

Homestead Bay Development Consent Application

Engineering Feasibility Assessment

VOLUME 5 - ADDENDUM

Prepared for:
RCL Homestead Bay Limited

Date:
18 September 2025

Prepared by:
Stantec New Zealand

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1 Purpose of the Report

This report is an Addendum to the Stantec New Zealand report “Homestead Bay Development Consent Application, Engineering Feasibility Assessment” (11 April 2025) submitted as part of the Fast Track Consent Application by RCL Homestead Bay Ltd for the development of a residential subdivision in Queenstown.

This Addendum provides additional information and updated Appendices to the 11 April 2025 report.



2 Responses to Otago Regional Council Peer Reviews

Otago Regional Council obtained several peer reviews of different parts of the Homestead Bay Fast Track Consent Application from SLR Consulting New Zealand Ltd (SLR) of the Fast Track Consent Application

Subsequently responses were provided to requested matters in the following SLR reports:

- RM24.355 / FTA063 – RCL Homestead Bay Ltd, Defence Against Water Technical Peer Review (31 July 2025)
- RM24.355 / FTA063 – RCL Homestead Bay Ltd, Stormwater Discharges Technical Peer Review (7 August 2025)
- RM24.355 / FTA063 – RCL Homestead Bay Ltd, Wastewater Discharge (Effects on Groundwater) Technical Peer Review (13 August 2025)
- RM24.355 / FTA063 – RCL Homestead Bay Ltd, Earthworks Technical Peer Review (1 August 2025).

These responses are contained in appendices to this Addendum:

- Appendix A – Stantec Technical Note, 5 September 2025, including attachments:
 - Homestead Bay Stormwater Model – Basis of Design, Stantec August 2025
 - Flood Diversion Assessment Homestead Bay, Queenstown, Geosolve, 21 May 2025
 - Update Stantec drawings 310104425-00-000-C0274 and 310104425-00-000-C0275, Rev 0A
 - Updated Construction Management Plan
 - Updated Sections of Southern Creek and Southwestern Creek (Stantec drawings 310104425-1-000-C0277 to C0278.
- Appendix B – “Wastewater Discharge Condition Feedback for RM24.355 / FTA063 – RCL Homestead Bay Ltd Wastewater Discharge”, LEI Memorandum 5 September 2025
- Appendix C – “RCL Homestead Bay Ltd: Groundwater Effects of Applying Treated Wastewater to Land”, Komanawa Solutions Ltd, 8 September 2025
- Appendix D – “Emerging Contaminants in Treated Wastewater”, LEI Memorandum, 5 September 2025.



3 Water Bore Monitoring

Initial testing of water quality in Bore CC11/0151 was reported in Section 5 of Appendix B of the Engineering Feasibility Assessment (“RCL Homestead Bay Ltd: Groundwater Exploration & Effects of Taking Groundwater for Water Supply”, Komanawa Solutions Ltd, 1 April 2025).

Subsequently, thirteen monthly samples (September 2024 to 2025) have been taken from the bore and tested for a range of water quality parameters. The Stantec New Zealand report “Homestead Bay Bore – Water Quality Monitoring” (September 2025) now summarises the testing results, concludes that the bore water can be treated to meet required standards, and identifies options for the basis of design for a water treatment plant. This report is in Appendix E.



4 Alternative Wastewater Treatment and Disposal

The Fast Track Consent Application (including subsequent attachments) submitted to the Environmental Protection Authority (EPA) by RCL Homestead Bay Ltd for the development of a residential subdivision in Queenstown has included proposals for wastewater treatment and subsequent disposal by dripper irrigation on the development area.

Queenstown Lakes District Council (QLDC) have proposed that wastewater from the Southern Corridor (including the proposed Homestead Bay development) should be treated and discharged as a single system. This proposal has been expressed in meetings between RCL Group and QLDC, and in public discussion documents for Te Tapuae Southern Corridor Structure Plan. No details have been provided on the QLDC concept.

A report “Homestead Bay Fast Track Consent – Alternative Wastewater Disposal” was prepared to show an indicative concept illustrating one possible way for how the Homestead Bay (HB) development could be connected to such a system implemented by QLDC. This report is included here as Appendix F. This concept is based on connection of Homestead Bay to HFWWPS and then upgrading the HFWWPS and its downstream systems to connect to Shotover Treatment Plant. Alternatives approaches are possible.





Appendices



Appendix A Stantec Technical Note, 5 September 2025 - Including attachments



Appendix B “Wastewater Discharge Condition Feedback for RM24.355 / FTA063 – RCL Homestead Bay Ltd Wastewater Discharge”, LEI Memorandum 5 September 2025



MEMORANDUM

Job 10934

To: Dan Wells, RCL Holdings

From: Brian Ellwood, Lowe Environmental Impact (LEI)

Date: 5 September 2025

Subject: Wastewater Discharge Condition Feedback for RM24.355 / FTA063 – RCL Homestead Bay Ltd Wastewater Discharge

This memorandum has been prepared in response to the technical review completed by SLR Consulting New Zealand Ltd (SLR) of the Fast Track Consent Application submitted by RCL Homestead Bay Ltd to the EPA for the proposed residential subdivision in Queenstown. The following sections address SLR's specific feedback and comments regarding the wastewater discharge consent conditions.

WASTEWATER DISCHARGE

Condition 1

Currently limits the volume of wastewater discharged to 3,974 cubic metres per day. This condition needs to be more nuanced, as 3,974 m³/day is the wet weather flow. The AEE has been based on the dry weather discharge of 2005 m³/ day and this dry weather limit needs to be incorporated into this consent condition.

Response: Additional text has been added to provide reference to a maximum discharge of 2005 m³/day over a 30-day average. The average allows for wet-weather flows. The limit is indirectly included with the discharge rate in condition 2.

Condition 3

(i) I recommend that this condition is amended to include that the system must be capable of achieving annual average concentrations of cBOD5 – 20 mg/L, TSS – 20 mg/L, TN - 7.5 mg/L, TP - 2.5 mg/L, E.coli - 1000 MPN/100mL. This is important because the AEE was based the WWTP achieving this level of performance, therefore it should be conditioned.

Response: The treatment quality is addressed in Condition 15 in conjunction with the fixed maximum nitrogen loading rates reported in Condition 10. The nitrogen loading rates of Condition 10 are fixed for all stages of the development to ensure that the effects of wastewater application are managed, aligning with the assessment of effects reported, while providing flexibility to the consent holder when designing and implementing the wastewater treatment plant and land treatment area.

By controlling the mass of nutrients applied at up to 220 kg N/ha/yr in anone area and averaging 193 kg N/ha/yr, the land treatment application rate could be initially lower than what is the design irrigation rate, i.e., a lower rate in mm/day, but a slightly stronger form of wastewater could be applied. This minimises the use of energy and chemicals in the wastewater treatment plant and reduces sludge generation, handling and off-site disposal.



Section 4.5.1 and Table 4.6 of the AEE detail example stage development scenarios. Condition 15 provides certainty to the consent authority that a high level of treatment will be delivered as a minimum.

Additionally, a new condition stating the minimum LTA in hectares should be included. This is currently 28.5 ha, but as discussed above, a reserve area is recommended. Perhaps in the order of an additional 5-10% of the proposed LTA.

Response: A minimum LTA area of 5 ha is detailed in condition 3 b), with the limit on irrigation depth and nitrogen loading ensuring sufficient area must be supplied. New condition 5 e) requires 10% additional area be available at all times to receive the wastewater based on the previous 12 months of flows. Condition 8 required certification that the land treatment area is sufficient for the capacity of the wastewater treatment plant.

PERFORMANCE MONITORING

Condition 12

I recommend that additional wells are added to the required monitoring well network. These are shown in Attachment A.

The primary purposes of these changes are to provide an earlier indication of groundwater effects from each of the LTA. The current monitoring network is limited and I recommend that each distinct LTA needs to have its own upgradient and downgradient monitoring wells, so that the performance of each LTA can be monitored.

Some of the new wells are proposed on LTA that may not initially be developed. These wells could be required as part of the staged approval process and be required to be installed when subsequent LTA are developed.

Response: Additional well details are provided in the attached plan. The proposed wells on third-party land, i.e., upgradient and downgradient, are subject to receiving landowner approval for installation and ongoing access. This specifically relates to P 11 and P14.

Conditions 13 and 14

Condition 13. To be updated to include new wells as described above.

Condition 14. This condition should specify which wells are considered up-gradient and which are down-gradient. This is because the new monitoring wells shown in Attachment A, include new up-gradient wells for some of the LTA.

Response: This is included in Condition 16



Additionally, the proposed trigger of 3 mg/L between up and down gradient wells is higher than the Jacks Point trigger of 1.5 mg/L. Given the current excellent quality of groundwater, this allows a significant increase in groundwater nitrate. I recommend the trigger remains at 1.5 mg/L.

Response: The trigger in condition 16 is reduced to 1.2 mg/L to be 20% lower than the Jacks Point requirement, and will be reached first if it is to occur. This will require the consent holder to take action ahead of a requirement on Jack's Point.

Condition 15

This condition should include reference to a nationally recognised groundwater sampling methodology.

Response: We consider this to be covered by proposed condition 23.

Condition 16.

This condition is inconsistent with the wastewater treatment performance standards used in the AEE. The standards proposed in the AEE (and discussed under Condition 3 above, are cBOD5 – 20 mg/L, TSS - 20 mg/L, TN - 7.5 mg/L, TP - 2.5 mg/L, E.coli - 1000 MPN/100mL.

Response: Now condition 15. See response above in relation to condition 3. These limits provide initial overall certainty to the consenting authority and operational flexibility when read in conjunction with the other conditions to facilitate a practical implementation pathway for the scheme's wastewater treatment infrastructure and land treatment area.

Appendix C “RCL Homestead Bay Ltd: Groundwater Effects of Applying Treated Wastewater to Land”, Komanawa Solutions Ltd, 8 September 2025





Stantec New Zealand Ltd and RCL Homestead Bay Limited

8 September 2025

Report No: Z23031-GSI-2

**RCL Homestead Bay Ltd: Groundwater Effects of Applying
Treated Wastewater to Land.**

Kōmanawa:

1. *(verb) spring, well up (of water)*
2. *(verb) to spring, well up (of thoughts, ideas)*

Kōmanawa Solutions Limited (KSL) is a water resource consultancy and research company specialising in water resource investigation and modelling, environmental limit setting and water resource impact assessment. Our goal is to provide excellent science to facilitate the robust management of natural resources in our changing climate. Clients include New Zealand enterprises in the private sector, central and local government agencies and community groups.

Our vision & Mission

KSL delivers high quality science and research. We aspire to be at the forefront of creativity and innovation to address our increasingly complex water resource challenges; *mō tatou, ā, mō kā uri ā muri ake nei* (for us and our children after us). Our mission is to develop solutions to the increasingly challenging water resource management issues we now face by providing a clear vision of the pathway from problem to solution. We work closely with our partners, communities, and stakeholders, deploying state-of-the-art scientific methods and building trust through knowledge and honest science communication.

Limitations

Kōmanawa Solution Ltd (KSL) has prepared this Report in accordance with the usual care and thoroughness of the consulting profession for the use of Stantec New Zealand Ltd and RCL Homestead Bay Limited in relation to the Fast Track Referral Application for Homestead Bay.

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Version control

Date	Report no	Issue notes
5/09/2025	Z23031GSI-2-Rev0	Initial draft by Jens Rekker without appendices.
8/09/2025	Z23031GSI-2-Final	Finalised report following comments from Amanda Leith

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Executive Summary

Changes in Stream and Groundwater Flow Regime

There is not a perfect understanding of the surface water and groundwater hydrology of Homestead Bay and its hinterland into the Remarkables Range. However, what can be established and relied upon is that in the current setting there are no known / observed sites of groundwater seepage such as springs or conspicuous baseflow seepage into water courses. It is also established from the geological materials unearthed in test pits and bore logs that the alluvium, glacial outwash gravels and glacial till gravels have relatively high permeability and effective porous, such that these are capable of draining hillslope water from creeks emerging from the Remarkable mountains onto the talus and alluvial fans draping the western slopes into Homestead Bay.

The proposed wastewater land treatment system would apply up to 23 litres per second of wastewater into soils via a soil dripper system. The wastewater applied within grassed land treatment areas would remain within the soil profile and susceptible to evapotranspiration for a few hours before infiltrating deeper into the subsoil, so some quantum of wastewater would be evapo-transpired to the atmosphere especially in dry spells. The remaining infiltration would increase the overall groundwater recharge rate, however the high permeability of the overall groundwater system would still have the capacity to conduct the water surplus to Lake Wakatipu directly, as it currently does with few if any signs of groundwater daylighting at the surface or creek courses.

The surplus of wastewater contributions to soil moisture joining the regional water table, any rises in catchment groundwater flows are highly unlikely to stimulate surface flow expression due to high permeability of the land and creek bed that would enforce infiltration to the regional water table. Maori Jack Creek in its middle and lower reaches particularly where it approaches the schist boundary, may exhibit slightly higher flow as a result of the ultimate wastewater land treatment with small increases in perennial water table heights. However, water quality or ecological impacts are highly unlikely to be more than minor.

Assessment needed on Well F42/0150

Development of a conceptual model and numerical estimation has demonstrated the combination of the proposed wastewater land treatment areas and future water supply bores in locations that three test bores have already been installed along the Lake Wakatipu lakeshore would be compatible from a water quality perspective.

- The closest LTA discharge is over 400 metres distant, is applied at the surface while the water supply intakes are found at depths of 30 metres or more with intervening clay silt layers of various thickness overlying the screen intakes.
- In terms of pathogenic protozoa, these large bodies micro-organisms could not extend through the soil profile to enter groundwater for transport in the direction of bores.
- In terms of bacteriophages, the current offset distance between the closest land treatment areas and bores is too great to allow the entry of faecal indicator bacteria as *E. coli*.
- In terms of nitrate nitrogen, water mass balances point to primary wastewater nitrate nitrogen concentrations being substantially reduced to nominal concentrations.
- In terms of viruses, the main available offset calculation tool indicates the minimum distance required between land treatment area and bore as less than 50% of the current offset distance between the closest land treatment areas and bores.

Source protection zone to be identified for each community water supply

I consider that there is a lack of clear requirement or guidance for the setting of source protection areas in Otago. Otago Regional Council has not applied groundwater protection zones over Homestead Bay, which would have been the sole mechanism within the Regional Plan: Water. The information generated by the act of specifying a groundwater-based source protection zone may also lead to risk of reverse sensitivity effects.

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1 Background

An area of land, owned by RCL Homestead Bay Ltd, within the land titles of Lot 12 and Lot 8, DP 443832, is the subject of referral for approvals under the Fast-Track Approvals Act 2024 to allow the development of primarily residential urban areas, associated services and infrastructure (e.g., roads, energy supplies, and 3 Waters reticulation). Among the necessary infrastructure for the residential – commercial land development is the provision of land treatment of treated wastewater generated within the residences and associated commercial / institutional buildings within the proposed urban development. Stantec NZ Ltd and Lowe Environment Impact Ltd had been responsible for preparing plans and assessments to RCL Homestead Bay Ltd for inclusion in the application documentation, including consideration of effects on surface and groundwater quantity and quality.

On 13 August 2025, Otago Regional Council provided the applicant with the technical peer review relating to “Wastewater Discharge (Effects on Groundwater)” prepared by Tim Baker of SLR Consulting NZ Ltd. The peer review pointed to three assessment requirements

Changes in Stream and Groundwater Flow Regime

LEI (2025) and Appendix C (LWP, 2025) report that all the water courses on the site are ephemeral. It is likely that some reaches of the stream will be reliant on groundwater baseflows and others will only flow when there is surface runoff from higher in the catchment.

LEI suggest that because these streams are ephemeral, they are unlikely to deliver contaminants to Lake Wakatipu. However, there is no consideration of whether the increased hydraulic load across the site (2,600 mm at the LTA, or 380 mm when spread out across the site) might change the flow regime of the streams (i.e. that flow more often) and what effect this might have on stream ecology.

*In the absence of any assessment of the potential changes in flow regime, it should be assumed that the stream will flow more often, and that the baseflow (groundwater) entering the stream is likely to contain higher nitrogen than it currently does, particularly down gradient of the main block of LTA. A robust monitoring regime should be in place to monitor for and assess the effects of any baseflow changes (**both quality and quantity**).*

The Application should include an assessment of the potential for changes in stream flow, and comment on whether this has an effect on the potential for contaminant transport into the lake.

Assessment needed on Well F42/0150

An assessment of potential effects has only been provided for the Jacks Point surface water take. No assessment of Well F42/0150 is presented. This is a gap and should be addressed and is required to protect the health of those people reliant on these supplies for the potable water.

Source protection zone to be identified for each community water supply

I (Tim Baker) also recommend a requirement for the source protection zone of each community supply, including the proposed RCL bore, to be clearly delineated and presented as part of the groundwater and surface water quality monitoring plan. Having a robust understanding of drinking water sources, and the potential hazards within the catchment is a requirement of the Water Services Act.

These peer review requirements have been apportioned to Kōmanawa Solutions Ltd to address.

2 Changes in Stream and Groundwater Flow Regime

The groundwater systems that occur in glacial and alluvial deposits between the bedrock of the Remarkable Range and Lake Wakatipu have yet to attract much investigation or regulatory attention from Otago Regional Council (ORC). The closest declared aquifer within the Regional Plan: Water is the Wakatipu Basin Aquifer(s) no closer than the east bank of the Shotover River and north bank of the Kawarau River downstream of Shotover Delta. The aquifer status does not extend to Homestead Bay glacial and alluvial deposits. The area has not been the subject of groundwater or surface water resources investigations, nor are environmental monitoring sites established or operated by ORC.

2.1 Surface Water

2.1.1 Existing Information

Homestead Bay lies within the Upper Clutha Lakes rohe of the Clutha / Mata Au Freshwater Management Unit (FMU). The sedimentary basin north of Homestead Bay is drained by Stoney Creek into the Kawarau River and four unnamed lake-draining creeks that discharge into Lake Wakatipu at Homestead Bay and Drift Bay. All creeks are largely fed by rain and snow melt with the Remarkables Range having a strong pluviographic gradient (see Figure 1 from ORC Grow Otago mapping). No hydrological flow gauging has been established by ORC to allow the generation of hydrological statistics, so rainfall – runoff modelling using HIRDS or the NZ Water Flow Model – Hydrology are the sole means of estimating surface water hydrology statistics.

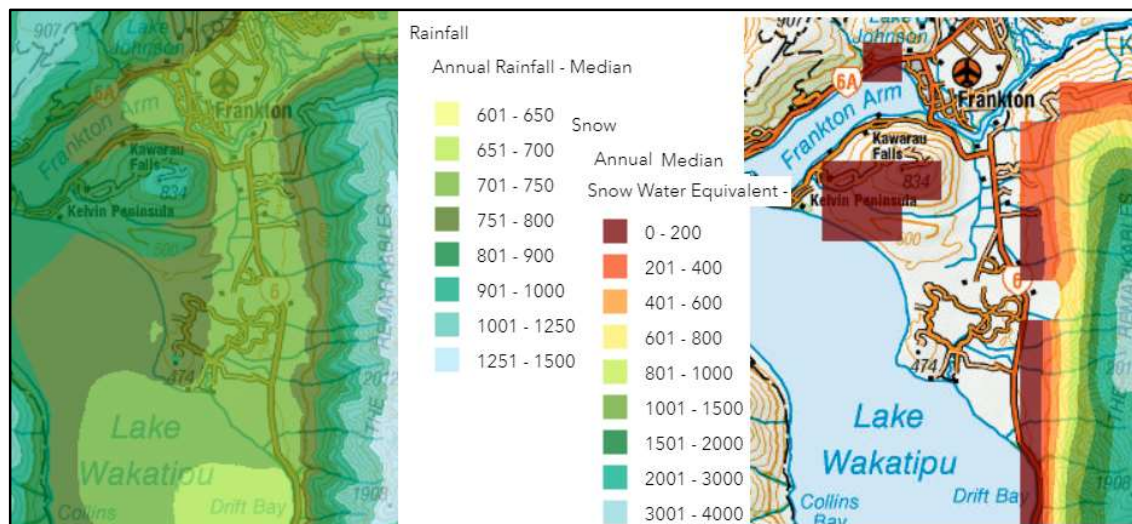


Figure 1: Colour flood of median annual rainfall (left) and snow accumulation (right) in millimetres per annum

The hydrology of Lake Wakatipu is largely natural and contributed by Main Divide (Southern Alps) river tributaries such as the Rees, Dart, Caples, Greenstone, Von, Afton, Lochy, Staircase, Wye, Twelve Mile, and Buckler. The specific median runoff of the Lake Wakatipu catchment is approximately 52 litres per second per square kilometre of catchment (L/s/km²). Lake Wakatipu, alongside Lake Wānaka and Lake Hāwea, contributes much of the water resources available at Clyde, Roxburgh, and the Lower Clutha / Mata Au.

The Upper Clutha Lakes rōhe tends not to be at full allocation due to the lack of surface water allocation limits set in the Regional Plan: Water, but also importantly due to the substantial overhang of catchment Mean Annual Flow (7-day) above the current consumptive allocation in individual resource consents. For example, MALF_{7d} at Willow Place is 75,100 L/s, while the total Wakatipu catchment surface water allocated in consents is only 756 L/s (effectively 1% of MALF_{7d}).

More specific hydrological or water resource statistics are available for creeks draining the Remarkables Range in the NZ Water Flow Model – Hydrology maintained by the National Institute of Water & Atmosphere (NIWA)

within the Shiny NZ River Maps database (<https://shiny.niwa.co.nz/nzrivermaps/>). Table 1 lists the derived hydrological statistics and Figure 2 maps the locations of the river-segments, in accordance with New Zealand river segment numbering referred to in Table 1.

Table 1: Rainfall – Runoff modelled Hydrological Statistics for Homestead Bay Sedimentary Basin

Creek / Burn Catchment	NZ River Segment #	Area (km ²)	Mean Flow (m ³ /s)	Median Flow (m ³ /s)	MALF _{7d} (m ³ /s)
Maori Jacks Creek at Lake confluence	14227448	10.756	0.21113	0.15399	0.054147
Homestead Bay minor creek	14227600	1.300	0.01269	0.00633	0.001905
Unnamed Trib Drift Bay No. 1	14227917	3.803	0.08735	0.06266	0.035764
Unnamed Trib Drift Bay No. 2	14227972	1.579	0.04089	0.02989	0.01674

Note: Green shaded catchments drain north to the Kawarau River in the Stoney Creek main stem; Blue shaded catchments drain individually to Homestead Bay and Drift Bay on Lake Wakatipu; “MALF_{7d}” = seven-day aggregated Mean Annual Low Flow statistic; Flow in units of 1 cubic metres per second (m³/s) is the same as 1,000 litres per second (L/s); creeks at lake edge may lack perennial flow due to infiltration.

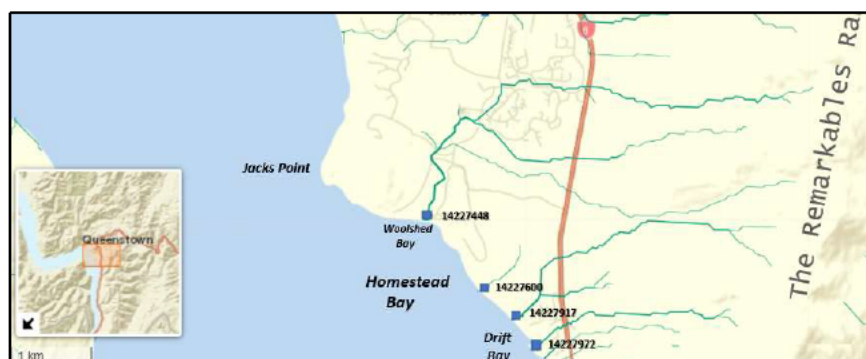


Figure 2: Location of creek river-segments within Remarkables – Peninsula Hill basin (NZ Rivers Maps)

Otago hydrologists consider that the New Zealand River Maps estimates of hydrological statistics are often inaccurate due to the more localised effects of precipitation, topography and underlying geology. In the case of the Homestead Bay catchments such as Woolshed Creek, the creek channels only carry flow during high intensity or extended period rainfall such as floods. In particular, Maori Jacks Creek is noted as ephemeral to intermittent in its lowest reaches adjacent to Lake Wakatipu. The small tributaries of Lake Wakatipu (*Homestead Bay minor creek* and *Unnamed Trib Drift Bay No. 1* from Table 1 and Figure 2) are both observed to be essentially dry flood channels due to the very high permeability of the creek beds, underlying deposits and deep regional water table.

2.1.1.1 Gauged Lake Tributaries

Quantification of hydrological statistics for the Lake Wakatipu tributaries is problematic due to the lack of recorded flows at hydrological flow sites on these tributaries. A long-term hydrological flow site is present on the Dart River at the Hillocks, and short records are available for Staircase Creek and Twelve Mile Creek. To provide some indications of water resource availability, Table 2 lists the control site, NZ river segment, catchment area and indicative (i.e., approximate) modelled MALF_{7d}. From the list, the largest and smaller tributary water resources can be determined. Wye Creek is listed with an indicative MALF_{7d} of only 66 L/s, despite being the closest tributary of scale close to Homestead Bay.

It is notable that Wye Creek, Staircase Creek, and Twelve Mile Creek flow gauging sites are all located over bedrock rather than glacial or alluvial

Table 2: Adjacent Lake Wakatipu Tributaries with a record of flow measurement and indicative MALF

Description of Site	NZ Segment #	Area (km ²)	Indicative* MALF _{7d} (L/s)	Specific MALF _{7d} (L/s)
Wye Creek at upstream of SH6 crossing	14230724	3.1	66	21.3
Staircase Creek at upstream of SH6 crossing	14238652	46	403	8.8
Twelve Mile Creek at Lake Wakatipu	14226451	5.05	100 (135*)	19.8

Note: * Values from NZ Rivers Maps and (Singh et al., 2021)¹; *A tailored estimate of MALF_{7d} provided in (Olsen, 2014)² using correlation with Shotover at Peats Huts hydrological flow site and 1 year of concurrent flow measurement on Twelve Mile Creek. Modelled hydrological statistics are provided for the Jacks Point – Homestead Bay – Remarkables sedimentary basin in Table 1 and mapped in Figure 2. The Woolshed and Drift Bay tributaries belong to the Lake Wakatipu watershed, while Stoney Creek is a Kawarau tributary.

2.1.2 Lake Wakatipu and Surface Water Tributaries

2.1.2.1 Lake Wakatipu

The Lake Wakatipu catchment has been part of the original Upper Clutha hydrological monitoring programme since 1963 as measured at the flow measurement site in the Frankton Arm of Lake Wakatipu, immediately upstream of the Kawarau Falls control gates.

Table 3: Station details, measuring period and summary statistics for Lake Wakatipu at Willow Place

	NZ Segment #	Area (km ²)	Start	End	No. of years	Mean (L/s)	Median (L/s)	MALF _{7d} (L/s)
Lake Wakatipu at Willow Place, Kelvin Heights	14223274	3,041	2/02/63	ongoing	54	181,257	157,353	75,100

Note: No. of years = Number of whole years of flow record. MALF_{7d} is the seven day Mean Annual Low Flow statistic.

Lake Wakatipu and tributaries have excellent physical availability and the ability to secure legal access to its waters. The lake itself has the following water resource dimensions.

¹ Singh, S; Sandoval, D; Rajanayaka, C; Henderson, R; and Shiona, H. 2021. Generation of Hydrological Statistics for Otago. Prepared for Otago Regional Council, NIWA Client Report No: 2021030CH, April 2021, Riccarton. 50 pages.

² Olsen, D. 2014. Management Flows for Aquatic Ecosystems in Twelve Mile Creek. Prepared for Otago Regional Council by ORC Resource Science Unit, December 2014, Dunedin. 32 pages ISBN 978-0-478-37696-8.

Table 4: Lake Wakatipu Water Resource Dimensions

Dimension	Value	Unit
Max. length	75.2	km
Max. width	5	km
Surface area	289	km ²
Average depth	130	metres
Max. depth	420	metres
Water volume	37.57	cubic kilometres
Residence time	12	years
Surface elevation	310	metres
Catchment area	2,674	km ²
Median Water Level	309.6	m AMSL
Upper Water Level	310.8	m AMSL
Water Level Range	1.2	m
Live storage	3.47	cubic kilometres
Mean Flow Rate at Outlet	181.3	m ³ /s
Outlet Flow MALF _{7d}	75.1	m ³ /s
Estimated allocated abstraction	0.75	m ³ /s

Annual median water levels, averaged over the 1963-2023 water years were 309.88 ± 0.12 m in Lake Wakatipu. Corresponding Lake Wakatipu annual interquartile and 5 - 95 percentile ranges were 0.40 and 0.99 metres. So, lake level is quite stable, responding to headwater rainfall or snowmelt. There is a weak seasonal pattern in lake level towards lower levels in the winter (Hawes, 2023)³.

2.2 Lot 8 and Lot 12 Surface Water Courses

Three, perhaps four, water courses cross the Lot 8 or Lot 12. The main water courses are shown in Figure 3. Northern Creek and Middle Creek are tributaries of Maori Jack Creek, while Southern Creek would discharge directly to Lake Wakatipu when it flows. Table 5 compares the modelled and observed flows (Mean NZ River Maps taken from Table 3).

Table 5: Comparison of Modelled and Observed Creek Flows

Creek / Burn Catchment	Area (km ²)	Mean River Maps Flow (L/s)	Observed Flow (L/s)
Maori Jack Creek (Northern & Middle Creek) at SH6	2.7	61	0*
Homestead Bay minor creek (dry gulch)	1.3	12	0 [‡]
Unnamed Trib Drift Bay No. 1 at SH6 (Southern Creek)	3.3	76	0*

Note: * In January 2025 even the lowest reaches of Maori Jack Creek were disconnected pools with inferred although not observed subsurface flow between pools and Lake Wakatipu. Therefore minimal creek flow from Northern and Middle creeks was inferred. ‡ Water course flows in mid and lower Maori Jack Creek observed in March 2023, minimal to nil flow rates observed. No surface outflow to Lake Wakatipu observed.

Observations of water course flows were made and reported within Land Water People (Norton, 2025) and Water Ways Consulting (Allibone, 2023) reports on the RCL Homestead Bay property. These reports found that there was no indication of perennial flow and a number of indications that the water courses were hydrologically active only during flood flows.

³ Hawes, I. 2023. Lake levels and water abstraction limits for Lake Wanaka and Lake Whakatipu. Unpublished report prepared for Otago Regional Council by Aquatic Research Solutions Ltd, May 2023, Tauranga. 34 pages.

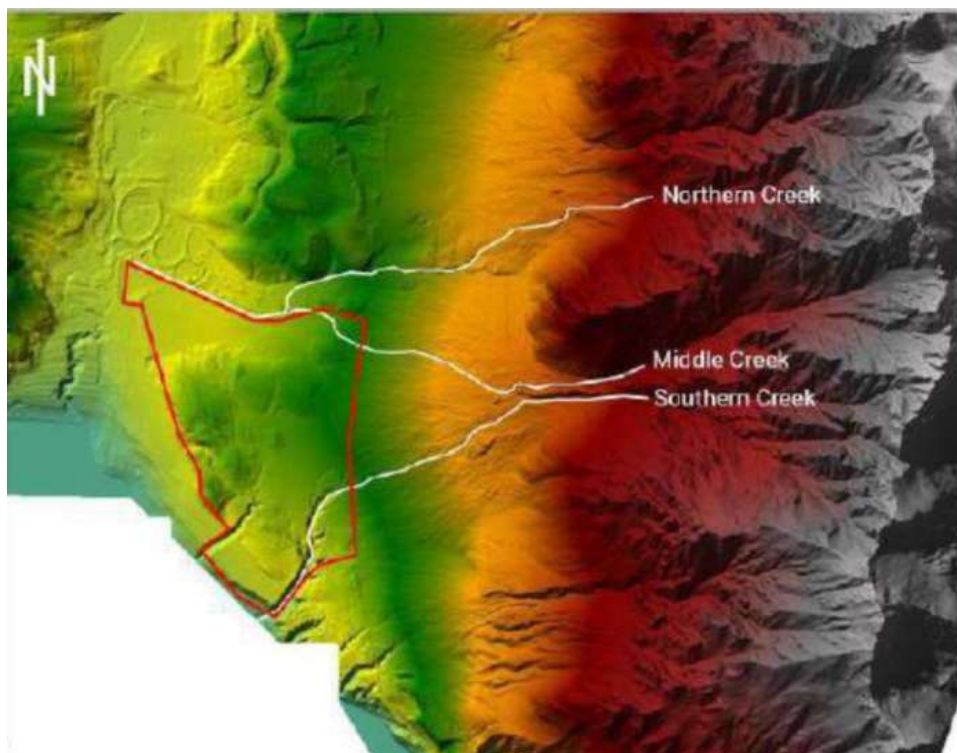


Figure 3: Alignment of main water courses crossing Lot 8 and 12 towards Lake Wakatipu (DEM underlay)

2.3 Depth To Water Table and Groundwater Levels

Deep water tables underlie most of the elevated areas of Lot 8 and 12 comprising the RCL property. Figure 4 and Figure 5 plot the depths to water table and water elevations across the site.



Figure 4: Plotted January 2024 measured depths to water table across Lots 8 and 12 in Geosolve reporting



Figure 5: Plotted January 2024 water table elevation across Lots 8 and 12 in Geosolve reporting

The figures bear out that the depth to water beneath the land surface is greater than 4 metres. There is also an indication from plotted groundwater elevation of much of Lot 8 grading towards Middle Creek alignment and accruing to the middle portion of the groundwater system underflowing Chief Reko Road. Figure 4 and Figure 5 provide solid indications that the creek network across the elevated parts of the property do not connect with the creek network despite the elevated hydraulic loading that can be expected to enter the top of the creek network from the Remarkables Range.

The clearly indicated hydrological mode implied by the observations of dry creeks and deep regional water table is that creeks lose their flow into the underlying alluvial fan and glacial till sandy gravels. The infiltrated water remains subsurface and does not emerge until passing under the lake shoreline. Thus a distinction needs to be made between the regional water table and any localised perched water tables. Perching of shallow water tables is a feasible consequence of low permeability shallow layers beneath subsoils. Providing the perching layers are not continuous or otherwise extensive, the perched groundwater would drain downwards to the regional water table.

3 Water Quality Risk to Downgradient Water Supply Wells

Homestead Bay has been a focus of recent water supply investigations relating to the growth of residential water supply demand. The current limited ability to connect to the Queenstown Lakes District Council municipal distribution of water supply or wastewater diversion to the Shotover Sewage Treatment Facility had stimulated the need to know of local alternatives, including the Jacks Point wastewater discharges to land in the case of wastewater and three separate groundwater source investigations.

The three investigations into groundwater sources since 2017, include the following:

- July 2017: Murphys Developments, 36 m depth, 300 mm diameter test production bore – F42/0150
- August 2024: RCL Homestead Bay, 98 m depth, 300 mm diameter test production bore - CC11/0151
- December 2024: Henley Downs, 48 m depth, 300 mm diameter test production bore - CC11/0158

The Murphys Developments drilling included two Aircore pilot holes and an observation bore. The test production bore has been fitted with a submersible pump and taken over for the reticulation of Nathaniel Place with its twelve building platforms. The RCL Homestead Bay observation bore is being regularly monitored with a view to the production bore becoming the first supply source to the RCL Homestead Bay residential development. Less is known of the Henley Downs bore other than from the bore consent returns that are public

information. The Henley Downs Water Holdings Limited listed the purpose of the bore as “Community Drinking Water Supply”⁴.

All test production bores have been test-pumped, although the reported test pumping of the Henley Downs bore was only two hours at 32.4 litres per second. The Murphys Developments and RCL test production bores were tested for multiple days and closely observed as part of step drawdown and constant rate testing to allow further groundwater assessments. These included taking initial water samples for drinking water quality analysis.

Each of these water bores is in proximity to the proposed RCL Homestead Bay wastewater land treatment areas (LTAs).

- Nathaniel Place water supply, F42/0150, 405 metres at closest approach to “L” LTA area.
- RCL Homestead Bay water supply, CC11/0151, 635 metres at closest approach to “I-2” LTA area.
- Henley Downs water supply, CC11/0158, 460 metres at closest approach to “L” LTA area.

In each case, the LTA is planned to apply treated wastewater to the soil at higher elevation as part of the Area 3 LTA zonation. For instance, the closest water bores to an LTA, CC11/0158 and F42/0150 lie about 45 metres lower than the proposed LTA, on the lake foreshore. An average slope gradient of 1:10 would apply to the height difference and lateral distance between the bores and closest LTA. The geological materials lying between these water bores and the upgradient LTAs were all permeable and porous, allowing a potential subsurface groundwater transmission from the LTA to water supplies serving communities around Homestead Bay.

3.1 Bore Properties

3.1.1 *Nathaniel Place Bore F42/0150*

This bore was drilled in July 2017 following earlier pilot hole drill with separate reverse circulation drilling rig to confirm favourable conditions. A dual rotation Western Star DR24 rig was used to install 300 millimetre diameter steel casing to full depth. The casing was jacked back to expose a 250 millimetre diameter stainless steel screen with 0.25 millimetre slot width. The screen length was 6 metres and topped by a 1 metre blank leader section of 250 millimetre diameter. The 6 metre screen interval was installed between the depths of 35.76 and 29.77 metres below ground level.

The resulting bore proved to be quite productive. After air-lift developing, the bore water test pumped with specific capacity, step drawdown and 72 hour constant rate tests. The bore head was protected by the installation of 1 by 1 metre concrete pad around the surface casing in accordance with ORC requirements of all new water bores. The standing water level was measured as 0.6 metres below ground level, which is quite shallow but consistent with a location near the lake shore (i.e., a groundwater seepage zone).

The geological logging of the drill hole highlighted a dense blue clayey silt layer from 0.8 to 3.2 metres below ground. This 2.4 metre thick layer is significant since it was found in other bore logs, including one 65 meter to the southwest, and the standing water level representing groundwater pressure in the bore rested higher than the top of the silt layer. The bore log is displayed in Figure 6.

The water bore was given a potential capacity of 38 to 40 litres per second in assessment (Dommissie, 2017). Currently the bore has been adopted by the developers of Nathaniel Place with water reticulation laid out to 12 lots and perhaps two water connections to date actually made to occupied dwellings.

3.1.2 *Henley Downs Bore CC11/0158*

This bore was drilled in December 2024. A dual rotation Western Star DR24 rig was used to install 300 millimetre diameter steel casing to full depth. The casing was jacked back to expose a 280 millimetre diameter stainless steel screen with 2.5 millimetre slot width. The screen length was 6 metres and topped by a blank leader section

⁴ Anecdotally, we understand that these drilling and pumping test investigations of CC11/0158 bore are for potential replacement of the current surface water intake on Lake Wakatipu for the Jacks Point water supply.

of 280 millimetre diameter. The 6 metre screen interval was installed between the depths of 42.13 and 48.13 metres below ground level.

The resulting bore proved to be productive. After air-lift developing, the bore water test pumped with specific capacity test of 2 hours. The specific capacity test result was 32.4 litres per second for a drawdown of 21.27 metres indicating a specific capacity of 1.5 litres per second per metre of drawdown (L/s/m). Such a specific capacity implies a tested transmissivity of 460 square metres per day (m²/d) using the (Perwick & Woodhouse, 2014) specific capacity conversion. The bore head was protected by the installation of 1 by 1 metre concrete pad around the surface casing in accordance with ORC requirements of all new water bores. The standing water level was measured as 0.62 metres below bore collar, which is quite shallow but consistent with a location near the lake shore (i.e., a groundwater seepage zone).

The geological logging of the drill hole highlighted a dense blue clayey silt layer from 3.8 to 5.6 metres below ground. This 1.8 metre thick layer is significant since it was found in other bore logs, including one 65 meter to the northeast, and the standing water level representing groundwater pressure in the bore rested higher than the top of the silt layer. A highly silty gavel was noted from 29.4 to 32.6 metre depth, above the main water-bearing layer of silty fine gravel deposits. The bore log is displayed in Figure 6.

The Henley Downs water is not connected to any existing water supply.

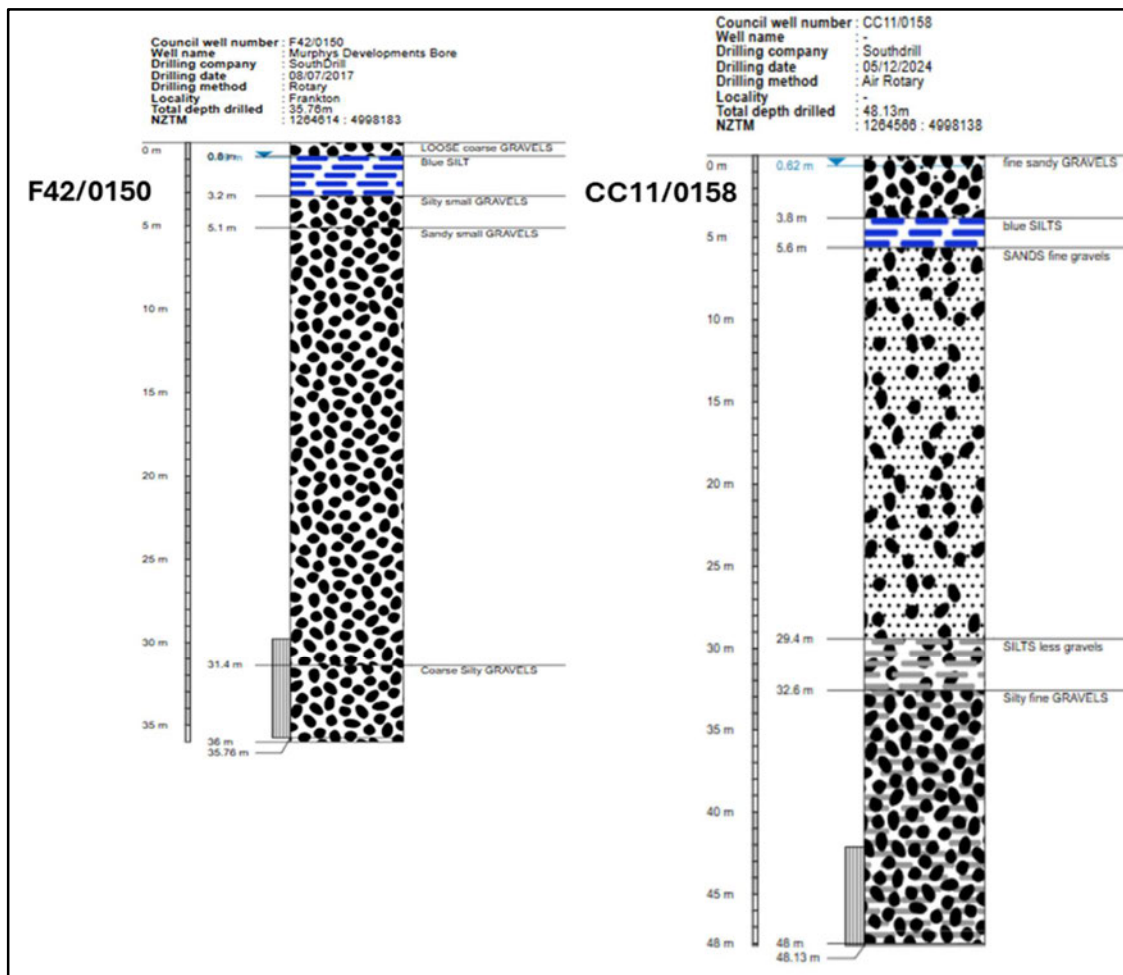


Figure 6: Bore logs for F42/0150 and CC11/0158 side by side to allow comparison

3.1.3 RCL Homestead Bay Bore CC11/0151

This bore was drilled in July 2024 following earlier pilot hole and observation bore (CC11/0151A) to confirm favourable conditions. A dual rotation Western Star DR24 rig was used to install 300 millimetre diameter steel casing to full depth. The casing was jacked back to expose a 256 millimetre diameter stainless steel screen with 0.5 millimetre slot width. The screen length was 6 metres and topped by a 1.6 metre blank leader section of 256 millimetre diameter. The 7 metre screen interval was installed between the depths of 87.9 and 94.88 metres below ground level.

The resulting bore proved to be quite productive. After air-lift developing, the bore water test pumped with specific capacity, step drawdown and 52 hour constant rate tests. The bore head was protected by the installation of 1 by 1 metre concrete pad around the surface casing in accordance with ORC requirements of all new water bores. The standing water level was measured as approximately 1.7 metres above ground level, which indicates a confined or semi-confined aquifer and approximately 12 metres higher than Lake Wakatipu.

The geological logging of the drill hole highlighted a dense blue-grey clayey silt layer from 4.8 to 75 metres below ground. This 70 metre thick layer is significant since it indicates a thick confining layer, and the standing water level representing groundwater pressure in the bore rested substantially higher than the top of the silt layer. Such a silt layer is not found with similar great thickness in other Homestead Bay bore logs.

The water bore was given a potential capacity of 40 litres per second in assessment. The RCL Homestead Bay water bore is not yet connected to any existing water supply, although it one of the bores proposed for supplying the RCL Homestead Bay residential development zone.

Council well number : CC11/0151
Well name :
Drilling company : Washingtons Exploration Limited
Drilling date : 11/07/2024
Drilling method :
Locality : Jacks Point
Total depth drilled : 94.38m
NZTM : 1265453 : 4997247

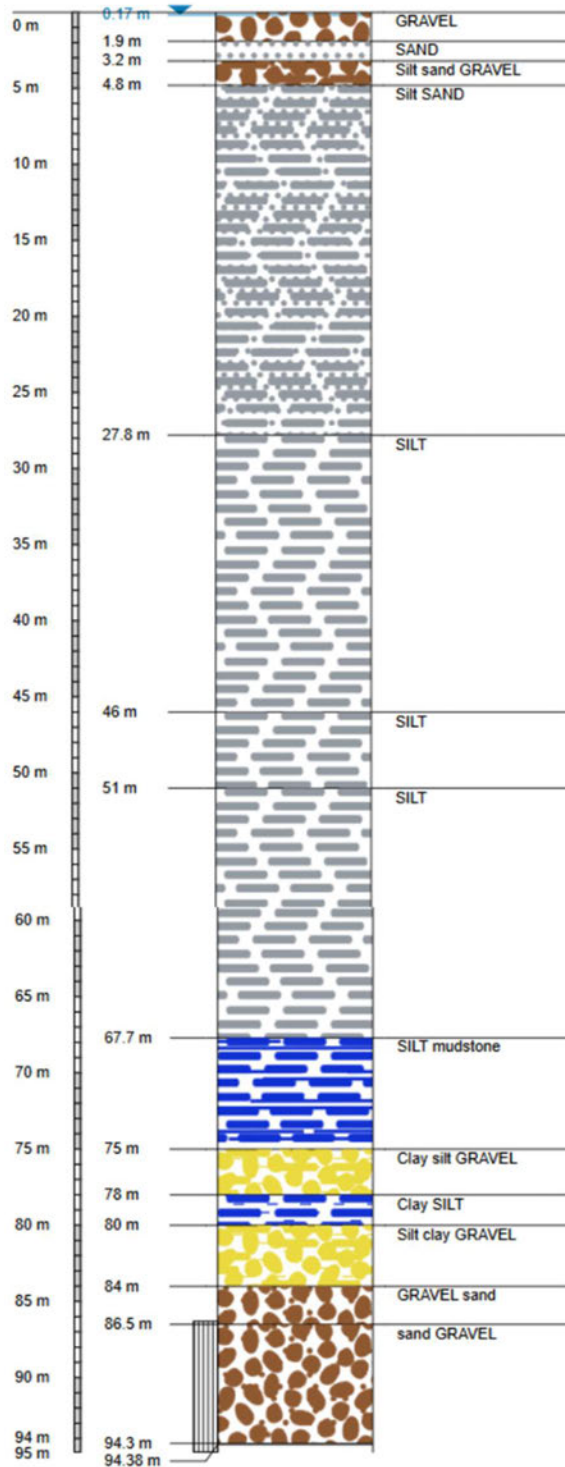


Figure 7: Bore log for CC11/0151 held by ORC wells database

3.1.4 Substances of Concern

Drinking water supplies may be affected by a wide range water quality agents or substances. These generally fall into microbes, inorganic contaminants, organic contaminants, and aesthetic (odour, taste or appearance affecting) substances. Pathogenic microbes and in/organic contaminants are of health concern when the content or concentration exceeds an acknowledged concentration threshold. Aesthetic substances may affect the useability of drinking or domestic water but would not be of health concern.

The substances of concern that could emanate from treated wastewater and migrate through the subsurface to the Homestead Bay water supply bores, include the follow:

- Pathogenic microbes (protozoa, bacteria, or viruses), and
- Nitrate (and nitrite) nitrogen.

Other potential contaminants, especially those with low dose or concentration rates of toxicity, may be transferred to the ground *via* the wastewater system but these contaminants are currently rare and often have high rates of in-groundwater attenuation. Microbes of pathogenicity and nitrate are major substances of concern.

3.1.4.1 Pathogens and their Indicators

Protozoa, include *Giardia* and *Cryptosporidium* are large body and water-borne protozoa species implicated in particularly surface water transmission to humans. The New Zealand Drinking Water Standards indicator of water-borne protozoa is turbidity. Drinking water with higher than 1 to 2 nephelometric turbidity units (NTU)⁵ exceeds the drinking water standard, requiring treatment and monitoring.

As water movement through soils, subsoils, vadose zone and saturated zone are all subsurface compartments that remove turbidity, the same removal processes would remove protozoa. Protozoa are not a normal or typical groundwater contaminant other than where contaminated surface water infiltrates in close proximity to an unprotected well or bore, particularly by smaller dimension oocytes. Past instances of protozoan contamination of groundwater are as follow:

- Direct entry of contaminated surface water, e.g., bypass of *Cryptosporidium* contaminated paddock runoff of a perforated bore casing such as Havelock North 2016 dysentery outbreak, or
- River / lake gallery well fields affected by protozoa contaminated surface water.

Since we are examining long-distance groundwater flow and transport, the penetration and survival of pathogenic protozoa is highly unlikely.

3.1.4.2 Bacteria

Pathogenic bacteria in water, include *E. coli*, *Salmonella*, *Shigella*, *Campylobacter*, *Legionella*, *Yersinia*, *Vibrio cholerae*, and *Pseudomonas sp.* The indicator of water-borne bacteria is *Escherichia coli* (*E. coli*) and the New Zealand drinking water standards set *E. coli* as the main performance indicator of treatment and indicator whether raw water is contaminated. The rod-like *E. coli* cells are about 2.0 µm long and 0.25–1.0 µm in diameter, making them a small-cell organism and are ubiquitously contained in sewage wastewater. Bacteria are subjected to immobilisation and mortality in the subsurface. A feature of subsurface water movement i.e., seepage, is that it is substantially slower than surface water transport of contaminants. While surface water typically flows at metres per second especially within streams, vadose or saturated groundwater flows at meters per day magnitude of flow rates. Therefore, the time dependent mortality factors lead to substantial removal of bacteria. Measured mortality time dependent rates for *E. coli* in oxidation ponds are half-life (T_{50}) of 1.8 days, T_{90} of 6.2 days. In septic tank effluent measurements of mortality time dependent rates, $T_{50} = 0.87$ days and $T_{90} = 2.9$ days.

⁵ Drinking water with a turbidity higher than 0.2 NTU is unacceptable according to New Zealand's Drinking Water Standards, and water must be less than 1 NTU for 95% of the day and not exceed 2.0 NTU for more than 15 minutes.

3.1.4.3 Viruses

Water-borne viruses include *Norovirus*, *Rotavirus*, and the viral agent of Hepatitis A (*Hepatovirus*). Such viral agents are mobile in groundwater and the RNA genetic material of the virus is relatively resistant to loss of viability in the colder environmental conditions of groundwater. Nonetheless water-borne viruses are subjected to immobilisation and loss of viability over long distances due to adhering to charge particles and the hostile environment of subsurface conditions. The hepatitis A virus and its water transport properties have been used in the assessments of bore contamination risk set out in section 4.4, below.

3.1.4.4 Nitrate Nitrogen

Nitrate is a macro nutrient with a nutrient cycle in grazing and cropping agriculture. Nitrate and nitrite toxicity of health concern is most immediate for infants with infantile blood processes with the potential for digested nitrite to morph for oxygen in haemoglobin oxygen attachment points. The World Health Organisation and NZ drinking water standard concentration is 50 mg/L as nitrate and 11.3 mg/L as nitrate nitrogen, which is set on the basis of Methemoglobinemia, a condition in infants consuming elevated nitrate water or water-mixed milk formula. Epidemiological research has suggested that chronic nitrate/nitrite exposure in adults is concerning for potential links to colorectal cancer, although evidence is not conclusive⁶. Some exposure and concentration recommendations are that to minimise drinking water nitrate nitrogen concentrations lower than 11.3 mg/L. The sole guideline or limit set in New Zealand is that for the protection of infants from Methemoglobinemia or Blue Baby Syndrome.

Nitrate nitrogen is highly mobile in surface and groundwater and may tend to rise to higher concentrations in soils and groundwater as part of the microbially mediated nitrification of soil nitrogen. Denitrification resulting in conversion of nitrate / nitrite solutes to nitrogen gases may occur in presence of reducing conditions (McMahon & Chapelle, 2008). The conditions for denitrification area considered to be present to some extent for water supply bore F42/0150 and CC11/0158 near Nathaniel Place, but to a more certain extent for bore CC11/0151 being confined and displaying reducing geochemical conditions in groundwater drawn at this deeper bore.

4 Public Health Water Quality Risk Assessment for Supply Bores

Given the three water supply bores at Homestead Bay and potential substances of health concern from the proposed wastewater dripper line application to soil, this section examines the water quality risks to the down-gradient supply bores from a public health perspective.

4.1 Wastewater Application to Land

The Homestead Bay Lot 12 and Lot 8 proposal for wastewater is for slow rate land treatment of pre-treated wastewater. The effluent discharge from the WWTP following secondary treatment is designed to have low concentrations not exceeding 1000 MPN/100 ml E.coli (equivalent to 1×10^7 E. coli/m³). The operating regime would be 7 mm of wastewater applied per day. The dry weather whole development discharge would be 2,005 m³/d, while the LTA L (area 0.4 ha) discharge would be 31 m³/d and LTA I (area 0.9 ha) discharge would be 64 m³/d.

4.2 Estimation of Bacteria and Nitrate Nitrogen Exposure Levels – LTA L

As noted, the closest LTA to the closer two supply bores F42/0150 and CC11/0158 is LTA L, part of the Area 3 (green) expansion of the land treatment proposal. The LTA has an area of 4,400 square metres and would have a dry weather application of wastewater of 7 millimetres per day. These dimensions, combined with the

⁶ World Health Organization. (2011). Nitrate and nitrite in drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality. https://web.archive.org/web/20220401011445/https://www.who.int/water_sanitation_health/dwg/chemicals/nitratenitrite2ndadd.pdf

indicated nitrogen and E. coli application rates allow the rates of application at LTA L to be estimated. Approximations of the aquifer and other parameters and constants are laid out in Table 6 and Table 7, including the distances between LTA and bore plus the water table drop with which to calculate groundwater gradient.

Table 6: Worksheet of Wastewater Concentrations, Loads and Unsaturated Zone Removal

	Value	Remarks
Source Concentrations		
Nitrogen (gN/m ³)	8.08	Based on RCL Wastewater Discharge Consent Level Design Report, Table 0.7 and Stage 3 nitrogen loading rate of 208 kgN/ha/yr and dosing rate of 7.05 mm.
E. coli (No. per 100mL)	1×10^{-3}	Post-treatment source concentration
Release in Injection Trench		
Area of LTA L (m ²)	4,400	Design length
Application Rate (mm)	7.05	
Dosing rate (m ³ /d)	31.02	Conservatively high rate based on development usage and occupancy
Unsaturated Zone Removal		
Depth To Water Beneath LTA (m)	10	Based on projections of water table height from Geosolve bore network
Time since release, t (hr)	15.2	Premised on a 10-metre unsaturated zone, and also based on the mean travel time of across sandy gravel (Sinton et al., 1997)
Removal rate constant, k (hr ⁻¹)	0.12	Based on (Environment Canterbury & PDP Ltd, 2002) and (Sinton et al., 1997) $N_t = N_0 e^{-kt}$ where: N_0 is the number of elements in the contaminant source, N_t is the number of elements after time t, t is time since release, k is the removal rate constant.

Table 7: Worksheet of Saturated Zone Attenuation, Velocity, Travel Time, and Pore Volume

Saturated Zone Processes	Value	Notes
Dispersion coefficient, ε (m/m)	0.1	Longitudinal dispersivity coefficient of 0.1 (Environment Canterbury & PDP Ltd, 2002). Also based on trials in the cobble gravel of the Heretaunga Plains (Thorpe et al., 1982)
Hydraulic conductivity, K (m/d)	120	Consistent with range of parameters and lithology. Conservatively high.
Aquifer Depth, D (m)	30	Consistent with drilling undertaken at F42/0150 and CC11/0158 (minimum depth)
Effective porosity, n_e (%)	20%	Consistent with observed values, and repacked aquifer material in laboratory column trials (Sinton et al., 1997)
Groundwater gradient, i (m/m)	0.08	As measured along the flow path: $\Delta h / \Delta l$, $36 / 452 = 0.079$ m/m, as measured from DEM
Distance, d of LTA to Bore(s), d (m)	405	As measured from DEM
Decay rate, λ (d^{-1})	0.84	Based on trials by Sinton <i>et al</i> (1997) $N_t = N_0 e^{-\lambda t}$ Where: - N_t is the number of elements in the contaminant source, t is time, and λ is the rate constant for decay.
Calculated Values -		
Groundwater velocity, v (m/d)	48	Groundwater velocity = $K i / n_e$
Travel time, t (d)	8.4	Travel time, $t = d / v$
Eventual Pore Volume (m^3)	1,256	Uses the dispersion coefficient to calculate the eventual pore volume of the effluent plume after lateral dispersion of the contaminant. This volume is used to recalculate the concentrations of nitrogen and <i>E. coli</i> .

Note: The distances from LTA L to bore F42/0150 and CC11/0158 are 405 metres and 452 metres, respectively. The length of 405 metres is used for a conservative estimation of saturated zone attenuation.

The sum of nitrogen and E. coli dilution and removals (in the case of E. coli) for the unsaturated zone and saturated zone are summed and the eventual nitrogen concentration and E. coli counts are provided in Table 8.

Table 8: Resulting Nitrogen Exposure Concentration and E. coli Count at Supply Bore

	Nitrate Nitrogen (gN/m³)	E. coli (No./100mL)	Active Removal Processes
Source Applied at LTA	8.08	1×10^{-3}	Assumed to be Nil
Saturated Zone 10 m beneath LTA	8.0	1.6×10^{-2}	Microbe removal in unsaturated zone
End of 452 m Groundwater Flow Path from LTA L	0.2	Nil	Dispersion and microbial decay
Estimated Bore Concentrated following addition of Initial Concentration	1.57	Nil	—
Applicable Drinking Water Standard	11.3	> 1	—

Note: The distances from LTA L to bore F42/0150 and CC11/0158 are 405 metres and 458 metres, respectively. The length of 405 metres is used for a conservative estimation of saturated zone attenuation. The measured ambient nitrate nitrogen concentration in bore F42/0150 was 1.37 in July 2017

Table 8 indicates that the eventual E. coli count at either of the supply bores potentially affected by LTA L wastewater discharges. That the nitrate nitrogen concentration does not exceed the relevant drinking water standard is unsurprising, as the initial wastewater concentration stood at 8 mg/L before the effects of saturated zone dilution. It is worthy of note that the measured Lake Wakatipu nitrate nitrogen concentration in July 2017 sampled on the lake edge in Homestead Bay was 1.15 mg/L. Therefore, the calculated eventual concentration in the bores of 1.57 mg/L would represent little increase in the lake's edge water column nitrate status.

4.3 Estimation of Bacteria and Nitrate Nitrogen Exposure Levels – LTA I-2

Supply bore CC11/0151 (RCL Homestead Bay's initial water supply bore) lies 635 from the edge of the nearest up-gradient LTA of LTA I. As part of Area 3 of the wastewater build-out, LTA I-2 would share many of the parameters relating to wastewater load and dosing rate. LTA I-2's position on the SH6 road edge places the base of the LTA at 375 metres elevation, likely meaning that the depth to water would be greater than for LTA L.

The same calculations undertaken in Table 6, Table 7, and results provided in Table 8 are considered unnecessary for the following reasons:

- The offset distance between LTA and supply bore is greater, increasing nitrogen dilution by dispersion and E. coli microbial decay,
- The unsaturated thickness to the water table may be greater, increasing unsaturated attenuation of E. coli, and
- Observations made in the drilling of CC11/0151 indicated that the screen is twice as deep and overlain by thick clayey silt measures that would oppose the vertical movement of microbes from the surface to the depth of the screens.

The balance of these factors and the results of estimation of LTA effects on F42/0150 and CC11/0158 demonstrating water quality effect that were less than minor mitigate for accepting that CC11/0151 would be less affected by the application of wastewater at LTA I-2.

4.4 Estimation of Viral Exposure Levels

The guidelines for the estimation of the separation distance between septic tank and a drinking water bore (Moore et al., 2013) are probably the sole system for estimation of the minimum offset distance for protection of viral water quality at a bore source outside of a detailed literature review or research level numerical modelling.

Worksheet No 2: Separation distance required

Step 1: Hepatitis A

Step 2: Secondary Treatment

Step 3: ☒ Disinfection Available

Step 4: Shallow Drifter

Distribution Aggregate: Pea Gravel

d1	10
d2	0.8
d4	0.1

Soil: Raw & Recent soil

Step 5: Vadose Zone

Type: Alluvial Sand

Saturated Zone: Gravel

Log₁₀ Reduction Required: 7.5

Actual Depth to Groundwater: 9.2

Nearest Table Depth: 9

Log₁₀ Removal Required: 7.35

Result: Separation distance required 190m

Diagram labels: Distribution aggregate, Conventional Trench, Shallow Drifter, Soil, Vadose zone, Groundwater, d1, d2, d3, d4

Figure 8: Worksheet to calculate separation distance between drifter septic discharge and water bore

Figure 8 outlines the settings selected in emulating the situation for one of the Area 3 LTAs (either LTA L or LTA I), the soil, subsoil and dominant unsaturated zone media, the saturated zone media and the log₁₀ reduction required to meet sufficient removal of a Hepatitis virus in groundwater. Conservative settings are employed. The calculation worksheet is based on (Moore et al., 2013) and implemented by Sean Leslie, Otago Regional Council.

One drawback of the above method is that it assumes a household level of wastewater discharge, typically no more than 2 m³/d. However, at the relatively light area application dosing rate of 7 millimetres per day, this drawback should not have a material effect on the estimation of minimum separation distance. This distance outlined in Figure 8 to achieve a 7.5 log₁₀ removal is 190 metres lateral. As the offset distance indicated is 190 metres and this is approximately half the distance between the closest LTA – supply bore offset, the viral protection from groundwater transport is indicated as adequate.

5 Source Protection Zone for Delineation Around each Supply Bore

5.1 Bores F42/0150 and CC11/0158

I disagree with the requirement to establish a source protection zone around two potential communal water supply bores that are not yet part of an established water supply scheme. The Nathaniel Place situation has been outlined above. I could perceive that there would be jeopardy to the land use interests of the developers and owners of lots in Nathaniel Place should on-site wastewater discharges of the growing number of houses that are being built or planned for the future affect either F42/0150 or CC11/0158 bores when used as domestic water supplies. The bore consent for both bores (F42/0150 or CC11/0158) list communal domestic water supply as the end use of the groundwater produced by the bores, which includes drinking water. For an external landowner advisor (i.e., Kōmanawa Solutions for RCL Homestead Bay Ltd) to delineate a groundwater-based source protection zone, which may include land use controls over discharges to land for which neighbouring

land users have no control. The information generated by the act of specifying a groundwater-based source protection zone could lead to risk of reverse sensitivity⁷.

Otago Region also does not have a regulatory or planning basis for non-council parties specifying source protection zones, other than those that may be actioned by the regional council by plan change to the Regional Plan: Water. The National Environmental Standard (Drinking Water Source) 2009 also has no basis for requiring the delineation and imposition of a source protection around all communal water supply source areas. Consultation and proposal for an updated National Environmental Standard dating from 2018 have yet to result in renewed regulation to require source protection.

In place of groundwater-based source protection zone delineation and recommendations for land or water use controls within the protection zone, this report outlines an effects-based assessment of the potential effects of the currently proposed wastewater land treatment activity on creek flow and down-gradient water quality. The water quality assessment focuses on the potential effects on the quality of water drawn at bores F42/0150, CC11/0158, and CC11/0151, which are all proposed in one form or another to become water supply bores. In my professional opinion, an effect-based assessment of water quality impacts on the potability of future water supply bores is the most appropriate means of ensuring the protection of such groundwaters. Accordingly, I am reluctant to embark on delineating source protection zones that may have little basis in future provisions or guidelines for their preparation.

⁷ Reverse sensitivity is the potential for a new, more sensitive land use to complain about, or seek to restrain, the environmental effects of an existing, established land use.

6 Summary Conclusions

6.1 Changes in Stream and Groundwater Flow Regime

There is not a perfect understanding of the surface water and groundwater hydrology of Homestead Bay and its hinterland into the Remarkables Range. However, what can be established and relied upon is that in the current setting there are no known / observed sites of groundwater seepage such as springs or conspicuous baseflow seepage into water courses. It is also established from the geological materials unearthed in test pits and bore logs that the alluvium, glacial outwash gravels and glacial till gravels have relatively high permeability and effective porous, such that these are capable of draining hillslope water from creeks emerging from the Remarkable mountains onto the talus and alluvial fans draping the western slopes into Homestead Bay.

The proposed wastewater land treatment system would apply up to 23 litres per second of wastewater into soils via a soil dripper system. The wastewater applied within grassed land treatment areas would remain within the soil profile and susceptible to evapotranspiration for a few hours before infiltrating deeper into the subsoil, so some quantum of wastewater would be evapo-transpired to the atmosphere especially in dry spells. The remaining infiltration would increase the overall groundwater recharge rate, however the high permeability of the overall groundwater system would still have the capacity to conduct the water surplus to Lake Wakatipu directly, as it currently does with few if any signs of groundwater daylighting at the surface or creek courses.

The surplus of wastewater contributions to soil moisture joining the regional water table, any rises in catchment groundwater flows are highly unlikely to stimulate surface flow expression due to high permeability of the land and creek bed that would enforce infiltration to the regional water table. Maori Jack Creek in its middle and lower reaches particularly where it approaches the schist boundary, may exhibit slightly higher flow as a result of the ultimate wastewater land treatment with small increases in perennial water table heights. However, water quality or ecological impacts are highly unlikely to be more than minor.

6.2 Assessment needed on Well F42/0150

Development of a conceptual model and numerical estimation has demonstrated the combination of the proposed wastewater land treatment areas and future water supply bores in locations that three test bores have already been installed along the Lake Wakatipu lakeshore would be compatible from a water quality perspective.

- The closest LTA discharge is over 400 metres distant, is applied at the surface while the water supply intakes are found at depths of 30 metres or more with intervening clay silt layers of various thickness overlying the screen intakes.
- In terms of pathogenic protozoa, these large bodies micro-organisms could not extend through the soil profile to enter groundwater for transport in the direction of bores.
- In terms of bacteriophages, the current offset distance between the closest land treatment areas and bores is too great to allow the entry of faecal indicator bacteria as E. coli.
- In terms of nitrate nitrogen, water mass balances point to primary wastewater nitrate nitrogen concentrations being substantially reduced to nominal concentrations.
- In terms of viruses, the main available offset calculation tool indicates the minimum distance required between land treatment area and bore as less than 50% of the current offset distance between the closest land treatment areas and bores.

6.3 Source protection zone to be identified for each community water supply

I consider that there is a lack of clear requirement or guidance for the setting of source protection areas in Otago. Otago Regional Council has not applied groundwater protection zones over Homestead Bay, which would have been the sole mechanism within the Regional Plan: Water. The information generated by the act of specifying a groundwater-based source protection zone may also lead to risk of reverse sensitivity effects.

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Appendix D “Emerging Contaminants in Treated Wastewater”, LEI Memorandum, 5 September 2025



MEMORANDUM

Job 10934

To: Dan Wells, Project Manager, RCL Group

From: Shamim Al Mamun and Brian Ellwood, Lowe Environmental Impact

Date: 5 September 2025

Subject: Emerging Contaminants in Treated Wastewater

BACKGROUND

RCL Homestead Bay is seeking consent to discharge treated community wastewater to land via subsurface drip irrigation (LTAs) in a staged development at Homestead Bay, Queenstown. The current AEE addresses conventional parameters (BOD, nutrients, TSS, pathogens, etc.) and soil/groundwater hydraulics. However, it does not address contaminants of emerging concern (CECs), also referred to as emerging contaminants (ECs), which are increasingly relevant to municipal wastewater schemes discharging to land.

This memo has therefore been prepared in response to a request for further information and to specifically address the following SLR comment:

"There is no commentary or assessment of Emerging Contaminants in the Wastewater AEE. Emerging contaminants include, but are not limited to, substances such as antibiotic residues, Per- and polyfluoroalkyl substances (PFAS) and pesticides, and have been recorded in wastewater discharges across New Zealand. While difficult to treat, their presence should be acknowledged and some form of monitoring for them included in the consent conditions."

A review of the emerging contaminants and their potential impact on wastewater applications in the LTAs and the nearby environment at the RCL Homestead Bay site is provided below.

Contaminants of Emerging Concern (CECs)

Contaminants of emerging concern (CECs) are chemicals and microbiological markers that are not yet comprehensively regulated but are now routinely detected at very low concentrations (nanograms per litre to micrograms per litre, ng/L-µg/L) in surface waters.

Key groups relevant to community wastewater include pharmaceuticals and personal care products (PPCPs), endocrine-disrupting compounds (EDCs), and per- and polyfluoroalkyl substances (PFAS) such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

In 2022, the European Commission adopted a proposal to update the lists of priority substances in surface water and groundwater (EC, 2022). The original list of 45 substances was expanded by an additional 25.

The new inclusions cover PFAS chemicals, personal care product ingredients, a range of pesticides, the plasticiser bisphenol-A (BPA), several pharmaceuticals (notably painkillers, anti-convulsants, and antibiotics), and silver.



Among the pharmaceuticals and personal care products (PPCPs) of direct relevance to wastewater and biosolids are the surfactants nonyl- and octylphenols, the estrogenic steroid hormones 17β -estradiol, estrone, and 17α -ethinylestradiol, the brominated flame retardant HBCDD (hexabromocyclododecane), the plasticiser BPA (bisphenol-A), antibiotics azithromycin, clarithromycin, and erythromycin, and widely prescribed pharmaceuticals such as carbamazepine, diclofenac, and ibuprofen, along with the antimicrobial triclosan (Northcott and Tremblay, 2024).

Per- and Polyfluoroalkyl Substances (PFAS)

Per- and polyfluoroalkyl substances (PFAS) are a large group of synthetic chemicals used for more than 50 years to provide non-stick, water-, oil-, fire-, weather-, and stain-resistant properties in consumer products and industrial applications. Common uses include textiles, carpets, food packaging, firefighting foams, pesticides, and stain repellents. The most recognised PFAS-PFOS, PFOA, and PFHxS-are part of the perfluoroalkyl acids (PFAAs), which are extremely stable and resistant to degradation, leading to long-term persistence in the environment (HEPA, 2025).

Many other PFAS act as precursors and can transform into PFAAs once released. Regulatory inventories in Australia (AICIS) and New Zealand (NZIoC) list multiple PFAS compounds, reflecting their widespread use. The Organisation for Economic Cooperation and Development (OECD) defines PFAS structurally as fluorinated substances containing at least one fully fluorinated methyl ($-\text{CF}_3$) or methylene ($-\text{CF}_2-$) group (HEPA 2025).

Per- and polyfluoroalkyl substances (PFAS) are a large family of manufactured chemicals used since the 1940s in industry and consumer products for their oil, water, and stain-resistant properties. Thousands of PFAS exist, with some more widely used and studied than others; among the best known are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), which historically saw broad application but have largely been replaced by other PFAS.

Global regulations under the Stockholm Convention banning the first twelve POPs (OCPs, PCBs, PCDD/Fs) are proving effective, with concentrations in biosolids declining at an estimated half-life of about 10 years. In contrast, for more recently banned POPs, such as polybrominated flame retardants, polychlorinated naphthalenes and paraffins, and perfluorinated chemicals, no clear downward trend has yet been observed (Zennegg et al., 2013).

The European Commission sponsored a risk assessment of organic pollutants and environmental impacts from sewage sludge management to support policy development on the Sewage Sludge Directive (86/278/EEC) (Huygens et al, 2022).

The study identified a long list of 1350 chemicals in wastewaters and sludge as reported in the scientific literature and legislation as being of concern (e.g., polyaromatic hydrocarbons (PAHs), perfluorinated alkyl substances (PFAS), and other CECs (e.g., chlorinated paraffins, pharmaceuticals, personal care products, speciality industrial chemicals)).

The Water New Zealand survey undertaken in July 2024 and February 2025 gathered over 7,000 observations from 13 wastewater treatment plants (WWTPs) across the country, collectively servicing a population of 2.57 million. The dataset covered sludge collection and treatment from 1998 through 2024. Around 60% of the data focused on concentrations of inorganic contaminants (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), while only 11 samples from three



WWTPs reported results for emerging organic contaminants such as nonylphenols and ethoxylates (NP/NPE), phthalates (DEHP), linear alkylbenzene sulphonates (LAS), and the synthetic musks tonalide and galaxolide. In addition, 34 observations from four WWTPs measured PFAS compounds (PFHxS, PFOS, PFOA).

The limited data available (11 samples from 3 WWTP) of the emerging organic contaminants considered in the guidelines showed values of all the contaminants below the proposed compliance limits (Ginés and Hernández, 2025).

PFAS BANS AND PHASING OUT IN NEW ZEALAND

New Zealand has progressively tightened restrictions on PFAS to reduce environmental and human health risks. As of October 2023, the manufacture and use of PFHxS, its salts, and related compounds are fully prohibited under the Hazardous Substances and New Organisms Act (SGS, 2024).

Firefighting foams containing PFAS have been progressively restricted since 2020. While limited use in contained systems is still permitted, the Environmental Protection Authority has confirmed that all PFAS-based foams will be completely banned in New Zealand after December 2025 (EPA, 2022).

In addition, the Environmental Protection Authority (EPA) has confirmed a ban on PFAS in cosmetics: importation and manufacture will cease from 31 December 2026, sales prohibited from 31 December 2027, and complete disposal will be mandated by 30 June 2028 (EPA, 2023).

These staged measures reflect New Zealand's precautionary approach to PFAS management, aligning with international efforts to curb their persistence and toxicity. This precaution will likely reduce the concentration of CECs in the wastewater.

MANAGEMENT OF EMERGING ORGANIC CONTAMINANTS

Food Standards Australia New Zealand (FSANZ) completed its review in December 2016, recommending tolerable daily intakes (TDIs) of 20 ng/kg bw/day for PFOS and 160 ng/kg bw/day for PFOA, noting insufficient information to establish a TDI for PFHxS but that the PFOS TDI was likely conservative and protective, and in 2017 submitted a consolidated report to Health covering HBGVs, dietary exposure and risk management.

In the 24th Australian Total Diet Study (ATDS) Phase 2, which analysed perfluorinated compounds across foods purchased from diverse retail outlets, PFOA was not detected and PFOS was found in only two of 50 foods at very low concentrations (≤ 1 ppb), consistent with international findings; subsequently, the 27th ATDS tested 30 PFAS in 1,336 composite samples representing 112 commonly eaten foods from all states and territories in two seasons and found PFAS levels in the general food supply to be very low, with PFOS detected in just five of 112 food types and in $< 2\%$ of all samples, yielding overall dietary exposure below the PFOS TDI and indicating no public-health or safety concerns or current need for Code maximum levels.



To support the 27th ATDS, FSANZ also reviewed recent evidence on PFAS and immunomodulation (vaccine response, infection susceptibility and hypersensitivity), concluding that while some statistical associations have been reported, the evidence at environmental exposure levels is not consistent with harmful effects on the human immune system (Food Standards Australia New Zealand (FSANZ), 2025).

ESR's (Institute of Environmental Science and Research) national groundwater survey, the ninth since 1990 and the first to include PFAS, tested 131 wells across New Zealand and found PFAS in 11% of them, mostly perfluoroalkyl carboxylic acids (PFBA most common); the highest combined PFHxS + PFOS was 16.5 ng/L, and all detections were below current NZ drinking-water health limits.

New Zealand does not yet have a nationally standardised monitoring programme for ECs in treated domestic wastewater. Most consents for land application focus on nutrients, pathogens, and metals, with little or no EC coverage. The Greater Wellington TR2016 review and MPI scoping paper highlight that pharmaceuticals, steroid hormones, and personal care products are commonly detected in NZ effluent streams, but routine monitoring is rare.

A few research studies and pilot programmes have measured pharmaceuticals (carbamazepine, diclofenac, ibuprofen), hormones (estrone, ethinylestradiol), and antimicrobial agents (triclosan) in treated wastewater, showing that these compounds can persist at ng/L–µg/L levels.

PFAS monitoring of wastewater effluent has begun more recently, often in response to specific site concerns (firefighting foams, landfill leachate inputs). However, it is not routine for purely domestic type wastewater plants as proposed at RCL.

Monitoring for ECs in liquid wastewater is still at the scoping and pilot stage in NZ; routine national practice has not yet been formalised.

The updated Guideline for Beneficial Use of Biosolids on land (2025), published by Water New Zealand, highlights that emerging contaminants such as pharmaceuticals, endocrine disruptors, antimicrobials, flame retardants, PFAS, and microplastics are increasingly important to monitor in land-applied biosolids.

The Biosolids guideline sets out a phased approach for introducing testing as laboratory methods become available, as currently New Zealand does not have the capability to test all the emerging contaminants in biosolids.

Predominantly, a PFAS panel (PFOA, PFOS, and other common PFAS) for monitoring in biosolids, soil and groundwater has been recommended by others where there is any plausible source (e.g., firefighting foam, industrial inputs).

The proposed discharge consents for RCL do not seek to authorise the discharge of biosolids, where it has been found that ECs can accumulate.



ASSESSMENT OF THE EFFECTS OF EMERGING CONTAMINANTS IN HOMESTEAD BAY WASTEWATER AND LTA

At the RCL Homestead Bay site, only treated community domestic type wastewater is proposed to be applied to land by subsurface drip, allowing it to pass through large depths with the majority of the LTA having >4 m of vadose zone, where the soil functions as a large, living filter. As the water moves downward, most emerging contaminants (e.g., pharmaceuticals, personal-care products, endocrine disruptors, and some PFAS, microplastics, etc.) are attenuated by a mix of sorption to organic matter and mineral surfaces, physical filtration, and biotransformation by soil microbes in the aerated root zone.

The soil reduces the contaminant mass that can reach groundwater through acting as a filter (Weil and Brady, 2016). At the RCL Homestead Bay site, a 4 m vadose zone is expected to reduce the concentration of CECs before they reach the groundwater. The waste application is subsurface, which will prevent direct runoff to streams or lakes, lowering risks to aquatic flora and fauna.

Furthermore, the proposed wastewater land application involves domestic and light commercial village trading centre wastewater only, with no industrial trade waste inputs and no contribution from airports, firefighting foam use, or other high-risk activities.

Routine monitoring for emerging contaminants (ECs) such as pharmaceuticals, PFAS, and endocrine-active compounds is not necessary in this context, for the following reasons:

1. Source Risk Profile

- a. Domestic derived wastewater from homes and light commercial is well characterised. It typically contains trace levels of pharmaceuticals and personal care products, but at concentrations orders of magnitude lower than levels of ecological or human health concern.
- b. The key drivers for EC risk in wastewater are industrial and trade waste discharges (e.g., chemical manufacturing, landfills, airports, firefighting training grounds). None of these sources are present here.

2. Current Regulatory Direction

- a. The draft National Wastewater Environmental Performance Standards (Taumata Arowai, 2025) do not require EC monitoring for wastewater discharges. ECs are explicitly excluded from the national framework and are to be managed, if relevant, via case-specific consenting.
- b. Existing NZ assessments (e.g., MPI scoping review; GWRC TR2016; MfE Emerging Contaminants reports) identify biosolids and industrial effluent as the priority pathways for ECs, not domestic wastewater to land.

3. Pathways and Attenuation

- a. Land application provides a treatment barrier: soils act as a filtration and adsorption medium, and many ECs undergo biodegradation in the unsaturated zone.
- b. International studies show significant attenuation of pharmaceuticals and hormones in soil-plant systems, with residual concentrations in groundwater generally below thresholds of concern.



4. Proportionality and Best Practice

- a. Standard monitoring of nutrients, pathogens, and metals remains the best tool for managing risks to water quality and public health.
- b. Introducing EC monitoring would add significant analytical cost, with little regulatory or environmental benefit in the absence of industrial or PFAS-related sources.
- c. A baseline scan could be considered as a precaution, but ongoing routine monitoring is disproportionate for domestic derived effluent.



SUMMARY

Soil functions as a biogeochemical sink and attenuation barrier for contaminant mass flux, as the unsaturated-zone processes of sorption to mineral/organic phases, filtration of particulates/colloids, matrix diffusion, and redox-dependent (aerobic/anaerobic) biotransformation reduce mobility and bioavailability of many contaminants of emerging concern (CECs).

Diverse edaphic microbial consortia mediate metabolism and mineralisation pathways (e.g., hydrolysis, oxidative/reductive degradation), while rhizosphere processes (rhizodeposition, phytouptake, phytostabilisation etc.) further enhance natural attenuation; persistent classes (e.g., many PFAS) are primarily retarded via sorption and ion-exchange on variable-charge surfaces and organic matter, with attenuation efficiency dependent on soil texture, pH, organic matter etc.

At RCL Homestead Bay, controlled land treatment via subsurface drip irrigation (LTA) increases vadose-zone residence time and retardation factors, lowering contaminant breakthrough to groundwater relative to alternative discharge options of direct surface water discharge or high-rate trench disposal systems. By intercepting the load in soils, the mass delivered to lotic and lentic receiving environments is reduced, decreasing chronic exposure risks to aquatic primary producers (periphyton, phytoplankton, macrophytes) and aquatic fauna (macroinvertebrates, fish), and limiting disturbances to community structure, endocrine endpoints, trophic transfer, and biodiversity.

The proposed hydraulic loading rates, dosing schedules, and buffer/setback criteria maintain unsaturated flow and avoid preferential pathways, meaning the LTA represents a protective and practicable option for emerging contaminants management compared with surface-water outfalls. The design of the system from treatment, with separate handling of biosolids and subsurface land-based application, means that there is no clear exposure pathway for human health-related effects of ECs.

A pragmatic approach would be for ORC to undertake a periodic review (e.g., every 5 years) of the evolving state of knowledge on emerging organic contaminants in New Zealand wastewater, with adaptive consent conditions or requirements via a regional plan implementation to further action if such reviews identify new risks.

CONCLUSION

For domestic wastewater without industrial or airport contributions, there is no compelling basis to require routine EC monitoring.

Management should focus on conventional parameters (nutrients, pathogens, organics), which directly drive environmental effects. EC monitoring should only be triggered if the wastewater source changes (e.g., addition of trade waste) or if national standards are revised to include specific EC requirements.



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Appendix E Homestead Bay Bore – Water Quality Monitoring



Homestead Bay Bore - Water Quality Monitoring

Prepared for:
RCL Group

Date:
September 2025

Prepared by:
Stantec New Zealand

Project/File:
310104425



Revision Schedule

Revision No.	Date	Description	Prepared by	Quality Reviewer	Independent Reviewer	Project Manager Final Approval
0	11 Sep 2025	For Client Review	AW	KN	RB	PW

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Appendix A	Homestead Bay Bore Water Quality Results
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Abbreviations

Abbreviations	Full Name
AV	Aesthetic Value
AVDWN	Aesthetic Values for Drinking Water Notice
DOC	Dissolved Organic Carbon
DWQAR	Drinking Water Quality Assurance Rules
DWSNZ	Drinking Water Standards for New Zealand
MAV	Maximum Acceptable Value
MDL	Method Detection Limit
TOC	Total Organic Carbon
UVT	Ultraviolet Transmittance
WTP	Water Treatment Plant

1 Introduction

This report provides a summary of the raw water quality monitoring programme completed for the Homestead Bay Bore, which is owned by RCL Group. The purpose of this report is to be used as a design input for the Homestead Bay Water Treatment Plant (WTP) concept design.

A DN150 exploratory bore (CC11/0151P) was drilled and air-lifted for development in June 2024, with a water sample collected and analysed for a limited number of water quality parameters. A subsequent DN300 test production bore (CC11/0151) was drilled in June 2024 with step drawdown testing and multi-day constant rate pump testing completed in July 2024. A water sample was collected from the test production bore after all the pump testing was completed, and it was analysed for a limited suite of water quality parameters. Please refer to *RCL Homestead Bay Ltd: Groundwater Exploration & Effects of Taking Groundwater for Water Supply* report (Rekker, 2024) for additional details.

Given the limited water quality data and differences in the two grab sample results, a water quality monitoring programme was developed. Grab samples were collected from the Homestead Bay test production bore (CC11/0151) on a monthly basis from September 2024 to August 2025, inclusive. The samples were analysed by Hill Laboratories for a full suite of parameters for the purposes of informing the required treatment process selection, to produce potable water that is compliant with the relevant requirements of the Water Services Act 2021, Water Services (Drinking Water Standards for New Zealand) Regulations 2022 (DWSNZ), Drinking Water Quality Assurance Rules 2022 (Revised 2024) (DWQAR), and Aesthetic Values for Drinking Water Notice 2022 (AVDWN).

The discussion of this report is limited to the water quality only. No discussion regarding the quantity of available water from the bore is provided in this report. Any historical water quality data collected and analysed prior to the start of this monitoring programme (September 2024) have not been included in the figures or data analysis. It is noted that there are other legislation and requirements applicable to a water supplier under the Water Services Act, such as having a Source Water Risk Management Plan (SWRMP); however, this is outside the scope of this report. References have been made to Health Canada Guidelines in this report for the purposes of information; however, the data analysis was completed with respect to applicable New Zealand standards and legislation.

2 Raw Water Quality

A summary of the notable water quality parameters, measured as part of the sampling suite, are summarised herein. The complete set of analytical results received from Hill Laboratories are provided in Appendix A.

2.1 Arsenic

Arsenic is a naturally occurring element that may be found in drinking water supplies, and is recognised as a human cancer-causing agent (Taumata Arowai, 2025).

A water sample collected from the exploration bore (June 2024) was analysed to have a concentration of 0.012 mg/L of total arsenic. This is greater than the Maximum Acceptable Value (MAV) of 0.01 mg/L, as outlined in the DWSNZ. This prompted the inclusion of arsenic in the water quality monitoring programme. A summary of the arsenic results is presented in Figure 2-1.

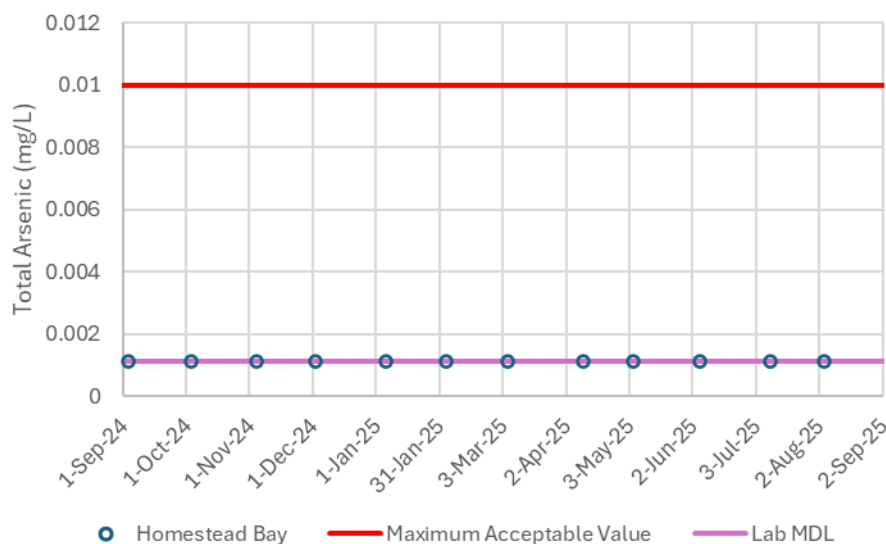


Figure 2-1: Homestead Bay Bore total arsenic results from September 2024 to August 2025. Data markers are shown as empty circles to signify that results were reported below the laboratory method detection limit.

For the duration of the monitoring programme, all samples were measured to be less than the laboratory's Method Detection Limit (MDL) for arsenic which is 0.001 mg/L. The sampling result values presented in Figure 2-1 were inputted as 0.001 mg/L for illustrative purposes, but are considered "non-detect" in practice. Based on the above data, there are no concerns with the presence of arsenic in the Homestead Bay Bore.

2.2 Turbidity

Turbidity is an aggregate water quality parameter that quantifies "cloudiness". It quantifies the amount of light scattering and absorbing effects of suspended solids. Suspended solids may come from either organic or inorganic sources.

For this monitoring programme, turbidity was measured at Hill Laboratories. The turbidity MAV for the Homestead Bay WTP has been selected to be 1.0 NTU. This is based on the assumption that bacterial compliance will be achieved through the addition of chlorine (i.e., sodium hypochlorite, chloring gas);

therefore, Section 4.10.1.1 of the DWQAR applies. The AVDWN states an aesthetic value (AV) of 5 NTU. A summary of the turbidity results is presented in Figure 2-2 with an MAV of 1.0 NTU.

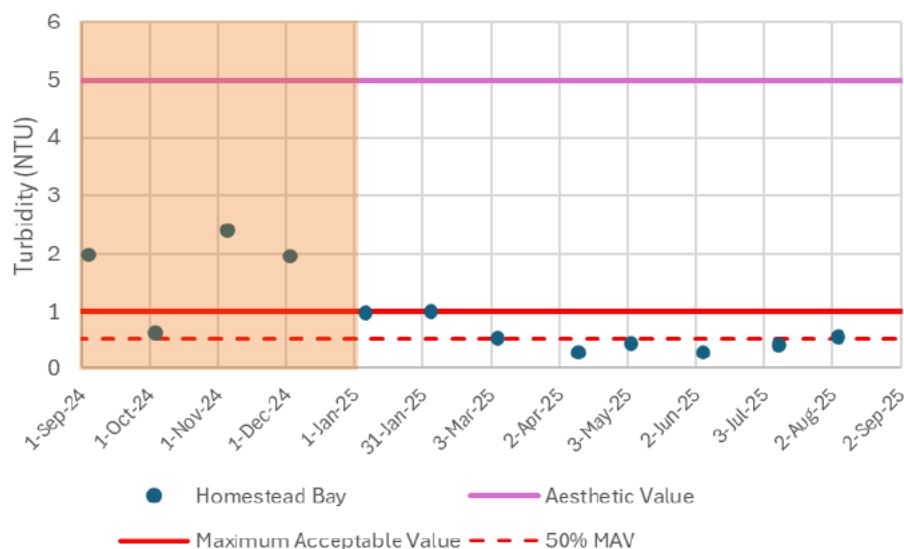


Figure 2-2: Homestead Bay Bore turbidity results from September 2024 to August 2025

Five of the six samples collected from September 2024 to February 2025 were measured at or above the MAV of 1 NTU. Data from September to December 2024 are shaded with an orange box as the elevated turbidity may be attributed to bore establishment and not reflective of the future water quality. However, the cause of these elevated turbidity readings cannot be confirmed at this stage.

Samples collected from March to August 2025 were measured below the MAV and at or below 50% of the MAV. If this turbidity trend were to continue, the Homestead Bay WTP could achieve bacterial compliance using chlorine without additional treatment (e.g., filtration).

2.3 pH

pH is a measure of how acidic or alkaline the water is. This is an important parameter for chemical treatment processes, including iron and manganese oxidation, chlorine addition for disinfection, and assessing the corrosivity of the treated water.

The required pH range, as stated in the AVDWN, is between 7.0-8.5. Water with a high pH has a soapy taste and feel, and a pH less than 8 is preferable for disinfection with chlorine to comply with Level 3 DWQAR. Ideally, the pH should range between 7.4 and 8.0. pH was measured in the field at the time of sampling and at Hill Laboratories. A summary of the pH results is presented in Figure 2-3.

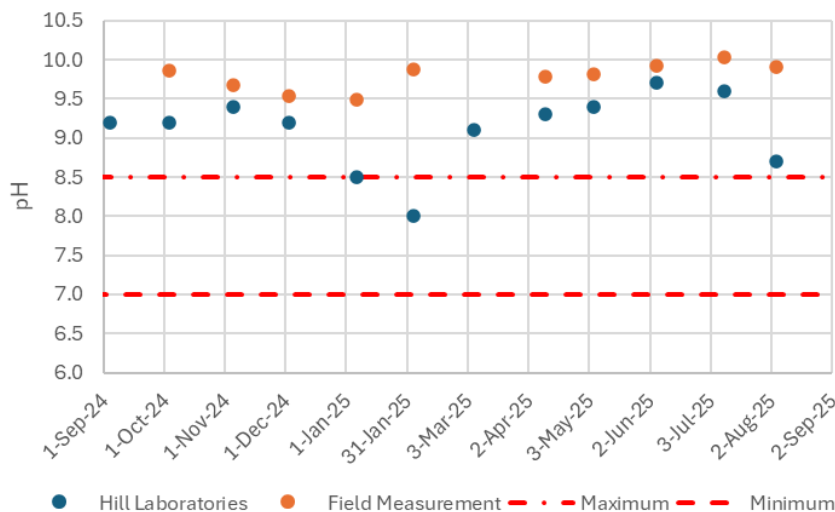


Figure 2-3: Homestead Bay Bore field and lab pH from September 2024 to August 2025

It is preferable to use pH data measured at the time of sampling, as pH is likely to change during sample transport to the laboratory; the difference in these results is illustrated in Figure 2-3. The range of pH measured at Hill Laboratories and in the field were 8.0-9.7 and 9.5-10, respectively; the field results were measured within a narrower band which may be illustrative of a trend and consistency. All pH results measured at Hill Laboratories or in the field were much higher than the grab samples collected in June and July 2024 (7.6-8.0).

The reason for the elevated pH is unknown, and is unexpected based on the alkalinity and hardness of the water (refer Section 2.6) as well as other parameters (e.g., anion / cation balance). Irrespective of the data set, the pH of the bore water is too high, and will require adjustment to between 7.4-8.0 through acid addition. This pH range enables easier bacterial compliance with chlorine, and results in a treated water with better chemical stability.

2.4 Iron

Iron is a commonly occurring metal in the environment. Iron in drinking water above 0.17 mg/L is likely to result in a bitter or metallic taste, while a concentration above 0.03 mg/L is likely to result in discoloured water (Health Canada, 2024). In addition to causing aesthetic complaints, iron can form scales on the inside of pipes and plumbing fixtures, and become a source of operational issues.

There is no known health concerns associated with iron in drinking water. For this reason, there is no MAV for iron, but there is an AV of 0.3 mg/L in New Zealand. A summary of the total iron results is presented in Figure 2-4.

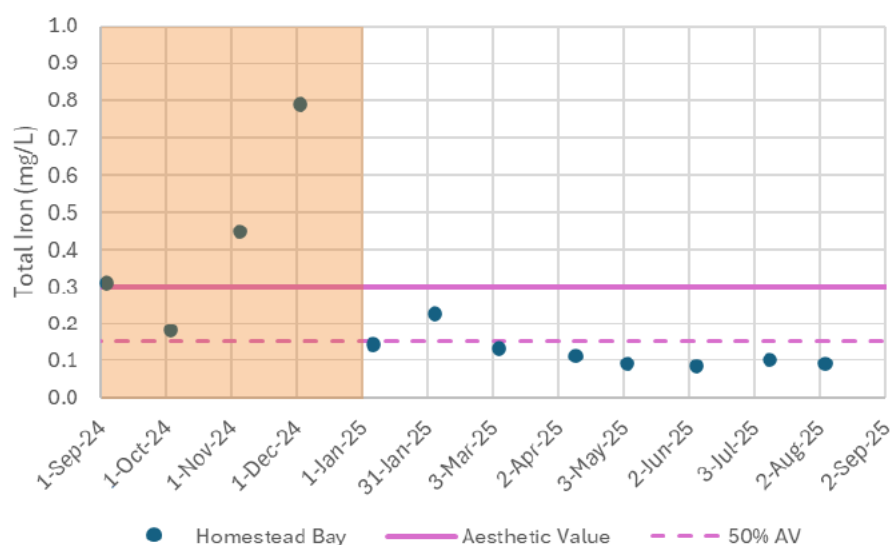


Figure 2-4: Homestead Bay Bore total iron results from September 2024 to August 2025

From September to December 2024, three samples were measured above the AV. These data points are shaded with an orange box as the elevated iron may be attributed to bore establishment and not reflective of the future water quality. However, the cause of these elevated total iron readings cannot be confirmed at this stage.

Seven of the twelve monthly samples were measured less than 50% of the AV. Total iron concentrations for the last six months were measured at approximately 0.1 mg/L. All dissolved iron concentrations were measured to be below the MDL of 0.02 mg/L. These low dissolved iron concentrations are not unexpected, as it is likely that dissolved iron in the bore water oxidises and comes out of solution during transport to the laboratory.

The provision of treatment for iron removal is not required for the purposes of complying with the DWSNZ and DWQAR as there is no MAV for iron. However, all water suppliers have the duty to take all reasonably practicable steps to supply drinking water that complies with aesthetic values (AVDWN) issued by Taumata Arowai (Section 24 of the Water Services Act 2021). If the total iron concentrations remain elevated, treatment for iron may be needed for compliance with the relevant legislation.

The elevated iron concentrations at the start of the monitoring programme and declining concentration trend, may be related to bore development and flushing. But the data may also be an indication of seasonal fluctuations in the bore water quality. The peak total iron concentration aligns with the field measured peak temperature and turbidity. However, confirmation as to whether this is a seasonal trend that will occur annually or not cannot be provided at this stage.

Based on the current data, and the presence of iron at detectable levels, there remains a residual risk of iron accumulation on equipment (e.g., UV reactor) and in the distribution network. The presence of iron may lead to customer complaints from coloured water events due to the need to provide a chlorine residual in the distribution network (Section 4.11.4 of the DWQAR); chlorine will oxidise the iron, creating metal precipitates that come out of solution. The risk and frequency of customer complaints at these iron levels cannot be quantified.

2.5 Manganese

Manganese is an essential nutrient occurring naturally in the environment, and is often found in ground water when iron is present. However, high levels of manganese can be a health risk to infants (Health Canada, 2019). Similarly to iron, manganese can cause aesthetic complaints due to colour or taste, form scales inside

pipes and plumbing fixtures, and cause operational issues. Manganese has an MAV of 0.4 mg/L in the DWSNZ and two AVs of 0.04 mg/L and 0.1 mg/L for laundry staining and taste, respectively. A summary of the total manganese results is presented in Figure 2-5, with the lower AV of 0.04 mg/L for laundry staining.

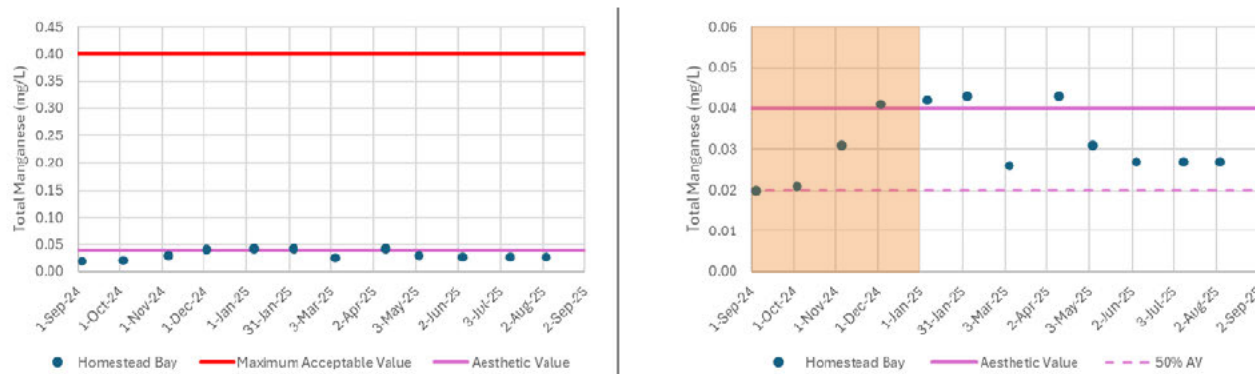


Figure 2-5: Homestead Bay Bore total manganese results from September 2024 to August 2025

For the duration of the monitoring programme, the total manganese concentrations remained below the MAV, but all samples were measured at or above 50% of the AV. Four out of the twelve samples were measured to be above the AV for laundry staining. All dissolved manganese concentrations were measured to be at least one order of magnitude lower than the total manganese, with some below the MDL of 0.0005 mg/L. These low dissolved manganese concentrations are not unexpected, as it is likely that dissolved manganese in the bore water oxidises and comes out of solution during transport to the laboratory.

Similar to the turbidity and total iron data, the results from September to December 2024 may have been collected during the bore establishment period and are highlighted in orange. However, the total manganese data differs from the turbidity and total iron data, as there appears to be a seasonal trend developing.

The provision of treatment for manganese removal is not required for the purposes of complying with the DWSNZ and DWQAR as all results were below MAV for manganese. However, a water supplier has the duty to take all reasonably practicable steps to supply drinking water that complies with aesthetic values (AVDWN) issued by Taumata Arowai (Section 24 of the Water Services Act 2021). If the total manganese concentrations remain elevated and above the AV, even on a seasonal basis, treatment for manganese may be needed for compliance with the relevant legislation.

The rising and falling trend in the total manganese data may be an indication of seasonal fluctuations in the bore water quality. The timing of the increase in the total manganese concentration aligns with the increase in the total iron concentration in November and December 2024, but not the decrease in total iron observed in January and February 2025. Additionally, the total manganese concentration increases and decreases at the same time the water temperature increases in November and decreases in May, respectively. However, confirmation as to whether this is a seasonal trend that will occur annually or not cannot be provided at this stage.

Based on the current data, and the presence of manganese at levels above the aesthetic value, there remains a residual risk of manganese accumulation on equipment (e.g., UV reactor) and in the distribution network. The presence of manganese may lead to customer complaints from coloured water events due to the need to provide a chlorine residual in the distribution network (Section 4.11.4 of the DWQAR); chlorine will oxidise the manganese creating metal precipitates that come out of solution. The risk and frequency of customer complaints at these manganese levels cannot be quantified.

2.6 Alkalinity and Hardness

Alkalinity quantifies the ability of the water to maintain a stable pH and neutralise acids or bases that are added. It is an important parameter to consider when assessing the corrosivity of the water. Hardness a

measure of the amount of dissolved calcium and magnesium in the water; high hardness can lead to scaling of plumbing fixtures and appliances leading to customer complaints.

The recommended minimum alkalinity concentration is 25 mg/L at a pH of 7.6; there is no MAV or AV for alkalinity. This generally results in a treated water with good chemical stability, lower corrosivity, and sufficient buffering capacity in the distribution network; however, water corrosivity is a complex subject and a corrosion study is recommended. The AVDWN states an AV for hardness of 200 mg/L as CaCO_3 for scale deposition and scum formation (pH dependent), and notes a taste threshold range of 100-300 mg/L as CaCO_3 . A summary of the total alkalinity and total hardness data is presented in Figure 2-6, with the respective AVs.

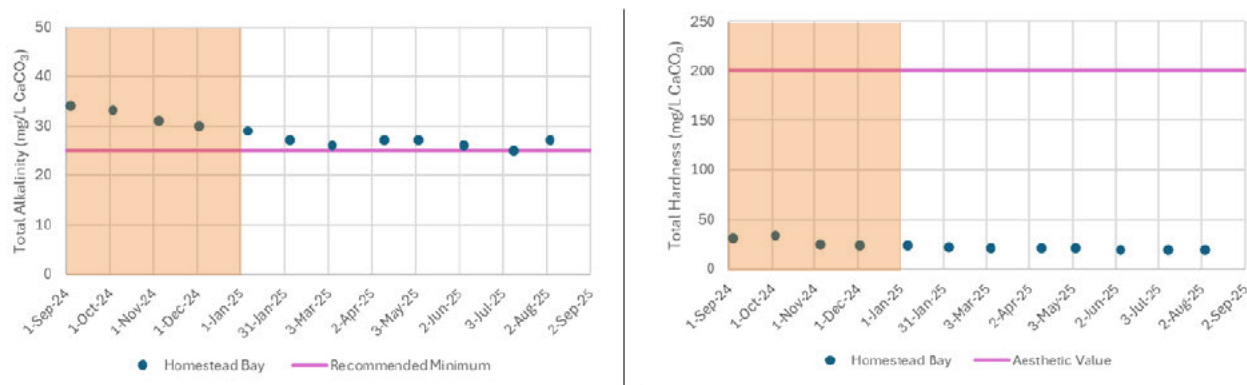


Figure 2-6: Homestead Bay Bore alkalinity and total hardness from September 2024 to August 2025

The alkalinity of the Homestead Bay Bore was measured to be at or just above the recommended minimum. The results from September to December 2024 may have been collected during the bore establishment period and are highlighted in orange. However, the need to lower the pH using an acid to comply with the DWQAR for bacterial compliance using chlorine and the aesthetic limits for pH, will consume alkalinity and potentially increase the corrosivity of the finished water. Careful management of both the pH and alkalinity of the treated water will be required.

The hardness concentrations measured were similar in magnitude to the alkalinity. This suggests that the water is soft.

2.7 Additional Water Quality Parameters

The bore water UV transmittance (UVT) was analysed monthly for the duration of the monitoring programme. For the first nine samples were filtered prior to analysis, with the last three samples were unfiltered. All samples were measured to be greater than 95%. However, the UVT is higher than expected for the iron and manganese concentrations that were measured. The filtered samples, would be representative of the water quality if a filtration step (e.g., greensand filtration) was provided at the Homestead Bay WTP, and not representative of the raw water as it is pumped out of the ground. The high UVT measured from the unfiltered samples may be due to the oxidation of the metals during transport as discussed above.

Ten out of twelve bore water samples were measured to have Dissolved Organic Carbon (DOC) concentrations less than the laboratory MDL of 0.5 mg/L. However, there were detectable levels of both Total Organic Carbon (TOC) and DOC, less than 3 mg/L, during the second half of the monitoring programme. These elevated concentrations are unexpected results for the bore. However, these concentrations are not high enough to warrant further investigation.

2.8 Summary

A summary of the data analysis is provided below:

- Total arsenic results for the duration of the monitoring programme were measured to be less than laboratory MDL of 0.001 mg/L. This is below the MAV of 0.01 mg/L.
- The turbidity has trended downwards to below the MAV of 1 NTU from January to August 2025.
- The pH is high and requires adjustment with an acid to comply with the DWQAR for bacterial compliance and the aesthetic limits for pH.
- Iron concentrations measured in 2025 were less than the AV. The iron concentrations measured in 2024 above the AV may be associated with bore development or a seasonal peak.
- Manganese concentrations measured for the duration of the monitoring programme were above 50% of the AV, and four out of twelve samples were measured above the AV for laundry staining. The rising and falling trend in the manganese concentrations may be indicative of a seasonal fluctuation in water quality, which aligns with an increase in the water temperature; however, confirmation that this is a seasonal phenomenon cannot be provided at this stage.
- The provision of treatment for iron and manganese removal is not required for the purposes of complying with the DWSNZ and DWQAR as there is no MAV for iron, and all manganese results were below MAV. However, a water supplier has the duty to take all reasonably practicable steps to supply drinking water that complies with aesthetic values. If the total iron and total manganese concentrations remain below the AV, the need to provide treatment becomes reduced. However, based on the current data there remains a residual risk of iron and manganese accumulation on equipment and in the distribution network, which may lead to customer complaints.
- Alkalinity of the bore water suggests that it is acceptable. However, pH adjustment with an acid will consume alkalinity and potentially increase the corrosivity of the finished water; therefore, both pH and alkalinity control will be required.
- The first nine UVT samples were filtered prior to analysis, with the last three samples were unfiltered. All samples were measured to be greater than 95%. The UVT is higher than expected for the iron and manganese concentrations that were measured. Additional water quality data will be collected at the next design phase for the UV reactor.
- DOC and TOC concentrations were generally low. Results in the second half of the monitoring programme were elevated, but not high enough to warrant further investigation or impact design.
- The hardness results indicate that bore water is soft.

3 Conclusions and Recommendations

The following conclusions are provided:

- The bore water quality can be treated to meet the requirements of the Water Services Act, DWSNZ, DWQAR, and AVDWN.
- The concept design of the Homestead Bay WTP could progress on the basis of one of the following options:
 - **Option 1: UV, chlorine, pH, and alkalinity control** This is a more affordable option. There are residual risks to the water supply system equipment and customer complaints by not removing iron and manganese. Additional water quality data will be collected at the next phase for the design of the UV reactor.
 - **Option 2: Greensand Filtration, UV, chlorine, pH, and alkalinity control** This is a more complex and expensive option, but addresses the residual risk of iron and manganese in the treated water. No additional data is required to progress the design of the greensand filtration system, or pH and alkalinity control.

4 References

- Health Canada. (2019). *Guidelines for Canadian drinking water quality : guideline technical document - manganese*. Ottawa: Health Canada.
- Health Canada. (2024). *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Iron*. Ottawa: Health Canada.
- Rekker, J. (2024). *RCL Homestead Bay Ltd: Groundwater Exploration & Effects of Drinking Groundwater for Water Supply*. Christchurch: Kōmanawa Solutions Ltd.
- Taumata Arowai. (2025, September 2). *Arsenic*. Retrieved from <https://www.taumataarowai.govt.nz/learning-hub/in-the-water/arsenic>

Appendices

Appendix A Homestead Bay Bore Water Quality Results

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3666119	SPV1
Contact:	Richard Bennett	Date Received:	06-Sep-2024	
	C/- Stantec New Zealand	Date Reported:	13-Sep-2024	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBAY_040924 04-Sep-2024 2:05 pm
Lab Number:	3666119.1

Individual Tests		
Sum of Anions	meq/L	0.77
Sum of Cations	meq/L	0.80
Turbidity	NTU	1.99
pH	pH Units	9.2
Total Alkalinity	g/m ³ as CaCO ₃	34
Bicarbonate	g/m ³ at 25°C	36
Total Hardness	g/m ³ as CaCO ₃	31
Electrical Conductivity (EC)	mS/m	7.6
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.007 #1
Dissolved Calcium	g/m ³	9.7 #1
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	1.58 #1
Dissolved Manganese	g/m ³	0.0038
Dissolved Potassium	g/m ³	0.54 #1
Dissolved Sodium	g/m ³	4.0 #1
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	0.8
Fluoride	g/m ³	0.37
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.38
Sulphate	g/m ³	2.3
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	< 0.5
Absorbance at 254 nm	AU cm ⁻¹	0.004
Transmittance at 254 nm*	%T, 1 cm cell	99.1
Drinking water metals suite, totals, trace		
Total Aluminium	g/m ³	< 0.0032
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0062 #1
Total Cadmium	g/m ³	< 0.000053
Total Calcium	g/m ³	8.5 #1

Sample Type: Aqueous		
Sample Name:		HBAY_040924 04-Sep-2024 2:05 pm
Lab Number:		3666119.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m³	< 0.00053
Total Copper	g/m³	< 0.00053
Total Iron	g/m³	0.31
Total Lead	g/m³	< 0.00011
Total Lithium	g/m³	0.00169
Total Magnesium	g/m³	1.51 #1
Total Manganese	g/m³	0.020
Total Mercury	g/m³	< 0.00008
Total Molybdenum	g/m³	0.00120
Total Nickel	g/m³	< 0.00053
Total Potassium	g/m³	0.52 #1
Total Selenium	g/m³	< 0.0011
Total Silver	g/m³	< 0.00011
Total Sodium	g/m³	3.7 #1
Total Tin	g/m³	< 0.00053
Total Uranium	g/m³	< 0.000021
Total Zinc	g/m³	0.0106
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m³	< 0.0010
Dissolved Cadmium	g/m³	< 0.00005
Dissolved Chromium	g/m³	< 0.0005
Dissolved Copper	g/m³	< 0.0005
Dissolved Lead	g/m³	< 0.00010
Dissolved Nickel	g/m³	< 0.0005
Dissolved Zinc	g/m³	< 0.0010

Analyst's Comments

^{#1} It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1
Turbidity	Analysis by Turbidity meter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3686406	SPV1
Contact:	Richard Bennett	Date Received:	04-Oct-2024	
	C/- Stantec New Zealand	Date Reported:	10-Oct-2024	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBAY_03102024 03-Oct-2024 1:50 pm
Lab Number:	3686406.1

Individual Tests

Sum of Anions	meq/L	0.75
Sum of Cations	meq/L	0.86
Turbidity	NTU	0.61
pH	pH Units	9.2
Total Alkalinity	g/m ³ as CaCO ₃	33
Bicarbonate	g/m ³ at 25°C	34
Total Hardness	g/m ³ as CaCO ₃	33
Electrical Conductivity (EC)	mS/m	7.3
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.008 #1
Dissolved Calcium	g/m ³	10.6 #1
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	1.69 #1
Dissolved Manganese	g/m ³	0.0069
Dissolved Potassium	g/m ³	0.55 #1
Dissolved Sodium	g/m ³	4.1 #1
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	0.9
Fluoride	g/m ³	0.27
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.30
Sulphate	g/m ³	2.3
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	0.6
Absorbance at 254 nm (unfiltered sample)	AU cm ⁻¹	0.009
Transmittance at 254 nm (unfiltered sample)*	%T, 1 cm cell	98.0

Drinking water metals suite, totals, trace

Total Aluminium	g/m ³	< 0.0032
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0062 #1
Total Cadmium	g/m ³	< 0.000053



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous		
Sample Name:		HBAY_03102024 03-Oct-2024 1:50 pm
Lab Number:		3686406.1
Drinking water metals suite, totals, trace		
Total Calcium	g/m ³	9.1 ^{#1}
Total Chromium	g/m ³	< 0.00053
Total Copper	g/m ³	< 0.00053
Total Iron	g/m ³	0.180
Total Lead	g/m ³	< 0.00011
Total Lithium	g/m ³	0.00141
Total Magnesium	g/m ³	1.38 ^{#1}
Total Manganese	g/m ³	0.021
Total Mercury	g/m ³	< 0.00008
Total Molybdenum	g/m ³	0.00114
Total Nickel	g/m ³	< 0.00053
Total Potassium	g/m ³	0.52 ^{#1}
Total Selenium	g/m ³	< 0.0011
Total Silver	g/m ³	< 0.00011
Total Sodium	g/m ³	3.7 ^{#1}
Total Tin	g/m ³	< 0.00053
Total Uranium	g/m ³	< 0.000021
Total Zinc	g/m ³	0.0040
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m ³	< 0.0010
Dissolved Cadmium	g/m ³	< 0.00005
Dissolved Chromium	g/m ³	< 0.0005
Dissolved Copper	g/m ³	< 0.0005
Dissolved Lead	g/m ³	< 0.00010
Dissolved Nickel	g/m ³	< 0.0005
Dissolved Zinc	g/m ³	< 0.0010

Analyst's Comments

^{#1} It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 200-300% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3709354	SPV1
Contact:	Richard Bennett	Date Received:	06-Nov-2024	
	C/- Stantec New Zealand	Date Reported:	12-Nov-2024	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBAY051124 05-Nov-2024 11:22 am
Lab Number:	3709354.1

Individual Tests

Sum of Anions	meq/L	0.70
Sum of Cations	meq/L	0.66
Turbidity	NTU	2.4
pH	pH Units	9.4
Total Alkalinity	g/m ³ as CaCO ₃	31
Bicarbonate	g/m ³ at 25°C	29
Total Hardness	g/m ³ as CaCO ₃	25
Electrical Conductivity (EC)	mS/m	7.0
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.007 #1
Dissolved Calcium	g/m ³	7.9
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	1.19 #1
Dissolved Manganese	g/m ³	0.0048
Dissolved Potassium	g/m ³	0.51 #1
Dissolved Sodium	g/m ³	3.6
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	0.9
Fluoride	g/m ³	0.24
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.21
Sulphate	g/m ³	2.2
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	< 0.5
Absorbance at 254 nm	AU cm ⁻¹	0.004
Transmittance at 254 nm*	%T, 1 cm cell	99.0

Drinking water metals suite, totals, trace

Total Aluminium	g/m ³	< 0.0032
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0067 #1
Total Cadmium	g/m ³	< 0.000053
Total Calcium	g/m ³	8.2

Sample Type: Aqueous		
Sample Name:		HBAY051124 05-Nov-2024 11:22 am
Lab Number:		3709354.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m ³	< 0.00053
Total Copper	g/m ³	< 0.00053
Total Iron	g/m ³	0.45
Total Lead	g/m ³	< 0.00011
Total Lithium	g/m ³	0.00146
Total Magnesium	g/m ³	1.18 ^{#1}
Total Manganese	g/m ³	0.031
Total Mercury	g/m ³	< 0.00008
Total Molybdenum	g/m ³	0.00105
Total Nickel	g/m ³	< 0.00053
Total Potassium	g/m ³	0.50 ^{#1}
Total Selenium	g/m ³	< 0.0011
Total Silver	g/m ³	< 0.00011
Total Sodium	g/m ³	3.7
Total Tin	g/m ³	< 0.00053
Total Uranium	g/m ³	< 0.000021
Total Zinc	g/m ³	0.0071
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m ³	< 0.0010
Dissolved Cadmium	g/m ³	< 0.00005
Dissolved Chromium	g/m ³	< 0.0005
Dissolved Copper	g/m ³	< 0.0005
Dissolved Lead	g/m ³	< 0.00010
Dissolved Nickel	g/m ³	< 0.0005
Dissolved Zinc	g/m ³	< 0.0010

Analyst's Comments

^{#1} It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1
Turbidity	Analysis by Turbidity meter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3733236	SPV1
Contact:	Richard Bennett	Date Received:	05-Dec-2024	
	C/- Stantec New Zealand	Date Reported:	13-Dec-2024	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:	HBay Bone	
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBAY031224 03-Dec-2024 3:20 pm
Lab Number:	3733236.1

Individual Tests		
Sum of Anions	meq/L	0.69
Sum of Cations	meq/L	0.65
Turbidity	NTU	1.95
pH	pH Units	9.2
Total Alkalinity	g/m ³ as CaCO ₃	30
Bicarbonate	g/m ³ at 25°C	30
Total Hardness	g/m ³ as CaCO ₃	24
Electrical Conductivity (EC)	mS/m	6.6
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.007 #1
Dissolved Calcium	g/m ³	7.8 #1
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	1.09 #1
Dissolved Manganese	g/m ³	0.0052
Dissolved Potassium	g/m ³	0.49
Dissolved Sodium	g/m ³	3.7 #1
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	1.1
Fluoride	g/m ³	0.30
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.19
Sulphate	g/m ³	1.9
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	< 0.5
Absorbance at 254 nm	AU cm ⁻¹	0.004
Transmittance at 254 nm*	%T, 1 cm cell	99.1
Drinking water metals suite, totals, trace		
Total Aluminium	g/m ³	< 0.0032
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0068 #1
Total Cadmium	g/m ³	< 0.000053
Total Calcium	g/m ³	7.7 #1

Sample Type: Aqueous		
Sample Name:		HBAY031224 03-Dec-2024 3:20 pm
Lab Number:		3733236.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m³	< 0.00053
Total Copper	g/m³	< 0.00053
Total Iron	g/m³	0.79
Total Lead	g/m³	< 0.00011
Total Lithium	g/m³	0.00153
Total Magnesium	g/m³	1.07 #1
Total Manganese	g/m³	0.041
Total Mercury	g/m³	< 0.00008
Total Molybdenum	g/m³	0.00102
Total Nickel	g/m³	< 0.00053
Total Potassium	g/m³	0.50
Total Selenium	g/m³	< 0.0011
Total Silver	g/m³	< 0.00011
Total Sodium	g/m³	3.7 #1
Total Tin	g/m³	< 0.00053
Total Uranium	g/m³	< 0.000021
Total Zinc	g/m³	0.0143
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m³	< 0.0010
Dissolved Cadmium	g/m³	< 0.00005
Dissolved Chromium	g/m³	< 0.0005
Dissolved Copper	g/m³	< 0.0005
Dissolved Lead	g/m³	< 0.00010
Dissolved Nickel	g/m³	< 0.0005
Dissolved Zinc	g/m³	< 0.0010

Analyst's Comments

^{#1} It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1
Turbidity	Analysis by Turbidity meter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3750086	SPV1
Contact:	Richard Bennett	Date Received:	07-Jan-2025	
	C/- Stantec New Zealand	Date Reported:	10-Jan-2025	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Patrick Leslie	

Sample Type: Aqueous

Sample Name:	HBAM_060125 06-Jan-2025 1:30 pm
Lab Number:	3750086.1

Individual Tests		
Sum of Anions	meq/L	0.67
Sum of Cations	meq/L	0.64
Turbidity	NTU	0.99
pH	pH Units	8.5
Total Alkalinity	g/m ³ as CaCO ₃	29
Bicarbonate	g/m ³ at 25°C	34
Total Hardness	g/m ³ as CaCO ₃	24
Electrical Conductivity (EC)	mS/m	6.5
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.007 #1
Dissolved Calcium	g/m ³	7.6 #1
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	1.16 #1
Dissolved Manganese	g/m ³	0.020
Dissolved Potassium	g/m ³	0.50 #1
Dissolved Sodium	g/m ³	3.5 #1
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	1.1
Fluoride	g/m ³	0.27
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.15
Sulphate	g/m ³	2.1
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	0.5
Absorbance at 254 nm	AU cm ⁻¹	0.007
Transmittance at 254 nm*	%T, 1 cm cell	98.3
Drinking water metals suite, totals, trace		
Total Aluminium	g/m ³	< 0.0032
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0067 #1
Total Cadmium	g/m ³	< 0.000053
Total Calcium	g/m ³	7.1 #1

Sample Type: Aqueous		
Sample Name:		HBAM_060125 06-Jan-2025 1:30 pm
Lab Number:		3750086.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m³	< 0.00053
Total Copper	g/m³	< 0.00053
Total Iron	g/m³	0.142
Total Lead	g/m³	< 0.00011
Total Lithium	g/m³	0.00157
Total Magnesium	g/m³	1.07 #1
Total Manganese	g/m³	0.042
Total Mercury	g/m³	< 0.00008
Total Molybdenum	g/m³	0.00093
Total Nickel	g/m³	< 0.00053
Total Potassium	g/m³	0.49 #1
Total Selenium	g/m³	< 0.0011
Total Silver	g/m³	< 0.00011
Total Sodium	g/m³	3.5 #1
Total Tin	g/m³	< 0.00053
Total Uranium	g/m³	< 0.000021
Total Zinc	g/m³	< 0.0011
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m³	< 0.0010
Dissolved Cadmium	g/m³	< 0.00005
Dissolved Chromium	g/m³	< 0.0005
Dissolved Copper	g/m³	< 0.0005
Dissolved Lead	g/m³	< 0.00010
Dissolved Nickel	g/m³	< 0.0005
Dissolved Zinc	g/m³	< 0.0010

Analyst's Comments

^{#1} It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 200-300% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3772078	SPV1
Contact:	Richard Bennett	Date Received:	07-Feb-2025	
	C/- Stantec New Zealand	Date Reported:	14-Feb-2025	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Patrick Leslie	

Sample Type: Aqueous

Sample Name:	HBAY_040225 04-Feb-2025 1:30 pm
Lab Number:	3772078.1

Individual Tests		
Sum of Anions	meq/L	0.63
Sum of Cations	meq/L	0.62
Turbidity	NTU	1.01
pH	pH Units	8.0
Total Alkalinity	g/m ³ as CaCO ₃	27
Bicarbonate	g/m ³ at 25°C	32
Total Hardness	g/m ³ as CaCO ₃	22
Electrical Conductivity (EC)	mS/m	6.1
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.008 #1
Dissolved Calcium	g/m ³	7.3 #1
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	0.99 #1
Dissolved Manganese	g/m ³	< 0.0005
Dissolved Potassium	g/m ³	0.51
Dissolved Sodium	g/m ³	3.8 #1
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	1.2
Fluoride	g/m ³	0.25
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.11
Sulphate	g/m ³	2.1
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	0.6
Absorbance at 254 nm	AU cm ⁻¹	0.003
Transmittance at 254 nm*	%T, 1 cm cell	99.3
Drinking water metals suite, totals, trace		
Total Aluminium	g/m ³	0.0050
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0058 #1
Total Cadmium	g/m ³	< 0.000053
Total Calcium	g/m ³	6.8 #1

Sample Type: Aqueous		
Sample Name:	HBAY_040225 04-Feb-2025 1:30 pm	
Lab Number:	3772078.1	
Drinking water metals suite, totals, trace		
Total Chromium	g/m³	< 0.00053
Total Copper	g/m³	< 0.00053
Total Iron	g/m³	0.23
Total Lead	g/m³	< 0.00011
Total Lithium	g/m³	0.00142
Total Magnesium	g/m³	0.95 #1
Total Manganese	g/m³	0.043
Total Mercury	g/m³	< 0.00008
Total Molybdenum	g/m³	0.00100
Total Nickel	g/m³	< 0.00053
Total Potassium	g/m³	0.53
Total Selenium	g/m³	< 0.0011
Total Silver	g/m³	< 0.00011
Total Sodium	g/m³	3.7 #1
Total Tin	g/m³	< 0.00053
Total Uranium	g/m³	< 0.000021
Total Zinc	g/m³	0.0016
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m³	< 0.0010
Dissolved Cadmium	g/m³	< 0.00005
Dissolved Chromium	g/m³	< 0.0005
Dissolved Copper	g/m³	< 0.0005
Dissolved Lead	g/m³	< 0.00010
Dissolved Nickel	g/m³	< 0.0005
Dissolved Zinc	g/m³	< 0.0010

Analyst's Comments

^{#1} It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 200-300% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3802777	SPV1
Contact:	Richard Bennett	Date Received:	08-Mar-2025	
	C/- Stantec New Zealand	Date Reported:	17-Mar-2025	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Patrick Leslie	

Sample Type: Aqueous

Sample Name:	HBAY_060325 06-Mar-2025 3:00 pm
Lab Number:	3802777.1

Individual Tests

Sum of Anions	meq/L	0.61
Sum of Cations	meq/L	0.60
Turbidity	NTU	0.52
pH	pH Units	9.1
Total Alkalinity	g/m ³ as CaCO ₃	26
Bicarbonate	g/m ³ at 25°C	28
Total Hardness	g/m ³ as CaCO ₃	21
Electrical Conductivity (EC)	mS/m	6.0
Dissolved Aluminium	g/m ³	< 0.003
Dissolved Boron	g/m ³	0.006
Dissolved Calcium	g/m ³	7.0 #1
Dissolved Iron	g/m ³	< 0.02
Dissolved Magnesium	g/m ³	0.93
Dissolved Manganese	g/m ³	< 0.0005
Dissolved Potassium	g/m ³	0.51
Dissolved Sodium	g/m ³	3.7
Bromide	g/m ³	< 0.05
Total Cyanide	g/m ³	< 0.002
Chloride	g/m ³	1.1
Fluoride	g/m ³	0.25
Nitrite-N	g/m ³	< 0.002
Nitrate-N	g/m ³	< 0.002
Nitrate-N + Nitrite-N	g/m ³	< 0.002
Reactive Silica	g/m ³ as SiO ₂	0.13
Sulphate	g/m ³	2.0
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5
Total Organic Carbon (TOC)	g/m ³	0.9
Absorbance at 254 nm	AU cm ⁻¹	< 0.002
Transmittance at 254 nm*	%T, 1 cm cell	> 99.5

Drinking water metals suite, totals, trace

Total Aluminium	g/m ³	< 0.0032
Total Antimony	g/m ³	< 0.00021
Total Arsenic	g/m ³	< 0.0011
Total Barium	g/m ³	< 0.0053
Total Beryllium	g/m ³	< 0.00011
Total Boron	g/m ³	0.0060
Total Cadmium	g/m ³	< 0.000053
Total Calcium	g/m ³	6.9 #1

Sample Type: Aqueous		
Sample Name:		HBAY_060325 06-Mar-2025 3:00 pm
Lab Number:		3802777.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m ³	< 0.00053
Total Copper	g/m ³	< 0.00053
Total Iron	g/m ³	0.131
Total Lead	g/m ³	< 0.00011
Total Lithium	g/m ³	0.00145
Total Magnesium	g/m ³	0.93
Total Manganese	g/m ³	0.026
Total Mercury	g/m ³	< 0.00008
Total Molybdenum	g/m ³	0.00080
Total Nickel	g/m ³	< 0.00053
Total Potassium	g/m ³	0.52
Total Selenium	g/m ³	< 0.0011
Total Silver	g/m ³	< 0.00011
Total Sodium	g/m ³	3.8
Total Tin	g/m ³	< 0.00053
Total Uranium	g/m ³	< 0.000021
Total Zinc	g/m ³	< 0.0011
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m ³	< 0.0010
Dissolved Cadmium	g/m ³	< 0.00005
Dissolved Chromium	g/m ³	< 0.0005
Dissolved Copper	g/m ³	< 0.0005
Dissolved Lead	g/m ³	< 0.00010
Dissolved Nickel	g/m ³	< 0.0005
Dissolved Zinc	g/m ³	< 0.0010

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 100-200% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3854216	SPV1
Contact:	Richard Bennett	Date Received:	12-Apr-2025	
	C/- Stantec New Zealand	Date Reported:	23-Apr-2025	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:		HBAY_110425 11-Apr-2025 12:30 pm	
Lab Number:		3854216.1	
Individual Tests			
Sum of Anions	meq/L	0.62	
Sum of Cations	meq/L	0.60	
Turbidity	NTU	0.28	
pH	pH Units	9.3	
Total Alkalinity	g/m³ as CaCO₃	27	
Bicarbonate	g/m³ at 25°C	26	
Total Hardness	g/m³ as CaCO₃	21	
Electrical Conductivity (EC)	mS/m	6.2	
Dissolved Aluminium	g/m³	< 0.003	
Dissolved Boron	g/m³	0.007 #1	
Dissolved Calcium	g/m³	6.8	
Dissolved Iron	g/m³	< 0.02	
Dissolved Magnesium	g/m³	0.96 #1	
Dissolved Manganese	g/m³	0.0023	
Dissolved Potassium	g/m³	0.67 #1	
Dissolved Sodium	g/m³	3.8 #1	
Bromide	g/m³	< 0.05	
Total Cyanide	g/m³	< 0.002	
Chloride	g/m³	1.0	
Fluoride	g/m³	0.24	
Nitrite-N	g/m³	< 0.002	
Nitrate-N	g/m³	< 0.002	
Nitrate-N + Nitrite-N	g/m³	< 0.002	
Reactive Silica	g/m³ as SiO₂	< 0.10	
Sulphate	g/m³	2.2	
Dissolved Organic Carbon (DOC)	g/m³	< 0.5	
Total Organic Carbon (TOC)	g/m³	< 0.5	
Absorbance at 254 nm	AU cm⁻¹	0.004	
Transmittance at 254 nm*	%T, 1 cm cell	99.0	
Drinking water metals suite, totals, trace			
Total Aluminium	g/m³	< 0.0032	
Total Antimony	g/m³	< 0.00021	
Total Arsenic	g/m³	< 0.0011	
Total Barium	g/m³	< 0.0053	
Total Beryllium	g/m³	< 0.00011	
Total Boron	g/m³	< 0.0053 #1	
Total Cadmium	g/m³	< 0.000053	
Total Calcium	g/m³	6.8	



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Sample Type: Aqueous		
Sample Name:		HBAY_110425 11-Apr-2025 12:30 pm
Lab Number:		3854216.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m ³	< 0.00053
Total Copper	g/m ³	< 0.00053
Total Iron	g/m ³	0.111
Total Lead	g/m ³	< 0.00011
Total Lithium	g/m ³	0.00142
Total Magnesium	g/m ³	0.89 #1
Total Manganese	g/m ³	0.043
Total Mercury	g/m ³	< 0.00008
Total Molybdenum	g/m ³	0.00102
Total Nickel	g/m ³	< 0.00053
Total Potassium	g/m ³	0.62 #1
Total Selenium	g/m ³	< 0.0011
Total Silver	g/m ³	< 0.00011
Total Sodium	g/m ³	3.7 #1
Total Tin	g/m ³	< 0.00053
Total Uranium	g/m ³	< 0.000021
Total Zinc	g/m ³	0.0019
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m ³	< 0.0010
Dissolved Cadmium	g/m ³	< 0.00005
Dissolved Chromium	g/m ³	< 0.0005
Dissolved Copper	g/m ³	< 0.0005
Dissolved Lead	g/m ³	< 0.00010
Dissolved Nickel	g/m ³	< 0.0005
Dissolved Zinc	g/m ³	< 0.0010

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1
Turbidity	Analysis by Turbidity meter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3881282	SPV1
Contact:	Richard Bennett	Date Received:	07-May-2025	
	C/- Stantec New Zealand	Date Reported:	14-May-2025	
	PO Box 13052	Quote No:	132882	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:		HBA9_050525 05-May-2025 11:00 am	
Lab Number:		3881282.1	
Individual Tests			
Sum of Anions	meq/L	0.63	
Sum of Cations	meq/L	0.59	
Turbidity	NTU	0.42	
pH	pH Units	9.4	
Total Alkalinity	g/m³ as CaCO₃	27	
Bicarbonate	g/m³ at 25°C	26	
Total Hardness	g/m³ as CaCO₃	21	
Electrical Conductivity (EC)	mS/m	6.3	
Dissolved Aluminium	g/m³	< 0.003	
Dissolved Boron	g/m³	0.006 #1	
Dissolved Calcium	g/m³	6.8 #1	
Dissolved Iron	g/m³	< 0.02	
Dissolved Magnesium	g/m³	0.93 #1	
Dissolved Manganese	g/m³	0.0007	
Dissolved Potassium	g/m³	0.50	
Dissolved Sodium	g/m³	3.7	
Bromide	g/m³	< 0.05	
Total Cyanide	g/m³	< 0.002	
Chloride	g/m³	1.2	
Fluoride	g/m³	0.24	
Nitrite-N	g/m³	< 0.002	
Nitrate-N	g/m³	< 0.002	
Nitrate-N + Nitrite-N	g/m³	< 0.002	
Reactive Silica	g/m³ as SiO₂	< 0.10	
Sulphate	g/m³	2.3	
Dissolved Organic Carbon (DOC)	g/m³	0.8 #2	
Total Organic Carbon (TOC)	g/m³	0.7 #2	
Absorbance at 254 nm	AU cm⁻¹	0.002	
Transmittance at 254 nm*	%T, 1 cm cell	99.5	
Drinking water metals suite, totals, trace			
Total Aluminium	g/m³	< 0.0032	
Total Antimony	g/m³	< 0.00021	
Total Arsenic	g/m³	< 0.0011	
Total Barium	g/m³	< 0.0053	
Total Beryllium	g/m³	< 0.00011	
Total Boron	g/m³	0.0055 #1	
Total Cadmium	g/m³	< 0.000053	
Total Calcium	g/m³	6.6 #1	



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Sample Type: Aqueous		
Sample Name:		HBA9_050525 05-May-2025 11:00 am
Lab Number:		3881282.1
Drinking water metals suite, totals, trace		
Total Chromium	g/m ³	< 0.00053
Total Copper	g/m ³	< 0.00053
Total Iron	g/m ³	0.090
Total Lead	g/m ³	< 0.00011
Total Lithium	g/m ³	0.00141
Total Magnesium	g/m ³	0.85 #1
Total Manganese	g/m ³	0.031
Total Mercury	g/m ³	< 0.00008
Total Molybdenum	g/m ³	0.00100
Total Nickel	g/m ³	< 0.00053
Total Potassium	g/m ³	0.51
Total Selenium	g/m ³	< 0.0011
Total Silver	g/m ³	< 0.00011
Total Sodium	g/m ³	3.8
Total Tin	g/m ³	< 0.00053
Total Uranium	g/m ³	< 0.000021
Total Zinc	g/m ³	< 0.0011
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Dissolved Arsenic	g/m ³	< 0.0010
Dissolved Cadmium	g/m ³	< 0.00005
Dissolved Chromium	g/m ³	< 0.0005
Dissolved Copper	g/m ³	< 0.0005
Dissolved Lead	g/m ³	< 0.00010
Dissolved Nickel	g/m ³	< 0.0005
Dissolved Zinc	g/m ³	< 0.0010

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

#2 It has been noted that the result for Dissolved Organic Carbon was greater than that for Total Organic Carbon, but within the analytical variation of these methods.

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the DOC result is significantly greater than that usually reported for this analyte (up to 100-200% at the 95% confidence level).

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 100-200% at the 95% confidence level).

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total acid digest for Silver analysis	Boiling nitric / hydrochloric acid digestion (5:1 ratio). APHA 3030 F (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1

Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3910788	SPV1
Contact:	Richard Bennett	Date Received:	07-Jun-2025	
	C/- Stantec New Zealand	Date Reported:	16-Jun-2025	
	PO Box 13052	Quote No:	137665	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBAY_060625 06-Jun-2025 11:49 am		
Lab Number:	3910788.1		
Turbidity	NTU		0.28
pH	pH Units		9.7
Total Alkalinity	g/m ³ as CaCO ₃		26
Bicarbonate	g/m ³ at 25°C		20
Total Hardness	g/m ³ as CaCO ₃		20
Electrical Conductivity (EC)	mS/m		6.2
Total Arsenic	g/m ³		< 0.0011
Dissolved Boron	g/m ³		0.008 #1
Total Boron	g/m ³		0.0057 #1
Dissolved Calcium	g/m ³		6.8 #1
Total Calcium	g/m ³		6.5 #1
Dissolved Iron	g/m ³		< 0.02
Total Iron	g/m ³		0.084
Total Lithium	g/m ³		0.00136
Dissolved Magnesium	g/m ³		0.86 #1
Total Magnesium	g/m ³		0.84 #1
Dissolved Manganese	g/m ³		< 0.0005
Total Manganese	g/m ³		0.027
Total Molybdenum	g/m ³		0.00088
Dissolved Potassium	g/m ³		0.48
Total Potassium	g/m ³		0.50
Dissolved Sodium	g/m ³		3.8 #1
Total Sodium	g/m ³		3.6 #1
Total Zinc	g/m ³		0.0013
Fluoride	g/m ³		0.24
Reactive Silica	g/m ³ as SiO ₂		< 0.10
Sulphate	g/m ³		2.2
Dissolved Organic Carbon (DOC)	g/m ³		< 0.5
Total Organic Carbon (TOC)	g/m ³		< 0.5
Absorbance at 254 nm (unfiltered sample)	AU cm ⁻¹		0.008
Transmittance at 254 nm (unfiltered sample)*	%T, 1 cm cell		98.1

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.



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Certificate of Analysis

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Client:	Stantec New Zealand	Lab No:	3935954	SPV1
Contact:	Richard Bennett	Date Received:	11-Jul-2025	
	C/- Stantec New Zealand	Date Reported:	16-Jul-2025	
	PO Box 13052	Quote No:	137665	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBA4_100725 10-Jul-2025 11:30 am		
Lab Number:	3935954.1		
Turbidity	NTU		0.41
pH	pH Units		9.6
Total Alkalinity	g/m ³ as CaCO ₃		25
Bicarbonate	g/m ³ at 25°C		21
Total Hardness	g/m ³ as CaCO ₃		19.6
Electrical Conductivity (EC)	mS/m		6.2
Total Arsenic	g/m ³		< 0.0011
Dissolved Boron	g/m ³		0.006
Total Boron	g/m ³		0.0061
Dissolved Calcium	g/m ³		6.5
Total Calcium	g/m ³		6.7
Dissolved Iron	g/m ³		< 0.02
Total Iron	g/m ³		0.101
Total Lithium	g/m ³		0.00139
Dissolved Magnesium	g/m ³		0.81
Total Magnesium	g/m ³		0.83
Dissolved Manganese	g/m ³		< 0.0005
Total Manganese	g/m ³		0.027
Total Molybdenum	g/m ³		0.00077
Dissolved Potassium	g/m ³		0.50
Total Potassium	g/m ³		0.50
Dissolved Sodium	g/m ³		3.6
Total Sodium	g/m ³		3.8
Total Zinc	g/m ³		< 0.0011
Fluoride	g/m ³		0.24
Reactive Silica	g/m ³ as SiO ₂		< 0.10
Sulphate	g/m ³		2.3
Dissolved Organic Carbon (DOC)	g/m ³		2.5
Total Organic Carbon (TOC)	g/m ³		2.8
Absorbance at 254 nm (unfiltered sample)	AU cm ⁻¹		0.007
Transmittance at 254 nm (unfiltered sample)*	%T, 1 cm cell		98.3



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Certificate of Analysis

Page 1 of 3

Client:	Stantec New Zealand	Lab No:	3956003	SPV1
Contact:	Richard Bennett	Date Received:	07-Aug-2025	
	C/- Stantec New Zealand	Date Reported:	14-Aug-2025	
	PO Box 13052	Quote No:	137665	
	Christchurch 8141	Order No:		
		Client Reference:		
		Submitted By:	Richard Bennett	

Sample Type: Aqueous

Sample Name:	HBA4_050825 05-Aug-2025 2:00 pm		
Lab Number:	3956003.1		
Turbidity	NTU	0.55	
pH	pH Units	8.7	
Total Alkalinity	g/m ³ as CaCO ₃	27	
Bicarbonate	g/m ³ at 25°C	31	
Total Hardness	g/m ³ as CaCO ₃	20	
Electrical Conductivity (EC)	mS/m	6.1	
Total Arsenic	g/m ³	< 0.0011	
Dissolved Boron	g/m ³	0.006	
Total Boron	g/m ³	0.0062	
Dissolved Calcium	g/m ³	6.8 #1	
Total Calcium	g/m ³	6.6	
Dissolved Iron	g/m ³	< 0.02	
Total Iron	g/m ³	0.091	
Total Lithium	g/m ³	0.00141	
Dissolved Magnesium	g/m ³	0.87 #1	
Total Magnesium	g/m ³	0.84	
Dissolved Manganese	g/m ³	< 0.0005	
Total Manganese	g/m ³	0.027	
Total Molybdenum	g/m ³	0.00069	
Dissolved Potassium	g/m ³	0.52 #1	
Total Potassium	g/m ³	0.50	
Dissolved Sodium	g/m ³	3.8 #1	
Total Sodium	g/m ³	3.7	
Total Zinc	g/m ³	< 0.0011	
Fluoride	g/m ³	0.23	
Reactive Silica	g/m ³ as SiO ₂	< 0.10	
Sulphate	g/m ³	2.2	
Dissolved Organic Carbon (DOC)	g/m ³	< 0.5	
Total Organic Carbon (TOC)	g/m ³	1.1	
Absorbance at 254 nm (unfiltered sample)	AU cm ⁻¹	0.008	
Transmittance at 254 nm (unfiltered sample)*	%T, 1 cm cell	98.1	

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Sample 1 Comment:

Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 100-200% at the 95% confidence level).



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Appendix F Homestead Bay Fast Track Consent – Alternative Wastewater Disposal



To: RCL Group

Attention: Dan Wells

Project Name Homestead Bay

Project/File: 310104425

From: Stantec New Zealand
Dunedin

Date: 18 September 2025

Reference: Homestead Bay Fast Track Consent – Alternative Wastewater Disposal**Revision Schedule**

Revision No.	Date	Description	Prepared by	Quality Reviewer	Independent Reviewer	Project Manager Final Approval
1	14 Sept 2025	Draft	PW/RB	GK	GK	PW
2	18 Sept 2025	Final	PW/RB	GK	GK	PW

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1 Introduction

The Fast Track Consent Application (including subsequent attachments) submitted to the Environmental Protection Authority (EPA) by RCL Homestead Bay Ltd for the development of a residential subdivision in Queenstown has included proposals for wastewater treatment and subsequent disposal by dripper irrigation on the development area.

Queenstown Lakes District Council (QLDC) have proposed that wastewater from the Southern Corridor (including the proposed Homestead Bay development) should instead be treated and discharged as a single system. This proposal has been expressed in meetings between RCL Group and QLDC, and in public discussion documents for Te Tapuae Southern Corridor Structure Plan. No details have been provided on the QLDC concept for this except that two alternative approaches are being considered:

- Wastewater should be collected and pumped to Shotover Treatment Plant for treatment and subsequent disposal, OR
- Alternatively, wastewater should be collected and treated in a new treatment plant in the Southern Corridor and subsequently pumped to a common disposal area (not yet defined) with Shotover Treatment Plant.

This Report addresses the first of these alternatives.

The Hanley's Farm Wastewater Pumping Station (HFWWPS) was originally designed to service approximately 2,800 DUEs by pumping to Shotover Treatment Plant. QLDC are currently implementing an upgrade to the HFWWPS to increase its capacity to 173 l/s. This is sufficient to cater for approximately 4,000 dwelling units (DUEs) at the wastewater generation rates specified in the QLDC Land Development and Subdivisions Code of Practice.

This will create additional capacity for approximately 1200 DUEs beyond that already served by HFWWPS in Hanley's Farm and some adjacent areas including part of Jacks Point. In general terms, QLDC have said in the Te Tapuae Southern Corridor Structure Plan that there will be up to 9300 DUEs in the corridor (8967 DUEs was indicated in earlier assessments and this has been used for the analysis for this Report). Further upgrades to the HFWWPS system would therefore be needed to then cater for the full Southern Corridor and QLDC have indicated that they are currently assessing the likely scope of these upgrades, including changes to the wastewater reticulation in Frankton and duplication (twinning) of existing pipelines.

This Report summarises an indicative concept illustrating one possible way for how the Homestead Bay (HB) development could be connected to such a system implemented by QLDC. This concept is based on connection of Homestead Bay to HFWWPS and then upgrading the HFWWPS and its downstream systems to connect to Shotover Treatment Plant. Alternative approaches are possible but are not covered in this report, for example a second pumping system from the Southern Corridor or different configurations of pumping stations and pipelines.

1.1 Existing Wastewater Infrastructure from Southern Corridor to Frankton

The main existing bulk wastewater conveyance infrastructure in the Southern Corridor, Kelvin Heights and Frankton is shown in Figure 1.

Reference: 310104425

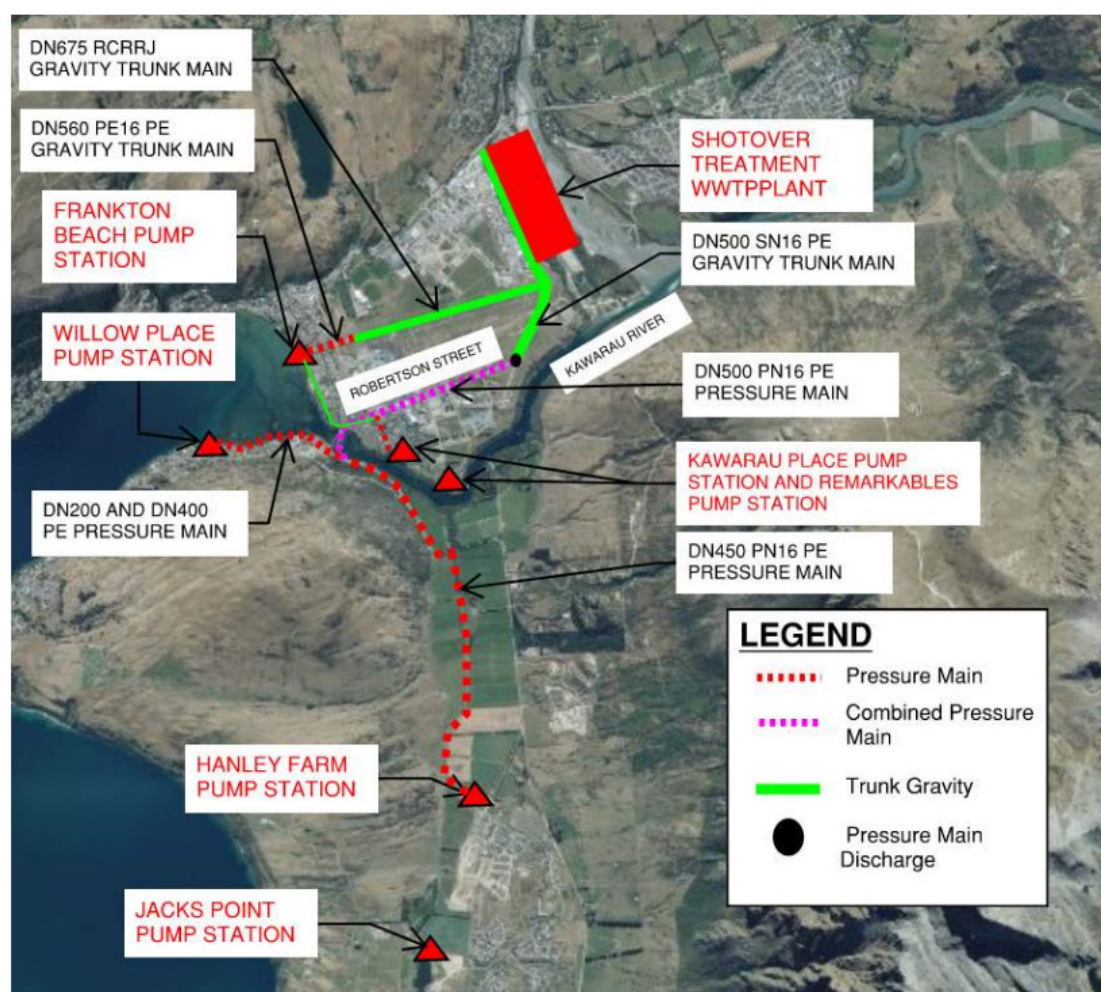


Figure 1: Main Existing Bulk Conveyance Wastewater Infrastructure

HFWWPS pumps via a single pumping main that runs through the consented Park Ridge Development (PRD) (Previously Coneburn SHA) and farmland to intersect with SH6. From here the pumping main runs along SH6 to the new Kawarau River Bridge where it converges with a pumping main from the Willow Place WWPS (WPWWPS). See Figure 2 and Figure 3. The HFWWPS pumping main crosses the Kawarau River Bridge (at times flows from the HFWWPS combines with flows from the WPWWPS). The pumping main continues through Frankton Flats to a receiving manhole (RMH) in Ginkgo Ave. From here it gravitates to a manhole at the top of the Runway End Safety Area (RESA) where it merges with flows from the Frankton Beach WWPS and is conveyed to the Shotover Wastewater Treatment Plant.

The WPWWPS can convey flows from Kelvin Heights through a pumping main on the Historic Kawarau Falls Bridge or through the pumping main on the new Kawarau River Bridge. The current configuration is unknown.

Reference: 310104425

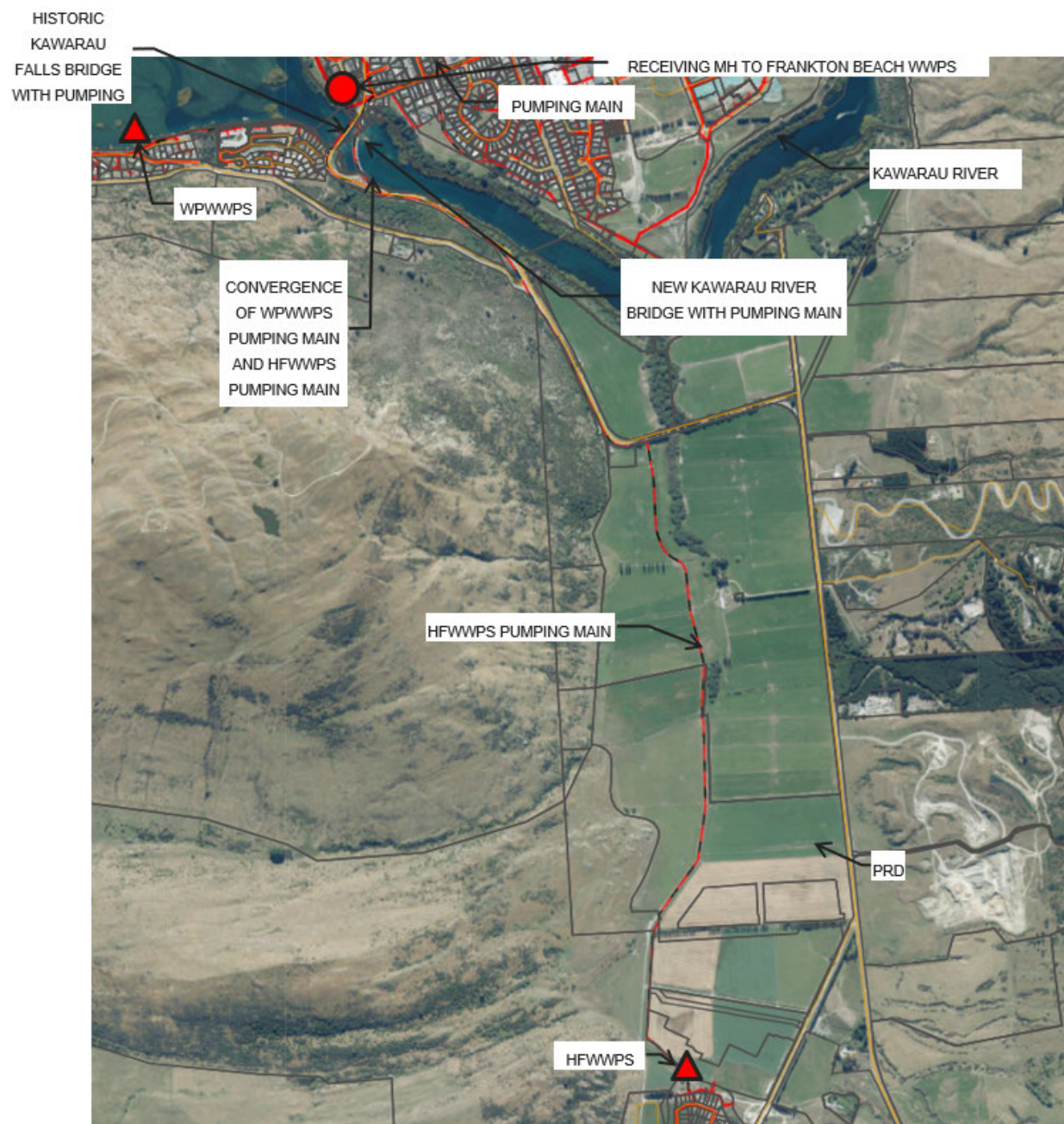


Figure 2: Existing Network Configuration of HFWWPS and WPWWPS to Frankton

Reference: 310104425



Figure 3: Existing Network Configuration of WPWWPS and HFWWPS Pumping Mains to Shotover WWTP

1.2 Assumptions

For the purposes of this assessment and Report on pumping wastewater from the Southern Corridor the following assumptions have been made:

1. The WPWWPS will operate separately to HFWWPS and wastewater systems from the Southern Corridor – this is to maximise the capacity to service the Southern Corridor. WPWWPS would be conveyed separately to Frankton Beach WWPS. A separate rising main crossing of the Kawarau River would be via either the Historic Kawarau Falls bridge (with backup connection to the new Kawarau River Bridge), or via an additional pipe on the new Kawarau River Bridge (QLDC have advised that a further pipe can be constructed on this bridge).

Reference: 310104425

2. Upgrades will be made to the wastewater network in Frankton to provide the downstream capacity needed for increased pumping of wastewater from the Southern Corridor such that there are no impediments to flows reaching Shotover Treatment Plant. QLDC have indicated that they will undertake implementation of upgrades to the gravity system from the RMH to Gingko Avenue
3. All wastewater is sent directly to Frankton. While QLDC say they are also considering this being via a new wastewater treatment plant in the Southern Corridor, this is outside the scope of this report.
4. Remarkables Park WWPS discharges into the gravity system at the end of the HF rising main.
5. Wastewater generation rates per DUE are as specified in the QLDC Land Development and Subdivisions Code of Practice. However, discussion on alternative generation rates and the potential impact on investment needed in new infrastructure is included in Section 1.2.1.

1.2.1 Wastewater Quantities

The QLDC Land Development and Subdivision Code of Practice requires the assessment of wastewater generation to be undertaken using the following criteria:

- 3 persons/house
- average dry weather flow of 250 L/p/d with standard fixtures
- peaking factors totalling 5.

This assessment and Report is based on these specifications.

However, measurement of wastewater discharging to gravity systems for similar developments in the QLDC area is understood to be at the rate of 520 litres/DUE/day in a QLDC assessment of Shotover Country in 2019. Similar assessment of flows from Hanley's Farm indicated a rate of 470 litres/DUE/day.

Adoption of a lower wastewater generation rate for design can therefore potentially reduce the risk of oversizing infrastructure and allow servicing of a larger development size.

2 Bulk Pumping Network from HB to HFWWPS

A previous concept for the connection of Homestead Bay to Hanley's Farm WWPS (HFWWPS) was included in a draft plan change application reporting submitted to QLDC in November 2023. This concept is still applicable.

The scheme is shown in Figure 4:

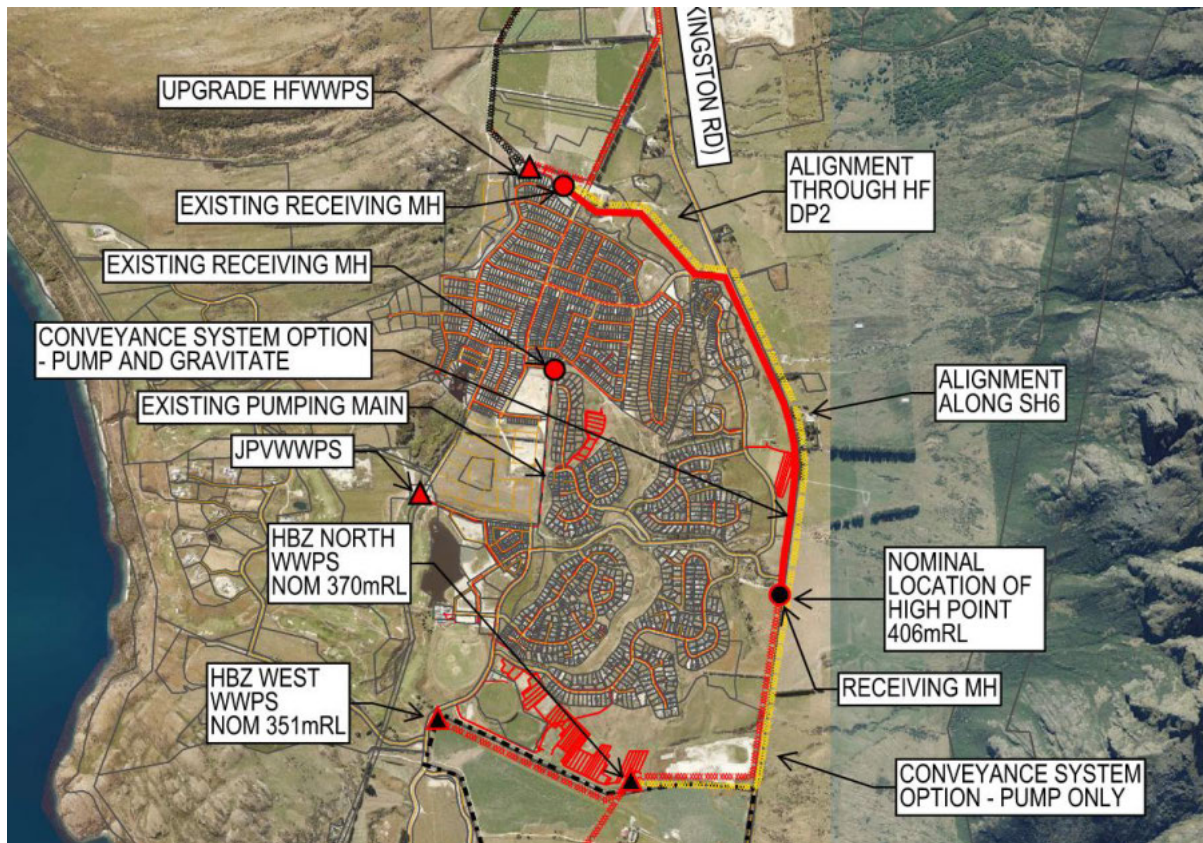


Figure 4: Scheme to connect Homestead Bay to HFWWPS

The outlet for HFWWPS shown in Figure 4 to a new rising main was the basis of the plan change reporting but is not the currently favoured option, subject to technical and cost confirmation.

The pipeline can be laid in the State Highway 6 corridor. It is also possible that an arrangement may be made with neighbouring landholder(s) such as QEII for an easement to be provided for reticulation on the side of State Highway 6. This is then the clearest route with the least impediments by other developments and is therefore followed for the pipeline between HB and HFWWPS. Other routes such as through the Jacks Point golf course do not warrant consideration at this time.

Two alternatives are then suitable as a method for conveyance from HB to HFWWPS:

1. Pumping to the high point on SH6 then gravitate to HFWWPS, or
2. Pumping all the way to HFWWPS.

Reference: 310104425

2.1 Pumping stations within Homestead Bay

Three pump stations are envisaged within Homestead Bay:

- 2 pump stations (with emergency storage) at the development low points (RL343 and RL350) as proposed in the Fast Track Consent Application, lifting to ...
- A third pump station near RL370.

A single pumping lift without the third pump station goes beyond the head achievable in commonly used wastewater pumps that are likely to be acceptable to QLDC. The third pump station also provides a means to amalgamate flows from different sources (in Homestead Bay or from other areas) without complexities of joint or multiple rising mains.

The location indicated for the third pump station was based on being about halfway on the rise to the highpoint on SH6; other locations are feasible including at the treatment plant area proposed in the Fast Track Consent Application (approximate RL390) or at a convenient junction of the rising mains from the two lower pump stations within the urban area.

Other developments could then connect to the HB system at any of the pump stations as suited to their location.

2.2 Reticulation within Homestead Bay

The proposed wastewater reticulation within Homestead Bay (including the two pump stations at RL343 and RL350) would remain unchanged if the third pump station was in the proposed treatment plant area.

Minor changes to the proposed wastewater reticulation within Homestead Bay would be needed if the third pump station was located outside the proposed treatment plant area.

2.3 Rising Main from Homestead Bay to HFWWPS

The pumped connection from HB to HFWWPS can be designed to accommodate only Homestead Bay or also include other nearby developments.

If say 5,000 DUEs (i.e. HB plus a further 2,400 DUEs) were serviced, then the rising main size from the upper pump station would be of the order of 400mm diameter for a single pipeline or twin 275mm diameter dual pipes. This is based on limiting pipe velocities to less than 2m/s for most efficient pumping.

Measures would be needed to achieve flushing flows in the early stages when there are few contributing properties. This might include:

- Dual pipelines instead of single pipeline (as above)
- Storage of wastewater in chambers for peak rate pumping once daily
- Flushing with fresh water, such as from the bore supply before water demand rises.

Reference: 310104425

2.4 Gravity Connection from SH6 Highpoint to HFWWPS

Gravity connection to HFWWPS from the end of a rising main at the highpoint on SH6 could be by connecting to the 225mm diameter pipe within DP2 and DP8 that leads to a short section of 375mm diameter pipe at the HFWWPS inlet. A review of the capacity of this gravity pipeline shows:

- The 225mm pipe also services other DUEs in Hanley's Farm. The range of surplus capacity in different sections of that pipe depends on the grade of that section but the limiting case is sufficient to service 567 DUEs from Homestead Bay.
- The final two 375mm pipe sections have a more limited capacity, having been designed much earlier. These would need replacing in a bigger pipe size or be augmented to be able to service the 567 DUEs – this would likely be best done by constructing a new pipe connection from the east side of the wet well.

A gravity pipe connection to HFWWPS therefore has capacity to service only initial stages of Homestead Bay, up to approximately 560 DUEs, but subject to replacement of the final two sections of 375mm pipe at the pump station site or a new inlet into the wet well from the 225 pipe.

2.5 Rising main connection from SH6 Highpoint to HFWWPS

A continuous rising/falling main from the high level (HBZ North in Figure 4 above) could be designed with capacity for the required catchment (say 5,000 DUEs as noted in Section 2.3 above). A control valve would be needed at the discharge end to keep the pipeline charged with wastewater when not pumping.

The pipe route could follow the Woolshed Creek as indicated in Figure 5:

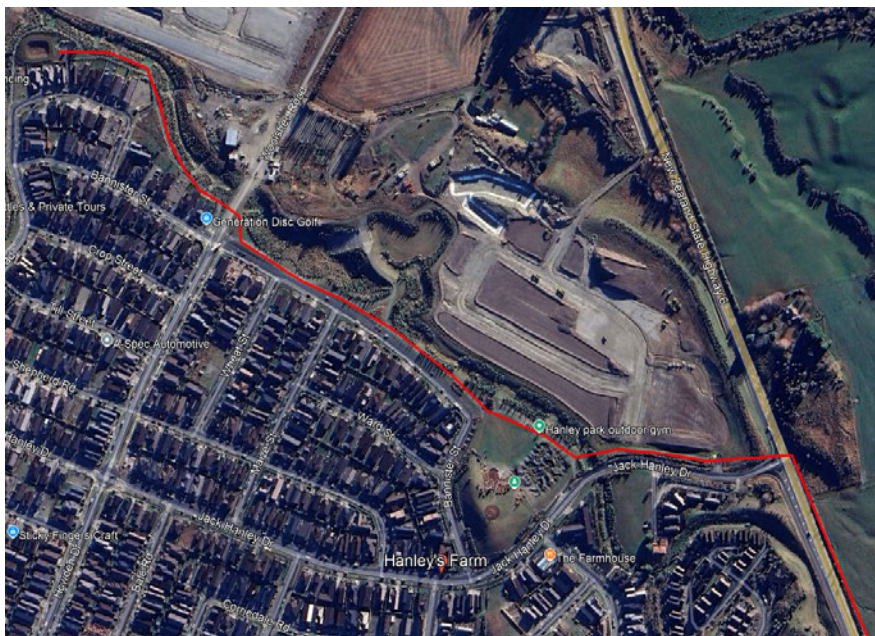


Figure 5: Possible pipe route along Woolshed Creek

The rising main would discharge directly to the HFWWPS wet well or discharge to a short length of gravity pipeline before the pump station.

Reference: 310104425

3 Pumping from HFWWPS to Frankton and Shotover Treatment Plant

As part of the work in planning the Homestead Bay development, options for pumping wastewater to Shotover Treatment Plant were considered (prior to adopting the proposed treatment and dripper irrigation system). Reporting on this has previously been provided to QLDC.

Principal options to service HB and the Southern Corridor were one or more of the following:

- Upgrade the existing Hanley's Farm and Willow Place conveyance systems to provide additional capacity – this may include increase in pipe capacity in Frankton by upgrade of existing pipes
- Supplement the existing Hanley's Farm and Willow Place systems to provide increased capacity – this may be by duplicating the existing systems with new pipelines or pump stations
- New bulk pumping system like that serving Hanley's Farm. This may use a new active travel bridge over the Kawarau River if that is developed.

An initial options assessment considered specific ways to achieve these options, leading to a long-list of fifteen options. From these, a shortlist of options was identified based on likelihood of technical feasibility, to advance to a hydraulic assessment of each to test feasibility. This was intended to focus effort into the representative and most promising options.

The favoured concept resulting from this process, referred to as Option 2C, was for a new main from HB to HFWWPS (as discussed in Sections 2.3 to 2.5), using the existing HFWWPS rising main and adding a booster station to the rising main before the Kawarau River bridge, somewhere near the White Cottage.

Assessment of this option has been taken further and is now reported here. Contributing flows were previously assessed at 7619 DUEs but for this most recent assessment these were increased to 8967 DUEs as higher estimates for the potential size of the Southern Corridor.

Key findings so far in this recent analysis are:

- The increase in contributing DUEs results in an increase in flow rate at peak flow.
- Total DUEs of 8967 equates to PWWF of 389 L/s. This results in a velocity of 3.7m/s through the existing DN450 PE100 PN16 pipe, which is outside the acceptable design range of 1.5-3m/s.
- Total DUEs of 7280 equates to PWWF of 316 L/s. This results in a velocity of 3m/s through the existing DN450 PE100 PN16 pipe.
- Pumping head also increases, requiring bigger pumps in the system, with the HFWWPS then unable to pump as far before needing the flow to be boosted.

Further pump system analysis then concluded that it is acceptable to convey wastewater flow through the existing HFWWPS rising main (DN450 PE100 PN16) from a total of 5760 DUEs which equates to a PWWF of 250 L/s.

This can be achieved by the following pumping system:

- Hanley's Farm WWPS – Utilise the recently installed Xylem NP 3231/735 pumps in Duty/Standby configuration (this may require impeller change at a later stage).

Reference: 310104425

- Addition of a new Interstage (booster) WWPS located at the junction of Kingston Road and Peninsula Road – Xylem NP 3231/735 pumps in D/A/S mode.



Figure 6: Proposed location of Interstage Pump Station

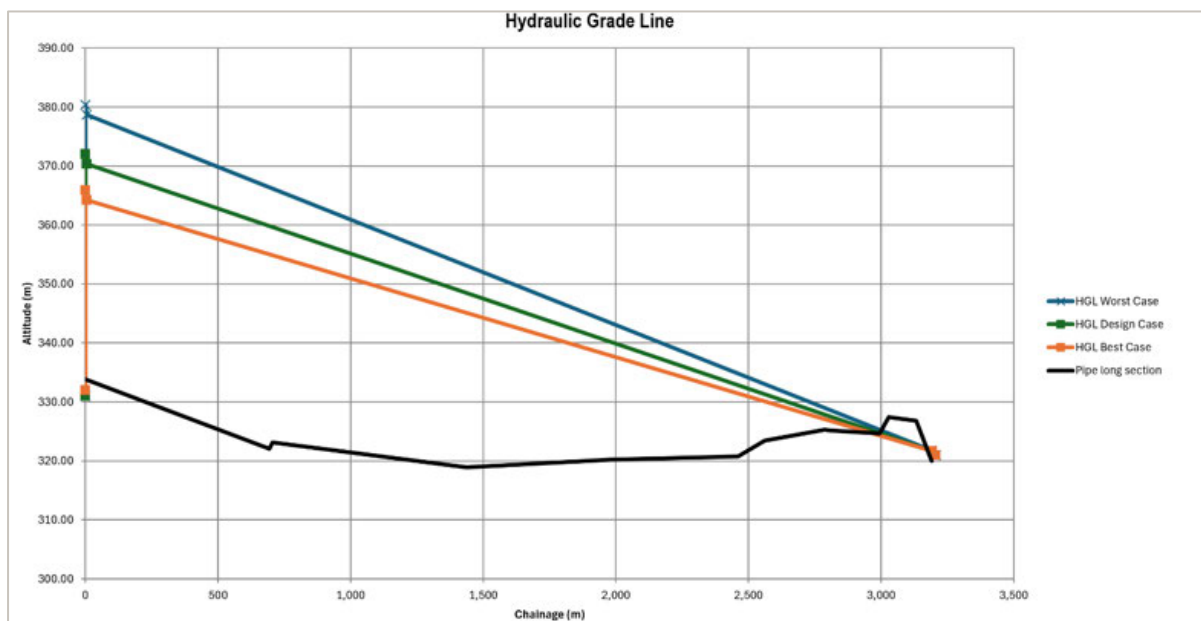


Figure 7: Hydraulic grade line - Hanley's Farm WWPS to Interstage WWPS

Reference: 310104425

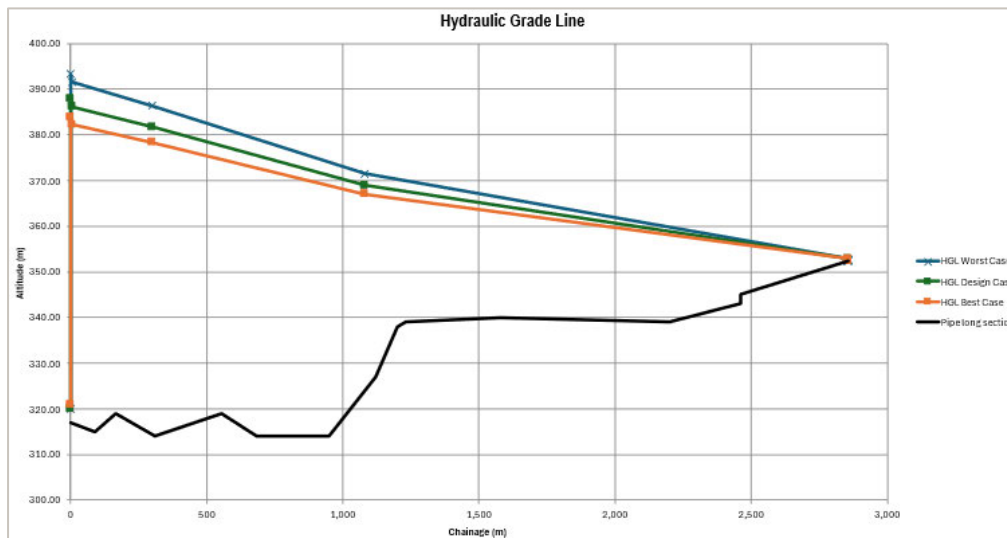


Figure 8: Hydraulic grade line – Interstage WWPS to the DN500 gravity main

3.1 Commentary

The Interstage WWPS location has been selected as there is sufficient space to construct the required infrastructure. However, it is located approximately 200m downstream of a pipeline high point which is above the hydraulic grade line as shown above in Figure 7. This will result in system performance issues which need to be mitigated during the design development phase. Some potential solutions include:

- Management by air valves – risk of inadequate pressure to operate the air valve and risk of odour release (could be managed but will become a maintenance requirement).
- Relocate interstage pump station to the high point (approx. 200m upstream) – there are space constraints at this location. There is not much scope to relocate the Interstage WWPS further upstream to 152 Kingston Road (site identified previously at the road bend) as the interstage pumping head is then outside of the range of a submersible pump.
- Re-lay approximately 200m of the DN450 PE100 PN16 pipe closer to the carriageway to eliminate the pipeline high point – PREFERRED but subject to closer assessment of ground levels.

It should also be noted that a reduction in design flow from 750 L/Lot/day to 520 L/Lot/day increases the number of lots that can be conveyed through this system from 5760 DUEs to 8308 DUEs. The latest estimated Southern Corridor extent is 8967 DUEs. Installing a second rising main could allow that size of catchment to be serviced if that is required.

3.2 QLDC Network in Frankton

While this report does not address the capacity of the network in Frankton to receive the additional wastewater from the Southern Corridor it is recognised that upgrade of that network will be needed to achieve this. QLDC have indicated that they intend to make these improvements such that there are no constraints on maximising capacity from HFWWPS. This includes an existing DN500 gravity main from the discharge point of the HFWWPS rising main discharge point in Frankton Flats.

Reference: 310104425

An upgrade to the capacity of the Shotover WWTP is currently underway, but there are reported issues with regard to the existing disposal field and QLDC are currently investigating options to resolve this. This Report is responding to QLDC's preference to connect to the Council's reticulated network and one concept for how this might work, however it does not consider the operation of the Shotover WWTP and disposal field.

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