Wellington Water

Tuesday 15 November 2022

OIA IRO-319
[redacted]
Email: [redacted]@irgroup.co.nz

Kia ora [redacted],

Official information request for the Geotechnical Report on work being undertaken at Naenae College.

I write regarding your official information request dated Thursday 20 October 2022 for a Geotechnical report on work being undertaken at Naenae College.

We have considered your request in accordance with the Local Government Official Information and Meetings Act 1987 (the Act) and have decided to grant your request in full.

Please see attached in our email response to you, the **Avalon WW Renewals Geotechnical Factual and Interpretative Report_Oct2022_FINAL.**

Pursuant to Section 7(2)(a) of the Act, some information within the report has been redacted as it contains personal information about private individuals.

We must stress that the provided report must not be used as a substitute for Geotechnical advice.

You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

Ngā mihi

[redacted]
Manager, Customer Experience
Wellington Water Ltd

Avalon Wastewater Renewals Stage 2 Investigations

Geotechnical Factual and Interpretative Report

PREPARED FOR WELLINGTON WATER LIMITED | OCTOBER 2022

We design with community in mind

Stantec

Revision schedule

Rev No	Date	Description	Signature of Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
0	05/10/2022	Issue 1	[redacted]	[redacted]	[redacted]	[redacted]

This document was prepared by Stantec New Zealand ("Stantec") for the account of Wellington Water Limited (the "Client"). The conclusions in the Report titled Avalon Wastewater Renewals - Geotechnical Interpretive Report are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from the Client and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided to applicable authorities having jurisdiction and others for whom the Client is responsible, Stantec does not warrant the services to any third party. The report may not be relied upon by any other party without the express written consent of Stantec, which may be withheld at Stantec's discretion.

Quality statement

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1 Introduction

Wellington Water is planning the renewal and upgrade for the wastewater network in Avalon, Lower Hutt. The program is aiming to address potential groundwater contamination issues and the limited capacity of the existing network.

Wellington Water (WW) have engaged Stantec to provide geotechnical services, to identify the ground and groundwater conditions at the project area and to better understand the project risks from a natural and geotechnical hazards point of view. The entire scope of works sees the project area being split into five zones: Zone A to Zone E, representing a proposed 5-year construction programme.

The investigation scope has been set out through risk screening carried out in collaboration with Wellington Water based on the location of pipes proposed for renewal, and criteria including depth of pipeline, proximity to utilities, and anticipated ground conditions.

This report presents the details, methodology and factual information of the second stage of geotechnical site investigations undertaken between the 29th of August and 3rd of September 2022 at six (6) locations across Avalon. This report focuses on Zones C, D and E to assist with the preliminary design, and to supplement the information found during the first round of investigations undertaken during February of 2022. The first stage of investigations comprised trial pits only, and was mainly focused in Zones A and B, but two trial pits were carried out in Zone C as well.

This report should be read in conjunction with the desktop study “Avalon Wastewater Renewals - Desk Study Report” dated September 2021 (Stantec, 2021A) as well as “Avalon Wastewater Renewals Stage 1 Investigations” dated April 2022 (Stantec, 2022B).

2 Project Location and Description

In the north-south direction, the project extends from Burcham Street and Fraser Park at the north to Kingston Street and Boulcott's Farm Golf Course at the south. At the east-west direction, the project extends from Harcourt Werry Drive at the west to High Street at the east. A plan of the entire area of the project is highlighted in blue in Figure: 2-1 below.

The project area is within the road corridor, with the pipeline possibly installed beneath the grass berms adjacent to the road, or under the road, on highly developed residential streets. The pipeline is in proximity to a number of other underground services and other structures. The site topography is generally flat for most of the site.

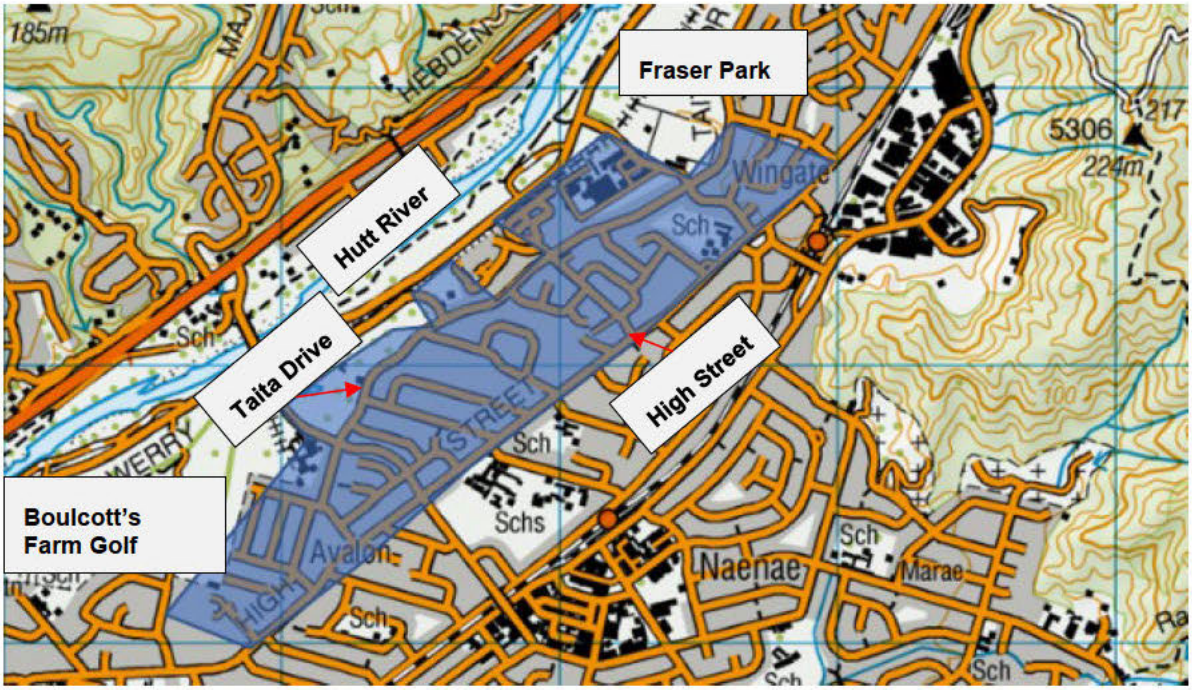


Figure: 2-1 Approximate project extents and location

3 Regional Geology

With reference to published geological map of the region the underlying geological conditions for the site has been summarised below.

The wider area of the project is part of the "Hutt Valley – Wellington Harbour basin" that has developed along the south – eastern side of the active Wellington Fault, during the last circa 1 million years, and consists of quaternary alluvial and marine sediments. The total length of the basin between Taita Gorge and the harbour entrance is approximately 23 km. It is a broadly wedge-shaped feature tapering from its widest extent of around 9.5 km across the harbour, to about 5 km wide at the Petone foreshore and then narrowing to only a few hundred metres in width at Taita Gorge (Figure 3-1).

The Basin has a 350 m thick sedimentary sequence. These loose sediments consist of alternating and interbedded marine fine sand and silt, river gravels, sands, silt, and peat. The Lower Hutt basin sediments comprise distinct stratigraphic units, as shown in Table 3-1.The Unit number referred in Table 3-1 and Figure 3-1 are the assigned unit names in the GNS geological model (Boon et al., 2010).

Table 3-1: Stratigraphic Units of the Sedimentary Deposits of the Lower Hutt Basin

Stratigraphical Unit	Lithology
Taita Alluvium (Unit 2)	Consists mainly of buried river channel and fan gravel Holocene deposits, but also includes flood and over-bank deposits of sand, silt and clay. Their age is and thickness ranges between 5 - 30m (Boon et al, 2010; Gyopari, 2014, Phreatos, 2003). This formation forms the floor of the Hutt Valley.
Melling Peat (Unit 2)	Consists of Holocene sand, gravel, silt and peat beds with fossil forests up to 10m thick (Boon et al, 2010; Gyopari, 2014).
Petone Marine Beds or Hutt Aquiclude (Unit 2)	They form an extensive confining strata or aquitard overlying the Waiwhetu Gravels (Phreatos, 2003). The beds comprise fine-grained silt, sand and coarse sand deposits, of Holocene age, which commonly contain shell and wood fragments up to 30m thick (Boon et al, 2010; Gyopari, 2014).
Waiwhetu Artesian Gravels or Hutt Aquifer (Unit 3)	This late Pleistocene (Otira Glaciation) unit forms the principal aquifer for the Lower Hutt valley. Dominated by gravel but there are also sandy gravel, silty gravel, gravelly sand and sand beds ranging from 20m to 30m thick. Sand deposits can be up to 10m thick. The highly permeable upper gravels are separated by discontinuous lenses of silt, peat and clay (Phreatos, 2003).
Wilford Shell Bed (Unit 4)	Middle - late Pleistocene firm sand, gravelly sand and silt, commonly shelly.
Moera Basal Gravels (Unit 5)	Middle Pleistocene very dense weathered clay-bound gravel, gravelly sand and stiff silt.

Within the project area, Melling peat or Petone marine beds (Unit 2) are not expected to be encountered over an extensive area, although they may be encountered locally. Taita alluvium is expected to be the predominant unit for most of the site and the anticipated installation depths, underlain directly by the Waiwhetu gravel in most of the cases at depths of the order of 8 m - 10 m across the site. Wilford shell beds (Unit 4) and Moera basal gravels (Unit 5) are expected to be encountered at depths that will not affect the project.

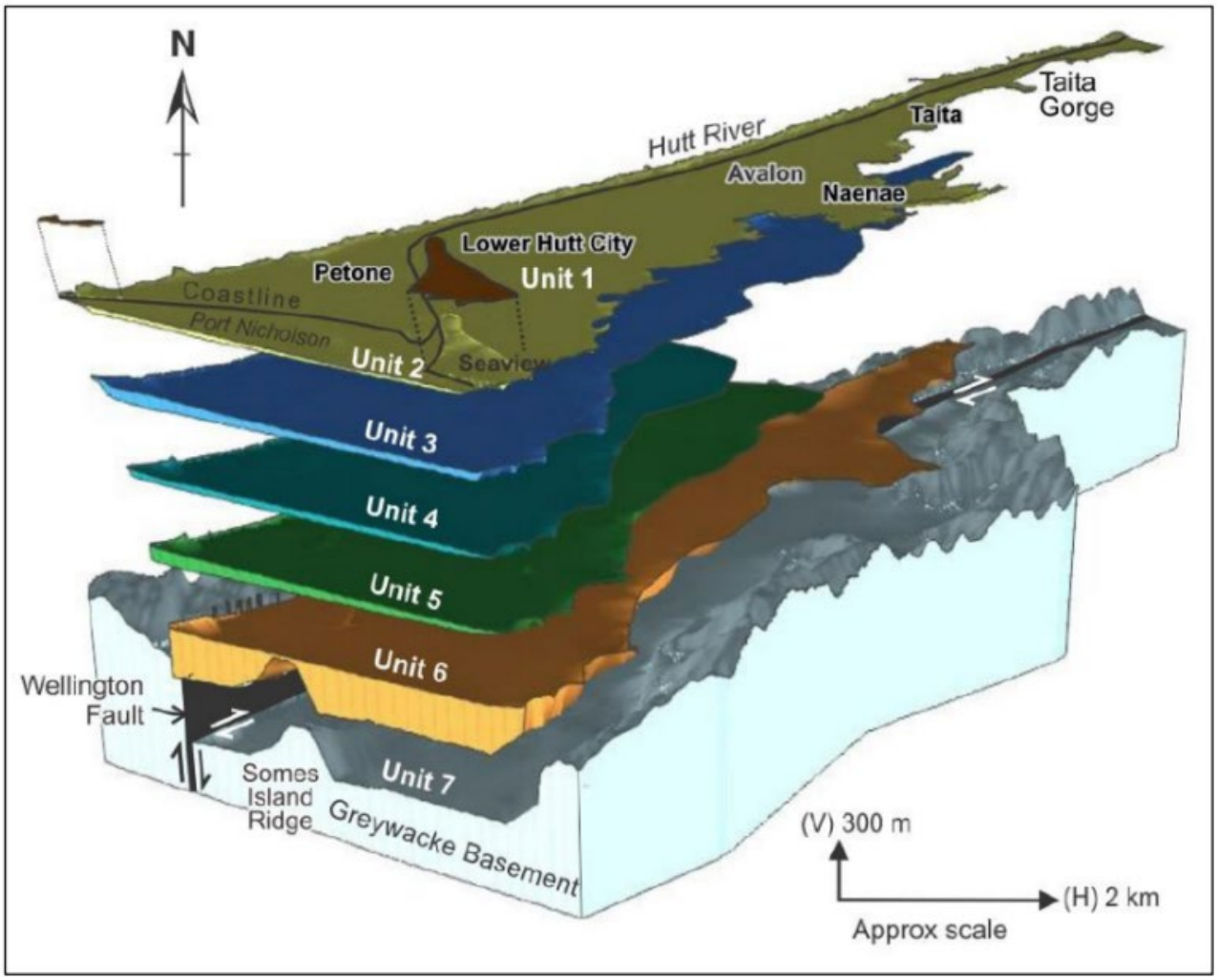


Figure 3-1: Schematic representation of the Lower Hutt Valley geological model (Boon et al., 2010)

4 Recent Site Investigations

Stantec completed a first round of site-specific investigations for the Avalon Wastewater Renewals Program between the 7th and 8th of February of 2022, which consists of Test Pits (TPs) and Dynamic Cone Penetrometer tests (DCPs) at seven (7) different locations across all zones within the project area but with a particular focus on Zones A and B. These investigations were carried out by E Carson & Sons and supervised by Stantec geotechnical staff.

For details regarding the first round of investigations and findings, please refer to the Avalon Wastewater Renewals Stage 1 Investigations Report dated April 2022.

The second stage of geotechnical investigations, the results of which are presented and interpreted in this report, comprise five (5) machine drilled boreholes, completed by Pro-Drill between the 29th of August and 3rd of September 2022 located within Zones C, D and E of the project. Site investigations were undertaken within private and public property. A summary of the ground investigations completed during the second stage is tabulated below in Table 4-1.

The drilling works were supervised by members of the Stantec geotechnical team, who photographed and logged samples in accordance with the NZGS 'Field Description of Soil and Rock' guidelines. The site investigations were undertaken following techniques outlined in the New Zealand Ground Investigation Specification (MBIE, 2017).

Fraste XL 170 and MS1000 drilling rigs were used, utilising sonic coring with PQ diameter coring barrels. Standard Penetrometer Tests (SPTs) were undertaken at 1m intervals in each of the boreholes.

All holes were double cased throughout the entire depth during drilling as a protection measure to mitigate any contamination of the aquifer and comply with the resource consent conditions. Bentonite was used to seal and backfill the holes as per the requirements in the resource consent.

Three shallow piezometers were installed in BH01, BH03 and BH05 to investigate shallow water tables at the site that could affect the project works. The depth to the Waiwhetu gravel and associated aquifer was roughly known at the wider site to be relatively deep and possibly not affecting the project works. The focus of the investigations was shallow water tables that could affect the pipeline installation.

Investigation coordinates reported in New Zealand Transverse Mercator (NZTM). An investigation location plan of the boreholes is provided in Appendix A.

Underground service location using Cable Avoidance Tool (CAT) and Ground Penetrating Radar (GPR) were undertaken at each site to best choose borehole locations to avoid utilities. Hydro-excavation was undertaken at all locations to reveal all services and underground amenities. In some cases, this meant hydro-excavation exceeding 2m was needed to ensure safety of the workers and to prevent damage to in-ground assets.

BH06, located at the road berm initially proposed adjacent to 8 Lincoln St, Lower Hutt was not carried out, as the existing wastewater services could not be exposed and identified with certainty, despite showing up in the GPR scan. An alternative location for the borehole near the initially examined and approved location was unable to be found due to the service congestion in the vicinity.

Table 4-1: Recent borehole investigation summary

Borehole ID	Test Location	Date Completed	Easting (m, NZTM 2000)	Northing (m, NZTM 2000)	Termination Depth (m BGL)	Piezometer details
BH01	Eastern end of Avalon Park adjacent to the intersection at Taita Dr and Avalon Park Dr.	29/08/2022	1762533	5438172	10.45	Piezometer install with 3m screen from 2m to 5m.
BH02	Berm outside 8 Avalon Crescent, Avalon.	02/09/2022	1762900	5438037	11.45	No Piezometer install.
BH03	Inside berm of entrance at western end of Avalon Park.	30/08/2022	1762287	5437916	11.45	Piezometer install with 3m screen from 1.45 to 4.45m.
BH04	Naenae college, 910 High Street, Avalon, Lower Hutt 5011.	03/09/2022	1762734	5437665	10.45	No Piezometer install.
BH05	Berm outside 2 Charleston Avenue, Avalon.	01/09/2022	1762106	5437459	10.45	Piezometer install with 3m screen from 1.45 to 4.45m.
BH06	**Unable to be undertaken**					

5 Ground and Groundwater Conditions

5.1 Ground Conditions

The overarching geological units encountered in the test pits are consistent with historical investigations in the area, as well as published geology. The encountered subsurface conditions change across the site which is to be expected due to the inherent variability of the alluvial soils in the Hutt Valley.

Fill was encountered to variable depths (locally up to 2m) across the project. Beneath the fill (or topsoil in grassed areas) is the Taita alluvium, which comprises of a range of soil types from clay to gravel, cobbles and boulders. Peat may also be encountered locally within the Taita alluvium but was not encountered in the boreholes. The Taita alluvium extended to approximately between 8m to 9m depth and was underlain by Waiwhetu artesian gravels.

The borehole investigations appeared to corroborate the test pit investigations which identified two distinct geological profiles within the project area. The Taita alluvium formation on Taita Drive predominantly comprised gravels and cobbles, while at the High Street area (BH04) it comprised a higher proportion of silt and sand.

Table 5-1 and Table 5-2 present the two encountered soil profiles at the site. Towards the western side of the site one similar ground profile was encountered at BH01, BH02, BH03 and BH05. On the eastern side of the project area (BH04), a different profile was encountered as expected by our findings in the earlier test pit investigations. The profiles seek to generalise the encountered ground conditions, but care should be taken as the Taita alluvium is likely to vary significantly over short distances. The borehole logs can be found in Appendix B.

Table 5-1: Encountered soil profile on western side of project extents (BH01, BH02, BH03, BH05)

Stratigraphical Unit	Description	Top of Layer (m bgl)	Bottom of Layer (m bgl)	SPT 'N'
Topsoil/Fill	Silt and gravelly silt	0	0.3 – 0.4	Not Tested
Taita Alluvium	Cobbly Gravel with some Sand, to Gravelly Sandy Cobble, medium dense to dense.	0.3 – 0.4 (from Test Pit investigation)	7.8 – 8.8	10-50+ (One 0 in BH02)
Waiwhetu Artesian Gravels	Predominantly gravel with cobbles with interlayers of gravelly silt and sandy gravel. Very dense, wet to saturated.	7.8 – 8.8	-	50+

Table 5-2: Encountered soil profile on eastern side of project extents (BH04)

Stratigraphical Unit	Description	Top of Layer (m bgl)	Bottom of Layer (m bgl)	SPT 'N'
Topsoil/Fill	Silt and gravelly silt	0	0.3 – 0.4	Not Tested
Taita Alluvium	Intermixed silt, gravelly silt, silty sand and gravel. Silt is low to moderate plasticity, firm to stiff. Gravel is dense to very dense.	0.3 – 0.4	~9.45	4 – 50+
Waiwhetu Artesian Gravels	Intermixed silt and silty sand. Gravels expected at greater depths.	~9.45	-	26 – 50+

5.2 Groundwater Summary

Over the course of the investigations, groundwater readings were taken both during drilling and within the piezometers. The groundwater monitoring targeted groundwater present in shallow depths from ground level, likely to affect the installation of the pipeline, rather than the Waiwhetu aquifer, as its presence is largely associated with the Waiwhetu gravel formation whose depth was largely defined by the boreholes to be unlikely to affect the pipeline installation.

Table 5-3 below summarises the groundwater levels measuring during the borehole investigations.

Table 5-3 Groundwater level summary

Zone	Expected range of Depth of Pipe within Zone (m)[1]	Borehole ID	Groundwater Level (During/after drilling)	Groundwater Level (29/09/22)	Measurement Comments	Probability of Encountering Groundwater during installation
A	0.5 – 1.6	-	Expected >3m		-	Low
B	0.5 – 2.3	-	Expected >3m		-	Low
C	0.5 – 2.4	BH01	4.6m (in piezometer, 01/09/2022)	4.95m	Piezometer	Low - Moderate
		BH02	7.1m (in the BH, during drilling 02/09/2022)		During Drilling	Low
D	0.6 – 2.2	BH03	4.5 m (in piezometer 01/09/2022)	4.31m	Piezometer	Low - Moderate
		BH04	3.0m (in the BH, during drilling 03/09/2022)		During Drilling	Moderate
E	0.9 – 2.1	BH05	4.5m (in piezometer 01/09/2022)	4.8m	Piezometer	Low - Moderate

NOTES:
1. Per Client provided information in September 2021. Some changes in depth ranges are possible, especially in zones C, D and E.

6 Geotechnical Considerations

6.1 Liquefaction

Liquefaction can be triggered by seismic loading in loose saturated coarse-grained soils primarily, such as fine gravels, and sands. The repetitive, cyclic, shaking causes excess pore water pressures to build up until the effective soil stress is near zero. In this state, soil particles are 'suspended' in the pore fluid, resulting in a substantial loss of soil strength and stiffness.

Table 6-1 summarises the results of SPT based liquefaction tests (Boulanger and Idriss, 2014) performed using parameters inferred from the borehole investigations. The tests were completed in Cliq (GeoLogismiki Version 3.0.2.4, 2006), a settlement and liquefaction software, where peak ground acceleration factors from MBIE/NZGS Module 1, Version 1 were used. For the proposed Importance Level 3 pipeline, the associated seismic parameters in Wellington for Serviceability Limit State (SLS) is 0.13g and 0.91g for Ultimate Limit State (ULS).

In BH01, BH02, BH03 and BH05 liquefaction triggering is not expected throughout the ground profile at the prescribed ULS earthquake event. In BH04, limited liquefaction triggering is expected in lenses containing silt or sand, encountered at approximately 9m depth. The silt encountered from 1.7m to 2.8m would be prone to liquefaction if saturated, but currently the groundwater level was found at lower depth. The liquefaction assessments have only been taken at point measurements and may not be representative of the wider project area. Due to the variable nature of the Taita alluvium, liquefaction triggering could be possible in discrete lenses and discontinuous layers, rather than systematically across the site and in a continuous layer.

Table 6-1: Predicted liquefaction induced free-field settlement

Borehole ID	Settlement at SLS	Settlement at ULS
BH01	Negligible	Negligible
BH02	Negligible	Negligible
BH03	Negligible	Negligible
BH04	Negligible	~5mm
BH05	Negligible	Negligible

Liquefaction is also likely to be more prevalent in the east of the project area as sands and silts are more abundant. However, based on the calculations overall risk to the pipeline due to liquefaction settlement is low for the proposed pipeline.

6.2 Cobbly Soils

It is anticipated that the proportion of cobbles present in the area is under-represented by the borehole drilling. By the very definition of a cobble (60mm – 200mm sized particle), these generally cannot wholly be retrieved by the drill as they are larger than the hole diameter. Cobbles are often broken up and crushed by the drilling and recovered as gravels (generally angular). A greater proportion of cobbles in the site subsoils has been proven by the trial pits carried out in Stage 1 investigations. Combining the results of the two stages of investigations, we anticipate cobbles to be present in the following areas:

West Side (Taita Drive)

- Very frequent within 3m of ground surface (beneath topsoil and fill)
- Frequent within full investigated depth (10m+)

East Side (High Street)

- Less frequent within investigated depth (10m+) than West side.

As discussed in the Avalon Wastewater Renewals Stage 1 Investigations Report for the test pit investigations, the presence of cobbly soils should be taken into account for trenchless construction methodologies (i.e., HDD) during both design and construction planning.

7 Conclusions

The borehole investigations corroborate our findings from the desk study and the Stage 1 test pit investigations. The site is underlain by topsoil (or fill), Taita alluvium and Waiwhetu artesian gravels. The soil stratigraphy differed across the site, which is to be expected with the inherent variability of alluvial soils. Along Taita Drive (BH01, BH02, BH03, BH05), the soil stratigraphy predominantly comprised gravels and cobbles, while the High Street area (BH04) showed the stratigraphy comprised a higher proportion of silt and sand.

In the depth of the proposed pipeline, as currently broadly understood, Taita alluvium is expected to be encountered for the majority of the alignment. Localised fill could be encountered but is not expected to be extensive.

Three piezometers were installed to identify and measure the depths of groundwater table at shallow depths from ground surface, likely to affect the installation of the pipeline. Groundwater was measured to generally be in the order of 4m to 5m in Zones C, D and E, but was measured as shallow as 3m in Zone D (BH04). The probability of encountering significant volumes of groundwater is expected to be low generally at the site, other than for Zone D, where the probability is moderate if the proposed pipe installation is deeper than 2.5 - 3 m.

The risk of liquefaction in Zones A and B is not quantifiable as borehole investigations have not been undertaken in these areas but it is expected to be generally low.

SPT based analysis was used to estimate the potential for liquefaction and the associated free-field settlements in Zones C, D and E, where deep investigations were carried out. Potential for liquefaction triggering under the ULS event was only found at the silty and sandy layers of BH4 in Zone D. Due to the variable nature of the Taita alluvium, liquefaction triggering is expected to be possible at isolated lenses and not through continuous layers. Liquefaction is also likely to be more prevalent in the east of the project area as sands and silts are more abundant. The overall risk to the pipeline due to liquefaction settlement is low for the proposed pipeline.

8 Construction Considerations

A discussion about the likely considered methodologies for the installation of the pipeline is presented below:

HDD is generally an effective method for pipe installation in silty and sandy soils, however, it may encounter difficulties in soils that comprise large proportions of cobbles or boulders. Cobbles and boulders are present at shallow depths in all zones along Taita Drive, as indicated by the site-specific recent investigations. In proximity to and along High Street, the proportion of cobbles encountered in trial pits and one borehole was lower and they are not expected to be as frequent.

Open trenching is a simple construction method that is generally not limited by soil stratigraphy. This method is considered suitable for all zones, based on the expected ground conditions. Temporary support will be needed in all Zones, considering the installation depth, composition and expected stability of the surrounding soil and especially if groundwater is encountered locally. Open trenching can be slow in areas where traffic management will be required, if underground utility congestion or near structures, which could be undermined by trench excavation.

Based on the recent borehole investigations, the probability of encountering groundwater and need for dewatering to the pipe installation depth, as broadly understood, is low across all zones. A higher probability of encountering groundwater within the pipe installation depth has been found in BH4, carried out in Zone D on High Street. The probability of encountering groundwater will increase in Zones C and E and especially Zone D, if the pipe installation depths are increased to > 2.5 m to 3 m. The potential for encountering groundwater should not be excluded and a plan should be in place for such an event. Where groundwater is encountered in the open trenches, advice should be sought regarding the potential of any induced settlements by pumping and the effect (if any) on adjacent structures.

Pipe bursting involves pushing or pulling a bursting head through the existing pipe to fragment it into the surrounding ground. The new pipe is dragged behind the bursting head. The geotechnical limitations of pipe bursting are that the ground essentially needs to be of such density or strength that can be displaced during the bursting. The method displaces fragments of the existing pipe into the soil and thus is most appropriate for compressible soils. Ground conditions suitable for pipe bursting/splitting include clays, silt, generally soft cohesive material. Loose and medium sands and gravels are also feasible. Stones or cobbles in the ground can cause the fragments to pile up rather than be pushed out and block the bursting head.

Pipe bursting could be feasible at the areas along or close to High Street, where the soils comprise firm to stiff silt or loose to medium dense sands, with minor gravel and cobbles. Considerable presence of cobbles and occasional boulders was encountered along Taita Drive in all zones, while the soil layers are medium dense to dense. Widespread use of the pipe bursting method around this area will probably be problematic.

We understand that Pipe ramming is considered for the installation at the area of the intersection between Taita Drive and Fairway Drive. Pipe ramming involves pneumatically thrusting a pipe (usually steel) into the ground. This method is generally suitable over short distances (<100m) and can be achieved in most soil types. Simicevic and Sterling (2001) suggest that pipe ramming is suitable in soils containing cobbles and boulders, where the particle size is smaller than the pipe diameter. Based on this, pipe ramming could be challenging along and in the proximity of Taita Drive, as the soils encountered were cobbly in nature and the size of cobbles were generally ranging from 80 mm to 150 mm with occasional boulders (>200 mm diameter). The soils along and in the proximity of High Street are more fine grained and appear more suitable for the pipe ramming methodology.

9 Limitations

This geotechnical report (the report) has been prepared in accordance with the scope of services set out in the contract based on your project-specific requirements and criteria. In some circumstances the scope of the report may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Stantec may have relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, (the data). Except as otherwise stated in the report, Stantec has not verified the accuracy or completeness of the data. Stantec will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Stantec.

This report was prepared expressly for the client and expressly for purposes indicated by the client or its representative. This report may not be relied upon by any other persons for any purpose. The client should not use this report for other than its intended purpose without seeking additional geotechnical advice. The report applies only to the site investigated as outlined within. This report should not be relied upon if there are any changes to the project without first asking Stantec to review our recommendations and design.

Our ground conditions assessment is based on publicly available information and recorded subsurface conditions at the selective discrete test and sampled locations, the type, spacing and frequency of which were selected to meet the project requirements agreed by the Client. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. Our overall interpretation is based on inferred soil, rock, and groundwater conditions between discrete points; actual conditions may differ from those inferred. Stantec accepts no liability for any unknown or adverse ground conditions that would have been identified had further investigations, sampling, and testing been undertaken. No warranty is expressed or implied that the conditions encountered following investigation or during construction will conform to the conditions described herein.

Subsurface conditions are created by natural processes and human activities that evolve and change over time and can result in changes to ground conditions. Groundwater levels presented in this report may vary over time due to diurnal, tidal and seasonal influences. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events and should be consulted to determine if additional tests are necessary.

Ground conditions cannot be fully substantiated until project implementation has commenced and therefore this report's recommendations require confirmation onsite during construction. As such, uncertainty in ground conditions should be verified by Stantec geotechnical professionals required at nominated design milestones and during construction. Only Stantec, who prepared this report, is fully familiar with the background information needed to assess whether this report's recommendations are valid and whether changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report, there is risk of misinterpretation and Stantec cannot be held responsible for such misinterpretation. Stantec should be notified and be given an opportunity to review the report recommendations made in this report where conditions encountered at the site differ from those inferred; and if there are changes to design or construction methodologies.

The report as a whole presents the findings of the site assessment, and the report should not be copied in part or altered in any way. The contents of this document are customarily included and developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), laboratory evaluation of field samples, and using current practices and standards. These should not under any circumstances be redrawn for inclusion in other documents or separated from the report.

10 References

Begg. J.G, Mazengarb. C. 1996: Geology of the Wellington Area, scale 1:50,000. Institute of Geological and Nuclear Sciences Geological Map 22. 1 sheet + 128p. Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Limited

Boon D., Perrin N.D., Dellow G.D., Lukovic B., 2010. It's our fault – Geological Characterisation and Site Subsoil Class revision of the Lower Hutt Valley, GNS Science Report 2010/163. 60p.

GeoLogismiki Cliq software Version 3.0.2.4. 2006.

Hastings District Council (2022). Hastings District Council GIS Maps accessed September 2022.

Mzila D., Hughes B., Gyopari M., 2014. Kapiti Coast groundwater resource investigation. Greater Wellington Regional Council, March 2014.

New Zealand Geotechnical Society (NZGS) and Ministry of Business Innovation & Employment (MBIE), 2021a. Guidelines for Earthquake Geotechnical Practice in New Zealand, Module 1: Overview of the Guidelines, Version 1, November 2021.

Phreatos, 2003; Revision of the numerical model for the Lower Hutt groundwater zone. Report prepared for Wellington Regional Council, April 2003.

Simicevic, J.; Sterling, R. 2001. Guidelines for Pipe Ramming. Prepared for U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC). TTC Technical Report #2001.04

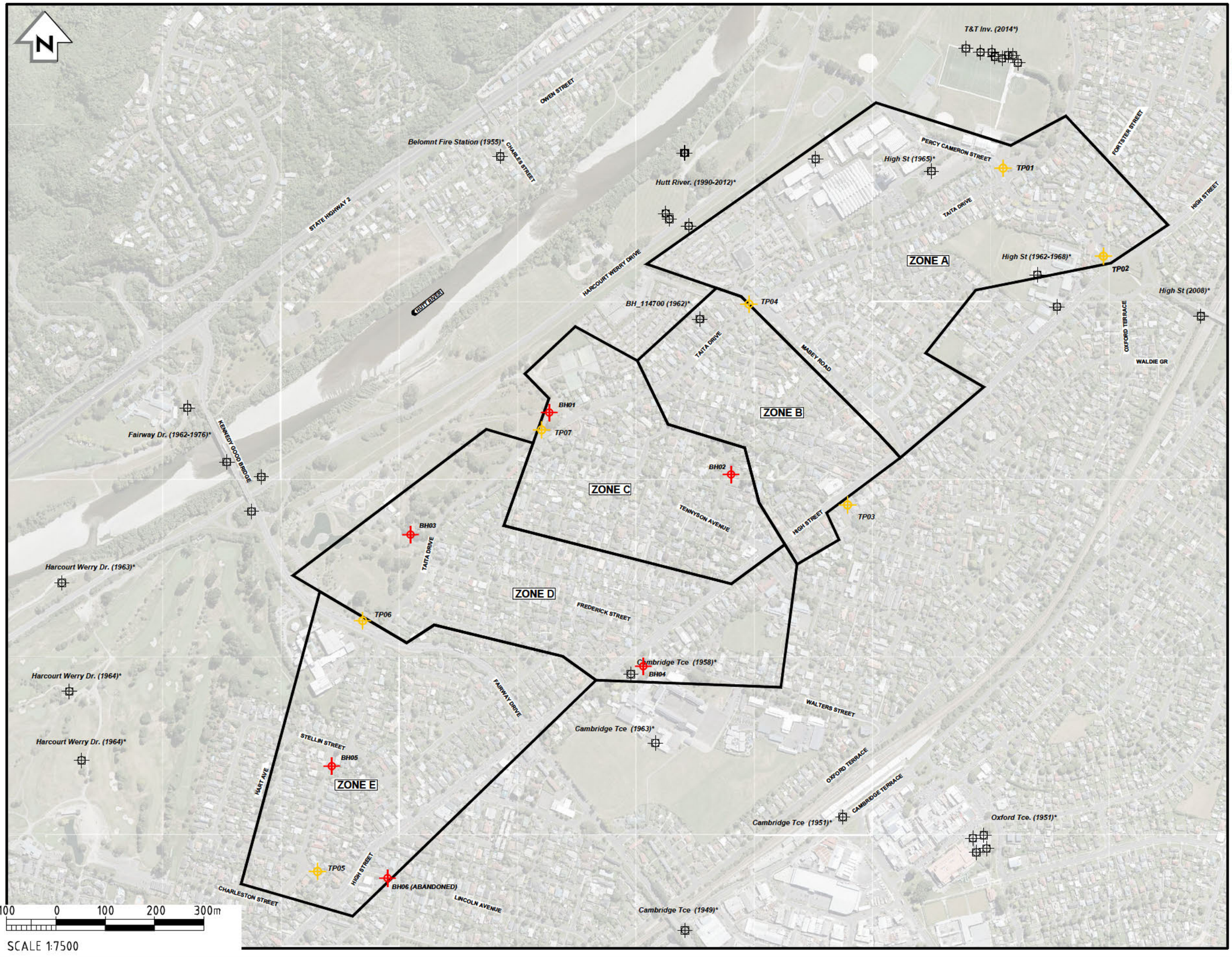
Stantec, 2021A: Avalon Wastewater Renewals, Desk Study Report, Prepared for Wellington Water, October 2021.

Stantec, 2021B: Avalon Wastewater Renewals, Stage 1 Investigations Geotechnical Factual and Interpretative Report, Prepared for Wellington Water, April 2021.

Appendices

We design with community in mind

Appendix A Investigation Location Plan



LEGEND

EXISTING INVESTIGATION POINTS

*For details, refer to Table B1 in Appendix B of the Stantec Desk Study Report, October 2021

TRIAL PIT INVESTIGATION LOCATIONS

BOREHOLE INVESTIGATION LOCATIONS

REV	DATE	DRN	DESCR PTION
A			

CLIENT LOGO

Wellington Water

Stantec

SCALE: AS SHOWN

DRAWN:

DATE: 03/22

DESIGN:

FIGURE No. A1

OF A

U:\310103608\4.0 Technical\4.13 Geotech\1. Desk Study\report Working\ACAD Plans\310103608-SK01.dwg

Appendix B Borehole Logs

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011	**BOREHOLE LOG**	Borehole ID **BH01** Sheet 1 of 2
Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762533 E 5438172 N (NZTM)	Total Dep h: 10.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Eastern end of Avalon park close to intersection at Taita Dr and Avalon Park Dr.		Date: 29/08/2022 Start 29/08/2022 End	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing Type	Sample and In Situ Testing Results	Other Observations	Groundwater	Installation/Backfill
					Hydrovac. (No sample retrieved).								
					(2.00)								
SPT	100	-2	2.0	Taita Alluvium	GRAVEL with minor sand and trace silt; dark grey, medium dense, dry. Gravel is fine to coarse, subrounded to angular. Sand is fine to medium.		MD	D	SPT	4,5//7,7,7,5 **N=26**			
					(2.45)								
SONIC	100		2.5		GRAVEL with minor sand, silt and cobbles; dark grey, medium dense, moist to wet. Gravel is fine to coarse, subangular to angular			M - W					
					(2.75)								
					Gravelly SILT; grey/brown, stiff to very stiff, moist. Gravel is fine to medium.		VS						
					(3.00)								
SPT	100	-3	3.0		*- 2.75m - 2.80m - core is baked* *- 2.90m - some sand*			M	SPT	6,8//9,9,9,11 **N=38**			
					Fine to coarse SAND with some gravel; dark brown, dense, moist. Gravel is fine and rounded.								
					(3.45)								
SONIC	100		3.5		GRAVEL with some cobbles; grey to brown, dense, dry. Gravel is fine to coarse, subangular to subrounded.			D			3.45m to 4m - fines washed away during drilling process.		
					(4.00)								
SPT	100	-4	4.0		Fine to coarse GRAVEL with some silt, minor cobbles and sand; brown, dense, moist to wet. Gravel is subangular to subrounded.			M - W	SPT	6,8//12,10,11,12 **N=45**			
					(4.45)								
SONIC	100		4.5		Silty GRAVEL with some cobbles; brown, dense, moist. Cobbles up to 80mm.								
		-5	5.0		*- 5.00m - becomes wet*		D		SPT	4,5//10,12,12,10 **N=44**			
SPT	100												
SONIC	100		5.5										
		-6	6.0					M	SPT	12,18//14,8,14,14 **N=50**			
SPT	100												
SONIC	100		6.5								6.45m some cobbles.		
		-7	7.0		(7.00)				SPT	6,6//7,10,18,15 **N=50+** for 280mm			
SPT	95				Sandy GRAVEL; dark brown, very dense, moist. Sand is fine to coarse. Gravel is fine to coarse and subangular.								
			7.5		(7.65)						7.5m some silt.		
SONIC	100				(7.80) Medium to coarse GRAVEL with some cobbles; subangular to subrounded, very dense, moist to wet.						7.8m to 11.45m - trace cobbles up to 80mm		
		-8	8.0		*- 7.65m - 10.45m - fines washed away during drilling process*				SPT	2,15//18,21,11 **N=50+** for 195mm			
SPT	97			Waiwhetu Gravels	Silty GRAVEL with some cobbles; brown, very dense, saturated. Gravel is subrounded.								
			8.5		*- 7.80m - 11.45m - trace fine to coarse sand* *- 8.00m - 8.45m - becomes saturated*								
SONIC	100						VD	S					
		-9	9.0						SPT	7,17//26,24 **N=50+** for 130mm			
SPT	95												
			9.5										
SONIC	100												

Contractor	Inclination
Prodrill	90°
Method	**Direction**
SONIC	-
Plant	**Barrel Type**
Fraste XL	-

Remarks Hole was double cased for its entire length. Coordinates taken with hand-held GPS.
Backfilled with bentonite 5m from bottom of hole and the rest with gravel fill. Piezometer install with 3m screen from 2m to 5m .

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011	**BOREHOLE LOG**	Borehole ID **BH01** Sheet 2 of 2

Project Name:	Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762533 E 5438172 N (NZTM)	Total Dep h: 10.45m
Client:	WELLINGTON WATER		Elevation: -	Logged By: TS
Description:	Eastern end of Avalon park close to intersection at Taita Dr and Avalon Park Dr.		Date: 29/09/2022 Start 29/09/2022 End	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing: Type	Sample and In Situ Testing: Results	Other Observations	Groundwater	Installation/Backfill
SPT	91			Waiwhetu Gravels	Silty GRAVEL with some cobbles; brown, very dense, saturated. Gravel is subrounded. (10.45)		VD	S	SPT	4,18//23,9 **N=50+** for 185mm			
		-11	10.5		Borehole terminated at 10.45m BGL due to Target depth								
			11.0										
			11.5										
		-12	12.0										
			12.5										
		-13	13.0										
			13.5										
		-14	14.0										
			14.5										
		-15	15.0										
			15.5										
		-16	16.0										
			16.5										
		-17	17.0										
			17.5										
		-18	18.0										
			18.5										
		-19	19.0										
			19.5										

Contractor	Inclination
Prodrill	90°
Method	**Direction**
SONIC	-
Plant	**Barrel Type**
Fraste XL	-

Remarks Hole was double cased for its entire length. Coordinates taken with hand-held GPS.
Backfilled with bentonite 5m from bottom of hole and the rest with gravel fill. Piezometer install with 3m screen from 2m to 5m .

BOREHOLE PHOTOGRAPHS: BH01

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Eastern end of Avalon park close to intersection at Taita Dr and Avalon Park Dr.

PROJECT NO.: 310103608
DATE: 29/09/2022
COORDINATES: 1762533 E 5438172 N (NZTM)

BH01 Box 1 (0.00m - 5.45m)

BH01 Box 2 (5.45m - 9.45m)

BOREHOLE PHOTOGRAPHS: BH01

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Eastern end of Avalon park close to intersection at Taita Dr and Avalon Park Dr.

PROJECT NO.: 310103608
DATE: 29/09/2022
COORDINATES: 1762533 E 5438172 N (NZTM)

BH01 Box 3 (9.45m - 10.45m)

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011

BOREHOLE LOG

Borehole ID **BH02**

Sheet 1 of 2

Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762900 E 5438037 N (NZTM)	Total Dep h: 11.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Berm outside 8 Avalon Crescent, Avalon.		Date: 02/09/2022 (Start) 02/09/2022 (End)	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing: Type	Sample and In Situ Testing: Results	Other Observations	Groundwater	Installation/Backfill
		-1	0.5		Hydrovac. (No sample retrieved).								
			1.0										
			1.5										
		-2	2.0		(2.00)								
SPT	100			Taita Alluvium	S LT with some clay; brown with grey mottling , very soft, moist. Moderate plasticity.		VS	M	SPT	0,0//0,0,0,0 **N=0**			
SONIC	90		2.5		(2.75)								
		-3	3.0		SAND with minor silt and some gravel; dark brown, dense, moist. Sand is fine to coarse, gravel is fine to medium and subrounded. *- 3.00m - 3.45m - Becomes gravelly SAND.*		S		SPT	5,6//7,9,12,12 **N=40**			
SPT	100				(3.45)								
SONIC	90		3.5		Sandy silty GRAVEL with some cobbles to cobbly GRAVEL; brown, dense, dry to moist. Gravel is fine to coarse and subrounded. Sand is fine to medium. Cobbles up to 80mm.								
		-4	4.0		*- 4.00m - minor sand*				SPT	6,8//10,11,14, 12 **N=47**			
SPT	100						D	D - M					
SONIC	90		4.5										
		-5	5.0						SPT	8,14//20,20,10 **N=50+** for 185mm			
SPT	91				(5.45)								
SONIC	91		5.5	Taita Alluvium/Waiwhetu Gravel	GRAVEL with some cobbles, silt and minor sand; brown, dense to very dense, dry. Gravel is subrounded to subangular.								
		-6	6.0		*- 6.00m - Becomes wet to saturated.*				SPT	9,12//11,14,12 ,10 **N=47**			
SPT	91				*- 6.45m - 7.00m - Fines washed away during drilling process. Crushed cobbles and boulders.*								
SONIC	91		6.5										
		-7	7.0				VD		SPT	7,43 **N=50+** for 145mm (seating)		02-09-2022	
SPT	98												
SONIC	100		7.5					D					
		-8	8.0						SPT	7,13//15,17,18 **N=50+** for 225mm			
SPT	100				(8.45)								
SONIC	100		8.5	Waiwhtu Gravel	GRAVEL with some cobbles, some silt and minor sand; light brown, dense to very dense, dry. Gravel is subrounded to subangular. *- 8.50m - minor cobbles up to 80mm*								
		-9	9.0						SPT	14,18//17,14,1 9 **N=50+** for 225mm			
SPT	100						D						
SONIC	100		9.5										

Contractor Prodrill	**Inclination** 90°	**Remarks** Hole was double cased for its entire length and back-filled with bentonite. Coordinates taken with hand-held GPS.
Method SONIC	**Direction** -	
Plant Fraste XL	**Barrel Type** -	

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011

BOREHOLE LOG

Borehole ID **BH02**

Sheet 2 of 2

Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762900 E 5438037 N (NZTM)	Total Dep h: 11.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Berm outside 8 Avalon Crescent, Avalon.		Date: 02/09/2022 (Start) 02/09/2022 (End)	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing: Type	Sample and In Situ Testing: Results	Other Observations	Groundwater	Installation/Backfill
SPT	96		10.5	Waiwhtu Gravel	GRAVEL with some cobbles, some silt and minor sand; light brown, dense to very dense, dry. Gravel is subrounded to subangular.		D	D	SPT	19,11//13,29,13 **N=50+** for 205mm			
SONIC	100	-11	11.0										
SPT	100					(11.45)			SPT	10,20//20,30 **N=50+** for 150mm			
			11.5		Borehole terminated at 11.45m BGL due to Target depth								
		-12	12.0										
			12.5										
		-13	13.0										
			13.5										
		-14	14.0										
			14.5										
		-15	15.0										
			15.5										
		-16	16.0										
			16.5										
		-17	17.0										
			17.5										
		-18	18.0										
			18.5										
		-19	19.0										
			19.5										

Contractor Prodrill	**Inclination** 90°
Method SONIC	**Direction** -
Plant Fraste XL	**Barrel Type** -

Remarks Hole was double cased for its entire length and back-filled with bentonite. Coordinates taken with hand-held GPS.

BOREHOLE PHOTOGRAPHS: BH02

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Berm outside 8 Avalon Crescent, Avalon.

PROJECT NO.: 310103608
DATE: 02/09/2022
COORDINATES: 1762900 E 5438037 N (NZTM)

BH02 Box 1 (0.00m - 6.00m)

BH02 Box 2 (6.00m - 9.45m)

BOREHOLE PHOTOGRAPHS: BH02

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Berm outside 8 Avalon Crescent, Avalon.

PROJECT NO.: 310103608
DATE: 02/09/2022
COORDINATES: 1762900 E 5438037 N (NZTM)

BH02 Box 3 (9.45m - 11.45m)

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011	**BOREHOLE LOG**	Borehole ID **BH03** Sheet 1 of 2
Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762287 E 5437916 N (NZTM)	Total Dep h: 11.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Inside berm of entrance at western end of Avalon Park.		Date: 30/08/2022 (Start) 30/08/2022 (End)	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Description (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing: Type	Sample and In Situ Testing: Results	Other Observations	Groundwater	Installation/Backfill
			0.5		Hydrovac. (No sample retrieved).								
		-1	1.0										
			1.5		(1.50)								
SONIC	100			Taita Alluvium	GRAVEL with some cobbles; dark grey, medium dense, dry to moist. Gravels are medium to coarse, subrounded to subangular. (1.75) [Fines washed away during drilling process]			D					
SPT	100	-2	2.0		GRAVEL with some cobbles and some silt; dark grey, medium dense, moist to wet. Gravels are fine to coarse. Subrounded to subangular. (2.45)				SPT	5,5//6,5,6,7 **N=25**			
SONIC	100		2.5		Silty GRAVEL with trace sand; grey, moderately dense to dense, dry to moist. Gravel is fine to coarse, subrounded to angular.								
SPT	100	-3	3.0		*- 2.80m - cobble 70mm*		MD	D - M	SPT	7,7//6,8,11,12 **N=37**			
SONIC	91		3.5		*- 3.00m - sand content decreases*								
SPT	100	-4	4.0						SPT	5,11//11,14,13,8 **N=50+** for 255mm		01-09-2022	
SONIC	91		4.5										
SPT	91	-5	5.0		(4.90) Sandy SILT with some gravel; grey with orange mottling, soft, wet. Gravel is fine to medium. Low plasticity.		S	W	SPT	11,15//18,7,10,12 **N=47**			
SONIC	91		5.5		*- 5.30m - silt content increases* (5.45) Silty GRAVEL with trace sand; brown with dark orange mottling, moist to wet, dense to very dense. Gravel is fine to coarse and subrounded to subangular.								
SPT	0	-6	6.0		*- 6.00m - sand content decreases*				SPT	50 **N=50+** for 50mm (seating)			
SONIC	89		6.5		*- 6.75m - 7.45m - trace cobbles up to 80mm.*		D	M - W					
SPT	100	-7	7.0		*- 7.00m - becomes saturated*				SPT	9,15//13,11,8,8 **N=40**			
SONIC	91		7.5	Taita Alluvium	(7.45) Silty SAND; grey with orange mottling, dense to very dense, moist to wet. Sand is fine to coarse. Minor organics, fibrous.								
SPT	100	-8	8.0	Waiwhetu Gravels	*- 7.80m - trace gravel, minor clay* (7.90) Fine to coarse GRAVEL with minor silt and sand; brown, very dense, wet to saturated. Gravel is fine to coarse. Sand is fine to coarse.				SPT	7,19//22,28 **N=50+** for 150mm			
SONIC	91		8.5		*- 8.00m - minor cobbles up to 70mm*								
SPT	100	-9	9.0				VD	W - S	SPT	8,18//20,25,5 **N=50+** for 245mm			
SONIC	100		9.5										

Contractor	Inclination
Prodrill	90°
Method	**Direction**
SONIC	-
Plant	**Barrel Type**
Fraste XL	-

Remarks Hole was double cased for its entire length. Coordinates taken with hand-held GPS.
Backfilled with bentonite 5m from bottom of hole and the rest with gravel fill. Piezometer install with 3m screen from 1.45 to 4.45m

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011	**BOREHOLE LOG**	Borehole ID **BH03** Sheet 2 of 2
Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762287 E 5437916 N (NZTM)	Total Dep h: 11.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Inside berm of entrance at western end of Avalon Park.		Date: 30/08/2022 (Start) 30/08/2022 (End)	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing Type	Sample and In Situ Testing Results	Other Observations	Groundwater	Installation/Backfill
SPT	91		10.5	Waiwhetu Gravels	Fine to coarse GRAVEL with minor silt and sand; brown, very dense, wet to saturated. Gravel is fine to coarse. Sand is fine to coarse.		VD	W - S	SPT	6,22//25,25 **N=50+** for 130mm			
SONIC	100	-11	11.0										
SPT	91								SPT	8,14//18,14,12 ,6 **N=50+** for 250mm			
					(11.45)								
			11.5		Borehole terminated at 11.45m BGL due to Target depth								
		-12	12.0										
			12.5										
		-13	13.0										
			13.5										
		-14	14.0										
			14.5										
		-15	15.0										
			15.5										
		-16	16.0										
			16.5										
		-17	17.0										
			17.5										
		-18	18.0										
			18.5										
		-19	19.0										
			19.5										

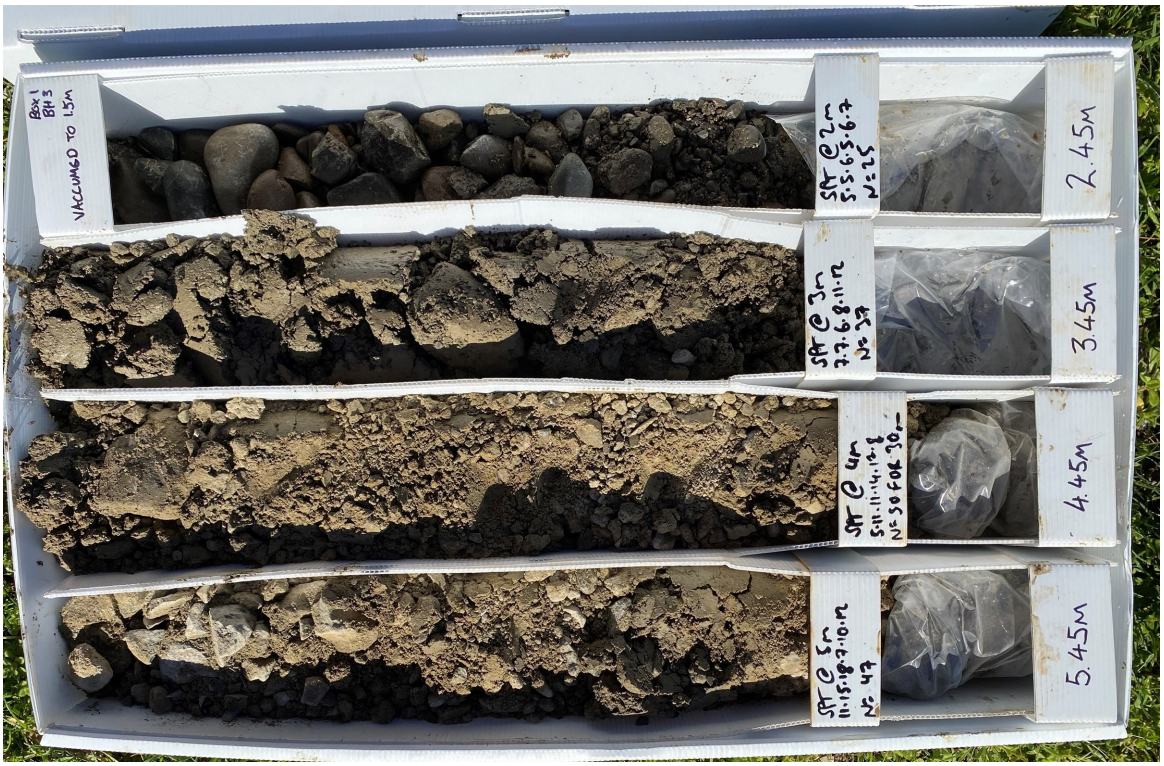
Contractor	Inclination
Prodrill	90°
Method	**Direction**
SONIC	-
Plant	**Barrel Type**
Fraste XL	-

Remarks Hole was double cased for its entire length. Coordinates taken with hand-held GPS.
Backfilled with bentonite 5m from bottom of hole and the rest with gravel fill. Piezometer install with 3m screen from 1.45 to 4.45m

BOREHOLE PHOTOGRAPHS: BH03

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Inside berm of entrance at western end of Avalon Park.

PROJECT NO.: 310103608
DATE: 30/08/2022
COORDINATES: 1762287 E 5437916 N (NZTM)



BH03 Box 1 (0.00m - 5.45m)

BH03 Box 2 (5.45m - 8.45m)

BOREHOLE PHOTOGRAPHS: BH03

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Inside berm of entrance at western end of Avalon Park.

PROJECT NO.: 310103608
DATE: 30/08/2022
COORDINATES: 1762287 E 5437916 N (NZTM)

BH03 Box 3 (9.45m - 11.45m)

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011	**BOREHOLE LOG**	Borehole ID **BH04** Sheet 1 of 2

Project Name:	Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762734 E 5437665 N (NZTM)	Total Dep h: 10.45m
Client:	WELLINGTON WATER		Elevation: -	Logged By: TS
Description:	Naenae college, 910 High Street, Avalon, Lower Hutt 5011.		Date: 03/09/2022 (Start) 03/09/2022 (End)	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing: Type	Sample and In Situ Testing: Results	Other Observations	Groundwater	Installation/Backfill
			0.5		Hydrovac. (No sample retrieved).								
		-1	1.0										
			1.5		(1.70)								
SONIC	100		2.0	Talta Alluvium	S LT with some clay; brown with orange mottling, soft to firm, moist. Moderate plasticity.		S	M	SPT	0,0//1,1,1,1 **N=4**			
SPT	0	-2	2.5		(2.80)								
SONIC	100		3.0		Gravelly S LT with some sand; light brown with orange mottling, soft to firm, wet to saturated. Gravel is fine to coarse, angular to subrounded. Sand is fine to coarse. (3.00)				SPT	5,5//4,5,8,12 **N=34**		03-09-2022	
SPT	100	-3	3.5		Fine to coarse GRAVEL with some silt, some cobbles, and minor sand; brown, dense, wet to saturated. Gravel is angular to subrounded. Sand is fine to medium.								
SONIC	100		4.0		*- 3.45m - becomes dry*								
SPT	100	-4	4.5		*- 3.50m - silt content decreases*				SPT	5,12//10,11,13 ,15 **N=49**			
SONIC	100		5.0		*- 4.00m - cobbles up to 80mm.*								
SPT	100	-5	5.5		*- 4.45m - cobble content decreases*			S	SPT	6,20//14,16,20 **N=50+** for 225mm			
SONIC	100		6.0				D						
SPT	91	-6	6.5						SPT	5,10//15,15,15 ,5 **N=50+** for 250mm			
SONIC	100		7.0										
SPT	100	-7	7.5		(7.45)				SPT	3,7//10,10,10, 8 **N=38**			
SONIC	100		8.0		Gravelly SAND with minor silt; dark grey, dense, moist to wet. Sand and gravel are fine to coarse. Gravel is subangular. (7.65)			W					
SPT	100	-8	8.5		Silty GRAVEL with trace sand; brown, dense, saturated, gravel is fine to coarse, angular to subrounded. Sand is fine to medium.			S	SPT	7,8//10,10,10, 8 **N=38**			
SONIC	100		9.0		(8.65)								
SPT	100	-9	9.5		Silty fine to medium SAND with some gravel; dark brown, medium dense, wet to saturated. Gravel is subangular and fine to coarse.		MD	W - S	SPT	4,6//6,10,5,5 **N=26**			
SONIC	100			Talta Alluvium/ Waiwhetu Gravels	*- 9.00m - gravel content increases* (9.45)								
					S LT with some clay and trace sand; grey, stiff, moist. Moderate plasticity.		St	M					

Contractor	Inclination
Prodrill	90°
Method	**Direction**
SONIC	-
Plant	**Barrel Type**
Fraste XL	-

Remarks Hole was double cased for its entire length and back-filled with bentonite. Coordinates taken with hand-held GPS.

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011

BOREHOLE LOG

Borehole ID **BH04**

Sheet 2 of 2

Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762734 E 5437665 N (NZTM)	Total Dep h: 10.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Naenae college, 910 High Street, Avalon, Lower Hutt 5011.		Date: 03/09/2022 Start 03/09/2022 End	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing: Type	Sample and In Situ Testing: Results	Other Observations	Groundwater	Installation/Backfill
SPT	100			Tata Alluvium/ Waiwhetu Gravels	Silty fine to medium SAND; grey, medium dense moist. Moderate plasticity. (10.00) (10.45)		MD	M	SPT	4,3//3,7,6,10 **N=26**			
		-11	10.5		Borehole terminated at 10.45m BGL due to Target depth								
			11.0										
			11.5										
		-12	12.0										
			12.5										
		-13	13.0										
			13.5										
		-14	14.0										
			14.5										
		-15	15.0										
			15.5										
		-16	16.0										
			16.5										
		-17	17.0										
			17.5										
		-18	18.0										
			18.5										
		-19	19.0										
			19.5										

Contractor Prodrill	**Inclination** 90°
Method SONIC	**Direction** -
Plant Fraste XL	**Barrel Type** -

Remarks Hole was double cased for its entire length and back-filled with bentonite. Coordinates taken with hand-held GPS.

BOREHOLE PHOTOGRAPHS: BH04

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Naenae college, 910 High Street, Avalon, Lower Hutt 5011.

PROJECT NO.: 310103608
DATE: 03/09/2022
COORDINATES: 1762734 E 5437665 N (NZTM)

BH04 Box 1 (0.00m - 4.45m)

BH04 Box 2 (4.45m - 8.45m)

BOREHOLE PHOTOGRAPHS: BH04

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Naenae college, 910 High Street, Avalon, Lower Hutt 5011.

PROJECT NO.: 310103608
DATE: 03/09/2022
COORDINATES: 1762734 E 5437665 N (NZTM)

BH04 Box 3 (8.45m - 10.45m)

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011	**BOREHOLE LOG**	Borehole ID **BH05** Sheet 1 of 2
Project Name: Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762106 E 5437459 N (NZTM)	Total Dep h: 10.45m
Client: WELLINGTON WATER		Elevation: -	Logged By: TS
Description: Berm outside 2 Charleston Avenue, Avalon.		Date: 01/09/2022 Start 01/09/2022 End	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing Type	Sample and In Situ Testing Results	Other Observations	Groundwater	Installation/Backfill
			0.5		Hydrovac. (No sample retrieved). (1.50)								
SPT	100	-1	1.5		S LT with some sand; brown, firm to stiff, moist to wet. Low plasticity.				SPT	1,1//2,3,5,5 **N=15**			
SONIC	100	-2	2.0		*- 2.20m - Minor clay, moderate plasticity.* (2.80)		S	M - W					
SPT	100	-3	2.5		Silty sandy GRAVEL; dark brown, loose to medium dense, moist. Gravel is fine to coarse, subrounded to angular. Sand is fine to coarse.				SPT	1,2//4,2,2,2 **N=10**			
SONIC	91		3.0										
SPT	100	-4	3.5		*- 3.80m - sand becomes absent*		MD		SPT	4,5//10,6,3,5 **N=22**			
SONIC	91		4.0		*- 4.50m - 5.00m - cobbles up to ~80mm in diameter* *- 4.60m - 5.00m - fines washed away during drilling process* (5.00)							01-09-2022	
SPT	100	-5	4.5	Taita Alluvium	Silty GRAVEL with some cobbles, to cobbly GRAVEL with minor sand; grey/brown, dense to very dense, moist. Gravel is fine to coarse, subrounded to subangular. Cobbles up to 80mm.				SPT	3,4//6,6,10,12 **N=34**			
SONIC	91		5.0										
SPT	100	-6	5.5					M	SPT	14,16 **N=50+** for 145mm (seating)			
SONIC	91		6.0										
SPT	100	-7	6.5				D		SPT	14,16//17,15,14,4 **N=50+** for 250mm			
SONIC	91		7.0										
SPT	100	-8	7.5						SPT	3,5//7,7,10,10 **N=34**			
SONIC	91		8.0		*- 8.50m - becomes light brown* (8.80)								
SPT	100	-9	8.5	Waiwhetu Gravels	Gravelly S LT; brown with orange mottling, very stiff, wet. Gravel is fine to coarse, subrounded to subangular. Low plasticity. (9.45)		VD	W	SPT	3,7//12,15,12,11 **N=50+** for 295mm			
SONIC	91		9.0		Sandy GRAVEL with minor silt; brown, very dense, saturated. Gravel is fine to coarse and subangular to subrounded. Sand is fine to coarse.			S					
			9.5										

Contractor	Inclination	Remarks
Prodrill	90°	Hole was double cased for its entire length. Coordinates taken with hand-held GPS. Backfilled with bentonite 5m from bottom of hole and the rest with gravel fill. Piezometer install with 3m screen from 1.45 to 4.45m
Method SONIC	**Direction** -	
Plant Fraste XL	**Barrel Type** -	

Stantec Level 15, 10 Brandon Street, Wellington, New Zealand, 6011

BOREHOLE LOG

Borehole ID **BH05** Sheet 2 of 2

Project Name:	Avalon Wastewater Renewals	Project No. 310103608	Coordinates: 1762106 E 5437459 N (NZTM)	Total Dep h: 10.45m
Client:	WELLINGTON WATER		Elevation: -	Logged By: TS
Description:	Berm outside 2 Charleston Avenue, Avalon.		Date: 01/09/2022 Start 01/09/2022 End	Checked By: EG

Method	Core Recovery (%)	Elevation (m)	Depth (m)	Geologic Unit	Material Descrip ion (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes, New Zealand Geotechnical Society, 2005)	Legend	Consistency/ Relative Density	Moisture Condition	Sample and In Situ Testing Type	Sample and In Situ Testing Results	Other Observations	Groundwater	Installation/Backfill
SPT	100			Waiwhetu Gravels	Sandy GRAVEL with minor silt; brown, very dense, saturated. Gravel is fine to coarse and subangular to subrounded. Sand is fine to coarse. (10.45)		VD	S	SPT	5,8//14,20,16 **N=50+** for 205mm			
			10.5		Borehole terminated at 10.45m BGL due to Target depth								
		-11	11.0										
			11.5										
		-12	12.0										
			12.5										
		-13	13.0										
			13.5										
		-14	14.0										
			14.5										
		-15	15.0										
			15.5										
		-16	16.0										
			16.5										
		-17	17.0										
			17.5										
		-18	18.0										
			18.5										
		-19	19.0										
			19.5										

Contractor	Prodrill
Method	SONIC
Plant	Fraste XL
Inclination	90°
Direction	-
Barrel Type	-

Remarks Hole was double cased for its entire length. Coordinates taken with hand-held GPS.
Backfilled with bentonite 5m from bottom of hole and the rest with gravel fill. Piezometer install with 3m screen from 1.45 to 4.45m

BOREHOLE PHOTOGRAPHS: BH05

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Berm outside 2 Charleston Avenue, Avalon.

PROJECT NO.: 310103608
DATE: 01/09/2022
COORDINATES: 1762106 E 5437459 N (NZTM)

BH05 Box 1 (0.00m - 5.45m)

BH05 Box 2 (5.45m - 9.45m)

BOREHOLE PHOTOGRAPHS: BH05

PROJECT: Avalon Wastewater Renewals
CLIENT: WELLINGTON WATER
DESCRIPTION: Berm outside 2 Charleston Avenue, Avalon.

PROJECT NO.: 310103608
DATE: 01/09/2022
COORDINATES: 1762106 E 5437459 N (NZTM)

BH05 Box 3 (9.45m - 10.45m)

DESIGN WITH COMMUNITY IN MIND

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of place and of belonging. That's why at Stantec, we always design with community in mind.

We care about the communities we serve—because they're our communities too. This allows us to assess what's needed and connect our expertise, to appreciate nuances and envision what's never been considered, to bring together diverse perspectives so we can collaborate toward a shared success.

We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in communities across the globe.

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