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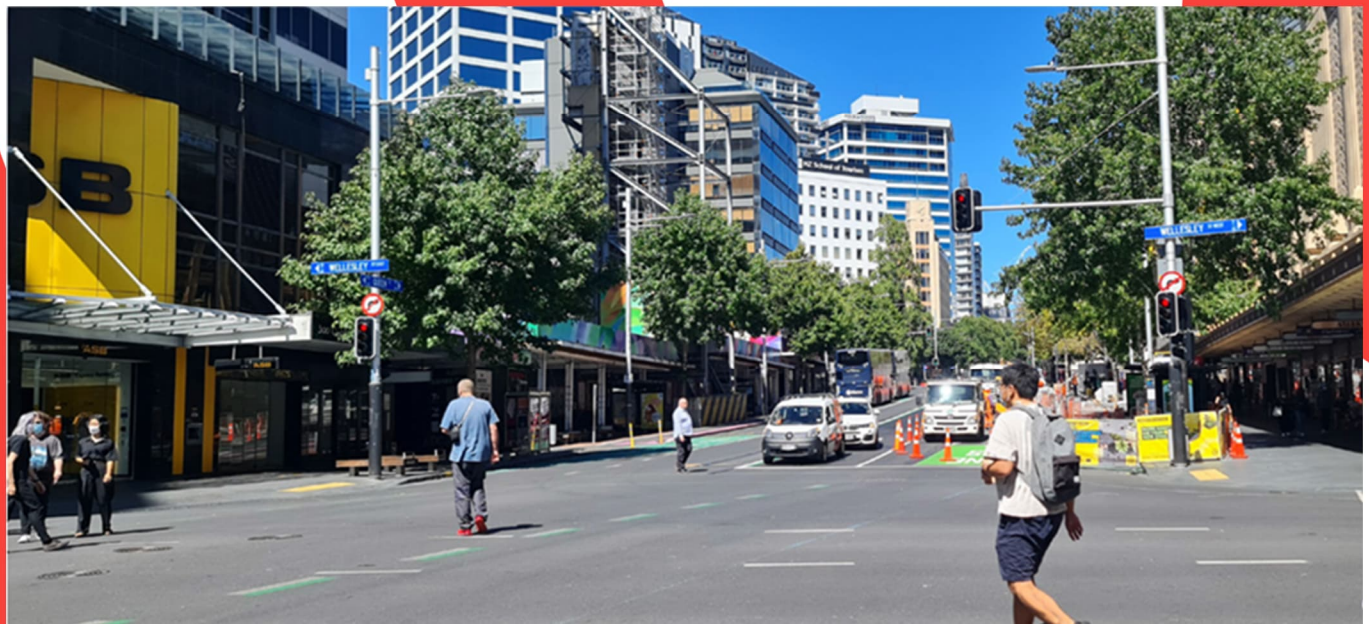
Watercare Services Limited

DEWATERING AND SETTLEMENT ASSESSMENT – ADDENDUM DETAILING SITE INVESTIGATIONS

QUEEN STREET WASTEWATER DIVERSION PROGRAMME: PART 3 - PART 6 LINK PROJECT

19 February 2025

W-SL001.04



DEWATERING AND SETTLEMENT ASSESSMENT – ADDENDUM DETAILING SITE INVESTIGATIONS

QUEEN STREET WASTEWATER DIVERSION PROGRAMME: PART 3 - PART 6 LINK PROJECT

Watercare Services Limited

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REV	DATE	DETAILS
R0	19 February 2024	Addendum to Dewatering and Settlement Assessment Report (dated 19 January 2025) detailing site investigation information and confirmation of Assessment of Effects.

	NAME	DATE
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Approved by:	Philip McFarlane	19 Feb 2025

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1 INTRODUCTION

The assessment of dewatering effects report Revision 0 (R0) was presented to the client on 3 December 2024, and updates based on client review (R1) was completed on 19 December 2024. The R0 and R1 assessment was based on historic site information, which were obtained from property files of the properties around the Marmion Shaft. This information was considered indicative only, but conservative.

Site specific ground investigations have been undertaken in December 2024 and January 2025. These investigations comprised:

- The drilling of one bore and installation of a piezometer at the corner of Marmion Street and Queen Street and within the Marmion Shaft consented envelope on 5-6 December 2024.
- Groundwater levels were measured prior to the hydraulic testing and monitoring equipment were installed for longer term monitoring.
- Hydraulic testing was conducted on 20-21 January 2025.

The Revision 1 dewatering and settlement modelling and analysis were not updated based on the site-specific investigations because the Revision 1 effects from dewatering and construction of the temporary Marmion shaft were assessed as negligible. The assumptions used for the dewatering and settlement modelling and assessment in Revision 1 are considered more conservative than those based on the findings of the subsequent investigations. Therefore, the Revision 1 effects assessment is considered sufficiently conservative, and an updated assessment is not required. The site investigation information is presented and compared with the assumptions made in the Revision 1 report to substantiate the statement above.

The measured groundwater level in the East Coast Bays Formation (ECBF) is at 13 m bgl (assume maximum groundwater level of 12 m bgl to account for seasonal variation), which is significantly deeper than what we have assumed previously, which was 6.6 m bgl. Drawdown required is thus very much less than estimated in the Revision 1 report and the associated consolidation settlement will be much less than that estimated in the Revision 1 report.

A shallow perched groundwater level (2.45 m bgl) was also measured during drilling but is likely influenced by the drilling fluid (water only) used. Based on the logging information this 2.45 m bgl water level is considered to be within the fill only (the underlying material has a higher hydraulic conductivity, and the groundwater will likely drain away, allowing an unsaturated zone to occur underneath and create a true, dual layer perched aquifer system).

The dewatering modelling was targeted in the ECBF residual soils. The majority of drawdown estimated for Revision 1 scenarios, occurred through the base of the shaft in the time taken to complete its sealing (50 days), not through the shaft sides due to secant pile wall installation prior to excavation. We consider that the secant pile wall will likely cut off the perched aquifer within the weak fill materials (up to 5 m bgl) that could be prone to settlement from the excavation/dewatering. Hence the perched aquifer is likely to experience very limited drawdown, if any and therefore its soils experience limited settlement.

Building foundations for the building at 345-361 Queen Street (the building closest to the Marmion shaft) is likely founded in competent rock and thus unlikely to be subject to damage from settlement of shallow unconsolidated sediments.

2 SITE SPECIFIC INFORMATION

A site-specific bore was drilled within the Marmion Shaft consented envelope on 5-6 December 2024 (Figure 1). The bore was drilled to a total depth of 22.0 m. Bore details and observations are presented in Table 1 and the bore log (excluding surveyed coordinates) is included in Appendix A.

Table 1: Site-specific bore summary: BH24/03

DEPTH (M BGL)	LITHOLOGY ENCOUNTERED	INTERPRETED GEOLOGY
0.0 – 3.0	Hydro-excavation, no samples	Fill (interpreted from underlying layer)
3.0 – 5.0	Clayey Silt with trace organics	Fill
5.0 – 10.0	Silt with some clay, interlayered with sands with some silt	East Coast Bays Formation Residual Soils
10.0 – 22.0 (end of hole)	Sandstone with some siltstone layers interlayered with Siltstone with some sandstone layers. Mostly very weak.	East Coast Bays Formation

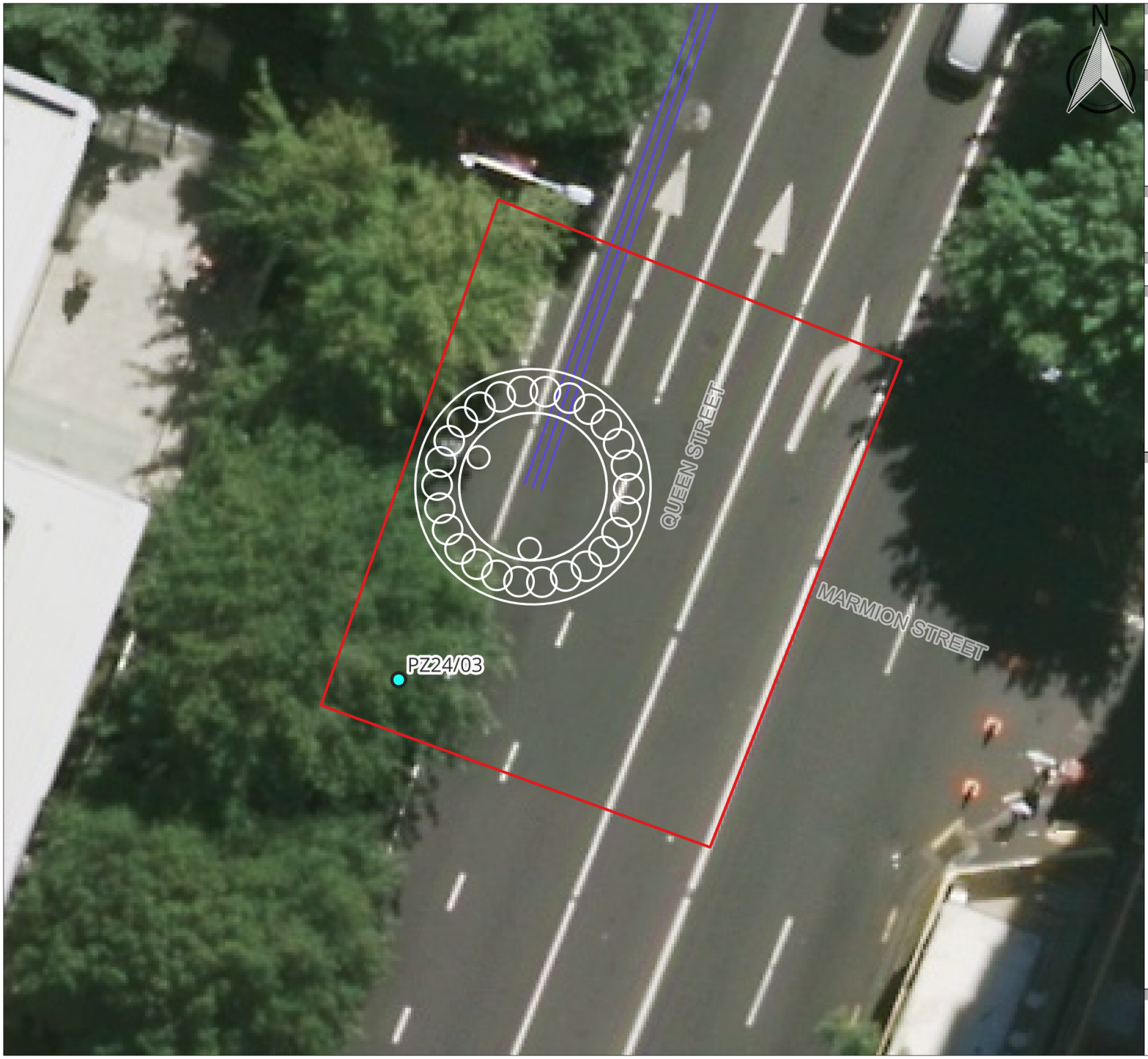
The piezometer was constructed in the machine drilled bore with 50 mm diameter uPVC and screened across the pipe invert from 14-17 m bgl.

Groundwater levels measured during drilling of the bore and prior to the slug testing of PZ24/03 are listed in Table 2. Note that groundwater levels measured during drilling are influenced by the drilling process and is considered indicative only.

Table 2: Groundwater levels measured in BH24/03 and PZ24/03.

DATE AND TIME	DEPTH OF BORE/PIEZOMETER (M BGL)	SCREENING DEPTH (M)	MEASURED GROUNDWATER LEVEL (M BGL)
5 Dec 2024 (prior to start of drilling)	3.0	During drilling – no screen installed	2.45
5 Dec 2024 17:00 (end of drilling shift)	16.5	During drilling – no screen installed	0.88
6 Dec 2024 (prior to start of drilling)	16.5	During drilling – no screen installed	6.85
20/1/2025 11.45 am	17.0	14-17	13.09

The first groundwater level was measured on the morning after the first day of drilling and has had some time to stabilise. This groundwater level is shallow (2.45 m bgl) and possibly indicates the presence of a shallow perched aquifer, as typically observed in this geological setting. A second groundwater level of 6.85 m bgl was obtained on the morning of 6 December 2024 when drilling had progressed into the underlying ECBF representing an indicative groundwater level for the regional ECBF aquifer. This level was similar to the groundwater level used during the Revision 1 dewatering and settlement assessment.



PROJECT

Watercare Services Limited
Auckland
Queen Street Wastewater Diversion - Part 3-6 Link

WSP Auckland

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FIGURE

Figure 1: Location of site-specific bore – Marmion shaft.

PROJECT NUMBER	REVISION DATE	REVISION
W-SL001.04	13 Feb 2025	R0

ATTRIBUTION

LEGEND

LEGEND

Site investigation 2024

Part 3-6 link works

Consenting envelope

P3-P6 LINK

SECANT SHAFT

SCALE

0 2 4 6 m

The groundwater level measured in piezometer PZ24/03, prior to slug testing, was 13.09 m bgl. It is considered that this represents the static groundwater level within the deeper regional ECBF aquifer because the piezometer was developed after installation to remove any drilling additives and/or drilling cake. Additionally, the groundwater level had more than a month to stabilise when the 13.09 m bgl measurement was taken.

Hydraulic testing (slug testing) was undertaken in PZ24/03 on 20-21 January 2025 and used to estimate hydraulic conductivity as listed in Table 1.

Table 3: Summary of site-specific hydraulic conductivity testing and analysis.

ID	DATE AND TIME	SCREEN DEPTH (M BGL)	PRE-TEST GROUNDWATER LEVEL (M BGL)	GEOLOGY OF SCREENED INTERVAL	AVERAGE HYDRAULIC CONDUCTIVITY K (M/D)
PZ24/03	20 Jan 2025 11:15 am	14-17	13.09	Moderately to slightly weathered SANDSTONE and SILTSTONE	0.029

3 COMPARISON WITH REVISION 1 ASSUMPTIONS

3.1 GROUND MODEL

The site-specific bore information generally agrees with the ground model developed as the base for the Revision 1 dewatering and settlement model. However, based on the drilling, the fill is approximately double the thickness (5 m instead of 2.8 m for Revision 1 report), although the overall thickness of soils above the basement rock material has not changed (10.0 m). Hence, the ground model is still considered generally applicable. The difference between Revision 1 and confirmed ground model assumptions at the shaft location is shown in Figure 2.

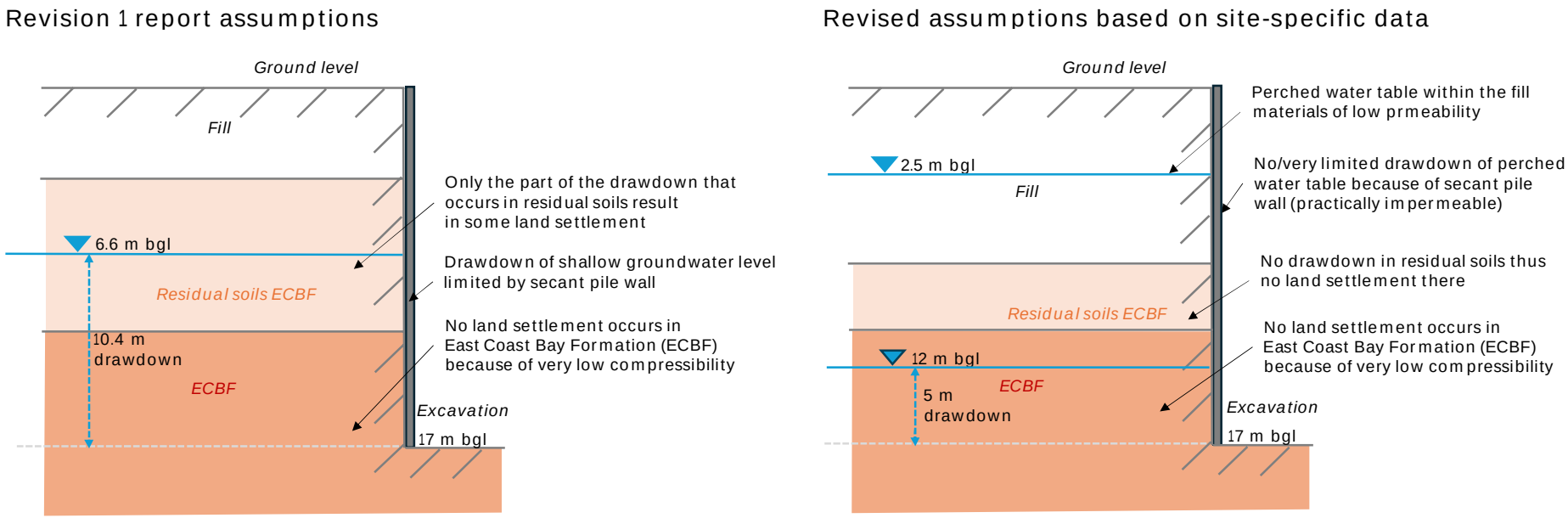


Figure 2: Comparative modelling assumptions Revision 1 report and based on site-specific investigations.

3.2 DEWATERING LEVELS

The static groundwater level used for the dewatering modelling in the Revision 1 report was 6.6 m bgl. The site investigation indicated a shallow perched groundwater level at 2.45 m bgl and a much deeper groundwater level of 13 m bgl for the regional ECBF aquifer. Though the perched groundwater level is much shallower, it is considered likely that the shallow perched aquifer has a maximum thickness of 2.5 m, because the groundwater will be perched in the fill, which is only 5 m thick. Based on the site-specific information, a conservative high groundwater level of 12 m bgl is assumed for the regional ECBF aquifer to account for seasonal variation. This is a conservative assumption because the seasonal variation in the ECBF aquifer based on monitoring of other piezometers along Queen Street Part 3 alignment indicated typically less than 0.5 m seasonal variation.

The drawdown within the shaft will be from the base of the excavation, until the base is sealed. No significant lateral seepage of water through the secant pile walls are expected. Any ingress of water through the secant pile walls should be managed through sealing. The fill materials will essentially be cut-off by the secant pile wall hence likely drawdown within the fill is expected to be very limited. In the unlikely event that there is some dewatering within the fill, we expect that the effects will be insignificant because:

- The perched level measured has likely been affected by the drilling, as can be seen for the ECBF groundwater level. It is therefore expected to be deeper than measured.
- Any drawdown beneath the nearest building, which is 8 m from the shaft will be much less than that at the shaft.
- A 1.5 m fluctuation of the perched groundwater table has been measured in nearby piezometer PZ01 at the corner of Mayoral and Queen Street. Assuming a similar fluctuation has occurred historically, as a minimum, at the location of Marmion Shaft, any settlement due to this fluctuation has already been experienced at the site.

Considering the above, the overall risk for significant dewatering and settlement associated with the perched groundwater identified within the fill, as a result of the proposed works, is considered to be low and easily managed by the monitoring and contingency plan programme that will be proposed and implemented before the start of the works.

The settlement caused by the 5 m of dewatering within the ECBF rock will be negligible, because this formation is practically incompressible under the effective stress increase caused by drawdown.

3.3 HYDRAULIC CONDUCTIVITY

The hydraulic conductivity of the ECBF was estimated from the slug testing in PZ24/03 as 0.029 m/day. This is consistent with the hydraulic conductivity used for the base case scenario of 0.025 m/day.

3.4 BUILDING FOUNDATIONS

An in-depth look at property files for 345-361 Queen Street, the building closest to the excavation indicates that the building is founded on 1.8 m diameter bell piles which are inferred to be founded in rock as it appears to be only a few meters deeper than basement levels and bedrock was encountered at approximately 6 to 6.5 m depth. This is consistent with the Geotechnical report (Tonkin & Taylor, Ref.: 4974, April 1981) attached in Appendix A that recommends piles embedded by at least 1.5 m into the hard Waitematā Group rock (ECBF). The building is inferred to be founded in competent rock and thus unlikely to be subject to damage from settlement of shallow unconsolidated sediments.

Furthermore, the property file shows that the building entrance on Queen Street (next to the Marmion shaft) is at an equivalent of Level 3 on the western side of the building. The basement (carpark) level (Level 1) is indicated at an average elevation of 28 m RL and Level 3 is indicated at an elevation of 35 m RL, which is 3 m below the street level at the Marmion shaft and therefore at least partially founded below the level of dewatering of the perched groundwater table in the fill.

Given the above and our conservative assessment presented in R1 of the report, we consider that the risk for any local effects on non-suspended basement slabs is very low and the effects likely to be negligible.

4 LIMITATIONS

This report ('Report') has been prepared by WSP New Zealand Limited ('WSP') exclusively for Watercare Services Limited ('Client') in relation to the assessment of dewatering effects along the Part 3-6 Link alignment of the Queen Street Wastewater Diversion, for consenting purposes ('Purpose') and in accordance with TO-WSP-65 signed 3 December 2024 ('Agreement'). The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

APPENDIX A – BORELOG BH24/03

Engineering Log Terminology

Common Abbreviations and Symbols

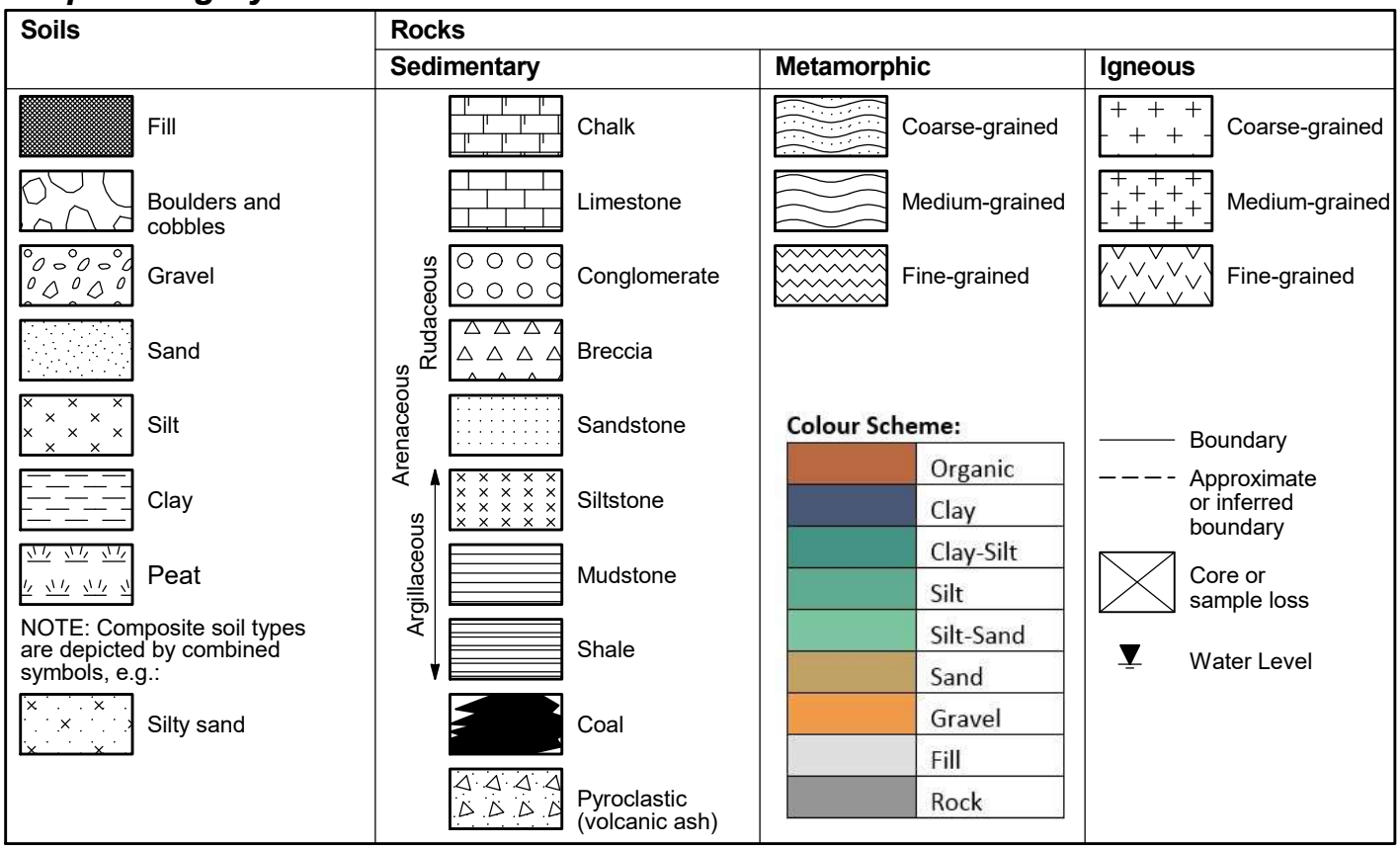
Drilling Method / Sample Type:

DT	Dual Tube	**SPT**	Split Spoon SPT
HA	Hand Auger	**SC**	Solid Cone SPT
HQ	HQ Triple Tube	**PT**	Thin-wall Push Tube
PQ	PQ Triple Tube		
OB	Open Barrel		
SNC	Sonic Drilling		
VE	Vacuum Excavation		
WD	Wash Drilling		

Field / Laboratory Tests:

SV	Field Shear Vane	**UUTx**	Unconsolidated Undrained Triaxial
PP	Pocket Penetrometer	**CUTx**	Consolidated Undrained Triaxial
PSD	Particle Size Distribution	**UCS**	Uniaxial Compressive Strength
Oed	1D Consolidation	**PL**	Point Load

Graphic Log Symbols for Soils and Rocks *(after BS 5930:1981)*



Soil Descriptions

Soil and rock descriptions follow the NZ Geotechnical Society (2005) "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes".

Grain Size Terms

Major	Subdivision	Particle Size
Boulders		> 200 mm
Cobbles		60 mm - 200 mm
Gravel	Coarse	20 mm - 60 mm
	Medium	6 mm - 20 mm
	Fine	2 mm - 6 mm
Sand	Coarse	0.6 mm - 2 mm
	Medium	0.2 mm - 0.6 mm
	Fine	0.06 mm - 0.2 mm
Silt		0.002 mm - 0.06 mm
Clay		< 0.002 mm

Proportional Terms (Coarse Soils)

Fraction	Term	% of soil mass	Example
Major	(UPPER CASE)	Major constituent	GRAVEL
Subordinate	(lower case)	> 20	Sandy
Minor	with some...	12 - 20	with some sand
	with minor...	5 - 12	with minor sand
	with trace of...	< 5	with trace of sand

Consistency / Density Terms

Consistency	S_u (kPa)	Density	R_D (%)	SPT (N)
Very Soft	< 12	Very loose	< 15	< 4
Soft	12 - 25	Loose	15 - 35	4 - 10
Firm	25 - 50	Medium Dense	35 - 65	10 - 30
Stiff	50 - 100	Dense	65 - 85	30 - 50
Very Stiff	100 - 200	Very Dense	> 85	> 50
Hard	> 200	*SPT values are uncorrected*		

Soil Descriptions *(continued)*

Particle Shape Terms:

Rounded	Subrounded	Subangular	Angular
			

Rock and Discontinuity Descriptions

Strength:

ES	Extremely Strong
VS	Very Strong
S	Strong
MS	Moderately Strong
W	Weak
VW	Very Weak
EW	Extremely Weak

Weathering:

UW	Unweathered
SW	Slightly weathered
MW	Moderately weathered
HW	Highly weathered
CW	Completely weathered
RS	Residual soil

Spacing:

VW	Very wide (>2 m)
W	Wide (600 mm - 2 m)
MW	Moderately wide (200 mm - 600 mm)
C	Close (60 mm - 200 mm)
VC	Very close (20 mm - 60 mm)
EC	Extremely close (<20 mm)

Discontinuity Type:

B	Bedding	
J	Joint	
C	Cleavage	
F	Foliation	
DD	Drilling Defect	
GZ	Gouge Zone	
SHZ	Shattered Zone	
SZ	Shear Zone	
CZ	Crush Zone	
DZ	Decomposed Zone	
IZ	Infilled Zone/Seam	

Discontinuity Roughness:

RO	Rough
SM	Smooth
SL	Slickensided

Discontinuity Shape:

ST	Stepped
UN	Undulating
PL	Planar

Discontinuity Aperture:

T	Tight
VN	Very Narrow (0 - 2 mm)
N	Narrow (2 mm - 6 mm)
MN	Moderately Narrow (6 mm - 20 mm)
MW	Moderately Wide (20 mm - 60 mm)
W	Wide (60 mm - 200 mm)
VW	Very Wide (> 200 mm)

Bedding Descriptions

Bedding Thickness Terms:

Term	Thickness
Thinly laminated	< 2 mm
Laminated	2 mm - 6 mm
Very thin	6 mm - 20 mm
Thin	20 mm - 60 mm
Moderately thin	60 mm - 200 mm
Moderately thick	0.2 m - 0.6 m
Thick	0.6 m - 2 m
Very thick	> 2 m

Bedding Inclination Terms:

Term	Inclination
Sub-horizontal	0° - 5°
Gently inclined	6° - 15°
Moderately inclined	16° - 30°
Steeply inclined	31° - 60°
Very steeply inclined	61° - 80°
Sub-vertical	81° - 90°
	From horizontal

Borehole No. BH24-03

Project:	Queen Street Diversions - Part 6	*Coordinates:*	Not established		
Client:	Watercare Service Limited	*Ref. Grid:*	n/a	*Depth:*	22 m
Project No.:	W-SL001.04	*R.L.:*	Not established	*Inclination:*	-90°
Location:	Intersection of Queen St & Marmion St	*Datum:*		*Azimuth:*	0°

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
FILL	Hydro-excavation to 3.00 m. Not Logged.	0.00								VE	0		HQ Size, Triple Tube, Wireline Rotary Coring			
	Clayey SILT, trace sand; mottled light grey, orange, dark brown. Very stiff, moist, low plasticity; sand, fine.	3.00								HQ	100				SWL 2.45m 5/12	
	3.20 - 3.50 m: PUSH TUBE (0.2 m recovery).									PT	100					
	Clayey SILT, trace sand, trace organics; intermixed dark brown, dark orange, light grey. Very stiff, moist, low plasticity; sand fine; organics, rootlets.	3.50	15	4// 3/3/4/5						SPT	78					
		4.00								HQ	100					
	4.50 - 5.00 m: PUSH TUBE (0.35 m recovery).	5.00								PT	70					
East Coast Bays Formation	SILT, some clay, trace sand; light grey mottled dark orange. Firm, wet, low plasticity; sand fine.	5.00	5	1// 1/1/1/2		CW			Lab: Atterberg Limits Moisture Content	SPT	67					
	Sandy SILT, trace clay; light grey mottled orange. Firm, wet, low plasticity; sand, fine, uniformly graded.	6.00								HQ	64					
	6.00 - 6.45 m: CORE LOSS (0.45 m) Sample slipped out of SPT spoon.	6.00	2	0// 0/0/1/1						SPT	0					
	Sandy SILT, trace clay; light grey mottled orange. Firm, wet, low plasticity; sand, fine.	6.45				CW				HQ	100					
	Silty fine SAND, trace clay; mottled light grey and dark orange. Very loose, wet, uniformly graded. 6.85m - Saturated, grades to light grey. 7.00m - Grades to dark grey.	7.00														
	SILT, some clay; dark grey. Firm, wet, low plasticity.	7.45				HW										
	Sandy SILT; dark grey. Firm, wet, low plasticity; sand, fine.	8.00	8	2// 1/2/2/3					Lab: Atterberg Limits Moisture Content	SPT	100					
	SILT, some clay; dark grey. Stiff, wet, low plasticity.	8.45								HQ	52					
	Silty fine SAND, trace clay; dark grey. "Loosely packed", wet, uniformly graded; clay, slightly plastic.	8.50														
	8.50 - 9.00 m: CORE LOSS (0.5 m) Suspect core washed away.	9.00														
	Silty fine SAND, trace clay; dark grey. Medium dense, wet, uniformly graded; clay, slightly plastic.	9.00	15	3// 3/3/4/5					Lab: Atterberg Limits Moisture Content PSD	SPT	100					
	SILT. Very stiff, low plasticity.	9.45				HW										
	SILT. Very stiff, low plasticity.	9.50								HQ	100					
	SILT. Hard, low plasticity.	10.00														

BOREHOLE SOIL/ROCK LOG A4 - WSP W-SL001.04 BH LOGS.GPJ WSP-OPUS2018_TEM.GDT 11/02/25

Notes:

Started:	5/12/2024	*Finished:*	6/12/2024
Drilling Co.:	Drill Force NZ	*Drilling Rig:*	Truck Mounted
Logged by:	RVD	*Checked by:*	BGS

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH24-03

Project:	Queen Street Diversions - Part 6	*Coordinates:*	Not established		
Client:	Watercare Service Limited	*Ref. Grid:*	n/a	*Depth:*	22 m
Project No.:	W-SL001.04	*R.L.:*	Not established	*Inclination:*	-90°
Location:	Intersection of Queen St & Marmion St	*Datum:*		*Azimuth:*	0°

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
East Coast Bays Formation	Moderately weathered, dark grey, fine SANDSTONE. Extremely weak; uncemented. [Silty fine SAND. Very dense, wet, uniformly graded].		50+	13// 13/11/23 for 55mm	EW	MW			10.00m - Loss of circulation started	HQ	100		HQ Size, Triple Tube, Wireline Rotary Coring			
										SPT	100					
	Slightly weathered, dark grey, laminated MUDSTONE. Very weak; bedding, very thin to moderately thin, sub-horizontal (50%). -INTERBEDDED WITH- Slightly weathered, dark grey, fine to coarse SANDSTONE. Very weak, uncemented; bedding, very thin to moderately thin, sub-horizontal (50%).	11			VW	SW		B5 B5 B10 B5 B5 B5	11.01m - B, 5°, RO, PL 11.20m - B, 5°, RO, PL 11.25m - B, 5°, RO, PL 11.45m - B, 10°, RO, PL 11.75m - B, 5°, RO, PL 11.80m - B, 3°, RO, PL 11.90m - B, 3°, RO, PL	HQ	100	61				
	12.00 - 12.30 m: SOLID CONE SPT. No recovery (0.3 m).	12	50+	41// 27/23 for 75mm						SC	0					
	Slightly weathered, dark grey, laminated MUDSTONE. Very weak; bedding, sub-horizontal.				VW	SW										
	Slightly weathered, dark grey, fine to coarse SANDSTONE. Very weak, moderately well cemented. MUDSTONE. Very weak.	13			VW	SW		B3 SHZ B5	12.60m - B, 3°, RO, PL 12.65m - SHZ, 5°, RO, ST 12.95m - DD 13.05m - DD	HQ	100	100				
	13.50 - 13.65 m: SOLID CONE SPT. No recovery (0.15 m).		50+	50 for initial 145mm						SC	0					
	Slightly weathered, dark grey, fine to coarse SANDSTONE. Very weak, moderately well cemented. MUDSTONE. Very weak.	14							Lab: UCS 14.00m - DD	HQ	97	97				
	MUDSTONE. Very weak. MUDSTONE. Very weak. MUDSTONE. Very weak.	15							14.45m - DD 14.70m - DD 15.20m - DD 15.60m - DD	HQ	100	100				
	MUDSTONE. Very weak. 15.82m - Grades to fine sandstone. 15.96m - Grades to fine to coarse sandstone.	16							15.85m - DD 16.11m - DD 16.15m - DD Lab: UCS						SWL 0.88m 5/12	
	MUDSTONE. Very weak.								16.35m - DD						SWL 8.21m 6/12	
	MUDSTONE. Very weak.	17			VW	SW			16.77m - DD 16.81m - DD 16.84m - SHZ, RO, ST Lab: UCS	HQ	100	93				
	Slightly weathered, dark grey, laminated MUDSTONE. Very weak; bedding, laminated to moderately thin, sub-horizontal (65%). -INTERBEDDED WITH- Slightly weathered, dark grey, fine to coarse SANDSTONE. Very weak, uncemented; bedding, very thin to moderately thin, sub-horizontal (35%).							B5	17.18m - B, 5°, RO, PL 17.43m - DD 17.50m - DD 17.80m - B, 5°, RO, ST 17.88m - DD 18.03m - DD							
	Slightly weathered, dark grey, fine to coarse SANDSTONE. Very weak, moderately well cemented.	18														
	Slightly weathered, dark grey, laminated MUDSTONE. Very weak; bedding, laminated to moderately thin, sub-horizontal (80%). -INTERBEDDED WITH- Slightly weathered, dark grey, fine SANDSTONE. Very weak, uncemented; bedding, very thin to moderately thin, sub-horizontal (20%).	19						B5 B5 B8	18.74m - DD 18.81m - DD 18.88m - DD Lab: UCS 19.03m - B, 5°, RO, PL 19.16m - B, 5°, RO, UN 19.38m - B, 8°, RO, PL 19.45m - B, 5°, RO, PL	HQ	100	100				
										HQ	92	23				

BOREHOLE SOIL/ROCK LOG A4 - WSP W-SL001.04 BH LOGS.GPJ WSP-OPUS2018_TEM.GDT 11/02/25

Notes:

Started:	5/12/2024	*Finished:*	6/12/2024
Drilling Co.:	Drill Force NZ	*Drilling Rig:*	Truck Mounted
Logged by:	RVD	*Checked by:*	BGS

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH24-03

Project:	Queen Street Diversions - Part 6	*Coordinates:*	Not established		
Client:	Watercare Service Limited	*Ref. Grid:*	n/a	*Depth:*	22 m
Project No.:	W-SL001.04	*R.L.:*	Not established	*Inclination:*	-90°
Location:	Intersection of Queen St & Marmion St	*Datum:*		*Azimuth:*	0°

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
East Coast Bays Formation	Slightly weathered, dark grey, laminated MUDSTONE. Very weak; bedding, laminated to moderately thin, sub-horizontal (80%). -INTERBEDDED WITH- Slightly weathered, dark grey, fine SANDSTONE. Very weak, uncemented; bedding, very thin to moderately thin, sub-horizontal (20%).*(continued)*					VW	SW				HQ	92	23				
	Cumulative CORE LOSS throughout drill run (0.12 m)	21								Lab: UCS 21.20m - DD							
	Slightly weathered, dark grey, fine to coarse SANDSTONE. Very weak, moderately well cemented.					VW	SW				HQ	100	95			SWL 12.66m 6/12	
	END OF BOREHOLE AT 22m - Target Depth Reached	22								21.79m - DD 21.81m - DD 21.97m - DD							
		23															
		24															
		25															
		26															
		27															
		28															
		29															

BOREHOLE SOIL/ROCK LOG A4 - WSP W-SL001.04 BH LOGS.GPJ WSP-OPUS2018_TEM.GDT 11/02/25

Notes:

Started:	5/12/2024	*Finished:*	6/12/2024
Drilling Co.:	Drill Force NZ	*Drilling Rig:*	Truck Mounted
Logged by:	RVD	*Checked by:*	BGS

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH24-03

Project:	Queen Street Diversions - Part 6	*Coordinates:*	Not established		
Client:	Watercare Service Limited	*Ref. Grid:*	n/a	*Depth:*	22 m
Project No.:	W-SL001.04	*R.L.:*	Not established	*Inclination:*	-90°
Location:	Intersection of Queen St & Marmion St	*Datum:*		*Azimuth:*	0°

PHOTOGRAPHS

Photo BH24-03.1
Box 1 0.0 - 7.0 m

Photo BH24-03.2
Box 2 7.0 - 10.5 m

BOREHOLE SOIL/ROCK LOG A4 - WSP W-SL001.04 BH LOGS.GPJ WSP-OPUS2018_TEM.GDT 11/02/25

Notes:

Started:	5/12/2024	*Finished:*	6/12/2024
Drilling Co.:	Drill Force NZ	*Drilling Rig:*	Truck Mounted
Logged by:	RVD	*Checked by:*	BGS

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH24-03

Project:	Queen Street Diversions - Part 6	*Coordinates:*	Not established		
Client:	Watercare Service Limited	*Ref. Grid:*	n/a	*Depth:*	22 m
Project No.:	W-SL001.04	*R.L.:*	Not established	*Inclination:*	-90°
Location:	Intersection of Queen St & Marmion St	*Datum:*		*Azimuth:*	0°

PHOTOGRAPHS

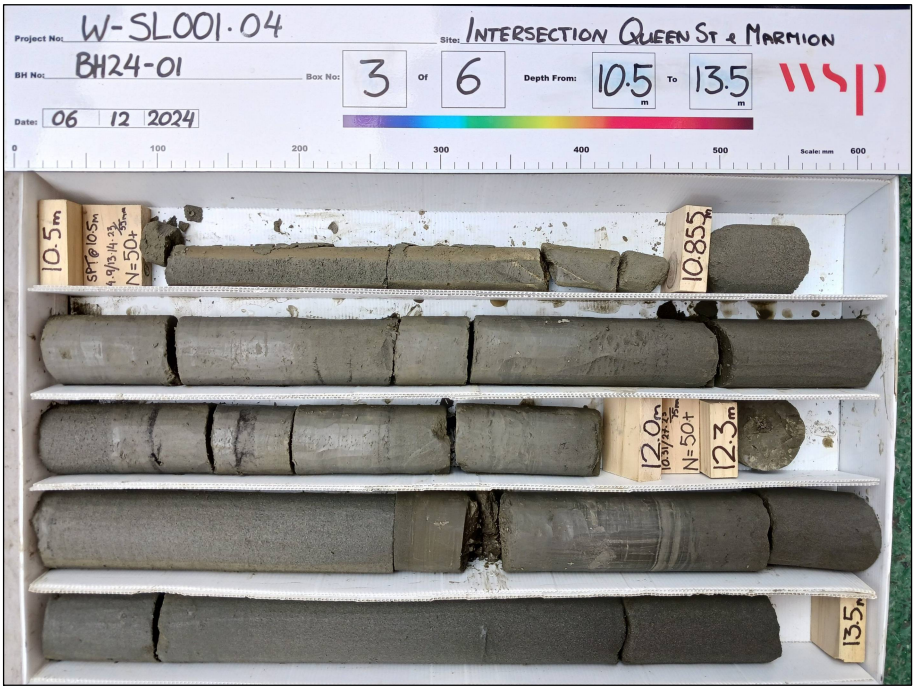


Photo BH24-03.3
Box 2 7.0 - 10.5 m

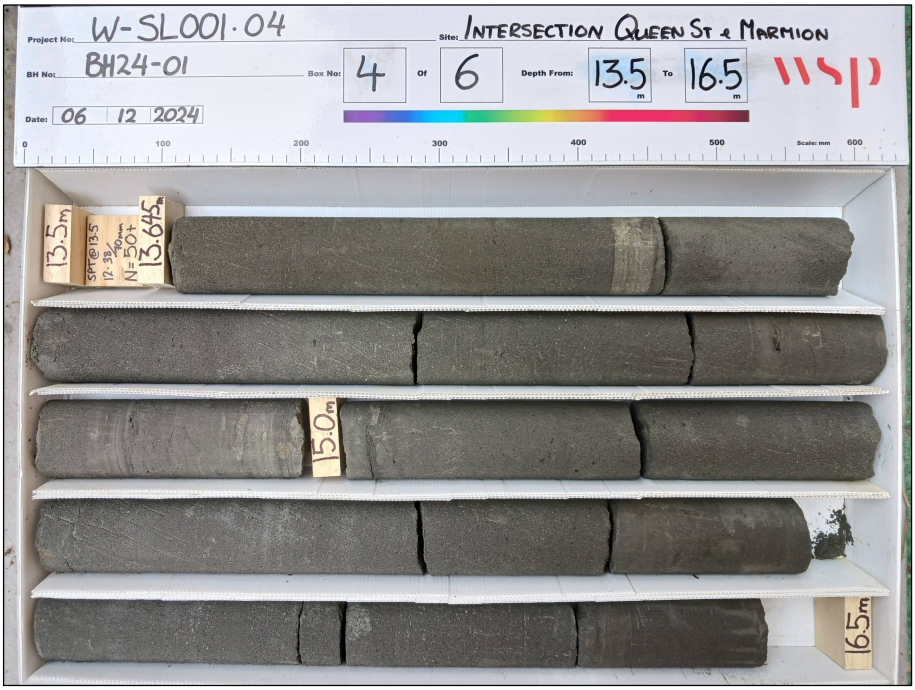


Photo BH24-03.4
Box 2 7.0 - 10.5 m

Notes:

Started:	5/12/2024	*Finished:*	6/12/2024
Drilling Co.:	Drill Force NZ	*Drilling Rig:*	Truck Mounted
Logged by:	RVD	*Checked by:*	BGS

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH24-03

Project:	Queen Street Diversions - Part 6	*Coordinates:*	Not established		
Client:	Watercare Service Limited	*Ref. Grid:*	n/a	*Depth:*	22 m
Project No.:	W-SL001.04	*R.L.:*	Not established	*Inclination:*	-90°
Location:	Intersection of Queen St & Marmion St	*Datum:*		*Azimuth:*	0°

PHOTOGRAPHS

Photo BH24-03.5
Box 2 7.0 - 10.5 m

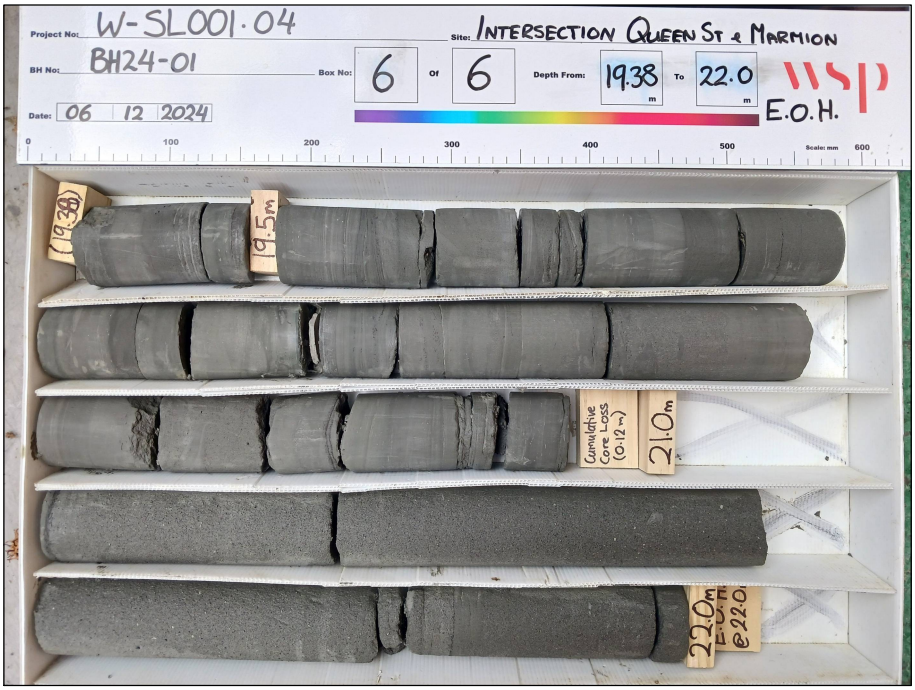


Photo BH24-03.6
Box 2 7.0 - 10.5 m

Notes:

Started:	5/12/2024	*Finished:*	6/12/2024
Drilling Co.:	Drill Force NZ	*Drilling Rig:*	Truck Mounted
Logged by:	RVD	*Checked by:*	BGS

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

APPENDIX B – GEOTECHNICAL REPORT, TONKIN & TAYLOR, 1981

TONKIN & TAYLOR

CONSULTING ENGINEERS
REGISTERED SURVEYORS AND TOWN PLANNERS
47 George Street, Auckland 1, New Zealand. P.O. Box 5271
Telephone: 771-865 Telex: NZ 21594 Cable: TONTAY

PROPOSED NEW SIX STOREY

OFFICE BLOCK

SOIL INVESTIGATION

345 - 361 Queen St.

REF: 4974

APRIL 1981

PREPARED FOR:

Mr C.R. O'Grady
Consulting Structural Engineer
4 Library Building Offices
Pakuranga Town Centre
PAKURANGA

DISTRIBUTION:

Mr C.R. O'Grady - 2 Copies
Tonkin & Taylor (file) - 2 Copies

REPORT

1.0 INTRODUCTION

This report presents the results of a soils investigation for a new building at the corner of Queen Street and Mayoral Drive. We understand the building is to be a six storey reinforced concrete frame structure with a floating ground floor slab and fairly wide spaced columns.

The investigation has been carried out at the request of Mr C.R. O'Grady, the Consulting Structural Engineer for the project. A letter outlining the proposed investigation and giving an estimate of the total cost was forwarded to Mr O'Grady and authority to proceed with the investigation was given in a letter dated 13 March 1981 from Chase Group, the site developers.

2.0 SCOPE OF INVESTIGATION AND PROCEDURES USED

Four boreholes were put down at the site at the locations shown on the layout plan enclosed in this report (Drawing 4974-1). The boreholes were put down by Brown Bros. Ltd using a truck mounted rotary drilling rig and Bores 1 to 3 were advanced with an open barrel sampler till hard stratum was encountered. A triple tube core barrel was then used to advance the holes into this hard material.

Standard penetration testing was carried out at regular intervals in the harder Waitemata materials found in Bore 3 where they consisted of dense, slightly to moderately cemented sands and an auxiliary borehole, 1P, was put down adjacent to Bore 1 to facilitate in situ pressuremeter testing of the Waitematas.

Selected pieces of open barrel and triple tube core were sealed and returned to our office for later inspection. All field work was carried out under the full time supervision of one of our technicians who was responsible for logging the cores and the in situ testing.

The soil profiles logged from the boreholes are shown on the borelog sheets which also show the standard penetration and in situ pressuremeter test results.

3.0 SOIL CONDITIONS

All boreholes show a layer of fill approximately 1 m thick overlying original ground at the site. This fill consists mainly of a scoriaceous gravel but in Bore 3 a generally stiff clay material was found overlying the original topsoil layer.

Below the fill a silty clay, of stiff strength was encountered to about 2 m depth overlying dense, weakly cemented silty sand layers of the weathered Waitemata Series. These silty sands were noted in all boreholes to become increasingly, and more uniformly, cemented with depth and were recorded as hard at about 6 m depth. Well cemented sandstones and siltstones of the Waitemata Series were encountered at about 9 m depth.

In spite of the marked variations in ground level of the site the nature of the Waitemata materials appears fairly consistent and with the exception of a small fractured zone encountered at depth in Bore 1 long lengths of intact core were recovered. The material logged between about 6-9 m depth consists essentially of a very dense silty sand containing occasional weakly to moderately cemented zones. The standard penetration N values obtained in this material were in excess of 100 and reflect its high in situ density.

A dip meter was used to obtain groundwater levels in the boreholes and the watertable was found to lie about 6 m below existing ground level. It should be noted however, that the watertable may be somewhat closer to the surface during the winter months especially at the lower part of the site bordering Myers Park.

4.0 FOUNDATION CONSIDERATIONS

We understand that column loadings have yet to be finalised but that bored and cast in situ pile foundations have already been chosen as the means of support for the building. We would agree that for a building of this magnitude and type, bored piles founded in the hard Waitemata materials seem the best option.

The piles could be either belled or straight sided but in any event we recommend that the piles should be taken at least 1.5 m into the hard Waitematas found at an average depth of 6 m in the boreholes. We also recommend that in calculating the skin friction component the top 1 m of the hard Waitematas should be ignored. For the design of these piles we recommend that the following soil properties be used:

ultimate end bearing pressure = 5000 kPa

ultimate skin friction = 200 kPa

For static loads a safety factor of 3 should be applied to the above loads in order to obtain allowable values. For seismic loading the appropriate safety factors are obtainable from the current code.

The appropriate founding levels for all piles cannot be predicted with certainty from the borehole information and allowance should be made for the fact that some piles may need to be taken somewhat deeper than 2 m below the upper level of the hard Waitematas as indicated on our borelogs.

We understand that the piles themselves are intended to provide resistance to lateral loading from wind and seismic forces. In this situation there would appear to be advantages in using large diameter piles without belling to provide sufficient bending strength in the upper part of the pile.

5.0 LIMITATION

Recommendations and opinions contained in this report are based upon data from boreholes. Inferences about the nature and continuity of subsoil away from boreholes are made but cannot be guaranteed.

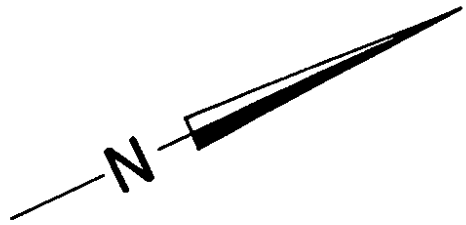
It is in all parties interests that we be retained to examine the site during foundation construction so that exposed subsoil can be compared with the report assumptions. In all circumstances, however, if variations in the subsoil occur which differ from that described or assumed to exist then the matter should be referred back to us.

This report has been prepared for the particular project described in the brief to us and no responsibility is accepted for the use of any part of this report in other contexts or for any other purpose.

G.A. Pickens

TONKIN & TAYLOR
Consulting Civil Engineers
& Registered Surveyors

Encl. Drawing 4974-1
Borelogs 1 to 3



MAYORAL DRIVE

LEGEND

T&T Machine Boreholes

REF. ANGUS Construction limited

No drawing number.

SCALE - 1 : 200

CHASE HOLDINGS LTD. DEVELOPMENT CNR. QUEEN ST. /MAYORAL DR.- AUCKLAND *Borehole Location Plan*	**TONKIN & TAYLOR** CONSULTING ENGINEERS AND REGISTERED SURVEYORS 47 GEORGE ST. NEWMARKET	DRAWING No. 4974 - 1 DATE APRIL 1980

Lap 10595

TEST RESULTS

SOIL TESTING FOR THIS INVESTIGATION HAS BEEN UNDERTAKEN BY **GEOTECHNICS LTD** OF AUCKLAND IN TERMS OF ITS REGISTRATION GRANTED BY —
THE TESTING LABORATORY REGISTRATION COUNCIL OF NEW ZEALAND

TEST RESULTS PRESENTED ON THE APPENDED SHEETS ARE TAKEN FROM A TELARC ENDORSED REPORT PROVIDED BY **GEOTECHNICS LTD.**

BOREHOLE LOGS AND TEST RESULTS
APPENDIX OF TERMS

SOIL DESCRIPTIONS

General: The descriptive system used is based mainly on grain size and comments on geological origin are supplementary

Soil Types and Symbols:

Symbol	Description
	limestone
	volcanic rock
	sandstone
	siltstone or mudstone
	cemented
	gravel (size > 2mm)
	sand (size 0.06 to 2.0 mm)
	silt (size 0.002 to 0.06 mm)
	clay (size < 0.002 mm)
	peat
	fill

These symbols are similar to those of the Unified Classification System (U.S.A.). They are adapted in some instances to denote soils not completely described in the adjacent table.

example

sandy clay

silty sand

Soil Strengths (cohesive)

Term	Undrained Shear Strength (kPa)
very soft	0 – 12
soft	12 – 25
medium	25 – 50
firm	50 – 100
stiff	100 – 200
hard	200 – 400
stone strength	>400

SOIL COLOURS

Colours, for purposes of description, have been simplified to light, standard and dark shades of red, pink, yellow, orange, brown, grey, green, blue and purple together with plain white and black.

ABBREVIATIONS

●	undrained triaxial test result	W_L	liquid limit
○	ditto – sample remoulded	PSD	particle size determination
■	laboratory vane test result	CONS	consolidation test
□	ditto – sample, remoulded	COMP	compaction test
N	blows per foot, standard penetration test (SPT)	Q	compressive strength
		Cu ϕu	undrained triaxial test (set)
B	blows per 3 feet for 3" open barrel driven as for S.P.T. test	C' ϕ'	effective stress triaxial test
		γ mm	max./min. density test
▽	recorded water level	k	permeability coefficient
W	natural moisture content	S.L.	shrinkage limit
W_p	plastic limit	O.C.	organic content
St	sensitivity	ρ	bulk density

SAMPLE TYPES

●	open barrel		large diameter thin walled tube (10 cm. or greater)
◎	double or triple barrel		small diameter thin walled tube
	standard penetration test	O	disturbed sample
△	block		

SITE: MAYORAL

BOREHOLE No. 1, 1P

JOB No: 4974 DATE DRILLED: 25, 27/3/81 RL GROUND: 32.6m

SHEET 1 OF 2

DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH K Pa (✳ Menard Pressuremeter; 200 300 400)	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS (%) (W_P W W_L)
FILL, scoria/gravels to 200mm		1			
CLAY, silty, stiff, yellow with occasional light grey pockets		2			
SILT, slightly clayey, stiff, dark yellow becoming more clayey with sandy layers, hard, grey		3			
SAND, silty, dense, grey becoming very dense with occasional hard slightly cemented clay layers (start of hard Waitematas) becoming moderately cemented in layers, slightly silty		4 5 6 7	31/3/81		
numerous horizontal fractures at 250mm intervals occasional cemented sand layers of stone strength		8 9 10 11 12 13			

NOTES:

DRILL METHOD: ROTARY RIG

SITE: MAYORAL

BOREHOLE No. 1, 1P

JOB No: 4974 DATE DRILLED: 25, 27/3/81 RL GROUND: 32.6m

SHEET 2 OF 2

DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH K Pa	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS (%) W_P W W_L
		14	◉		
SANDSTONE, slightly silty, grey		15			
		16	◉		
		17			
		18	◉		
SILTSTONE, slightly sandy, grey		19	◉		
		20	◉		
END OF BOREHOLE 20.3m					

NOTES:

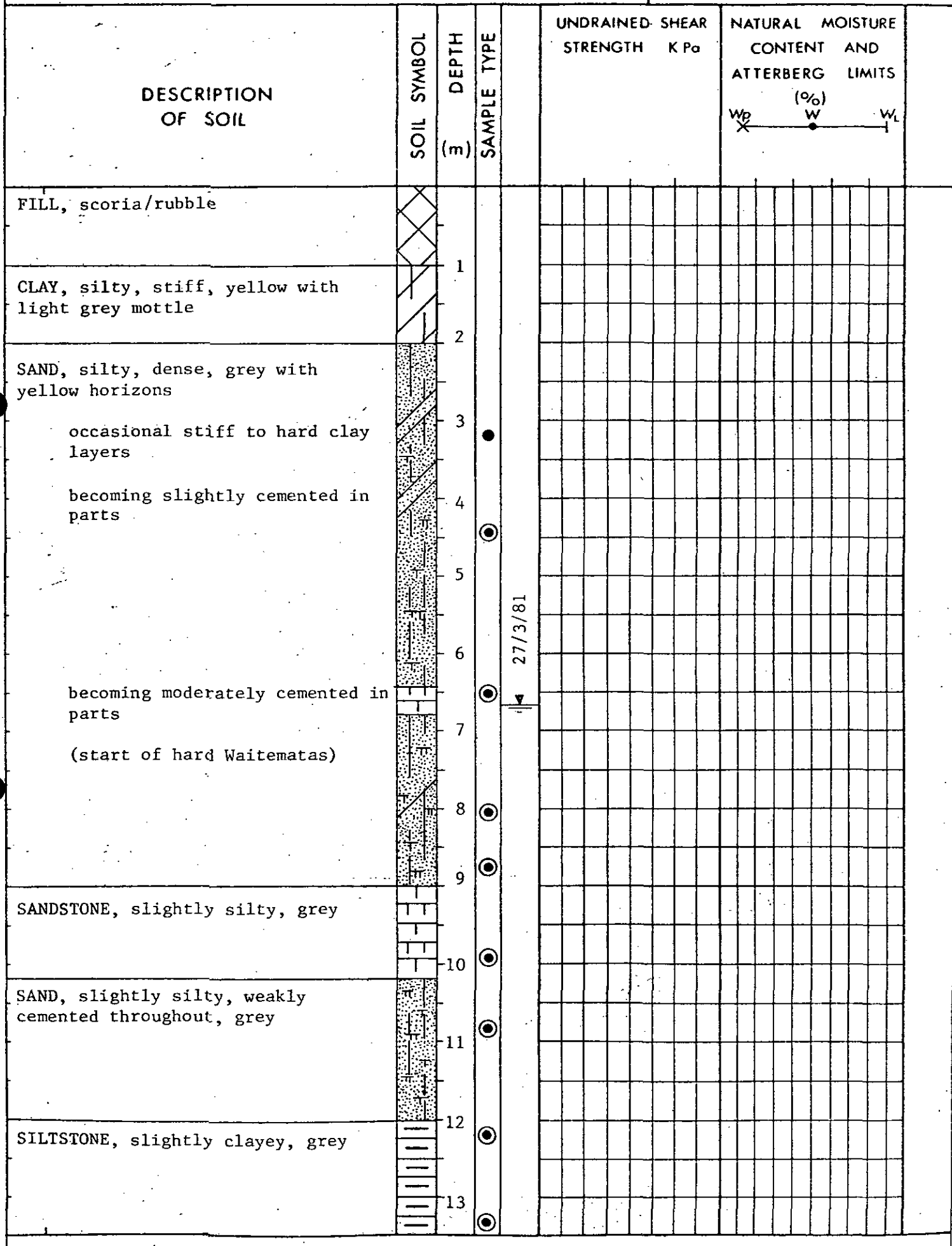
DRILL METHOD: ROTARY RIG

SITE: MAYORAL

BOREHOLE No. 2

JOB No: 4974 DATE DRILLED: 26/3/81 RL GROUND: 32.6m

SHEET 1 OF 2



NOTES:

DRILL METHOD: ROTARY RIG

TONKIN & TAYLOR CONSULTING CIVIL AND FOUNDATION ENGINEERS

SITE: MAYORAL

BOREHOLE No. 2

JOB No: 4974 DATE DRILLED: 26/3/81 RL GROUND: 32.6m

SHEET 2 OF 2

DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH K Pa	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS (%) W_P W W_L
SANDSTONE (as above)					
SILTSTONE (as above)		14	◉		
SANDSTONE					
SILTSTONE		15	◉		
END OF BOREHOLE 15.0m		16			

NOTES:

DRILL METHOD: ROTARY RIG

SITE: MAYORAL

BOREHOLE No. 3

JOB No: 4974 DATE DRILLED: 30,31/3/81 RL GROUND: 25.6m

SHEET 1 OF 1

DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	UNDRAINED SHEAR STRENGTH K Pa	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS (%) W_P W W_L
FILL, clay, silty, stiff, yellow					
SILT, organic, brown					
CLAY, silty, stiff, yellow with grey pockets		1			
SILT, sandy, firm to stiff, yellow with grey clayey pockets		2			
CORE LOST					
SILT as above but becoming more clayey, stiff to hard		3			
SAND, silty, dense, grey		4			
becoming weakly cemented throughout		5	>100 31/3/81		
becoming moderately cemented in layers, hard		6			
(start of hard Waitematas)		7	>100		
		8			
		9	>100		
SANDSTONE, slightly silty, grey		10			
		11	>100		
		12			
			>100		
END OF BOREHOLE 12.5m					

NOTES:

DRILL METHOD: ROTARY RIG