Memorandum

To:	Ōhoka Residential Subdivision Expert Panel	**Of:**	Environmental Protection Authority
From:	Julian Weir (CPEng)	**Date:**	2 November 2026
Reviewed by:	Andrew Dark (CPEng)	**Project no:**	PRJ-2700437
Subject:	4078 - FTAA-2606-1253 Ōhoka Residential Subdivision Groundwater / Hydrogeology Advice		

My name is Julian Weir. I am a Principal Engineer and Groundwater Modelling Lead Consultant with Aqualinc Research Ltd (Aqualinc). I have been engaged by the Ōhoka Residential Subdivision Expert Panel, acting on behalf of the Environmental Protection Authority (EPA), to provide independent expert advice on groundwater and hydrogeology associated with the Ōhoka Residential Subdivision Fast-Track application. This memorandum summarises my key findings, proposed requests for further information (RFIs) and conceptual consent conditions.

1 Qualifications and Experience

I am a civil engineering consultant, hydrogeologist and specialist groundwater modeller. I hold the qualifications of Bachelor of Engineering (Hons) and Master of Engineering from the University of Canterbury. I am a Chartered Professional Engineer (CPEng), a Chartered Member of Engineering New Zealand (CMEngNZ), a Practice Area assessor for Engineering New Zealand and a member of the New Zealand Hydrological Society. I am also registered on the New Zealand section of the International Professional Engineers Register (IntPE(NZ) / APEC Engineer).

I have 26 years of experience in groundwater-related research and consultancy, and a further four years in general civil engineering and water-related work. I have extensive experience in all areas of groundwater modelling and have prepared technical evidence for major resource consent hearings in the Canterbury, Tasman and Hawke's Bay regions. During this time, I have developed multiple catchment-scale groundwater models and used these to predict groundwater and surface water flow responses to proposed activities.

I have conducted many aquifer tests and analyses, particularly in complex hydrogeological settings within the Canterbury and Tasman regions. My Master of Engineering thesis research in 1998 involved developing and progressing analytical methods for analysing stream depletion effects from groundwater pumping.

2 Code of Conduct

I have read the Environment Court's Code of Conduct for Expert Witnesses (2023) and agree to comply with it. This assessment has been completed in accordance with that Code.

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3 Information Considered

I have reviewed the various reports and studies relevant to my review, as published on the EPA's Fast-Track website[1]. While I have read many reports to determine whether they contain content relevant to my area of expertise, I have largely based my assessment on the following key reports that relate to the assessment of effects on groundwater and hydrogeology:

Documents provided by the Applicant:

- Appendix 17a: 'Groundwater Assessment of Environmental Effects' report by Pattle Delamore Partners (PDP) dated 25 May 2026.
- Appendix 20: 'Hydrology Assessment' by PDP dated 2 June 2026.
- Appendix 17c: Supplementary 'Water Supply Memo' by PDP dated 10 September 2026.
- 'Change in Water Balance Assessment' by PDP dated 31 August 2026.
- Appendix 31: 'Updated Stormwater Management Report' by PDP dated 10 September 2026.
- 'Construction Earthworks Spring and Groundwater Monitoring Plan' report by PDP dated 31 August 2026.

Documents provided by Commenters:

- Appendix 5: 'Groundwater Resources' - Technical Advice memo by Philippa Aitchison-Earl of Environment Canterbury (ECan) dated 12 October 2026.
- Appendix 9: 'Stormwater Engineering' - Technical Advice memo by John Kindness of GHD (on behalf of ECan) dated 12 October 2026.
- Appendix 8: 'Water' - Technical Advice memo by Paul Reed of Beca (on behalf of Waimakariri District Council, WDC) dated 7 October 2026.
- Appendix A-3 of the Ōhoka Residents' Association submission – expert statement by Dr Helen Rutter of Lincoln Agritech.

I have also read comments provided by other parties (including some residents), but I consider the groundwater matters raised are consistent with those discussed in the above documents. I have therefore not listed these other documents separately.

4 Key Findings

This memorandum outlines areas of agreement and areas where I consider additional information and/or conditions would be beneficial to quantify the potential effects of the proposed subdivision or to mitigate potential adverse effects. I have also recommended where I consider the information should be provided prior to approval (if granted) or as part of detailed design later. A large volume of information has been made available to review over a relatively short timeframe. Therefore, while I consider some aspects of the proposal are adequately documented, I have intentionally kept this memorandum succinct by briefly reporting on areas of agreement and what I consider key shortcomings that may be alleviated by further information or proposed conditions.

4.1 Groundwater Monitoring and Seasonal Groundwater Level Variations

For a subdivision such as this, some alterations to the shallow groundwater hydrology are expected, particularly at a local scale. While some effects can be appropriately predicted, others may not be apparent until the works are underway or complete. Therefore, I generally support PDP's proposed Construction Earthworks Spring and Groundwater Monitoring Plan that includes monitoring of surface waterways, springs and shallow groundwater levels (at multiple sites). However, I consider the plan needs to be expanded to include the wider potential effects on neighbouring bores, springs and waterways, for up to two years following completion of development (to capture a range of seasonal responses). It also needs to provide clear triggers to identify adverse effects and clear actions to manage and/or mitigate these adverse effects (i.e. a management plan rather than just a monitoring plan). The staged nature of the development provides an opportunity for adverse responses to be mitigated prior to continuation of subsequent stages.

[1] https://www.fasttrack.govt.nz/projects/Ohoka-residential-subdivision/substantive-application

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RFI: Expand the Construction Earthworks Spring and Groundwater Monitoring Plan to capture potential effects on neighbouring bores, springs and waterways, for up to two years following completion of development. Include clear triggers to identify adverse effects and clear actions to mitigate these adverse effects.

I recommend this is provided prior to approval.

Section 3.4 of the monitoring plan notes data is to be reviewed three times yearly in alignment with data collections. If adverse effects occur between these download periods, then it may be some time before mitigation is actioned. It may also be that telemetered data is needed at a key site (or sites) to provide early indication. Consider proposing a condition that requires investigation (including data collection), assessment and remedial action if a trigger is breached or following a validated complaint from a neighbour (or other adversely affected party).

RFI: Propose a condition that requires investigation, assessment and remedial action following a trigger breach or a validated complaint from a neighbour (or other affected party).

I recommend this is provided prior to approval.

Reasonable groundwater level monitoring has been conducted on site via one existing longer-term monitoring bore (M36/0596) and 23 newly installed monitoring bores. This provides good spatial coverage over the site, though the records in the new shallow bores are relatively short (data from March 2025 to April 2026 has been presented, though presumably monitoring is ongoing). Further insight into longer-term shallow groundwater level responses may be gained by correlating the shorter records with the longer-term record.

RFI: Provide a longer-term assessment of historical shallow groundwater levels considering all monitoring data available on site (or nearby). This may be achieved by correlating short-term records with longer-term records.

I recommend this is provided prior to approval.

Section 3.2.2 of PDP's Groundwater Assessment of Environmental Effects (AEE) notes the existence of 53 bores that have been used for groundwater level monitoring, which is a valuable dataset. However, no comment is made as to whether all of this data has been considered.

4.2 Stormwater Management Areas (SMAs)

I agree with the concept of setting SMA outlets to highest expected groundwater levels to reduce the opportunity for increased groundwater discharge and maximise drainage back to groundwater (if the SMAs are unlined). However, little information is provided on the depths of the SMA basins, how these were derived and how they relate to potential effects on shallow groundwater levels (both highs and lows). Nor is any mention made of how the SMAs will be managed long-term (for example, a regular programme of soil testing for bed clogging and/or contaminant build-up, and associated excavation, disposal and replacement of bed materials). Further information is requested.

RFI: Provide more information on how the SMAs were designed in relation to managing effects on groundwater and how they may respond under different conditions of high and low groundwater levels.

I recommend this is provided prior to approval.

Consent condition concept: Develop a SMA maintenance programme in relation to effects on groundwater quality and quantity.

I recommend this type of condition is provided prior to approval.

4.3 Effects of Earthworks and Hydrology Infrastructure on Groundwater

PDP's conceptual description of the site's hydrogeology is reasonable, with springs likely being sourced from the water table ('depression' springs rather than 'artesian' springs), and wetlands well connected to shallow

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groundwater (given high groundwater levels in places). Figure 3 of PDP's Groundwater AEE presents generalised catchment-scale groundwater flow directions, and these conform to the general understanding of groundwater flow directions in Canterbury. However, it is not stated how these were derived, or which aquifer(s) these represent. Further information on the subdivision-scale groundwater flow patterns would be useful, how these differ between the shallow and deeper aquifers, and whether any differences could result in adverse effects from the proposed subdivision (such as effects on Ōhoka Stream).

RFI: Provide more information, at the subdivision scale, on the groundwater flow patterns and directions at different depths.

I recommend this is provided prior to approval.

PDP's Change in Water Balance Assessment concludes that the proposed development may result in a long-term average net reduction in land surface recharge of approximately 6 l/s. Sufficient detail was provide by PDP for me to undertake a high-level (order-of-magnitude) assessment of the input values, and based on this I generally agree with the final value presented by PDP, noting that it may vary seasonally above and below this value.

4.4 Deep Groundwater Supply

Section 5 of PDP's AEE discusses the design water supply rates for various aspects of the development. Design rates are noted for the individual units at the Retirement Village, but no allowance has been noted for commercial activities at the village (such as offices, dining areas, laundry and cleaning facilities, garden irrigation, etc.). Please confirm if this is required.

RFI: Confirm if additional water supply is required for commercial activities at the proposed Retirement Village.

I recommend this is provided prior to approval.

The predictions of effects from the proposed deep groundwater supply, and the potential sustainable yields from new deep bores, have been based on the response in WDC's deep Ōhoka supply bore (BW24/0262) located north of the property. This is a helpful starting point, though each new bore will require step testing[2] when drilled to verify yields and to (eventually) confirm the total number of bores required. I note that this is proposed in PDP's Supplementary Water Supply Memo, which I support.

Consent condition concept: Step test each new deep groundwater supply bore and analyse for aquifer properties and sustainable yield.

I recommend this type of condition is provided prior to approval (though testing can be undertaken as part of detailed design, once bores are installed).

In assessing potential interference effects in neighbouring bores and stream depletion effects, aquifer properties have been taken from a test on WDC's existing deep bore at Ōhoka. This is a good starting point, and a potentially conservatively low aquifer transmissivity value has been used for well interference purposes (though this is not conservative for stream depletion assessment). However, the test may not necessarily reflect on-site parameters. Furthermore, Section 3.2.4 of PDP's AEE notes that there are shallow aquifer tests in the area, but PDP have instead used a shallow aquifer transmissivity derived from the 'Bal' equation, which is not considered reliable.

Regardless, a carefully designed, conducted and analysed constant-discharge test[3] is required when one (or more) of the proposed deep bores has been installed, monitoring groundwater levels in both the pumped aquifer

[2] A step test (or step-drawdown test) is a short-duration pumping test in which a bore is pumped at several successively higher constant rates (steps), each held for a set period, while water levels in the same bore are measured. Test results are used to estimate aquifer transmissivity, to assess bore efficiency and well losses, and to determine a sustainable pumping rate for the bore.

[3] A constant discharge test is a longer-duration pumping test in which a bore is pumped at a single, steady rate for an extended period (typically three days) while groundwater levels are measured in the pumped bore and in nearby observation bores. The drawdown and recovery data are used to estimate aquifer properties (such as transmissivity, storativity and vertical leakage) which can then be used to assess longer-term interference and stream depletion effects.

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and the shallow aquifer. A second test in the shallow aquifer is also required to better define shallow aquifer and stream-bed properties, as these directly influence the assessments of both interference effects and stream depletion. This is particularly important as many of the potentially affected neighbouring bores are in the shallow aquifer. I note again that testing is proposed in PDP's Supplementary Water Supply Memo, which I support.

Consent condition concept: Conduct constant-discharge aquifer tests in both the deep (pumped) aquifer and the shallow aquifer. Properties from the test analyses are to be used in refined interference and stream depletion assessments, quantifying effects both during construction (dewatering) and post-development.

I recommend this type of condition is provided prior to approval (though testing can be undertaken as part of detailed design, once bores are installed).

For consideration, it may be possible to use the interference observed in monitoring bore P02 (noted on Page 7 of PDP's AEE) to derive aquifer parameters, if the associated pumped bore and pump rate (that caused the interference) are known.

I also support the concept that the (eventual) surrender of the existing irrigation takes has potential to yield a positive response in both groundwater levels and river flows during the irrigation season (when the bores would have been used). I agree with PDP that assessing the additional response from the proposed new development (including the proposed new deep takes), less the positive response from surrendering the existing shallow takes, is the correct method to quantify the net effects of changing water use.

4.5 Source Water Risk Management

It is proposed to install the new supply bores to a depth similar to that of the nearby WDC deep bore (BW24/0262, screened between 78-84 m bgl). In their AEE, PDP have assumed a default 100 m source water risk management area (SWRMA) for the bores, and note that this would be revised once the bores are installed and tested. I consider this a reasonable interim approach, and agree that a bespoke SWRMA assessment should be completed for each bore; this may result in a zone that is smaller or larger than the default. The assessment could include more detailed consideration of contaminant removal processes.

Consent condition concept: A suitably qualified hydrogeologist is to prepare a SWRMA assessment for each new supply bore.

I recommend this type of condition is provided prior to approval (though the assessments can be completed as part of detailed design, once the bores are installed and tested).

In PDP's AEE, the vertical travel time from the land surface to the proposed new bore depths has been calculated using Darcy's relationship for flow through porous media, assuming an effective transport porosity of 0.1. In my experience, this porosity value is too large (it is more consistent with bulk porosity than effective porosity)[4] and results in transport velocities that are insufficiently conservative. From field studies near Burnham, Dann *et al.* (2008) derived an effective transport porosity of 0.0038 using pumping and tracer test data, though this study focussed on transport through preferential flow paths within open framework gravels. As part of SWRMA assessments I completed for Christchurch City Council (CCC) supply bores, a value of 0.02 was agreed by a panel of experts, acknowledging transport through both aquifers and tighter intermediate aquitard layers.

Using an effective porosity of 0.1, PDP have calculated an overall travel time between the shallow water table and the pumped aquifer of approximately two years. If a value of (say) 0.02 is used, the travel time would be proportionally shorter at approximately 0.4 years, which is less than the one-year travel time required for microbial protection (SWRMA Zone 2). While I agree with the method used to calculate the travel time, consideration of more conservative transport parameters is recommended.

RFI: Consider the use of more conservative contaminant transport parameters (particularly effective transport porosity) in estimating the travel time to the deep supply bores.

[4] Bulk (or total) porosity is the volume of all voids in a soil or rock expressed as a fraction of its total volume, including isolated and dead-end pores. Effective porosity is the smaller fraction made up of connected pores that actually carry groundwater flow and contaminant transport. Travel time is estimated by dividing the Darcy flux velocity by the effective porosity, so a lower effective porosity gives a faster travel time. In heterogeneous alluvial gravels, flow is often concentrated along preferential pathways, so the effective transport porosity can be much lower than the bulk porosity.

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I recommend this is provided prior to approval.

It is proposed to provide UV and/or chlorine treatment of the abstracted water for potable supply, which I support. While this provides one barrier to microbial contamination, a source water travel time of less than one year (based on using more conservative contaminant transport parameters) means a second protection barrier is not provided, and consequently a multi-barrier approach does not exist. Therefore, I recommend consideration be given to installing the proposed new bores deeper than the 70-80 m depth currently proposed.

In the proposed consent conditions, a minimum bore depth of 60 m is noted, which I consider is too shallow. A target depth of 100-150 m may be more appropriate, similar to WDC's deep supply bores in Kaiapoi that supply Rangiora (as noted in Section 7.1 of PDP's Supplementary Water Supply Memo), assuming other water quality attributes (like iron) are suitable. Based on Figure 7 of PDP's AEE, some deeper bores in the area may have higher yields than shallower bores. An initial deep bore could be trialled, and if sufficient water is not found at this greater depth, then it could be pulled back to the currently proposed depth of 70-80 m.

RFI: Consider installing new deep bores to a depth of 100-150 m to provide greater source water protection.

I recommend this is provided prior to approval.

Section 7.5 of PDP's AEE notes that water quality monitoring has suggested elevated concentrations of dissolved metals in groundwater. It is helpful that this has been identified at an early stage, though no explanation of the possible causes is given. Further commentary and/or field studies would be helpful to know if this is an ongoing concern to human health.

RFI: Investigate and report on the potential cause(s) of elevated dissolved metals in groundwater and associated concentrations, trends and (if needed) treatment feasibility.

This can be undertaken as part of detailed design.

In the Supplementary Water Supply Memo, PDP note several options considered for supplying irrigation water to the polo field, including supply from the proposed deep bores (bypassing treatment) and shallow bores. I expect that the peak flow rate of approximately 3 l/s (Table 3 of the Supplementary Water Supply Memo) could be supplied (untreated) from a single bore located on (or adjacent to) the polo field grounds. This is a design suggestion and does not warrant an RFI.

Any new potable supply would need to be tested in accordance with relevant drinking water standards. If granted, consent conditions should include such a requirement.

Consent condition concept: Potable water supplies to be tested in accordance with relevant drinking water standards.

I recommend this type of condition is provided prior to approval (though testing will be undertaken post-installation).

I support a proposed nominal bore diameter of 300 mm to allow for flexibility with pump set-up. All bore heads should be fitted with appropriate sanitary seals.

4.6 Groundwater Influence on Surface Water Flooding

The updated Stormwater Management Report acknowledges that groundwater levels are expected to be high at times within the development, which I agree with. Based on the available records, groundwater is also likely to intercept the ground surface at times in certain places, and does so permanently in the spring areas. High groundwater levels limit infiltration, thereby exacerbating the potential flood risk. It is not clear how (or if) the flood modelling has allowed for high groundwater levels, and further commentary on this would assist in better understanding potential flood risk.

RFI: Provide additional commentary on how the flood modelling has accounted for high groundwater levels.

I recommend this is provided prior to approval.

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Specific shallow groundwater monitoring for SMAs should be considered where groundwater depth is critical to design and operation (during both wet and dry periods).

RFI: Provide additional commentary on groundwater monitoring proposed for SMAs.

This can be undertaken as part of detailed design.

4.7 General Comments

PDP's use of analytical methods is a practical and commonly applied approach for an initial assessment of effects. However, the site is complex with multiple streams, drains and springs. This means that simplifying assumptions applied to analytical models can be violated. Consequently, complex sites (such as this proposal) are sometimes modelled using a numerical model that can better accommodate the spatial variability and complexity (including the deeper aquifer).

RFI: Provide an assessment of whether the assumptions required for the analytical methods used are appropriate in this setting.

I recommend this is provided prior to approval.

Future climate in the Waimakariri District is projected to be more variable and volatile (e.g. higher extreme rainfall events and longer droughts)[5]. Future climate should be accommodated in the hydrology and hydraulic designs.

RFI: Provide details of how future climate projections have been considered in the hydrology and hydraulic designs of the development.

I recommend this is provided prior to approval.

I do not have expertise in liquefaction susceptibility, but understand that the presence of groundwater increases this risk.

RFI: Confirm what allowance has been made for assessing liquefaction susceptibility under high groundwater conditions.

I recommend this is provided prior to approval.

5 Closing Remarks

For a subdivision like this, some alterations to the shallow groundwater hydrology are expected. Overall, I consider the Applicant's groundwater assessment provides a reasonable basis for understanding the site's hydrogeological setting, and I agree with many of the findings and proposed measures. However, while not every potential adverse effect or hydrogeological response can be soundly predicted, there are aspects that would benefit from additional information, and these concerns are largely echoed by Commenters. Where responses cannot be reliably predicted, monitoring, with appropriate triggers, review and action, is recommended to mitigate unforeseen adverse effects.

Some of the issues I raise above may be able to be resolved via expert conferencing, which I would be happy to participate in.

[5] https://niwa.co.nz/sites/default/files/Summary_Report_WDC.pdf and/or https://map.climatedata.environment.govt.nz/

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