Technical Comment

To: Rebecca Robertson

From: Michael Killick (Technical Specialist – Soils and Groundwater Quantity)

Date: 28 January 2019

Map References: NZTM2000 1242000E 4926000N

File Reference: APP-20181676

Subject: ***Request for Technical Comment***

environment SOUTHLAND

Te Taiao Tonga

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Dear Rebecca

the main points of the technical comment below are summarised as follows:

- **Stream depletion**: hydraulic connectivity of the proposed take to small streams, Murray Creek and/or the Oreti River could be classified as Low, Moderate, or High, depending on results of pump testing of any bore(s) drilled pursuant to the application. High hydraulic connectivity (and consequent low flow restrictions) can be avoided relatively easily and are only likely to result from bore placement close to the Oreti River. Moderate connectivity to the Oreti River, Murray Creek and/or small streams is likely and would require assessment according to the allocation of the River and/or streams concerned.
- **Interference with neighbouring bores**: uncertainty remains as to whether interference with neighbouring bores will be within acceptable limits according to plan provisions. According to conservative estimates, available drawdown is already exceeded in one or more existing bores without considering the proposed take.
- **Aquifer allocation and sustainability**: full allocation of the Lumsden aquifer according to pSWLP limits is considered sustainable according to current knowledge and plan provisions; remaining available allocation is expected to be insufficient for the proposed take at the rate proposed due to anticipated transfer of an existing take (AUTH-204993) into the Lumsden allocation.

Stream depletion

Assessments of stream depletion and bore interference are made according to analytical models using aquifer parameters estimated from analysis of pump test data. For semi-confined takes such as that proposed, these parameters include the transmissivity and specific yield of the overlying aquifer (T_o and S_y) and the transmissivity and storativity of the semi-confined aquifer (T and S), and estimates of leakage and/or hydraulic conductivity of the aquitard which separates the two aquifers. The theoretical process of stream depletion in this case involves a lowering of 'potentiometric head' – the hydraulic pressure of the semi-confined, pumped aquifer – which draws water through the overlying aquitard, lowering the water table of the further overlying, unconfined aquifer, which in turn affects hydraulically connected streams. (By contrast, interference with neighbouring bores may arise directly from lowering of potentiometric head in the pumped aquifer in which both the production bore and neighbouring bores are located.)

The model used by the applicant for the assessment of effects (AEE) is Ward and Lough (2011) which is suited to the hydrogeological setting of the location. In the meeting between the applicant, consultant and ES staff in preparation for the application it was agreed that given the speculative nature of effects assessment for a bore or bores yet to be drilled such as those proposed, parameters used for that assessment should be conservative.

According to existing reports of pump tests for bores in the Lumsden aquifer in the area of the proposed take the parameters used for stream depletion assessments in the AEE appear reasonably conservative, with the exception of stream bed conductance (λ). For other groundwater take applications this parameter has been estimated between 1-10m/day for small, spring fed streams in Southland which is significantly higher than the 0.1m/day used in the AEE. A higher value of λ means that more water is expected to pass through the bed of a stream in response to a decline in the water table.

The hydraulic conductivity (K) of silt may be 1m/day or more, hence a silty stream bed 1m thick and 3m wide could have a value of λ =3m/day. According to the methodology of the proposed Water and Land Plan (pSWLP) and the model of Ward and Lough (2011) this could result in 'Moderate hydraulic connectivity' of a take even several hundred metres from a small stream such as Murray Creek. It is unlikely to produce an estimate of 'High hydraulic connectivity', requiring a low flow cutoff condition, but Moderate connectivity would bring into consideration the allocation limit of the stream. (High connectivity should not be ruled out on the basis of this comment but will have to be assessed according to estimates of aquifer parameters when pump tests for the proposed bore are done and analysed.)

Similarly, λ for the Oreti River might be estimated at λ =100m/day due to its wide, gravelly bed. At closer than 400m to the River, a take assessed using Ward and Lough with the other aquifer parameters from the AEE might be found to have High hydraulic connectivity and hence require a low flow cutoff of the type which the proposal aims to avoid. At least one of the proposed bore sites (Bore 7) appears within such a distance of the River.

Interference with neighbouring bores

In a technical assessment for AUTH-20171076, an irrigation take with three bores at Saleyard Road, Castlerock and one (E44/0623) north of Friscoe Road, directly adjacent to the applicant's property, Hughes (2017) estimates that modelled drawdown caused by that take in another three bores at Castlerock – E44/0012, E44/0256, and E44/0300 – already exceeded acceptable limits according to a 'low aquifer transmissivity scenario' i.e. T =1,000m^2/day (more conservative in relation to existing drawdown than the AEE for the current proposal) but did not exceed those limits under a 'high

transmissivity scenario' i.e. T =3,500m^2/day. (High transmissivity can in some instances increase effects such as bore interference, but in the semi-confined setting modelled by Ward and Lough (2011), lower transmissivity within the ranges considered is more conservative i.e. effects are greater.) Hughes (2017) finds support for the 'high transmissivity scenario' in recorded water level data from two of the affected bores, showing that 'acceptable drawdown' had not in fact been exceeded. The value of T =3,500m^2/day, however, is very different to those described in the AEE as typical of the location: T =600-700m^2/day. In similar fashion to the above, the AEE for the current application is forced to abandon modelled drawdown calculations in favour of measured data for one affected bore, E44/0300, because according to the model, acceptable drawdown would already be exceeded by effects of existing takes without any further effects of the proposed take.

The approach of resorting to measured data depends on the fact that historical abstraction has been less than consented abstraction; a more conservative assessment considers that this may not be so in future. Consented takes are assessed to represent reasonable use, so it should be considered that they may be reasonably used to their consented limits during the lifetime of the consent even if they have not been to date, e.g. as noted in the AEE for this application regarding E44/0623. Such an increase in abstraction within consented limits may be facilitated by addition of further infrastructure to better utilise the full consented volume, or may be necessitated by dry seasons. In this light, recorded drawdown in E44/0300 was 0.65m lower in 2018 than in 2017, lower than that considered by Hughes (2017), reflecting dryer conditions and higher abstraction in the 2017-18 season.

It is therefore reasonable to conclude that according to a conservative assessment that there may be no remaining available drawdown in at least those bores identified by Hughes (2017) – E44/0012, E44/0256, and E44/0300 – even without the proposed take, and estimation of sufficient available drawdown was exceeded in one of those bores (E44/0300) in the AEE for the current proposal using modelling with 'average' parameters, less conservative than those described as typical of bores near the site. It should be added that, in this last respect, E44/0300 is a monitoring bore already subject to substantial effects of neighbouring abstraction, it is essentially a bore which monitors effects of abstraction and recovery in Lumsden aquifer, and some degree of exceedance of the pSWLP limits might be accepted by ES staff so long as the bore remains an effective monitoring bore for the wider Lumsden aquifer. Such a decision is not within the scope of this comment, however.

Further complications arise from the hypothetical 'amalgamation' of multiple bores used for existing takes (not the applicant's) in section 3.1.1 of the application. Each of the bores in these groups represents a sizeable take though under a common consent, and the distances of the individual bores from other bores are not equal. A question arises as to whether interference of these bores with each other should be considered when estimating existing drawdown. According to the pSWLP, bores on the same property as a proposed take are not considered for drawdown interference. But these bores are not on the same property as the proposed take considered here, each contributes to a lawfully established take and is subject to effects. Whether the effects of these bores on each other forms part of existing drawdown to be considered when estimating the remaining available drawdown for each of the bores is a question best decided by the Consents team. The extent of the comment here is simply to point out that such drawdown exists and may be substantial, and does not appear to be considered in the AEE.

<u>Aquifer capacity and sustainability</u>

Despite assertions in the application that Lumsden aquifer is well understood, there is uncertainty about the source(s) of throughflow in the aquifer and its points of natural discharge, if any. In this respect,

Lumsden aquifer does not fit the theoretical description of a fully confined aquifer which neither recharges nor discharges naturally, but is a static, finite body of water. 'Confinement' with respect to Lumsden aquifer refers more to 'local confinement' for the purposes of resource allocation and assessment of effects. In addition, interaction between Lumsden aquifer and the overlying, unconfined aquifer may occur in places as described in the application and considered appropriately through use of a semi-confined model.

In reality if an aquifer 'recharges' i.e. potentiometric head is naturally restored which is observed to happen rapidly in Lumsden aquifer following cessation of abstraction, and the capacity of the aquifer is not diminished as the current allocation regime assumes, then consumption of throughflow or recharge water must diminish some alternative sink or path for that water, be it soil or substrate, streams, springs, or other aquifers. The nature and location of such processes is not described in the application, nor has it generally been described in other applications to date.

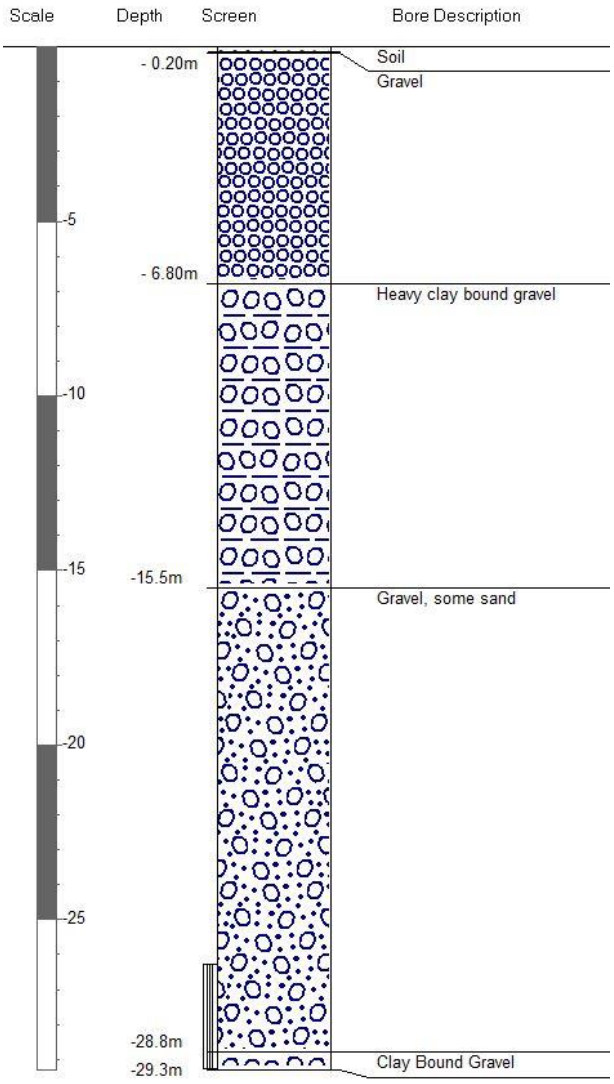
Notwithstanding the above, the limit of allocation for abstraction from Lumsden aquifer as a discretionary activity under the pSWLP is considered to reflect current understanding of the sustainable capacity of the aquifer for resource allocation. It is reasonable to emphasize this allocation limit rather than that of the Regional Water Plan (RWP) especially if, as the application asserts, the pSWLP limit is not subject to any significant appeals in the current plan process. Nonetheless, the Consents team are better placed to determine the relative importance of provisions of the two plans at the current time.

Current allocation of Lumsden aquifer under the pSWLP (as at 18 December, 2018) is 5,628,246m^3/year, 97.7% of the discretionary limit of 5,760,000m^3/year. As noted in the application, a proposal in an unrelated application to increase the take under an existing consent (AUTH-300056) would bring this to 97.9% allocation, leaving 122,178m^3/year available for allocation, the entirety of this total being the subject of the proposed take. There is, however, a likely reclassification of another existing take which will add to the current total allocation from Lumsden aquifer.

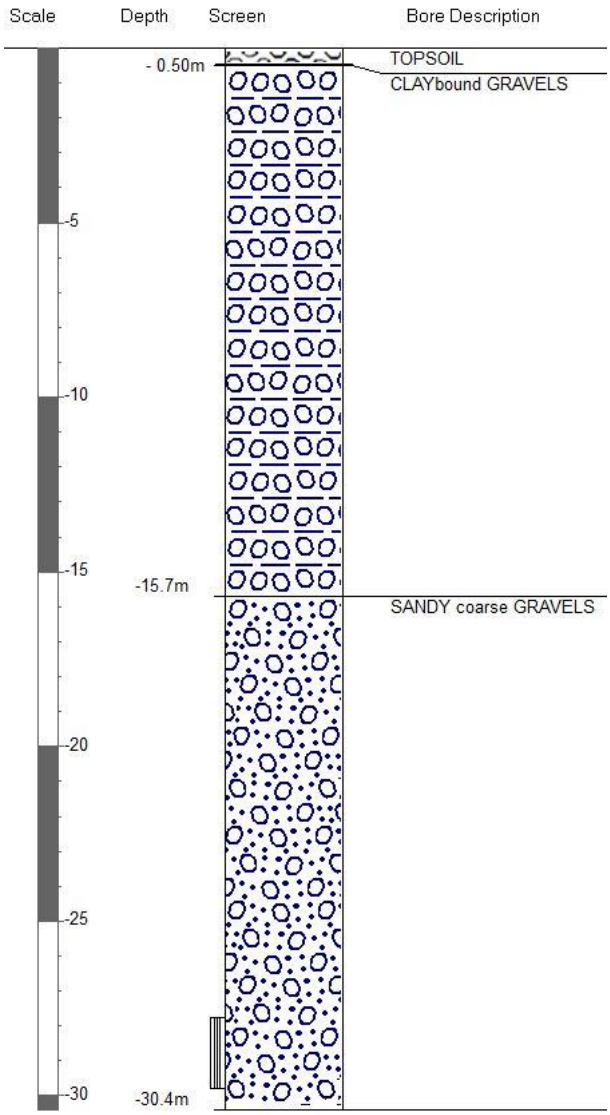
The existing take under AUTH-204993 from E44/0370 on the applicant's property is accounted in ES allocation records to be from Castlerock Groundwater Management Zone (GMZ), however, the depth, bore log, initial water level measurement (-4.68m in April, 2016) and location within the estimated extent of Lumsden aquifer all point to it being sourced from the Lumsden aquifer. The AEE for AUTH-204933 appears to make an assumption of an unconfined take without any supporting evidence, and this was not questioned in considering the application – perhaps due to the modest size of the take (43,800m^3/year). It is worth considering, however, that a recommendation will be forthcoming to add this take to the current Lumsden aquifer allocation. Borelogs of E44/0623, used for irrigation under AUTH-20171076 and sourced in Lumsden aquifer, and E44/0370 are shown in Figure 1 below.

If the take under AUTH-204993 is added to Lumsden aquifer allocation, the remaining available allocation will be 73,878m^3/year, about 60% of the proposed take. Whatever the remaining allocation of Lumsden aquifer is determined to be, there is no reason in principle why it should not be considered for allocation.

Borelog for well E44/0623



Borelog for well E44/0370



Reference

Hughes, B. (2017). *Water Permit Application – Holmesdale Trust Well Interference Assessment.*