main Tukituki and Waipawa rivers, with a lesser component of seepage from other, smaller streams that occur across the basin. The Ruataniwha Basin is effectively enclosed by lower permeability strata and, as a result, groundwater discharges from the basin principally via upwards seepage into the main rivers and also through groundwater abstraction.

In such a setting, where the natural groundwater discharge is via seepage into streams and rivers, all groundwater abstraction will, in the long term, result in an equal volume of water lost from the streams and rivers, aside from a small component of irrigation return water.

2.2 Summary of assessment of environmental effects

As part of the assessment of environmental effects provided with the application, a variety of information has been provided to describe the potential effects of the takes. This information includes:

- The results of numerical groundwater modelling used to describe the impacts of additional abstraction on rivers flows.
- The results of an assessment of the effects of lowering the shallow groundwater level on wetlands that occur in the local area of each of the proposed takes.
- The results of an assessment of drawdown interference effects on neighbouring bores due to pumping from each of the proposed takes.

We note that both the assessment of effects on the wetlands and on neighbouring bores are based on the results of the groundwater model; they do not use available aquifer test data. Although this helps to ensure that the assessments are consistent across the area it also places greater reliance and emphasis on the numerical modelling. The numerical model does include the results of pumping test analyses as part of the model input datasets, but it is not clear that the model reasonably simulates the results of the pumping tests. Further comments on these data and assessments are provided in later sections of this memo (Section 11, 12 and 13), with comments on the information as it pertains to each individual take provided in Section 3 to 10.

2.3 Comments on the numerical groundwater model

In the modelling included in the August 2021 AEE report, the adverse effects are defined as impacts on the Waipawa at SH2 and Tukituki at Tapairu Road flow sites, which are considered (in the modelling) to represent flows at the basin outlets. The conclusion in the AEE is that adverse effects at those sites are not expected to occur as a result of the combined Tranche 2 abstractions and augmentation flows. We note the following:

- The model is calibrated to flows at the Waipawa at SH2 and Tukituki at Tapairu Road flow sites (although the modelled flow changes are not large across the basin).
- Comparison of the modelled to observed flows at the Waipawa at SH2 and Tukituki at Tapairu Road flow sites outside the calibration period indicates good agreement between simulated and observed flows (although a range in parameters can achieve this).

- The sensitivity analyses carried out show a consistent direction of effect at the Waipawa at SH2 and Tukituki at Tapairu Road flows sites (i.e. reduction in average flows and increases in low flows) despite relatively large changes in parameters.

However, the Tranche 2 takes will impact other streams and rivers across the basin. It is not clear that the model is suitable for forecasting effects on these other streams for the following reasons:

- The model is not calibrated to flows in smaller streams and rivers within the basin, which include low flow sites for example on the Tukipo River.
- The model was not calibrated to observed patterns of gains and losses from the rivers and streams within the basin (including the Waipawa and Tukituki).

Information provided by Aqualinc (2021b) indicates that the model appears to broadly replicate the pattern of gaining and losing reaches across the model area. However, the model tends to over represent the observed scale of losses from streams within the basin and under represents the scale of observed gains to streams within the basin. Overall, these discrepancies make little difference to calibration of the model at the basin outlet points (i.e. they will cancel each other out) but these differences will affect estimates of the modelled streambed conductance within the basin. In turn, this will affect the estimates of stream depletion effects in local streams due to pumping within the basin.

Maps showing the distribution of streambed hydraulic conductivity compared to the aquifer hydraulic conductivity in the upper most model layer have also been provided. These indicate that generally, streambed hydraulic conductivity values tend to be lower in the south of the model area compared to the north of the model area with the greatest values (between 1 and 5 m/d) occurring in tributaries to the Waipawa and upstream of Tikokino. As expected, streambed hydraulic conductivity values are typically lower than the modelled hydraulic conductivity of the surrounding strata.

In general, our opinion is that the model is a suitable tool for estimating the overall effects of the proposed Tranche 2 takes on flows at the basin outlets (i.e., at the Waipawa at SH2 and Tukituki at Tapairu Road flow sites) and this is the stated purpose of the model. However, the discrepancies between the modelled pattern of stream losses and gains within the basin and the observed patterns imply that the model is likely to be less suitable for assessing local effects of pumping on streams flows within the basin and, by extension, drawdown interference, because modelled drawdown interference will be affected by modelled stream depletion particularly in shallow strata. We also note that absolute values of changes in the shallow aquifer level have been used in these assessments, which may not be appropriate.

3.0 Te Awahohonu Forest Trust (TAFT)

3.1 Details of the application

The Te Awahohonu Forest Trust (TAFT) applied for a take of 4,914,920 m^3/year of Tranche 2 groundwater in November 2014 to irrigate 540 ha of pasture on a Gwavas Station property, located on 5740 State Highway 50 and 50 and 90 Matheson Road, Tikokino. TAFT does not currently hold any groundwater consents for the property. The applicant originally proposed that 2,890,000 m^3/year of the Tranche 2 groundwater take would be used for the purpose of irrigation and the remaining 2,024,920 m^3/year would be used for augmentation. The combined rate of Tranche 2 groundwater take is not to exceed 420 L/s and no one point of take is to exceed a rate of 100 L/s. The consent duration sought by TAFT is 20 years.

The 90th percentile water demand for pasture calculated using 'IrriCalc' is approximately 580 mm/year, which over 490 ha equates to an annual volume of 2,841,220 m^3/year. However, a larger area of 850 ha could be irrigated with 2,841,220 m^3/year of Tranche 2 groundwater if less water intensive crops and/or horticulture or a mixture of pasture, crops and horticulture were used.

Groundwater for irrigation is proposed to be taken from four existing bores (well no. 16563, 16592, 16593 and 5515) and a fifth proposed deep bore.

- Well no. 16563 has a depth of 162.2 m below ground level (bgl) and is screened below 145 m depth, across a blue gravel/blue clay layer.
- Well No. 16592 is an exploratory bore with a depth of 220.8 m bgl and is screened below 193.16 m across a coarse pink-grey ash and gravel layer.
- Well no. 16593 also an exploratory bore has a depth of 222.3m bgl and is screened below 138.30 m across grey ash/pumice. This bore is incorrectly located on the HBRC online GIS maps. Static water levels at the time of drilling are reportedly around 3 m below ground level.
- Well No. 5515 is 66.0 m deep and is screened below 54 m across a gravel layer.

One or more proposed bores will be used for augmentation with discharge directly to the Mangaonuku Stream at a rate of 189 L/s (daily average).

3.2 Local hydrogeological setting

The TAFT properties are located at the northern end of the Ruataniwha Basin and close to the outcrop of the lower permeability strata. The two largest surface waterways in the local area are the Mangaonuku Stream and the Mangamate Stream, which converge to form the Mangaonuku Stream around 1 km downstream of the TAFT properties.

Given the local setting, recharge to the deeper strata in this area is likely to include runoff from the surrounding higher ground as well as via some seepage losses from the local surface waterways. Static water levels appear to be variable; bores in the terrace above bore 5515 are around 20 to 30 m below ground level (e.g. bore 5881), which would be close to, or slightly below the likely level of the nearby surface waterways. However, groundwater levels in the deeper bores drilled by TAFT indicate that groundwater pressures at depth may be greater and closer to the surface.

The drillers log for bore 5515 indicates mostly claybound gravels to around 40 m depth overlying permeable gravels. The drillers log for bore 16563 and other deeper bores indicates generally similar strata to around 60 m depth, below which is a series of clay and gravels units, together with a few ash/pumice intervals.

3.3 Existing aquifer test information

Details of a pumping test are only available for one of the TAFT bores (5515) which yielded the following aquifer parameters, based on observations in bore 3882 (53 m deep):

Table 2: Pumping test results

Well number	Transmissivity (pumped aquifer) (m^2/day)	Storage	Aquitard Conductance (K'/B') (1/day)
5515	1,000	5.90E-05	3.00E-05

The aquifer parameters generally indicate reasonably permeable pumped strata with a relatively low rate of leakage from overlying strata, suggesting that drawdown effects in shallow strata due to pumping are likely to be delayed in time and likely widely distributed. Although these parameters are only applicable to bore 5515, the limited leakage effects are likely to be applicable for the other bores that make up part of the TAFT application given the greater depth of those bores.

3.4 Potential local well interference effects

Based on the aquifer parameters listed, drawdown interference effects in neighbouring bores within 500 m (which is approximately the distance to the nearest bore of a similar depth) of bore 5515 that are a similar depth could reach around 3.5 m due to pumping at 100 L/s for 100 days. Drawdown effects in shallower strata would likely be less than 0.1 m within 500 m of the take. No aquifer parameters are available for the deeper bores, although effects on shallow bores are expected to be less than 0.1 m because of the greater thickness of strata overlying the screened intervals of those bores, however cumulative effects due to all the bores pumping together may exceed 0.1 m.

Drawdown interference effects on neighbouring bores have been assessed as part of the application and as noted above, the drawdown interference assessment is based on changes in water levels calculated by the numerical model. Based on plots provided in the application, these indicate that drawdown effects on bores in the area around the TAFT property more than 50 m deep would be in the order of 8 m, which is likely to be broadly in keeping with the results of the aquifer testing. Drawdown effects on shallower bores (classified as <50 m deep) are estimated to be around 0.2 m, which, again, is likely to be broadly in keeping with the results of the pumping test.

However, we note that the model results represent the drawdown effects from 3 March 2001, which the applicant indicates represents the time of the greatest simulated effects of abstraction. It is not clear from the AEE that all bores were pumping at the fully consented rate at that time, so the model forecast drawdown interference effects may be an underestimate of the potential effect if the bores pump at the fully consented rates. In general, whilst the model provides some useful indication of drawdown interference effects particularly at a cumulative scale, in our opinion, drawdown interference effects would be better characterised based on the aquifer parameters derived from pumping tests from individual bores.

3.5 Potential local stream depletion effects

The closest surface waterways to the TAFT properties are the Mangaonuku and Mangamate Streams, which are within a few metres of bore 5515 and within 100 to 200 m of the other deeper bores. Static water levels may be close to or slightly below the stage of the local streams, implying that the streams may lose water to groundwater in this area.

The onsite assessment of waterways in the area around the TAFT property identified that the local streams were either flowing at a very low rate, or were dry in March 2021 and that the streams have a gravelly substrate. It is likely that these streams lose water to groundwater, and therefore drawdown effects in shallow groundwater due to pumping will likely increase the rate of loss, or, where the streams are naturally dry, prolong the length of time that the streams are dry and the length of the reach where the streams are dry. In our opinion, this effect is not considered in the assessment, beyond a comment that the modelled estimate of changes in shallow water levels are negligible.

3.6 Potential local effects on wetlands

Based on the information provided in the AEE, no wetlands were identified in the area around the TAFT properties. However, there may be wetlands that have not been identified.

3.7 Other local effects including augmentation discharge effects

Discharges to water are a permitted activity according to the application provided some conditions are met. TAFT propose to discharge water into the Mangaonuku Stream and it will be important that the discharge site is carefully chosen to ensure that scouring does not occur, and that discharge does not occur at times of heavy rainfall (which is not intended).

4.0 Papawai Partnership

4.1 Details of the application

The applicant Papawai Partnership, located at 1041 State highway 50, Ongaonga, currently holds a groundwater resource consent (WP 140555T) that authorises abstraction from bores 1859 and 16508 at a combined rate of 130 L/s, with a maximum annual volume of 608,212 m^3/year (1 July – 30 June in consecutive years) and 120,960 m^3/28 day period. The applicant notes that the existing consented volume is not adequate to provide sufficient application rates.

Papawai Partnership have made two applications for Tranche 2 groundwater with the intention of increasing production and more efficiently farming non-irrigated areas of the property. The original application submitted in March 2017 sought a take of up to 423,062 m^3/year of Tranche 2 groundwater, the second application submitted in August 2019 sought up to 1,052,455 m^3/year of Tranche 2 groundwater. Combined, the take totals 1,475,517 m^3/year consisting of 1,010,817 m^3/year for irrigation and 464,700 m^3/year to augmentation. The consent has been sought for a duration of 20 years.

The Tranche 2 irrigation allocation will serve to supplement the existing take of 608,212 m^3/year which will provide adequate irrigation to 181 ha of pasture or extend to 320 ha of less water intensive crops and/or horticulture or a mixture of pasture, crops and horticulture. The requested volume will be extracted from bores 1859 and 16508.

The augmentation volume of 464,700 m^3/year will be abstracted from existing bore 16508 or from other bore(s) on the property. Discharge of augmentation water will be into a disused, shallow bore located approximately 300 m south of 16508. The discharge bore is regarded to be directly connected to the nearby Waipawa River and is to be tested prior to augmentation.

4.2 Local hydrogeological setting

The Papawai Partnership bores are located in the central part of the Ruataniwha Basin on the true right bank of the Waipawa River and around 5 km north-east of Ongaonga. The applicant's two bores are both relatively deep:

- Bore 1859 is screened from 77.5 m to 87.5 m below ground level with static groundwater levels around 10 m below ground level at the time of drilling. The drillers log describes the lithology above the screened interval as consisting of gravel, with some clay. Based on the drillers log, groundwater levels in the deeper strata were higher than in the shallower strata.
- Bore 16508 is screened from 85 m to 119 m below ground level with static water levels at the time of drilling around 4 m below ground level. The lithology above the screened intervals consists of gravels with some clay, and many water bearing intervals noted in the drillers log.

The Waipawa River is located around 400 m away from both the bores, which are located around 2 km from each other. Both bores are located on a slight terrace above the river, suggesting that the static water levels in the bores may be at or close to the river stage elevation.

4.3 Existing aquifer test information

Aquifer test information is available for bore 16508, which is summarised in Table 3.

Table 3: Pumping test results			
Well number	**Transmissivity (pumped aquifer) (m^2/day)**	**Storage**	**Aquitard Conductance (K'/B') (1/day)**
16508	1,160	1.50E-04	<2.00E-05

The results of the pumping test indicate a reasonably permeable aquifer with relatively low levels of leakage from overlying strata, although this would not preclude an effect from pumping in shallow bores.

4.4 Potential local well interference effects

Drawdown interference effects as a result of pumping from the applicant's bores have been estimated based on the aquifer parameters listed above. Pumping rates are assumed to be up to 130 L/s from either bore, which would enable the applicant to use their proposed annual volume (plus their existing consented volume) within around 150 days.

These indicate that drawdown interference effects in neighbouring bores could exceed 4 m within 500 m (which is around the distance to the nearest neighbouring bore (2933) of a similar depth to 1859) in the pumped aquifer and exceed 0.1 m in shallower strata.

In the application, drawdown interference is estimated to be around 2 m in bore 2933, which in part may reflect a split pumping rate between the applicant's two bores and that some of the effect is considered as part of the existing consent that Papawai Partnership currently holds, although this is not clear from the application. However, based on a split pumping rate and using the analytical solution, drawdown effects are still expected to be more than 3 m in bore 2933, which does not allow for cumulative effects from other Tranche 2 takes. Therefore, the numerical model may underestimate local well interference effects compared to the analytical solution which is based on the pumping test data from bore 16508.

In shallower strata, drawdown interference effects in the numerical model used in the application are estimated to be around 0.3 m to 0.4 m, which is slightly greater than estimated by the analytical model although the numerical model allows for effects from neighbouring takes including Springhill Dairies.

4.5 Potential local stream depletion effects

Stream depletion effects may occur in the closest surface waterways, including the Waipawa River, although given the depth of the bores and that the relatively low value of leakage derived from the pumping test data, we would expect that these effects will develop relatively slowly. Some depletion will occur however, and depletion may also occur in nearby tributaries to the Waipawa River (for example the Kahahakuri Stream) and more widely due to a lowering of shallow groundwater levels.

The applicant has briefly considered these effects in the application but has noted that the effects are expected to be negligible. In our opinion, there is insufficient evidence presented in the application to demonstrate that this is true as no assessment of the scale of flow loss has been undertaken, and no assessment of the values of surface waterways is provided.

4.6 Potential local effects on wetlands

In a similar way to the assessment of effects on local streams, only a limited assessment of effects on local wetlands has been completed. This assessment also concludes that declines in the shallow water takes of up to 0.5 m represent negligible effects, which does not seem justified or backed by any consideration of the ecological impact of that decline on local wetlands.

4.7 Other local effects including augmentation discharge effects

Papawai Partnership indicate that they intend to discharge augmentation water through a shallow bore located within 300 m of the river. Whilst this may be appropriate, no testing has been undertaken to demonstrate whether this will be feasible, or what mounding effects may occur in the area around the discharge point. Both these aspects should be considered together with an assessment of how effectively the discharge augments flows in the Waipawa River.

5.0 Tuki Tuki Awa Ltd

5.1 Details of the application

Tuki Tuki Awa have applied for a Tranche 2 groundwater consent to provide additional water to irrigate areas of their property which extends across two catchments: the Upper Tukituki sub catchment and Tukipo Sub catchment. The property is located at 406 Tukituki Road, Takapau and is a dairy farm with approximately 136 ha of pasture and crops. Water for irrigation is currently supplied under surface water consent WP120320T. This consent grants a volume of 174,180 m^3 per 28 day period at a rate of no greater than 78 L/s alongside 560 m^3 in any 28 day period for dairy shed usage. The overall consent is subject to low flow restrictions when the Tukituki River is at or below relevant low flow limits at specific monitoring sites.

The applicant lodged an application in February 2015 to take Tranche 2 groundwater for a total of 952,400 m^3/year, of which 882,800 m^3/year was to be used for irrigation purposes and 129,600 m^3 for river augmentation. As currently proposed, groundwater will be used to supplement the surface water take when restrictions are in place. The applicant proposed the following:

- To take groundwater from four proposed 300 mm diameter bores, screened at a depths of greater than 50 m
- To abstract a maximum of 103 L/s of groundwater for irrigation of crops and pasture alongside the required stream augmentation.
- The annual volume of groundwater abstraction between 1st July to the following 30th June shall not exceed 952,400 m^3
- Consent duration of 20 years is sought.

To determine the required irrigation across the property, calculations were made using IrriCalc. This modelled the applicant's water usage from 1972-2014 and derived a daily irrigation usage to the 90th percentile (1 in 10 year drought) annual volume. The seasonal depth was calculated as approximately 450 m^3/ha for the proposed property which equates to an annual volume of 678,100 m^3/year for pasture. The calculated volume is less than that sought by Tuki Tuki Awa (822,800 m^3/year) however is considered adequate to irrigate 136 ha of pasture, or crops and/or horticulture or a mixture of pasture, crops and horticulture.

The 90th percentile augmentation volume of 129,600 m^3/year is to be extracted from one or more of the proposed wells that are to be drilled on the property adjacent to the Tukituki River, into which the augmentation allocation will be discharged. During wetter periods the farm is not likely to irrigate to the same volume over the 150-day season and therefore the Tranche 2 allocation will not be utilised.

5.2 Local hydrogeological setting

The applicant's property is located towards the western edge of the Ruataniwha Basin and close to the edge of the alluvial sediments that form the water bearing strata infilling the basin. There are few bores in this area and as a result, information on the local groundwater resource is sparse. In general, the strata are likely to be similar to that found elsewhere in the basin, including variable deposits of gravels, sands, silts and clays. The property is located close to the upper part of the Tukituki River where it enters into the

basin and some connection between abstraction from strata in the area and the river is likely. However, the magnitude of the connection is likely to be dependent on the local properties of the strata.

5.3 Existing aquifer test information

No existing aquifer test information is available for the Tuki Tuki Awa takes and the local aquifer properties are not defined in the area.

5.4 Potential local well interference effects

Although drawdown interference effects have been estimated via the numerical model of the Ruataniwha Basin, these estimates are not based on observed data, and the model calibration is not likely to be accurate in this area as there are no local groundwater monitoring points. Therefore, it is not expected to provide accurate estimates of potential drawdown interference effects. Drawdown interference effects should be estimated in the area based in the results of pumping tests on the Tuki Tuki Awa bores after they are drilled. However, it is noted that a review undertaken for the application indicated that there were no bores within 2 km of the applicant's bores.

5.5 Potential local stream depletion effects

It was noted in the application that due to the proposed depth of wells being screened at 50 m, the take would not be considered directly stream depleting under Plan Change 6. However, delayed stream depletion effects will still occur, which are not defined via either a pumping test, or via the numerical model. Therefore, stream depletion effects may still occur to an extent which is more than minor and should be considered (locally in addition to cumulative effects considered by the model).

5.6 Potential local effects on wetlands

Similarly to the assessment of effects on local streams, only a limited assessment has been completed relating to the effects on local wetlands in the catchment. The assessment concluded that declines in the shallow water takes (up to 0.1 m) represent negligible effects. This conclusion does not seem to be backed or justified by considerations for the impact the decline may have on the local wetlands.

5.7 Other local effects including augmentation discharge effects

As with other Tranche 2 augmentation discharges, discharges to water are a permitted activity according to the application provided some conditions are met. Tuki Tuki Awa propose to discharge water into the Tukituki River and it will be important that the discharge site is carefully chosen to ensure that scouring does not occur, and that discharge does not occur at times of heavy rainfall (which is not intended).

6.0 Plantation Road Dairies

6.1 Details of the application

Plantation Road Diaries (PRD) is located at 1404 Ongaonga Road and Wakarara Road, Ongaonga within the Kahahakuri sub catchment in the lower basin between the Waipawa and Tukituki Rivers. The original application sought a take of 6,000,000 m^3/year of Tranche 2 groundwater, following the application being lodged, PRD changed their proposal and reduced the volume of the groundwater take to 3,751,225 m^3/year from the deep bores located on the property.

IrriCalc was used to calculate the 90th percentile water demand for the properties pasture requirements, this was calculated to be approximately 600 mm/year. This equates to a volume of approximately 2,418,255 m^3/year over an irrigated area of 403 ha. The volume calculated is less than the total volume of irrigation water initially sought by PRD for irrigation purposes (2,775,914 m^3/year). Through less water intensive crops and/or horticulture, or a mixture of crops, horticulture and pasture a larger area of 459 ha

may be irrigated with 2,418,225 m^3/year. The remaining balance of the Tranche 2 groundwater allocation will be used for augmentation at 1,333,000 m^3/year.

The applicant proposes to take Tranche 2 groundwater from the following bores:

- The existing bore no. 4830 which has a depth of 137 m bgl
- Two future deep bores proposed as T2a and T2b

Augmentation water will be sourced from one or more proposed bores located on adjacent property also owned by PRD for discharge directly into the Kahahakuri Stream immediately beside the location at a rate of 103 L/s as a daily average.

A duration of 20 years to match the duration of other applicants under this consent is proposed in the AEE.

6.2 Local hydrogeological setting

The Plantation Road Dairies property is located towards the centre of the Ruataniwha Basin, on the true right bank of the Kahahakuri Stream in an area where the stream has been observed to gain from groundwater between the Ongaonga Road bridge and the confluence with the Tukituki River.

Static groundwater levels in deeper bores in this area are above surface artesian, which is consistent with the pattern of gains observed in the local stream and indicates that groundwater discharges to surface water in the area around the Plantation Road Dairies property.

The drillers log for bore 4830 indicates that the strata consist of variable intervals of gravels with clay units, which is typical of the bores drilled in the basin. Given the above surface artesian groundwater level pressures, it is likely that the clay units act to confine the more permeable gravels, although the clay units will allow some vertical movement of groundwater from deeper strata towards the surface.

6.3 Existing aquifer test information

Existing aquifer testing information is available for bore 4830 (137 m deep and screened from 125 m bgl to 135 m bgl) and a summary of the available data is provided below. Other aquifer test data is available from nearby bores including a test completed last year on PRD bore 16817.

Table 4: Pumping test results

Well number	Transmissivity (pumped aquifer) (m^2/day)	Storage	Aquitard Conductance (K'/B') (1/day)
4830	230	3.00E-04	7.00E-06

The results of the pumping test indicated relatively low permeability strata with limited leakage effects, suggesting that a direct link between the pumped strata and the surface is likely to be slow and effects at the surface may be widely distributed. However, given the hydrogeological setting in this area, abstraction would reduce discharge rates to local surface waterways over the long term.

6.4 Potential local well interference effects

Drawdown interference effects due to the proposed take could be relatively large; drawdown effects during the pumping test above on bore 1869 (98 m deep, 1.5 km away) were in excess of 7.5 m after 35 days pumping at 100 L/s. Therefore, greater effects could occur after a full season of pumping using the consented pumping rate.

In the application, drawdown interference effects in bore 1869 due to pumping from the Tranche 2 bores are predicted to be less than 1 m, which seems inconsistent with the results of the pumping test, although we note that different pumping rates may be assigned to different bores. However, it would seem likely that drawdown interference effects will exceed 1 m. This is an example of where the numerical model may not represent local effects and where a site specific pumping test should be undertaken to confirm drawdown interference effects, including an appropriate allowance for cumulative effects.

6.5 Potential local stream depletion effects

Based on the available pumping test data from bore 4830, stream depletion effects on an individual surface waterway are not expected to be large in the short term due to the apparently low leakage value determined from the pumping test but longer term effects may be significant. Plantation Road Dairies propose to drill two additional deep bores to source water for the irrigation and augmentation takes. Aquifer parameters for these bores are not defined and the location of these bores is also not yet defined, consequently localised stream depletion effects that would develop with longer term pumping as a result of the Plantation Road Dairies take cannot be determined with certainty at this stage of the process.

6.6 Potential local effects on wetlands

Local effects on wetlands have been assessed in the same manner as other properties that form part of the Tranche 2 applications. These were undertaken using the estimates of drawdown in the shallow strata from the numerical model, which reportedly indicated drawdown effects of up to around 0.4 m. These effects were identified as potentially having a measurable impact on water levels in the nearby drains and wetlands, many of which are spring fed. However, the application appears to conclude that these effects are negligible, although the basis for that conclusion is unclear. The values of the nearby wetlands are not described in the report, and the effect of reducing flows on those values has not been assessed.

6.7 Other local effects including augmentation discharge effects

Plantation Road Dairies indicate in their consent application that augmentation will be directly discharged into the Kahahakuri Stream directly adjacent to the location of the augmentation take. Whilst this may be an appropriate method no investigations have been undertaken to access the feasibility of this, particularly as aquifer parameters are not defined for the location nor are local gaining and losing reaches described. Both of these factors should be assessed in conjunction with how effectively the augmentation will support the Kahahakuri Stream.

7.0 Springhill Dairies (formerly Ingleton Farms)

7.1 Details of the application

Springhill Dairies lodged an application in January 2014 for the property located at 665 State Highway 50 and 36 Butler Road within the Mangaonuku Sub Catchment and partially within the Waipawa Sub catchment. Springhill Dairies sought a Tranche 2 groundwater take of up to 1,005,213 m^3/year from deep bores to supplement the already consented takes resulting in a combined volume of 4,029,077 m^3/year to provide adequate irrigation to 702 ha of pasture and crops.

The 90th percentile assumed annual water demand for pasture has been calculated using IrriCalc to be approximately 480 mm/year. Over an irrigated area of 702 ha the calculation equates to 3.4 million m^3/year. It is stated that the required irrigation demand can be met through utilising the existing consented takes in combination with the supplementary Tranche 2 volume sought by the applicant, with consideration for the volume of Tranche 2 groundwater available for augmentation.

An irrigation volume of 588,313 m^3/year would be adequate to irrigate around 123 ha of intensive pasture or 188 ha of less water intensive crops and/or horticulture, or a mixture of horticulture, crops and pasture. The remaining balance of 416,900m^3/year will be available for augmentation.

The applicant proposes the following:

- Consent duration of 20 years
- Tranche 2 groundwater take from up to five of the existing bores (Table 5).
- Well no. 5167 will be used for the augmentation groundwater take, at a proposed rate of 38 L/s (daily average) into the Manganuku Stream.
- The rates of Tranche 2 groundwater to be taken from existing bores will not exceed (and be less than) that of the existing consent

Table 5: Springhill Dairies bores

Site	Use	Current status	Depth (m)
Bore 5167	Irrigation & augmentation take	Existing bore and irrigation take; proposed augmentation take	124.6
Bore 4593	Irrigation	Existing	84.7
Bore 1518	Irrigation	Existing	152.9
Bore 3870	Irrigation	Existing	144.7
Bore 4122	Irrigation (not used for Tranche 2)	Existing	134.2
Bore 5497	Irrigation	Existing	56.1
Augmentation discharge	Discharge to Mangaonuku Stream	Proposed	-

7.2 Local hydrogeological setting

The Springhill Dairies bores are located on the true left bank of the Waipawa River in the central part of the Ruataniwha Basin. All the existing bores are relatively deep and four bores used for irrigation are located in a cluster towards the north-west edge of the property. All these bores have above surface static water levels.

Drillers logs for the Springhill Dairies bores indicate typical sequences of gravels with clay intervals which are likely to contribute to the above surface pressures in the deeper bores, although lower permeability clay intervals will allow some vertical flow.

7.3 Existing aquifer test information

Aquifer test information is available or four of the Springhill Dairies bores, summarised below. Not all the bores included sufficient data to determine a reliable estimate of leakage and/or storage as some of the tests only represented a single bore, although transmissivity values could be determined.

Table 6: Pumping test results- Springhill Dairies			
Well number	**Transmissivity (pumped aquifer) (m^2/day)**	**Storage**	**Aquitard Conductance (K'/B') (1/day)**
1518	147	-	-
3870	765	2.00E-04	7.00E-5
4593	100	-	-
5497	436	-	-

The results of the pumping tests for the Springhill Dairies bores indicate that they are screened within relatively low to moderately permeable strata and where the data is available, leakage from overlying strata is relatively limited. The low values of transmissivity and relatively high pumping rates from the proposed bores will mean that drawdown interference effects may be relatively large.

7.4 Potential local well interference effects

Based on the aquifer parameters in Table 6, and assuming a pumping rate of around 80 L/s from bore 3870, drawdown interference effects in neighbouring bores of a similar depth may be up to around 1.7 m within 1,300 m (approximately the distance to the closest bore, 16477) after pumping for 100 days. Drawdown effects in shallow bores within 1,300 m may exceed 0.1 m, assuming the value of leakage in Table 6. Given the depth of the nearest bore of a similar depth and the likely above surface artesian pressures, a drawdown effect of 1.7 m is, on its own, not likely to restrict the use of that bore. However, we have not considered cumulative effects (including the existing consented takes from the applicant's bores).

In the application, drawdown interference effects on bore 16477 are estimated to be around 2.23 m based on the model, which is approximately in keeping with the assessment above. However, there are a number of assumptions around this estimate, including that bore 3870 is the main bore from which the additional Tranche 2 water will be drawn from and it is important that all bores pumping at the full rates sought are accounted for. The consent will not preclude the use of other bores and as Table 6 indicates, those will have different aquifer properties which could result in different drawdown interference effects. This consideration is not addressed as part of the application.

7.5 Potential local stream depletion effects

In keeping with other applications discussed in this memo, potential stream depletion effects are likely to be delayed in time and widely distributed due to the depth of the bore and the apparently low leakage effects due to the presence of clay intervals in the strata overlying the bore screened interval. However, this is based on a single pumping test showing values of leakage and other bores could show the presence of more leaky strata. Nonetheless, the low value of leakage means that the local stream depletion effects due to pumping as proposed in the application (i.e. from bore 3870) may be assessed via the numerical model, although we would highlight the uncertainties in the model which have not been explored in detail.

7.6 Potential local effects on wetlands

In a similar way to the other proposed consents in the area, effects on local wetlands have been assessed via drawdown effects in the shallow strata based on the results from the numerical model. In this area,

these indicate that drawdown effects could reach up to 0.3 to 0.4 m. The application considered effects on the Mangaoho Stream, which flows to the north of the Springhill Dairies property and where drawdown effects at the surface are expected to be around 0.1 m. These effects are considered to be negligible by the applicant. We note that according to the 1:50 000 scale topographic map, there are other streams and ponds located on the applicant's property, but effects on these surface waterways and potential wetlands are not part of the applicant's assessment.

It is not clear from the application how the conclusion that drawdown effects of 0.3 to 0.4 m are expected to be negligible and some further information should be provided to help justify this conclusion, including some consideration of the values of the waterways and wetlands.

7.7 Other local effects including augmentation discharge effects

As with the other proposed discharges, discharges to water are a permitted activity according to the application provided some conditions are met. Springhill Dairies propose to discharge water into the Mangaonuku Stream and it will be important that the discharge site is carefully chosen to ensure that scouring does not occur, and that discharge does not occur at times of heavy rainfall (which is not intended). Consideration of the effect of their discharge in combination with the discharge from TAFT (further upstream) may also need to be considered.

8.0 I & P Farming (formerly Abernethy Partnership)

8.1 Details of the application

I & P Farming (formerly the Abernethy Partnership) applied for a Tranche 2 groundwater take in March 2017 to increase production of the property located at 337 Ongaonga-Waipukurau Road, Waipukurau within the Kahahakuri Sub catchment (T3). The initial application sought 477,122 m^3/year of Tranche 2 groundwater; however this volume was not sufficient to support irrigation of 166 ha of pasture and crops. In August 2019 a second application was sought for 722,888 m^3/year with groundwater proposed to be abstracted from proposed bores with a total volume of 1,200,010 m^3/year inclusive of augmentation.

There are no current groundwater consents on the property, however irrigation is required to increase the farms crop production and pasture growth. The proposed Tranche 2 consent will be sought for a 20 year duration in both the 2017 and 2019 applications.

A proposed irrigation volume of 916,010 m^3/year has been estimated based on Irricalc's 90th percentile water use at a flow rate of 83 L/s over the 150 day irrigation season based on an assumed 166 ha area of pasture. A larger area of 310 ha of less water intensive crops and/or horticulture, or a mixture of the three practices could be sustained at 916,010 m^3/year.

The proposed augmentation of 284,000 m^3/year equates to 22 L/s (daily average) which will be discharged into an unnamed stream within the property that drains into the lower reaches of the Tukituki River directly south of the farm.

8.2 Local hydrogeological setting

The I & P Farming property is located in the centre of the basin close to the western edge and on the true left bank of the Tukituki River. Although there are reportedly no groundwater takes on the property, groundwater levels from neighbouring bores that are around 100 m deep indicate above surface artesian groundwater levels.

Drillers logs from nearby bores indicate that the strata in the area are consistent with other nearby areas, and show a variable sequence of gravels with silts, sands and occasional clay intervals.

8.3 Existing aquifer test information

No bores have been drilled on the I & P Farming property and therefore aquifer test information in the immediate area of the proposed bores is not available. However, some aquifer test information is available from bores located slightly north of the property, which are screened between 40 and 60 m deep. These indicate highly permeable strata, with transmissivity values between 2,500 m^2/day and 3,000 m^2/day. Leakage values are also available from these bores, which indicate that leakage values (as K'/B') are between 0.0001 and 0.00007, which are generally low values indicating limited direct connections with the surface.

8.4 Potential local well interference effects

The closest neighbouring bores to the property, and to where the bores are reportedly proposed to be located according to the application are around 750 m away (for example bore 5419, 55 m deep). Drawdown interference effects cannot be accurately estimated without a pumping test, although based on the application, drawdown interference effects in bores that are a similar depth could be around 0.54 m.

This estimate appears to contrast with estimates of drawdown interference using the analytical solutions, and allowing for leakage as discussed above, which suggest a potential drawdown interference effect of around 1 m after pumping at 80 L/s for 100 days. Drawdown interference effects would be better assessed based on the results of site specific testing including to assess effects on neighbouring shallow bores.

8.5 Potential local stream depletion effects

Based on the nearby pumping test data, rates of vertical leakage may be relatively low in this area, in which case stream depletion effects may be slow to develop and widespread. However, there are a large number of local streams, including the spring fed Black Stream, as well as the Tukituki River mainstem, in which stream depletion effects will ultimately occur. Given the absence of specific pumping tests, estimation of local stream depletion effects is uncertain and further information should be provided regarding this potential effect.

8.6 Potential local effects on wetlands

The closest identified wetlands to the site are various spring fed ponds together with streams that feed into Black Stream. Drawdown interference effects in this area (based on the results of the groundwater model) are in the range of 0.3 to 0.4 m and the application indicates that these effects could result in lowering of the water levels in the spring fed ponds as well as reducing the flow rate in Black Stream. The application states that this effect is no more than minor, but no consideration of the values of the streams, or the potential effects on the ecological receptors is provided. Therefore, in our opinion, there is not sufficient information provided with the application to justify this conclusion and further information should be provided.

8.7 Other local effects including augmentation discharge effects

Discharges to water are a permitted activity according to the application provided some conditions are met. I & P Farming propose to discharge water into an unnamed tributary of the Tukituki River and it will be important that the discharge site is carefully chosen to ensure that scouring does not occur, and that discharge does not occur at times of heavy rainfall (which is not intended). This site is also not included in the model and the modelled discharge location is within the Tukituki River. It will be important that the actual discharge effect is monitored to ensure that it is consistent with the modelled effect.

9.0 Buchanan Trust No.2

9.1 Details of the application

Buchanan Trust No.2 originally applied for a Tranche 2 groundwater take of up to 1,631,018m^3/year in April 2017 to irrigate 242.6 ha of pasture on their property at 19 Ngaruru Road, Ongaonga within the Kahahakuri Sub Catchment. The take was proposed to use one existing bore 16408 at a depth of 119.8 m bgl and three new deep bores T2a, T2b and T2c located throughout the property. At the time of the original application only 70% or 1,145,794 m^3/year of the total allocatable volume was available through Tranche 2 groundwater. 786,594 m^3/year is proposed for irrigation with the remaining 359,200 m^3/year for augmentation, which may be taken from one or more of the proposed bores on site.

IrriCalc was used to calculate the 90th percentile for annual water demand, which is approximately 600 mm/year which equates to 131 ha of pasture (assumed) being fully irrigable from the 786,594 m^3/year available volume. A larger area of 230 ha of less water intensive crops and/or horticulture, or a mixture of crops, pasture and horticulture could be irrigated with the same volume. The remaining balance of 359,200 m^3/year of Tranche 2 allocation will be available for augmentation use. The rate of augmentation is proposed at 51 L/s (daily average) which is to be discharged into the nearby Ongaonga Stream, which converges with the Tukituki River approximately 4km south of the property.

Whilst the applicant did not originally specify a duration for the consent sought, the duration sought is now 20 years to align with the other applicants.

9.2 Local hydrogeological setting

The Buchanan Trust No.2 property is located on the northern outskirts of Ongaonga and at the western edge of the mapped alluvial gravels that make up the Ruataniwha Basin. Only one bore is located on the property (16408, 120 m deep) and the drillers log for the bore indicates that the strata are similar to other parts of the basin, with variable units of gravels, sands, silts and clays. Bore 16408 is screened from 114 m bgl to 119 mbgl and static water levels in the bore were reportedly around 2 m below ground level at the time of drilling.

The closest stream to the Buchanan Trust No.2 property is the Ongaonga Stream for which there appears to be no concurrent gauging data. Therefore, it is not clear whether the stream loses or gains from groundwater in this location.

9.3 Existing aquifer test information

Aquifer test information is available for the existing bore that has been drilled on the property, which is summarised below:

Table 7: Pumping test results

Well number	Transmissivity (pumped aquifer) (m^2/day)	Storage	Aquitard Conductance (K'/B') (1/day)
16408	350	1.20E-04	<1.00E-05

These aquifer parameters indicate that the strata across which bore 16408 is screened are low to moderately permeable, with relatively limited leakage effects from overlying or underlying strata. These aquifer parameters imply that direct effects on surface waterways due to pumping are not expected, although drawdown effects could be relatively large depending on pumping rates. Likewise, effects at the surface are likely to be limited, although widespread.

9.4 Potential local well interference effects

The Buchanan Trust No.2 property Is located adjacent to Ongaonga and there are many shallow bores used for domestic supply within the township. The closest deep bore (according to the HBRC GIS system is bore 5671 (70 m deep) and is around 750 m away, although this bore may not experience direct drawdown interference effects as it is somewhat shallower. However, estimated drawdown interference effects in bore 5671 due to pumping at 60 L/s for 150 days could exceed 5 m if all pumping occurred from bore 16408. This estimate does not allow for the effects of the augmentation take.

In comparison, estimated drawdown interference effects in the application are around 1 m on bore 5671. Whilst the lower estimate could be due to some allowance for the different depths of bores in the area, there is a sufficiently large difference to suggest that site specific drawdown interference effects are required.

9.5 Potential local stream depletion effects

The pumping test results indicated a relatively low value for leakage, suggesting that stream depletion effects are likely to be delayed in time and spatially widespread. However, this depends on any new bores required at the property being drilled to the same depth as the existing bore and that leakage effects in those bores are a similar scale to those experienced in bore 16408. The local effects should be considered by the applicant, including longer term effects.

9.6 Potential local effects on wetlands

The applicant has identified the Ongaonga Stream as a potentially affected nearby waterway and wetland, where shallow drawdown effects could reach up to 0.2 m in the local area around the Buchanan Trust No.2 property. These effects are classified by the applicant as negligible. We note that based on aerial imagery, there are other small ponds and wetland areas in the local vicinity and a shallow water table drawdown effect of 0.2 m may have an effect on the ecology of the sites. In our opinion, the wetland assessment should be carried out considering the ecological values of nearby streams and wetland and the effect of the potential drawdown on those values.

9.7 Other local effects including augmentation discharge effects

Discharges to water are a permitted activity according to the application provided some conditions are met. Buchanan Trust No.2 propose to discharge water into the Ongaonga Stream and it will be important that the discharge site is carefully chosen to ensure that scouring does not occur, and that discharge does not occur at times of heavy rainfall (which is not intended).

10.0 Purunui Trust

10.1 Details of the application

The Purunui Trust lodged an application in April 2020 to take up to 1,575,000m^3/year of Tranche 2 groundwater for irrigation of 175 ha of pasture/process crop on their property located at 385 and 375 Swamp Road, Ongaonga within the Kahahakuri Sub Catchment. The applicants propose to take Tranche 2 groundwater from three new future bores located around the property.

The applicant sought a proposed irrigation volume of 1,050,000 m^3/year (at a volume not exceeding 252,000 m^3 within a 28-day period) capped at meeting full water demand of up to a one-in-ten-year drought. The remaining balance of 525,000 m^3/year (at a volume not exceeding 126,000 m^3/year within any 28-day period) was for augmentation.

As Purunui Trust is the most recent applicant for the Trance 2 groundwater allocation, the full volume sought is not available due to the 15 million m^3/ year cap on the combined Tranche 2 take. However, a total volume of 554,921 m^3/year or 35% of the volume applied for is available. Assuming equal scaling

volume this would equate to 370,321 m^3/year of irrigable water and the remaining 184,600 m^3/year available for augmentation. This volume would be adequate to irrigate 62 ha of pasture or up to 93 ha of less water intensive crops and/or horticulture or a mixture of pasture, crops and horticulture.

Using 'IrriCalc' the 90th percentile annual water demand has been calculated to be approximately 600 mm/year which equates to the annual volume of 370,321 m^3/year for irrigation over the 62 ha and 184,600m^3/year for augmentation.

Augmentation at a proposed rate of 14 L/s (daily average) will be discharged into a pre-existing unused well near the Waipawa River. The well is thought to be directly connected to the river and will be tested prior to augmentation to confirm this. The rate of abstraction from the irrigation wells will not exceed 14 L/s (daily average).

No specific duration for consent has been sought by the applicant.

10.2 Local hydrogeological setting

The Purunui Trust property is located around 5 km to the east of Ongaonga on the true right bank of the Waipawa River. Nearby deep bores (e.g. 3104, 142 m deep) show flowing artesian groundwater pressures, although some shallower bores show groundwater levels that are below ground level.

The logs for nearby bores show typical strata for the area, including gravels with clays and sands with occasional clay intervals. The strata indicate that vertical anisotropy is likely to be significant, which reflects the above surface artesian groundwater levels in deep bores.

10.3 Existing aquifer test information

The Purunui Trust is not intending to utilise existing bores and have proposed that three 50 m deep new bores will be drilled to take water under their Tranche 2 consent (if granted). However, pumping test data is available for some nearby bores, which indicate generally permeable strata with some transmissivity values in excess of 3,000 m^2/day. A summary of the data for the three closest bores is provided below. Not that these bores are located at least 2 km from the applicant's property.

Table 8: Pumping test results

Well number	Transmissivity (pumped aquifer) (m^2/day)	Storage	Aquitard Conductance (K'/B') (1/day)
1881 (51 m deep)	1,600	1.10E-04	1.00E-5
1452 (55 m deep)	3,129	-	-
4764 (123 m deep)	1,300	5.00E-04	7.00E-04

The results of the pumping tests indicate that leakage effects are generally small, in keeping with other tests in the basin. Similarly, to other areas of the basin effects on shallow strata and/or surface waterways are expected to be relatively slow and delayed in time, although the weaknesses in the overlying lower permeability strata are likely to allow some more rapid effects to occur in some areas.

10.4 Potential local well interference effects

Based on the HBRC mapping data, there are a large number of bores in the area around the Purunui Trust property. Depth data is not available for many of these bores and the closest bore that is around 50 m deep (the proposed depth of the Purunui Trust bores) is around 700 m from the proposed bore locations (5082, 42 m deep). Based on the parameters listed above, and using the most conservative value of transmissivity (1,300 m^2/day), drawdown interference effects on the nearby bores within 750 m after pumping for 100 days at 42 L/s (28 L/s irrigation + 14 L/s augmentation) could be around 1.3 m depending on leakage. Effects in shallower bores could be much less, potentially less than 0.1 m.

In comparison, drawdown interference effects on bore 5082 as listed in the application are around 0.29 m, which is significantly less than estimated via the nearby pumping test data.

10.5 Potential local stream depletion effects

Localised stream depletion effects could develop as a result of the take, although given the location of the property adjacent to the Waipawa River, these effects are likely to be dominantly focussed on the Waipawa River. However, the Kahahakuri Stream also flows just to the south of the Purunui Trust property and some stream depletion effects are likely to occur on this stream as well. These effects should be assessed based on site specific testing.

10.6 Potential local effects on wetlands

In keeping with the other Tranche 2 sites, effects on wetlands have been considered through the effects on shallow groundwater levels. In this area, the applicant has estimated drawdown effects of up to 0.4 m and some comment is made regarding a lowering of flow rates within the Kahahakuri Stream, with the assessment concluding that there would be a 'negligible' effect. In our view, further information is required on wetland effects.

10.7 Other local effects including augmentation discharge effects

Purunui Trust propose to discharge the augmentation water into an existing unused large diameter bore that is reportedly located around 200 m to 300 m from the Waipawa River. There is no information supplied to demonstrate that the discharge can occur as intended, or that the full augmentation discharge will appear in the river (as is modelled). Therefore, site specific testing will be required to ensure that this is the case and to ensure that adverse mounding does not occur in neighbouring properties if these are located close to the discharge site.

11.0 Cumulative effects on wetlands

The application has considered effects on wetlands by assessing the simulated drawdown effect from the Tranche 2 pumping in shallow model layers. These indicate that simulated drawdown effects could reach up to 0.8 m in central areas of the Ruataniwha Basin. However, we note that the simulated drawdown effects do not appear to be centred on the main areas of abstraction and there are some areas where the largest drawdown effects are simulated that appear to be located away from any areas of abstraction. The application notes that this is due to the effect of the augmentation discharges, but this does not appear to fully explain the simulated pattern, particularly in the south of the model area where no discharges would occur because it is located away from the Tranche 2 properties. Some further information to explain the origin of this simulated effect would be helpful.

Despite this uncertainty, broadly, use of the numerical model is likely to provide a reasonable approach to estimating the cumulative effect of pumping on shallow groundwater levels in the basin, particularly where there are a number of properties in close proximity. However, we have several reservations regarding the way in which those impacts have been considered in terms of the ecological impacts on the wetlands. The assessment in the application does not appear to consider the wetland values.

Furthermore, the assessment only considers the individual effects of the takes on the wetlands, and does not assess those effects in terms of the additional impact they will have over and above the existing impacts. Whilst the impact from the Tranche 2 applications may be limited in isolation, it will add to existing effects to an extent that could be more than minor and further assessment is required to determine whether this is the case. There is also some uncertainty in whether there are additional wetlands to those that have been identified by HBRC and the applicant.

12.0 Cumulative effects on well interference

Drawdown interference effects between bores due to the Tranche 2 takes are assessed using the results from the numerical model (based on data from March 2001). Effects on deeper bores are assessed on the basis of drawdown effects in model layer 6, whilst effects in shallower bores are assessed on the basis of drawdown in the uppermost model layer. Other factors that are used to consider the impact of cumulative drawdown interference effects include estimates of seasonal effects together with estimates of the static water levels in the bores and assumptions regarding the pump depth in the bore. These data are combined to determine the available drawdown in each bore after the effect of the Tranche 2 pumping is accounted for. The applicant has applied an arbitrary threshold to define bores that are affected, based on at least 20% of the available drawdown in the bore being affected by interference effects.

There are four main issues with this approach:

- Reliance on the model to determine drawdown interference is likely to incorrectly estimate drawdown effects, as noted in several of the individual site assessments described above. Only a single model layer has been used for deep bores, and a single model layer has been used for shallow bores, which is not likely to reasonably represent the actual depths of the bores considered. Furthermore, there is uncertainty with respect to the model outputs, resulting in uncertainty in these assessments.
- The approach to determining the seasonal changes in water levels appears to be based on a contouring algorithm between different monitoring bores. Whilst contouring algorithms can be helpful to estimate the spatial distribution of water levels from point data, their use to determine seasonal effects is not considered appropriate. This is because it will not be possible to account for boundary effects such as nearby rivers and streams, which will result in limited seasonal variations around a point, and greater drawdown effects will be estimated away from these boundaries. The limitations have resulted in inaccurate estimates of seasonal water level variations across the basin, which has led to inaccurate assessments of drawdown interference.
- The use of an arbitrary threshold of 20% of remaining drawdown effectively assumes that bore owners will need 80% of the available drawdown for their own self-induced drawdown effects. As outlined above, we are concerned with that an appropriate allowance for seasonal variation and cumulative effects has not been made. Therefore, the remaining drawdown may be less.
- The assessment does not include any consideration of potential existing cumulative effects of drawdown that will already occur. Although these effects are already consented, the Tranche 2 takes will add to these effects and may result in circumstances where effects are more than minor.

Combined, these issues mean that the drawdown interference assessment provided in the application is unlikely to present a reasonable assessment of the potential effects of the Tranche 2 takes on neighbouring bores. In our opinion, drawdown interference effects assessments should be based on site specific testing for individual bores or groups of bores, together with an appropriate allowance for cumulative effects.

The plots (Figure 2 and Figure 3) below show the location of existing groundwater take consents in the Ruataniwha Basin and also, as an example, groundwater levels from bore 15048 (33 m deep) which is located within Ongaonga.

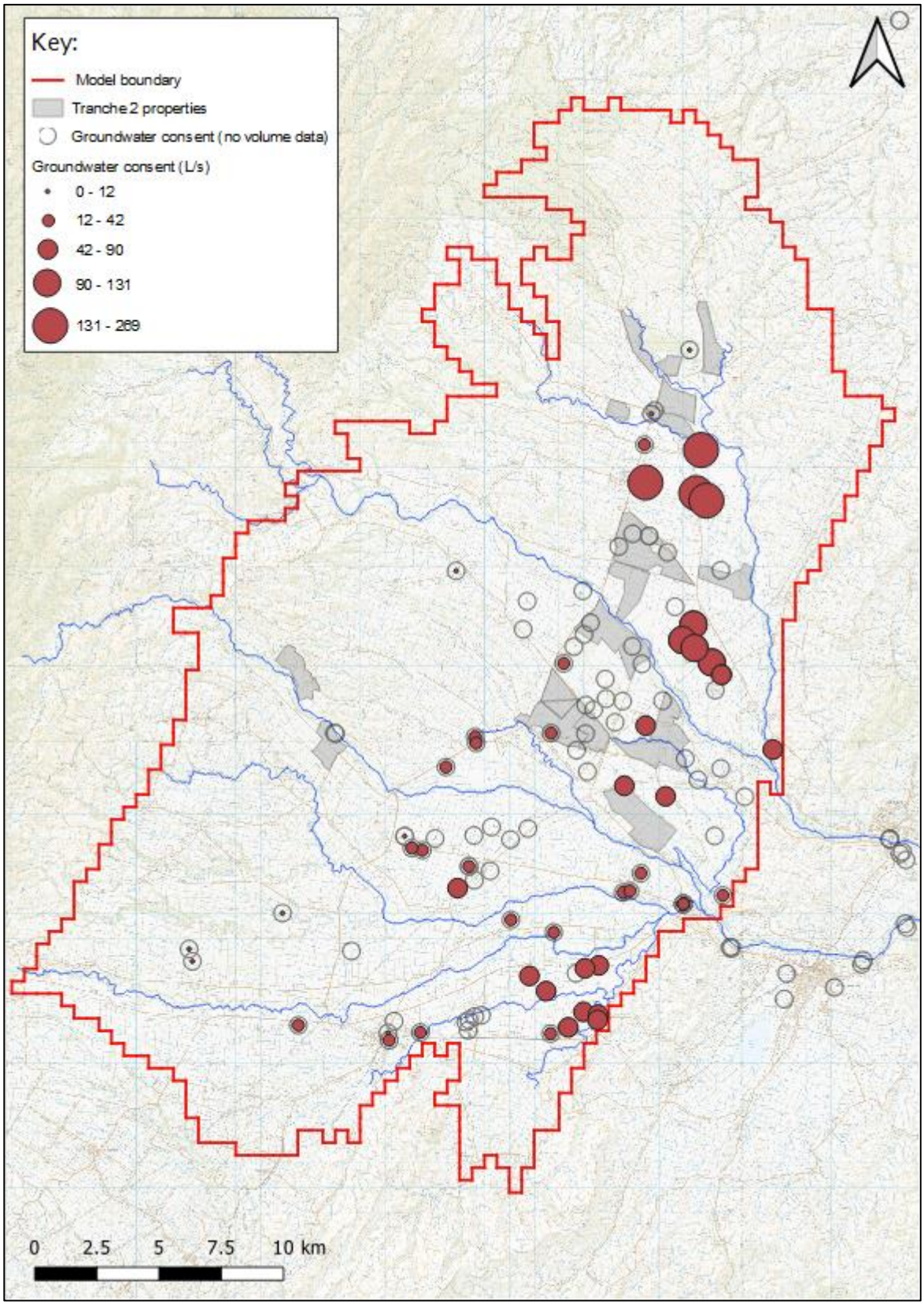

Figure 2: Location of existing groundwater consents in the Ruataniwha Basin

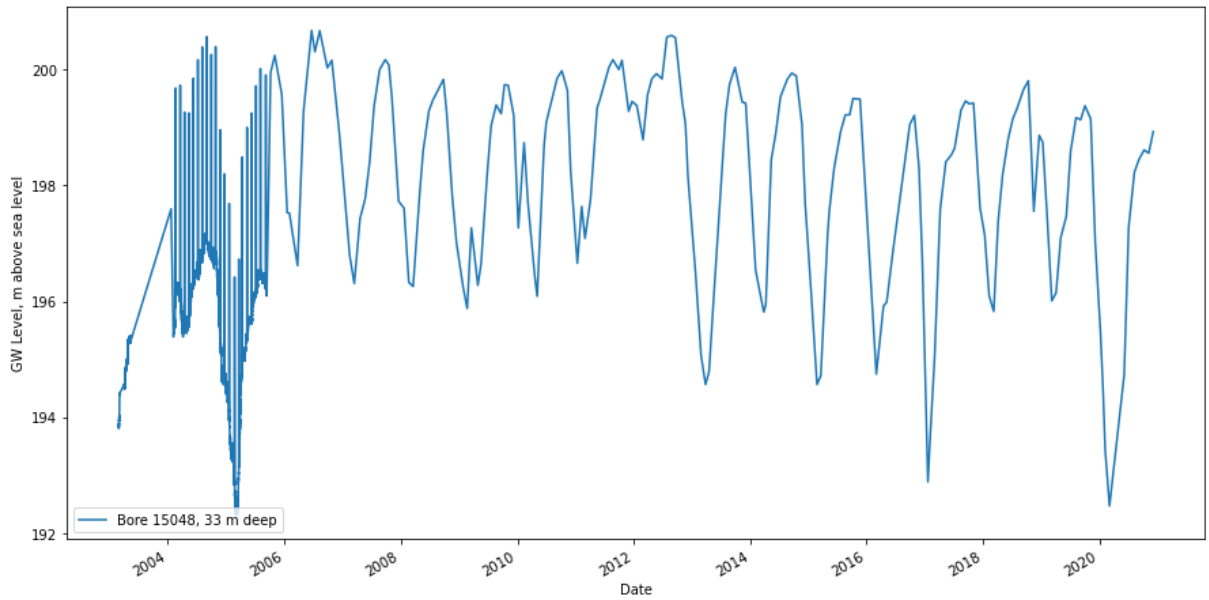

Figure 3: Groundwater levels in bore 15048

The existing seasonal range of groundwater levels in bore 15048 is around 5 to 6 m, which provides some indication of the potential scale of existing cumulative effects in this area including the effects from pumping from deeper takes and natural seasonal variations. It is worth noting that groundwater levels in the bore appear to show an overall long term declining trend, although the scale of that effect is small, in the order of 1 m over 15 years. Greater seasonal variations have occurred since 2011, which may reflect an increase in local abstraction at that time. There are other bores in the Ruataniwha Basin that display greater declining trends and seasonal variations.

Overall, it is considered important that cumulative effects from all abstraction in the basin is assessed appropriately.

13.0 Cumulative effects on stream flows

13.1 Effects on low flow sites and existing users

There are a several low flow sites located across the basin, where triggers are employed to restrict the rates of abstraction for surface water users (or closely connected groundwater users) depending on the rates of flows. The key low flow sites that are located within the basin include:

- Tukipo River at SH50
- Tukipo River at Ashcott Road
- Kahahakuri Stream at Ongaonga Road Bridge
- Mangaonuku Stream upstream of Waipawa

Plots of the effects of the Tranche 2 applications (based on the results of the numerical model) on flows at some of those sites (excluding the Kahahakuri Stream) indicate that effects will occur and that in some cases those effects will result in flows dropping below the low flow limit, although generally, this appears to be for short periods of time with the greatest effects at the Mangaonuku Stream upstream of Waipawa. Although the Kahahakuri Stream is not directly assessed, given its location in the centre of the basin, effects are likely to occur. Therefore, some effects on existing users whose consents are linked to these sites are expected to occur and those effects should be considered in the application.

13.2 Effects on other waterways

Effects on other surface waterways that occur within the basin are also expected, including for example the Ongaonga Stream and Black Stream. Comment on the potential effects on both these streams, as well as other surface waterways is included in the application by way of the wetland assessment, where drawdown effects in shallow strata are considered to represent the effect on the streams. However, in terms of streams, the effects are considered at a single point, whereas the effects will occur along a reach of the stream.

Some reduction in flow in these other waterways will occur as a result of the proposed Tranche 2 takes and in general, no augmentation is proposed to offset those effects (although in some cases the augmentation discharge will be into the nearby stream, for example I & P Farming will discharge into an unnamed stream adjacent to their property and Buchanan Trust No.2 will discharge into the Ongaonga Stream). However, it is unclear whether these discharges will offset the effects of the abstractions and given that these small waterways are likely to be reliant on shallow groundwater discharge, these effects may be important.

The application notes that some streams are dry (based on a single site visit in March 2021 which was a dry period) and therefore no effects are expected on those waterways other than increasing the time during which the streams are dry. It would helpful if further information were provided in this respect including the results of some monitoring data that shows when the streams are dry, how often this occurs and an assessment of the scale of change the Tranche 2 takes may cause on the streams, together with further information on the resulting ecological effects.

14.0 Management and monitoring conditions

The proposed consent conditions do not include any conditions relating to monitoring of the potential effect of the proposed takes on either surface water flows or on groundwater levels, in which case there is a significant reliance on the estimates provided in the application. In our opinion, these are subject to some uncertainty, with some uncertainty ranges being much greater than others, particularly with respect to impacts on shallow bores in areas where the applicant's bores are proposed. Therefore, some monitoring conditions would be appropriate, including for both drawdown interference as well as impacts on stream flows.

To help mitigate the uncertainty around drawdown interference, site specific testing should be required. Although the conditions indicate that any new bore should be tested and that a drawdown interference assessment is required (Conditions 6 a, b and c), there is no requirement that the well interference assessment is made based on the results of a pumping test. In our opinion, condition 6 should be amended so that any new bores(s) are subjected to a pumping test or tests that both demonstrates its yield and also provides a set of aquifer parameters that can be used to determine drawdown interference effects. Drawdown interference effect should be determined based on the results of a constant rate pumping test. However, ideally this information would be available prior to a decision being made on the application.

To help mitigate the uncertainty regarding the effects of the takes on stream flows and on shallow groundwater levels, it would also be prudent to require a review after a period of 5 years after the consents have been exercised. This would enable an assessment of the scale of drawdown in shallow and deep strata and the efficiency of the augmentation programme compared to the predicted effects provided in the application. This may require installation of some shallow monitoring bores in those areas where effects are predicted to be greatest, as well as ensuring that river flow monitoring is available and ideally automated, particularly in smaller streams.

15.0 Summary and conclusion

The Tranche 2 applications represent a relatively large scale increase in the volume of water that may be abstracted from the Ruataniwha Basin. We recognise that the Tranche 2 applications will not all be utilised immediately and that there will be a lead in period as infrastructure is developed. In addition, the effects presented in the application are intended to represent a 'worst case' where irrigation occurs at full capacity during a dry year. However, we also note that the Tranche 1 groundwater takes are not yet fully utilised i.e. there is water that has been consented but is not yet used, so therefore there are additional consented effects that could occur outside the effects from the Tranche 2 takes, in addition to climate change.

Much of the assessment provided in the application is based on the results of a numerical groundwater model that was developed to represent groundwater and surface water interaction within the basin. In general, although there is uncertainty with any model that represents a real world system, the model is considered appropriate at a broad scale and reasonably represents flows in the Tukituki and Waipawa Rivers at the basin outlets. Accordingly, the predictions from the model regarding the effects of the Tranche 2 takes and the effects of the proposed augmentation approach at those sites are likely to be reasonable. These generally indicate that (up to the 1 in 10 year event level) the impact of the Tranche 2 takes on flows at the basin outlets (i.e. the Waipawa at SH2 and Tukituki at Tapairu Road flow sites) can likely be offset by the proposed augmentation including where a range of parameter values are considered. In our opinion, the overall impact of the proposed takes on flows at those flow locations is likely to be relatively low based on the information provided, but effects in some years could be much greater if the consented augmentation volume is reached prior to low flow periods.

However, based on the information provided, the model appears to generally overestimate losses from, and underestimate gains, to streams within the basin, suggesting that the model parameters may not be accurate in some areas. The model is not calibrated to intra-basin flows and therefore this leads to uncertainty in the predictions from the model in terms of impacts on groundwater levels and stream flows within the basin. Furthermore, where there is no pumping test data to inform the model parameters, there is also additional uncertainty in terms of those parameters.

Predictions from the model form the basis of the assessment of drawdown interference effects and the assessment of effects on wetlands and local streams within the model and there is therefore uncertainty in those assessments. This uncertainty is not assessed in the application. In our opinion, there are also significant shortcomings in the methodology applied for the drawdown interference assessment, as well as the wetland assessment, which does not consider the ecological values of the potentially affected water bodies.

Based on the assessments of the individual applicant properties, drawdown interference assessments and assessments of potential effects on nearby streams and wetlands should be undertaken based on the results of site specific testing, including pumping tests. This is illustrated in several instances, where the modelled estimates of drawdown interference are not consistent with the results of pumping tests.

Overall, based on the information that has been currently provided, our view is that adverse effects on smaller streams, wetlands, existing abstraction wells and the main rivers during periods of low flows in very dry years could be significant and further assessment is warranted to address this.

16.0 References

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17.0 Limitations

This memorandum has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Hawke's Bay Regional Council and others (not directly contracted by PDP for the work), including Aqualinc Research Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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