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20 August 2021

Attention: Darren De Klerk

Dear Darren

RE: Takapau WWTP Hydrogeology s92 Response (T:D.20)

As part of Central Hawke's Bay District Council (CHBDC) efforts to renew its consent for wastewater discharge at the Takapau Wastewater Treatment Plant (WWTP), a revised system comprised of spray irrigation of treated wastewater at the surface is proposed.

In April 2021, CHBDC submitted to Hawke's Bay Regional Council (HBRC) the *Takapau Wastewater Treatment Plant Discharge Resource Consent Application and AEE*, which included a hydrogeological assessment prepared by Beca (2021)[1] that describes the groundwater system at and around the site, and the potential movement of treated wastewater once it has infiltrated into the groundwater system.

As requested by HBRC, PDP reviewed the consent application documents and provided their technical inputs in a memorandum issued on 25 May 2021 to HBRC[2]. HBRC compiled the review comments and issued a memo to CHBDC titled Takapau Response to s92 Request for Further information, dated 27 May 2021.

This letter addresses the three groundwater comments of the request for further information. Specifically, the PDP review comments raised concerns about the possibility of the Pōrangahau Stream being a potential receiving environment of the treated wastewater discharged at the Takapau WWTP, and the possibility of bores being contaminated by these activities.

Comment No. 20 – Potential groundwater impacts on Pōrangahau Stream

Shallow groundwater flow direction at the Takapau WWTP

Comment No. 20 in the 27 May 2021 Request for Further Information relates to the potential impact from groundwater at the Takapau WWTP on the Pōrangahau Stream:

> *"The groundwater review indicates that groundwater beneath the proposed irrigation area is likely to travel in an east-southeast direction and resurface within the gaining reaches of the Pōrangahau Stream."*

[1] Beca, 2021. Takapau Wastewater Treatment Plant – Hydrogeological Assessment. Report No. T:B.14. Prepared for Central Hawke's Bay District Council. 23 April 2021.

[2] PDP, 2021. Takapau WWTP Discharge Consent Review. Memorandum to Sophia Edmead, Hawke's Bay Regional Council, dated 25 May 2021.

Beca’s groundwater review does not conclude that groundwater beneath the Takapau WWTP flows to the ESE. Based on the water level measurements in the six new piezometers installed at and around the proposed irrigation area, the shallow groundwater is interpreted to flow toward the ENE, sub-parallel to the Makaretu River.

As shown on Figure 1, water levels were recently measured in the six piezometers on 8 June 2021 and confirm that the shallow groundwater flow direction at the Takapau WWTP is interpreted to be to the ENE, consistent with the previous measurements in February 2021.

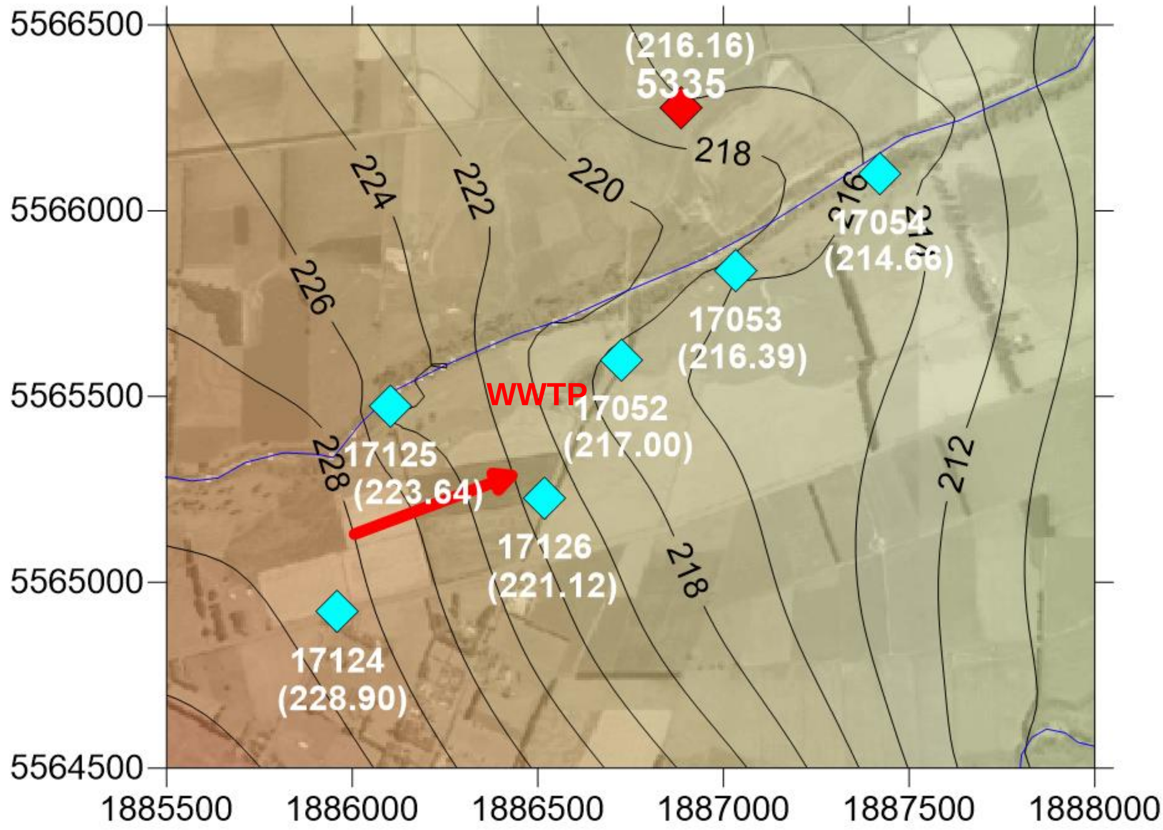

Figure 1: Shallow groundwater elevations (mRL) at Takapau WWTP site, 8 June 2021. Red arrow shows interpreted groundwater flow direction.

We believe that the misunderstanding of the conclusions of our review (that shallow groundwater flow at the Takapau WWTP was to the ESE) may have been due to the groundwater flow vectors shown on Figure 8 of our report[3], of which one vector indicated an ESE direction as a result of a localised “bulls-eye” around one monitoring point, but more generally the flow is to the E and ENE consistent with Figure 1 above.

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[3] Beca, 2021. Ibid.

These vector arrows were the result of the data contouring software based on the groundwater levels measured in the six piezometers at the Takapau WWTP and a single nearby well on the north side of the Makaretu River. The interpreted groundwater flow directions shown by the vector arrows are to the south away from the Takapau WWTP due to a lack of shallow groundwater level data points.

Pōrangahau Stream as a potential interceptor

PDP states that our study corroborates the findings of Johnson (2011)[4] that the Pōrangahau Stream **gains flow** from groundwater as it flows to the east. In their review, PDP also mentioned that they expect that the Pōrangahau Stream is the most likely receiving environment of the treated wastewater discharge from the Takapau WWTP (towards the gaining Pōrangahau Stream and away from the losing reach of the Makaretu River).

In the Beca groundwater review[5], we did not make any statement about the Pōrangahau Stream since our main concern was with the Makaretu River. In our assessment, we agreed with Johnson (2011) about the Makaretu River losing water to groundwater near the Takapau WWTP area (Figure 1). This is consistent with the regional map in Johnson (2011), presented as Figure 5 in our report, which shows the Makaretu River as a losing reach in the vicinity of the Takapau WWTP. This same map shows the Pōrangahau Stream as a gaining reach east of the Takapau WWTP.

However, the lack of groundwater level data points near the Pōrangahau Stream constrained our capacity to provide any statements beyond the general regional scale for that stream. If any assessment for the Pōrangahau Stream on a local scale is to be done based on our conceptual groundwater model, the most reasonable one is that the Pōrangahau Stream is actually conservative or slightly losing water to groundwater upstream from the confluence with the Maharakeke Stream, and losing downstream from that point. This is illustrated in the 3D hydrogeological model presented in Figure 7 of our report (Figure 2 below).

In addition, an assessment by PDP (2019)[6] for the Silver Fern Farms facility, located on the south side of the Pōrangahau Stream about 3 km ESE of the Takapau WWTP, concluded that the Pōrangahau Stream is likely **losing flow** to groundwater at this location: "*…overall, the information suggests that the Pōrangahau Stream typically loses water to groundwater beneath the site*." That assessment was based on groundwater level measurements collected during both the wet season (August 2017) and dry season (January 2017) from 20 different bores around the Silver Fern Farms. PDP makes the following conclusions for the Silver Fern Farms site: "*The implications of [losing water to groundwater] are that nutrients leaching to groundwater as a result of the wastewater irrigation are unlikely to enter the Pōrangahau Stream through the site, except during periods of high groundwater levels*." This is essentially the same conclusion for the Takapau WWTP and the Makaretu River.

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[4] Johnson, K., 2011. Tukituki River hydrological characterisation – supporting information for water allocation. Hawke's Bay regional Council, Napier. EMT 11/05. HBRC plan no. 42665. As cited in Wilding, T.; Waldron, R. 2012. Hydrology of the Tukituki catchment: flow metrics for 17 subcatchments. HBRC Report 12/18, Plan #4405, 66 pages.

[5] Beca, 2021. Ibid.

[6] PDP, 2019. Silver Fern Farms Takapau Consent Renewals Section 92 Request. Letter to Alison Johnstone dated 28 June 2019.

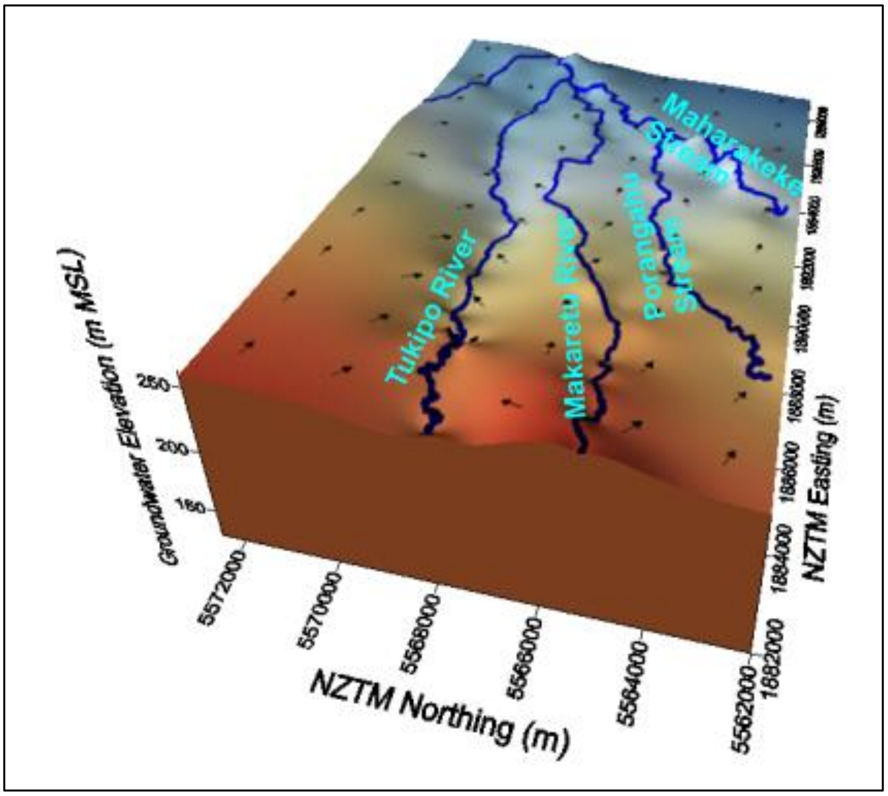

Figure 2: Conceptual 3D model showing the regional shallow water elevation in the area around Takapau WWTP. Abstracted from Figure 7 of Beca (2021).

Makaretu River paleo-channel deposits

The shallow geology of the Takapau WWTP site is mapped as alluvial deposits flanking the Makaretu River. Directly underlying and adjacent to the Makaretu River is the Q1a unit, which forms the lower terrace of alluvial deposits composed of gravels with sandy, clayey, or silty matrix (Figure 3). Underlying and flanking the Q1a unit is the older Q2a unit, which forms the upper terrace of alluvial deposits and has a higher content of fine material (clay and silt).

The difference in clay content between the Q1a unit (lower terrace) and Q2a unit (upper terrace) means that the Q1a and Q2a aquifers have different hydraulic conductivities. As stated in our report[7], the estimated range of saturated hydraulic conductivity values for the shallow aquifer in the upper terrace could be 1-2 orders of magnitude lower depending on fines content.

[7] Beca, 2021. Ibid.

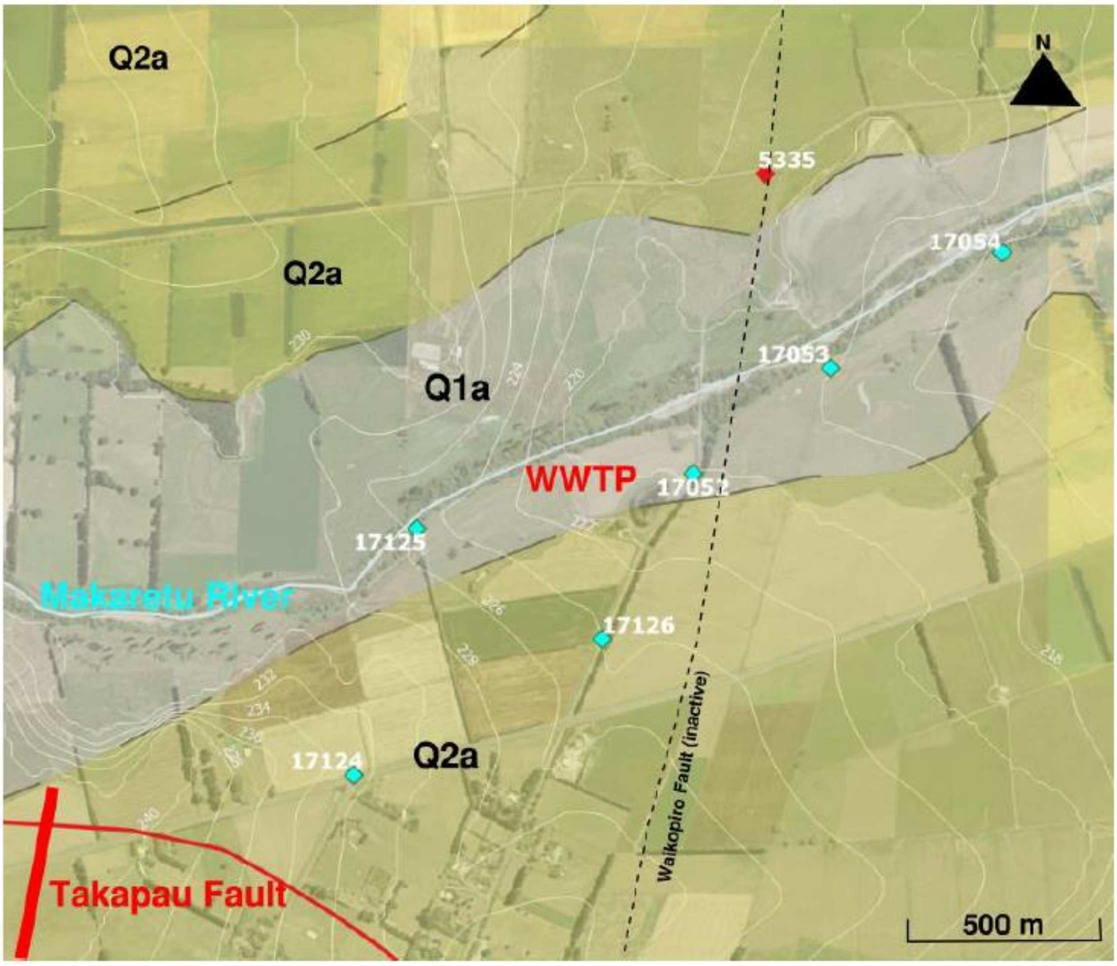

Figure 3: Geology of Takapau WWTP area showing the Q1a lower terrace alluvial deposits and the older Q2a upper terrace alluvial deposits. Abstracted from Figure 2 of Beca (2021).

This difference in hydraulic conductivity between younger and older alluvial deposits is consistent with other studies of similar alluvial river deposits (Gyopari & McAlister, 2010[8]; Gyopari et al., 2014[9]). These studies show that alluvial deposits underlying the Waikanae River floodplain, for example, form a highly permeable riparian aquifer through paleo-channels: *"The aquifer hydraulic conductivity increases appreciably in the recent alluvium adjacent to the Waikanae River due to their coarser texture and relatively well-rounded nature."*

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[8] Gyopari, M. & McAlister, D., 2010. Wairarapa Valley groundwater resource investigation – upper valley catchment hydrogeology and modelling. Greater Wellington Regional Council, Publication No. GW/EMI-T-10/74.

[9] Gyopari, M., Mzila, D., and Hughes, B. H., 2014. Kāpiti Coast groundwater resource investigation: catchment hydrogeology and modelling report. Greater Wellington Regional Council, Publication No. GW/ESCI-T-14/92, Wellington.

We believe that this is likely the same for the younger Q1a unit adjacent to the Makaretu River. The sub-parallel paleo-channels of shallow fluvial systems inferred from the HBRC online map likely reflect near-surface groundwater orientation, which tracks in an approximate ENE direction as shown in Figure 4. [10]

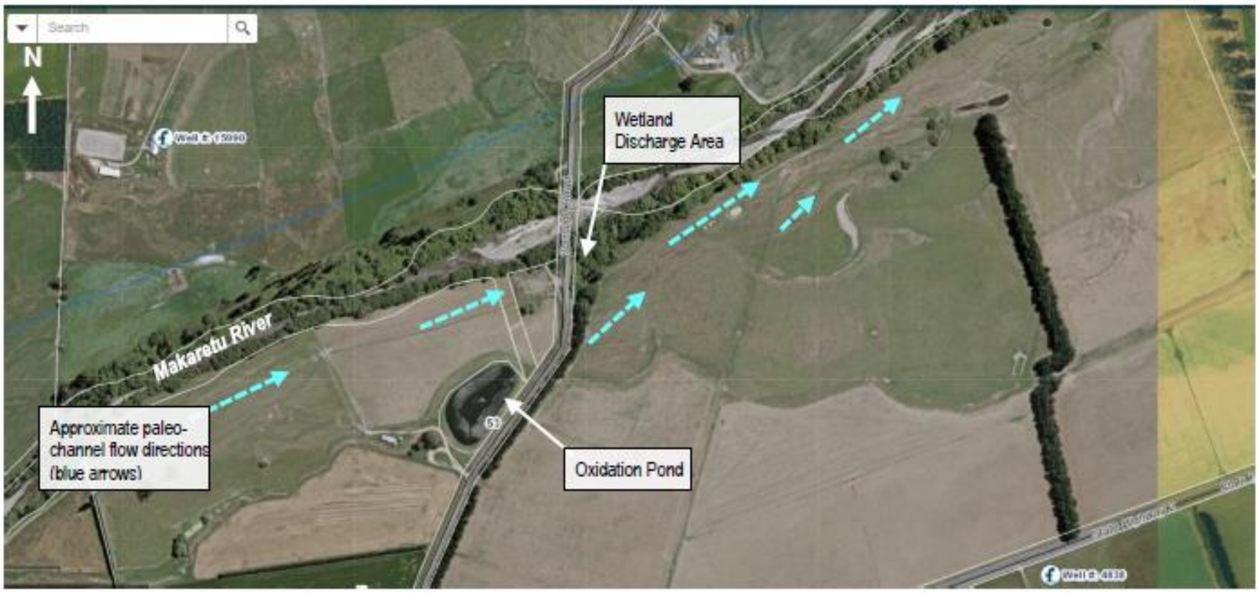

Figure 4: Image illustrating inferred paleo-channels through the younger lower terrace deposits at Takapau WWTP site (Bay Geological Services, 2019)

The implication of these paleo-channels in the younger Q1a units suggests that groundwater flow is likely to be routed through the paleo-channels in the lower terrace deposits and flow sub-parallel to the Makaretu River (toward the ENE) in the vicinity of the Takapau WWTP. This is confirmed by the inferred direction of shallow groundwater flow based on the water level measurements in the six piezometers. It is unlikely that shallow groundwater would flow against the hydraulic gradient toward the SE through the clay-rich upper terrace deposits toward the losing reach of the Pōrangahau Stream. Accordingly, preparation of a separate assessment of effects regarding the Pōrangahau Stream is not justified.

Comment No. 26 – Potential groundwater impacts on bores

Comment No. 26 in the 27 May 2021 Request for Further Information relates to the potential impact from groundwater at the Takapau WWTP on bores to the south:

> *"Given the uncertainty in the groundwater flow direction, please provide an assessment of the effect of the proposed activity on the bores in the rural residential area to the south of the State Highway and proposed land application area."*

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[10] Johansen, A.C., 2019. Groundwater monitoring plan, Takapau oxidation pond and discharge wetland, Burnside Road, Takapau. Prepared for Central Hawke's Bay District Council. Prepared by Bay Geological Services Ltd.

Potential effects on bores to the south

While there may be some uncertainty whether the shallow groundwater flow direction is interpreted to be toward the ENE or to the east, there is little chance that shallow groundwater from the Takapau WWTP site would flow upgradient towards the south or southwest. As shown in Figure 1, there is a strong hydraulic gradient in the shallow groundwater at the Takapau WWTP toward the ENE with the water level in the upgradient piezometer (17124) being more than 6 m higher than the nearest downgradient piezometer (17126) located about 600 m away.

As discussed in our report[11], there is the possibility of upgradient bores reversing the hydraulic gradient when pumping, in which case the capture zone of the pumped bore could cause nearby shallow groundwater to flow toward the pumping bore. It is not possible to fully quantify this without details of well operation and performance (pumping rate and durations, drawdown etc); however, qualitatively we would note:

- There are only three water take consents within 2 km of the WWTP, all of them relate to bores deeper than 30 m and based on bore 1762 described below, there is likely to be some hydraulic separation between shallow groundwater and the deeper aquifer screened in these bores.
- All other unconsented takes and shallower bores are likely to have lower pumping rates and, therefore, are unlikely to reverse the hydraulic gradient over large distances.
- The water take consent associated with bore 1762 is the Takapau community supply. According to its HBRC log, this bore is screened from 31.0 to 33.5 m below ground level (BGL) and there is approximately 22 m of lower permeability units (comprised of multiple clay layers) above the screened interval. These units are likely to provide some hydraulic separation between the pumped aquifer and the shallow groundwater. Further, the Source Protection Zone is presumably based on an assessed extent of drawdown and suggests that this does not extend a significant distance downgradient.

Potential effects on down-gradient bores

Another concern raised by PDP was the potential effects on the water quality of the down-gradient bores, especially the ones used for drinking water. PDP mentioned that there is a downward vertical hydraulic gradient between the shallow and deep groundwater bores, indicating that there is potential that contaminants could migrate to the deeper aquifer. Furthermore, they said that bores within 2 to 2.5 km from a wastewater discharge have greater potential to be impacted by pathogens.

As mentioned in our assessment[12], there is just one bore (4838) located within 2.5 km down-gradient from the Takapau WWTP. The top of the screened interval for bore 4838 is 80.4 m BGL.

Although there is a downward vertical hydraulic gradient in the area, we do not think that contaminants can easily migrate from the shallow aquifer to the deep aquifer. The bore log of 4838 indicates that there are 41 m of potential confining layers (dominated by clay, silt, and clay-bound gravels) between 10 m and 80 m

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[11] Beca, 2021. Ibid.

[12] Beca, 2021. Ibid.

BGL. This provides a considerable hydraulic barrier between these deeper strata and the surficial groundwater.

A GNS hydrochemical study (Morgenstern et all. 2012)[13] regarding the groundwater flow patterns in the Ruataniwha Basin indicates that the deep groundwater is only connected with the surface water in the vicinity of large rivers such as the Waipawa and Tukituki Rivers. Near small rivers and streams, the authors mention that the groundwater is almost purely recharged by rain, and that there is little connection between the deep and shallow groundwater. Thus, we expect that these deep aquifers in which bore 4838 is screened at are recharged by rainfall in their outcrop areas to the west, in the Ruahine Range, especially during winter.

Therefore, we expect that the risks posed by the Takapau WWTP for groundwater users are negligible.

Comment No. 27 – Potential groundwater impact from nitrate-nitrogen

Comment No. 27 in the 27 May 2021 Request for Further Information relates to the potential impact from groundwater at the Takapau WWTP on downgradient drinking water supply bores:

> *“Please provide an assessment of the effects of the proposed activity on down-gradient drinking water supply bores with respect to nitrate-nitrogen. This should include a comparison of the groundwater impacts with the limits in Table 5.9.2 of Plan Change 6 and pathogens and allowing for a degree of uncertainty and variability around groundwater flow.”*

As discussed in our groundwater assessment14, there is just one bore (4838) located within 2.5 km downgradient from the Takapau WWTP. The top of the screened interval for bore 4838 is 80.4 m bgl. Although there is a downward vertical hydraulic gradient in the area, we do not think that contaminants can easily migrate from the shallow aquifer to the deep aquifer. The bore log of 4838 indicates that there are 41 m of potential confining layers (dominated by clay, silt, and clay-bound gravels) between 10 m and 80 m bgl. This provides a considerable hydraulic barrier between these deeper strata and the surficial groundwater. Therefore, it is unlikely that nitrate-nitrogen could impact deep groundwater at concentrations exceeding the limits in Table 5.9.2 of Plan Change 6.

Conclusion

Overall, we do not consider the Pōrangahau Stream to be a potential receiving environment of the treated wastewater discharged at the Takapau WWTP because it is unlikely that shallow groundwater would flow against the hydraulic gradient toward the SE through the clay-rich upper terrace deposits and toward the

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[13] Morgenstern, U.; van der Raaij, R. W.; Baalousha, H., 2012. Groundwater flow pattern in the Ruataniwha Plains as derived from the isotope and chemistry signature of the water. Lower Hutt (NZ): GNS Science. 44 p. (GNS Science report; 2012/23).

[14] Beca, 2021. Ibid.

losing reach of the Pōrangahau Stream. Shallow groundwater flow is likely to move through paleo-channels in the lower terrace alluvial deposits toward the ENE sub-parallel to the Makaretu River.

Accordingly, preparation of a separate assessment of effects regarding the Pōrangahau Stream is not justified.

Similarly, it is unlikely that shallow groundwater from the Takapau WWTP site would flow upgradient towards the south or southwest and affect bores in the rural residential area to the south of the State Highway, or would affect downgradient deep drinking water bores at concentrations exceeding the limits in Table 5.9.2 of Plan Change 6.

Yours sincerely

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on behalf of

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