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9 February 2017

Simon Woodlock
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Dear Simon

RESPONSE TO S92 REQUEST CRC173284 - CRC173289

As requested in your correspondence (dated 9 December 2016) this letter provides additional information related to the resource consent applications for the proposed BCIL Akarana Storage Pond. This letter answers the questions in the same order as they are expressed in your S92 request.

1.0 Dam break study and Potential Impact Classification

Refer to attached Damwatch letter

2.0 Engineering, design and hazards

Refer to attached Damwatch letter with regard to question 2a, 2b, 2d and 2e.

Question 2c. Please provide an Independent Peer Review of the design of the dam and associated dam break assessment. The NZSOLD DSG (2015) recommend 'a formal peer review of the investigation and design, by an independent engineer, should be completed. It should include an early initial review …'

An independent peer review has been undertaken and a letter summarising the findings is attached to this letter.

3.0 Groundwater Quantity

Question 3 a. The groundwater level information provided with the application is sourced from water level readings dated in the 1950's and 1960's with a few spot measurements in more recent years. There is therefore a lack of certainty of what the current range of groundwater levels at the proposed site as they will depend on current Rangitata Diversion Race (RDR) losses (which may be quite different than in the past) and on longer term groundwater level trends.

Please provide further information regarding current groundwater level conditions at the proposed site.

Response to question 3 a: The efficiency of the RDR race over time (including seepage losses from the channel) has been described in the evidence from Young (2003) for the Rangitata River Water Conservation hearing. He indicates that the efficiency of the race pre-1996 was between 90 and 95 % and comments that work from a natural resources engineering student in 1996 show that in 1996 these losses had reduced to between 94 and 98 % with RDR adopting a loss rate of 1.37 m^3/s for the full length of the

RDR (a loss of around 4.4 %). In 2000/2001 the available hydrometric data indicated that the efficiency averaged 96.5 % (a loss rate of 3.5 %). Based on this information it appears that no significant change in RDR seepage losses has occurred or perhaps a slight decrease in seepage over time.

An ECan report titled Land-surface recharge and groundwater dynamics: Rakaia-Ashburton Plains (2010) (Report No. R09/55) provides time series plots of groundwater levels for the plains area in the vicinity of the proposed storage pond. Although the plots provided do not include the period in the 1950's – 1960's (the plots start in 1973/1974) the report indicates that groundwater levels in the area are either stable or show a decreasing trend. A search of the ECan GIS database indicates that the closest bores with available groundwater level data in the 1950's and 1960's and up to year 2016 are bores K36/0051 and K37/0215. Bore K36/0051 is located approximately 17 kilometres south-west of the site. A plot of the water level data from this bore is shown in Figure 1 below. This bore shows that groundwater levels have generally been stable from 1950 to present. K37/0215 is located approximately 28.5 kilometres south of the site. A plot showing water level data from this bore is provided as Figure 2, which shows a decreasing trend in groundwater levels approximately since the year 2000.

Considering that seepage from the RDR has not changed or slightly reduced since the 1950's/1960's and that groundwater levels in the general either show a stable or decreasing trend over time it is likely that current groundwater levels at the site are similar or lower than those measured in the 1950's and 1960's.

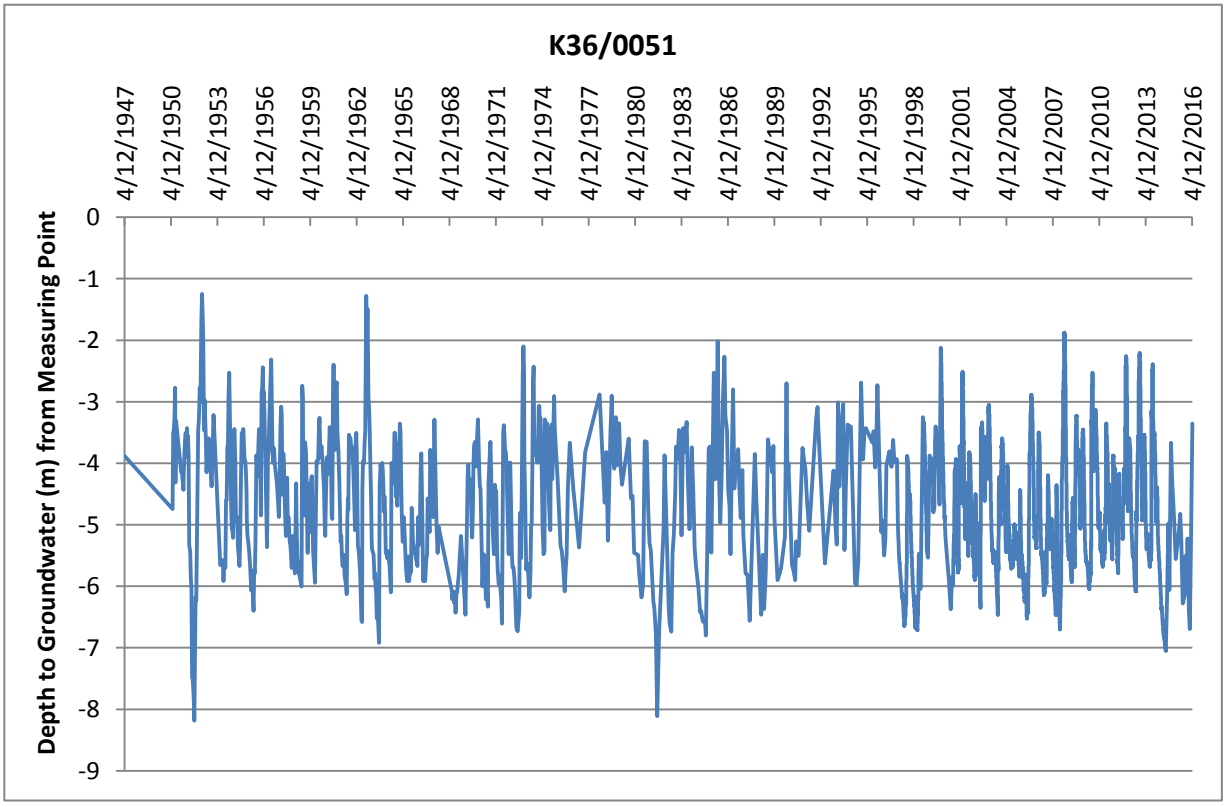

Figure 1 : K36/0051 Depth to Groundwater

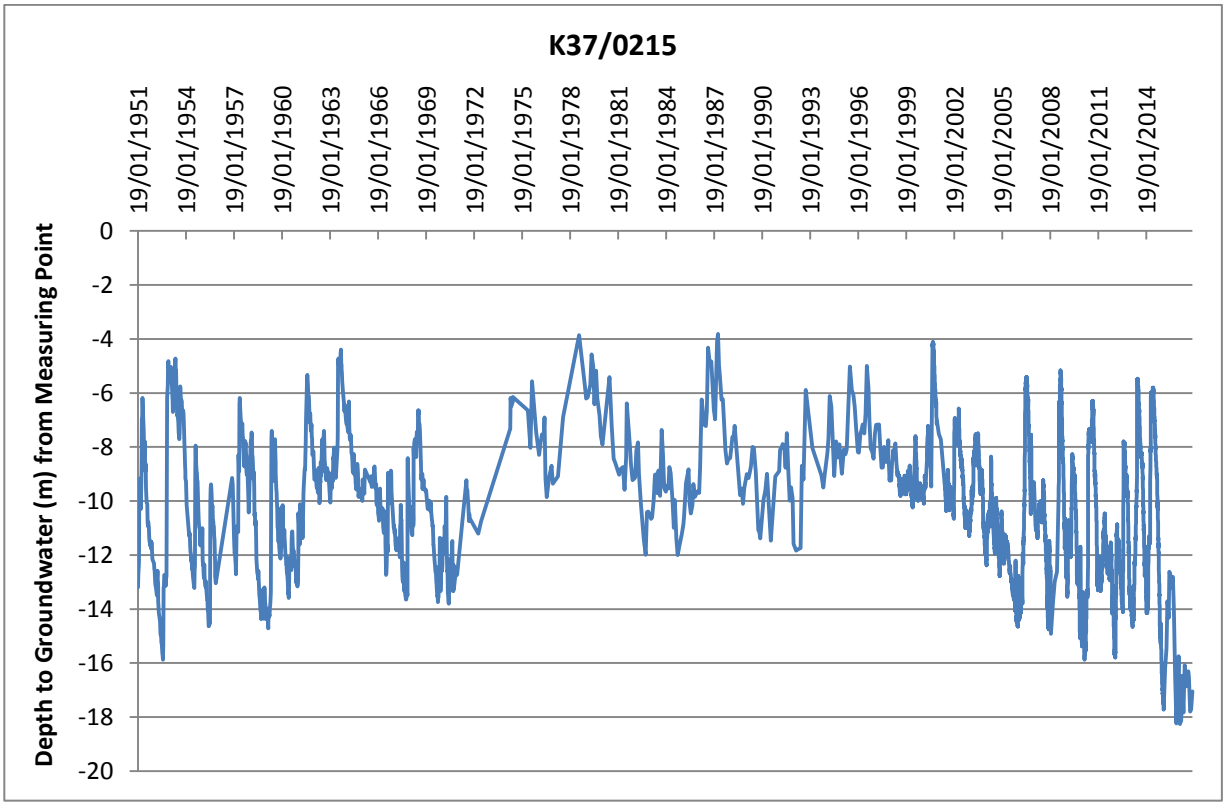

Figure 2 : K37/0215 Depth to Groundwater

Question 3 b: The application states that the effect on groundwater level of seepage from the pond is *'very localised, and is not expected to adversely affect area groundwater levels'*. This cannot be sufficiently assessed without information relating to the following:

i. Expected seepage rates – a range from best practice, to perhaps measured rates in some of their existing ponds.

ii. Some analytical or modelled solution of potential groundwater mounding over the area. This could range from the very simple (such as the mounding solution in Aqtesolve) to a modflow model. Any solution should use a range of aquifer parameters and seepage rates to provide an indication of the potential scale of effects

Please provide the information detailed in points i and ii above.

Response to question 3 b: The material that will form the invert of the pond will consist of a loess/silt mixture which is available at the site. Test pitting and borehole investigations at the site undertaken by Damwatch Engineering indicated that the thickness of the loess/silt material varied across the site between approximately 0.5 to 1.5 m bgl. Insitu, constant head permeability testing of the loess/silt mixture was undertaken by Damwatch Engineering with the results analysed by Opus in March 2016. The testing indicated that the permeability of the loess/silt material present at site ranged between $2.2x10^{-9}$ and $3.2x10^{-9}$ m/s, which we have interpreted to be hydraulic conductivity. This equates to a hydraulic conductivity of up to 0.1 m/year. As detailed in the Damwatch Engineering report, the loess/silt liner will be compacted and hence it can be expected that the liner will have a lower permeability than indicated by the insitu testing.

Based on a maximum pond depth of 4.5 m above this 1 m thick loess/silt liner, the hydraulic gradient could be up to 4.5 m/m initially. Using a hydraulic conductivity of 0.1 m/year, this gives a seepage rate of up to 0.45 m/year (450 mm/year).

ECan (2010) provides land surface recharge rates (i.e. rainfall recharge to shallow groundwater) for the surrounding area including the proposed pond site in Table 2.2 of the report. The proposed pond site is located within Area 4 based on Figure 2-2 of the ECan report. The report indicates that the dryland surface recharge for the proposed pond site is expected to range from 142 to 1,102 mm/year, with a mean of 545 mm/year. No irrigation is currently undertaken at the site.

Based on this, the natural land surface recharge currently occurring at the site is expected to be similar or slightly higher than the expected seepage rate through the loess/silt liner. With construction of the pond, this natural rainfall recharge will cease as any rainfall will become part of the stored water. This indicates that seepage to groundwater may in fact decrease, so the potential for any mounding to occur is unlikely, provided the liner is well constructed.

Damwatch Engineering indicated that the material underlying the insitu loess/silt material at the site consisted dominantly of gravel with varying quantities of silt, sand and cobbles interbedded with gravelly sand. Some silt lenses were observed up to 0.2 m thick and the silt content of the gravelly strata was found to increase towards the base of the investigation boreholes (upward of 30 m bgl). No permeability testing of the gravelly strata was undertaken, although based on the description of the strata, hydraulic conductivity is likely to be in the range of 0.001 to 0.1 m/day or higher according to Kruseman and de Ridder's (1991) typical values for gravel, silt and sand mixtures. Overall, the hydraulic conductivity of the underlying gravelly strata is likely to be significantly higher than the base of the proposed pond and will therefore reduce any potential mounding effects by allowing any seepage from the pond to be dispersed, although as described above, the seepage rate is likely to be within the current dryland recharge occurring at the site so no mounding is expected.

It is worth noting that groundwater was not encountered in any of the test pits. Water was encountered in only one of the boreholes drilled at the site (at approximately 7 and 21 m bgl) but this was thought to potentially be due to seepage from the nearby RDR due to the bores proximity to the race (approximately 50 m).

A large increase in groundwater levels, or mounding, has the potential to create issues for domestic and public supply bores due to an increased potential for leaching of contaminants present in the unsaturated zone, from septic tanks for example. ECan's online GIS database indicates that the closest active and proposed bores are located approximately 4 km to the south east and no domestic supply or public supply bores exist within 2 km of the proposed pond. Based on this, even if a small increase in groundwater levels were to occur on the site, no mounding would be expected at these bores. There is one dwelling located immediately north of the proposed pond but this dwelling is connected to a community water supply.

Based on the information described above, effects on groundwater levels from seepage through the base of the proposed pond are not expected to be dissimilar to those naturally occurring from land surface recharge in the area. Any seepage that does occur is unlikely to cause any significant mounding issues as the underlying strata is expected to be much more permeable than the seepage rate of the loess/silt liner material. Therefore, any mounding effects are considered likely to be less than minor provided a 1 m thick silt/loess layer is maintained at the base of the pond as described by Damwatch Engineering.

4.0 Groundwater quality

Question: There is some contamination risk to groundwater quality at this site especially during the excavation stage. It is therefore advisable to monitor groundwater quality in few locations downgradient to local groundwater flow direction. In some situations of dewatering of groundwater , soil profile may develop acidic conditions if soil profile contains peaty or carbonaceous material.

Please provide information on any groundwater monitoring proposed during the excavation of the dam.

Response to question: The soils and geology of the site has been described in the AEE in section 4.2 (PDP,2016) and in the geotechnical investigation report (Damwatch, 2016). These reports describe the soils and surface geology of the general area as well as site specific soil and geology information based on deep trial pits, shallow pits, sonic boreholes and laboratory testing. The available information indicates that the soil profile is not likely to contain any significant amounts of peaty or carbonaceous material and hence it is considered that there is no contamination risk to groundwater quality during excavation in the unlikely event that dewatering is required.

Please do not hesitate to contact Bas Veendrick (03-3457122 or bas.veendrick@pdp.co.nz) should you have any questions or require anything further.

Yours sincerely

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References

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Kruseman, G.P. and de Ridder, N.A. 1991. Analysis and evaluation of pumping test data. International Institute for Land Reclamation and Improvement. Wageningen, The Netherlands, 377 p.

Limitations

This letter has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Environment Canterbury and Damwatch Engineering Ltd. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the letter. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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