SAWREY
CONSULTING ENGINEERS LTD

Petone Recreation Ground Grandstand

Detailed Seismic Assessment

For Hutt City Council

Volume 2: Appendices
Appendix A – Building Act Excerpt
Appendix B – Engineering Assessment Summary Report
Appendix C – CSI Report on Structural Investigation
Appendix D – Tetratech Coffey Report on Geotechnical Investigation

Project 10131

July 2023

Appendix A – Earthquake Prone Building Definition

The building acts definition of an earthquake prone building is:

133AB Meaning of earthquake-prone building

1) A building or a part of a building is earthquake prone if, having regard to the condition of the building or part and to the ground on which the building is built, and because of the construction of the building or part,—
   a) the building or part will have its ultimate capacity exceeded in a moderate earthquake; and Reprinted as at 1 December 2017 Building Act 2004 Part 2 s 133AB 127
   b) if the building or part were to collapse, the collapse would be likely to cause—
      i) injury or death to persons in or near the building or on any other property; or
      ii) damage to any other property.
2) Whether a building or a part of a building is earthquake prone is determined by the territorial authority in whose district the building is situated: see section 133AK.
3) For the purpose of subsection (1)(a), **ultimate capacity** and **moderate earthquake** have the meanings given to them by regulations.

Compare: 1991 No 150 s 66

Section 133AB: inserted, on 1 July 2017, by section 24 of the Building (Earthquake-prone Buildings) Amendment Act 2016 (2016 No 22).

Appendix B – Engineering Assessment Summary Report

1. Building Information	
Building Name/ Description	Petone Recreational Ground Grandstand
Street Address	12 Kirks Avenue Petone
Territorial Authority	Hutt City Council
No. of Storeys	Approximately Three storeys, ground floor facilities, first floor offices, and first to third floor grandstand seating.
Area of Typical Floor (approx.)	The ground floor area is approximately 510m^2
Year of Design (approx.)	1939 by John S Swan and WM E Lavelle Registered Architects and built by Nicholls and Pearce for the Petone Borough Council.
NZ Standards designed to	NZSS 95:1935 / NZSS 95:1939
Structural System including Foundations	Shallow foundations including pads, ground beams and strip footings. Concrete ground floor slab. Reinforced concrete frames with varying brick infill. Steel trusses, posts and roof bracing with corrugated metal roofing. Note: Most ground floor concrete walls shown on the original drawings were built as URM infill walls.
Does the building comprise a shared structural form or shares structural elements with any other adjacent titles?	No
Key features of ground profile and identified geohazards	3m-6m crust overlaying liquefiable soils at depth. 200kPa at underside of slab and 300kPa at the underside of footings.
Previous strengthening and/ or significant alteration	Seismic strengthening to the roof undertaken in 1979 designed by Spencer Holmes Miller and Jackson. Seismic strengthening to 34%NBS undertaken in 2014 designed by Sawrey Consulting Engineers. No documentation was found for alterations to the changing rooms and facilities on the ground floor that appear to have been designed and built in the 1970's.
Heritage Issues/ Status	Not a heritage building.
Other Relevant Information	None

2. Assessment Information	
Consulting Practice	Sawrey Consulting Engineers Ltd
CPEng Responsible, including: • Name • CPEng number • A statement of suitable skills and experience in the seismic assessment of existing buildings[1]	• Stephen Sawrey • CPEng Registration Number 68541 • Professional Structural Engineer since 1980. • 40 years' experience in the assessment of earthquake risk buildings. • Earthquake Risk Building seminars, Earthquake Conferences etc. • Assessment of earthquake damaged buildings in Canterbury and Wellington • Experience in Detailed Seismic Assessments, Initial Seismic Assessments, intrusive investigations; and seismic strengthening projects.
Documentation reviewed, including: • date/ version of drawings/ calculations[2] • previous seismic assessments	• Original drawings by John S Swan and WM E Lavelle Registered Architects 1939. • Drawings for the Seismic strengthening to the roof undertaken in 1979 by Spencer Holmes Miller and Jackson. • Report. Previous ISA report by GHD in March 2014. • Report. Previous DSA report and calculations by Sawrey Consulting Engineers in June 2014. • Drawings & Calculations. Seismic strengthening to 34%NBS undertaken in 2014 by Sawrey Consulting Engineers. Ref 8757 S000o,S101o, S102o, S201o, S202A, S301o, S302o, S303o. S304o, S401o, S402o, S403o, S404o, S405o, S406o. • Report. Previous ISA report by Sawrey Consulting Engineers in April 2020. • Report. Independent Concrete and Reinforcing Investigation Report; Project: Kirks Avenue, Petone Rec Grandstand by Concrete Structure Investigations Ltd, 2 June 2023.
Geotechnical Report(s)	Petone Recreation Grandstand - Geotechnical Investigation and Assessment Reference: 773-WLGGE317986 by Tetra Tech Coffey Rev-1 21 April 2023.
Date(s) Building Inspected and extent of inspection	One inspection of the inside and outside of the building were carried out on 21 February 2023. Site meeting and walkover inspection with other consultants one in March 2023 and one in May 2023.
Description of any structural testing undertaken and results summary	• Core testing to concrete samples – chloride testing and compressive strength testing. Results: f'c = 35MPa, "unlikely that chloride is a contributing factor regarding corrosion". • Measuring reinforcing and structural steel thicknesses after rust has been removed. Worst locations are 3% to 40% remaining steel. • Measurement of cover concrete thicknesses. Worst locations 10 to 30mm.
Previous Assessment Reports	• Previous ISA report by GHD in March 2014. • Previous DSA report and calculations by Sawrey Consulting Engineers in June 2014. • Previous ISA report by Sawrey Consulting Engineers in April 2020.
Other Relevant Information	NA

---

[1] This should include reference to the engineer's Practice Field being in Structural Engineering, and commentary on experience in seismic assessment and recent relevant training

[1] Or justification of assumptions if no drawings were able to be obtained

3. Summary of Engineering Assessment Methodology and Key Parameters Used	
Occupancy Type(s) and Importance Level	Major Structures (affecting crowds). Importance level IL3.
Site Subsoil Class	D
For an ISA:	
Summary of how Part B was applied, including: • Key parameters such as μ, S_p and F factors • Any supplementary specific calculations	N/A
For a DSA:	
Summary of how Part C was applied, including: • the analysis methodology(s) used from C2 • other sections of Part C applied	• Section C2 Assessment Procedures and Analysis, • Pseudo Pushover Analysis on some URM Infill Walls • Model Response Spectra Analysis • Strut & Tie Analysis on URM Walls & Selected Concrete Walls • Section C6 Structural Steel Buildings • Section C5 Concrete Buildings
Other Relevant Information	N/A

<table>
<tr><th colspan="3">4. Assessment Outcomes</th></tr>
<tr><td>Assessment Status
(Draft or Final)</td><td colspan="2">Final</td></tr>
<tr><td>Assessed <i>%NBS</i> Rating</td><td colspan="2">20% NBS (IL3)</td></tr>
<tr><td>Seismic Grade and Relative Risk (from Table A3.1)</td><td colspan="2">D</td></tr>
<tr><td><u>For an ISA:</u></td><td colspan="2"></td></tr>
<tr><td>Describe the Potential Critical Structural Weaknesses</td><td colspan="2">NA</td></tr>
<tr><td>Does the result reflect the building's expected behaviour, or is more information/ analysis required?</td><td colspan="2">NA</td></tr>
<tr><td>If the results of this ISA are being used for earthquake prone decision purposes, and elements rating <34%NBS have been identified:</td><td>Engineering Statement of Structural Weaknesses and Location

NA</td><td><i>Mode of Failure and Physical Consequence Statement(s)</i>

NA</td></tr>
<tr><td><u>For a DSA:</u></td><td colspan="2"></td></tr>
<tr><td>Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed</td><td colspan="2">Further investigation recommended.</td></tr>
<tr><td>Describe the Governing Critical Structural Weakness</td><td colspan="2">• Link beam at the first-floor level.
• Transverse walls supporting the roof.
• Bleacher portal frames.
• Rear wall.</td></tr>
<tr><td>If the results of this DSA are being used for earthquake prone decision purposes, <u>and</u> elements rating <34<i>%NBS</i> have been identified (including Parts)[3]:</td><td>Engineering Statement of Structural Weaknesses and Location

Refer table 9 in Section 4.</td><td><i>Mode of Failure and Physical Consequence Statement(s)</i>

<i>Refer table 9 in Section 4.</i></td></tr>
<tr><td>Recommendations
(<i>optional for EPB purposes</i>)</td><td colspan="2"></td></tr>
</table>

---

[3] Indicate what form should the DSA take/ what the specific areas to focus on are

[3] If a building comprises a shared structural form or shares structural elements with other adjacent titles, information about the extent to which the low scoring elements affect, or do not affect the structure.

Appendix C – CSI Report on Structural Investigation

Independent Concrete and Reinforcing Investigation Report

Project: Kirks Avenue, Petone Rec Grandstand

Engineer	***Sawrey Consulting Engineers Ltd.***	
	Attn: Uriah McCall	
Date:	***2/06/2023***	

This report has been prepared for Sawrey Consulting Engineers Ltd. by Concrete Structure Investigations Limited under a specific brief and terms of engagement. Where not covered by those terms, the ACENZ document "Conditions of Contract for Consultancy Services" (2009) are deemed to apply. Our liability under these terms does not extend to third parties. No part of this report including the whole of same shall be used for any other purpose or by any third party without the prior written consent of CSI Ltd.

Job Number: 224181

Professional Procedure

This report was written by:

Daniel Traeger (Job Manager)

Email: daniel@csiscan.nz
Phone: +64 (0) 27 2305843
Public Key SHA1 Digest: B8 24 C7 BD CD 5C 40 45 EA 56 7A 8F D4 E5 B0 F3 81 86 B7 71 99

This report was reviewed by:

Farhaad Ali
Email: farhaad@csiscan.nz
Phone: +64 (0) 274443558
Public Key SHA1 Digest: 7C DD 4D 70 4D 98 B6 DD 9E E5 C4 A1 D5 5C F3 AD 5F C2 6B 8B

Table of Contents

Table of Figures

1 Project Scope

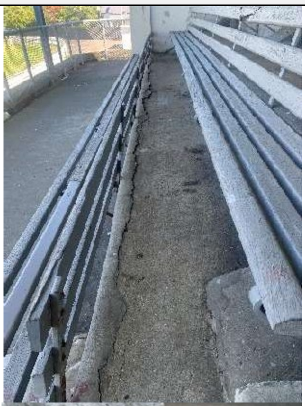
Concrete Structure Investigations Limited (CSI) were engaged by Sawrey Consulting Engineers Ltd to undertake a condition survey at the Rec Grandstand, Petone.

The scope of works was developed in cooperation between Sawrey Consulting Engineers Ltd. and CSI. The scope consists of the items as follows:

Item / Position	Photos / Locations	Scope
1a. End of concrete wall. Near col 13 Near Grids AZ Above bleachers	 	• Remove concrete around bars • Polish bars and measure remaining cross section • Make good with Sika product (412/910N)

1b. Near col 18 Near grids FZ Above bleachers		• Remove concrete around bars • Polish bars and measure remaining cross section • Make good with Sika product (412/910N)
2a. Steel column Near col 6 Near grids F6 Above bleachers		• Visual inspection to determine up to what height replacement may be required (Above lintel on North face) • Confirm (original) cross section of steel where no rust is apparent

2b. Near col 1 Near grids AX Above Bleachers		• Visual inspection to determine up to what height replacement may be required (Above lintel on North face) • Confirm (original) cross section of steel where no rust is apparent

3a – 3d. Beam at columns 2-5 at grids C3 Above bleachers	 	<u>Main bars:</u> • Remove corroded material at worst main bar • Measure remaining cross section • Make good with Sika product <u>Stirrups:</u> • Remove corroded material at worst stirrup bar • Measure remaining cross section • Make good with Sika product (412/910N)
4. Beam between col 1 and col 6. Along grid X between grids X1 and X3. Above bleachers	 	• Measure the remaining stirrup steel where there are 3 or more stirrups in a row which are exposed. • Measure the remaining main bar steel at the outside corner above columns 2 - 5 and at the position of most sever corrosion. • Make good with Sika product (412/910N)

5. Cantilever RC slab Near col 4 Near grids D4 Above bleachers		• Measurements of remaining steel in exposed bars perpendicular to the balustrade • Make good with Sika product (412/910N)
6. Chloride testing		• Compare chloride content between the North and the South face to establish whether sea-spray is a contributing factor for the deterioration of the structure • Chloride testing at random locations to establish if chloride contributes to the deterioration of the structure • Make good with Sika product (412/910N)
7. Original concrete wall		Compressive strength testing on original concrete • Remove plaster to confirm original concrete • Extract core to meet standard • Make good with Sika product (412/910N)

8. Transverse brick walls at ground floor, walls 2 to 8 and 4 to 10		Confirmation that either • the brick wall continues to the underside of the concrete bleacher beam, or • there is a concrete confinement beam at the top of the wall.
9. Lintel/beam over the corridor next to column 10		Confirm reinforcing steel size & position • Break out to determine bar size • Make good with Sika product (412/910N) • Scan to determine the number of bars for the bottom layer (if possible)

2 Building Plans and Scanning Locations

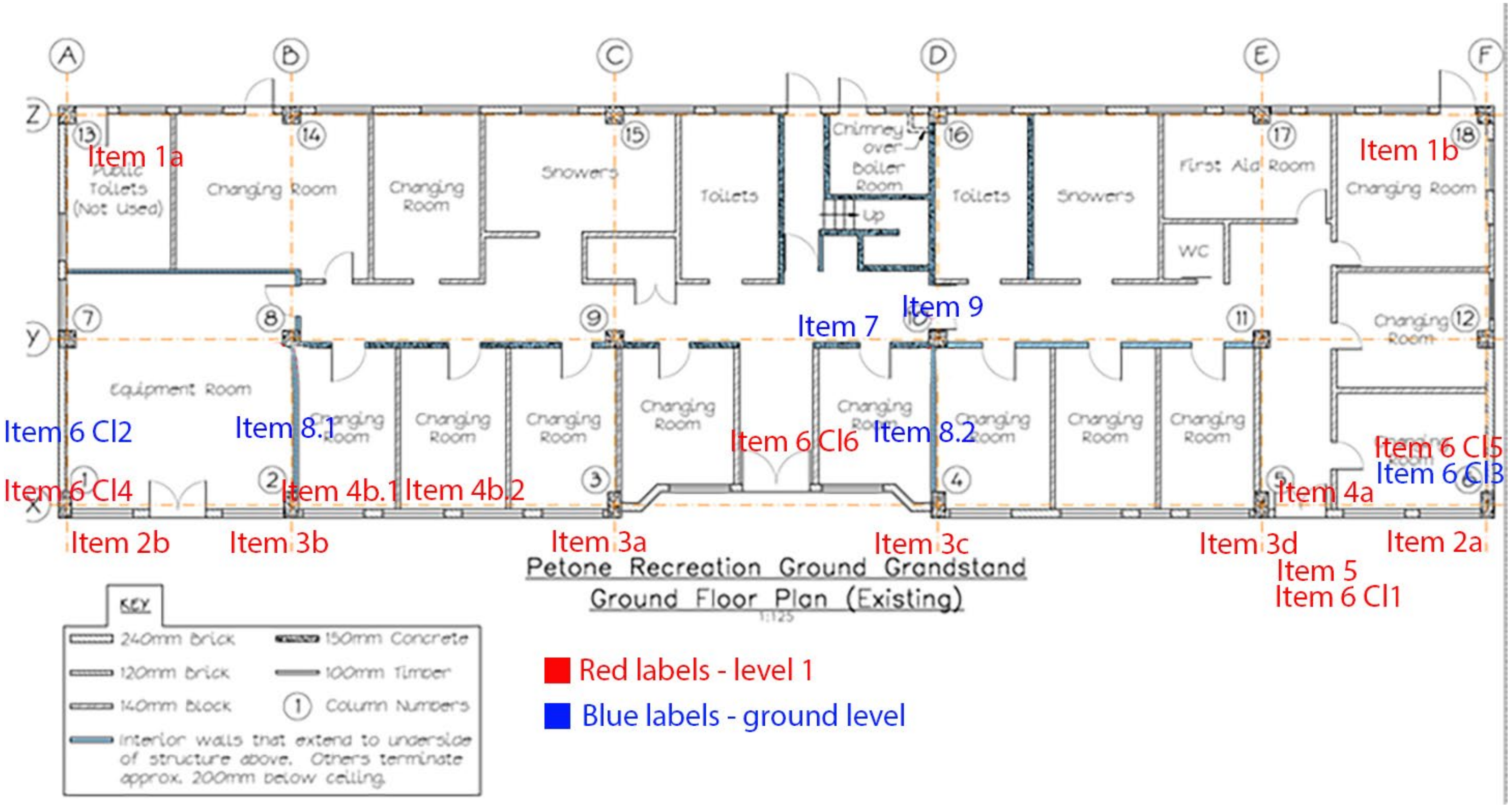


Figure 1: Plan - investigated locations

Note: locations are appropriate

3 Investigations

3.1 Item 1

3.1.1 Item 1a

Location: Grid A, near column 13

3.1.1.1 As-is condition

Figure 2: Location 1a - as-is

Figure 3: Location 1a - as-is

Figure 4: Location 1a - breakout

Figure 2, Figure 3 and Figure 4 display the condition of the structure at location 1a. Exposed and heavily corroded reinforcing was present. The expansion of the reinforcing bar inferred by corrosion put stress on the concrete, causing it to crack and eventually spall. Due to the progressed state of corrosion pitting and flaking on the bars has occurred.

3.1.1.2 Investigation

Figure 5: Polished main bar

The flaked iron-oxide was removed on the main bar and the bottom of the bar was polished.

The main bar appears to have an original bar diameter of 20mm. Due to corrosion the effective bar shape is not round anymore. Where measured, the narrowest portion of the cross section was 9mm. The cover is approximately 11mm.

Surface rust on the horizontal steel is apparent, no reduction in cross section could not be measured. The bar diameter is 12mm. There was little to no cover on the steel section facing towards the west.

3.1.2 Item 1b

<u>Location:</u> Grid F, near column 18

3.1.2.1 As-is condition

Figure 6: Location 1b - as-is

Figure 6 shows spalled concrete, caused by the effects of the expansion of corroding steel.

Figure 7: Location 1b - breakout

Figure 8: Location 1b - breakout

Figure 8 and Figure 9 display the location after removing the spalled concrete. Clear signs of corrosion pitting are visible.

3.1.2.2 Investigation

Figure 9: Polished bar

The vertical and horizontal bars (nominal diameters of 20mm and 10mm) were measured to have a remaining cross section of 16.9mm and 8.6mm, respectively.

The cover to the vertical and horizontal bars was measured to be 42mm and 32mm, respectively.

3.2 Item 2

A visual inspection has been carried out using a platform ladder, the platform is at a height of approximately 1.8m. Part of the brief was to carry out a visual inspection to evaluate the possibility of replacing the lower portion of the portal frame. However, it is not possible to make an informed statement due to the general bad condition of the steel. A detailed assessment by a qualified and certified steel expert is required for such a conclusion. As high up as a visual inspection was possible, sever corroded steel sections were visible. While the area of corrosion seems to decrease with increasing height, sever corroded spots showing flaking are noticeable.

3.2.1 Item 2 – Steel Thickness

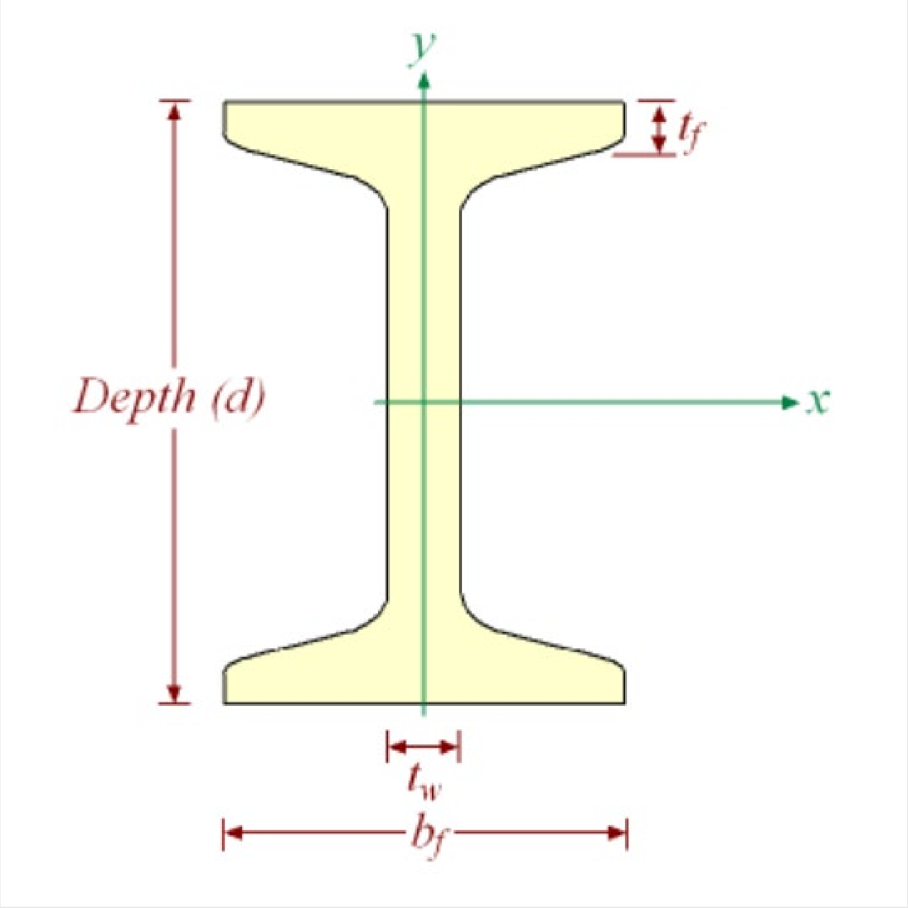


Figure 10: Sketch steel beam profile

Steel thickness:

- $t_f \approx$ 10mm
- $t_w \approx$ 9-10mm

3.2.2 Item 2 – Connections

3.2.2.1 Location 2a – Connections Grid F/X

Figure 11: Location 2a - connection, sever corrosion

The steel frame is connected through welded steel plates to the structure. Sever corrosion can be seen on all connecting parts.

Figure 12: Location 2a - connection, sever corrosion

Figure 13: Location 2a - connection, sever corrosion

Figure 14: Grid F/X - connection, sever corrosion

Figure 14 shows sever corrosion on the base plate and the connection (fixing) to the structure is visible.

Figure 15: Grid F/X - connection, sever corrosion

Figure 15 and Figure 16 show the baseplate which appear to have lost some of its base. Corrosion caused concrete to spall.

Figure 16: Grid F/X - connection, sever corrosion

3.2.2.2 Location 2b – Connections Grid A/X

Figure 17: Location 2b - connection, sever corrosion

Figure 17, Figure 18, and Figure 19 display the steel frame connection. Sever corrosion can be seen on all connecting parts. Spalled concrete and flaking of the steel is apparent.

Figure 18: Location 2b - connection, sever corrosion

Figure 19: Location 2b - connection, sever corrosion

Figure 20: Grid AX - connection, sever corrosion

Figure 20 and Figure 21 display sever corrosion on the baseplate and the connection (fixing) to the structure.

Figure 21: Grid AX - connection, sever corrosion

3.2.3 Item 2a

<u>Location:</u> Grid F – portal steel frame

3.2.3.1 Sever corrosion – Example 1

Figure 22: Item 2a – example 1, sever corrosion

Figure 23: Item 2a – example 1, sever corrosion

Sever corrosion on the web and the flange of the steel profile is apparent above the middle (second) horizontal profile.

3.2.3.2 Sever corrosion – Example 2

Figure 24: Item 2a – example 2, sever corrosion

Figure 25: Item 2a – example 2, sever corrosion

Figure 25 and Figure 26 show sever corrosion on various sections of the steel frame. The top flange of the horizontal member shows flaking, and the connection to the vertical profile appears to be heavily corroded. The flanges have corrosion of varying severity.

3.2.3.3 Sever corrosion - Example 3

Figure 26: Item 2a – example 3, sever corrosion

3.2.4 Item 2b

Location: Grid A – portal steel frame

3.2.4.1 Sever corrosion – Example 1

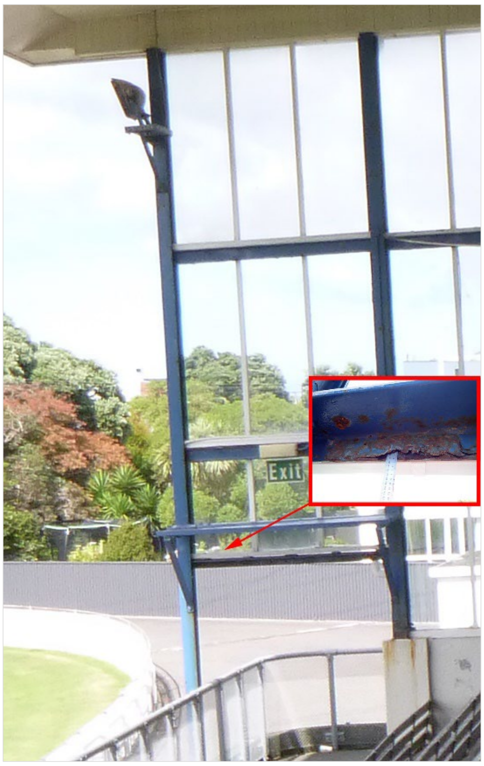


Figure 27: Item 2b – example 1, sever corrosion

Figure 28: Item 2b – example 1, sever corrosion

Figure 28 displays a horizontal connection to the portal frame. Sever corrosion and pitting is present.

3.2.4.2 Sever corrosion – Example 2

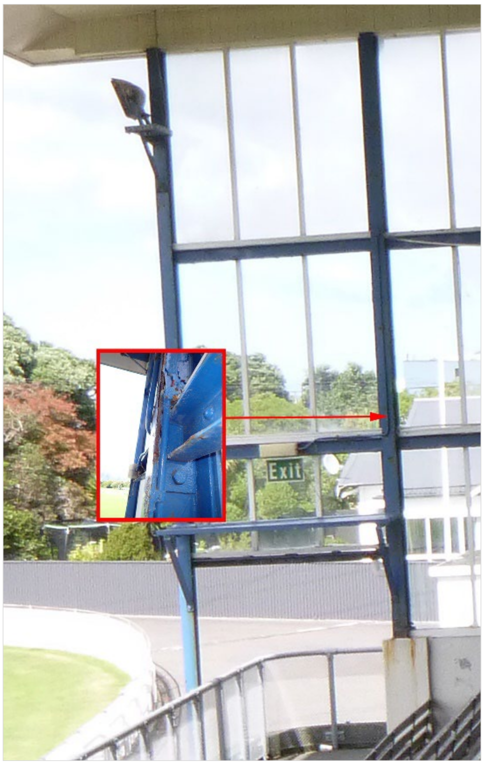


Figure 29: Item 2b – example 2, sever corrosion

Figure 30: Item 2b – example 2, sever corrosion

Figure 29, Figure 30, Figure 31, Figure 32 shows the NW face of the western portal frame. Despite this side being covered by the roof and protection from weather exposure by the windows, sever corrosion has developed.

3.2.4.3 Sever corrosion – Example 3

Figure 31: Item 2b – example 3, sever corrosion

Figure 32: Item 2b – example 3, sever corrosion

3.2.4.4 Sever corrosion – Example 4

Figure 33 Item 2b – example 4, sever corrosion

Figure 34: Item 2b – example 4, sever corrosion

Figure 33 and Figure 34 show corrosion on the steel profiles.

3.3 Item 3

3.3.1 Item 3a – Beam at column 3

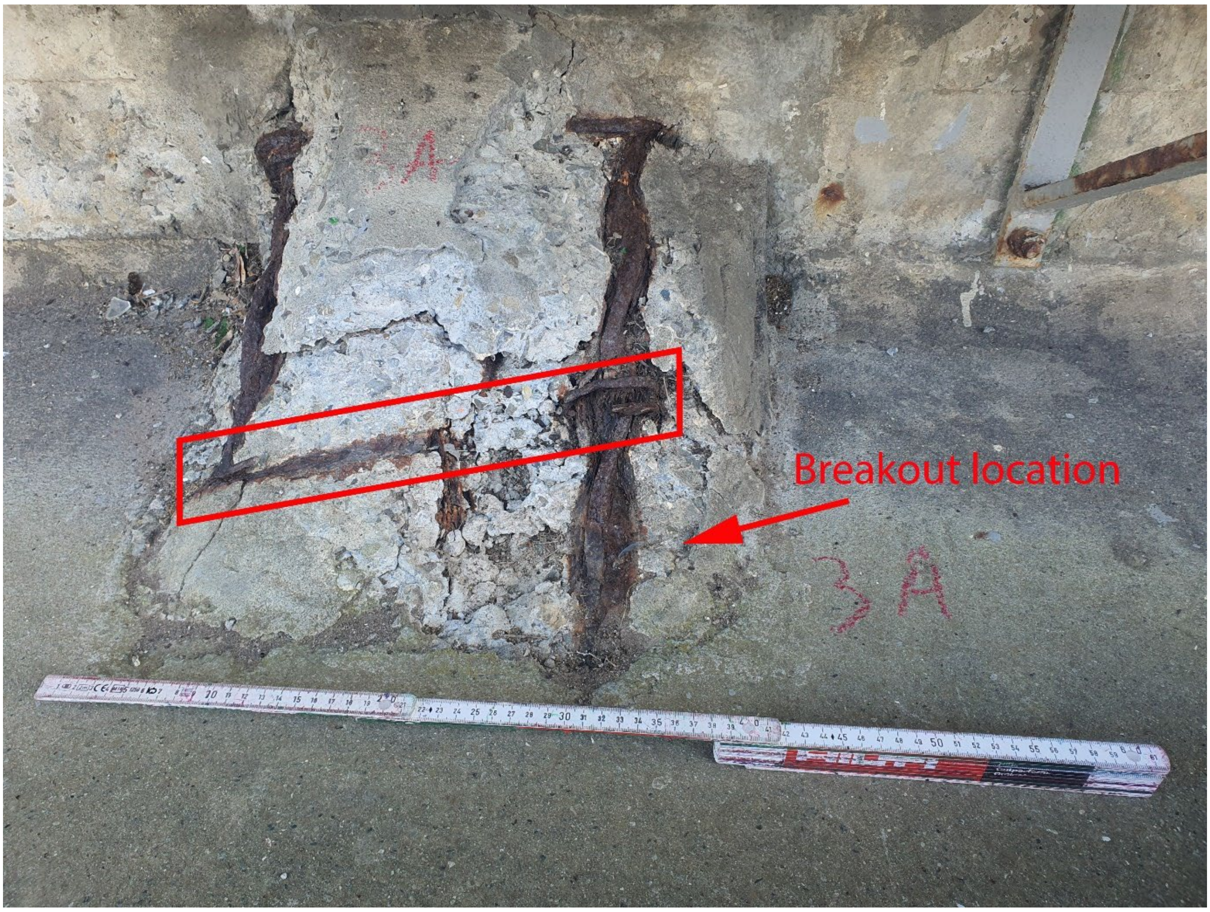


Figure 35: Location 3a - as is

Figure 35 displays the level of deterioration of the raking beam at grid C/3. Exposed and severely corroded reinforcement was present. The level of corrosion has caused the concrete to crack and spall. A stirrup appears to have fully disintegrated, highlighted by red quadrangle.

Figure 36: Item 3a – Breakout location

Figure 36 and Figure 37 show the deterioration of the raking beam.

The left bar with a nominal diameter of 20mm was found to have a reduced cross section of 5mm. One of the bars had some springing properties which is an indication for discontinuation. The bar must be assumed to be broken, although this could not be visually confirmed.

Figure 37: Item 3a – Breakout location

3.3.2 Item 3b – Beam at column 2

Figure 38: Location 3b - as is

Figure 38 displays location 3b before a breakout was performed. The material on the top, which shows clear signs of spalling, does not resemble the original concrete. The spalled material was easily removed by hand.

Figure 39: Location 3b - before breakout

Figure 39 displays the location before the concrete was removed around the bars.

Figure 40: Location 3b - breakout locations

Figure 40 shows the locations where remaining cross sections were measured.

3.3.2.1 Measurements – Location M1

Figure 41: Location 3b - M1

The measured bar, with a nominal diameter of 20mm, was found to have a diameter of 18.93mm and 18.1mm, respectively.

3.3.2.2 Measurements – Location M2

Figure 42: Location 3b - M2

The measured bar, with a nominal diameter of 20mm, was found to have a diameter of 16.7mm and 17.7mm, respectively.

3.3.3 Item 3c – Beam at column 4

Figure 43: Location 3c - as is

Figure 43 displays location 3c in the condition before concrete was removed. It appears that some material that does not resemble the original concrete has been added at some stage. Most of the material was not present at the time of the investigations. The remaining material was easily lifted as it had segregated from the structure caused by spalling.

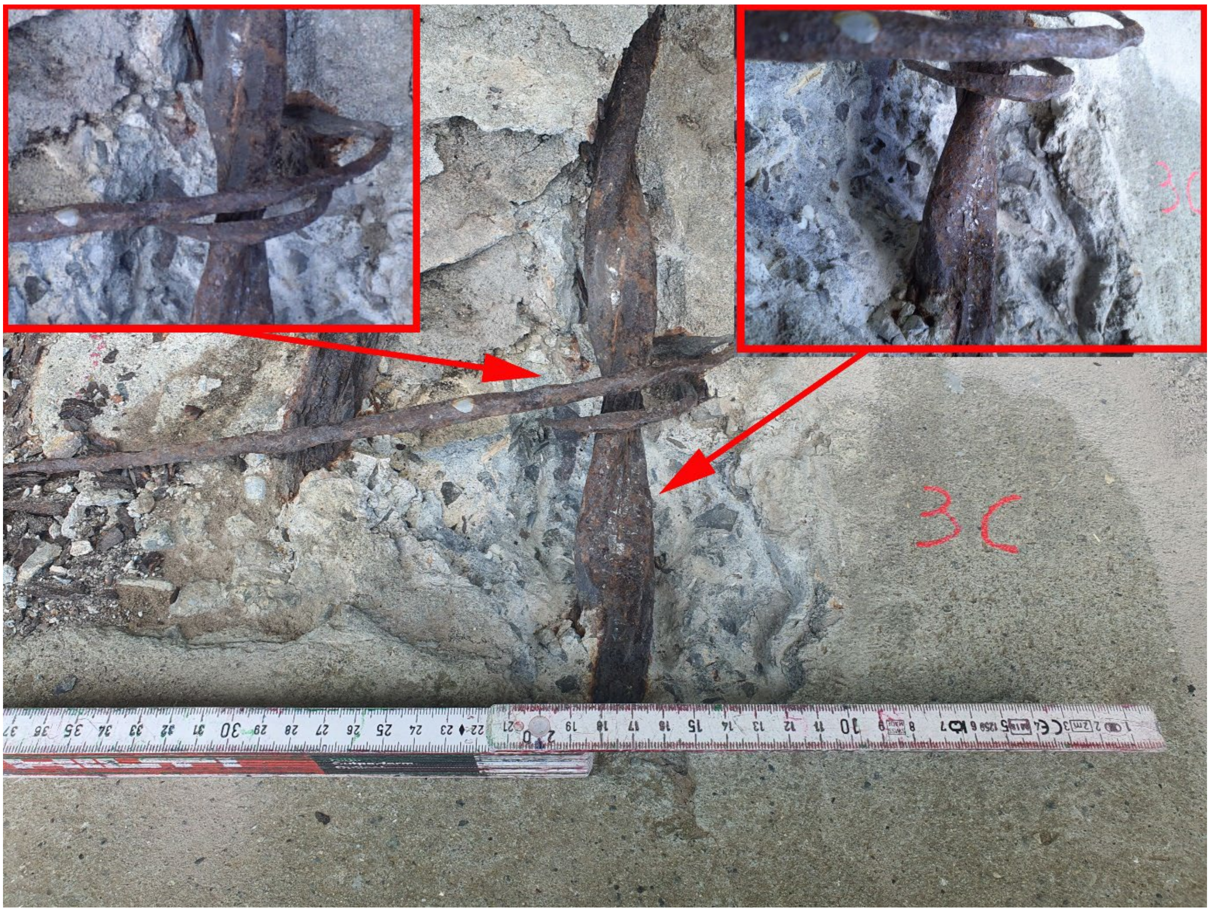


Figure 44: Item 3c – Breakout location

Figure 44 shows where remaining cross sections were measured.

Figure 45: Location 3c - as is

Figure 45 and Figure 46 display sever decay of the bars. The main bars, which have a nominal bar diameter of 20mm, were measured to have a remaining cross section of 12mm and 14mm, respectively. The stirrup, which has a nominal bar diameter of 12mm, was confirmed to have a remaining cross section of 3.1mm.

Figure 46: Location 3c - as is

3.3.4 Item 3d – Beam at column 5

Figure 47: Location 3d - as is

Figure 47 displays the condition of location 3d before investigations took place. It appears that some of the material does not resemble original concrete. Spalling can be seen on the right side.

Figure 48 Location 3d - Breakout

The main bar, with a nominal bar diameter of 20mm, was measured to have a remaining cross section of 16.2mm.

The stirrup, with a nominal bar diameter of 12mm, was measured to have a remaining cross section of 6.3mm.

3.4 Item 4

3.4.1 Item 4a – Beam Grid X

Figure 49: Location 4a - as is

Figure 49 displays the East facing edge of the beam on grid X. The location is near grid E. Material that does not resemble original concrete is apparent on the vertical face. Spalling of the patched material is noticeable.

Figure 50: Location 4a - as is

Figure 50 shows the edge and vertical face on the beam after the newer material was removed. Very little impact was required for the material to break away.

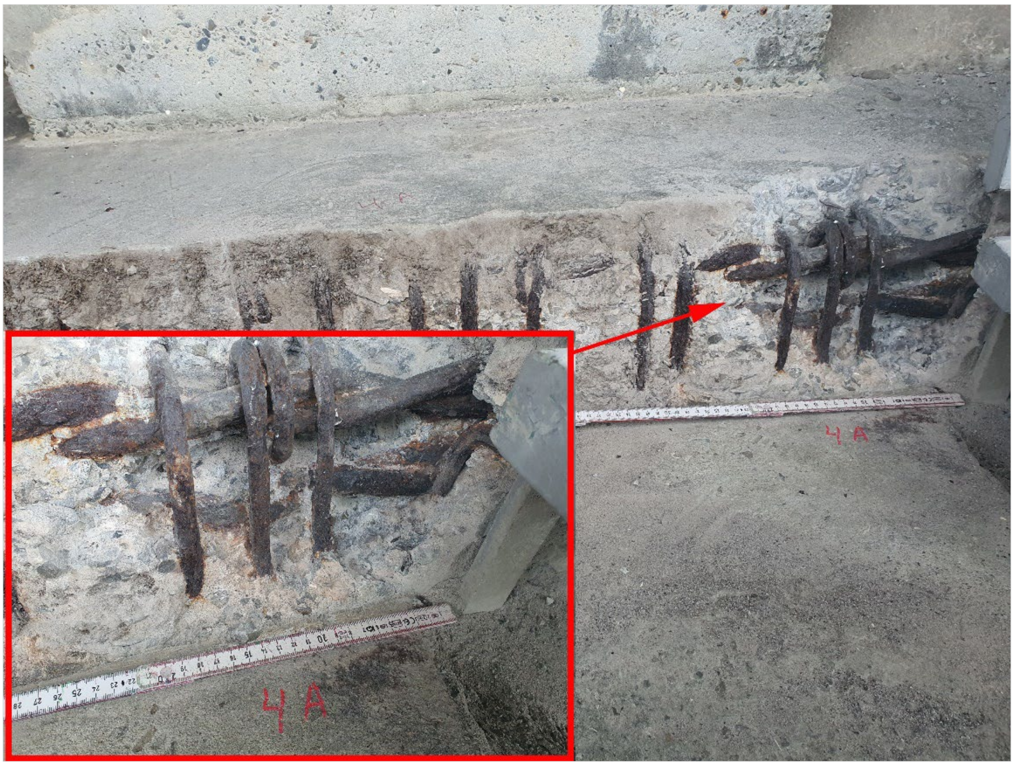


Figure 51: Location 4a – Breakout

One of the top main bars and one of the reinforcing layers below were measured. The nominal bar diameter is 20mm. Both bars had a reduced cross section of 15mm, respectively.

A stirrup, with a nominal diameter of 12mm was measured to have a reduced cross section of 6mm.

Figure 52: Location 4a – polished bars

Figure 52 and Figure 53 show the decay of the steel caused by corrosion.

Figure 53: Location 4a – polished bars

3.4.2 Item 4b.1 – Beam Grid X

Figure 54: Location 4b.1 - as is

Figure 54, Figure 55, Figure 56, Figure 57, Figure 58, Figure 59, Figure 60 display the top corner and the vertical face of the beam at grid X. The location is 11.5m north of grid A. Bars can be seen exposed and heavily corroded, a portion of concrete was loose and able to be lifted off.

Figure 55: Location 4b.1 - as is

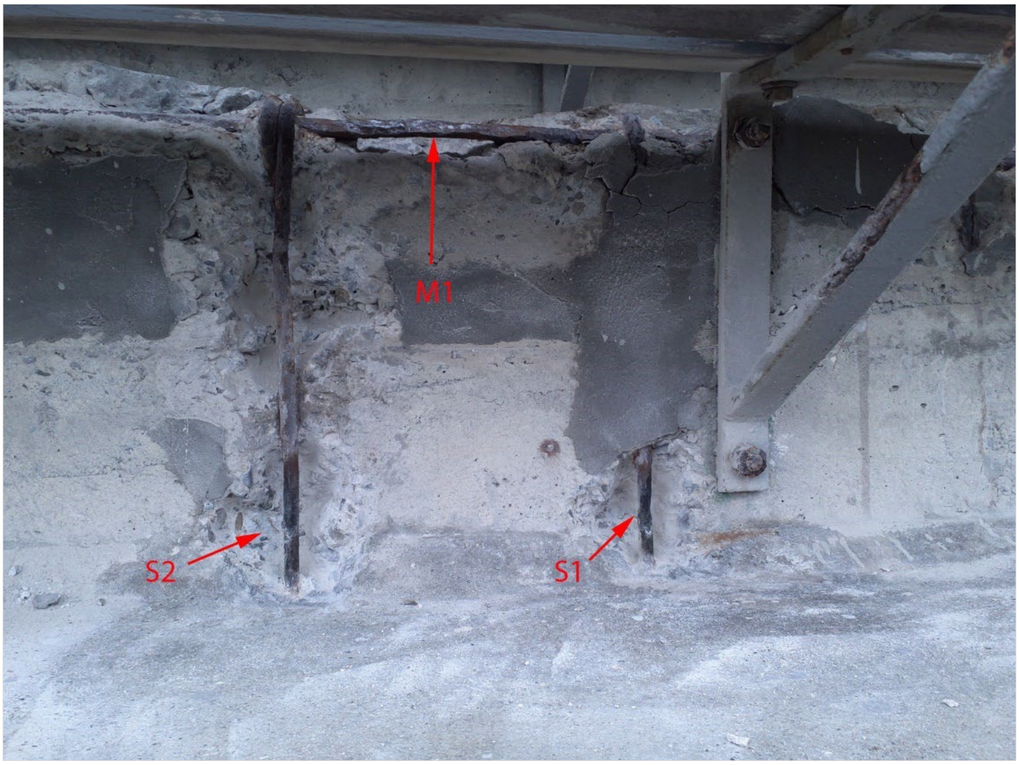


Figure 56: Location 4b.1 – Breakout

Figure 57: Location 4b.1 - main bar

The main bar’s cross section has reduced to 9mm, from a nominal diameter of 20mm.

Figure 58: Location 4b.1 - main bar

Figure 59: Location 4b.1 - stirrup S1

The diameter of the stirrup S1 was measured to have a cross section of 9.5mm. The nominal stirrup diameter is 12mm.

Figure 60: Location 4b.1 - stirrup S2

The diameter of the stirrup S2 was measured to have a cross section of 9mm. The nominal stirrup diameter is 12mm.

3.4.3 Item 4b.2 – Beam Grid X

Figure 61: Location 4b.2 - as is

Figure 61, Figure 62, Figure 63, and Figure 64 display the vertical, east facing top corner of the beam at grid X. The location is 14.9m north of grid A. Material not resembling the original concrete is visible.

Figure 62: Location 4b.2 – Breakout

Figure 63: Location 4b.2 - main bar

One main bar, with a nominal diameter of 20mm, was measured to have a remaining cross section of 17.5mm.

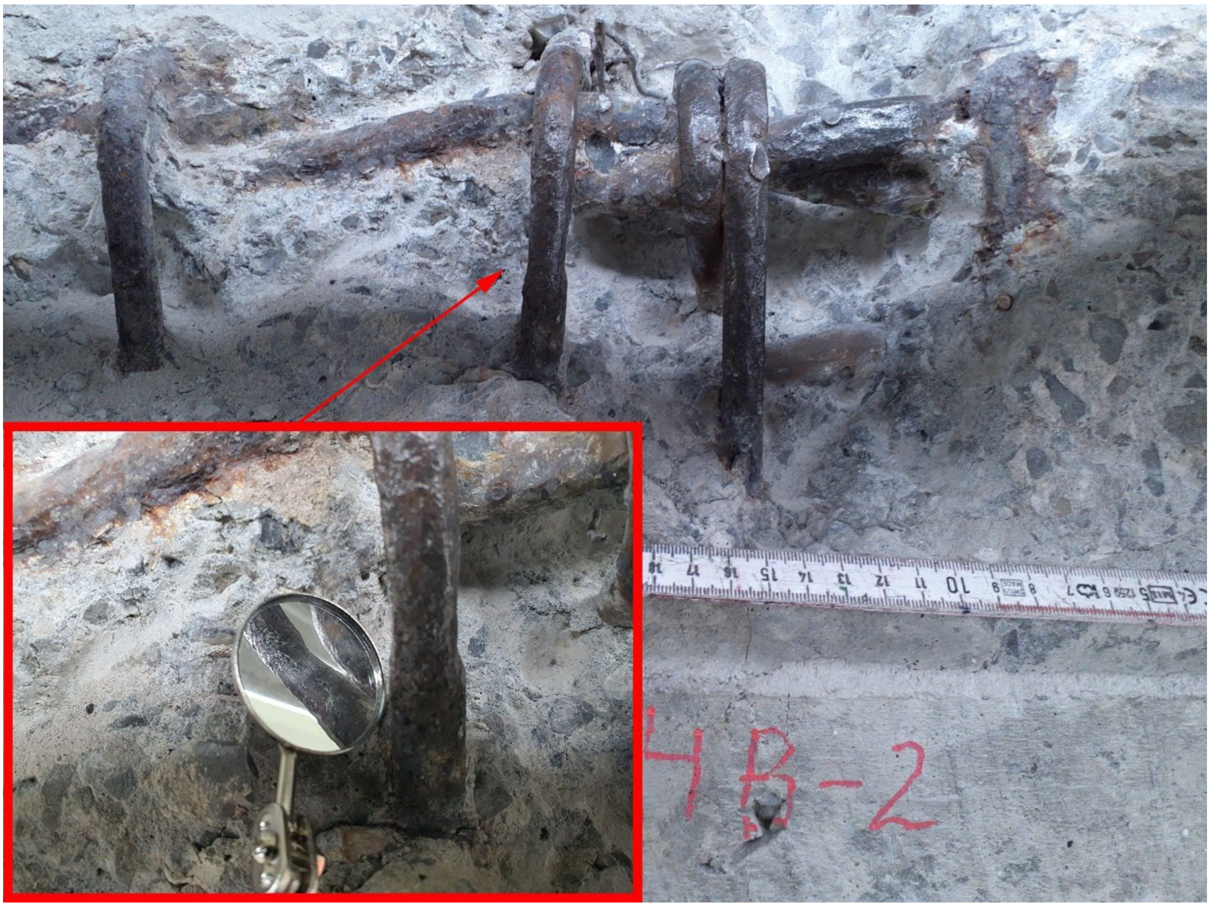


Figure 64: Location 4b.2 – Stirrup

The diameter of the stirrup was measured to have a remaining cross section of 10.5mm. The nominal stirrup diameter is 12mm.

3.5 Item 5

3.5.1 Item 5.1

Figure 65: Location 5.1 - as-is

Figure 65 displays a spot on the slab where concrete has spalled, an exposed corroded bar is visible. The lowest cover was measured to be 27.5mm.

Figure 66: Location 5.1 – breakout

Figure 66 shows a double twisted bar (orientated in W-E direction) with a nominal diameter of 6.5mm which was found to be rusted completely through, refer to Figure 67 for a close-up look.

Figure 67: Location 5.1 – breakout

Figure 68: Location 5.1 – breakout

Figure 69: Location 5.1 – breakout

The second layer twisted bars (orientated in N-S direction) with a nominal diameter of 10mm show some corrosion, but no loss of cross section was noticeable.

3.5.2 Item 5.2

Figure 70: Location 5.2 - as-is

Figure 71 displays a spot on the slab where concrete has spalled, an exposed corroded bar is visible. The lowest cover was measured to be 20mm.

Figure 71: Location 5.2 – breakout

Figure 71 displays a double twisted bar (orientated in W-E direction) with a nominal diameter of 6.5mm which was found to be rusted through.

3.6 Item 6

3.6.1 Cl.1

Figure 72: Chloride testing location Cl.1

Concrete samples Cl.1 were collected next at the location of Item 5.1. The location is on the slab near column 4 (grid D/X). Although the location is covered by the roof, it must be assumed that it is partially exposed to any weather systems approaching from the NE to SE.

3.6.2 Cl.2

Figure 73: Chloride testing location Cl.2

Concrete samples Cl.2 were extracted on the northern face of column 1 (grid A/X). The wall is on the inside and has subsequently not been exposed to the weather and possible sea water.

3.6.3 Cl.3

Figure 74: Chloride testing location Cl.3

Concrete samples Cl.3 were extracted on the southern face of column 6 (grid F/X). The wall is on the inside and has subsequently not been exposed to the weather. A large area (top portion of the column) is affected by efflorescence.

3.6.4 Cl.4

Figure 75: Chloride testing location Cl.4

Concrete samples Cl.4 were extracted on the southern face of column 1 (grid A/X). The surface is exposed to the elements, particularly any weather system approaching from the south. In addition, it is probable that the south facing walls are subjected to sea salts carried by strong southerly winds.

3.6.5 Cl.5

Figure 76: Chloride testing location Cl.5

Concrete samples Cl.5 were extracted on the northern face of the wall on grid F, between grids X and Y. The wall is exposed to the elements, predominantly to any weather system approaching from the south. Exposure to sea salts is not expected at this location.

3.6.6 CL.6

Figure 77: Chloride testing location Cl.6

Concrete samples Cl.6 were extracted on the middle flight of stairs, presumably on or near grid Y. The location is facing towards the east and is covered by the roof. Subsequently there is only minimal exposure to the elements.

3.6.7 Chloride Testing Results

Considering the overall testing results it is unlikely that chloride is a contributing factor regarding corrosion.

Table 3-1: Chloride testing results

Sample Label		**Depth Increment**	**Total Chloride Concentration (% w/w concentrate)**	**Exposure to Elements(Y/N)**	**Orientation**
Cl	1 – 1 1 – 2 1 – 3	0–10 mm 10–30 mm 30–50 mm	0.074 0.116 0.223	Y Mostly covered	Facing upwards
Cl	2 – 1 2 – 2 2 – 3	(Not specified)	0.028 0.033 0.056	N	Inside Facing North
Cl	3 – 1 3 – 2 3 – 3	0–10 mm 10–30 mm 30–50 mm	<0.001 0.022 0.301	N	Inside Facing South
Cl	4 – 1 4 – 2 4 – 3	0–10 mm 10–30 mm 30–50 mm	0.030 0.024 0.037	Y	Facing South
Cl	5 – 1 5 – 2 5 – 3	0–10 mm 10–30 mm 30–50 mm	0.166 0.078 0.047	Y	Facing North
Cl	6 – 1 6 – 2 6 – 3	0–10 mm 10–30 mm 30–50 mm	0.067 0.073 0.066	Y Covered, indirect exposure	Facing East

Refer to 6 Appendix to view the original laboratory report.

3.6.7.1 Inside | Outside Comparison

Concrete samples were taken on the north (grid F) and the south (grid A) walls. One sample per wall was extracted on the inside and the outside, respectively.

Comparing the matching samples (Cl.2 vs. Cl.4 and Cl.3 vs. Cl.5) does not show differences between the interior and the exterior. There are no significant differences between the samples.

3.6.7.2 North | South Comparison

Concrete samples were taken on the north (grid F) and the south (grid A) walls.

Comparing the samples (Cl.4 vs. CL.5) taken on the outside of the walls on grid A and F, no significant difference is apparent. Subsequently it is very unlikely that sea salts are a contributing factor for the deterioration of the structure, although this is based on one sample only.

3.7 Item 7

Figure 78: Core extraction location

Figure 78 displays the location where a core for compression testing was extracted. The core was taken south of column 10 on the wall on grid Y.

Figure 79: Extracted core

Compression testing confirmed a compressive strength for the core of 35 MPa.

Refer to 6 Appendix to view the original laboratory report.

3.8 Item 8

3.8.1 Grid B | Column 2-8

3.8.1.1 Near column 2

Figure 80: Wall between column 2-8

3.8.1.2 Between column 2&8

The location is approximately 1680mm East from column 8.

Figure 81: Wall between column 2&8

Figure 82: Wall between column 2&8

The wall on grid B consists of bricks.

3.8.2 Grid D | Column 4-10

3.8.2.1 Between column 4&10

The location is approximately 1680mm East from column 10.

Figure 83: Wall between column 4&10

The wall on grid D consists of bricks.

3.9 Item 9

Figure 84: Lintel – grid D

Figure 84 displays a breakout on the southern side of the lintel. One vertical bar was exposed. GPR scanning indicated the presence of one horizontal bar at greater depth. Considering the signal characteristic, it can be concluded that the horizontal bar has the same or similar bar diameter as the vertical bar. The vertical bar was measured to be 9.8mm, refer to Figure 85.

Figure 85: Lintel - grid D breakout

4 Conclusion of Results

As displayed throughout the report, several structural elements show deterioration of various levels. The severity and their possible consequence for the structure and its integrity must be assessed and commented on by Sawrey Consulting Engineers Ltd.

5 Proposed Actions

Based on the assessment by Sawrey Consulting Engineers Ltd and the future intention of use for the building, the following investigation techniques and possible remediation methods may be a viable option.

Insufficient cover may have contributed to the development of corrosion. Concrete, typically with a pH value of around 13 provides passive protection to steel. For the passive protection to be effective a minimum cover to the steel is required. As far as I'm concerned, the minimum cover as per the Building Code is 30mm, however, this information shall be confirmed by Sawrey Consulting Engineers Ltd. Steel is subject to an increased risk of corrosion if the minimum cover is not met. This can be due to the following reasons.

- The minimum cover was not met during the construction.
  Some measurements taken during the investigations outlined in this report had low cover which will have contributed to corrosion.
    - ➢ Recommendation: Scanning to identify the areas of low cover.
      This allows to gauge the overall scale of the problem and to evaluate possible methods of remediation.
- The original minimum cover has been reduced by the process of carbonation.
  Carbonation is the process of reacting calcium hydroxide in the concrete with carbon dioxide in the atmosphere which forms calcium carbonate and water. This process starts on the surface and gradually moves towards the inner of the concrete, it is a slow and continuous process.
  Carbonation effectively reduces the passive protection of concrete due to a change of the pH value in the concrete.
    - ➢ Recommendation: Extracting concrete samples for carbonation testing.
      This confirms whether carbonation is apparent, and what the remaining effective cover is.

To understand the extent of corrosion half-cell potential testing is required. Half-cell potential testing is an electro chemical process used to detect active corrosion. This method is used to indicate the probability for corrosion of steel occurring within the embedded concrete. Figure 86 displays an example for half-cell potential mapping. Localised breakouts are required to correlate potential-measurements to the actual state of corrosion.

Figure 86: Example of half-cell Potential mapping

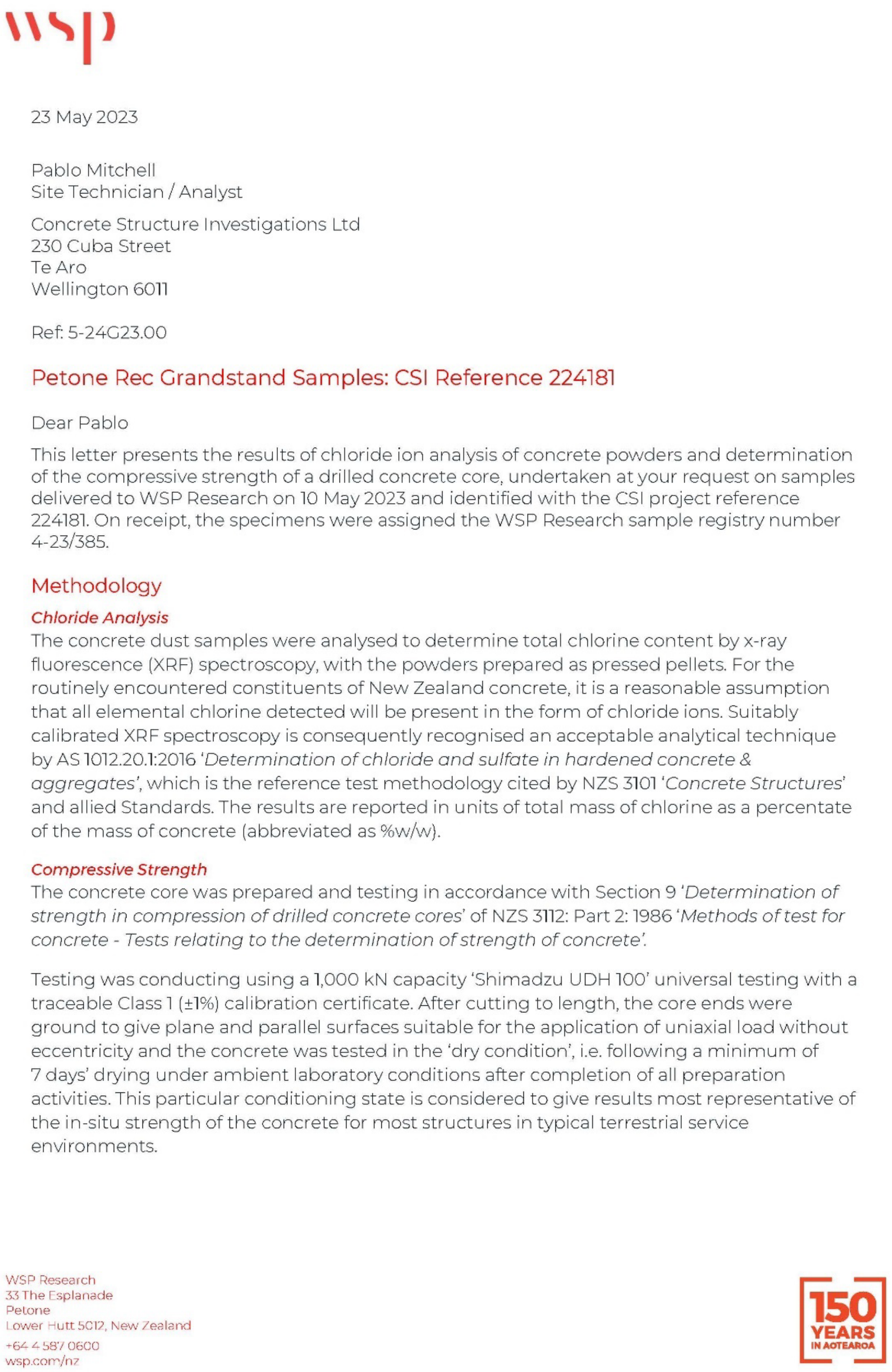
Corrosion can be halted using sacrificial anodes. Sacrificial anodes are a cathodic protection system which is based on an electrochemical protection method where dissimilar metals are coupled galvanically. The anodes contain a more active, less noble metal than steel causing the free electrons to move and react with the anode.

A combination of installing sacrificial anodes, replacing carbonated concrete, and reinstating the minimum cover to the steel where required may be viable approach for remediation and prolonging the life of the structure.

Note: All scan results and interpretation are a professional estimate based on the limitations of the hardware, software and environment. If the location, size and depth of the reinforcing steel bars must be determined to an absolute certainty, then a physical examination of those bars is required.

Our investigation and report are limited to those areas specifically identified within this report, for the sole purpose of the scope identified. Unless stated otherwise, we have not inspected framing or any other parts of the structure which are covered, concealed or inaccessible and there is the possibility that different conditions exist elsewhere within the subject structure.

6 Appendix



23 May 2023

Pablo Mitchell
Site Technician / Analyst

Concrete Structure Investigations Ltd
230 Cuba Street
Te Aro
Wellington 6011

Ref: 5-24G23.00

Petone Rec Grandstand Samples: CSI Reference 224181

Dear Pablo

This letter presents the results of chloride ion analysis of concrete powders and determination of the compressive strength of a drilled concrete core, undertaken at your request on samples delivered to WSP Research on 10 May 2023 and identified with the CSI project reference 224181. On receipt, the specimens were assigned the WSP Research sample registry number 4-23/385.

Methodology

Chloride Analysis

The concrete dust samples were analysed to determine total chlorine content by x-ray fluorescence (XRF) spectroscopy, with the powders prepared as pressed pellets. For the routinely encountered constituents of New Zealand concrete, it is a reasonable assumption that all elemental chlorine detected will be present in the form of chloride ions. Suitably calibrated XRF spectroscopy is consequently recognised an acceptable analytical technique by AS 1012.20.1:2016 '*Determination of chloride and sulfate in hardened concrete & aggregates*', which is the reference test methodology cited by NZS 3101 '*Concrete Structures*' and allied Standards. The results are reported in units of total mass of chlorine as a percentate of the mass of concrete (abbreviated as %w/w).

Compressive Strength

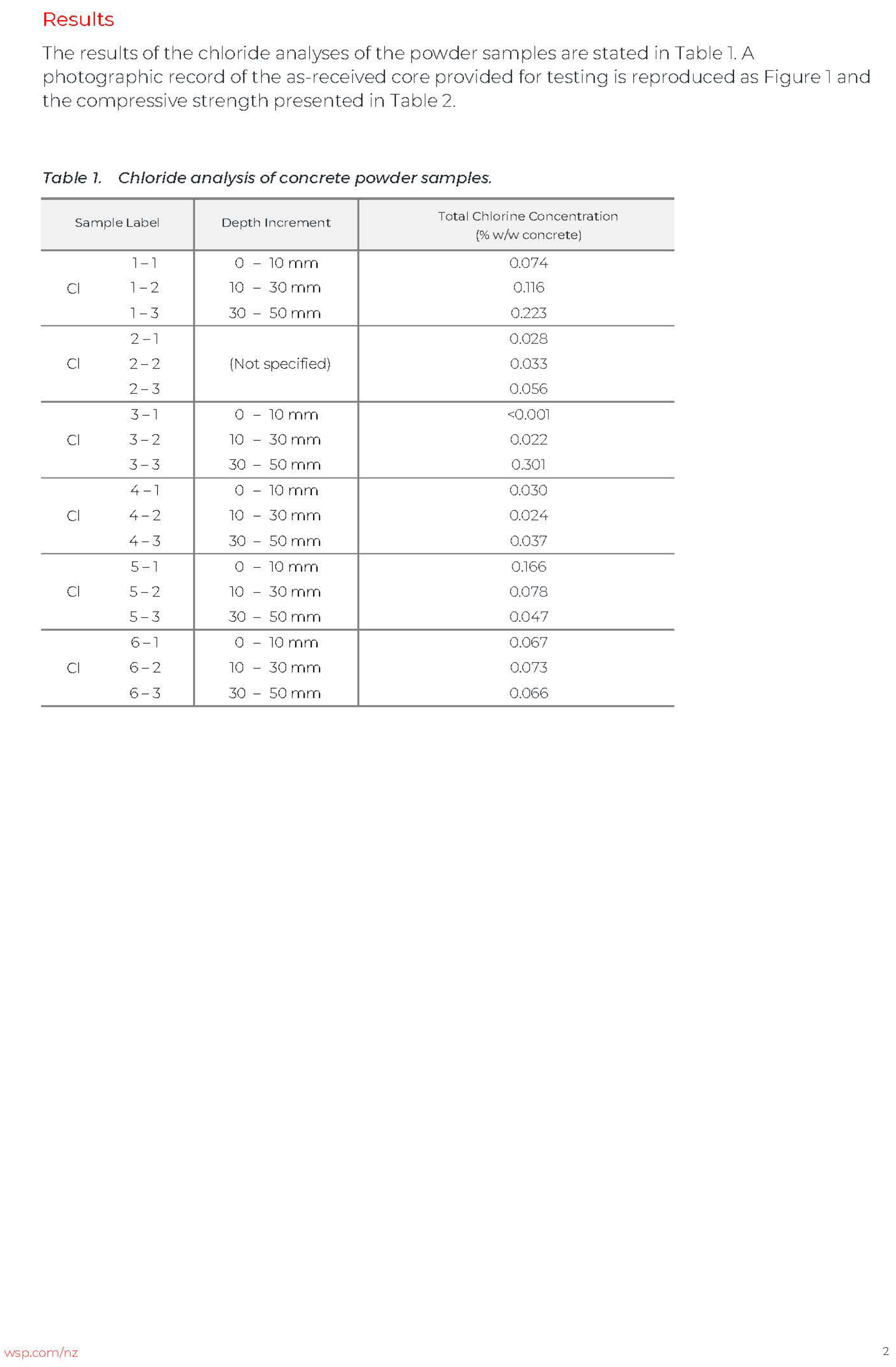
The concrete core was prepared and testing in accordance with Section 9 '*Determination of strength in compression of drilled concrete cores*' of NZS 3112: Part 2: 1986 '*Methods of test for concrete - Tests relating to the determination of strength of concrete'.*

Testing was conducting using a 1,000 kN capacity 'Shimadzu UDH 100' universal testing with a traceable Class 1 (±1%) calibration certificate. After cutting to length, the core ends were ground to give plane and parallel surfaces suitable for the application of uniaxial load without eccentricity and the concrete was tested in the 'dry condition', i.e. following a minimum of 7 days' drying under ambient laboratory conditions after completion of all preparation activities. This particular conditioning state is considered to give results most representative of the in-situ strength of the concrete for most structures in typical terrestrial service environments.

WSP Research
33 The Esplanade
Petone
Lower Hutt 5012, New Zealand
+64 4 587 0600
wsp.com/nz

150 YEARS IN AOTEAROA

Figure 87: Material testing - original report



Results

The results of the chloride analyses of the powder samples are stated in Table 1. A photographic record of the as-received core provided for testing is reproduced as Figure 1 and the compressive strength presented in Table 2.

Table 1. Chloride analysis of concrete powder samples.

Sample Label		Depth Increment	Total Chlorine Concentration (% w/w concrete)
Cl	1 – 1	0 – 10 mm	0.074
	1 – 2	10 – 30 mm	0.116
	1 – 3	30 – 50 mm	0.223
Cl	2 – 1	(Not specified)	0.028
	2 – 2		0.033
	2 – 3		0.056
Cl	3 – 1	0 – 10 mm	<0.001
	3 – 2	10 – 30 mm	0.022
	3 – 3	30 – 50 mm	0.301
Cl	4 – 1	0 – 10 mm	0.030
	4 – 2	10 – 30 mm	0.024
	4 – 3	30 – 50 mm	0.037
Cl	5 – 1	0 – 10 mm	0.166
	5 – 2	10 – 30 mm	0.078
	5 – 3	30 – 50 mm	0.047
Cl	6 – 1	0 – 10 mm	0.067
	6 – 2	10 – 30 mm	0.073
	6 – 3	30 – 50 mm	0.066

wsp.com/nz 2

Figure 88: Chloride test – original report

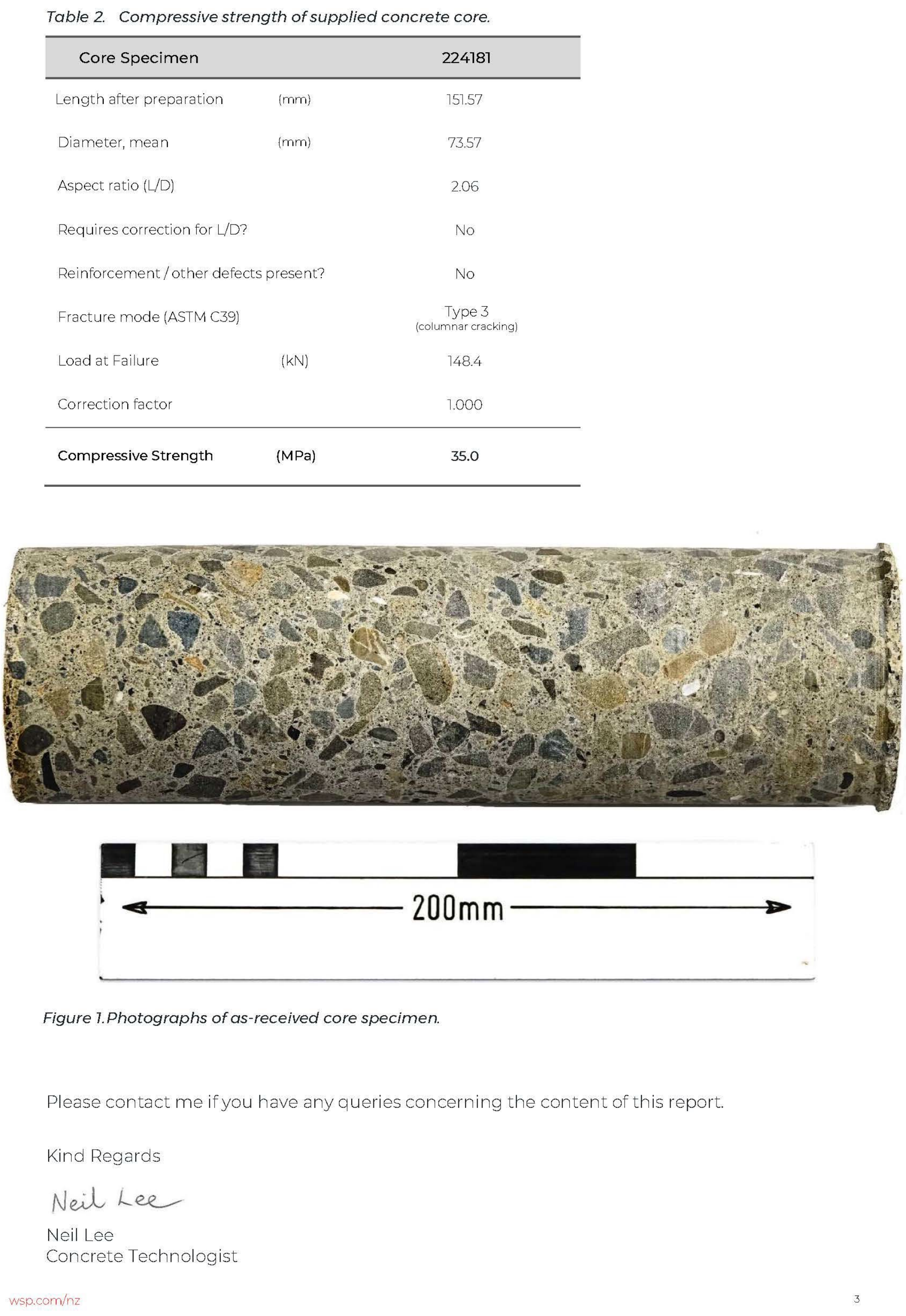


Table 2. Compressive strength of supplied concrete core.

Core Specimen		224181
Length after preparation	(mm)	151.57
Diameter, mean	(mm)	73.57
Aspect ratio (L/D)		2.06
Requires correction for L/D?		No
Reinforcement / other defects present?		No
Fracture mode (ASTM C39)		Type 3 (columnar cracking)
Load at Failure	(kN)	148.4
Correction factor		1.000
Compressive Strength	**(MPa)**	**35.0**

Figure 1. Photographs of as-received core specimen.

Please contact me if you have any queries concerning the content of this report.

Kind Regards

Neil Lee

Neil Lee
Concrete Technologist

wsp.com/nz 3

Figure 89: Compressive strength test – original report

7 GPR Limitations

GPR Limitations within concrete structures:

Note: The below limitations do not cover all possible limitations but only the most common.

Data Collection and Interpretation – The technician providing the GPR results is potentially the biggest limiting factor involved with this science. Technicians must not only be trained in operating the technology, they also must have a sound understanding of the material/structure and application in each specific situation; however, teaching an individual how to interpret the data they receive with the equipment can take long periods of time and ongoing training. The highest quality equipment operated by an inexperienced technician will offer little information to the customer as the ability to interpret the data is essential. In short, the technology/science of ground penetrating radar is only as good as the operator's expertise and education in data collection and interpretation.

Moisture – Moist or 'green' concrete can be problematic for GPR as the presence of moisture will reflect/inhibit the passage of the radar pulse and thereby limit penetration and data quality.

Depth Penetration – The depth range of GPR is limited by the electrical conductivity of the medium, the transmitted centre frequency and the radiated power. As conductivity increases, the penetration depth decreases. Higher frequencies do not penetrate as far as lower frequencies but give better resolution. The best penetration is achieved in dry materials such as granite, limestone, and dry concrete.

Size of Target – There are two main ways in which GPR is limited when discussing the size of a target. GPR technology is unable to determine the diameter of the target being located. Dimensions of objects can in certain circumstances be given within tolerances which are specific to the site conditions and scanner used. As a rule of thumb, objects smaller than half the size of the wavelength cannot be detected. Larger objects may also not be detected, depending on the size and orientation. The wavelength is correlated with the centre frequency of the antenna used.

Obstructions – Targets may be obstructed by objects positioned in front of them, prohibiting the wave propagation to the target. Closely spaced neighbouring objects may also prohibit the detection of targets beneath.

Appendix D –Tetratech Coffey Report on Geotechnical Investigation

Petone Recreation Grandstand

Geotechnical Investigation and Assessment

Sawrey Consulting Engineers

Reference: 773-WLGGE317986

21 April 2023

PETONE RECREATION GRANDSTAND

Geotechnical Investigation and Assessment

Report reference number: 773-WLGGE317986
21 April 2023

PREPARED FOR

Sawrey Consulting Engineers
7/92 Queens Drive, Lower Hutt
Wellington
5040 New Zealand
p: +64 4 566 1483

PREPARED BY

Tetra Tech Coffey
6/342 Lambton Quay
Wellington
6011 New Zealand
p: +64 4 385 9885
f: +64 4 385 3066
NZBN 9429033691923

QUALITY INFORMATION

Revision history

Revision	Description	Date	Author	Reviewer	Approver
1	Investigation and Assessment Report	21/04/2023	CH	AG	SM

Distribution

Report Status	No. of copies	Format	Distributed to	Date
1	1	PDF	Stephen Sawrey Uriah McCall	21/04/2023

Restriction on Disclosure and Use of Data

Please refer to the attached Important Information About Your Tetra Tech Coffey Report.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. INTRODUCTION

Sawrey Consulting Engineers has requested Tetra Tech Coffey (NZ) Ltd provide geotechnical services to inform a detailed seismic assessment (DSA) for the Petone Recreation Grandstand. Strengthening of the structure to 34%NBS has previously been completed in 2014. Tetra Tech Coffey completed a geotechnical desktop study for the site in September 2014 for this previous DSA. This found the site may have a high liquefaction potential, but a crust may be present at the site which would mitigate the risk of differential settlements. A shallow intrusive investigation to better understand the subsoils and inform the latest DSA has been requested. This may be followed up by a deeper investigation if required.

1.1 SCOPE OF WORK

Tetra Tech Coffey's scope of work includes the following:

Site Investigation

- Site walkover
- 3 Window sampler boreholes to 3m depth

Geotechnical Assessment

- Update the existing Tetra Tech Coffey ground model based on the site investigation and more recent publicly available data, including geotechnical soil parameters
- Provide an estimate Site Subsoil Class to NZS1170.5
- Soil bearing capacity for the existing foundations.
- Soil spring stiffness for the existing foundations.
- Assessment of the liquefaction risk at site
- Recommendations on future investigation and geotechnical assessment works.

1.2 RECEIVED INFORMATION

We have received the drawing set "Petone Recreation Ground Grandstand Seismic Strengthening to 34%NBS" dated 19.12.14.

From this the existing foundations for the grandstand appear to be:

- Concrete pad 610mm thick and 2m wide at a founding depth ~0.7m
- Ground beam ~0.5m founding depth ~0.3m thick

2. SITE DETAILS

The Grandstand is located in the south-western corner of the Petone Recreation Ground and faces out east towards the sporting recreational grounds. The site is flat, ~730m north of the Petone beach shoreline, and ~1.5km west of the Hutt River. Refer to Figure 1 below for site location.

The structure is 4 stories high. The ground floor contains changing rooms, toilets, and an equipment room. The grandstand seating starts on the second floor continues eastwards to the top of the fourth floor. Underneath the grandstand stairs are further utility rooms.

The grandstand is surrounded by asphalt providing walking areas and an uncovered carpark on the southern section that can be accessed via Kirks Ave. The northern area of the grandstand is accessed via a driveway that is entered on Udy St. North of the grandstand is a single-story caretaker's structure.

Figure 1: Site Location, Petone Rec Grandstand – Source Google Earth Pro

3. PREVIOUS TETRA TECH COFFEY ASSESSMENT

Tetra Tech Coffey previously completed a desktop study at the site in September 2014. The Key findings from the report were:

- The site is expected to be underlain by up to 2m of variable fill and sandy gravel and gravelly sand.
- Groundwater is anticipated at 1.3m depth.
- High Liquefaction potential at the site, however a crust may be present at the site, which would mitigate the risk of differential settlement.
- Site Subsoil Class D

4. NEW ZEALAND GEOTECHNICAL DATABASE (NZGD)

A review of the New Zealand Geotechnical Database (NZGD)[1] shows multiple boreholes and CPT investigations within 250m of the Petone Recreational Grandstand site. These investigations are summarised in the table below, with further borehole details and CPT logs in Appendix B. Please refer to Figure 3 below for the location of following investigations.

CPT_188325 went to depth of 14.97m below ground. The CPT log shows very dense Gravelly Sand between 4 to 6mbgl, underlain by medium dense to dense sand to 10m. Sand mixtures consisting of medium dense to

---

[1] *https://www.nzgd.org.nz/ARCGISMapViewer/mapviewer.aspx*

loose Silty Sands and stiff to firm Sandy Silts was recorded between 10 and 14.97m depth. CPT_188330 and CPT_188332 are both similar with very dense sand encountered at 4m depth.

A series of boreholes within 100-240m south and south-east of the site were also reviewed. These logs included general soil descriptions and no strength data was included. These boreholes typically indicate sand and gravel to 9m depth, underlain by sand, shell, silt and organics. While the subsoil profile noted in the area from the NZGD was generally consistent, Borehole BH_114775 indicates the sand, shell, silt and organics layer is present from ~2.5m depth with peat noted at 9-16m depth. This indicates some degree of variable in the subsoil profile of the area within the upper 20m.

Table 1: NZGD Summary

Borehole ID	Investigation Depth	Water Depth	Distance from the Petone Rec Grandstand
BH_114775	47.5m	Not recorded	133m south
BH_114776	48.8m	Not recorded	120m south
BH_114590	11.4m	Not recorded	221m east
BH_114591	14.9m	Not recorded	210m east
BH_114592	10.1m	Not recorded	237m east
CPT_188330	4.49m	1.5m	180m north
CPT_188325	14.97m	1.5m	210m north
CPT_188332	4.98m	1.5m	230m north

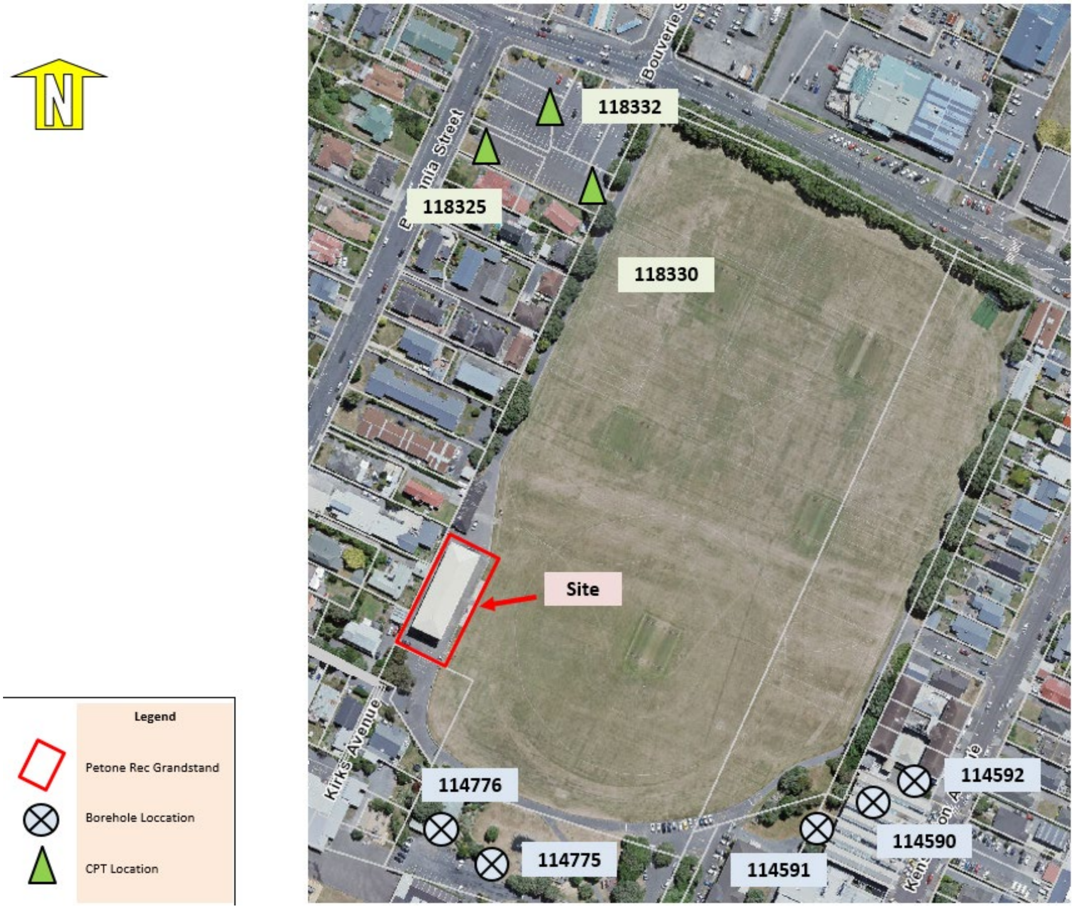


Figure 2: NZGD Investigation Locations

5. GROUND INVESTIGATION

Site-specific investigation was carried out on the 15th of March 2023 consisting of 3 Window Samplers (WS) to 3m depth with in-situ Dynamic Cone Penetrometer (DCP) tests. All WS were terminated early due to collapse at 3m. This is indicative of sandy soil conditions beneath the water table. Please refer to Figure 3: Site Investigation Plan provided by Geotechnics.

Figure 3: Site Investigation Plan

6. GROUND MODEL

We have evaluated a geological ground model based on window samplers conducted on site, coupled with the NZGD data including the CPT investigation north and Boreholes to the southeast of site. The window samplers are used to determine the shallow ground model, while assumed deeper model extrapolated from the wider available data. Generally, the subsoil profile comprises medium dense to very dense sandy gravel, gravelly sand and gravel. The upper 200 to 700mm comprises a mixture of gravel, sand and silt of variable density. The boreholes to the south and southeast of the site typically show similar ground conditions (gravel and sand) in the upper 3m.

Table 2: Assessed ground model for Petone Recreation Grandstand

Unit	Description	Top Depth (m)	Bottom Depth (m)	Consistency	DCP (blows/100mm)	Cone Resistance qc (MPa)#
A	Silt/ silty sand	0.1	0.3/0.7	Soft to stiff/ loose to dense	2-6	-
B	Sandy Gravel	0.3/0.7	2.2/2.5	Medium dense to very dense	4-12	
C	Gravelly Sand	2.2/2.5	3.0+	Dense to very dense	8-18	
D	Sand and Gravel*	3	6	Generally described as dense	-	12-30+
E	Sand*	6	10	Medium dense to dense	-	8-12
F	Silt/ sand/ organics*	10	>15	Loose to medium dense/ firm to stiff	-	2-10

* estimated from nearby NZGD data

assessed from the CPT trace available on NZGD

The window sampler borehole logs and associated DCP testing as well as relevant logs from NZGD are presented in Appendix A.

6.1 GROUNDWATER

Groundwater was recorded during the ground investigation at ~1.25mbgl. This is consistent with nearby geotechnical investigations. A design groundwater level of 1.25m is recommended for the site.

6.2 GEOTECHNICAL DESIGN PARAMETERS

Geotechnical design parameters are provided in Table 3 based on our in-situ testing and experience of similar materials in the region.

Table 3: Geotechnical Design Parameters for Petone Recreation Grandstand

Unit	Depth (m)	Unit Weight, γ (kN/m^3)	Effective Friction Angle, Ø' (°)	Cohesion, c' (kPa)	E', Youngs Modulus (MPa)
Silt/ Silt sand	0.1 – 0.7	18	28	2	10-25
Sandy gravel	0.7 – 6.0	19	34	0	40-60

Sand	6.0 – 10.0	19	33	0	10-20

6.3 SITE SUBSOIL CLASS

Based of Map 4 Lower Hutt Valley Site Subsoil Class Map, produced by GNS in 2010[2]. The Site is classified as Site Subsoil Class D with a depth to bedrock >200m. This is consistent with the deep nearby boreholes and in accordance with NZS1170.5

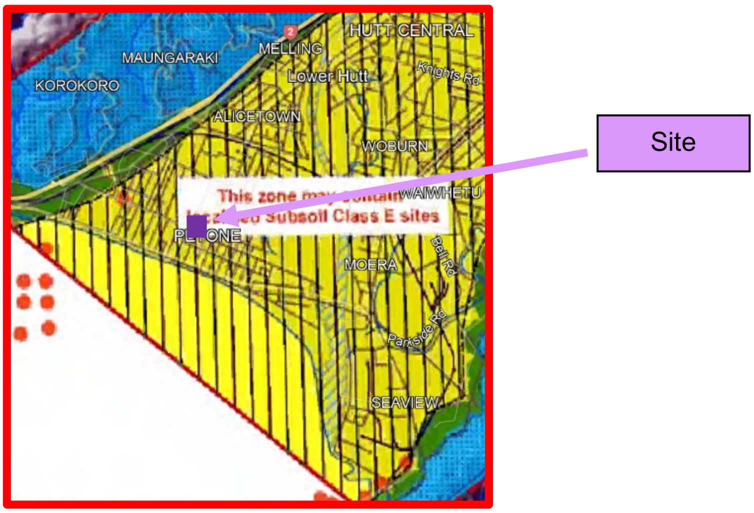


Figure 4: Lower Hutt Site Subsoil – Map 4 (Boon et al 2010)

6.4 GROUND MOTION PARAMETERS

The ground motion parameters for geotechnical assessment are provided in Table 8 below. The values are un-weighted peak ground accelerations (PGA) values and effective earthquake magnitudes (M_{eff}). The calculation method follows Section 6 of the NZTA Bridge Manual Edition 3.3[3] as recommended by MBIE/NZGS Geotechnical Guidance Module 1 (rev0)[4].

Table 4: Ground Motion Parameters

Design Life	Design Case	IL	Annual Probability	$C_{0,1000}$	M_{eff}	R_u or R_s	f	PGA
50 years	SLS	2	1/25 years	0.45	6.2	0.25	1	0.09
50 Years	ULS	2	1/500 years	0.45	7.1	1	1	0.35

We note that updated PGA values have been provided in the latest update of the NZGS Practice Module 1 (rev1 published November 2021) and that these are higher than those outlined in Table 4 above. However,

---

[2] *It's our Fault – Geological and Geotechnical Characterisation and Site Class Revision of the Lower Hutt Valley, GNS Science Consultancy Report 2010/163, dated June 2010*

[3] *NZTA Bridge Manual SP/M/002 3rd Editionhttps://www.nzta.govt.nz/resources/bridge-manual/bridge-manual.html*

[4] *NZGS practise module - https://www.building.govt.nz/assets/Uploads/building-code-compliance/b-stability/b1-structure/geotechnicalguidelines/geotech-module-1.pdf*

these don't apply to assessment or design of strengthening works of existing buildings under Earthquake Prone Building Legislation. Additionally, the New Zealand Seismic Hazard Model has been released by GNS and MBIE. Seismic hazards and forecasted ground shaking have been updated for the Wellington region and are higher than those outlines in Table 4 or the NZGS Practice Module 1 (rev1). Importantly, this research has not yet been included in the building code. The client should be made aware that future changes to the building code may alter the seismic hazard parameters recommended for geotechnical design in the Wellington region.

6.5 LIQUEFACTION ASSESSMENT

Based on the site investigation data and the ground model presented in Table 2 above, the upper 3m is considered unlikely to liquefy due to the medium dense to very dense gravel and dense to very dense sand encountered from the water table depth. Between 3 and 6m depth, the NZGD data indicates that dense gravel is expected at the site, which is also considered unlikely to liquefy. From 6m depth, sands, silts and organics of variable strength are noted on the NZGD data. These layers may be prone to liquefaction during ULS loading as the CPT data ~200m north of the site indicates that the soils between 6 and 13m depth are susceptible to liquefaction under these conditions.

Liquefaction induced settlements affecting shallow foundations are considered unlikely under SLS loading and ULS loading. While some of the subsoils may liquefy under ULS loading, it is considered the site has a confirmed 3m thick non-liquefiable crust, which is likely to be ~6m considering the likely ground model from nearby data.

Lateral spreading is not anticipated at the site as there is no free face within 200m of site.

6.6 FOUNDATION CONDITIONS

Based on the provided information and ground model presented in Section 6 above, it assumed that that the foundations are founded on the sandy gravel soils (unit B). 300kPa ultimate bearing capacity is assumed at this depth.

The ground beams are assumed to be founded at ~0.5m depth and at WS01 at the southern end of the structure, loose to medium dense silty sand (unit A) was encountered to 0.7m depth. The ultimate bearing capacity of this unit is 200kPa and we therefore recommend the ground beams at the southern end of the structure be checked with 200kPa ultimate bearing capacity as a conservative approach.

This is suitable for assessment of existing buildings in line with the "The Seismic Assessment of Existing Building, Section C4 – Geotechnical Considerations".

For design work, reduction factors from B1/VM4 should be applied. We suggest 0.8 for load combinations involving earthquake overstrength and 0.5 for all other load combinations.

6.7 PRELIMINARY SUBGRADE REACTION MODULUS

Based on the above information and assumptions, subgrade reaction modulus values have been calculated for the range of Young's Modulus values in Table 3 and foundation types presented in section 1.2.

Subgrade reaction modulus values of 15-35 MN/m^3 can be assumed for the foundation assessment. These values can be refined further as required with provided loads.

If the structural analysis is sensitive to this range of subgrade reaction modulus values, we recommend having a series of iterations between the structural and geotechnical calculations for soil-structure interaction to update the subgrade modulus values.

Spring stiffness values (MN/m) can be calculated from the subgrade reaction values by multiplying by the area over which the spring is applied (width and length).

7. RECOMMENDATIONS

If any in ground improvements are required as part of the strengthening works or further certainty is required about the ground conditions or liquefaction potential below 3m depth a deeper intrusive investigation is recommended. We would recommend 2 x CPTs tests to 15m depth with a DPSH if required to penetrate gravelly layers.

8. CONCLUSION AND RECOMMENDATIONS

The following conclusion for the Petone Recreation Grandstand is the following.

- The ground model comprises variable soils to up to 0.7m depth underlain by medium dense to very dense sandy gravel and dense to very dense gravelly sand to 3m depth. Gravel dominate soils are anticipated to extend to ~6m underlain by sandy soils to ~10m based on the publicly available data.
- Groundwater is at 1.25m depth
- The site is considered to have a 3m thick non-liquefiable crust and likely up to 6m thick non-liquefiable crust. Therefore, the potential for surface deformation or differential settlement is considered low.
- Bearing capacity is generally considered to be 300kPa, however foundations founded shallower than 0.7m depth at the southern end of the structure should be checked for 200kPa ultimate bearing capacity.
- If any in ground improvements are required as part of the strengthening works or further certainty is required about the ground conditions or liquefaction potential below 3m depth a deeper intrusive investigation is recommended. We would recommend 2 x CPTs tests to 15m depth with a DPSH if required to penetrate gravelly layers.

For and on behalf of Tetra Tech Coffey

Prepared by

Hemi

Cavell Hemi

Engineering Geologist
BSc

Reviewed by

Andreas Giannakogiorgos
Senior Principal Geotechnical Engineer
BSc, MSc, DIC, CMEng, CPEng, IntPE(NZ)

Authorized by

SaMartin

Sarah Martin
Geotechnics Leader Wellington
BSc, MSc

APPENDIX A: NZGD DATA

BH_114775	BH_114776	BH_114590	BH_114591	BH_114592
0 – 1.22m ***TOPSOIL***	*0 – 0.91m* **Fill**	*0 – 0.8m* **Fill**	*0 – 1.2m* **Silty SAND** and **GRAVELS**	*0 – 5.9m* brown and grey, dense **Sandy GRAVEL**
1.22 – 2.44m brown **metal** and **SAND**	*0.91 – 6.1m* blue **metal** and **SAND**	*0.8 – 3.1m* brown sandy GRAVEL	*1.2 – 3.7m* brown and grey, dense Sandy **GRAVEL**	*5.9 – 6.9m* dense, grey **SAND** with shells
2.44 – 9.2m grey blue **Sands** and **Silts**, with shells and organics	*6.1 – 15.9m* blue **SAND** and shells, trace silt and organics	*3.1 – 7.7m* coarse SAND and fine GRAVEL layers	*3.7 – 12.2m* grey, dense, coarse **Gravelly SAND,** with shells and organics	6.9 – 10.1m dense, grey **Sandy GRAVEL**, with shells
9.2 – 16.2m brown, **SILT**, peat and blue sand	*15.9 – 29.0m* grey blue **SILT** with shells and blue sand	*7.7 – 11.4m* dense, grey SAND, with shells and wood	*12.2 – 14.9m* grey, dense Silty SAND, with shells and wood	-
16.2 – 32.0m blue **metal**, trace clay	*15.9 – 29.0m* blue **metal** *@ 32.3 to 47.6 brown*	-	-	-
32.0 – 47.5m **GRAVEL**	**-**	**-**	**-**	**-**

CONE PENETRATION TEST (CPT) LOG

HOLE NO.: CPT08

CLIENT: ENGEO

PROJECT: 10 Udy Street, Petone

JOB NO.: 21/135

SITE LOCATION:

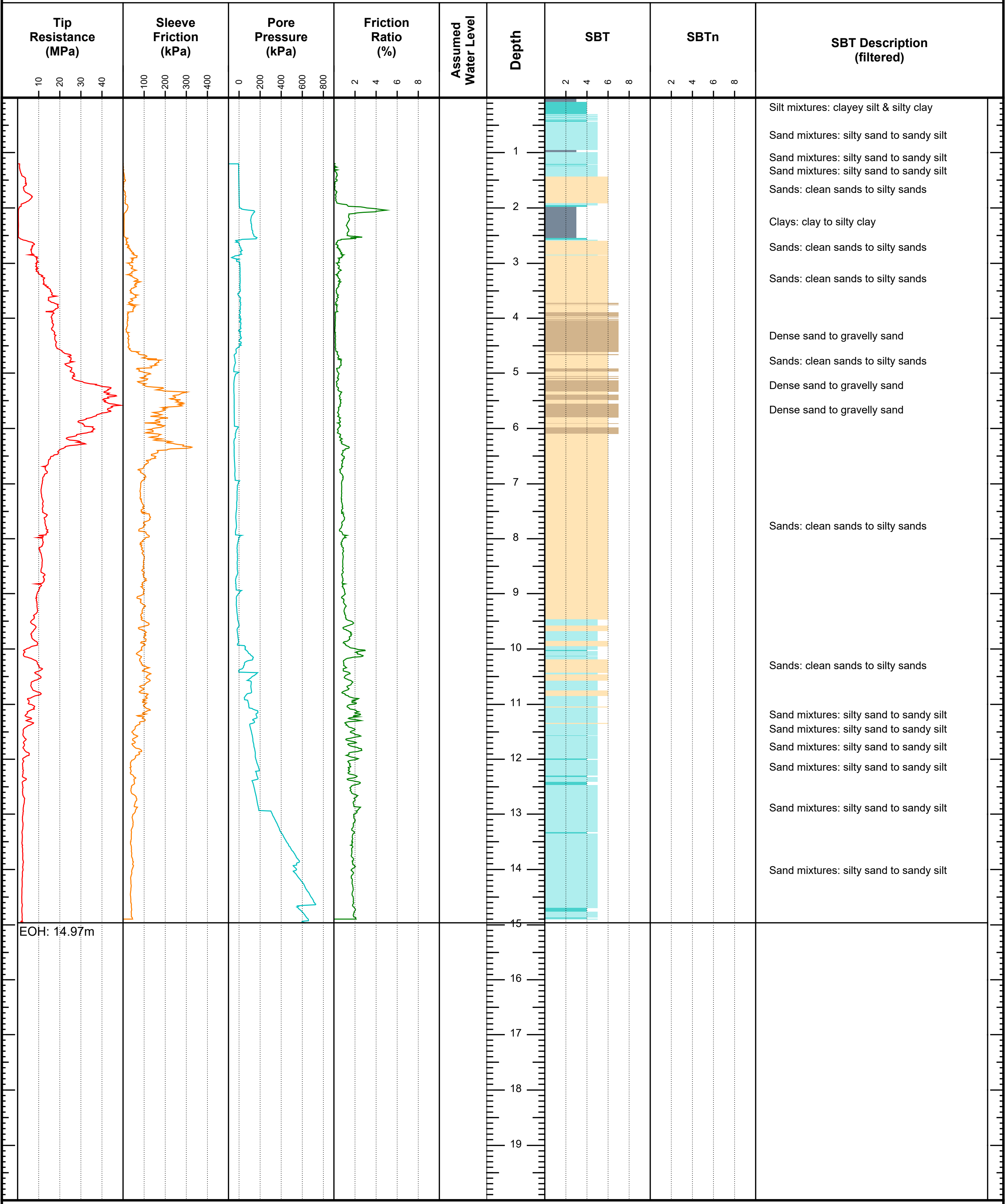
CONTRACTOR: Griffiths Drilling

START DATE: 17/09/2021

CO-ORDINATES:

ELEVATION: Ground

END DATE: 17/09/2021



Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sands: clean sands to silty sands

Clays: clay to silty clay

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Dense sand to gravelly sand

Sands: clean sands to silty sands

Dense sand to gravelly sand

Dense sand to gravelly sand

Sands: clean sands to silty sands

Sands: clean sands to silty sands

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

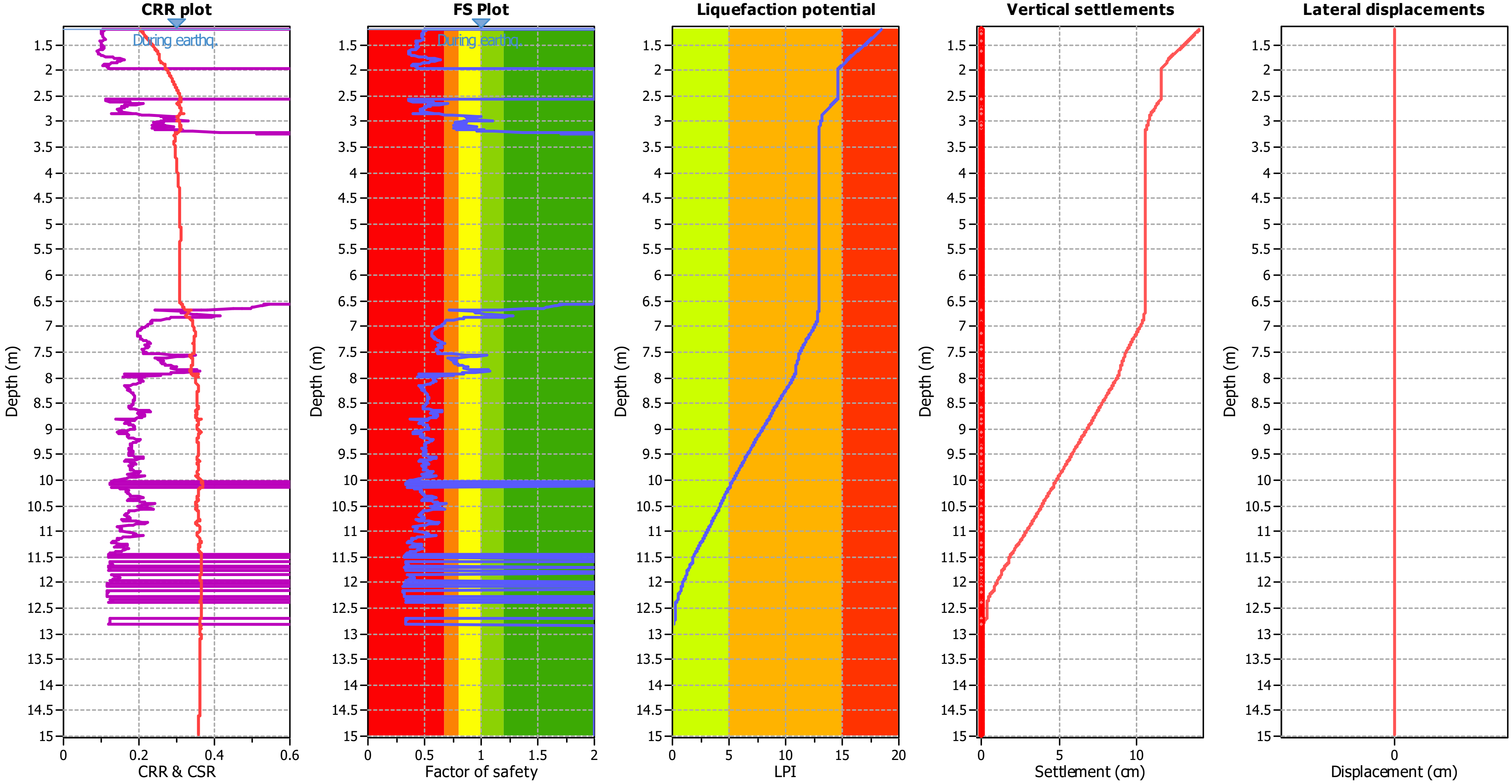
EOH: 14.97m

REMARKS:

NOTES:

Generated with CORE-GS by Geroc - CPT - Basic - 24/09/2021 8:36:34 am

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.10
Peak ground acceleration: 0.35
Depth to water table (insitu): 1.50 m

Depth to GWT (erthq.): 1.20 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

GRIFFITHS DRILLING

CONE PENETRATION TEST (CPT) LOG

HOLE NO.: CPT03

CLIENT: ENGEO

PROJECT: 10 Udy Street, Petone

JOB NO.: 21/135

SITE LOCATION:

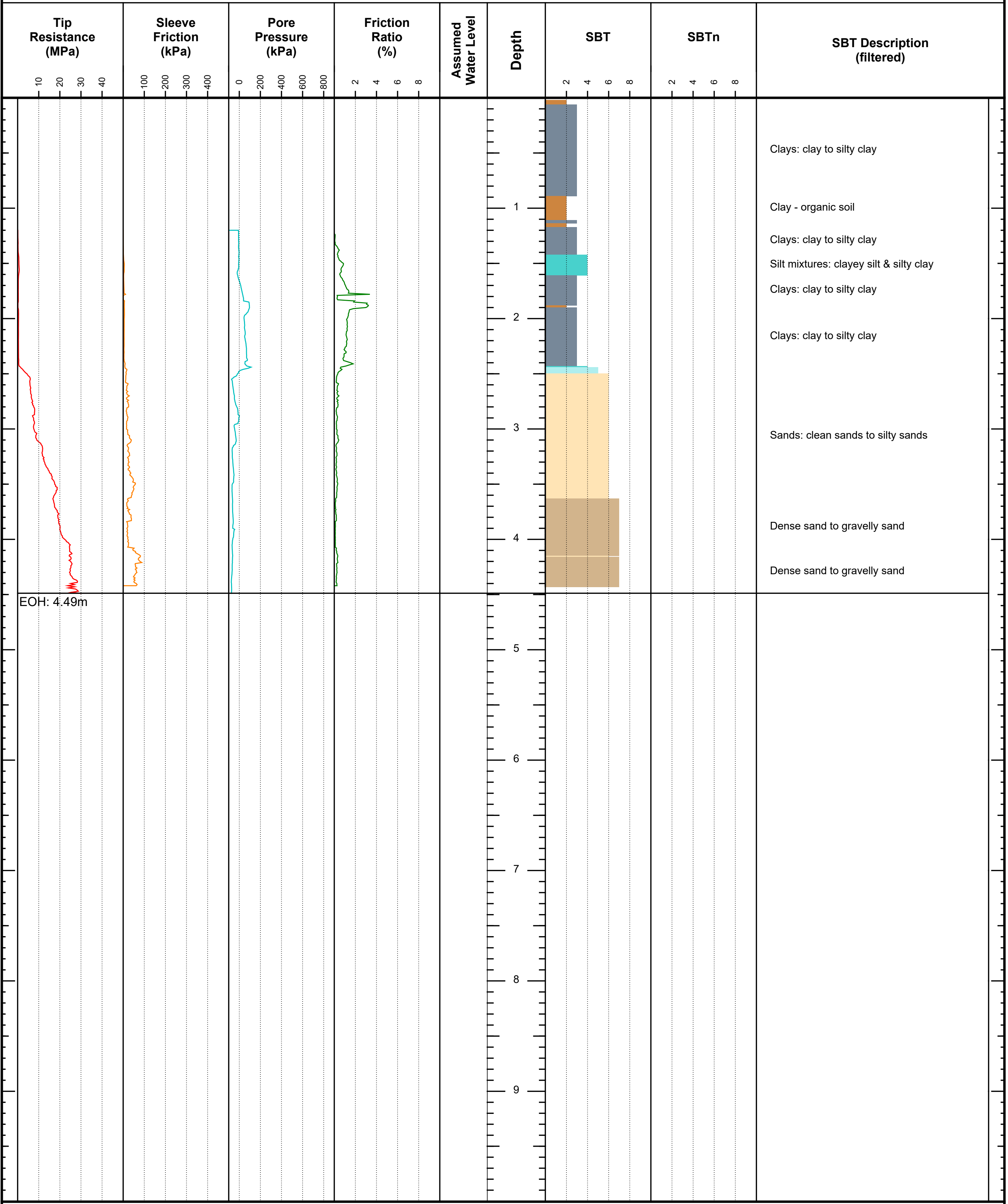
CONTRACTOR: Griffiths Drilling

START DATE: 17/09/2021

CO-ORDINATES:

ELEVATION: Ground

END DATE: 17/09/2021

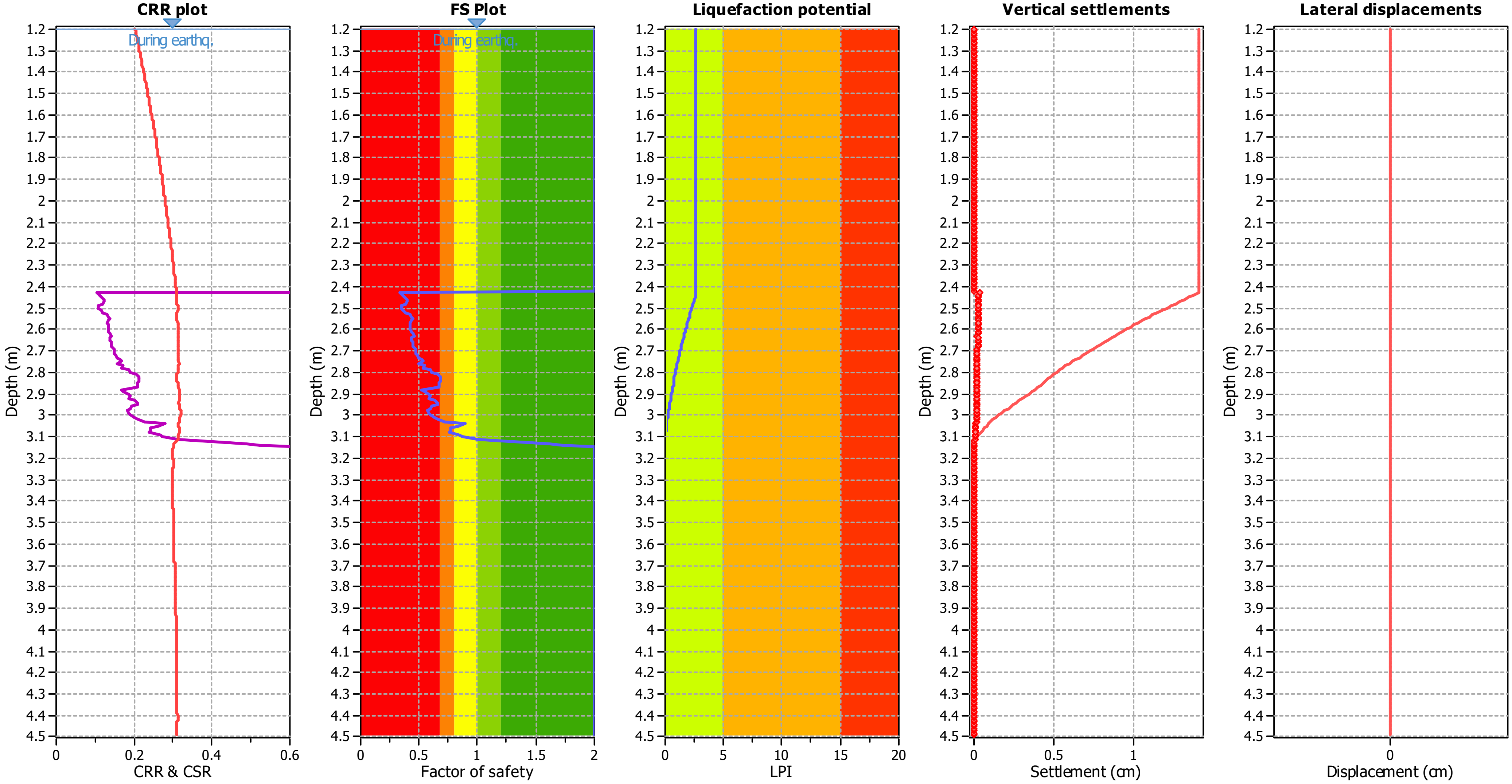


REMARKS:

NOTES:

Generated with CORE-GS by Geroc - CPT - Basic - 24/09/2021 8:36:33 am

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

CONE PENETRATION TEST (CPT) LOG

HOLE NO.: CPT04

CLIENT: ENGEO

PROJECT: 10 Udy Street, Petone

JOB NO.: 21/135

SITE LOCATION:

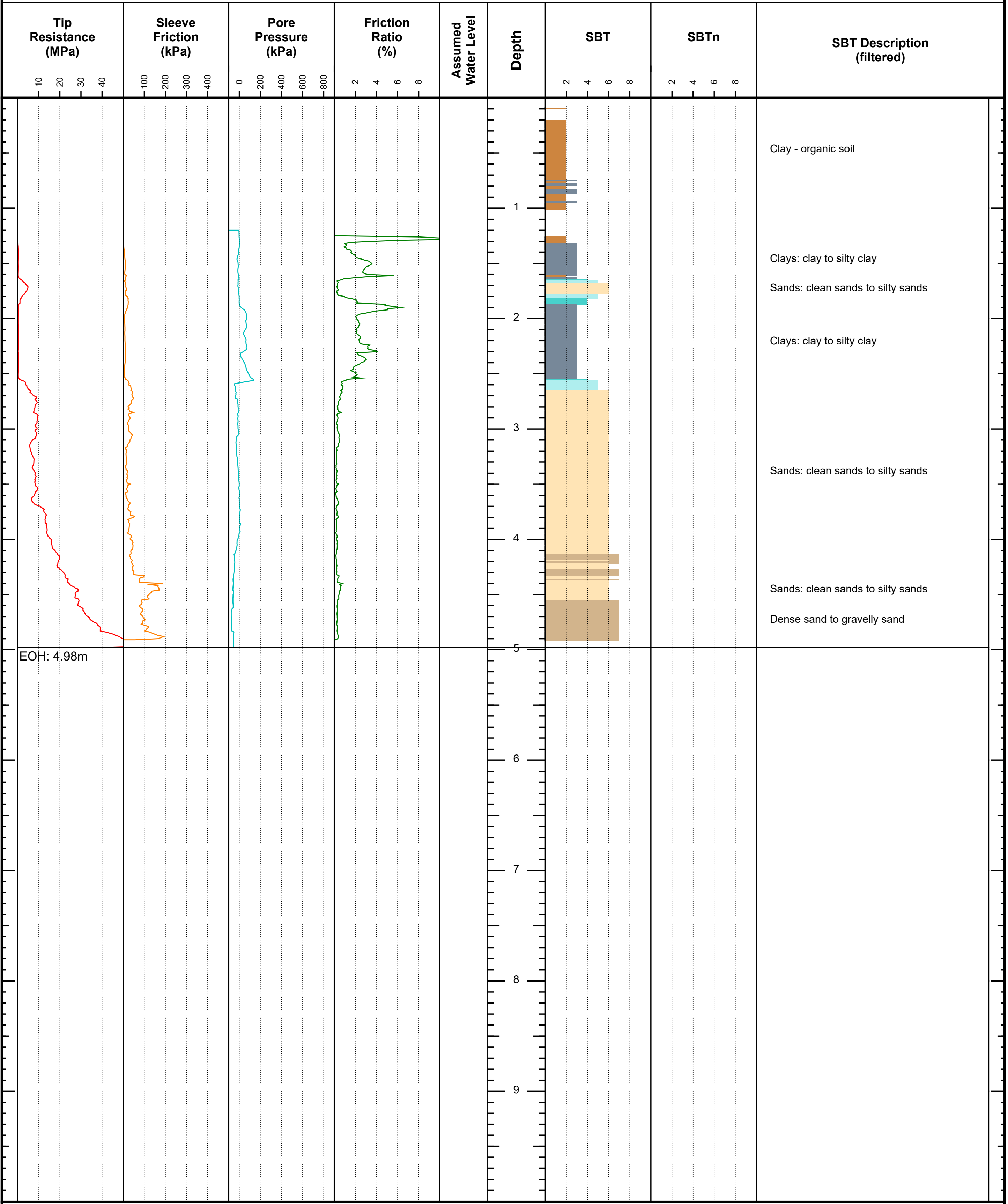
CONTRACTOR: Griffiths Drilling

START DATE: 17/09/2021

CO-ORDINATES:

ELEVATION: Ground

END DATE: 17/09/2021

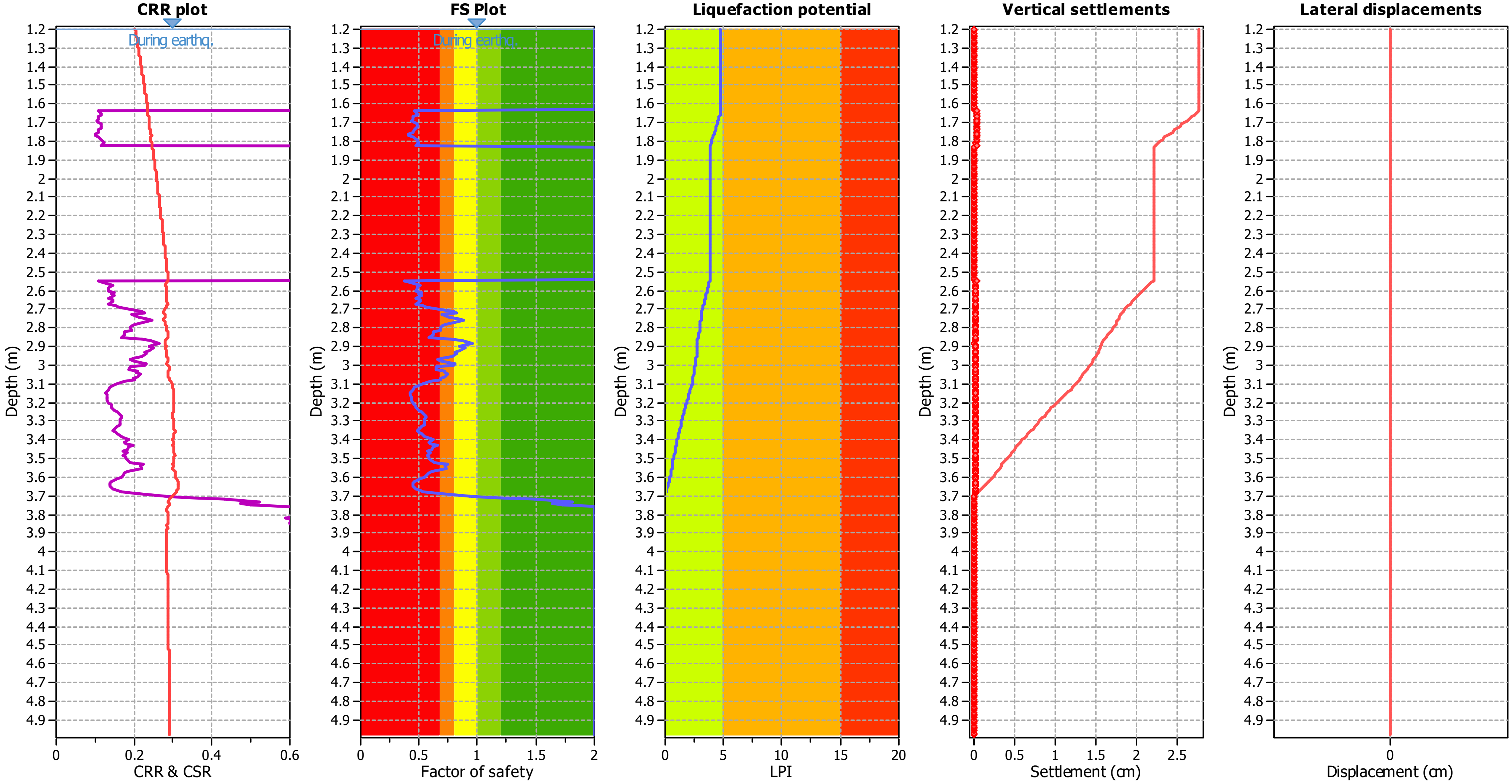


REMARKS:

NOTES:

Generated with CORE-GS by Geroc - CPT - Basic - 24/09/2021 8:36:34 am

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.10
Peak ground acceleration: 0.35
Depth to water table (insitu): 1.50 m

Depth to GWT (erthq.): 1.20 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

APPENDIX B: WINDOW SAMPLER LOGS

GEOTECHNICS

30 March 2023
Our Ref: 1090829.0000.0.0/Rep1
Client Ref: 773-WLGGE317986

Tetra Tech Coffey (NZ) Limited
P O Box 8261
Symonds Street
Auckland 1150

Attention: Sarah Martin

Dear Sarah

Petone Rec Grandstand

Site Report – Geotechnical Investigation

Customer's Instructions

We were instructed to complete:

- The drilling of three window sampler boreholes with associated down-hole Scala Penetrometer and shear vane testing.
- Photograph, log, and sample recovered material.

Date of Procedure

15/03/2023

Locations

Test locations were determined by TTC Ltd.

The attached plan provides indicative locations only and is not to scale. All other information we provide regarding location should be referenced to the asset owner.

Coordinates are provided in the bore logs.

a Method used to determine locations: GIS\Web map viewer
b Method used to determine RL: Estimated from contours
c Expected accuracy for location: ±5 m
d Expected accuracy for elevation: ±5 m

Samples

Samples were taken and can be collected from the Geotechnics Wellington office.

Methods

NZS 4402:1988 Test 6.5.2 - Determination of the penetration resistance of a soil (Hand method using a dynamic cone penetrometer) - Scala

NZGS 8:2001 - Test method for determining the vane shear strength of a cohesive soil using a hand held shear vane

Material Description

Material descriptions are provided in the attached results.

Results

The following is attached:

- Test location plan
- Window sampler borehole logs
- Scala Penetrometer test results.

Photos can be downloaded from the following link:

Photographs

This link will expire on 30/04/2023 after which we can provide the photos upon request. Whilst we provide this information via link for your convenience, please note that once downloaded, we consider the information uncontrolled.

Test Remarks

Material Logging

The logs represent our best assessment of the sub-surface conditions, but due to the subjective nature of material logging, we take no responsibility for any inaccuracies or misinterpretations.

Scala

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2019) "Pavement Design - A Guide to the Structural Design of Road Pavements".

Our standard test procedure is to over-drill Scala penetrometer tests every 1 m.

Shear Vane

Shear Vane tests are potentially unsuitable for material described in the borehole logs as ‘non-plastic’, ‘sandy SILT’, ‘silty SAND’ or ‘rootlets’. Tests in these materials may not be compliant with the stated test method.

General Remarks

This report has been prepared for the benefit of Tetra Tech Coffey (NZ) Limited, with respect to the particular brief given to us and it cannot be relied upon in other contexts or for any other purpose without our prior review and agreement.

The inherent uncertainties of site investigation work, mean the nature and continuity of subsoil away from the test location could vary from the data logged.

Samples not destroyed during testing will be retained for one month from the date of this report before being discarded.

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of the letterhead page.

GEOTECHNICS LTD

Report approved by:	Authorised for Geotechnics by:
....	....
Yan Agate Project Manager	Corey Papu-Gread Project Director

31-Mar-23
t:\geotechnicsgroup\projects\1090829\workingmaterial\20230330.selo.1090829.0.0.0.rep1.docx

LOCATION PLAN

Locations are indicative only

GEOTECHNICS

Level 4, 2 Hunter Street
Wellington, 6011

Site	Petone Rec Grandstand	Our Ref	1090829.0000.0.0/Rep1	Drawn By	LAMC	Date	23/03/23
Location	Petone Rec, Lower Hutt	Customer Ref	773-WLGGE317986	Checked By	SELO	Date	23/03/23
Project	GWN Petone Rec Grandstand TTC	Lab Ref	N/A	Scale	Not to Scale		

N

Aerial photograph sourced from Google GIS web map viewer (Copyright 2023)

BOREHOLE No.: **WS01**

Hole Location: Please refer to test location plan

SHEET: 1 OF 1

GEOTECHNICS

BOREHOLE LOG

PROJECT: GWN Petone Rec Grandstand TTC
LOCATION: Petone, Lower Hutt
JOB No.: 1090829.0000

CO-ORDINATES: (NZTM2000) 5434725.58 mN 1757694.76 mE
R.L.: 2.00m
DATUM: NZVD2016

DRILL TYPE: Window Sampler
DRILL METHOD: WS
DRILL FLUID: N/A

HOLE STARTED: 15/03/2023
HOLE FINISHED: 15/03/2023
DRILLED BY: Geotechnics Ltd
LOGGED BY: SELO
CHECKED: LAMC

GEOLOGICAL

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

ENGINEERING DESCRIPTION

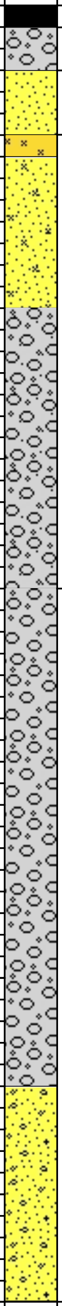
CORE RECOVERY (%)	METHOD	CASING	Depth interval
100	WS	60mm	0.0 - 1.0 m
100	WS	60mm	1.0 - 2.0 m
100	WS	45mm	2.0 - 3.0 m

WATER: 15/03/2023 (▼ at approx. 1.2 m)

TESTS: WS01-1 @ 0.35m

RL (m): 1 (at 1.0 m), 0 (at 2.0 m), -1 (at 3.0 m)

DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0



Depth (m)	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	Description and Additional Observations
0.00			*0.00m:* Asphalt (removed).
0.05	D-M	D	*0.05m:* GRAVEL, some sand; light grey. Dense, dry to moist; gravel, fine to coarse, angular to subangular; sand, fine to coarse.
0.15	M	D	*0.15m:* Silty gravelly SAND; greyish brown. Dense, moist; sand, fine to coarse; gravel, fine to medium, angular to subangular.
0.30	M-W	S	*0.30m:* SILT, trace sand; reddish brown. Soft, moist to wet, low plasticity; sand, fine.
0.35	M-W	L MD (0.60)	*0.35m:* Silty SAND; light grey with orange streaks. Loose, moist to wet; sand, fine. *0.60 - 0.70m:* Medium dense.
0.70	M-W	MD D (0.85)	*0.70m:* Sandy GRAVEL, trace silt; dark greyish brown. Medium dense, moist to wet, well graded; gravel, fine to coarse, subangular to rounded; sand, fine to coarse. *0.85 - 1.35m:* Dense.
1.35	S	D	*1.35m:* GRAVEL, some sand; dark grey. Dense, saturated; gravel, fine, subangular to subrounded; sand, medium to coarse. *2.00 - 2.50m:* GRAVEL, some sand. Gravel, fine to coarse, subangular to subrounded; sand, fine to coarse.
2.50	S	D VD (2.80)	*2.50m:* Gravelly SAND; dark grey. Dense, saturated; sand, fine to coarse; gravel, fine to medium, subangular to subrounded. *2.80 - 3.00m:* Very dense.

3m: Collapse

FLUID LOSS (%): 25 50 75
SHEAR STRENGTH (kPa): 10 25 50 100 200
COMPRESSIVE STRENGTH (MPa): 1 5 20 50 100 250
DEFECT SPACING (cm): 20 60 200 600 2000

COMMENTS:

Hole Depth 3m

Scale 1:18

Rev.: A

BoreLog - 31/03/2023 3:49:09 pm - Produced with Core-GS by GeRoc

GEOTECHNICS

Level 4
2 Hunter Street
Wellington 6011
New Zealand

p. +64 4 381 8584

Page 1 of 1

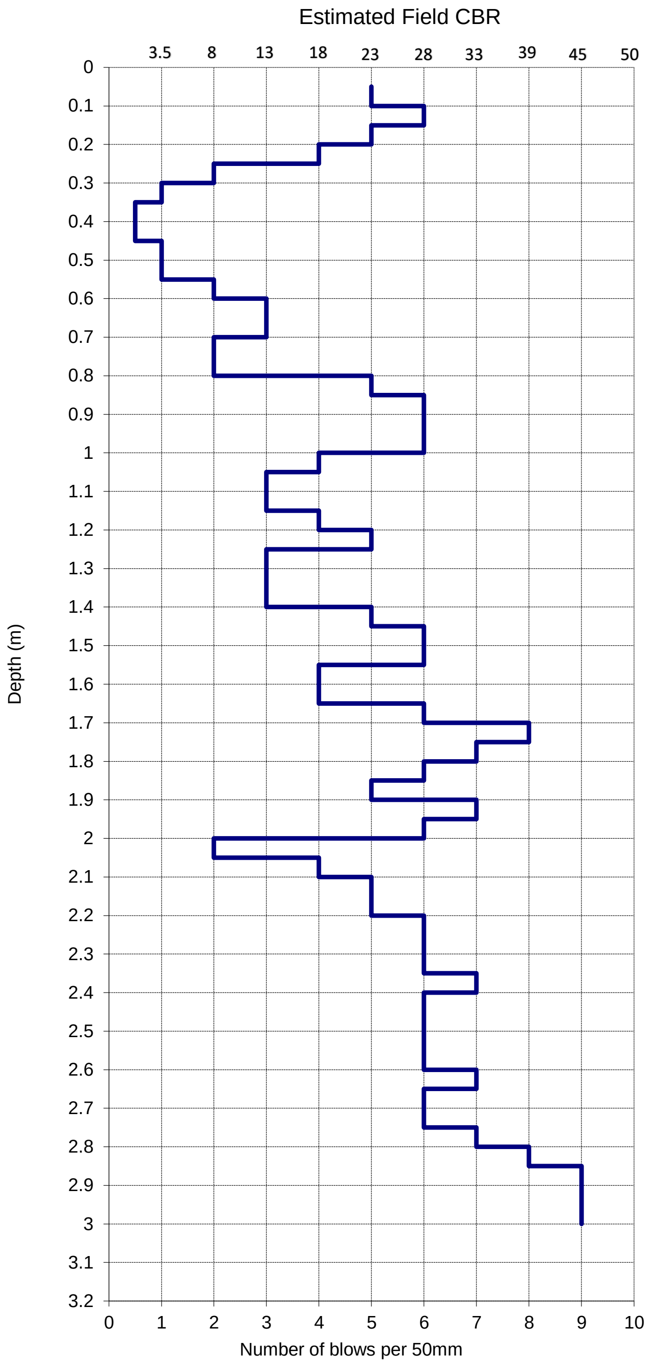
Lab Ref/URN
N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN Petone Rec Grandstand TTC	Project ID	1090829.0.0.0
Customer Project ID	773-WLGGE317986	Equipment ID	WGTN850
Site Location	Petone, Lower Hutt	Material Source	N/A
Material Description	Please refer to borehole log WS01	Test Series	N/A
Depth from ground surface to commencement of penetration (m)	0.05	Test Number	SC01

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5434725.58	1757694.76	2

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	100	5	1750	1800	7	3450	3500	
100	150	6	1800	1850	6	3500	3550	
150	200	5	1850	1900	5	3550	3600	
200	250	4	1900	1950	7	3600	3650	
250	300	2	1950	2000	6	3650	3700	
300	350	1	2000	2050	2	3700	3750	
350	400	0.5	2050	2100	4	3750	3800	
400	450	0.5	2100	2150	5	3800	3850	
450	500	1	2150	2200	5	3850	3900	
500	550	1	2200	2250	6	3900	3950	
550	600	2	2250	2300	6	3950	4000	
600	650	3	2300	2350	6	4000	4050	
650	700	3	2350	2400	7	4050	4100	
700	750	2	2400	2450	6	4100	4150	
750	800	2	2450	2500	6	4150	4200	
800	850	5	2500	2550	6	4200	4250	
850	900	6	2550	2600	6	4250	4300	
900	950	6	2600	2650	7	4300	4350	
950	1000	6	2650	2700	6	4350	4400	
1000	1050	4	2700	2750	6	4400	4450	
1050	1100	3	2750	2800	7	4450	4500	
1100	1150	3	2800	2850	8	4500	4550	
1150	1200	4	2850	2900	9	4550	4600	
1200	1250	5	2900	2950	9	4600	4650	
1250	1300	3	2950	3000	9	4650	4700	
1300	1350	3	3000	3050		4700	4750	
1350	1400	3	3050	3100		4750	4800	
1400	1450	5	3100	3150		4800	4850	
1450	1500	6	3150	3200		4850	4900	
1500	1550	6	3200	3250		4900	4950	
1550	1600	4	3250	3300		4950	5000	
1600	1650	4	3300	3350		5000	5050	
1650	1700	6	3350	3400		5050	5100	
1700	1750	8	3400	3450		5100	5150	



Test Remarks

Cells containing 'WS' indicates overdrilling by the window sampler.

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2019) "Pavement Design - A Guide to the Structural Design of Road Pavements".

Tested By	SELO/LAMC	Date	15/03/2023
Data Entry By	SELO	Date	22/03/2023
Checked by	LAMC	Date	22/03/2023

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **WS02**

Hole Location: Please refer to test location plan

SHEET: 1 OF 1

PROJECT: GWN Petone Rec Grandstand TTC
LOCATION: Petone, Lower Hutt
JOB No.: 1090829.0000

CO-ORDINATES: (NZTM2000) 5434742.06 mN 1757719.78 mE
R.L.: 2.00m
DATUM: NZVD2016

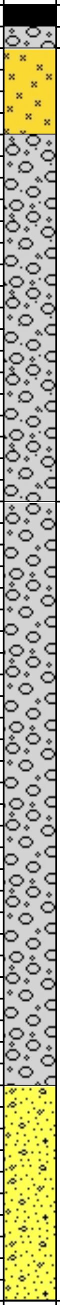
DRILL TYPE: Window Sampler
DRILL METHOD: WS
DRILL FLUID: N/A

HOLE STARTED: 15/03/2023
HOLE FINISHED: 15/03/2023
DRILLED BY: Geotechnics Ltd
LOGGED BY: SELO
CHECKED: LAMC

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)
		100	WS	60mm			1	0.5 1.0
	15/03/2023	100	WS	60mm	WS02-1 @ 1.50m		0	1.5 2.0
		100	WS	45mm	WS02-2 @ 2.60m		-1	2.5 3.0



MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	Description and Additional Observations
		0.00m: Asphalt (removed)
D-M	MD	*0.05m:* GRAVEL, some sand, minor silt; grey . Medium dense, dry to moist; gravel, fine to medium, angular to subangular; sand, fine to coarse.
M	F-St	*0.10m:* SILT, some sand, trace gravel; dark brown. Firm to stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to medium, angular to subangular.
	MD D MD D VD	*0.30m:* Sandy GRAVEL; greyish brown. Medium dense, moist; gravel, fine to coarse, angular to subrounded; sand, fine to coarse. *0.40 - 0.60m:* Dense. *0.60 - 0.75m:* Medium dense. *0.75 - 1.05m:* Dense. *1.05 - 1.30m:* Very dense.
S	D	*1.15m:* GRAVEL, some sand; dark grey. Very dense, moist to wet, poorly graded; gravel, fine, subangular to subrounded; sand, fine to coarse. *1.30 - 2.50m:* Saturated. *1.40 - 1.55m:* Dense. *1.90 - 2.50m:* Some silt; greyish brown. Dense.
	VD	*2.50m:* Gravelly SAND; dark grey. Very dense, saturated; sand, medium to coarse; gravel, fine to coarse, angular to subrounded.

3m: Collapse

COMMENTS:

Hole Depth 3m

Scale 1:18

Rev.: A

GEOTECHNICS

Level 4
2 Hunter Street
Wellington 6011
New Zealand

p. +64 4 381 8584

Page 1 of 1

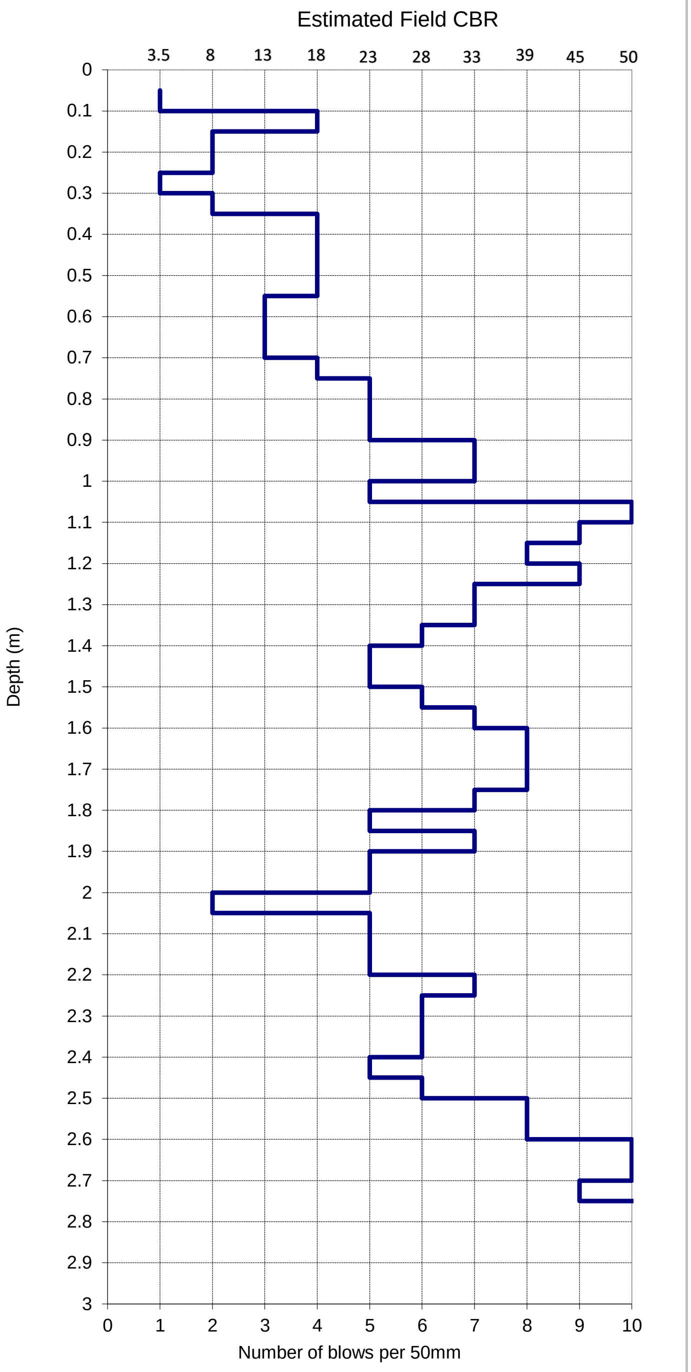
Lab Ref/URN
N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN Petone Rec Grandstand TTC	Project ID	1090829.0.0.0
Customer Project ID	773-WLGGE317986	Equipment ID	WGTN850
Site Location	Petone, Lower Hutt	Material Source	N/A
Material Description	Please refer to borehole log WS02	Test Series	N/A
Depth from ground surface to commencement of penetration (m)	0.05	Test Number	SC02

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5434742.06	1757719.78	2

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	100	1	1750	1800	7	3450	3500	
100	150	4	1800	1850	5	3500	3550	
150	200	2	1850	1900	7	3550	3600	
200	250	2	1900	1950	5	3600	3650	
250	300	1	1950	2000	5	3650	3700	
300	350	2	2000	2050	2	3700	3750	
350	400	4	2050	2100	5	3750	3800	
400	450	4	2100	2150	5	3800	3850	
450	500	4	2150	2200	5	3850	3900	
500	550	4	2200	2250	7	3900	3950	
550	600	3	2250	2300	6	3950	4000	
600	650	3	2300	2350	6	4000	4050	
650	700	3	2350	2400	6	4050	4100	
700	750	4	2400	2450	5	4100	4150	
750	800	5	2450	2500	6	4150	4200	
800	850	5	2500	2550	8	4200	4250	
850	900	5	2550	2600	8	4250	4300	
900	950	7	2600	2650	10	4300	4350	
950	1000	7	2650	2700	10	4350	4400	
1000	1050	5	2700	2750	9	4400	4450	
1050	1100	10	2750	2800	11	4450	4500	
1100	1150	9	2800	2850		4500	4550	
1150	1200	8	2850	2900		4550	4600	
1200	1250	9	2900	2950		4600	4650	
1250	1300	7	2950	3000		4650	4700	
1300	1350	7	3000	3050		4700	4750	
1350	1400	6	3050	3100		4750	4800	
1400	1450	5	3100	3150		4800	4850	
1450	1500	5	3150	3200		4850	4900	
1500	1550	6	3200	3250		4900	4950	
1550	1600	7	3250	3300		4950	5000	
1600	1650	8	3300	3350		5000	5050	
1650	1700	8	3350	3400		5050	5100	
1700	1750	8	3400	3450		5100	5150	



Test Remarks

Cells containing 'WS' indicates overdrilling by the window sampler.

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2019) "Pavement Design - A Guide to the Structural Design of Road Pavements".

Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/LAMC	Date	15/03/2023
Data Entry By	SELO	Date	22/03/2023
Checked by	LAMC	Date	22/03/2023

BOREHOLE No.: WS03

Hole Location: Please refer to test location plan

SHEET: 1 OF 1

GEOTECHNICS

BOREHOLE LOG

PROJECT: GWN Petone Rec Grandstand TTC
LOCATION: Petone, Lower Hutt
JOB No.: 1090829.0000

CO-ORDINATES: (NZTM2000) 5434771.63 mN
1757712.81 mE
R.L.: 2.00m
DATUM: NZVD2016

DRILL TYPE: Window Sampler
DRILL METHOD: WS
DRILL FLUID: N/A

HOLE STARTED: 15/03/2023
HOLE FINISHED: 15/03/2023
DRILLED BY: Geotechnics Ltd
LOGGED BY: SELO
CHECKED: LAMC

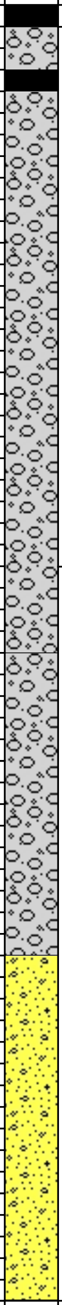
GEOLOGICAL

GEOLOGICAL UNIT,
GENERIC NAME,
ORIGIN,
MATERIAL COMPOSITION.

FLUID LOSS (%) 25 50 75
WATER
CORE RECOVERY (%)
METHOD
CASING
TESTS
SAMPLES
RL (m)
DEPTH (m)

ENGINEERING DESCRIPTION

GRAPHIC LOG
MOISTURE CONDITION / WEATHERING
STRENGTH/DENSITY CLASSIFICATION
SHEAR STRENGTH (kPa) 10 25 50 100 200
COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250
DEFECT SPACING (cm) 20 60 200 600 2000
Description and Additional Observations



Depth (m)	RL (m)	Core recovery (%)	Method	Casing
0.0 – 1.0		100	WS	60mm
1.0	1			
1.0 – 2.0		100	WS	45mm
2.0	0			
2.0 – 3.0		100	WS	35mm
3.0	-1			

WATER: 15/03/2023 (at approx. 1.3m)

TESTS: WS03-1 @ 0.60m

MOISTURE CONDITION: M (0.05 – 1.30m); S (1.30 – 3.0m)

STRENGTH/DENSITY CLASSIFICATION: VD; D; MD; D; VD

0.00m: Asphalt (removed)

0.05m: Sandy GRAVEL; greyish brown. Very dense, moist; gravel, fine to coarse, angular to subrounded; sand, fine to coarse.

0.15m: Asphalt

0.20m: Sandy GRAVEL; dark brown. Dense, moist, well graded; gravel, fine to coarse, subangular to subrounded; sand, fine to coarse.
0.45 - 1.35m: Medium dense.
1.00 - 1.50m: Trace silt.
1.30 - 1.50m: Saturated.
1.35 - 1.50m: Dense.

1.50m: Sandy GRAVEL; dark grey. Dense, saturated; gravel, fine to medium, subangular to subrounded; sand, fine to coarse.

2.20m: Gravelly SAND; dark grey. Dense, saturated; sand, fine to coarse; gravel, fine, subangular to subrounded.
2.40 - 3.00m: Very dense.

3m: Collapse

COMMENTS:

Hole Depth
3m

Scale 1:18

Rev.: A

BoreLog - 31/03/2023 3:49:13 pm - Produced with Core-GS by GeRoc

GEOTECHNICS

Level 4
2 Hunter Street
Wellington 6011
New Zealand

p. +64 4 381 8584

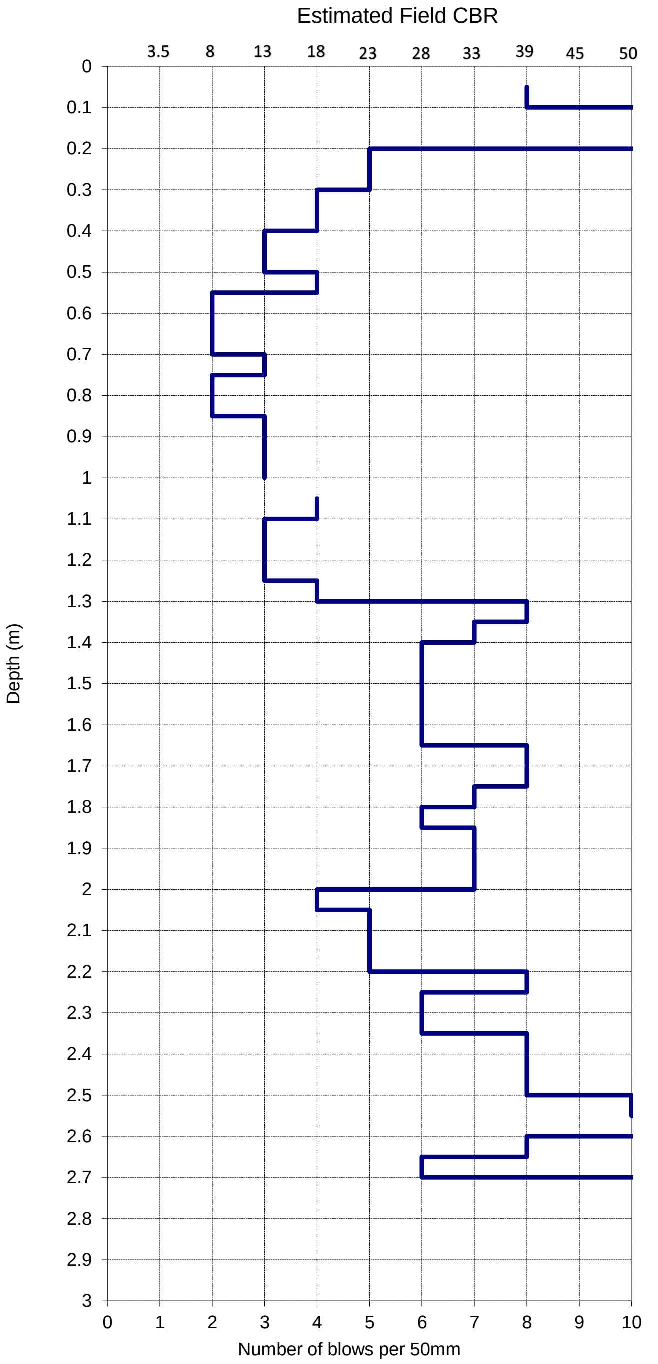
Page 1 of 1	
Lab Ref/URN	N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN Petone Rec Grandstand TTC	Project ID	1090829.0.0.0
Customer Project ID	773-WLGGE317986	Equipment ID	WGTN850
Site Location	Petone, Lower Hutt	Material Source	N/A
Material Description	Please refer to borehole log WS03	Test Series	N/A
Depth from ground surface to commencement of penetration (m)	0.05	Test Number	SC03

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5434771.63	1757712.81	2

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	100	8	1750	1800	7	3450	3500	
100	150	16	1800	1850	6	3500	3550	
150	200	24	1850	1900	7	3550	3600	
200	250	5	1900	1950	7	3600	3650	
250	300	5	1950	2000	7	3650	3700	
300	350	4	2000	2050	4	3700	3750	
350	400	4	2050	2100	5	3750	3800	
400	450	3	2100	2150	5	3800	3850	
450	500	3	2150	2200	5	3850	3900	
500	550	4	2200	2250	8	3900	3950	
550	600	2	2250	2300	6	3950	4000	
600	650	2	2300	2350	6	4000	4050	
650	700	2	2350	2400	8	4050	4100	
700	750	3	2400	2450	8	4100	4150	
750	800	2	2450	2500	8	4150	4200	
800	850	2	2500	2550	10	4200	4250	
850	900	3	2550	2600	12	4250	4300	
900	950	3	2600	2650	8	4300	4350	
950	1000	3	2650	2700	6	4350	4400	
1000	1050	WS	2700	2750	14	4400	4450	
1050	1100	4	2750	2800	13	4450	4500	
1100	1150	3	2800	2850		4500	4550	
1150	1200	3	2850	2900		4550	4600	
1200	1250	3	2900	2950		4600	4650	
1250	1300	4	2950	3000		4650	4700	
1300	1350	8	3000	3050		4700	4750	
1350	1400	7	3050	3100		4750	4800	
1400	1450	6	3100	3150		4800	4850	
1450	1500	6	3150	3200		4850	4900	
1500	1550	6	3200	3250		4900	4950	
1550	1600	6	3250	3300		4950	5000	
1600	1650	6	3300	3350		5000	5050	
1650	1700	8	3350	3400		5050	5100	
1700	1750	8	3400	3450		5100	5150	



Test Remarks

Cells containing 'WS' indicates overdrilling by the window sampler.

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2019) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/LAMC	Date	15/03/2023
Data Entry By	SELO	Date	22/03/2023
Checked by	LAMC	Date	22/03/2023

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

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. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.