

PROJECT SUMMARY

Site Address 19 Belfield Street, Dallington, Christchurch 8061

Prepared to Hayley Sorensen c/o Smartlift Solutions Ltd t/a Smartlift Systems

Project No. 25288

Issue Date 30 September 2025

Revision A

BCN N/A

Design Scope

<input type="checkbox"/> New Build - Residential	<input type="checkbox"/> New Build - Commercial
<input checked="" type="checkbox"/> Earthquake Repair / Re-level	<input type="checkbox"/> Earthquake Strengthening
<input type="checkbox"/> Alteration to existing structure	<input type="checkbox"/> Extension to existing structure
<input type="checkbox"/> Engineering Peer Review	

CONSTRUCTION MONITORING NOTICE

Refer to attached 'Construction Monitoring Schedule' for full details of required site inspections. A minimum of 48 hours' notice is required to carry out any inspections.

The number of inspections listed in the schedule will depend on the contractor's method of construction, concrete pour sequencing, etc. and shall be agreed with the contractor as the works progress.

A producer statement (PS4 Construction Review) will be issued once all the above inspections have been completed, and once a producer statement (PS3 Construction) or a Memorandum: Record of building work covering all structural items has been provided by the contractors involved.

PRODUCER STATEMENT – PS1 DESIGN

BUILDING CODE CLAUSE(S): B1/VM1, VM4, AS1, MBIE Guidance
ISSUED BY: Peridot Engineering Limited
(Engineering Design Firm)
TO: Hayley Sorensen c/o Smartlift Solutions Ltd t/a Smartlift Systems
(Owner/Developer)
TO BE SUPPLIED TO: Christchurch City Council
(Building Consent Authority)
IN RESPECT OF: Foundation Re-levelling/Repair to Existing Residential Building
(Description of Building Work)
AT: 19 Belfield Street, Dallington, Christchurch 8061
(Address, Town/City)
LEGAL DESCRIPTION: Lot 9 DP 16872

JOB NUMBER: 25288

N/A ☐

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement):*

Structural engineering design as per the calculations attached

in respect of the requirements of the Clause(s) of the Building Code specified above for Part only, as specified in the Schedule, of the proposed building work.

The design carried out by us has been prepared in accordance with:

- ☒ Compliance documents issued by the Ministry of Business, Innovation & Employment *(Verification method/acceptable solution)* B1/VM1, VM4, AS1 and/or;
- ☒ Alternative solution as per the attached Schedule.

The proposed building work covered by this producer statement is described on the drawings specified in the Schedule, together with the specification, and other documents set out in the Schedule.

On behalf of the Engineering Design Firm, and subject to:

- Site verification of the following design assumptions: soil per geo report by KGA, date 29 June 2023, ref. : K230406-1
- All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that:

- the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the Schedule, will comply with the relevant provisions of the Building Code and that;
- the persons who have undertaken the design have the necessary competency to do so.

I recommend the CM 3 level of **construction monitoring**.

I, *(Name of Engineering Design Professional)* Nam Nguyen, am:

- ☒ CPEng number 1020176
- and hold the following qualifications BE(Hons), CMEngNZ, CPEng

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than \$200,000
The Engineering Design Firm is not a member of ACE New Zealand.

SIGNED BY *(Name of Engineering Design Professional):* Nam Nguyen
(Signature below):

N/D Nam

ON BEHALF OF *(Engineering Design Firm):* Peridot Engineering Limited

Date: 30/9/2025

Note: This statement has been prepared solely for the Building Consent Authority named above and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Engineering Design Firm only. As a condition of reliance on this statement, the Building Consent Authority accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in tort or otherwise, is limited to the sum of \$200,000.

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

SCHEDULE to PS1

Please include an itemised list of all referenced documents, drawings, or other supporting materials in relation to this producer statement below:

- Structural drawings by Peridot Engineering, dated 30 September 2025, Revision A, ref. No 25288 and numbered: S001 (rev 1), S100 (rev 1), S101 (rev 1), S401 (rev 1), S402 (rev 1), S403 (rev 1).
- Structural calculations by Peridot Engineering ref. no 25288.
- Alternative solutions as per MBIE Guidance "Repairing and rebuilding houses affected by the Canterbury EQ".

GUIDANCE ON USE OF PRODUCER STATEMENTS

Information on the use of Producer Statements and Construction Monitoring Guidelines can be found on the Engineering New Zealand website

<https://www.engineeringnz.org/engineer-tools/engineering-documents/producer-statements/>

Producer statements were first introduced with the Building Act 1991. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects (NZIA), Institution of Professional Engineers New Zealand (now Engineering New Zealand), Association of Consulting and Engineering New Zealand (ACE NZ) in consultation with the Building Officials Institute of New Zealand (BOINZ). The original suite of producer statements has been revised at the date of this form to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with part of the reasonable grounds necessary for the issue of a Building Consent or a Code Compliance Certificate, without necessarily having to duplicate review of design or construction monitoring undertaken by others.

PS1 DESIGN Intended for use by a suitably qualified independent engineering design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;

PS2 DESIGN REVIEW Intended for use by a suitably qualified independent engineering design review professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;

PS3 CONSTRUCTION Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:2013 or Schedules E1/E2 of NZIA's SCC 2011²

PS4 CONSTRUCTION REVIEW Intended for use by a suitably qualified independent engineering construction monitoring professional who either undertakes or supervises construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate.

This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACE New Zealand and Engineering New Zealand to interpret the Producer Statement.

Competence of Engineering Professional

This statement is made by an engineering firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its personnel.

The person signing the Producer Statement on behalf of the engineering firm will have a professional qualification and proven current competence through registration on a national competence-based register such as a Chartered Professional Engineer (CPEng).

Membership of a professional body, such as Engineering New Zealand provides additional assurance of the designer's standing within the profession. If the engineering firm is a member of ACE New Zealand, this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent engineering professional".

Professional Indemnity Insurance

As part of membership requirements, ACE New Zealand requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI Insurance minimum stated on the front of this form reflects standard practice for the relationship between the BCA and the engineering firm.

Professional Services during Construction Phase

There are several levels of service that an engineering firm may provide during the construction phase of a project (CM1-CM5 for engineers³). The building Consent Authority is encouraged to require that the service to be provided by the engineering firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4

Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Refer Also:

- ¹ Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2013
- ² NZIA Standard Conditions of Contract SCC 2011
- ³ Guideline on the Briefing & Engagement for Consulting Engineering Services (ACE New Zealand/Engineering New Zealand 2004)
- ⁴ PN01 Guidelines on Producer Statements

www.acenz.org.nz

www.engineeringnz.org

To the Building Official,

Christchurch City Council

19 Belfield Street, Dallington, Christchurch 8061

Compliance with Building Code Clause B2 – Durability

The purpose of this letter is to demonstrate how compliance with Clause B2 (Durability) of the Building Code will be achieved for the above project. We can confirm that for specifically designed structural elements that are included within our design documentation:

Material	Means of compliance	Details
Reinforced concrete	B2/AS1	Concrete cover to reinforcing has been selected in accordance with NZS3101, Part 1, Section 3
Structural timber	B2/AS1	Timber treatment has been selected in accordance with Table 1A of B2/AS1
Mild steel structure	Alternative Solution	Protection for mild steel has been specified in accordance with SNZ TS 3404 – Durability requirements for steel structures and components and AS/NZS2312 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings. This guide works on a time to first maintenance basis and assumes on-going maintenance. Refer to the attached maintenance plan (optional but recommended).
Other		

Yours faithfully,

Nam Nguyen

For and on behalf of

Peridot Engineering Limited

Structural maintenance schedule

This schedule of ongoing inspection and maintenance of structural elements shall be included with the Operations and Maintenance manuals and provided to the Owner/Body Corporate and building managers.

Inspection/maintenance timeframe and item	
Half-yearly	<p>Wash down all exposed steelwork that is not in a fully interior environment including:</p> <ul style="list-style-type: none"> • Veranda steelwork • Steel Carpark structure (beams, columns, braces etc) • Deck and balcony steelwork • Exposed façade steelwork, both primary and secondary structure • Plantrooms and plenums with fresh-air intakes • External structural components such as Buckling Restrained Braces, Viscous Dampers, Eccentrically Braced Frames and the like • Sub-ground floor mild-steel structures such as beams, isolation bearings etc.
(b) 5 yearly	Inspect and repair sealant that encloses structural mild-steel components and/or timber with mild-steel fixings
(c) 10 yearly	Check exposed timber fixings for corrosion, repair as required.
	Inspect/replace sealant that encloses structural mild-steel components and/or timber with mild-steel fixings. This will typically include sealants around the perimeter of precast panels. Note that 10 years is the expected useful life for many sealants
	Check exposed structural steel within plantrooms and plenums for corrosion. Repair protective coatings as required.
	Check all exposed steelwork that is not in a fully interior environment for signs of corrosion. Repair protective coatings as required.
	Audit of damage to exposed intumescent coatings. Repair as required.
(d) 25 yearly	Inspect samples of structural steel that is hidden from view but not enclosed within a vapour barrier, and repair protective coatings as necessary. A typical example is a veranda with built-in steelwork. (Such steelwork should typically have duplex protective coatings). Inspection may typically require removal of claddings and/or the drilling of holes for borescope access. Repair as required.
	Inspect all exposed, external timber. Repair as required.
	Inspect all exposed, external reinforced concrete for signs of spalling or cracking. Repair as required.
	Audit of damage to enclosed intumescent coatings. Repair as required.
Following fit-out or alterations	Audit of damage to intumescent coatings. Repair as required.
Following seismic shaking > SLS1 event	Inspections and repair as per b), c) and d) above

CERTIFICATE OF DESIGN WORK

MEMORANDUM FROM LICENSED BUILDING PRACTITIONER

Section 30C and Section 45, Building Act 2004

The Building

Street address

19 Belfield Street

Suburb

Dallington

Town/city

Christchurch

Postcode

8061

Building consent no.

The Owner

Name(s)

Email

Phone

Address

Basis for providing this memorandum

I am providing this memorandum in my role as the **specialist** designer who carried out or supervised specific Primary structure elements of restricted building work (RBW) design work as described in this memorandum. Other designers will provide memoranda covering the remaining RBW design work. Refer also to the attached PSI.

Identification of restricted building work (RBW) design work

I, **Nam Nguyen** carried out or supervised the following RBW design work:

Primary structure: B1

Design work that is RBW	Description (as required) and reference to plans and specifications	Carried out or supervised
Foundations and subfloor framing <input checked="" type="checkbox"/>	Foundation re-level design as per calculations attached	Supervised
Retaining walls <input type="checkbox"/>		Supervised
Beams <input type="checkbox"/>		Supervised
Portal <input type="checkbox"/>		Supervised
Bracing <input type="checkbox"/>		Supervised
Other (primary) <input type="checkbox"/>		Supervised

Note: SED = Elements subject to Specific Engineering Design outside of the scope of NZS3604:2011, unless otherwise noted.

Initial **NN**

Date **30/09/2025**

Waivers and modifications

Are waivers or modifications of the Building Code required?

No

If yes, please provide details of the waivers or modifications:

Building Code clause

Waiver/modification required

Issued by

Name	Nam Nguyen	Design entity/company	Peridot Engineering Limited
Chartered status	CPEng	Chartered no.	1020176
Email	admin@peridoteng.nz	Website	https://www.peridoteng.nz/
Phone (daytime)	(03) 2222298	Phone (after hours)	
Mobile			
Postal address	Unit 5, 105 Gasson Street, Sydenham, Christchurch		
Physical address	Unit 5, 105 Gasson Street, Sydenham, Christchurch		

Declaration

I, Nam Nguyen, LBP state that I have applied the skills and care reasonably required of a competent design professional in carrying out or supervising the RBW described in this memorandum and that based on this, I certify that the RBW described in this memorandum:

- complies with the Building Code; or
- complies with the Building Code subject to any waiver or modification of the Building Code described in this memorandum.

Signature

N/D Nam

Date 30/09/2025



Address 19 Belfield Street, Dallington, Christchurch 8061

No.	Item of inspection	Timeframe
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(Delete any that do not apply)

Notes:

- Christchurch City Council | Exemption from building consent | BCN/2025/7826 | 10/10/2025 | Page 9 of 194

RELEVELLING DESIGN

Project # :

DESIGN BY :

DATE :


25288

KJ

15/09/2025

FOUNDATION PAD

LABEL: Relevelling pads



Site parameters

Wind region: NZ1/2

Wind zone: EXTRA HIGH

Wind pressure (ULS): 0.55 kPa

Snow load: 0.63 kPa

Importance level : 2

Soil Parameters (refer geotechnical report)

f_b= 150 kPa

Φ_{ULS}= 0.5

D_f= 0.2 m

Ultimate soil bearing capacity

Geotechnical strength reduction factor

Pad depth

LOAD CASE FACTORS

LOAD CASE	NOTES	G	Q	Wind (down)	Snow	Scale factor
LC1	1.35G	1.35				1.00
LC2	1.2G+1.5Q	1.20	1.50			1.00
LC3	1.2G+Wu+ψ _c Q	1.20	0.40	1.00		1.00
LC4	1.2G+Su+ψ _c Q	1.20	0.40		1.00	1.00

Calculations are completed for gravity design only (EQ loads are not considered). ULS case governs.

Building parameters

	Floor only	1 storey			2 storey		3 storey	
Building element	Ground floor	Foundation wall	Lower walls	Roof	1st floor	Mid walls	2nd floor	Upper walls
Type	TIMBER FLOOR	Foundation wall - 200 conc.	BRICK CLAD (70)	HEAVY ROOF	TIMBER FLOOR	BRICK CLAD (70)	TIMBER FLOOR	LIGHT CLAD
G	0.60 kPa	4.80 kPa	1.65 kPa	0.85 kPa	0.60 kPa	1.65 kPa	0.60 kPa	0.40 kPa
Q	1.50 kPa			0.25 kPa	1.50 kPa		1.50 kPa	
Span* of		Foundation height	Lower wall height	Roof span	Joist span	Mid wall height	Joist span	Upper wall height

*Span is the average of the bearer or joist spans on either side of the pile under consideration.

Pad	Span* of		Foundation height	Lower wall height	Roof span	Joist span	Mid wall height	Joist span	Upper wall height	Pad Spacing	Design load, kN				Min sq. pad dimension	Bearing pressure including self weight	CHECK
	Bearer	Joist									LC1	LC2	LC3	LC4			
Type 1	1.5 m	2.0 m	0.6 m	2.6 m	1.5 m					2.0 m	25.2 kN	30.3 kN	26.2 kN	26.4 kN	700 mm	33.5 kN	91%
Type 2	1.5 m	2.0 m	0.6 m	2.6 m	4.27 m					2.0 m	31.6 kN	38.0 kN	35.4 kN	36.1 kN	750 mm	41.7 kN	99%
Type 3											0.0 kN	0.0 kN	0.0 kN	0.0 kN	250 mm	0.4 kN	9%
Type 4											0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	9%
Type 5											0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	9%

Pad notes

Type 1

Type 2

Type 3

Type 4

Type 5

Externa pads - WESTERN ELEVATION, NORTH OF SUNROOM AND SOUTH OF DINING

Externa pads - NORTHWEST CORNER OF LOUNGE

Design Notes

The height of piles shall be as per NZS 3604:

(a) Above finished ground level: not less than 150 mm;

(c) No timber pile shall be cut off closer than 300 mm to finished ground level. This distance may be reduced to 150 mm where a bituminous damp-proof course, or other suitable impervious material is placed between the pile and framing timbers and overlaps these timbers by at least 6 mm (see figure 6.3). See 6.4.3.3 for pile treatment.

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Project # :

25288

DESIGN BY :

KJ


DATE :

15/09/2025

FOUNDATION PAD

LABEL:

Relevelling pads



Site parameters

Wind region: NZ1/2

Importance level : 2

Wind zone: EXTRA HIGH

Wind pressure (ULS): 0.55 kPa

Snow load: 0.63 kPa

Soil Parameters (refer geotechnical report)

f_b= 100 kPa

Φ_{ULS}= 0.5

D_f= 0.2 m

Ultimate soil bearing capacity

Geotechnical strength reduction factor

Pad depth

LOAD CASE FACTORS

LOAD CASE	NOTES	G	Q	Wind (down)	Snow	Scale factor
LC1	1.35G	1.35				1.00
LC2	1.2G+1.5Q	1.20	1.50			1.00
LC3	1.2G+Wu+ψ _c Q	1.20	0.40	1.00		1.00
LC4	1.2G+Su+ψ _c Q	1.20	0.40		1.00	1.00

Calculations are completed for gravity design only (EQ loads are not considered). ULS case governs.

Building parameters

	Floor only	1 storey			2 storey		3 storey			Design load, kN				Min sq. pad dimension	Bearing pressure including self weight	CHECK
Building element	Ground floor	Foundation wall	Lower walls	Roof	1st floor	Mid walls	2nd floor	Upper walls	Pad Spacing	LC1	LC2	LC3	LC4			
Type	TIMBER FLOOR	Foundation wall - 200 conc.	BRICK CLAD (70)	HEAVY ROOF	TIMBER FLOOR	BRICK CLAD (70)	TIMBER FLOOR	LIGHT CLAD								
G	0.60 kPa	4.80 kPa	1.65 kPa	0.85 kPa	0.60 kPa	1.65 kPa	0.60 kPa	0.40 kPa								
Q	1.50 kPa			0.25 kPa	1.50 kPa		1.50 kPa									
Span* of		Foundation height	Lower wall height	Roof span	Joist span	Mid wall height	Joist span	Upper wall height								
Type 1	1.5 m	2.0 m	0.6 m	2.6 m	1.5 m				2.0 m	25.2 kN	30.3 kN	26.2 kN	26.4 kN	850 mm	35.0 kN	97%
Type 2	1.5 m	2.0 m	0.6 m	2.6 m	4.27 m				2.0 m	31.6 kN	38.0 kN	35.4 kN	36.1 kN	950 mm	43.9 kN	97%
Type 3										0.0 kN	0.0 kN	0.0 kN	0.0 kN	250 mm	0.4 kN	13%
Type 4										0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	13%
Type 5										0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	13%

*Span is the average of the bearer or joist spans on either side of the pile under consideration.

Pad notes

Design Notes

Type 1

Externa pads - WESTERN ELEVATION, NORTH OF SUNROOM AND SOUTH OF DINING

Type 2

Externa pads - NORTHWEST CORNER OF LOUNGE

Type 3

Type 4

Type 5

The height of piles shall be as per NZS 3604:

(a) Above finished ground level: not less than 150 mm;

(c) No timber pile shall be cut off closer than 300 mm to finished ground level. This distance may be reduced to 150 mm where a bituminous damp-proof course, or other suitable impervious material is placed between the pile and framing timbers and overlaps these timbers by at least 6 mm (see figure 6.3). See 6.4.3.3 for pile treatment.

Project # :

DESIGN BY :

DATE :


25288

KJ

15/09/2025

FOUNDATION PAD

LABEL: Relevelling pads



Site parameters

Wind region: NZ1/2

Wind zone: EXTRA HIGH

Wind pressure (ULS): 0.55 kPa

Snow load: 0.63 kPa

Importance level : 2

Soil Parameters (refer geotechnical report)

f_b= 150 kPa

Φ_{ULS}= 0.5

D_f= 0.2 m

Ultimate soil bearing capacity

Geotechnical strength reduction factor

Pad depth

LOAD CASE FACTORS

LOAD CASE	NOTES	G	Q	Wind (down)	Snow	Scale factor
LC1	1.35G	1.35				1.00
LC2	1.2G+1.5Q	1.20	1.50			1.00
LC3	1.2G+Wu+ψ _c Q	1.20	0.40	1.00		1.00
LC4	1.2G+Su+ψ _c Q	1.20	0.40		1.00	1.00

Calculations are completed for gravity design only (EQ loads are not considered). ULS case governs.

Building parameters

	Floor only	1 storey			2 storey		3 storey	
Building element	Ground floor	Foundation wall	Lower walls	Roof	1st floor	Mid walls	2nd floor	Upper walls
Type	TIMBER FLOOR	Foundation wall - 200 conc.	INTERNAL WALL	HEAVY ROOF	TIMBER FLOOR	BRICK CLAD (70)	TIMBER FLOOR	LIGHT CLAD
G	0.60 kPa	4.80 kPa	0.25 kPa	0.85 kPa	0.60 kPa	1.65 kPa	0.60 kPa	0.40 kPa
Q	1.50 kPa			0.25 kPa	1.50 kPa		1.50 kPa	
Span* of		Foundation height	Lower wall height	Roof span	Joist span	Mid wall height	Joist span	Upper wall height
Pad	Bearer	Joist						
Type 1	1.5 m	2.5 m	0.6 m	2.6 m	5.77 m			
Type 2								
Type 3								
Type 4								
Type 5								

*Span is the average of the bearer or joist spans on either side of the pile under consideration.

Pad Spacing	Design load, kN				Min sq. pad dimension	Bearing pressure including self weight	CHECK
	LC1	LC2	LC3	LC4			
2.5 m	31.5 kN	41.9 kN	39.6 kN	40.8 kN	800 mm	46.0 kN	96%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	9%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	250 mm	0.4 kN	9%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	9%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	9%

Pad notes

Type 1

Type 2

Type 3

Type 4

Type 5

Internal pads - between main dwelling and extensn/sunroom

Design Notes

The height of piles shall be as per NZS 3604:
(a) Above finished ground level: not less than 150 mm;
(c) No timber pile shall be cut off closer than 300 mm to finished ground level. This distance may be reduced to 150 mm where a bituminous damp-proof course, or other suitable impervious material is placed between the pile and framing timbers and overlaps these timbers by at least 6 mm (see figure 6.3). See 6.4.3.3 for pile treatment.

Project # :

DESIGN BY :

DATE :


25288

KJ

15/09/2025

FOUNDATION PAD

LABEL: Relevelling pads



Site parameters

Wind region: NZ1/2

Wind zone: EXTRA HIGH

Wind pressure (ULS): 0.55 kPa

Snow load: 0.63 kPa

Importance level : 2

Soil Parameters (refer geotechnical report)

f_b= 100 kPa

Φ_{ULS}= 0.5

D_f= 0.2 m

Ultimate soil bearing capacity

Geotechnical strength reduction factor

Pad depth

LOAD CASE FACTORS

LOAD CASE	NOTES	G	Q	Wind (down)	Snow	Scale factor
LC1	1.35G	1.35				1.00
LC2	1.2G+1.5Q	1.20	1.50			1.00
LC3	1.2G+Wu+ψ _c Q	1.20	0.40	1.00		1.00
LC4	1.2G+Su+ψ _c Q	1.20	0.40		1.00	1.00

Calculations are completed for gravity design only (EQ loads are not considered). ULS case governs.

Building parameters

		Floor only	1 storey			2 storey		3 storey	
	Building element	Ground floor	Foundation wall	Lower walls	Roof	1st floor	Mid walls	2nd floor	Upper walls
	Type	TIMBER FLOOR	Foundation wall - 200 conc.	INTERNAL WALL	HEAVY ROOF	TIMBER FLOOR	BRICK CLAD (70)	TIMBER FLOOR	LIGHT CLAD
	G	0.60 kPa	4.80 kPa	0.25 kPa	0.85 kPa	0.60 kPa	1.65 kPa	0.60 kPa	0.40 kPa
	Q	1.50 kPa			0.25 kPa	1.50 kPa		1.50 kPa	
	Span* of		Foundation height	Lower wall height	Roof span	Joist span	Mid wall height	Joist span	Upper wall height
Pad	Bearer	Joist							
Type 1	1.5 m	2.5 m	0.6 m	2.6 m	5.77 m				
Type 2									
Type 3									
Type 4									
Type 5									

*Span is the average of the bearer or joist spans on either side of the pile under consideration.

Pad Spacing	Design load, kN				Min sq. pad dimension	Bearing pressure including self weight	CHECK
	LC1	LC2	LC3	LC4			
2.5 m	31.5 kN	41.9 kN	39.6 kN	40.8 kN	1000 mm	48.3 kN	97%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	13%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	250 mm	0.4 kN	13%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	13%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.3 kN	13%

Pad notes

Type 1

Type 2

Type 3

Type 4

Type 5

Internal pads - between main dwelling and externsion/sunroom

Design Notes

The height of piles shall be as per NZS 3604:
(a) Above finished ground level: not less than 150 mm;
(c) No timber pile shall be cut off closer than 300 mm to finished ground level. This distance may be reduced to 150 mm where a bituminous damp-proof course, or other suitable impervious material is placed between the pile and framing timbers and overlaps these timbers by at least 6 mm (see figure 6.3). See 6.4.3.3 for pile treatment.

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Project # :

DESIGN BY :

DATE :


25266

KJ

15/09/2025

FOUNDATION PAD

LABEL: Relevelling pads



Site parameters

Wind region: NZ1/2

Wind zone: EXTRA HIGH

Wind pressure (ULS): 0.55 kPa

Snow load: 0.63 kPa

Importance level : 2

Soil Parameters (refer geotechnical report)

f_b= 150 kPa

Φ_{ULS}= 0.5

D_f= 0.5 m

Ultimate soil bearing capacity

Geotechnical strength reduction factor

Pad depth

LOAD CASE FACTORS

LOAD CASE	NOTES	G	Q	Wind (down)	Snow	Scale factor
LC1	1.35G	1.35				1.00
LC2	1.2G+1.5Q	1.20	1.50			1.00
LC3	1.2G+Wu+ψ _c Q	1.20	0.40	1.00		1.00
LC4	1.2G+Su+ψ _c Q	1.20	0.40		1.00	1.00

Calculations are completed for gravity design only (EQ loads are not considered). ULS case governs.

Building parameters

	Floor only	1 storey			2 storey		3 storey	
Building element	Ground floor	Foundation wall	Lower walls	Roof	1st floor	Mid walls	2nd floor	Upper walls
Type	TIMBER FLOOR	Foundation wall - 200 conc.	INTERNAL WALL	HEAVY ROOF	TIMBER FLOOR	BRICK CLAD (70)	TIMBER FLOOR	LIGHT CLAD
G	0.60 kPa	4.80 kPa	0.25 kPa	0.85 kPa	0.60 kPa	1.65 kPa	0.60 kPa	0.40 kPa
Q	1.50 kPa			0.25 kPa	1.50 kPa		1.50 kPa	
Span* of		Foundation height	Lower wall height	Roof span	Joist span	Mid wall height	Joist span	Upper wall height
Pad	Bearer	Joist						
Type 1	1.5 m	1.5 m		2.5 m	3.7 m			
Type 2	1.5 m	1.5 m		2.5 m				
Type 3								
Type 4								
Type 5								

*Span is the average of the bearer or joist spans on either side of the pile under consideration.

Pad Spacing	Design load, kN				Min sq. pad dimension	Bearing pressure including self weight	CHECK
	LC1	LC2	LC3	LC4			
1.5 m	9.5 kN	15.5 kN	13.3 kN	13.8 kN	550 mm	20.5 kN	90%
1.5 m	3.1 kN	7.8 kN	4.1 kN	4.1 kN	400 mm	10.4 kN	87%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	300 mm	1.5 kN	22%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.6 kN	22%
	0.0 kN	0.0 kN	0.0 kN	0.0 kN	200 mm	0.6 kN	22%

Pad notes

Type 1

Type 2

Type 3

Type 4

Type 5

Internal piles under LBW

Internal piles not under LBW

Design Notes

The height of piles shall be as per NZS 3604:

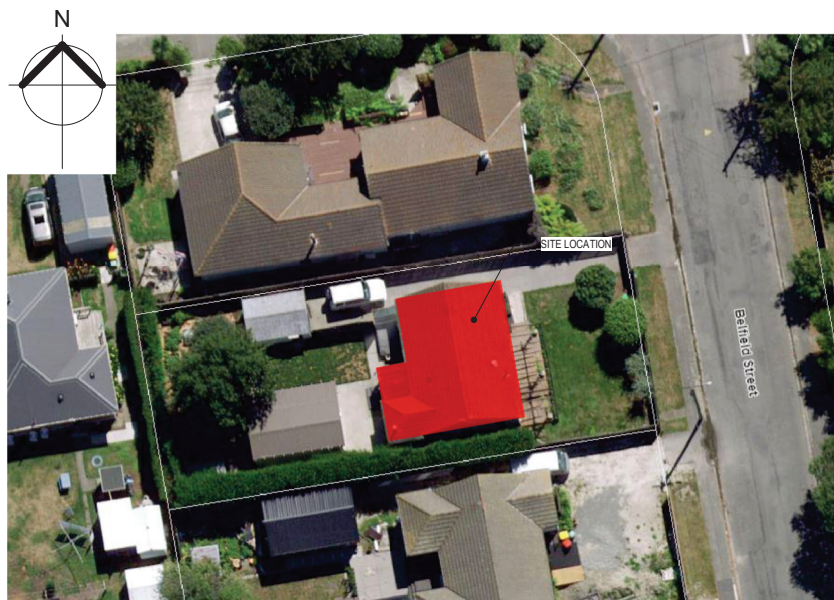
(a) Above finished ground level: not less than 150 mm;

(c) No timber pile shall be cut off closer than 300 mm to finished ground level. This distance may be reduced to 150 mm where a bituminous damp-proof course, or other suitable impervious material is placed between the pile and framing timbers and overlaps these timbers by at least 6 mm (see figure 6.3). See 6.4.3.3 for pile treatment.

REPAIR DESIGN FOR EXISTING RESIDENTIAL DWELLING

19 BELFIELD STREET, DALLINGTON, CHRISTCHURCH

PROJECT - 25288



STRUCTURAL DRAWING REGISTER		
SHEET NO.	SHEET TITLE	SHEET REV.
S001	STANDARD NOTES AND DETAIL	1
S100	FLOOR LEVEL MEASUREMENT	1
S101	RE-LEVELLING PLAN	1
S401	RE-LEVELLING / REPAIR DETAILS	1
S402	RE-LEVELLING / REPAIR DETAILS	1
S403	RE-LEVELLING / REPAIR DETAILS	1
S404	RE-LEVELLING / REPAIR DETAILS	1
S405	RE-LEVELLING / REPAIR DETAILS	1

DATE: 30/09/2025 , REV: A

GENERAL NOTES

1. ALL MATERIALS AND WORKMANSHIP SHALL COMPLY WITH THE CURRENT RELEVANT NZS STANDARDS AND BUILDING CODE.

2. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL AND OTHER CONSULTANTS' DRAWINGS AND SPECIFICATIONS. THE PRINCIPAL CONSULTANT MUST BE NOTIFIED OF ANY DISCREPANCY.

3. DURING CONSTRUCTION, THE STRUCTURE SHALL BE MAINTAINED IN A STABLE STATE BY MEANS OF TEMPORARY PROPPING, SHORING, BRACING AND GUYING PROVIDED BY THE CONTRACTOR.

4. IF, DURING CONSTRUCTION, ANY PART OF THE WORK DISPLAYS SIGNS OF DISTRESS, EXCESSIVE DEFLECTION, CONFLICTS AMONG COMPONENTS, OR ANY OTHER INDICATIONS OF POTENTIAL ISSUES, THE CONTRACTOR MUST PROMPTLY NOTIFY THE ENGINEER AND REQUEST AN INVESTIGATION AND INSTRUCTIONS BEFORE PROCEEDING WITH ANY FURTHER WORK. ALL REASONABLE EFFORTS MUST BE IMMEDIATELY UNDERTAKEN TO STABILIZE THE STRUCTURE AND PREVENT THE ESCALATION OF THE IDENTIFIED ISSUE.

5. NO DIMENSION ARE TO BE SCALED FROM THESE DRAWINGS. ALL DIMENSIONS TO BE ESTABLISHED ON SITE.

6. CONTRACTOR SHALL VERIFY ALL DIMENSIONS REQUIRED FOR SET-OUT AND CONSTRUCTION. NO DIMENSION ARE TO BE SCALED FROM THESE DRAWINGS. ALL DIMENSIONS TO BE ESTABLISHED ON SITE.

7. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

8. ALL PROPRIETARY PRODUCTS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS AND INSTRUCTIONS.

9. ASK IF IN DOUBT.

INSPECTION NOTES

1. THE CONTRACTOR MUST KEEP A COPY OF THE APPROVED CONSENT DOCUMENTS ON SITE AT ALL TIMES DURING CONSTRUCTION.

2. THE CONTRACTOR MUST BE SATISFIED THAT THE WORKS HAVE BEEN COMPLETED IN ACCORDANCE WITH THE DRAWINGS AND SPECIFICATIONS BEFORE CONFIRMING AN INSPECTION BY THE ENGINEER.

3. WHERE THE ENGINEER IS ENGAGED FOR INSPECTIONS AND/OR SUPERVISION, A MINIMUM OF 48 HOURS NOTICE SHALL BE GIVEN.

4. THE CONTRACTOR SHALL ARRANGE AND PASS ALL REQUIRED COUNCIL AND ENGINEERING INSPECTIONS.

5. THE CONTRACTOR TO ISSUE PS3 CERTIFICATION FOR ALL COMPLETED WORKS IN ACCORDANCE WITH THE CONSENT DOCUMENTATION.

CONCRETE NOTES

1. ALL WORKMANSHIP & MATERIALS SHALL BE IN ACCORDANCE WITH NZS3101 & NZS3109.

2. FOR MINIMUM COVER TO REINFORCEMENT REFER TO 3101 CLAUSE 3.1.1. THE COVER AND ARRANGEMENT OF THE STEEL SHALL BE SUCH THAT CONCRETE CAN BE PROPERLY PLACED AND COMPACTED IN ACCORDANCE WITH NZS3109.

3. WHERE CONCRETE IS CAST ON OR AGAINST GROUND AND COMPACTED IN ACCORDANCE WITH NZS 3109, THE MINIMUM COVER FOR A SURFACE IN CONTACT WITH THE GROUND SHALL BE 75 mm, OR 50 mm IF USING A DAMP-PROOF MEMBRANE BETWEEN THE GROUND AND THE CONCRETE TO BE CAST. COVER TO FORMWORK COMPLYING WITH NZS 3109, OR TO FREE SURFACES SHALL BE EQUAL TO OR GREATER THAN THE VALUE GIVEN IN TABLE 3.6 OF NZS 3101 OR SHALL BE MINIMUM:

- 75mm - AGAINST NATURAL GROUND
- 50mm - AGAINST BOXING OR SCREED CONCRETE
- 50mm - SURFACES EXPOSED TO WEATHER
- 35mm - SURFACES FULLY ENCLOSED EXCEPT FOR A BRIEF PERIOD DURING CONSTRUCTION

4. CONCRETE STRENGTH AT 28 DAYS SHALL BE MINIMUM:

- 25MPa - ALL MEMBERS U.O.
- 25MPa - MASONRY INFILL
- 30MPa - CONCRETE OF MEMBERS IN ABOVE-GROUND EXTERIOR ENVIRONMENT IN COASTAL FRONTAGE AREAS AS DEFINED IN CLAUSE 3.4.2.4 OF NZS 3101
- 30MPa - PRECAST PANELS

5. ALLOWANCE SHALL BE MADE FOR ALL CAST-IN CLEATS AND BOLTS

6. ALL CONCRETE THAT IS TO BE POURED AGAINST SHALL BE SCABBLED TO 5mm AMPLITUDE

7. REFER ARCHITECTURAL DRAWINGS FOR WATERPROOFING

8. SLABS ON GROUND SHALL BE SAWCUT 1/4 OF SLAB THICKNESS TO APPROVED DIMENSION BETWEEN 24 AND 48 HOURS AFTER POURING UNLESS OTHERWISE INSTRUCTED. ALTERNATE WIRES AND/OR BARS ARE TO BE CUT 40mm FROM JOINTS AND NO LAPS ARE TO OCCUR AT JOINTS. ALTERNATIVE CONSTRUCTION MAY SUPERSEDE THESE DETAILS I.E. POURS IN PANELS OR STRIPS, SAWCUT GRIDS 500X5000 MAXIMUM U.N.O.

REINFORCEMENT NOTES

1. REINFORCEMENT SHALL BE IN ACCORDANCE WITH NZS 4671.

2. ALL REINFORCEMENT SHALL BE DUCTILE CLASS E.

3. GRADE 300 BARS MAY BE STRAIGHTENED ON SITE BUT SHALL NOT BE RE-BENT UNLESS APPROVED AND INSTRUCTED BY ENGINEER.

4. ALL GRADE 500 BARS SHALL **NOT** BE BENT OR STRAIGHTENED ON SITE UNLESS APPROVED AND INSTRUCTED BY ENGINEER.

5. NO WELDING OR HEATING OF BARS ALLOWED WITHOUT THE CONSENT FROM THE ENGINEER.

6. WHERE CRANKED BARS ARE SHOWN, THE SLOPE SHALL NOT BE GREATER THAN 1 TO 12, UNLESS SHOWN OTHERWISE ON STRUCTURAL DRAWINGS.

7. TYPICAL REINFORCEMENT DESIGNATIONS ARE AS FOLLOWS: 16HD12 EF DENOTES 16 BARS, GRADE 500E DEFORMED 12mm DIA BARS IN EACH FACE, D16 @ 300 EF T&B DENOTES GRADE 300E DEFORMED 16mm DIA BARS AT 300mm CRS PLACED IN THE TOP AND BOTTOM LAYERS.

8. REINFORCEMENT IS SHOWN DIAGRAMMATICALLY AND MAY NOT BE TO SCALE OR IN TRUE PROJECTION.

9. REINFORCEMENT MESH LAPED WITH A MINIMUM OF 2 CROSS WIRE BUT NOT LESS THAN:

- SE62-SE72 MESH LAP LENGTH 300mm.
- SE62-SE82 MESH LAP LENGTH 400mm.

10. REINFORCEMENT IN SLABS IS TO BE SUPPORTED ON STOOLS OR OTHER APPROVED METHODS - STARTERS TO BE TIED IN PLACE BEFORE POURING.

11. SPLICES IN REINFORCEMENT SHALL BE MADE IN THE POSITION SHOWN ON THE DRAWINGS, OR AS OTHERWISE APPROVED BY THE ENGINEER. UNSPECIFIED BAR LAPS SHALL BE DONE IN A STAGGERED PATTERN.

12. NO HOLES, CHASES OR EMBEDMENT OF PIPES OTHER THAN THOSE SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE MADE IN CONCRETE MEMBERS WITHOUT AN APPROVAL FROM THE ENGINEER.

13. REINFORCEMENT LAP LENGTHS IN CONCRETE TO COMPLY WITH THE TABLE BELOW (ALL SHALL BE STAGGERED UNLESS NOTED OTHERWISE):

BAR DIAMETER	D10	D12	D16	D20	D25	D32
GRADE 300 (D)	400	500	650	800	1000	1250
GRADE 500 (HD)	650	800	1050	1300	1650	2100

14. MINIMUM DIAMETER OF BEND FOR REINFORCEMENT TO COMPLY WITH THE TABLE BELOW. THE DIAMETER OF BEND TO BE MEASURED FO THE INSIDE OF THE BAR BEND.

BAR TYPE	BAR DIAMETER, D _b mm	MINIMUM DIAMETER OF BEND, mm
MAIN BARS	6-20	5 x D _b
	24-40	6 x D _b
STIRRUPS OR TIES	6-20	2 x D _b (PLAIN BAR) 4 x D _b (DEFORMED BAR)
	24-40	3 x D _b (PLAIN BAR) 6 x D _b (DEFORMED BAR)

GENERAL:

• BGL - BELOW GROUND LEVEL

• COS - CONFIRM ON SITE

• CRS - CENTRES

• DIA - DIAMETER

• DPC - DAMP-PROOF COURSE

• DPM - DAMP-PROOF MEMBRANE

• EQ - EQUAL

• EXT - EXISTING

• FL - FINISHED LEVEL

• GL - GROUND LEVEL

• ID - INSIDE DIAMETER

• NTS - NOT TO SCALE

• OD - OUTSIDE DIAMETER

• RD - RADIUS

• SED - SMALL END DIAMETER

• SG - STRUCTURAL GRADE

• SIM - SIMILAR

• TBC - TO BE CONFIRMED

• THK - THICK

• TYP - TYPICAL

• UNO - UNLESS NOTED OTHERWISE

• UIS - UNDERSIDE

CONCRETE AND REINFORCEMENT:

• B - BOTTOM

• C - CENTRAL

• CC - CONSTRUCTION CONTROL JOINT

• CVR - COVER

• D - GRADE 300 DEFORMED BAR

• EF - EACH FACE

• EW - EACH WAY

• FF - FAR FACE

• H - HORIZONTAL

• HD - GRADE 500 DEFORMED BAR

• HR - GRADE 500 PLAIN BAR

• NF - NEAR FACE

• R - GRADE 300 PLAIN BAR

• RB - GRADE 500 RED BAR

• REO - REINFORCEMENT

• STR - STIRRUP

• T - TOP

• SC - SAWCUT

• V - VERTICAL

STEEL WORK:

• UB - UNIVERSAL BEAM

• UC - UNIVERSAL COLUMN

• PFC - PARALLEL FLANGE CHANNEL

• EA - EQUAL ANGLE

• UA - UNEQUAL ANGLE

• MS - MILD STEEL

• SHS - SQUARE HOLLOW SECTION

• RHS - RECTANGULAR HOLLOW SECTION

• CHS - CIRCULAR HOLLOW SECTION

• WP - WELD PLATE

WELDING:

• CFW - CONTINUOUS FILLET WELD

• CPBW - COMPLETE PENETRATION BUTT WELD

• DBBW - DOUBLE BEVEL BUTT WELD

• DVBW - DOUBLE V BUTT WELD

• FW - FILLET WELD

• FSBW - FULL STRENGTH BUTT WELD

• FWAR - FILLET WELD ALL ROUND

• PPBW - PARTIAL PENETRATION BUTT WELD

• SBBW - SINGLE BEVEL BUTT WELD

• SVBW - SINGLE V BUTT WELD

BLOCKWORK NOTES

1. MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH NZS 4210.

2. ALL BLOCK WORK TO BE OBSERVATION TYPE B.

3. MASONRY IS TO BE CONSTRUCTED BY THE HIGH LIFT METHOD WITH CLEAN OUT PORTS AT EVERY VERTICAL BAR AND AT THE BOTTOM OF EVERY LIFT. BOTTOM COURSE TO BE OPEN ENDED BOND BEAM BLOCKS PLACED UPSIDEDOWN.

4. FIX VERTICAL BARS BEFORE LAYING BLOCKS AND PLACE HORIZONTAL BARS AS LAYING PROCEEDS.

5. ALL CELLS TO BE FILLED WITH 25 MPa CONCRETE U.N.O.

6. CONCRETE FOR FILLING SHALL HAVE EXPANDING ADMIXTURE ADDED ON SITE AND MIXED IMMEDIATELY PRIOR TO PLACING.

7. REINFORCEMENT LAP LENGTHS IN MASONRY TO COMPLY WITH THE TABLE BELOW (ALL SHALL BE STAGGERED UNLESS NOTED OTHERWISE):

MIN LAP LENGTH IN MASONRY REINFORCEMENT, mm					
BAR GRADE	D10	D12	D16	D20	D25
300MPa (D)	400	500	650	800	1050
500MPa (HD)	700	900	1200	1400	1750

BOND-BEAM / LINTEL DETAIL

BLOCK WALL VERTICAL CONTROL JOINT

TYPICAL HORIZONTAL STEEL INTERSECTIONS DETAILS

STEELWORK NOTES

1. MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH STANDARDS LISTED IN NZS 3404.

2. ALL STRUCTURAL STEEL TO BE CONSTRUCTION CATEGORY 2 IN ACCORDANCE WITH AS/NZS 5131:2016.

3. WELDING SHALL BE IN ACCORDANCE WITH NZS 1554.1.

4. CHECK AND VERIFY ALL DIMENSIONS AND LEVELS ON SITE BEFORE COMMENCING FABRICATION OF ANY STRUCTURAL STEELWORK.

5. BASEPLATES SHALL BEAR DIRECTLY ON 10 +/- 5MM NON-SHRINK GROUT OR DRY PACK MORTAR UNO.

6. WASHERS TAPERED WHERE NECESSARY, ARE TO BE USED UNDER ALL NUTS & BOLT HEADS.

7. STEEL MEMBERS SHALL BE (UNLESS SHOWN OTHERWISE ON STRUCTURAL DRAWINGS):

- GRADE 300 - HOT ROLLED OPEN SECTIONS AND PLATES;
- GRADE 350 - HOLLOW SECTIONS;
- GRADE 250 - HOT ROLLED FLATS.

8. BOLTED CONNECTION SHALL BE WITH GRADE 8.8 BOLTS SNUG TIGHTENED TO AS 1252.

9. BOLT HOLES SHALL BE DRILLED AND SHALL BE OVERSIZED 2 mm FOR BOLTS EQUAL OR LESS THAN M24 AND 3 mm FOR BOLTS > M24, UNLESS SHOWN OTHERWISE ON STRUCTURAL DRAWINGS.

10. ALL BOLTS SHALL HAVE AT LEAST 2 FULL THREADS PROJECTING ABOVE THE NUT.

ALL BOLT HOLES IN BASE PLATES SHALL BE NOT MORE THAN 6 mm GREATER THAN THE ANCHOR BOLT DIAMETER. A SPECIAL PLATE WASHER WITH MINIMUM THICKNESS OF 4 mm SHALL BE USED UNDER THE NUT IF THE HOLE DIAMETER IS 3 mm OR MORE LARGER THAN THE BOLT DIAMETER.

11. BOLTS PROPERTY CLASS 8.8 AND HIGHER SHALL NOT BE BENT, WELDED, TACK WELDED, OR DAMAGED WITH DIRECT HEAT OR HOT METAL.

12. WASHERS SHALL BE USED UNDER BOLT HEADS AND NUTS.

13. HOLD DOWN BOLTS AND CAST-IN ITEMS SHALL BE SET ACCURATELY USING TEMPLATE FOR POSITIONING.

14. ALL WELDS IN MEMBERS UNDER SEISMIC LOADING SHALL BE STRUCTURAL PURPOSE CATEGORY (SP).

15. HOLLOW SECTION MEMBERS SHALL BE CAPPED AND ALL JOINTS SEALED.

16. ALLOWANCES SHALL BE MADE FOR TOLERANCE, VENT HOLES ETC FOR HOT DIP GALVANISED ITEMS. VENT HOLES SHALL BE SEALED AFTER GALVANISING.

17. ALL EXTERNAL STEEL WORK EXPOSED TO THE ATMOSPHERE SHALL BE TREATED TO **TS2100** TO ACHIEVE A TIME TO FIRST MAINTENANCE OF **40 YEARS** FOR EXPOSURE **CATEGORY C2**, OR EQUIVALENT IN ACCORDANCE WITH SECTION 2 OF SNZ TS 3404:2018. REFER TO ARCHITECT FOR FINAL COAT FINISH.

18. ALL INTERNAL STEEL WORK IN SUBFLOOR SPACES, WITHIN EXTERNAL WALLS OR ROOF CAVITY WITH THE STEEL ON THE COLD SIDE OF THE DEW POINT SHALL BE TREATED TO **TS24** TO ACHIEVE A TIME TO FIRST MAINTENANCE OF **40 YEARS** FOR EXPOSURE **CATEGORY C3**, OR EQUIVALENT IN ACCORDANCE WITH SECTION 2 OF SNZ TS 3404:2018. REFER ARCH. FOR FINAL COAT FINISH.

19. ALL SHELTERED STEEL WORK NEAR OPENINGS IN EXTERNAL WALLS SHALL BE TREATED TO **TS24** TO ACHIEVE A TIME TO FIRST MAINTENANCE OF **40 YEARS** FOR EXPOSURE **CATEGORY C3** OR EQUIVALENT IN ACCORDANCE WITH SECTION 2 OF SNZ TS 3404:2018. REFER ARCH. FOR FINAL COAT FINISH.

20. ADDITIONALLY BOTTOM 100mm OF EXTERNAL CAST IN STEEL POSTS FROM TOP OF PILE/FOOTING TO BE COATED WITH A SELF PRIMING NON-CONDUCTIVE BARRIER COATING (EPOXY MASTIC OR SIM.) TO AT LEAST 350 MICRONS THICK.

21. ALL OTHER INTERNAL STEEL WORKS SHALL BE COATED TO TABLE 4 OF SNZ TS 3404:2018.

Table 4 – Internal steelwork – Coating required only for appearance, surface-specific corrosivity category C1 and temporary protection during construction

System designation ^a	Surface preparation	Number of coats	Typical colour	Initial gloss	Allowable surface-specific corrosivity during construction ^b
ALK6	Sa 2½	3	Wide range	Flat to full gloss	C4
IZS1		1		Flat	
PUR1	St 3	2	Limited range	Semi-gloss to full gloss	C4
ALK1 ^c	St 3/Sa 2	1		Flat to full gloss	C2 ^d
ALK3		2	Wide range		C3

NOTE – All galvanized coatings are suitable for internal steelwork.

a Based on AS/NZS 2312:2014.

b Based on a maximum of 1 year's exposure during construction.

c The alkyl primer system ALK1 should not be used in grey colour because the breakdown of the system will be highly visible. Red oxide colour is preferred to reduce the visual impact of minor and structurally acceptable rusting that may occur on the ALK1 system in a few years.

d Based on a maximum of 1 weeks' exposure during construction.

CLIENT

1

30/09/2025

FOR BUILDING CONSENT

DESIGNED BY: K.J.

DRAWN BY: D.Y.

REVIEWED BY: N.N.

DATE: 30/09/2025

A3 SCALE: 1 : 20

REPAIR DESIGN FOR EXISTING RESIDENTIAL DWELLING

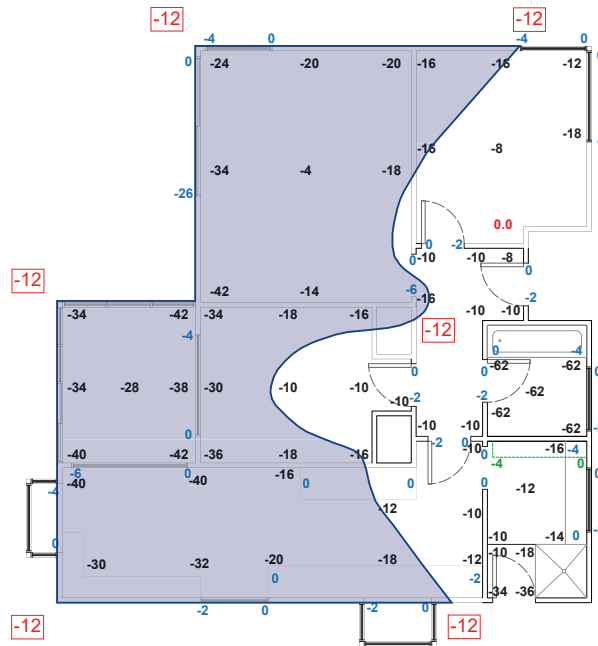
19 BELFIELD STREET, DALLINGTON, CHRISTCHURCH

STANDARD NOTES AND DETAIL

FOR BUILDING CONSENT

JOB NO. 25288
SHEET NO. S001
SHEET REV. 1

Christchurch City Council | Exemption from building consent | BCN/2025/7826 | 10/10/2025 | Page 17 of 194



NOTES

1. THE FLOOR PLAN AND MEASUREMENTS OF THE FLOOR LEVEL VARIATION HAVE BEEN TAKEN FROM STRUCTURAL ENGINEERS REPORT BY VIDEN GROUP, DATED 05 JULY 2023, REF. NO: 226-161.
2. FLOOR LEVEL TO BE RE-MEASURED AFTER FLOOR COVERINGS REMOVED AND BEFORE RE-LEVELLING COMMENCES TO ENSURE THE SUCCESSFUL RE-LEVELLING OPERATION.
3. THE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE ENGINEERS EVALUATION, SCOOPING REPORTS AND ANY RELEVANT PHOTOS AND DOCUMENTS.
4. CONTRACTOR TO VERIFY THE EXTENT OF REPAIR. ANY DISCREPANCY SHALL BE REPORTED TO THE CLIENT AND THE ENGINEER.
5. FINAL LEVELLING OF FLOOR SLOPES MAY VARY AND SHOULD BE VERIFIED IF SUBSTANTIALLY DIFFERENT FROM THE TARGET LEVELS. RE-LEVELLING TO BE CARRIED OUT BY AN EXPERIENCED CONTRACTOR. THE CONTRACTOR NEEDS TO ENDEAVOR TO MINIMISE ANY SUBSEQUENT DAMAGE OCCURRING WHILST RE-LEVELLING. NOTIFY THE ENGINEER AND THE CLIENT SHOULD ANY DAMAGE ARISES.
6. NO PART OF THE FLOOR SHALL HAVE A FINISHED FLOOR LEVEL VARIATION GREATER THAN 1:200 (0.5%).
7. CARPET, VINYL, TILE FLOOR COVERING TO BE REMOVED BEFORE RE-LEVELLING COMMENCES.
8. PATIOS/DECKS/PATHS/CONCRETE STEPS/DRIVEWAYS/FENCE MAY NEED TO BE REMOVED FOR RE-LEVELLING OPERATION, AND TO BE REINSTATED AFTERWARDS. THIS IS TO BE DISCUSSED AND CONFIRMED WITH THE CLIENT AND ENGINEER BEFORE WORK COMMENCES.
9. CONTRACTOR TO CHECK THE UNDERGROUND SERVICES BEFORE EXCAVATION.

HAZARDS

1. NEW CONSTRUCTION AREA TO BE FULLY FENCED BEFORE COMMENCING CONSTRUCTION. ALL WORK TO COMPLY WITH NZBC CLAUSE F5/AS1 PART 1.

SEDIMENT CONTROL

1. SEDIMENT TO BE CONTROLLED WHERE FOUNDATION OR ROOFING DRAINAGE AREA TO BE REMOVED.
2. ALL SEDIMENT CONTROL TO COMPLY WITH NZBC E1 AND CONTRACTOR TO OVERSEE ALL SEDIMENT CONTROL.
3. STRAWBALES TO BE LAID ALL BOUNDARIES WHERE RUN OFF MAY OCCUR.
4. STRAWBALES TO BE PLACED IN A 200mm DEEP TRENCH, TIED TOGETHER AND ANCHORED TO GROUND WITH STAKES.
5. SURPLUS GRAVEL TO BE CONTAINED BEHIND SEDIMENT FENCES.

PROPERTY NOTES

SITE DESCRIPTION

LAND DESCRIPTION: LOT 9 DP 16872
SITE TOPOGRAPHY: FLAT
LAND ZONING: TC2

BUILDING DESCRIPTION:
GROSS FLOOR AREA: 97m²
YEAR BUILT: CIRCA 1950's
LEVELS: SINGLE
CONSTRUCTION: TYPE A / TYPE B

LEGEND

LEVELS TAKEN ON WINDOW SILLS, DOOR HEADS, LINTELS AND BENCHES INDICATED IN **BLUE**

LEVELS UNDERNEATH THE CUPBOARDS INDICATED IN **GREEN**

Relevel Existing Floor by mechanically jacking the perimeter foundation using the underpinning method outlined on A05. Lifting pads are recommended to be at 1.5m c/c max. Jack and pack piles or replace them as required, as per A06 and A07. Refer to appended details.

Pile notching as required per A04.

Target levels are provided as a guide, final levels are expected to be confirmed based on limiting significant consequential damage to doors and windows and other inbuilt items, and should target a when new condition.

+/- #

STRUCTURAL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL AND OTHER RELEVANT DRAWINGS AND SPECIFICATIONS IF ANY. REFER TO THE ARCHITECTURAL DRAWINGS FOR ALL DIMENSIONS, LEVELS, DUCTS, AND OTHER SETTING OUT INFORMATION. CONTRACTORS MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK AND ORDERING MATERIALS.
DO NOT SCALE.



CLIENT

Christchurch City Council | Exemption from building consent | BCN/2025/7826 | 10/10/2025 | Page 18 of 194

REV	DATE	DESCRIPTION
1	30/09/2025	FOR BUILDING CONSENT

DESIGNED BY: K.J.
DRAWN BY: D.Y.
REVIEWED BY: N.N.
DATE: 30/09/2025
A3 SCALE: 1 : 100

REPAIR DESIGN FOR EXISTING RESIDENTIAL DWELLING
19 BELFIELD STREET, DALLINGTON, CHRISTCHURCH

FLOOR LEVEL
MEASUREMENT

FOR BUILDING CONSENT

JOB NO.
25288
SHEET NO.
S100
SHEET REV.
1



LEGENDS



PAD TYPE A :
INDICATIVE MIN. 700x700mm CONCRETE PAD, MIN.500mm BELOW NGL.
AT MAX. 2000mm CRS. ACTUAL LOCATIONS OF JACKING PADS SHALL
BE CONFIRMED BY CONTRACTOR DURING CONSTRUCTION PHASE.
REFER TO THE TABLE BELOW FOR ALTERNATIVE PAD OPTIONS.



PAD TYPE B:
INDICATIVE MIN. 800x800mm CONCRETE PAD, MIN.500mm BELOW NGL.
AT MAX. 2500mm CRS. ACTUAL LOCATIONS OF JACKING PADS SHALL
BE CONFIRMED BY CONTRACTOR DURING CONSTRUCTION PHASE.
REFER TO THE TABLE BELOW FOR ALTERNATIVE PAD OPTIONS.



INTERNAL TIMBER FLOOR TO BE RE-LEVELLED VIA JACKING AND
PACKING PILES METHOD OR PILE REPLACEMENT METHOD AS PER
SPECIFIC ENGINEERING DETAILS.

TYPE OF INTERNAL FLOOR TO BE CONFIRMED AT SITE



• **CONCRETE SLAB** - THE SLAB FOUNDATION TO BE RE-LEVELLED
BY MECHANICAL LIFTING METHOD. ANY VOIDS UNDER THE SLAB
TO BE FILLED WITH NON-SHRINKABLE FLOWABLE GROUT AS PER
DETAILS ON S402.

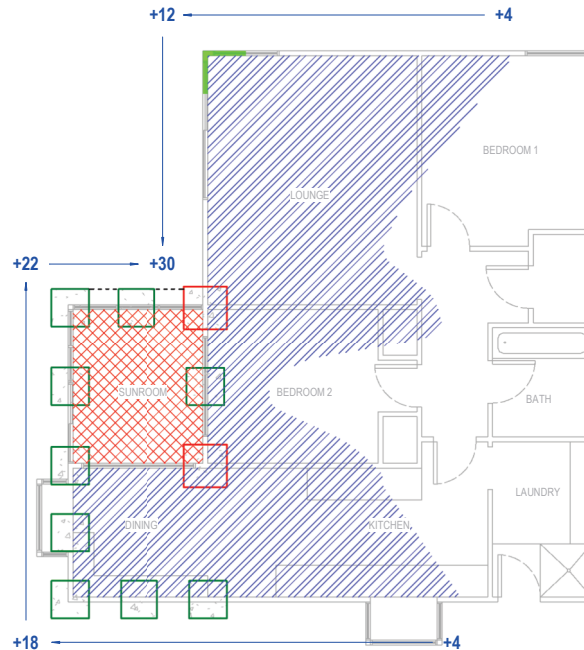


EXTERNAL PERIMETER FOUNDATION TO BE RE-LEVELLED VIA
OVERPINNING METHOD AS PER OUR SPECIFIC ENGINEERING DETAIL.



CONCRETE PERIMETER FOUNDATION TO BE RE-LEVELLED BY XX mm,
TO BE CONFIRMED ON SITE BY CONTRACTOR.

ALTERNATIVE PAD DIMENSION - BEARING CAPACITY	
	100kPa
TYPE A	0.9x0.9m
TYPE B	1.0x1.0m



RE-LEVELLING PLAN

1 : 100

GENERAL NOTES

- CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON SITE.
- FOLLOWING COMPLETION OF FOUNDATION REMEDIATION, A LBP SHALL INSPECT AND PROVIDE REMEDIATION STRATEGY FOR, AND SUPERVISE REPAIR OF NON-STRUCTURAL ELEMENTS, SUCH AS EXTERNAL CLADDING AND EXTERNAL AMENITIES.
- THE EXTENT OF REQUIRED RE-LEVELLING MUST BE CONFIRMED ON-SITE BY THE CONTRACTOR. ALL EFFORTS MUST BE MADE TO RESTORE THE BUILDING TO THE REQUIRED PERFORMANCE LEVEL, INCLUDING LEVEL VARIATIONS WITHIN ACCEPTED TOLERANCES, AS OUTLINED IN MBIE GUIDANCE.
- TARGET FLOOR LEVELS SHALL BE DETERMINED WITH CONSIDERATION GIVEN TO THE PERFORMANCE OF BUILDING AMENITIES, SUCH AS DOOR AND WINDOW ALIGNMENTS, CABINETRY, AND ROOF LININGS. IN SOME CASES, ACHIEVING THIS MAY PROVE IMPRACTICAL DUE TO POSSIBLE ADDITIONAL STRESS ON THE SUPERSTRUCTURE.
- IF CONSEQUENTIAL DAMAGE, SUCH AS MISALIGNMENT OF EXISTING WINDOW SILLS NOT RELATED TO EARTHQUAKES, BEGINS TO APPEAR DURING THE RE-LEVELLING, THE ENGINEER SHALL BE CONSULTED TO PROVIDE INSTRUCTIONS ON FURTHER RE-LEVELLING WORKS.
- GEOTECHNICAL ENGINEERING INVESTIGATION REPORT BY KGA GEOTECHNICAL DATED 29 JUNE 2023 STATES THAT ULTIMATE BEARING CAPACITY (UBC) OF 150kPa IS INFERRED TO BE ACHIEVED AT DEPTH OF 500mm BELOW THE NGL. SOIL BEARING CAPACITY IS TO BE VERIFIED BY PERIDOT ON SITE.
- MIN. 2 PORTABLE JACKS SHALL BE PLACED IN EACH EXCAVATED PIT AT 100mm FROM EDGE OF EXCAVATION. THE SPACING OF UNDERPINNING PADS REFERS TO OUR ENGINEERING DETAIL BELOW.

DWELLING FOUNDATION RE-LEVEL

- SECTION OF THE PERIMETER FOUNDATION IS TO BE RE-LEVELLED VIA MECHANICAL LIFTING METHOD (UNDERPINNING AND OVERPINNING) AS PER SPECIFIC ENGINEERING DETAIL.
- SECTION OF THE INTERNAL TIMBER FLOOR IS TO BE RE-LEVELLED VIA JACKING AND PACKING METHOD AS PER MBIE GUIDANCE AND SPECIFIC ENGINEERING DETAIL.
- SECTION OF THE DWELLING PERIMETER FOUNDATION IS TO BE REPLACED AS PER SPECIFIC ENGINEERING DETAIL (IF REQUIRED).
- ANY CRACKING DAMAGE TO THE FOUNDATION SHALL BE REPAIRED AS PER SPECIFIC ENGINEERING DETAIL.

PILE REPLACEMENT NOTES

IF PILE REPLACEMENT IS REQUIRED ON SITE, NEW PILE FOOTING SHALL BE AS FOLLOWS:

- UNDER LOAD BEARING WALL: MIN. 550mm SQ, MIN. 500mm BELOW NGL.
- NOT UNDER LOAD BEARING WALL AND SUPPORT INTERNAL TIMBER FLOOR ONLY: MIN. 400mm SQ, DEPTH TO BE BELOW TOPSOIL OR MIN. 150kPa WHICHEVER IS GREATER.

INSPECTIONS

- POST CUT INSPECTION OF THE UNDERPINNING PADS (RE-LEVELLING), INTERNAL CONCRETE FOOTINGS (IF ANY), FOUNDATION BEAM (IF REQUIRED), THE SIZE, GROUND CONDITIONS AND THE BEARING CAPACITY AT THE EXCAVATED DEPTH
- PRE-POUR INSPECTION TO CHECK REINFORCING STEEL OF THE UNDERPINNING PAD (RE-LEVELLING), FOUNDATION BEAM REPLACEMENT (IF ANY) PRIOR TO POURING OF CONCRETE
- FINAL FLOOR LEVEL, SUB-FLOOR CONNECTIONS, AND CRACK REPAIRS (IF ANY).

NOTE: MINIMUM 48 HOURS NOTICE IS REQUIRED FOR ALL INSPECTIONS.



REV	DATE	DESCRIPTION
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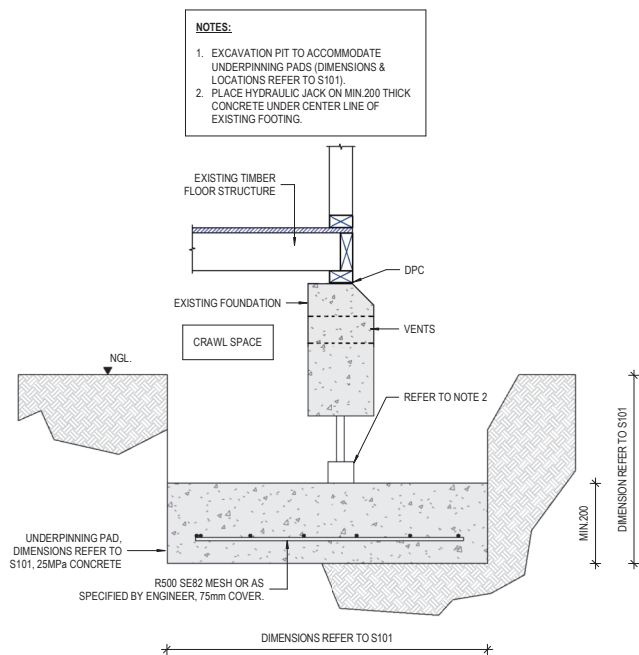
DESIGNED BY: K.J.
DRAWN BY: D.Y.
REVIEWED BY: N.N.
DATE: 30/09/2025
A3 SCALE: 1 : 100

REPAIR DESIGN FOR EXISTING RESIDENTIAL DWELLING
19 BELFIELD STREET, DALLINGTON, CHRISTCHURCH

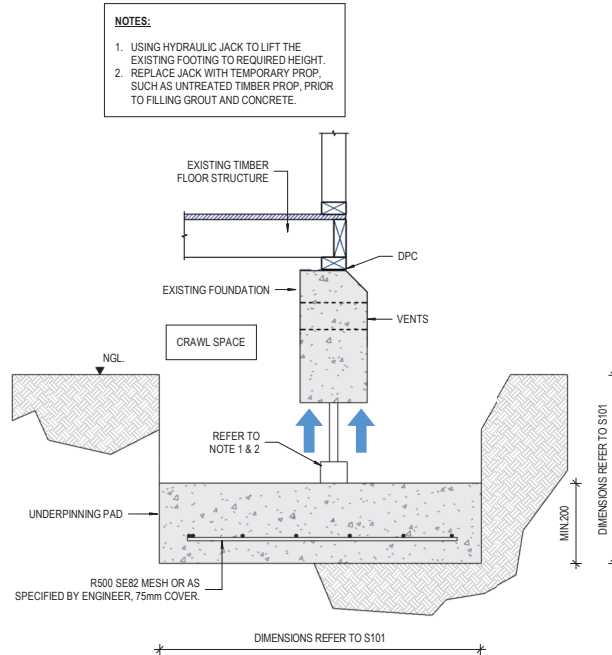
RE-LEVELLING PLAN

FOR BUILDING CONSENT

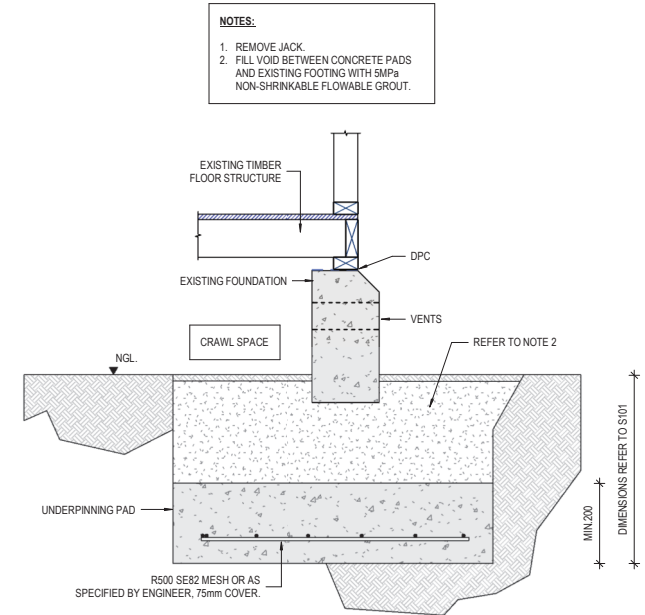
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25288
SHEET NO.
S101
SHEET REV.
1



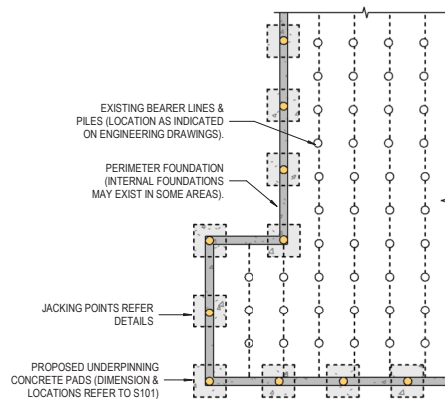
1 PERIMETER FOUNDATION LIFTING DETAIL STEP 1
SCALE A1 1:10 / A3 1:20



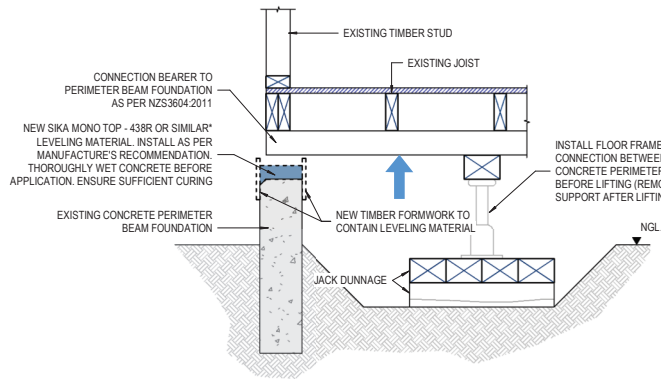
2 PERIMETER FOUNDATION LIFTING DETAIL STEP 2
SCALE A1 1:10 / A3 1:20



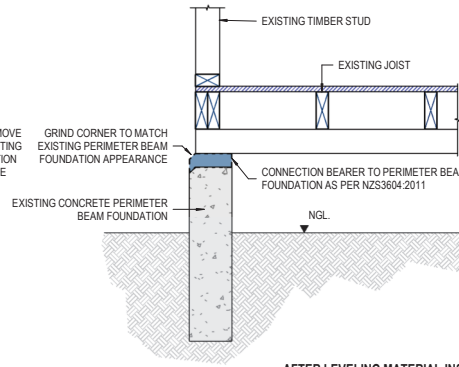
3 PERIMETER FOUNDATION LIFTING DETAIL STEP 3
SCALE A1 1:10 / A3 1:20



4 INDICATIVE TIMBER SUBFLOOR & FOUNDATION PLAN - TYPE B
SCALE A1 1:10 / A3 1:20



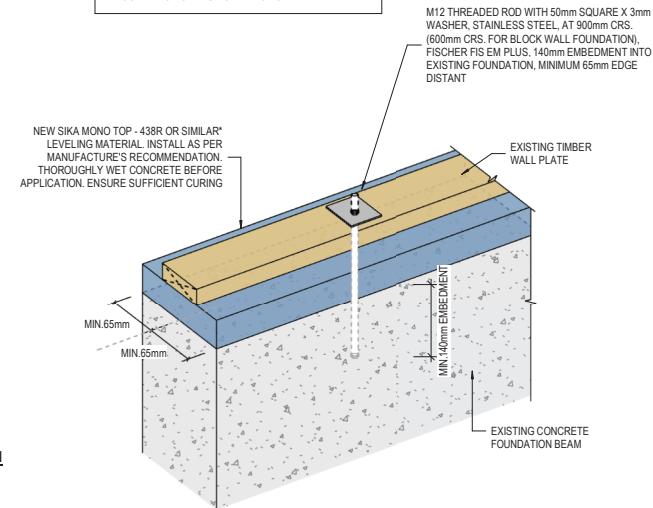
DURING LEVELING MATERIAL INSTALLATION



AFTER LEVELING MATERIAL INSTALLATION

1
CONCRETE PERIMETER FOUNDATION OVERPINNING DETAIL
A1 1:10 / A3 1:20

NOTES:
1. FIXINGS SHALL BE PROVIDED WITHIN 300mm OF ANY CORNER OR CHANGE OF DIRECTION.

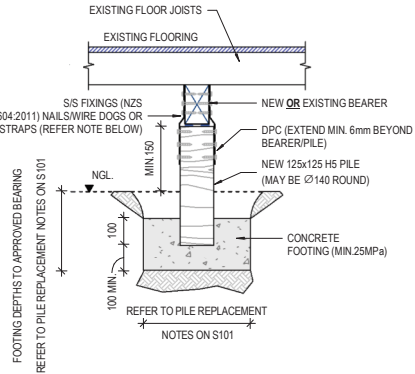


2
ALTERNATIVE PERIMETER FOUNDATION HOLD-DOWN DETAILS
A1 1:10 / A3 1:20

NOTES:

PILE/BEARER FIXINGS BY NZS3604: 2011

- 2 S/S WIRE DOGS AND 2 S/S 100x4 Ø SKEWED NAILS (1 WIRE DOG & NAIL EACH FACE OF BEARER)
- Ø140 TIMBER PILE (H5) MAY BE USED IN LIEU OF 125x125.
- ALL FIXINGS TO BE STAINLESS AS PER NZS3604:2011.

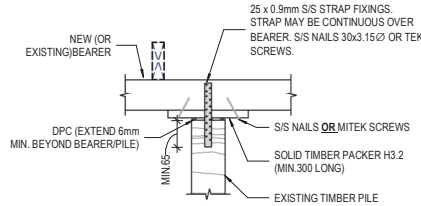


1 PILE-TO-BEARER CONNECTION DETAIL - NEW TIMBER PILE
SCALE A1 1:10 / A3 1:20

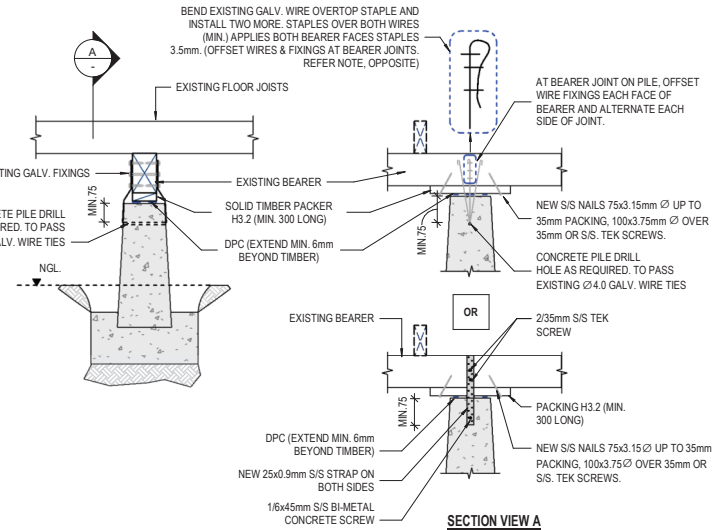
NOTES:

PILE/BEARER FIXINGS BY NZS3604: 2011

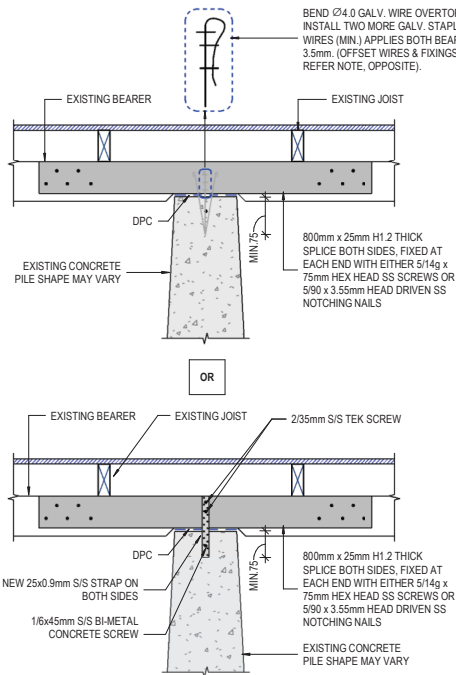
- 2 S/S WIRE DOGS AND 2 S/S 100x4mm MIN Ø SKEWED NAILS (1 WIRE DOG & NAIL EACH FACE OF BEARER).
- Ø140 TIMBER PILE (H5) MAY BE USED IN LIEU OF 125x125.
- ALL FIXINGS TO BE STAINLESS AS PER NZS3604:2011.



2 JACKING AND PACKING DETAIL - EXISTING TIMBER PILE
SCALE A1 1:10 / A3 1:20



3 JACKING AND PACKING DETAIL - EXISTING CONCRETE PILE
SCALE A1 1:10 / A3 1:20



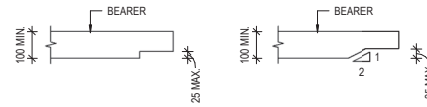
4 TYPICAL NOTCHING DETAIL AT INTERMEDIATE SUPPORT OF BEARER
SCALE A1 1:10 / A3 1:20

NOTES:

- PILE/BEARER FIXINGS BY NZS3604: 2011
- ALL CONSTRUCTION AND FIXINGS IN ACCORDANCE WITH THE BUILDING CODE & NZS3604:2011.
- ALL NEW TIMBER SHALL BE RADIATE PINE S/G8 GRADE.
- WHERE HARDWOOD TIMBER PREVENTS NAIL DRIVING DRILL PILOT HOLES TO 0.8 x DIA OF FIXING TO ASSIST PLACEMENT.
- FOR ALL PILES A DAMP PROOF COURSE OR OTHER IMPERIOUS MATERIAL SHALL BE PLACED BETWEEN THE PILE AND THE FRAMING TIMBER OR PACKER.
- ALL DIMENSIONS SHOWN ARE MIN. UNLESS NOTED OTHERWISE.
- TO BE READ IN CONJUNCTION WITH SPECIFICATION.
- FOR ANCHOR PILES, PLEASE CONTACT THE ENGINEER FOR A SPECIFIC CONNECTION DETAIL.
- MAX NOTCH SIZE 1/3 DEPTH OF BEARER OR 25mm WHICHEVER IS LESS.
- WHERE BEARERS SPAN OVER INTERMEDIATE SUPPORTS, THEY MAY BE NOTCHED ON THE UNDERSIDE FACE OF THE BEARER BY 20mm OVER A MAXIMUM LENGTH EQUIVALENT TO THE PILE WIDTH PLUS 50mm.

NOTES:

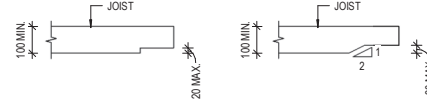
- THE ENDS OF 100mm AND 125mm DEEP BEARERS MAY BE NOTCHED BY 25mm WITH A SQUARE CUT TRANSITION IF THE TRANSITION IS SLOPED AT 2 TO 1 THEN THE NOTCH DEPTH MAY BE INCREASED TO 35mm.



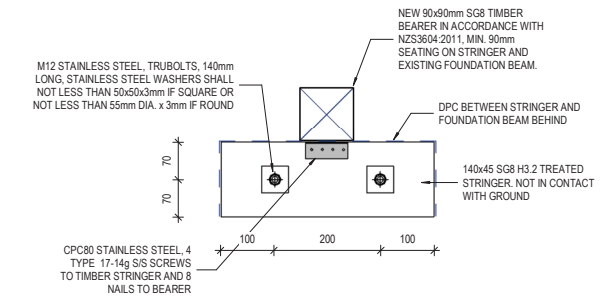
5 TYPICAL NOTCHING DETAIL AT BEARER END
SCALE A1 1:10 / A3 1:20

NOTES:

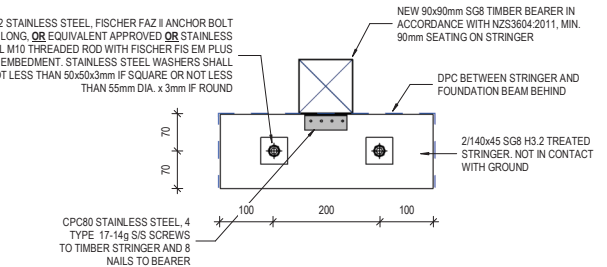
- THE ENDS OF 100mm AND 125mm DEEP JOISTS MAY BE NOTCHED BY 20mm WITH A SQUARE CUT TRANSITION IF THE TRANSITION IS SLOPED AT 2 TO 1 THEN THE NOTCH DEPTH MAY BE INCREASED TO 30mm.



6 TYPICAL NOTCHING DETAIL AT JOIST END
SCALE A1 1:10 / A3 1:20



7 TIMBER BEARER TO FOUNDATION BEAM HOLD DOWN CONNECTION
SCALE A1 1:10 / A3 1:20



8 TIMBER BEARER TO STRINGER CONNECTION
SCALE A1 1:10 / A3 1:20

STRUCTURAL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL AND OTHER RELEVANT DRAWINGS AND SPECIFICATIONS IF ANY. REFER TO THE ARCHITECTURAL DRAWINGS FOR ALL DIMENSIONS, LEVELS, DUCTS, AND OTHER SETTING OUT INFORMATION. CONTRACTORS MUST VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK AND ORDERING MATERIALS.
DO NOT SCALE.



REV	DATE	DESCRIPTION
1	30/09/2025	FOR BUILDING CONSENT

DESIGNED BY: K.J.
DRAWN BY: D.Y.
REVIEWED BY: N.N.
DATE: 30/09/2025
A3 SCALE: As indicated

REPAIR DESIGN FOR EXISTING RESIDENTIAL DWELLING
19 BELFIELD STREET, DALLINGTON, CHRISTCHURCH

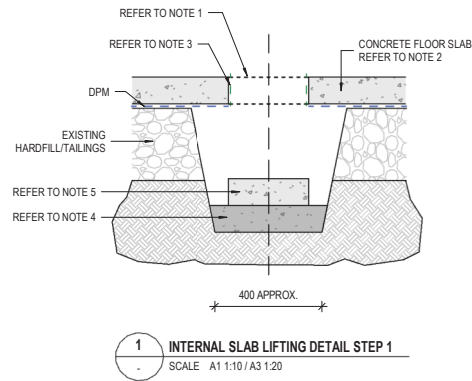
RE-LEVELLING / REPAIR
DETAILS

FOR BUILDING CONSENT

JOB NO.
25288
SHEET NO.
S403
SHEET REV.
1

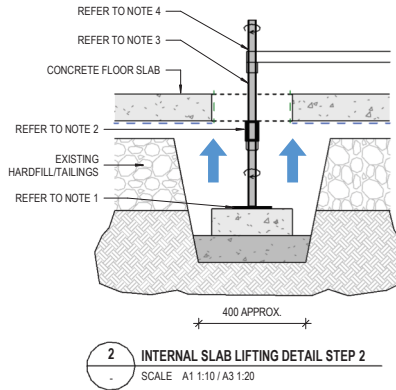
NOTES:

1. CORE DRILL Ø300 HOLES IN CONCRETE FLOOR SLAB. THE CONTRACTOR SHALL AVOID DRILL THROUGH EXISTING SLAB REINFORCING WHERE POSSIBLE.
2. EXCAVATE TO MINIMUM REQUIRED DEPTH (OR TO BASE OF TAILINGS/TOP SOIL).
3. TAPE EXISTING DPM FROM UNDER EDGE OF SLAB TO CORED HOLE, AND EXTEND TAPE TO EDGE OF SLAB.
4. CAST MIN100DEEP CONCRETE FOOTING TO BASE OF EXCAVATION (25MPa).
5. SET-IN Ø300 CORED CONCRETE SLAB DISC TO TOP OF INSITU FOOTING, BEFORE CONCRETE SETTING.
6. CORE DRILL Ø110 HOLES THROUGH FLOOR SLAB FOR VOID FILLING, AND TAPE DPM TO EDGES OF SLAB.



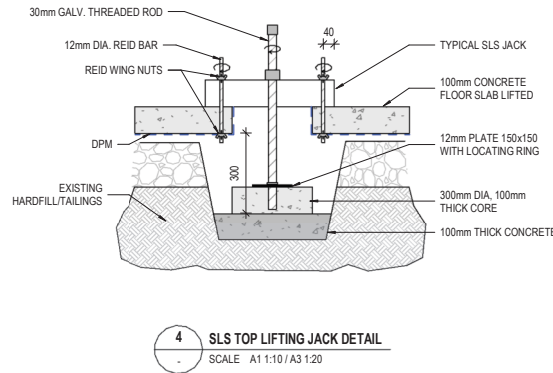
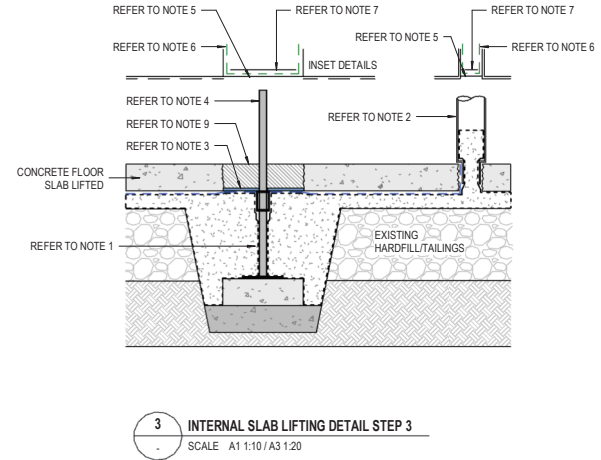
NOTES:

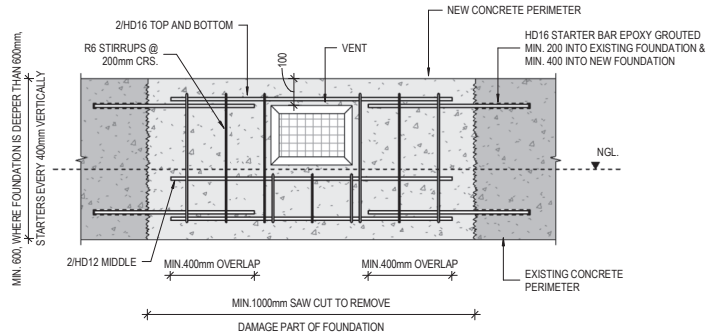
1. PLACE 150x150x10mm MS FLAT ON TOP OF THE CORED DISC.
2. PLACE 75x75x500 LONG RHS (PRE WRAPPED WITH DENSOTAPE) LIFTING BRACKET WITH DRILLED HOLE AND WELDED NUT, TO USIDE OF FLOOR SLAB.
3. SCREW-IN Ø32 THREADED ROD THROUGH RHS BRACKET AND NUT UNIL BRACKET IS HARD AGAINST SOFFIT OF SLAB.
4. FIX RATCHET BAR TO TOP OF THREADED ROD, AND JACK FLOOR SLAB TO REQUIRED HEIGHT, IN CONJUNCTION WITH FOUNDATION AND OTHER FLOOR SLAB SECTION, LEVELLING.



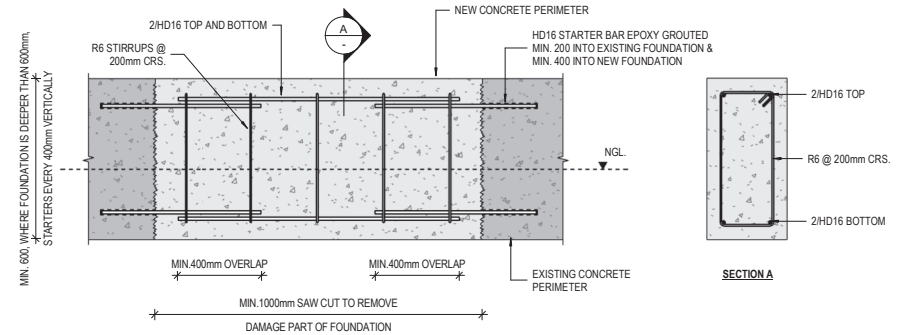
NOTES:

1. SLEEVE AND WRAP OR GREASE LOWER THREADED ROD SECTION.
2. VOID FILL UNDER SLAB & DPM USING 110 PVC STAND PIPES TO CREATE HEAD TO GROUT. (FILL TO FLOOR LEVEL AT CORED HOLES.)
3. CLEAN-OUT VOID FILL WITHIN CORED HOLE TO BASE OF FLOOR SLAB, OR 100mm BELOW FLOOR LEVEL.
4. REMOVE (UV SCREW) THREADED ROD, SOME 12-24 HOURS FOLLOWING VOID FILLING. LEAVING LIFTING BRACKET IN PLACE.
5. CUT & REMOVE TAPE TO LOWER EDGES OF CORED HOLE.
6. SIKA BLACK SEAL ELASTIC APPLIED TO BASE + EDGES OF 300mm x 110mm
7. PLACE POLYTHENE (DPM) DISC OVER THE ABOVE(REFER INSET DETAILS)
8. CONTRACTOR TO REINSTATE THE REINFORCEMENT IN EXISTING SLAB WHERE NEEDED.
9. SCRABBLE CONCRETE SURFACE AND FILL SLAB HOLES WITH CONCRETE & GRIND SURFACE FOLLOWING CONCRETE SETTING.



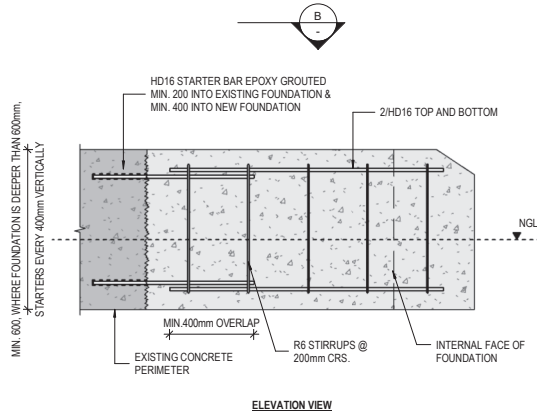


1 PARTIAL FOUNDATION REPLACEMENT DETAIL - VENT
SCALE A1 1:10 / A3 1:20

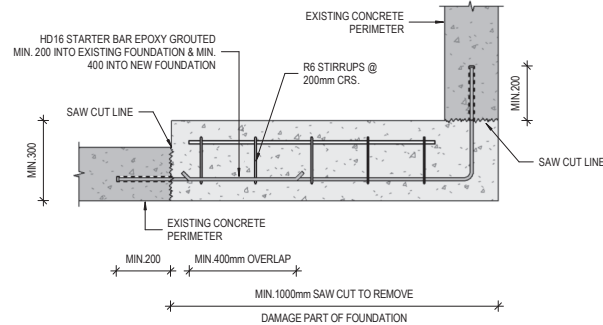


2 PARTIAL FOUNDATION REPLACEMENT DETAIL
SCALE A1 1:10 / A3 1:20

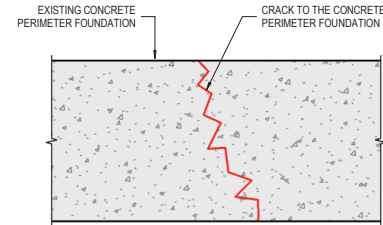
- NOTES:**
1. COVER TO STEEL TO BE 75mm (MIN)
 2. CONCRETE STRENGTH FOR REPAIRED PART OF FOUNDATION TO BE 25 MPa.
 3. FOR FOUNDATIONS GREATER THAN 600mm IN DEPTH, THE CHEMSET STARTERS ARE TO BE REPEATED AT 400mm CRS.
 4. NEW SECTION OF FOUNDATION TO BE MIN 300mm THICK.



3 PARTIAL FOUNDATION REPLACEMENT DETAIL - CORNER
SCALE A1 1:10 / A3 1:20



PLAN VIEW B



CRACK REPAIR NOTES:

1. PREPARE ALL CONCRETE CRACK'S SURFACES CLEAN AND FREE FROM LOOSELY ADHERING PARTICLES, OR CONTAMINANTS SUCH AS DIRT, OIL, DUST, GREASE ETC.
2. APPLICATION OF PRODUCT TO INTERFACE SHALL BE IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
3. CRACK INJECTION WORK SHOULD BE LEFT FOR 5-7 DAYS TO FULLY CURE BEFORE FULL STRUCTURAL INTEGRITY IS ACHIEVED.
4. CONTRACTOR TO CONFIRM CRACK REPAIR HAS BEEN COMPLETED IN ACCEPTABLE STANDARD.

CRACK WIDTH	REPAIR METHOD	PRODUCT SPECIFICATIONS
HAIRLINE TO 0.2 mm	NO REPAIRS REQUIRED	
0.2 mm - 10 mm	LOW VISCOSITY EPOXY INJECTION	FOSROC NITOFILL LV OR HILTI CI 060 OR EQUIVALENT APPROVED
10mm - 20 mm	CEMENTITIOUS GROUT INJECTION	FOSROC CONBEXTRA OR SIKADUR 31 OR RAMSET POZILITE HB/ POZICOTE FR OR EQUIVALENT APPROVED
>20 mm OR WITH >3 mm OUT OF PLANE MOVEMENT	BREAKOUT AND RECAST WITH NEW ENHANCED PERIMETER FOUNDATION	

4 CRACK IN CONCRETE PERIMETER FOUNDATION (INDICATIVE)
SCALE A1 1:10 / A3 1:20

Viden Group

Structural Engineers Report

For Earthquake Damage Assessment

Address: 19 Belfield Street, Dallington, Christchurch 8061
Client Wrightway Construction
Project Ref: 226-161
Revision: .
Date: 5 July 2023

I. Documentation Control



Author	Julio Ortiz Structural Engineer BE(Hons), MEngNZ	
Reviewed By	Mark Patterson Senior Engineer BE(Civil), DipEng, CPEng, CMEngNZ	
Authorised for Release	Mark Patterson Senior Engineer BE(Civil), DipEng, CPEng, CMEngNZ	

This report is not for construction.

This technical report has been prepared by Viden Consulting Engineers Ltd. for use by Wrightway Construction to assist with determining a repair solution for the damage sustained to the property during the Canterbury Earthquake Sequence (CES).

No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person without prior written permission.

II. Property Summary

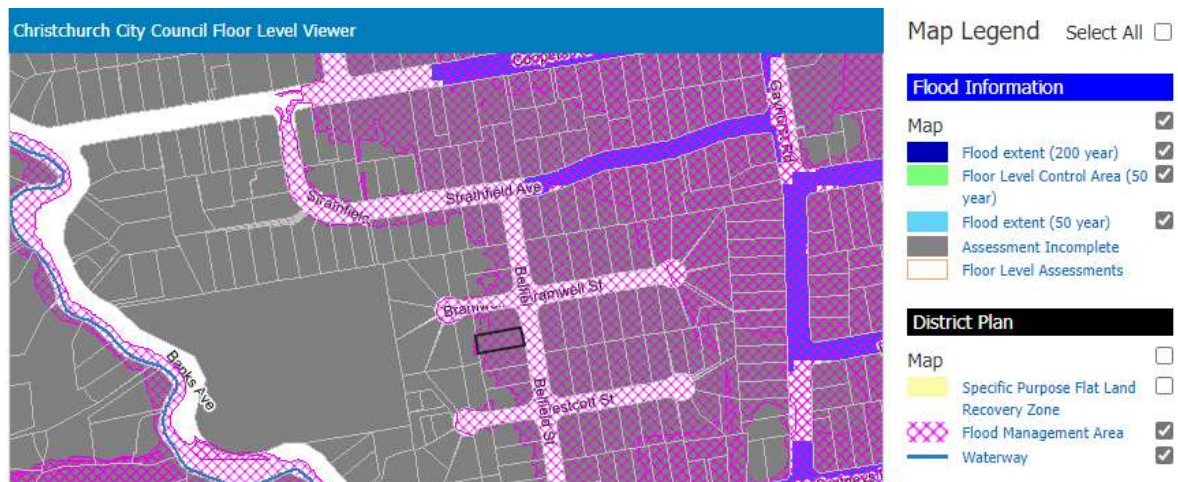
Street View	Aerial View
	
Inspection Date:	Tuesday, 14 March 2023
Council District:	Christchurch City Council
Topography:	Flat

III. Technical Background

MBIE Technical Category: Technical Category 2 (TC 2)

Listed Land Use Register: No Records (Checked 10 March 2023)

Flood Management Area: The property is located inside the Flood Management Area

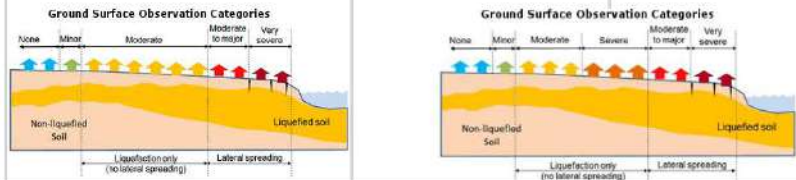


Floor Level Assessment

Street Address	19 Belfield Street
Within District Plan Flood Management Area (FMA)	Yes
Building Code Floor Level	Not assessed. Please contact CCC.
District Plan Floor Level	Not assessed. Please contact CCC.
Recommended Floor Level (not mandatory)	Not assessed. Please contact CCC.
Predicted 1 in 50 Year Flood Level	Not assessed. Please contact CCC.
Predicted 1 in 200 Year Flood Level	Not assessed. Please contact CCC.
Minimum Ground Level	11.76 m Christchurch Drainage Datum
Average Ground Level	12.01 m Christchurch Drainage Datum
Maximum Ground Level	12.25 m Christchurch Drainage Datum

New Zealand Geotechnical Database (NZGD):

New Zealand Geotechnical Database: Property Summary Report

General Property Information					
Property Address	19 Belfield St				
QPID #	1210230	Suburb	Dallington		
Valuation Reference No	22371/13800	DPID #			
Legal Description	LOT 9 DP 16872				
Easting (NZTM)	1573392	Northing (NZTM)	5182223		
CERA Zone	Green	MBIE Technical Category	TC2		
Liquefaction Observations					
Earthquake	4 Sept 2010	22 Feb 2011	13 June 2011		
Liquefaction Observed [from aerial photos]	None	Moderate to Severe	Moderate to Severe		
Ground Surface Observation Category	None	Moderate Liquefaction	Refer to Road Map		
					
Discrepancies are possible between observations from aerial photography and ground based observations. Refer to notes 1 & 2.					
Property Surface Elevation from LIDAR Surveys (m LVD37)					
Survey Dates	Pre Quake	5 Sep 2010	8 Mar-30 May 2011	18 Jul - 3 Sep 2011	17 - 18 Feb 2012
Maximum Elevation	3.55	3.37	3.23	3.24	3.09
95 percentile	3.46	3.29	3.16	3.11	3.04
Mean Elevation	3.26	3.15	3.03	2.99	2.91
5 percentile	3.02	2.97	2.87	2.83	2.78
Minimum Elevation	2.97	2.89	2.75	2.72	2.58
Refer to note 3.					
Cumulative Property Elevation Changes from LIDAR Surveys (m LVD37)					
Period: Pre Quake -	to 5 Sep 2010	to 30 May 2011	to 3 Sep 2011	to 18 Feb 2012	
Surface Change	- 0.11	- 0.23	- 0.27	- 0.35	
Other Change	- 0.10	- 0.14	- 0.14	- 0.23	
Tectonic Change	- 0.01	- 0.09	- 0.13	- 0.12	
Refer to note 3.					
Interpolated Ground Water Surface Elevation at the time of each Earthquake (m LVD37)					
Earthquake	Sep 2010	Feb 2011	Jun 2011	Dec 2011	
Surface Elevation	0.56	0.67	0.59	0.63	
For back analysis purpose only. Refer to note 4.					
Design Ground Water Surface Elevations (m LVD37)					
	Median surface	Median with surrogates	85 percentile offset	15 percentile offset	
Surface Elevation	0.54	0.54	0.38	- 0.47	
Refer to note 5.					

IV. Contents

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1. Instruction

My instruction was to provide a report on the earthquake related structural damage and provide recommendations on repair methodology for the property 19 Belfield St.

My observations are based on a site assessment of the property and a review of the details provided to me, as well as other available information including the property summary report and data downloaded from the New Zealand Geotechnical Database (NZGD).

2. Documents

I have been provided with the following documents and information of significance:

- EQC Scope of Works, dated 13 September 2011
- EQC Full Assessment Report, dated 13 September 2011
- DC Building Contract Quotation, dated 15 June 2012
- EQC Opting Out Letter, dated 2 July 2012
- DC Building Contract Quotation, dated 14 January 2013
- House Levellers Si Ltd Letter, dated 9 April 2013
- DC Building Contract Quotation, dated 15 April 2013
- Colin Plastering Ltd Letter, dated 18 September 2013
- Edifice Tax Invoice, dated 18 March 2014
- Wrightway Floor Level Survey, dated 1 November 2022
- Cavity Critter Underfloor Inspection Report, dated 6 February 2023

I have also downloaded information from the New Zealand Geotechnical Database (NZGD).

Important Notice: Some of the information contained in this report have been created from maps and/or data extracted from the New Zealand Geotechnical Database (<https://www.nzgd.org.nz>) which were prepared and/or compiled for the Earthquake Commission (EQC) to assist in assessing insurance claims made under the Earthquake Commission Act 1993 and/or for the Canterbury Earthquake Recovery Authority (CERA). The source maps and data were not intended for any other purpose. EQC, CERA, their data suppliers and their engineers, Tonkin & Taylor, have no liability for any use of the maps and data or consequences of any person relying on them in any way. This "important notice" must be reproduced where that information or any derivatives are reproduced.

3. Observations

Building Description

The dwelling at 19 Belfield Street is a single-level property built circa the 1950s. The roof is timber-framed with a concrete tile roof. The walls are timber-framed and clad with stucco plaster and a brick veneer at the southwestern corner. The foundation combines external piles with a perimeter façade and concrete perimeter foundation.

It appears that EQC has carried out cosmetic repairs to the internal linings and exterior cladding. Relevelling work was documented; however, there was no evidence of relevelling work in the Cavity Critter report.

For the purpose of this report, the elevation facing Belfield Street will be referred to as the eastern elevation. Refer to the house floor plan below, showing the layout of the house and the notation used throughout this report:

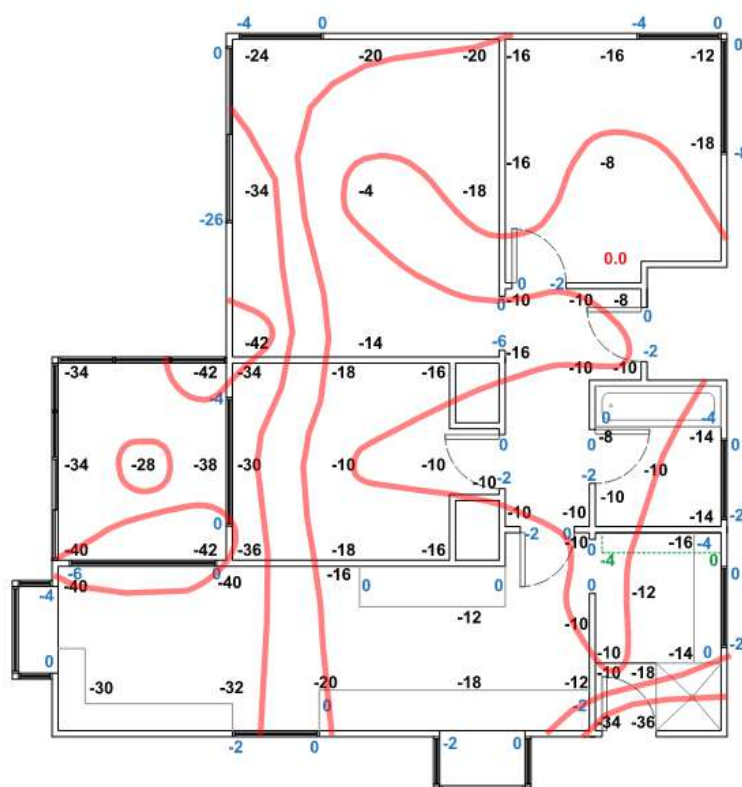


 FLOOR LAYOUT - MAIN DWELLING
scale 1:100

Floor Levels:

A level survey was carried out with a Zip® Level altimeter. An overall floor level variation of 42mm was recorded over the floor of the dwelling. The floor slopes from high points in the north-eastern corner, in bedroom 1, towards a low point on the west elevation, particularly around the lounge and sunroom area.

See the contour plan below:



LEVEL SURVEY - MAIN DWELLING
scale 1:100

Windowsills, door heads and benchtop levels were taken to confirm they align with the adjacent floor slopes. Generally, the levels recorded on the windowsills and joinery correlate with the adjacent floor levels. However, some inconsistencies were noted between the floor levels and levels taken on other elements. Points to note were as follows:

- In the lounge, the window head sloped 26mm down towards the south, while the adjacent floor sloped 10mm in the same direction.
- Between the kitchen and dining area, the windowsill sloped 2mm down towards the west while the adjacent floor sloped 12mm in the same direction.

Notes from the Homeowner:

As part of our inquiries, a discussion with the homeowner took place prior to the structural assessment, the following was recorded:

- The property was bought three years ago.
- The main concern is the floor levels.

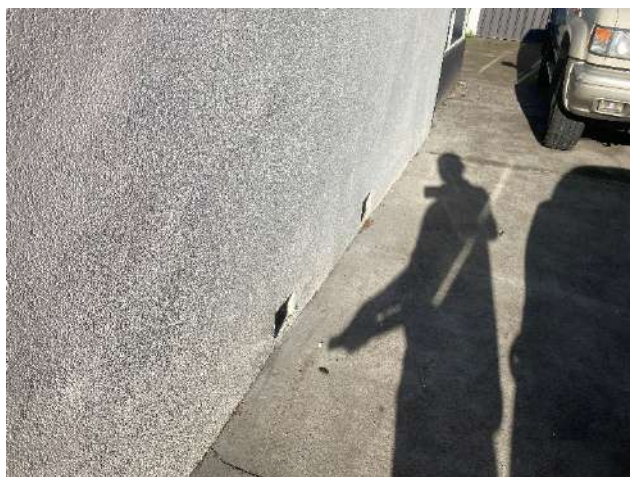
- The homeowner is concerned that the repairs to the cladding are not carried out to an appropriate standard.
- The kitchen bench and joinery have been renovated. The floor was tiled over hardwood. The dining area has been levelled.
- The laundry has been renovated. A new bench and tiles were installed.

External:

An external walk-over of the property was carried out during our assessment, the following information was noted:

North Elevation:

- The window outside of the lounge was measured to be plumb.
- The driveway had cracks along its length. There was no significant damage or cracking at the interface between the house cladding and the driveway.



- Cracking to the plaster was noted at the interface with the concrete patio. A timber board was also showing signs of rot.
- No damage to the concrete patio was noted on this elevation.

East Elevation:

- There were signs of previous repair work to the cladding outside of bedroom 1 and the laundry.
- The verandah posts were twisted. Little sign of movement was noted between the main dwelling and the verandah beams.

South Elevation:

- The window frame outside of the kitchen and the laundry door were plumb.
- There was no significant damage noted to the cladding along this elevation.
- The brick veneer was generally level at the southwestern corner.

West Elevation:

- No damage or separation was noted to the concrete steps outside of the sunroom.
- The brick veneer outside of the dining area was sloping 12mm down towards the north. A silicone type product had been applied between the brick and the

window frame that appeared recent.



- The frame outside of the lounge was measured to be plumb. However, the top of the frame showed some adjustment, being smaller at the centre of the span. There was no sign of damage to the frame or surroundings.



Internal

An internal walk-over of the property was carried out during our assessment, the following information was noted:

Entry/Hallway:

- There were reasonably consistent gaps around the entry door. However, it appeared that the striker plate had been adjusted or replaced.



- The cupboard doors opened and closed freely.
- Minor cracking to the wall lining was noted adjacent to the bedroom 1 door.

Lounge:

- The door has been removed, and the adjacent floor has a noticeable hump.



- There was an uneven finish on top of the sliding door. No damage was noted in the surroundings. It appears that the ceiling in this location has been adjusted to suit.



- Minor cracking to the cornice was noted on the north wall.

Bath:

- The wall tiles were installed subsequent to the earthquakes and were measured to be level.
- The door had a minor taper on the side. However, the door was functioning.

Laundry:

- The bench and tiles were installed after the earthquakes.
- The external door appeared to have been modified on the bottom. There was also a new cover installed on the inside face.



Kitchen/Dining:

- The windows operated freely, with no issues noted.
- New benches and joinery had been installed following the earthquakes. The tiles were measured to be level. The homeowner stated that they had to leave uneven finishes around the ceiling as it was uneven at the time of the renovations.
- The door had a tapering gap at the bottom. The door generally opened and closed.



- Minor cracking to the wall linings was noted above the window on the southern wall.

Sunroom:

- The sliding doors were functioning, with no issues noted.
- The window on the north wall was stuck opened. No damage was noted.

Bedroom 1:

- The windows were operational. However, there was a tapered gap on one side between the window frame and the timber.



- Minor cracking was noted to the interface between the ceiling and the cornice.

Bedroom 2:

- The windows operated freely, with no issues noted.
- There was a noticeable tapered gap at the bottom of the door.



4. Previous Reports

EQC Scope of Works and Full Assessment Report, dated 13 September 2011

EQC carried out a damage assessment and provided a scope of works and full assessment report on 13 September 2011. The following was recorded:

- Cracking to the plaster on all four elevations.
- Replace 10 piles.
- Replace 19 linear meters of the perimeter foundation. Grind out and epoxy fill cracks.
- A comment stated that the house had sunk to the west side.
- Replace broken purlins. Repoint ridge capping.
- Cosmetic damage to the wall linings in the hallway, bathroom, laundry, kitchen, dining, bedroom 1, bedroom 2, and lounge.
- Cosmetic damage to the ceiling linings in the hallway, bedroom 1, and bedroom 2.
- Realign the external door at the rear. Ease the kitchen and lounge doors.

DC Building Contract Quotation, dated 15 June 2012

DC Building provided EQC with a contract quotation document on 15 June 2012. The document presents a quote for the items presented in the EQC Scope of Works from 2011. In this documents it is noted to replace 6 piles instead of 10.

EQC Opting Out Letter, dated 2 July 2012

EQC provided an opt-out letter on 2 July 2012. It is recorded that the homeowner is responsible for managing the repairs.

DC Building Contract Quotation, dated 14 January 2013

DC Building provided EQC with a contract quotation document on 14 January, 2013. The document presents a quote for the items presented in the EQC Scope of Works from 2011, excluding the external work. The document states that the external work has been removed "as requested."

House Levellers Si Ltd Letter, dated 9 April 2013

House Levellers provided a letter on 9 April 2013. The following was recorded:

- Settlement of up to 40mm was recorded to the perimeter foundation piles along the southwest elevation.
- The intention is to release the affected piles and replace them with new H5 timber piles.
- Internal non-loadbearing piles are to be packed.
- The ring foundation at the southwest extension will require lifting and underpinning. The ring foundation will be lifted as best as the structure allows.
- The concrete patios will need to be removed to allow for adequate access.

- The structure is not on a concrete ring foundation apart from the southwest corner extension. They also noted that the structure requires up to 30 piles to be replaced.

DC Building Contract Quotation, dated 15 April 2013

DC Building provided EQC with a contract quotation document on 15 April, 2013. The document presents a quote for the external items presented in the EQC Scope of Works from 2011.

Colin Plastering Ltd Letter, dated 18 September 2013

Colin Plastering Ltd. provided a letter highlighting their findings after a site visit. They recommended to re-plaster and re-mesh the walls as the existing repairs would be extremely difficult.

Extensive Cracking - Fully Meshed

Any repairs carried out to the existing cladding would be extremely difficult to match. Due to the finish applied to the residence and the nature of the cracks we would recommend re-plastering and re-meshing the walls to mitigate the damage.

Edifice Tax Invoice, dated 18 March 2014

Edifice provided a tax invoice on 18 March 2014. The invoice included:

- Repairs to the cladding
- Jacking and packing six piles
- Epoxy cracks to the ring foundation and concrete patio.

Wrightway Floor Level Survey Plan, dated 1 November 2022

Wrightway Construction carried out a floor-level survey and produced a plan on 1 November, 2022. The following was recorded:

- The house has a floor level variance of 42mm.
- The floor gradients exceed the MBIE guidelines.

19 Belfield Street

Floor level Survey 01/11/22

Carried out with a Zip level Pro 2000 by Andrew Woods LBP.

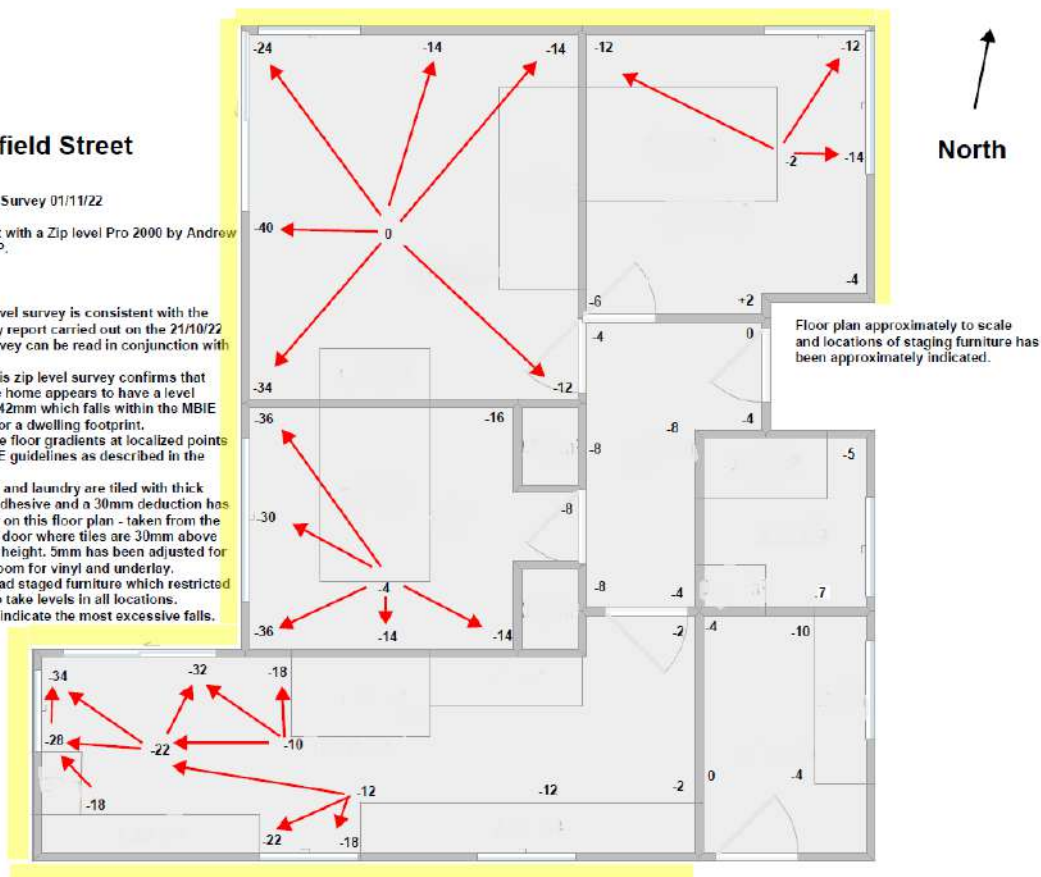
This floor level survey is consistent with the CPI property report carried out on the 21/10/22 and this survey can be read in conjunction with that report.

However, this zip level survey confirms that globally, the home appears to have a level variance of 42mm which falls within the MBIE guidelines for a dwelling footprint.

However, the floor gradients at localized points exceed MBIE guidelines as described in the CPI report.

The Kitchen and laundry are tiled with thick mortar/tile adhesive and a 30mm deduction has adjusted for on this floor plan - taken from the Hall/kitchen door where tiles are 30mm above timber floor height. 5mm has been adjusted for in the bathroom for vinyl and underlay. The home had staged furniture which restricted the ability to take levels in all locations.

Red arrows indicate the most excessive falls.



Cavity Critter Under Floor Inspection Report, dated 6 February 2023

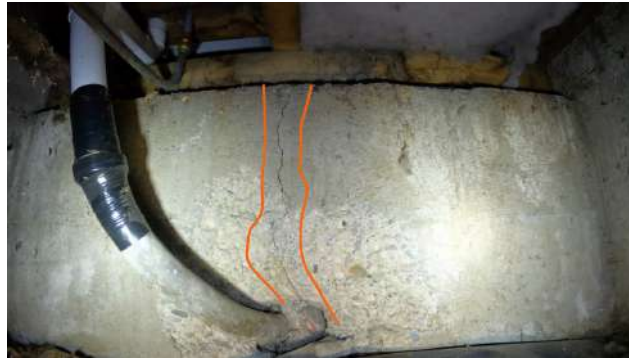
Cavity Critter carried out a subfloor inspection and report on 30 May, 2022. This report provides images of the individual piles and perimeter foundation throughout the dwelling. See the subfloor plan below indicating the existing foundation layout:

- The condition of the subfloor members appears reasonable for a building of this age. The perimeter foundation generally appears to have been constructed from concrete with rounded stone aggregates, which can be typical for a dwelling of this era. In general, the inside face of the concrete was relatively well compacted, although there were some areas of 'boney' concrete where the aggregates were more prominent. The timber subfloor is generally supported by timber bearers sitting directly on the perimeter foundation and concrete piles.



- There was one crack noted in the perimeter foundation along the eastern

elevation.



- Notching of a bearer under the lounge area was noted. No packing of the piles was recorded.



- There were two piles cracked in the middle.



KGA Geotechnical Investigation Report, dated 29 June 2023

KGA Geotechnical prepared a geotechnical report at our request on 29 June 2023. The following was recorded:

- The soils encountered onsite comprise topsoil and fill up to 0.5m depth over silty sand to approximately 1.5m depth. The underlying soil layers comprise silt to 2.8m, sand and sandy silt to 3.5m, sand and gravel to 6.3 and sand up to 10.3m depth.
- Based on the observations from the hand-dug trial pits, the concrete perimeter footing for the original dwelling is founded at a depth of approximately 0.45m

near the southeastern corner of the dwelling, atop the sandy silt/ silty sand. The hand dug trial performed near the northeastern corner of the structure did not encounter the foundation footing of the structure. The test indicated that the perimeter façade appears to be seated at ground level atop topsoil material. The founding depths of the perimeter beam of the southwestern extension, concrete patio/sunroom foundations, and internal/external piles are not known.

- During KGA's site testing, groundwater was encountered at an average depth of approximately 2.0m.
- KGA provided an assessment of the calculated nominal liquefaction settlement index values (in the upper 10m) under Serviceability Limit State (SLS) and Ultimate Limit State (ULS) levels of shaking intensity. Their results are summarised here:
 - At SLS levels of shaking intensity, the liquefaction-induced vertical settlements were calculated to be 10mm.
 - At ULS levels of shaking intensity, calculated settlements were up to 50mm.
 - These settlements generally fall within a TC2 categorisation as defined by the MBIE Guidance.
- Liquefaction-induced ground deformation analysis was carried out by KGA analysing the CPT data. The ULS performance levels indicate up to 10% of the deposit may liquefy, with liquefaction occurring in layers of limited thickness and ground deformation resulting in relatively minor differential settlements. On the other hand, KGA points out that, based on the degree of liquefaction ejecta present onsite and nearby following the February 2011 earthquake, they consider that their analyses are likely to underestimate the true liquefaction potential and overall performance of the site. A site performance in line with "high" effects from excess pore water pressure and liquefaction from Table 5.1 of Module 3 may be more representative of expected site performance.
- "The inferred lateral movement from LiDAR (NZGD) indicates that the site has experienced 220mm (\pm 400mm) of horizontal movement to the southwest during the CES. Ground observations by the EQC for the February and June 2011 earthquakes indicate the site was not subject to lateral spreading. Furthermore, no cracks were mapped in the vicinity of the site. Based on these considerations, we believe the site presents a potential for minor global lateral movement of the ground across the site."
- KGA concludes the following:
 - "As the current measured floor levels were conducted over ten years after the major events of the CES, the measured settlements likely include construction-related variations, historic static settlements, and settlements due to seismic-induced liquefaction. We note that it is not possible to accurately quantify the amount of settlement attributable to initial static settlements versus settlements that occurred during seismic shaking or reconsolidation settlements that occurred subsequent to shaking. However, based on the generalised western tilt of the structure and post-earthquake aerial photography evidence of onsite (and nearby) liquefaction ejecta following the February 2011 earthquake, it is our opinion that the dwelling has likely been materially affected as a result of liquefaction-related settlements during the CES."

- KGA's recommendations for the foundation repair are:
 - "The structure may be relevelled using a performance-based underpinning methodology, with underpins based into natural soils below 0.5m depth where a geotechnical ultimate bearing capacity of 150kPa may be assumed."
 - "The shallow piles may be relevelled using jacking and packing methodology."
 - "Localised piles may be replaced to structural engineer design if they exhibit evidence of excessive tilting or settlement, or if excessive packing would be required. New piles should be seated below 0.5m depth and designed for a GUBC of 150kPa."

5. Technical Discussion

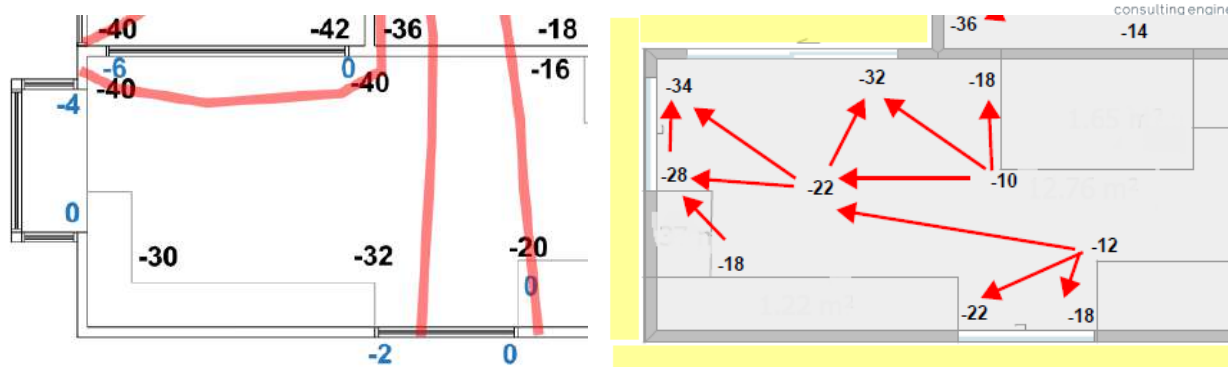
Viden recorded an overall floor level variation of 42mm. The level survey identified floor slopes with high points in the north-eastern corner, in bedroom 1, towards low points in the west elevation, in the lounge and sunroom. The floor levels were also recorded by Wrightway Construction, with a 42mm floor variance. The floor slopes in both level surveys are consistent.

Interior walls were painted after the CES. The bathroom, laundry, and kitchen have also been renovated. New floor tiles were installed in the kitchen. The homeowner stated they attempted some localised relevening in the dining room, when the tiles were installed. The homeowner also stated that the windows had been renovated in the kitchen.

There were some inbuilt inconsistencies recorded between the floor levels and adjacent elements. The top of the lounge sliding door was sloping 26mm down towards the south, while the floor was only sloping 10mm. There were elements on the outside and inside of the frame that showed that some adjustment was made at the time of construction. In the lounge slider, the separation between the frame and the soffit was 10mm less in the middle to allow for the difference with the soffit. A similar situation was observed inside with the cornice, moulding, and the top of the sliding door.



The window on the southern elevation, between the kitchen and the dining area, was generally level, while the adjacent floor was 12mm sloping down towards the west. However, the floor levels were recorded around the furniture and not directly under the windowsill. When this area is compared to the Wrightway floor level survey, the levels recorded directly under the windowsill were sloping 4mm down towards the west, in line with the windowsill sloping 2mm in the same direction. See localised floor surveys below:



There is a clear trend of the house sloping down towards the west. The initial EQC scope of works indicates that the "home has sunk to the west side" and "have allowed to remove and replace some of the foundation and piles." The document indicates replacing 10 piles and removing the perimeter foundation. The EQC scope of works also registered 3 doors that needed to be eased or adjusted. See the extract below:

Foundations

Damage: Earthquake damage

Require Scaffolding? No

Element	Type	Material	Damages	Measure	Rate	Cost
Piles	Ordinary	Concrete	Floor has moved less than 100mm			
			Replace pile more than 6 under house	10.00 No of	185.00	1,850.00
Ring foundation	Load bearing	Concrete	Cracks to ring foundation			
			Grind out and epoxy fill cracks	2.50 l/m	30.00	75.00
			Foundation out of plumb			
			Remove, dispose, replace ring foundation	19.00 l/m	290.00	5,510.00

General Comments: Home has sunk to the west side have allowed to remove and replace some of the foundation and piles.

House Levellers stated in their letter dated 9 April 2013 that they noticed a settlement of up to 40mm towards the southwest corner. Their strategy was to replace approximately 30 piles with further engineering input. However, this quote was replaced with the one from Edifice, which quoted to jack and pack 6 piles. There are no records outlining the rationale for changing the repair strategy. Ultimately, the Cavity Critter report reveals that the piles have not been packed and that one of the bearers appears to have been notched under the lounge door. It is not clear if the notch of the bearer was completed before or after the CES. See quotes and the photo of the notched bearer below:

We note that there has been no specific EQC Engineering design and details included in the Scope of Works. The Scope of Works details 10 piles for replacement and that the structure is on a ring foundation. During our assessment we note that the structure is not on a concrete ring foundation apart from the south west corner extension. We also note the structure requires up to 30 replacement piles. This type of project will require a specific engineering underpin and pile plan and may require a building consent.

Foundations

Piles	CIF - Jack & Pack Concrete Pile Including Fixings as Needed	\$103.44	6
Ring Foundation	CEF - Grind Out and Epoxy Cracks - Foundation	\$103.46	6
	EPSP - Solid Plaster Repair	\$84.99	12



Wall verticalities were measured with a spirit level throughout the dwelling. No real trend was noted on the walls, with most being within 5mm variance over the length of a 1200mm level.

The NZGD maps show moderate to severe liquefaction in the February 2011 and June 2011 events.

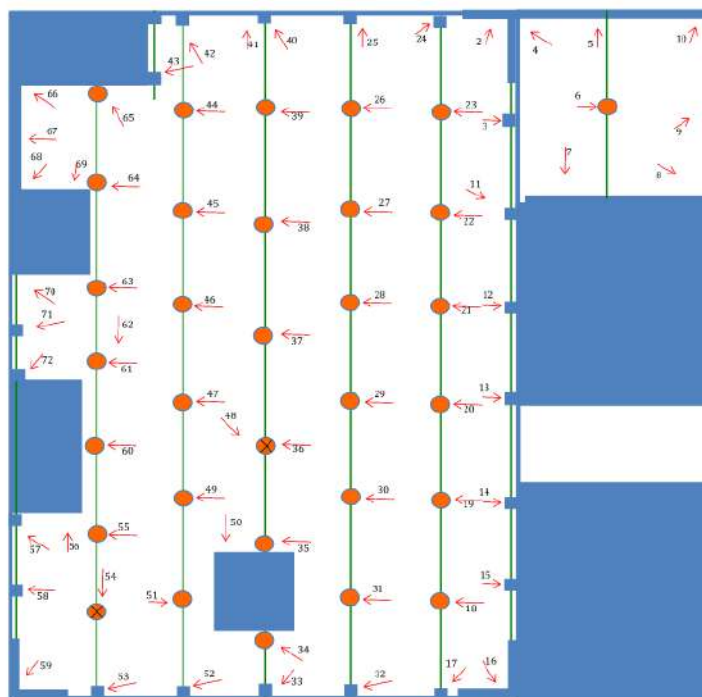


KGA conclude in their geotechnical report that the dwelling has likely been materially affected due to liquefaction-related settlements during the CES. They base this on the general western tilt of the structure and post-earthquake aerial photography evidence of liquefaction ejecta at the site (and in the vicinity) following the February 2011 earthquake.

Considering all of the above, I believe it is likely that the dwelling has settled down towards the western elevation as a result of the CES. The eastern section of the house has a consistent floor dislevelment of approximately 18mm. Minor signs of stress were still visible in the lounge cornice and above the kitchen window, where the change in floor slopes was noted.

Therefore, foundation relevening is recommended by a combination of jacking and

packing piles, replacing them or underpinning of the perimeter foundation elements. Due to the make up of the foundation and the combination of footings, piles and foundation beams, a combination of strategies will be required. See the foundation plan below and the releveling strategy appended to this document.



X Cracked pile.

If releveling is confirmed, it should target a 'when new' condition and be performance-based. The target levels provided are an indicator. However, the final levels will need to be determined during releveling and based on the acceptable level of consequential damage. See A03 for the proposed extent of the releveling.

It appears likely that the notching of the bearer was completed as part of the earthquake repairs; however, this will need to be confirmed. If confirmed, a repair of the notched bearer can be carried out following the details appended to this report.

If pile replacement is required due to the condition of the existing piles, a new pile detail can be provided.

There was minor damage to the internal linings, likely to have resulted from the CES or as part of the repair process. This damage appears consistent with previous EQC documentation and does not appear to have been remediated or was remediated unsuccessfully. Therefore, repairs are recommended to be carried out following section 7 of the MBIE guidelines.

In the EQC Scope of Works, it was recommended to remediate the cracking to the cladding. In the Edifice quote, repairs to the cladding were recorded. However, the workmanship and detail around the openings do not appear to meet the required standard. As a result, it is recommended that the cladding repairs be assessed and remediated by a contractor experienced in this type of cladding repair.

We concur with the recommendation made by KGA in their geotechnical report which states: "Removing the heavy roofing and replacing the heavy elements with an equivalent lightweight alternative is likely to result in a foundation with better overall performance (following completion of the releveling works). Likewise, replacing the heavy concrete patio at the southwestern elevation with a timber decking alternative would be beneficial for future structural performance." However, we note this is a recommendation not a requirement.

6. Limitations

This report has been developed from a visual inspection of the structural damage sustained to the dwelling as a direct result of the Canterbury Earthquake Sequence (CES); electrical, service connections, sanitary fittings and secondary elements such as windows and fittings were not inspected unless specifically noted in the report.

The inspection comprised only structural elements readily visible and accessible by reasonable means in accordance with Viden health and safety requirements. Unless otherwise noted, structural elements hidden by wall linings, ceilings and cladding have not been inspected.

This report does not constitute construction issue documentation, and further engineering advice should be sought before finalisation of the repair solution.

7. Photos



1.



2.



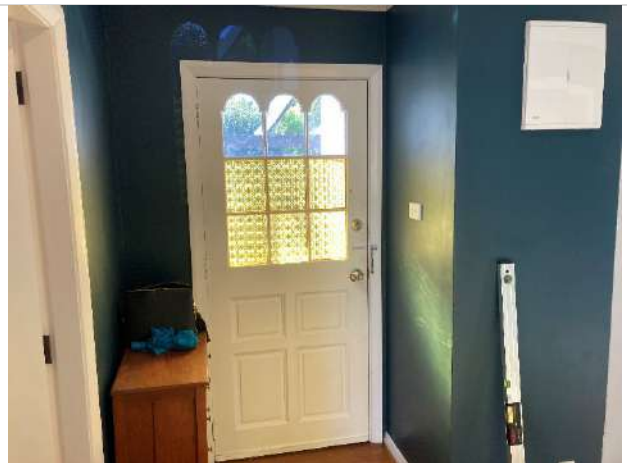
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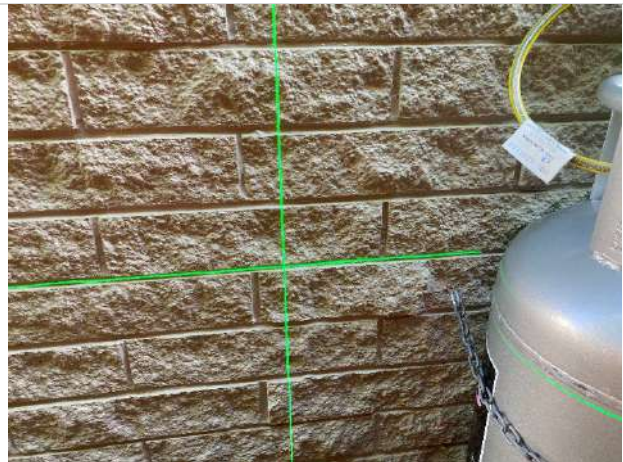
7.



8.



9.



10.



11.



12.

8. Appendices

A01 Floor Plan

A02 Level Survey

A03 Floor Relevelling Plan

A04 Notching Detail

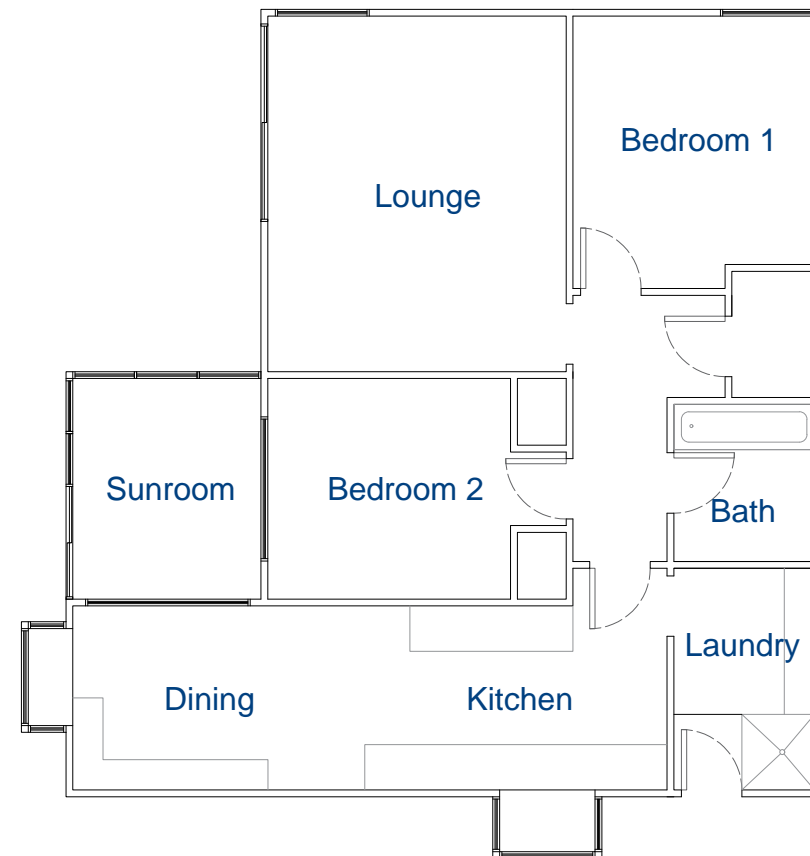
A05 Perimeter Foundation Underpinning Detail

A06 Pile Packing Detail

A07 New Pile Detail

A08 KGA Geotechnical Report

A09 Cavity Critter Subfloor Investigation Report



EASTERN ELEVATION

 FLOOR LAYOUT - MAIN DWELLING
scale 1:100

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REVISION:

DRAWN BY: YR

SCALE: 1:100 @A3

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FLOOR
LAYOUT PLAN

A01

March 2023

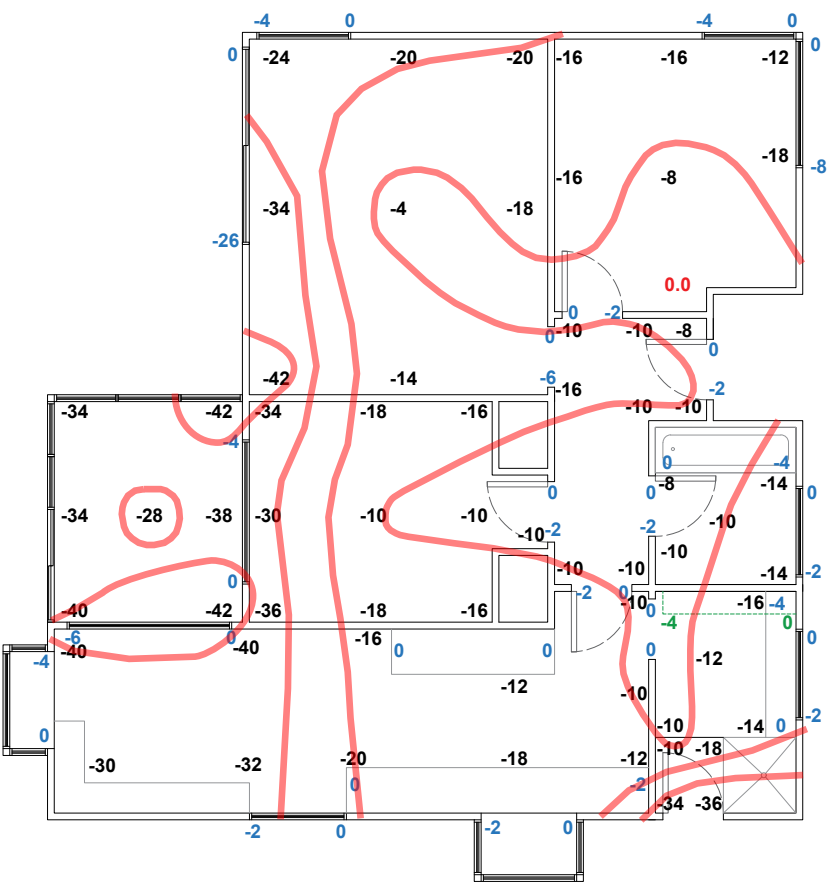
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LEGEND

LEVELS TAKEN ON WINDOW SILLS, DOOR HEADS, LINTELS AND BENCHES INDICATED IN BLUE

LEVELS UNDERNEATH THE CUPBOARDS INDICATED IN GREEN



LEVEL SURVEY - MAIN DWELLING
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DRAWN BY: YR

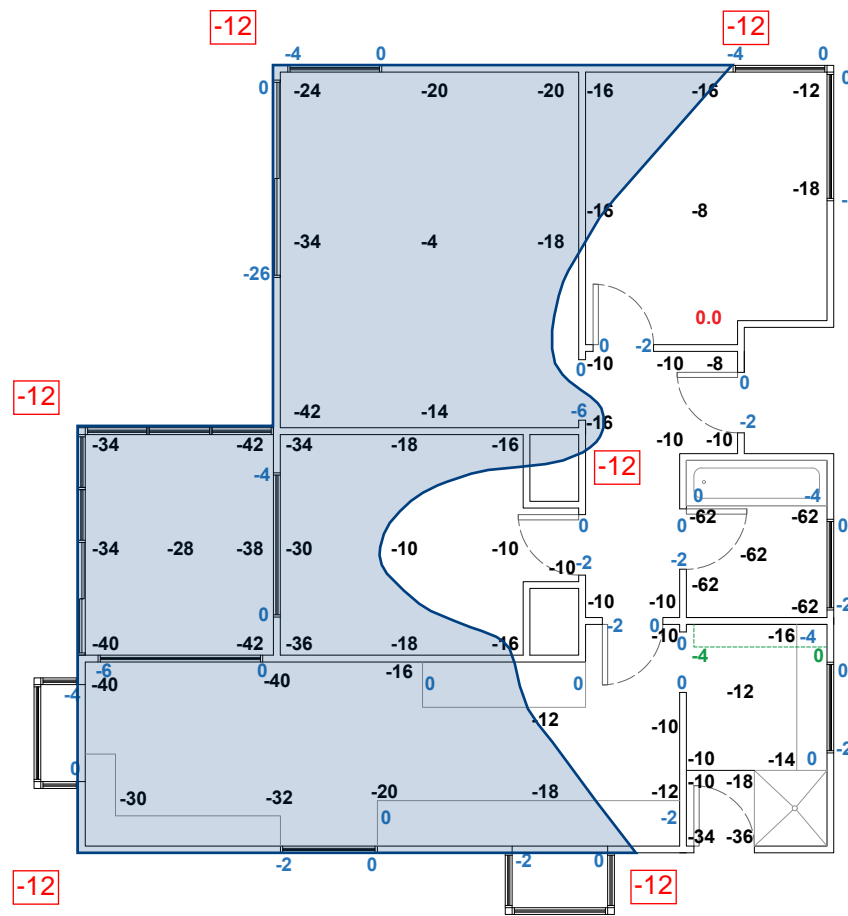
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LEVEL SURVEY
PLAN

A02

March 2023



LEVEL SURVEY - MAIN DWELLING
scale 1:100

LEGEND

LEVELS TAKEN ON WINDOW SILLS, DOOR HEADS, LINTELS AND BENCHES INDICATED IN **BLUE**

LEVELS UNDERNEATH THE CUPBOARDS INDICATED IN **GREEN**



Relevel Existing Floor by mechanically jacking the perimeter foundation using the underpinning method outlined on A05. Lifting pads are recommended to be at 1.5m c/c max. Jack and pack piles or replace them as required, as per A06 and A07. Refer to appended details.

Pile notching as required per A04.



Target levels are provided as a guide, final levels are expected to be confirmed based on limiting significant consequential damage to doors and windows and other inbuilt items, and should target a when new condition.

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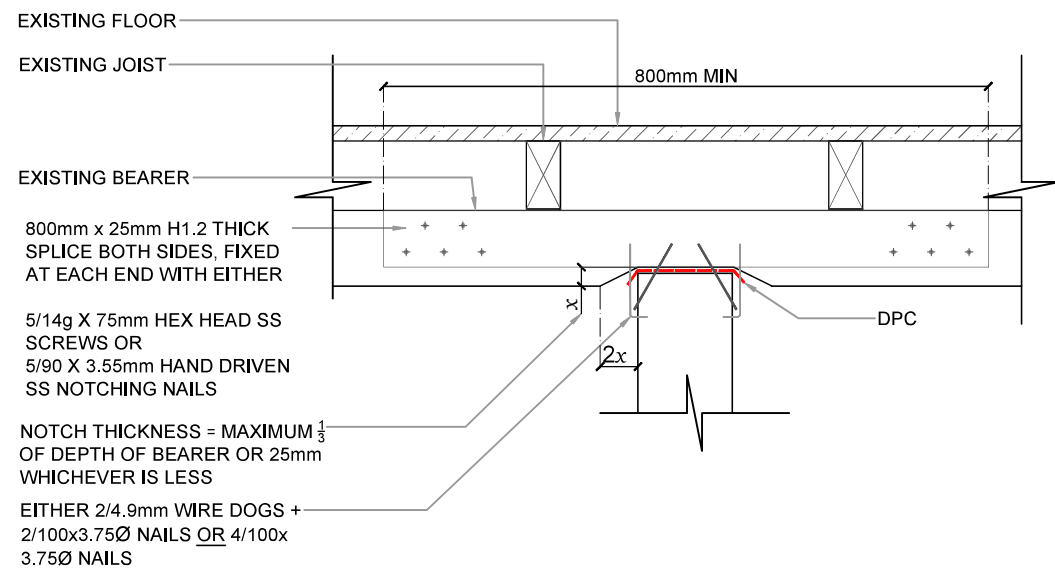
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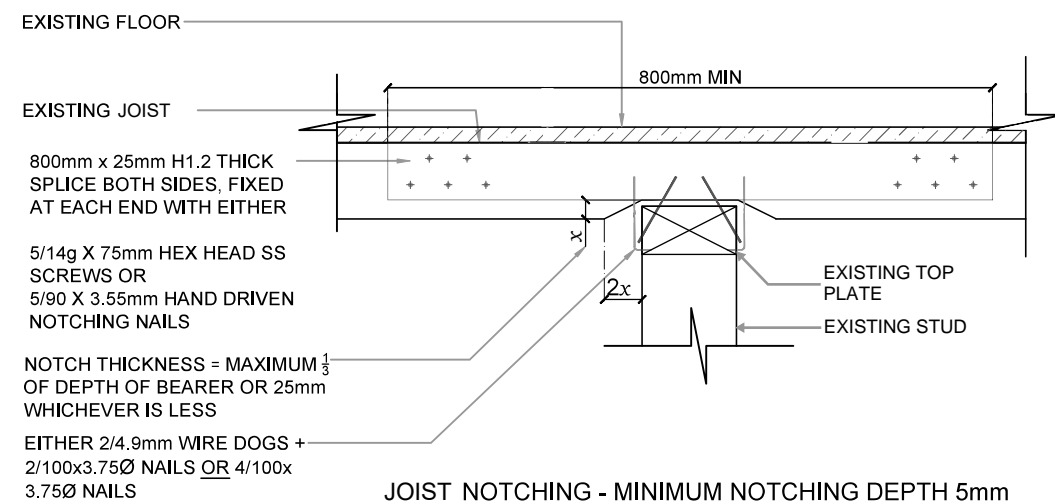
RELEVELLING
PLAN

A03

March 2023



BEARER NOTCHING - MINIMUM NOTCHING DEPTH 5mm



JOIST NOTCHING - MINIMUM NOTCHING DEPTH 5mm

NOTES:

1. ALL CONSTRUCTION AND FIXINGS IN ACCORDANCE WITH THE BUILDING CODE & NZS 3604:2011.
2. ALL STEEL FIXINGS TO BE TYPE 304 STAINLESS STEEL.
3. ALL NEW TIMBER SHALL BE RADIATA PINE SG8 GRADE.
4. WHERE HARDWOOD TIMBER PREVENTS NAIL DRIVING DRILL PILOT HOLES TO 0.8 x DIA OF FIXING TO ASSIST PLACEMENT.
5. FOR TIMBER PILES OF HEIGHTS BETWEEN 150mm AND 300mm ABOVE FINISHED GROUND LEVEL A DAMP PROOF COURSE OR OTHER IMPERVIOUS MATERIAL SHALL BE PLACED BETWEEN THE PILE AND THE FRAMING TIMBERS OR PACKER.
6. ALL DIMENSIONS SHOWN ARE MINIMUM UNLESS NOTED OTHERWISE
7. TO BE READ IN CONJUNCTION WITH SPECIFICATION.

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NOTCHING
DETAIL

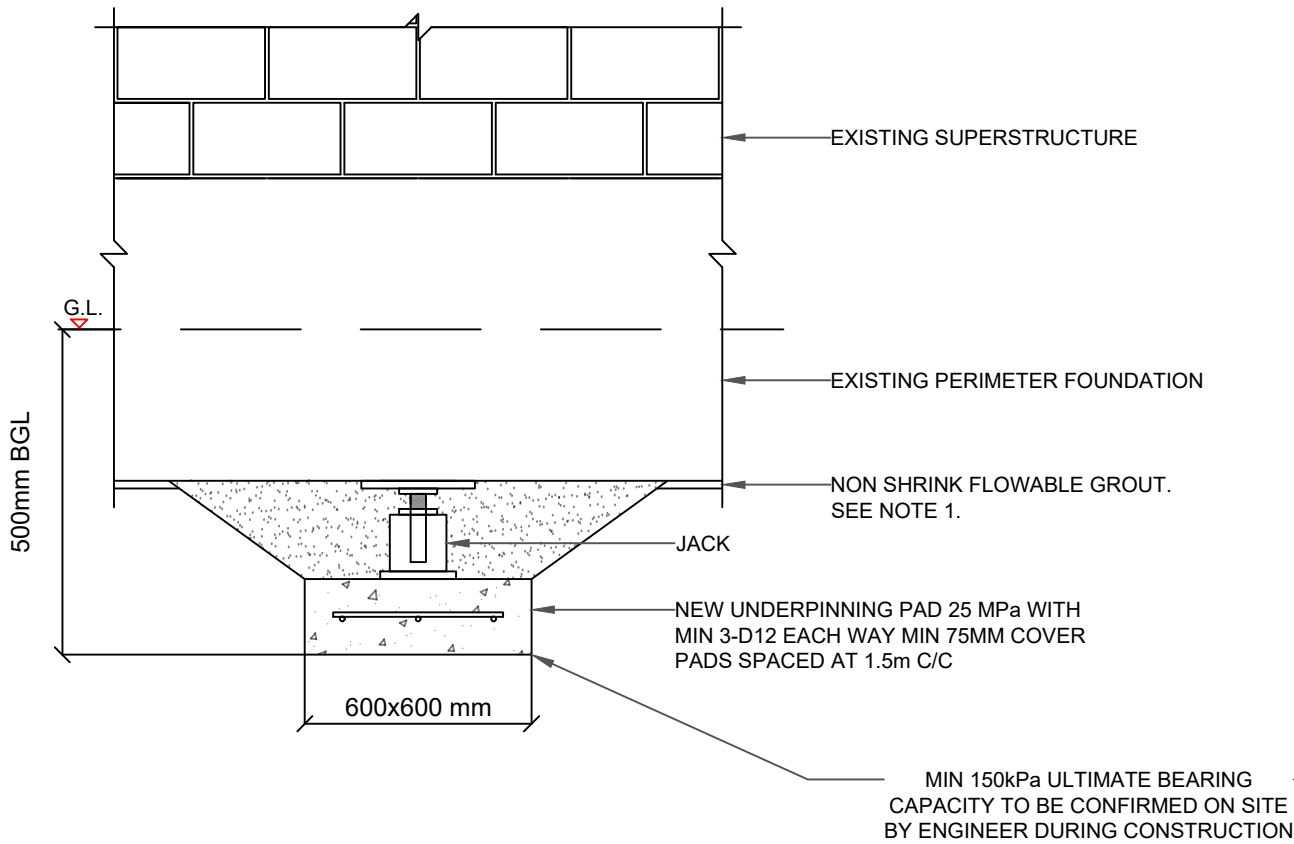
A04

March 2023

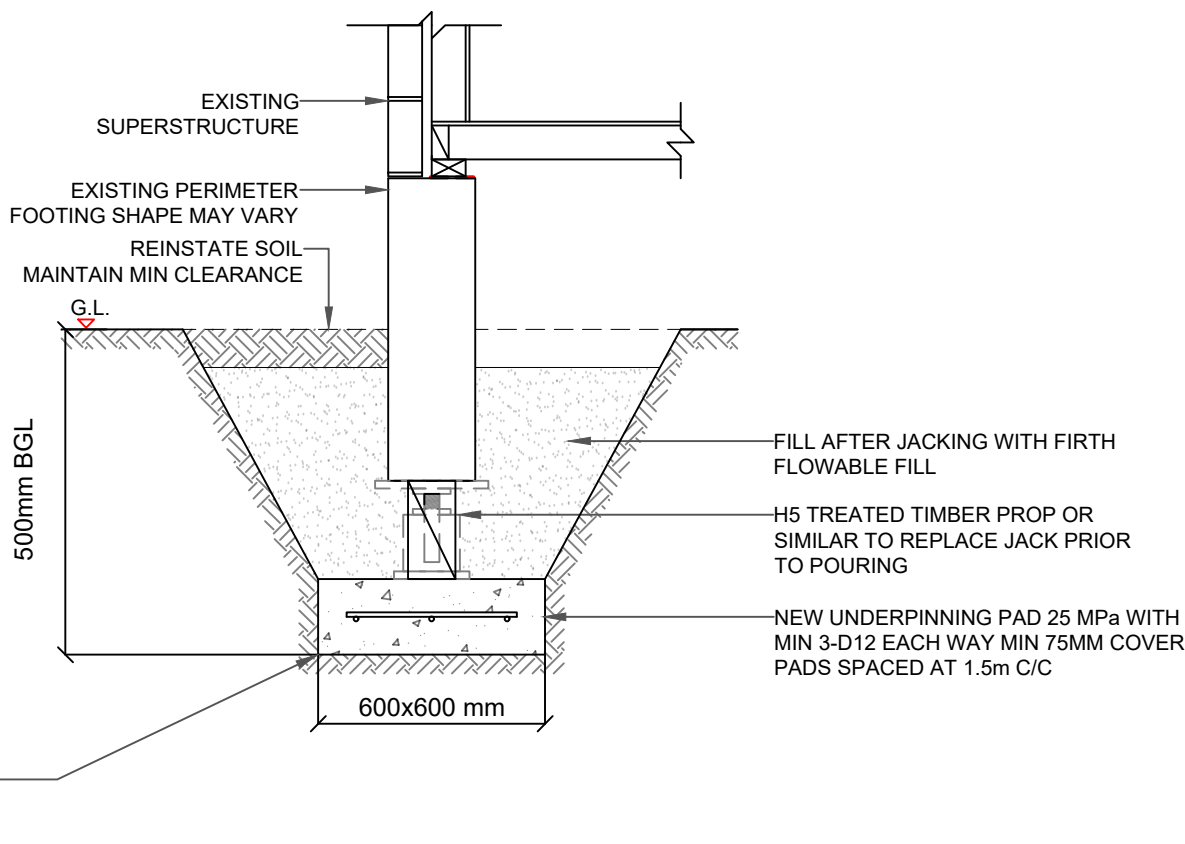
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NOTES

- 1. GRUB OUT BELOW FOUNDATION BETWEEN JACKING PADS AND FILL WITH NON SHRINK FLOWABLE GROUT.
- 2. INSPECTION OF GROUND AT BASE OF EXCAVATION REQUIRED BY ENGINEER. EXCAVATIONS TO BE TAKEN THROUGH ANY TOPSOIL OR FILL AND BE FOUNDED IN 150kPa MINIMUM.
- 3. EXCAVATE, REINFORCE AND CONCRETE UNDERPINNING PADS UNDER THE EXISTING PERIMETER FOUNDATION WALL AT LOCATIONS AND TO SIZES SHOWN ON THE DRAWINGS.
- 4. FOLLOWING JACKING, PROVIDE H5 90x90mm TIMBER STRUTS OR SIMILAR BETWEEN THE UNDERPINNING PADS AND THE PERIMETER FOUNDATION AND REMOVE JACKS.
- 5. FILL THE SPACE BETWEEN THE UNDERSIDE OF THE FOUNDATION AND THE GROUND AT THE JACK PITS BETWEEN THE JACKS WITH FIRTH FLOWABLE FILL. (MIN 10MPa)
- 6. REINSTATE THE ADJACENT GROUND.



PERIMETER FOUNDATION JACKING USING REINFORCED
CONCRETE JACKING PADS (ELEVATION)



PERIMETER FOUNDATION JACKING USING REINFORCED
CONCRETE JACKING PADS (SECTION)

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PERIMETER
FOUNDATION
UNDERPINNING
DETAIL

A05

March 2023

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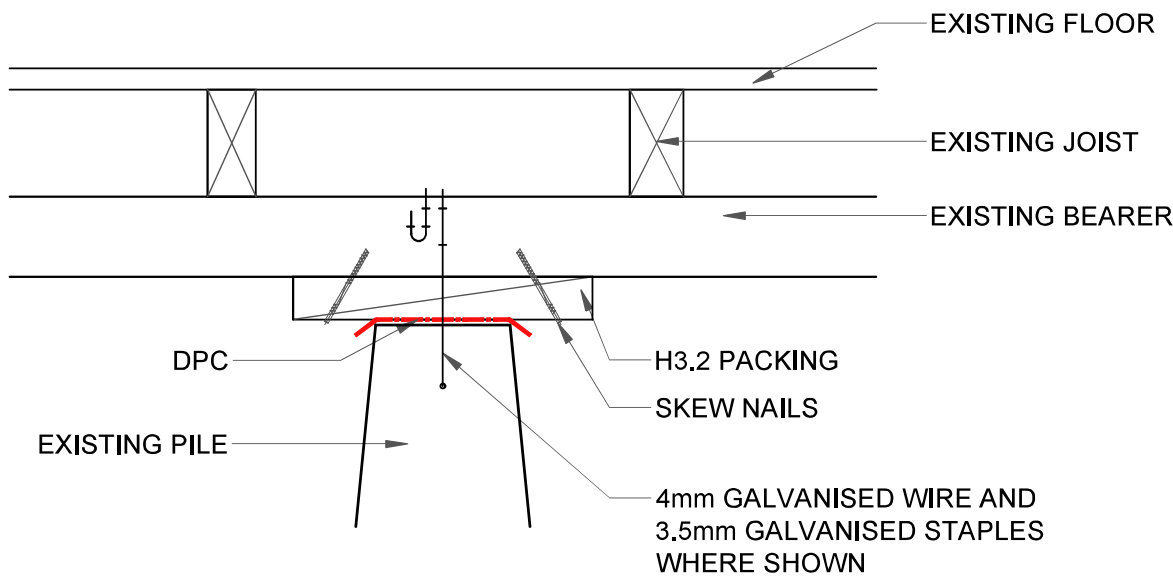
PILE PACKING
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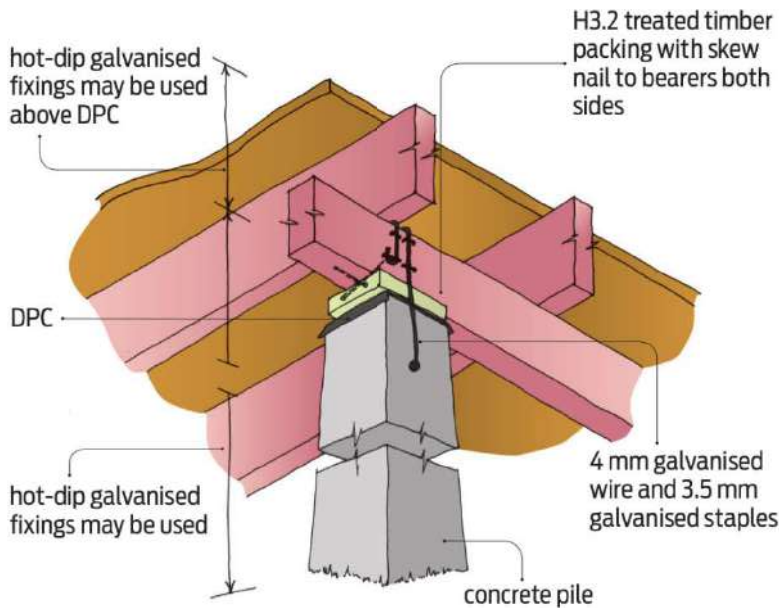
March 2023

JACK & PACK NOTES

1. ALL CONSTRUCTION AND FIXINGS IN ACCORDANCE WITH THE BUILDING CODE & NZS 3604:2011.
2. H3.2 PACKERS TO BE THE FULL WIDTH OF THE BEARER & EXTEND THE FULL WIDTH OF THE PILE TOP
3. REPLACE PILE IF 100mm OR MORE PACKING IS REQUIRED.
4. REPLACE PILE IF ANY PILE IS LEANING 15mm OFF PLUMB OR LOOSE IN IT'S FOOTING
5. ALL STEEL FIXINGS AS REQUIRED BY NZS 3604:2011 (FIXINGS WITHIN 600mm OF GROUND LEVEL MUST BE STAINLESS STEEL)



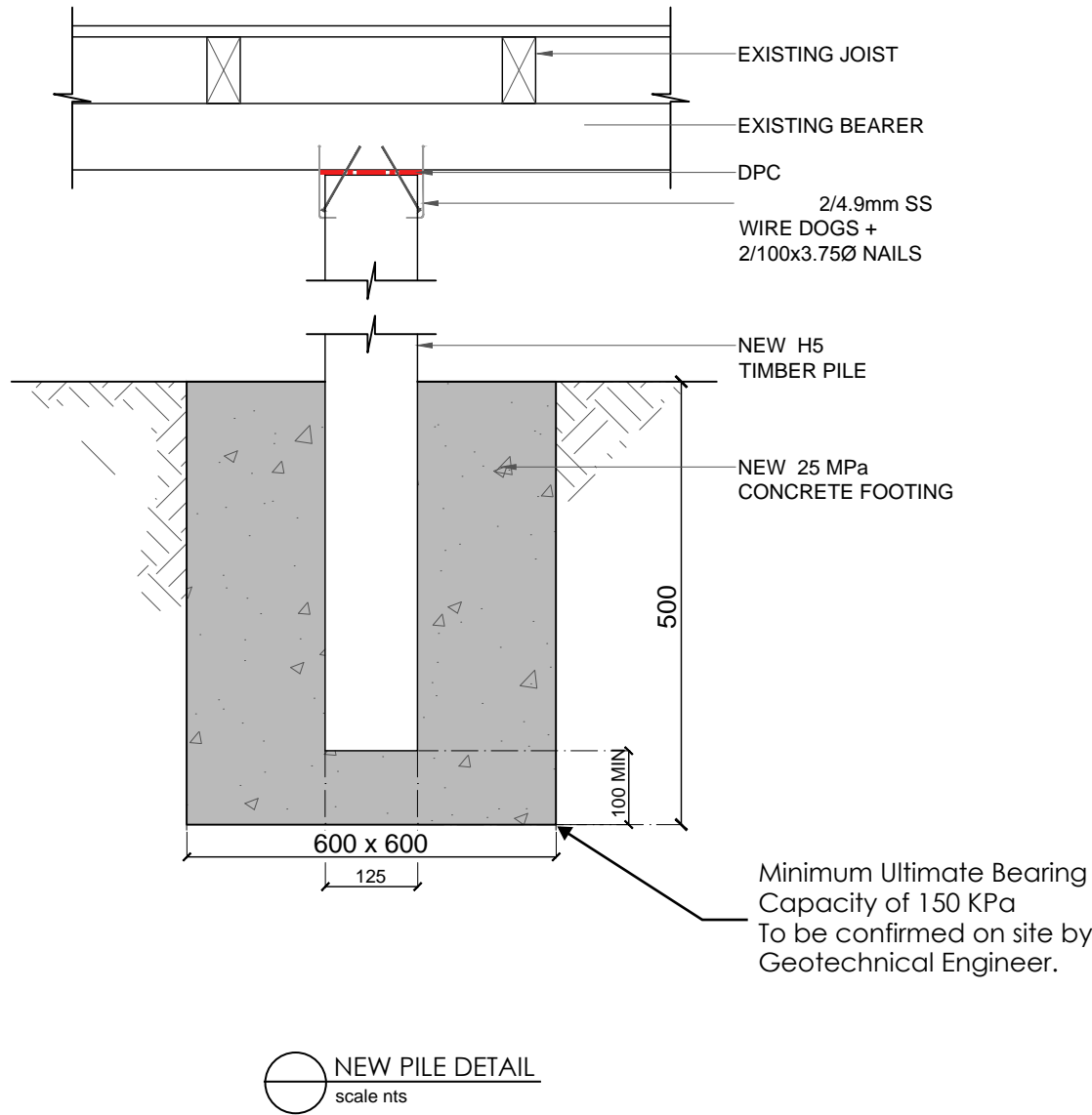
CONC PILE PACKING DETAIL



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NOTES

1. ALL CONSTRUCTION AND FIXINGS IN ACCORDANCE WITH THE BUILDING CODE & NZS 3604:2011.
2. ALL STEEL FIXINGS TO AS REQUIRED BY NZS 3604:2011
3. ALL NEW TIMBER SHALL BE RADIATA PINE SG8 GRADE.
4. FOR TIMBER PILES OF HEIGHTS BETWEEN 150mm AND 300mm ABOVE FINISHED GROUND LEVEL A DAMP PROOF COURSE OR OTHER IMPERVIOUS MATERIAL SHALL BE PLACED BETWEEN THE PILE AND THE FRAMING TIMBERS OR PACKER
5. ALL DIMENSIONS SHOWN ARE MINIMUM UNLESS NOTED OTHERWISE
6. TO BE READ IN CONJUNCTION SPECIFICATION.
7. FOR USE IN TC1 & TC2 ZONES FOR SINGLE STOREY BUILDINGS



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NEW PILE
DETAIL

A07

March 2023



K230406-1

29 June 2023

**Geotechnical Engineering Investigation
Dwelling Foundation Assessment
19 Belfield Street
Dallington
Christchurch**

Prepared For:

Viden Consulting Engineers Ltd
PO Box 41137
Ferrymead
Christchurch 8247

KGA Geotechnical Group Limited
Supporting the Construction Industry since 1990

7A William Pickering Drive | Albany | Auckland
P O Box 302 361 | North Harbour | Auckland 0751
09 478 6655

Unit 3, 201 Opawa Road | Hillsborough | Christchurch
P O Box 7630 | Sydenham | Christchurch 8240
www.kga.co.nz 03 343 5302

REPORT ISSUE AUTHORISATION

Geotechnical Engineering Investigation
Dwelling Foundation Assessment
19 Belfield Street
Dallington
Christchurch

Prepared by:


K230406-1

Elizabeth Creek

MSc (Geological Engineering), MEngNZ
Geotechnical Engineer

Reviewed by:


K230406-1

Jonathan Shelley

MEng (Civil Hons), MEngNZ
Geotechnical Engineer

Authorised by:


K230406-1

Abilio Nogueira

BE (Eng. Geol.), CMEngNZ, CPEng
Director

EXECUTIVE SUMMARY

Geotechnical Engineering Investigation

Dwelling Foundation Assessment

19 Belfield Street

Dallington, Christchurch

SUB-SOIL CONDITIONS	Lithology	The sub-surface conditions comprise fill material up to 0.5m depth over silts and sands to 1.5m. Low to moderately plastic silts are present to 2.5m with sands to 3.5m, and sandy gravels to 6.5m. Below this are sandy soils to at least 20m depth.	
	Soil Classification as per NZS 1170.5:2004	Class 'D' (Deep or soft soil sites)	
	Groundwater Depth	Encountered at an average depth of approximately 2.0m	
	Bearing Capacity	A geotechnical ultimate bearing capacity (GUBC) of 150kPa was found below 0.5m depth	
SEISMIC ASSESSMENT	Vertical Displacement under Earthquake Ground Motions (Index Value)	SLS	ULS
		Up to 10	Up to 30
	Liquefaction Potential Index (LPI) Value	SLS	ULS
		< 1	Up to 5
	Liquefaction Severity Number (LSN) Index Value	SLS	ULS
		Up to 3	1 to 9
	Horizontal Movement	Lateral Spreading	Lateral Stretch
		Minor	Minor
FOUNDATION RECOMMENDATIONS	Seismic Technical Categorisation	MBIE	TC2
		Site Specific	TC2
	<p>KGA must be provided with any repair/rebuild methodologies prior to implementation, in order to confirm the suitability of our proposed strategies.</p> <p>Foundation Repair:</p> <ul style="list-style-type: none"> Mechanical rellevelling using underpins seated at 0.5m depth into natural soils with a GUBC of 150kPa. Piles may be re-levelled using jacking and packing methodology as per MBIE Guidance Appendix A.1.1.2, Option 1: Jacking and packing methodology. Localised piles may be replaced to structural engineer design if they exhibit evidence of excessive tilting or settlement; new piles to be seated below any topsoil or fill and designed for an ultimate unfactored soil bearing capacity of 150kPa. Consideration should be given to replacing heavy roofing and concrete patios with lightweight alternatives. <p>Foundation Rebuild:</p> <ul style="list-style-type: none"> TC2 - Option Type A or B Timber Floor, designed for a GUBC of 150kPa. Foundation excavation to extend below existing topsoil and fill material (encountered to 0.5m depth during our onsite investigation). Same foundation type to be used across the entire structure, and consideration should be given to replacing heavy roofing and concrete patios with lightweight alternatives. 		
REPORT DISTRIBUTION	A full copy of this report must be provided to all relevant parties involved in the project. This should include, but not be limited to, owner, architectural designers, engineers (civil and structural) and the earthworks/building contractor.		

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Attachments:

Site Plan
Hand Auger and Scala Penetrometer Logs
Hand Trial Pit Logs
CPT Log

Appendix A:	Third Party Documents
Appendix B:	Background Information Documents
Appendix C:	Site Photographs
Appendix D:	Event-Specific Liquefaction Analyses
Appendix E:	SLS & ULS Liquefaction Analyses

1. INTRODUCTION

At the instruction of Viden Consulting Engineers Ltd (Viden), we have undertaken a geotechnical engineering investigation on the property comprising 19 Belfield Street in Dallington, Christchurch. The work was carried out in accordance with our Agreement dated 2 June 2023.

As part of our investigation, we have undertaken a detailed site and environs walkover inspection, and referenced available information from the New Zealand Geotechnical Database (NZGD), Environment Canterbury (ECan) and Christchurch City Council (CCC) websites. We also conducted a subsurface investigation comprising hand auger boreholes, with associated Scala penetrometer tests, hand trial pits and cone penetrometer testing in order to assess ground conditions and likely behaviour of the ground, as well as to provide guidance on foundation repair and/or replacement strategies for the existing dwelling on the site.

The investigation was carried out with reference to the Ministry of Business, Innovation & Employment (MBIE) Guidance - Version 3, dated December 2012 - "Repairing and rebuilding houses affected by the Canterbury earthquakes" and subsequent updates, as well as the relevant New Zealand Geotechnical Society (NZGS) and MBIE Modules; "Earthquake Geotechnical Engineering Practice".

This report presents our findings and conclusions. It has been prepared in the context of providing geotechnical information for use in assessing options for the proposed foundation remedial works, and for use in structural design as part of a Building Consent application.

2. SITE DESCRIPTION

The property is legally described as Lot 9, DP 16872 and has an area of 627m². The property is rectangular in shape and is located on the western side of Belfield Street. It is otherwise bounded by residential properties, as shown on our site plan, attached to this report. The site is located approximately 200m northeast of the Avon River. The site and nearby surroundings are near level.

3. EXISTING STRUCTURES AND PROPOSED DEVELOPMENT

3.1 Existing Structures

The property is currently occupied by a single storey dwelling, a standalone garage and a sleepout. The dwelling comprises lightweight cladding and heavy roofing, with timber floors supported by internal shallow piles. The main dwelling foundations comprise a combination of external piles with a perimeter facade (Foundation Type A1 as per the MBIE Guidance) and concrete strip footings; the southwestern extension has concrete perimeter foundations supporting heavy cladding (Foundation Type B2). A concrete patio is located at the northwestern corner of the structure. The foundation type of the enclosed sunroom at the centre of the western elevation is unknown.

We understand our report is limited to the dwelling, and that the garage and sleepout structures (located northwest and southwest of the dwelling, respectively) are beyond our scope.

A concrete driveway extends along the northern site boundary to the garage, and concrete pathways are present along the western and southern elevations of the dwelling. Timber decking is present at the southern portion of the eastern elevation (south of the dwelling entry), and the remainder of the site comprises lawn and garden areas, with mature trees east and west of the dwelling.

A review of the historical aerial photographs, as obtained from the ECan database, indicates that the dwelling was constructed in the 1950s, and the garage was constructed in the early 1970s. The dwelling appears to have been extended at the southwestern corner in the early 1980s, with the sunroom constructed at the centre of the western elevation in the (the photographs from this time period are unclear), and the sleepout constructed in the late 2010s.

3.2 Proposed Works

We understand that the dwelling shows indications of damage despite previous earthquake repair works having been completed following the events of the 2010 and 2011 Canterbury Earthquake Sequence (CES). The existing structural damage is detailed in the assessment report by Viden, described in further detail in Section 4. It is our understanding that the most appropriate foundation repair or replacement strategies will be determined based on the conclusions of this geotechnical report.

4. BACKGROUND INFORMATION

4.1 Sources Consulted

The following third party information sources were consulted and referred to in this report:

- EQC/EQR Documentation
- Cavity Critter Underfloor Inspection Report
- Viden Draft Structural Engineers Report
- New Zealand Geotechnical Database (NZGD)
- Environment Canterbury (ECan)
- Christchurch City Council (CCC)

A summary of our understanding of the third party information is presented below. We note that the below summary of information is limited to that considered relevant to the geotechnical assessment of the property, and is intended to present facts and opinions as contained in third party sources and does not constitute interpretation or endorsement by KGA. Our references to the bedrooms in the house are based on the floor plan contained in the Viden report, included in Appendix A.

4.2 EQC / Fletcher EQR Documentation

EQC / Fletcher EQR issued various documents detailing the recorded earthquake damage and planned remediation work following the major events of the CES. We have provided an overview of relevant information from the following documents.

EQC Full Assessment Report & Scope of Works (CLM/2011/116146) – 13 September 2011

- Cracking of cladding plaster on all elevations.
- Recommended replacement of 10 piles.
- Recommended replacement of 19 linear meters (1m) of the perimeter foundation.
- Grind out and epoxy fill perimeter beam cracking.
- Cosmetic damage identified within interior linings.
- Realignment recommended for rear external door, and easement recommended for internal kitchen and lounge doors.

EQC Opting Out of EQR Letter (CLM/2010/109241 and CLM/2011/116146) – 2 July 2012

This letter indicates that EQC has provided a repair strategy for identified earthquake damage, and that the Claimant (homeowner) is responsible for arrange those repairs without recourse to EQR.

DC Building Contract Quotations – June 2012 to April 2013

The initial quotation (15 June 2012) indicates that the amount of piles to be replaced has been reduced from ten to six. A subsequent quotation dated 14 January 2013 states that the external work was removed “as requested”; however, a final quotation from 15 April 2013 includes for the external items from the EQC Scope of Works.

House Levellers Si Ltd Letter – 9 April 2013

- 40mm of settlement was recorded along the perimeter foundation piles of the southwestern elevation; these were scheduled to be replaced with new H5 timber piles on concrete pads.
- Up to 30 piles are indicated to require replacement (in the opinion of House Levels Si Ltd).
- The perimeter foundation along the southwestern extension required lifting and underpinning.
- Internal non-load bearing piles were scheduled to be packed.
- Concrete patios were to be removed to allow for access.

Tax Invoice from Edifice Ltd (Ref. W03071) – 18 March 2014

The Edifice Tax Invoice included for cladding repairs, jacking and packing six subfloor piles, and epoxy crack filling along the perimeter foundation and concrete patio.

Wrightway Floor Level Survey Plan – 1 November 2022

- Maximum floor level variation of 42mm, with gradients in excess of MBIE Guidelines.
- High areas are shown near the southeastern corner of the dwelling, with low points along the western elevation.
- Apparent hogging in Lounge, Bedroom 1 and Bedroom 2.

4.3 Cavity Critter Underfloor Inspection Report – 6 February 2023:

- The ground is obscured by polythene damp proof membrane (DPM), and the majority of the subfloor timber is obscured by insulation material.
- Subfloor piles comprise precast concrete. It is unknown if the piles are concreted into the ground due to the presence of the DPM.
- A pile near the centre of the structure (photograph 29) appears to be wicking moisture from the ground up to the timber bearer, suggestive of wet ground conditions below the DPM.

- Signs of historical (possibly repaired) above floor water leaking are present near the centres of the southern and eastern elevations (photographs 40 and 61, respectively). These areas correlate with the Kitchen and Bath, as per the Viden plan. Yellow mould is also shown at the base of the pile near photograph 61, which also indicates wet ground conditions below the DPM.
- A notched and cracked bearer (unreinforced) is present near the centre of the structure (photograph 48); the pile below is also shown to be cracked. An additional notched bearer is shown on photograph 36.
- A second cracked pile is located near the northeastern corner (photograph 54).
- Cracking is present within the perimeter footing near the southwestern corner (photograph 67).

4.4 Viden Structural Engineers Draft Report (226-161) – 3 May 2023

Viden undertook an earthquake assessment of the dwelling, comprising a review of the EQC and third party documentation (detailed in the previous subsections of this report), site visit and floor level survey, discussion of observed damage and recommended repair strategies.

Viden's site visit and floor level survey indicate the following (for reference, the floor level survey is included within Appendix A of this report):

- Floor dislevelment of 42mm, with the high point near the northeastern corner of the structure (Bedroom 1), and low points at the western elevation (Lounge and Sunroom), as well as the southeastern corner of the dwelling.
- Floor slopes are considered to generally align with windowsills, door heads, lintels and benches.
- Some inbuilt inconsistencies are present between floor levels and adjacent elements, including the lounge sliding door, as well as elements on the interior and exterior frame indicating adjustments at the time of construction.
- Hogging style settlements are apparent within the Lounge, Sunroom and Bedroom 2.
- Homeowner indicated localised relevening was attempted following the CES within the Dining room when floor tiles were installed within the Kitchen. Windows within the Kitchen were also renovated after the CES.

Viden conclude that the dwelling has likely settled down to the western elevation as a result of the CES, and recommend that a geotechnical investigation is conducted in order to confirm the settlement mechanism onsite. Viden consider that levelling can be achieved by mechanical jacking the perimeter foundation and jacking and packing the internal piles.

4.5 New Zealand Geotechnical Database (NZGD) & Environment Canterbury (ECan)

The NZGD and ECan websites were searched for geotechnical information in the form of relevant well/borehole logs and Cone Penetrometer Test (CPT) data. Two relevant CPTs were found in the vicinity of the property; the locations are indicated on our site plan, and the test logs are reproduced in Appendix B. The data is described further in Section 7.1 of this report.

The ECan website indicates that the site is overlaying a “Coastal Confined Gravel Aquifer System”. According to GNS Science, the median depth to the water table ranges from 2m to 3m below ground level (bgl).

A summary of aerial photography and field observations, as well as the Peak Ground Acceleration (PGA) experienced on the site during the major earthquake events of the Canterbury Earthquake Sequence (CES) is given in Table 1. We have also scaled the PGA to a magnitude 7.5 event to be able to compare the recorded PGA to the ULS and SLS values recommended in the MBIE Guidance ($PGA_{7.5}(ULS)=0.35g$, $PGA_{7.5}(SLS)=0.13g$).

For the magnitude scaling factor assessment, it is important to note that the 13 June and 23 December 2011 aftershocks each comprised two separate earthquakes. In both cases, the second of the two earthquakes was the more damaging, but the first earthquake is inferred to have caused elevated pore water pressure and increased the susceptibility for liquefaction to occur. To take the two earthquakes into consideration for modelling purposes, the Tonkin & Taylor Liquefaction Vulnerability Study considers the second earthquake with an increased magnitude to include the effects of the first one. The design earthquake magnitude for each event is presented in Table 1, and a copy of the Property Summary Report is included in Appendix B.

Table 1: Summary Desk Study Information

	September 2010 (M 7.1)	February 2011 (M 6.2)	June 2011 (M 6.0)	December 2011 (M 5.9)
Aerial Photography Liquefaction Interpretation (KGA)	No observed liquefaction ejecta	Minor to moderate observed liquefaction ejecta onsite; moderate to severe liquefaction ejecta observed nearby and within roadway	No observed liquefaction ejecta	No observed liquefaction ejecta
Aerial Photography Liquefaction Interpretation (EQC)	No observed liquefaction ejecta	Moderate to severe observed liquefaction ejecta	Moderate to severe observed liquefaction ejecta	No observed liquefaction ejecta
Ground Observations (EQC)	No observed ground cracking or ejected liquefied material	No lateral spreading but minor to moderate quantities of ejected material (property only)	No lateral spreading but minor to moderate quantities of ejected material (roadway only)	<i>Not mapped</i>
Mapped Ground Cracks	No cracks mapped onsite or nearby			
Lidar Cumulative Vertical Displacement¹	230mm subsidence			
Horizontal Ground Movement²	220mm (±400mm) southeast			
Groundwater Depth (m)³	2.6	2.4	2.4	2.3
PGA (g)	0.19	0.41	0.25	0.27
Scaled PGA_{7.5} (g)⁴	0.17	0.29	0.17	0.18

¹ To February 2012, tectonic vertical changes excluded, may be subject to Lidar accuracy limit

² Horizontal Ground Movement – “Local” (Observed – Tectonic)

³ Interpreted from the “Property Summary Report”

⁴ Scaled to M7.5 using Idriss and Boulanger recommendations (2008)

4.6 Christchurch City Council (CCC) – Flooding Risk

According to email communication with the CCC (included within Appendix B), the property is within a CCC District Plan Flood Management Area, with a Finished Floor Level (FFL) requirement of 12.30m RL, and a recommended FFL of 12.56m RL. According to CCC LiDAR data, ground level onsite ranges from 11.76m RL to 12.25m RL. The CCC should be contacted directly to comment on the floor level requirement, as a full flood risk assessment is outside the scope of this report.

4.7 Environment Canterbury (ECan) – Listed Land Use Register

ECan has identified sites where hazardous activities and industries have been located throughout Canterbury, and maintains the Listed Land Use Register (LLUR) database which alerts about potential contamination before site works commence. After consultation of the database regarding these sites, the following information was obtained: “The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on your selected land parcel”. The relevant extracts from the LLUR are presented in Appendix B.

Due to the limited extent of our investigation, we cannot guarantee that contamination is not present.

5. SITE OBSERVATIONS

The following observations were noted during our site walkover on 14 June 2023 (relevant site photographs are included within Appendix C):

- Presence of decking, pathways and concrete driveway adjacent to dwelling foundation limits possible trial pit locations.
- Minor cracking noted to plaster cladding.
- Minor cracking noted within render of perimeter façade, particularly near services / openings / vents.
- Dwelling appears to be well maintained.
- Cracking of concrete walkways and driveway.

6. GEOLOGY

The published Geology of the Christchurch urban area (1992) shows the site is underlain by the Yaldhurst Member of the Springston Formation. The Springston Formation was deposited during the Holocene epoch ($\leq 10,000$ years old), and has accumulated the inland margin of the Christchurch Formation. The Springston Formation contains postglacial fluvial channel and overbank sediments resulting in the deposition of well-sorted gravels, sands and silts sourced from the Southern Alps. Due to the movement of the Waimakariri River channels, the deposits appear as fan shaped wedges or localised lenses, creating extensive layers with varying thicknesses.

The Yaldhurst Member is the most recent deposit of the Springston Formation and was deposited just above the present Waimakariri River flood level during the last 3000 years. It contains three distinct lithological units; alluvial sand and silt overbank deposits; historic river flood channels containing silts, sands and alluvial gravel; and peat deposits.

7. GROUND INVESTIGATION

7.1 Existing Ground Information

A search of the ECan and NZGD websites identified two CPTs within the vicinity of the site. We considered these tests relevant, and the CPT data was used in our liquefaction analyses. The investigation logs are indicated on the attached site plan and reproduced in Appendix B; the data points are listed in Table 2.

Table 2: NZGD Data

NZGD Test Reference	Source	Source Reference	Probe Depth (m)	Approx. Distance From Site (m)
CPT_189374	Geotechnics	CPT02	20.5	25 (southeast)
CPT_19781	McMillan Drilling for T&T	DAL-TC2-CPT010	10.0	30 (northwest)

7.2 Current Ground Investigation

In order to supplement the existing nearby ground information, a project specific deep and shallow ground investigation for subsoil identification and bearing capacity purposes was undertaken. The subsurface conditions on site were explored by drilling four hand auger boreholes (HA01 to HA04), performing four Scala penetrometer tests (SP01 to SP04) within the borehole locations, and completing one CPT (CPT-01). To investigate the perimeter foundation embedment and founding soils, two hand dug trial pits (HTP01 to HTP02) were excavated alongside the perimeter foundation wall in conjunction with Scala penetrometer tests (SP05 to SP06).

The shallow ground investigation services were provided by Landform Projects Ltd on behalf of KGA on 14 June 2023, with the CPT undertaken by Ground Investigation Ltd on the same date. An overview of the ground investigations is presented in Table 3 and a description of the testing is given in the following sections.

Table 3: Schedule of Exploratory Ground Investigation

Test Type	Test Ref.	Depth (m)	Reason for Termination	Date of Test
Hand Auger	HA01	3.0	Target depth	14 June 2023
	HA02	3.0	Target depth	
	HA03	2.8	Collapsing sand	
	HA04	3.0	Target depth	
Scala Penetrometer (Hand Auger Locations)	SP01	3.0	Target depth	14 June 2023
	SP02			
	SP03			
	SP04			
Hand Dug Trial Pits	HTP01	0.6	Base of foundation located	14 June 2023
	HTP02	0.3		
Scala Penetrometer (Trial Pit Locations)	SP05	1.1	Target depth	14 June 2023
	SP06			
CPT	CPT-01	10.3	Target depth	14 June 2023

The exploratory test locations were selected to provide representative indications of the subsurface ground conditions within the area being assessed. The test locations are shown on our site plan.

7.3 Scala Penetrometer Tests and Hand Auger Boreholes

The Scala penetrometer probe consists of a hand operated dynamic cone penetrometer and is used to evaluate the penetration resistance of a soil. A 9kg hammer weight is dropped over a distance of 510mm driving a 20mm diameter cone into the ground. The number of hammer blows is recorded for each 50mm of penetration. Testing is in accordance with Test 6.5.2:1988 of NZS 4402.

Hand auger boreholes were drilled in conjunction with the Scala penetrometer testing using a 50mm diameter hand auger and a soil description log in accordance with the NZGS Guidelines “Field description of soil and rock” is presented for each borehole. Scala Penetrometer testing was carried out at nominal 1.0m depth intervals with hand auger boreholes drilled over the Scala test points to the same depth to reduce the friction on the rod for subsequent testing.

The hand auger boreholes and Scala penetrometer tests were intended to be taken to 3.0m depth or to a depth where effective refusal was reached, whichever was shallower.

7.4 Hand Dug Trial Pits

The hand dug trial pits were excavated using a shovel at selected points around the perimeter foundation beam. The hand excavations were advanced carefully adjacent to the foundations to prevent any damage, and were extended to at least the underside of the footing. A steel rod was then pushed underneath the footing to confirm that the concrete does not extend deeper in the centre of the foundation than at the exterior.

Scala penetrometer testing was carried out from ground level at the test pit locations, to a depth of 1.0m or refusal, in order to gain an indication of the soil density immediately below the perimeter foundations.

7.5 Cone Penetrometer Testing

The CPT testing was undertaken by Ground Investigation Ltd with a 1.1 tonne Pagani TG63-150, using a cone of 10cm² cross-sectional area, and a 150cm² friction sleeve area. Continuous measurement of pore water pressure was undertaken during testing (u₂). The tests were undertaken in accordance with A.S.T.M. Standard D 5778-12 procedure. The test target depth was to a minimum depth of 10m or refusal, whichever came first.

7.6 Subsurface Conditions

The subsurface ground conditions encountered are briefly described and summarised in Table 4. For more detailed descriptions, reference should be made to the attached investigation logs. In order to prepare a subsurface model of the site, the subsurface conditions encountered have been inferred between our boreholes. It must be accepted that the conditions are likely to vary between each borehole location, particularly when the distance between test locations is large.

Table 4: Subsurface Conditions

	Geotechnical Unit	Depth to Base (m)	Description	Scala Pen. Reading (blows per 100mm)	CPT q_t Value (MPa)
1	TOPSOIL / FILL	0.3 – 0.5	Organic silt with sand and gravel	1 – 5	--
2	Silty SAND / Sandy SILT	1.3 – 1.5	Silty sand / sandy silt, very loose to medium dense	1 – 4	0.6 – 1.2
3	SILT	2.4 – 2.8	Stiff to hard silt, low to moderate plasticity	2 – 10	1 – 3
4	SAND & Sandy SILT	3.5 *	Medium dense to very dense sand and sandy silt	8 – 24	3 – 7
5	* SAND & GRAVEL	6.3	Medium dense to very dense sand and gravel	--	15 – 50+
6	* SAND	10.3+	Medium dense to dense sand	--	12 – 20

* Unit and/or depth interpreted from onsite CPT with no physical data below hand auger termination depth

7.7 Groundwater

Groundwater was encountered between 2.0m to 2.1m depth during our site testing. This is slightly shallower, though generally consistent with GNS water levels inferred in Section 4.5, as well as water level values from the NZGD Property Summary Report, provided in Table 1. Groundwater levels can and will vary with changes in weather patterns, particularly following periods of prolonged wet or dry weather; we note that our investigation was conducted during the winter months when groundwater is generally higher.

7.8 Foundation Depths

Based on observations made within the hand dug trial pits, the perimeter foundation footing elements of the main structure are founded at a depth of approximately 0.45m at HTP01 near the southeastern corner of the dwelling, atop the sandy silt/silty sand of Geotechnical Unit 2. Our test at HTP02 near the northeastern corner of the structure did not encounter the foundation footing of the structure; the test indicates that the perimeter façade appears to be seated at ground level atop topsoil material. The founding depths of the perimeter beam of the southwestern extension, concrete patio/sunroom foundations, and internal/external piles are not known.

8. HISTORIC SITE PERFORMANCE & SETTLEMENT MECHANISMS

8.1 Measured Floor Level Variation

According to the Viden and Wrightway floor level surveys, the dwelling tilts down from the northeastern corner to the western elevation; both surveys measured a maximum vertical variation of 42mm. Measurements from windowsills, door heads, lintels and benches generally correlate well with nearby floor slopes. Hogging style settlements were recorded within the Lounge, Sunroom and Bedroom 2.

We understand that a degree of relevening repairs have been completed, and therefore consider that the measured levels are unlikely to be a perfectly accurate representation of structural settlement following the CES.

8.2 Long-Term Historic / Static Settlements

We note that the western portion of the structure comprises a variety of extensions and additions as well as a heavy concrete patio, and these features comprise several different types of foundations. It is likely that a degree of floor dislevelment may be associated with their construction. Furthermore, it is possible that these features are seated within non-engineered fill material (encountered to a depth of 0.5m during site testing); these soils presents a risk of long term static settlement under structural loads, particular if saturated (as indicated by potentially damp conditions indicated from the Cavity Critter photographs). Due to the presence of concrete driveways and pathways adjacent to the structure in these locations, our testing was unable to be undertaken in order to determine the seating depth of these foundations.

We note that hogging style settlements within several rooms at the western portion of the dwelling may indicate static settlement within shallow founding soils. However, the natural silty and sandy soils present below the fill depths are not considered to present a risk of long term static settlement behaviours under structural loads, based on the strength and consistency of these materials. We therefore consider that portions of the structure may be seated within the unsuitable fill materials, though this was not possible to confirm at the time of our site testing.

8.3 Liquefaction Induced Settlements (CES)

The onsite CPT data was assessed against the major earthquakes of the CES, using the magnitude, PGA and water table information presented in Table 1, with the calculated settlement results presented in Table 5 and the analyses outputs provided within Appendix D.

The seismic design requirements adopted for use in the analyses are defined in Part C of the MBIE Guidelines “Repairing and rebuilding houses affected by the Canterbury earthquakes” with the recent update regarding Boulanger & Idriss (2014) liquefaction analysis methodology. These are:

- Boulanger and Idriss (2014) methodology for liquefaction triggering.
- Zhang et al. (2002) volumetric densification calculation.

Table 5: Liquefaction Settlements Back-Analysis for CES

Test	Calculation Limit Depth (m)	Calculated Vertical Settlement (mm)			
		Sept 2010	Feb 2011	Jun 2011	Dec 2011
CPT-01	10.3 (MBIE 'Index' depth)	5	25	15	15

Our onsite CPT analyses indicate total cumulative settlements of approximately 60mm within the upper 10m of the soil column for the major events of the CES. This does not correlate well with the LiDAR cumulative vertical displacement of 260mm as indicated on the Property Summary Report, though we note that additional settlement may have occurred below 10m depth, and that the accuracy for LiDAR vertical measurements is $\pm 100\text{mm}$.

According to the aerial photographs taken following the February 2011 earthquake event, minor to moderate liquefaction ejecta was present onsite, and moderate to severe ejecta was present within the neighbouring sites and roadway. This indicates that our analyses may underestimate the true liquefaction potential of the site.

According to the analyses, the sandy soils between approximately 2.4m and 3.5m (Geotechnical Unit 4 as per Table 4) are likely to have liquefied under the level of shaking experienced during the February 2011 earthquake. Settlements due to liquefaction at this depth would generally present as tilt-style settlement, which correlates well with the general western tilt noted within the floor level survey and Viden report. However, we consider that localised weaknesses within the silty soils of Geotechnical Units 1 and 2 may have also allowed localised 'venting' of ejecta; this mechanism would account for the observed ejecta onsite and in the surrounding area following the February 2011 event.

Post-earthquake general observations show that the empirical calculation of the settlement is uncertain with perhaps a $\pm 50\%$ margin to the numbers given in Table 5. We therefore recommend that engineering judgment is applied when interpreting the computed settlements.

We point out that the settlements presented in Table 5 describe the settlements of the ground not occupied by a building, but occurring due to dissipation of excess pore water pressure generated during earthquake shaking. Additional settlements may also occur due to yield of the liquefied soils under foundation loading, soil loss of volume (liquefaction ejecta) and lateral spreading, but these components are very difficult to predict. Subsurface conditions may vary across the site, making accurate prediction of future settlements even more difficult.

8.4 Cyclic Softening Induced Settlements (CES)

There is a tendency for very soft to soft or sensitive clays and silts to undergo cyclic softening (loss of shear strength and stiffness) as a result of strong shaking. However, the density of the onsite soil the silty soils indicates that cyclic softening is unlikely to occur within these materials.

8.5 Land and Foundation Performance Conclusions

As noted above, we understand that a degree of repair works have been completed following the CES which may influence the current settlement trend of the dwelling floor. However, we consider that floor dislevelment associated with construction of the western extension/addition elements is likely, particularly as these features comprise different foundation styles than the main/original dwelling. Furthermore, due to the variable foundation styles present across the building footprint and potential for foundation elements to be embedded within topsoil and fill material, it is likely that static behaviour has contributed to the observed settlements at this site. The evidence of hogging within the timber floors suggests relative settlement between the heavier load bearing walls and the light internal floors, which is typically observed in heavyweight dwellings founded on soft, compressible or organic soils and areas subject to shallow liquefaction.

Our liquefaction analyses indicate that liquefaction related settlements are likely to have occurred between roughly 2.5m and 3.5m depth during the February 2011 earthquake event. Our aerial photograph interpretation indicates that the site was subject to minor to moderate amounts of liquefaction ejecta, and that moderate to severe amounts of ejecta were present within the nearby area and roadway. Based on the findings of our liquefaction analyses as well as the 'tilt' style settlement pattern of the dwelling, we consider that the relatively heavier western foundations (including the patio element and possibly the sunroom, should those foundations comprise a heavy concrete pad) may have been more affected by liquefaction related settlements, and have 'dragged' the original portion of the foundation down.

As the current measured floor levels were conducted over ten years after the major events of the CES, the measured settlements likely include construction related variations, historic static settlements, and settlements due to seismic induced liquefaction. We note that it is not possible to accurately quantify the amount of settlement attributable to initial static settlements versus settlements that occurred during seismic shaking or reconsolidation settlements that occurred subsequent to shaking. However, based on the generalised western tilt of the structure and post-earthquake aerial photography evidence of onsite (and nearby) liquefaction ejecta following the February 2011 earthquake, it is our opinion that the dwelling has likely been materially affected as a result liquefaction related settlements during the CES.

9. FUTURE LAND PERFORMANCE & DESIGN CONSIDERATIONS

9.1 Liquefaction Analysis – General

Liquefaction analyses were completed for both SLS and ULS design criteria, using the CPT data referenced in Tables 2 and 3. Calculations were performed over the full investigation depth, approximately equal to the MBIE 'Index' depth of 10.0m, using the input parameters described in Table 6.

Table 6: Input Parameters to NZS1170.5:2004 & NZGS/MBIE Module 1

Input Parameters	Design Event		
	SLS (A)	SLS (B)	ULS
Building Importance Level	IL2		
Soil Class	Class D		
Annual Exceedance Probability	1/25	1/25	1/500
Magnitude	7.5	6.0	7.5
Peak Ground Acceleration	0.13	0.19	0.35

This section presents two parameters commonly used to predict the liquefaction vulnerability; the liquefaction induced settlements, and the characteristics of liquefaction and the resulting ground deformation.

The in situ groundwater level was considered to exist at 2.0m bgl, and the groundwater level during earthquake used for the calculation was conservatively assumed at 1.5m bgl.

9.2 Liquefaction Analysis – Estimated Future Settlements

We have analysed the CPT data using the current software 'CLiq' and a copy of the output from the analyses has been included within Appendix E. The software includes for normalisation of the data for overburden pressure and is considered to provide improved indications of liquefaction potential. We have also adopted the same seismic design requirements from the most recent updates of the MBIE Guidance, as listed in Section 8.3. The results are presented in Table 7.

Table 7: Liquefaction Analysis Results

Test	Calculation Limit Depth (m)	Calculated Vertical Settlement (mm)		
		SLS (A)	SLS (B)	ULS
CPT-01	10.3 (MBIE 'Index' depth)	5	10	30
CPT_189374	10.0 (MBIE 'Index' depth)	< 5	< 5	5
	20.5 (Full depth)	< 5	< 5	10
CPT_19781	10.0 (MBIE 'Index' depth)	< 5	5	50

The above calculated settlements for onsite CPT-01 generally fall within a TC2 categorisation as defined by the MBIE Guidance. As previously discussed in Section 8.3, our liquefaction analysis is considered to potentially under-estimate liquefaction related settlements, and the values in Table 7 may not fully represent the risk of liquefaction across the site.

As described in Section 8.3, the empirical calculation of the settlement is uncertain with perhaps a $\pm 50\%$ margin to the numbers given in Table 7. Subsurface conditions may also vary across the site. Our calculations pertain to the ground not occupied by a building, but occurring due to dissipation of excess pore water pressure generated during earthquake shaking. We therefore recommend that engineering judgment is applied when interpreting the computed settlements.

9.3 Liquefaction Induced Ground Deformation

Guidance on expected levels of liquefaction-induced ground deformation is provided within Section 5.4 of Module 3 of the Earthquake Geotechnical Engineering Practice documents issued by MBIE and NZGS. This provides a summary of expected performance levels for liquefied soil deposits, based on the liquefaction triggering factor, LPI and LSN. The LPI and LSN are indices that quantify liquefaction-induced damage by taking into consideration the severity, thickness and depth of the liquefiable layers within the soil profile. The expected level of ground performance is summarised in Table 5.1 of Module 3, defined as six performance levels as a consequence of liquefaction (L0 – 'Insignificant' to L5 – 'Very severe'). We have analysed the CPT data using CLiq and the calculated LPI and LSN values are presented in Table 8.

It should be noted that LPI and LSN indices are typically applied to area-wide screening, and are considered to have reasonable predictive capacity when applied this way; however, they may misrepresent performance in approximately 20% to 30% of cases. Therefore the expected performance levels provided in Table 8 below are only intended as general guidance, and the uncertainties and/or non-uniformities of ground deformation should be considered in any subsequent design.

Table 8: General Performance Levels

Test	SLS (B)		Effect from Liquefaction	ULS		Effect from Liquefaction
	LPI	LSN		LPI	LSN	
CPT-01	<1	3	Insignificant	5	9	Mild to moderate
CPT_189374	<1	<1	Insignificant	<1	1	Insignificant
CPT_19781	<1	2	Insignificant	7	15	Moderate to high

For onsite CPT-01, the LPI and LSN values in Table 8 indicate a performance level of L0 ('insignificant' effect from excess pore water pressure and liquefaction) for the SLS case and L1 to L2 ('mild' to 'moderate') for the ULS case. The ULS performance levels indicate up to 10% of the deposit may liquefy, with liquefaction occurring in layers of limited thickness, and ground deformation resulting in relatively minor differential settlements. As indicated above, based on the degree of liquefaction ejecta present onsite and nearby following the February 2011 earthquake, we consider that our analyses are likely to underestimate the true liquefaction potential and overall performance of the site and a site performance in line with "high" effects from excess pore water pressure and liquefaction from Table 5.1 of Module 3 may be more representative of expected site performance. Reference should be made to the aforementioned Table and Module for a full description of the expected characteristics and consequences of liquefaction.

9.4 Potential for Lateral Spreading

The inferred lateral movement from LiDAR (NZGD) indicates that the site has experienced 220mm (± 400 mm) of horizontal movement to the southeast during the CES. Ground observations by the EQC for the February and June 2011 earthquakes indicate the site was not subject to lateral spreading. Furthermore, no cracks were mapped in the vicinity of the site. Based on these considerations, we believe site presents potential for minor global lateral movement of the ground across the site.

9.5 Shrink-Swell Characteristics

Based on the near-surface silt and sand based alluvium soils, as noted in our boreholes, and our experience of similar soils elsewhere, the shallow soils are considered to be susceptible to minor swelling and shrinking movements under seasonal variations of water content.

10. SITE DESIGNATION & TECHNICAL CATEGORY

We have assessed the site subsoil class as Class “D” – (Deep or soft soil) for structural design purposes in accordance with Clause 3.1.3 of the New Zealand design standard NZS 1170.5:2004. This assumption is based on the following:

- Our ground investigation did not encounter very soft or very loose soils for a thickness greater than 10.0m below this site. We therefore consider that Class “E” soil conditions are not present.
- Based on our knowledge of the local geology and the GNS geological map data, we infer that dense to very dense sand and gravel type soils extend to depths of greater than 100m below this site.

EQC mapping from the NZGD indicated that moderate to severe liquefaction was observed following the February 2011 event; our own aerial photograph interpretation indicates that onsite ejecta was minor to moderate, whilst moderate to severe quantities of ejecta were observed within the roadway and at nearby properties.

The site experienced M_w 7.5 scaled peak ground accelerations (PGAs) of 0.17g to 0.29g, as per Table 1. Therefore, the site may be classified as ‘sufficiently tested’ for an SLS event according to Section 13.5 of the MBIE Guidance document.

The site is situated in a TC2 area as per the MBIE mapping available on the NZGD. Our liquefaction analysis and lateral spreading assessment in Section 9 suggest that a TC2 classification is applicable to the site in accordance with Table 3.1 of the MBIE Guidance. Based on the above and the observed site performance during the past events of the CES, we believe that a TC2 classification is suitable for the purposes of foundation design.

11. GEOTECHNICAL CONSIDERATIONS FOR FOUNDATION REPAIR/REBUILD

11.1 Geotechnical Considerations

Based on our investigation results and observations, the following information should be considered for any foundation repair / replacement works:

- Topsoil and fill were identified up to 0.5m depth at investigation points.
- A geotechnical ultimate bearing capacity of 150kPa may be considered in the natural soil below the topsoil and fill.
- The local groundwater level was encountered at approximately 2.0m bgl.
- According to our assessment, the property is likely to behave as equivalent to a TC2 site as defined in the MBIE Guidance document for residential sites.

We point out that decision to repair or rebuild is contingent upon a structural engineering assessment. As such, this report offers solutions for either scenario. We note that our assessments and conclusions are based on our interpretations of the data available at the time of writing this report, and are not intended to represent a definitive account of the geotechnical performance of the site. Therefore, the proposed strategies may be subject to revision should additional information become available. KGA must be provided with any repair / rebuild methodologies prior to implementation in order to confirm the suitability of the proposed strategies from a geotechnical perspective.

11.2 Foundation Repair Solution

If a foundation repair is considered suitable for the structure, the structure may be releveled by using a performance-based underpinning methodology, with underpins based into natural soils below 0.5m depth where a geotechnical ultimate bearing capacity (GUBC) of 150kPa may be assumed. From a geotechnical perspective we consider that a repair strategy is suitable for the site on the basis that the existing foundations of the dwelling did not perform poorly. Following repair works, we expect that future seismic behaviour will not be worse than those observed in the past.

The shallow piles may be releveled using jacking and packing methodology as per MBIE Guidance Appendix A.1.1.2, Option 1: Jacking and packing methodology. Localised piles may be replaced to structural engineer design if they exhibit evidence of excessive tilting or settlement, or if excessive packing would be required. New piles should be seated below 0.5m depth and designed for a GUBC of 150kPa.

A mechanical releveling strategy for perimeter footings, strip foundations and any heavily loaded internal elements of the dwelling must be assessed by the structural engineer, and reinforcement works to the perimeter footing may be necessary prior to lifting attempts. Reference should be made to Update 10 of the MBIE Guidance (June 2018). Structural repairs to the perimeter foundation should be in accordance with Part A, Appendix A4 of the MBIE Guidance and in consultation with the structural engineer.

Removing the heavy roofing and replacing it with a light-weight option is not explicitly required at this site; however, we consider that replacing the heavy elements with an equivalent light-weight alternative is likely to result in a foundation with better performance overall (following completion of the releveling works). Likewise, replacing the heavy concrete patio at the southwestern elevation with a timber decking alternative would be beneficial for future structural performance.

11.3 Foundation Rebuild Solution

If the structural engineer considers that a new foundation is necessary for the dwelling, suitable foundation options would be Type A or B of the MBIE Guidance (Section 5.3.2), based into natural soils below 0.5m depth. These options consist of a standard NZS 3604:2011 type foundation with timber piles (Type A) or timber piles and concrete perimeter foundations (Type B). These foundations should be specifically designed for an ultimate unfactored bearing capacity of 150kPa.

All topsoil and fill should be removed from the foundation excavations, and any loose materials within the excavations should be removed or compacted using tamping techniques. The bearing capacity in the exposed excavations must be confirmed onsite prior to foundation construction works.

We recommend that the same foundation type is used across the entire structure, and that the existing concrete patio is replaced with a timber decking alternative. Additionally, consideration should be given to replacing heavy elements (roofing) with equivalent light-weight alternatives.

12. INFRASTRUCTURE DESIGN

12.1 Services

Underground service pipes and connections should be designed in accordance with the relevant recommendations contained in the MBIE Guidance (particularly Section 5.7), CCC Infrastructure Design Standards (IDS), and the CCC Construction Standard Specification (CSS).

12.2 Landscaping

Where trees are proposed for landscaping, these should be planted a minimum distance of the radius of the expected canopy or half the height of the mature tree (whichever is greater) from any proposed foundations. This will prevent any adverse effects on the foundations caused by tree roots.

13. FURTHER WORKS

In order to ensure consistency with the recommendations contained within this report, we recommend that KGA or a Chartered Professional Engineer with experience in the geotechnical field is asked to review the foundation design drawings with respect to geotechnical elements. We also recommend that founding conditions are checked at the time of construction to confirm or otherwise the assumed bearing capacity and advise on any modifications deemed necessary to ensure that all foundations are in competent soils.

Territorial Authorities also often require specific engineering observations and PS4 Producer Statement documentation as part of Building/Resource Consent conditions and subsequent Code Compliance Certification. To this end, we recommend liaising with KGA to undertake the necessary observations required to ensure that the foundation construction is consistent with the assumptions made in this geotechnical report.

14. LIMITATIONS

Our report was prepared in line with the current MBIE Guidance. To satisfy the requirements of the Building Code and the New Zealand Standard “NZS 1170 - Structural Design Actions”, foundations must be designed so that the building must remain functional under SLS level loads; minor damage is acceptable provided the damage is readily repairable, and the building does not collapse under ULS level loads, but could suffer moderate to significant structural damage.

Desk study data was obtained from several investigation and modelling study sources made available to the public and engineering industry post the Canterbury earthquake sequence. Acknowledgment is given regarding the free use of the New Zealand Geotechnical Database, Christchurch City Council and Environment Canterbury websites. The data is used in good faith and no responsibility can be taken for the accuracy or completeness of the data.

This report was prepared in the context defined in Section 1 above and must not be relied upon by any other party other than our Client, for whom it was prepared, and the relevant Territorial Authority. It has been compiled with respect to the brief given to us, and must not be relied upon in any other context, recreated for any other purpose, or used by any person who is not our Client without first obtaining our written permission.

We point out that our conclusions are based on desk study material, a visual surface inspection of the site, third party investigation data from nearby sites and discrete exploratory hole positions. Ground conditions may vary between investigation points. The recommendations given in this report are provided as an overall strategy to minimise risks from geotechnical hazards. It should be noted that they are unlikely to remain effective if they are adopted in a piecemeal manner.

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ATTACHMENTS



- Legend**
- Site Boundary
 - Hand Auger Boreholes and Scala Penetrometer Test Location (Landform Projects on behalf of KGA, 14 June 2023)
 - Hand-dug Trial Pit and Scala Penetrometer Test Location (Landform Projects on behalf of KGA, 14 June 2023)
 - CPT Location (Ground Investigation Ltd on behalf of KGA, 14 June 2023)
 - NZGD CPT Locations

0 5 m 10 m
LINZ CC BY 4.0 © Imagery Basemap contributors



Produced by Datanest.earth

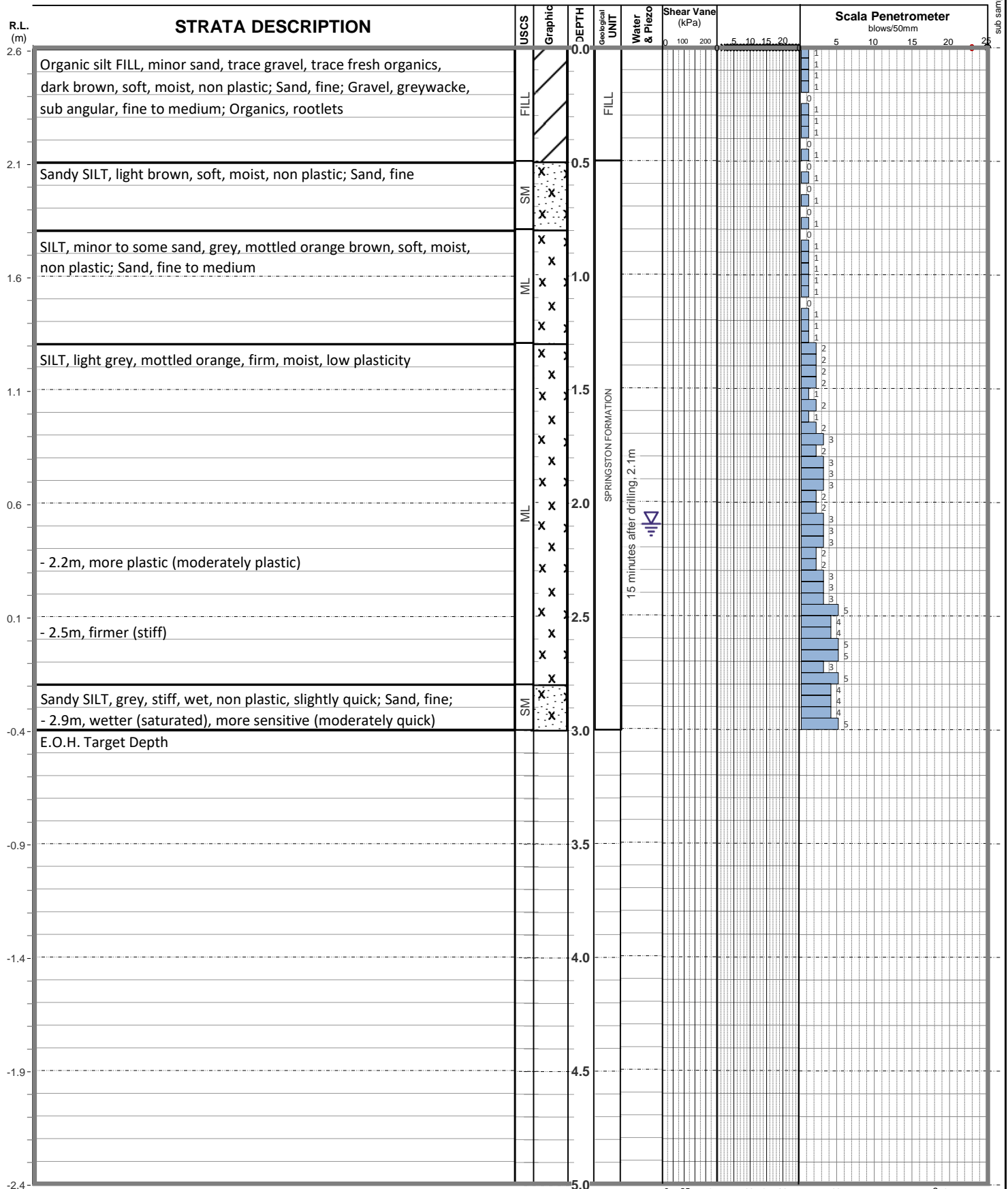
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Client: Viden Consulting Engineers Ltd		Figure No.: 1 Size: A4
Project: 19 Belfield Street	Drawn: EC	
Date: 29-06-2023	Checked: AN	Version: FINAL
Proj No.: K230406	Scale: 1:400	

BOREHOLE LOG

Hole # **HA01/SP01**

Project: 19 Belfield Street
 For: KGA Geotechnical Group Ltd.
 Project #: K230406
 Co-ordinates: 1573384.131, 5182225.720
 Drill method: Hand Auger
 Hole depth: 3.00
 Grid system: NZTM2000 (E, N)
 Contractor: LFP
 Equipment: HA + SP

LFP Ref #: 1794
 Date started: 14/06/2023
 Date finished: 14/06/2023
 R.L.: 2.6 m NZVD(2016)
 Logged by: CLS
 Checked By: RBW



Notes: R.L. sourced from RTK survey

x peak (kPa)
 residual (kPa)
 Size: mm
 #:

Borehole logged in accordance with the "Guidelines for the Classification and Description of Soil and Rock for Engineering Purposes" Dec 2005 NZGS.
 R.L. is inferred and/or interpolated unless otherwise stated.

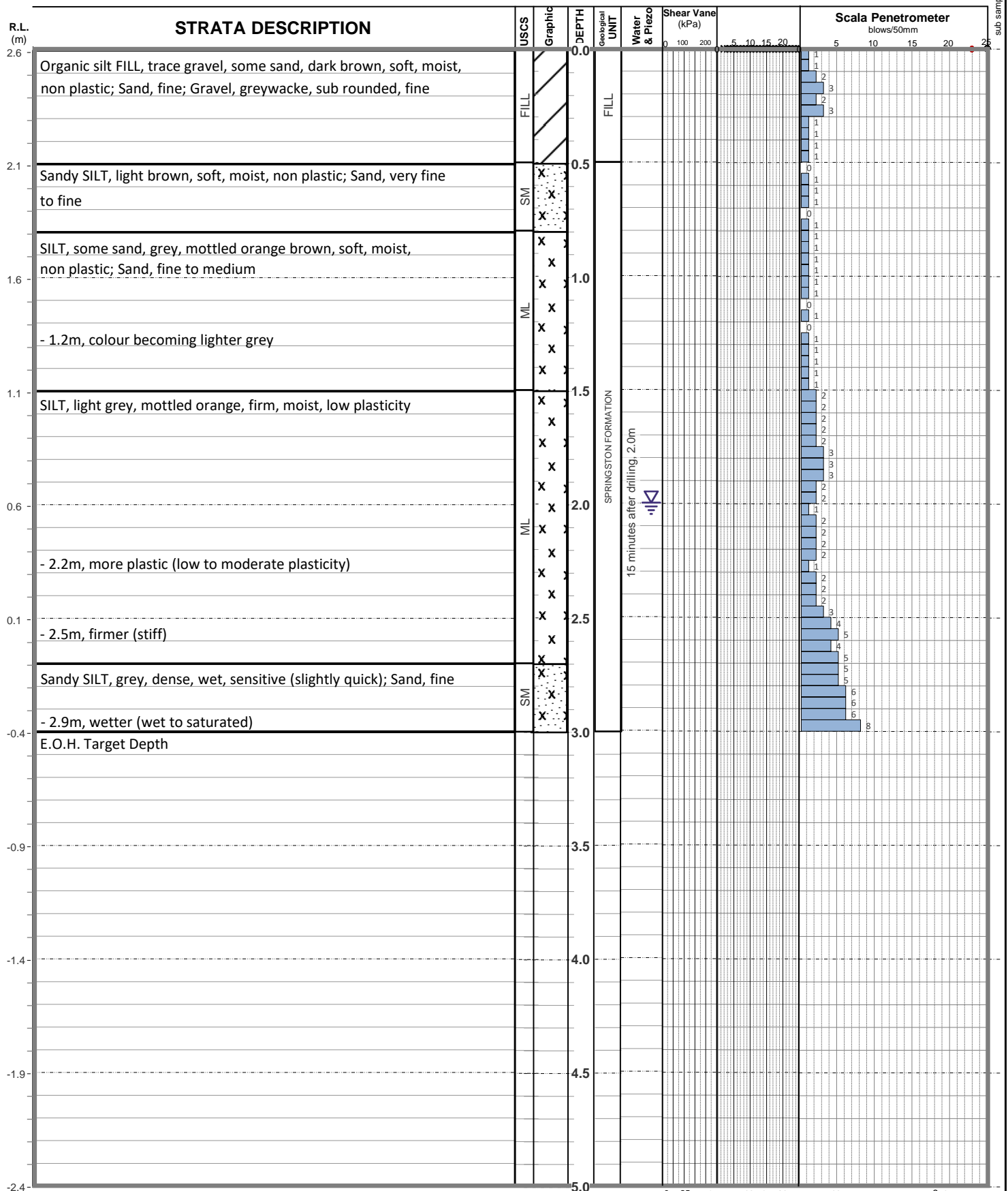
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 Scale Penetrometer Test carried out to NZS 4402: Test 6.5.2 & field measured as mm per blow(s).

BOREHOLE LOG

Hole # **HA02/SP02**

Project: 19 Belfield Street
 For: KGA Geotechnical Group Ltd.
 Project #: K230406
 Co-ordinates: 1573381.063, 5182222.582
 Drill method: Hand Auger
 Hole depth: 3.00
 Grid system: NZTM2000 (E, N)
 Contractor: LFP
 Equipment: HA + SP

LFP Ref #: 1794
 Date started: 14/06/2023
 Date finished: 14/06/2023
 R.L: 2.6 m NZVD(2016)
 Logged by: CLS
 Checked By: RBW



Notes: R.L. sourced from RTK survey

x peak (kPa)
 residual (kPa)
 Size: mm
 #:

Borehole logged in accordance with the "Guidelines for the Classification and Description of Soil and Rock for Engineering Purposes" Dec 2005 NZGS.
 R.L. is inferred and/or interpolated unless otherwise stated.

Shear Vane performed and corrected as per NZGS Guidelines.
 Scala Penetrometer Test carried out to NZS 4402: Test 6.5.2 & field measured as mm per blow(s).

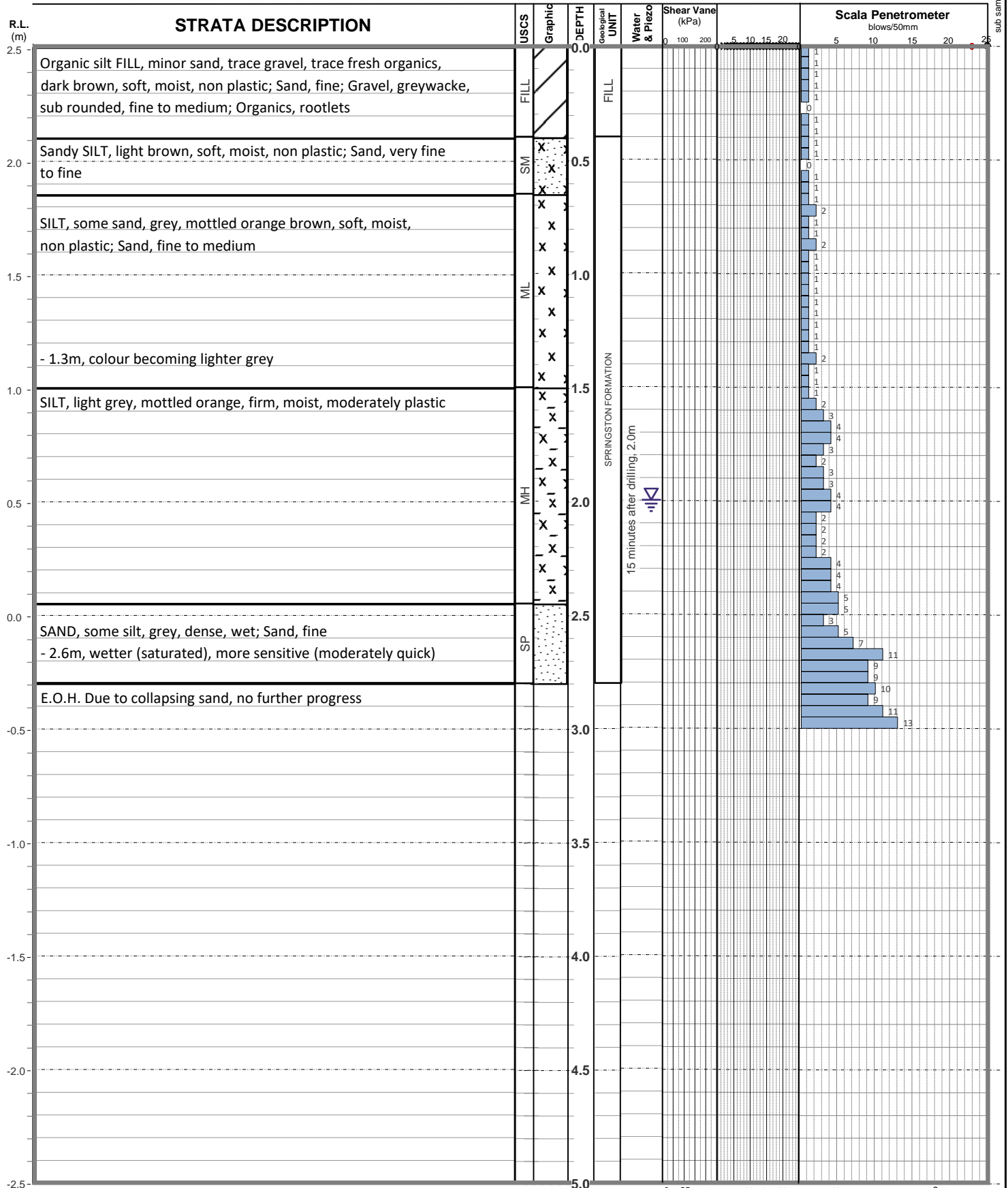
BOREHOLE LOG

Hole # **HA03/SP03**

Project: 19 Belfield Street
 For: KGA Geotechnical Group Ltd.
 Project #: K230406
 Co-ordinates: 1573399.882, 5182227.061
 Drill method: Hand Auger
 Hole depth: 2.80

Grid system: NZTM2000 (E, N)
 Contractor: LFP
 Equipment: HA + SP

LFP Ref #: 1794
 Date started: 14/06/2023
 Date finished: 14/06/2023
 R.L.: 2.5 m NZVD(2016)
 Logged by: SAS
 Checked By: RBW

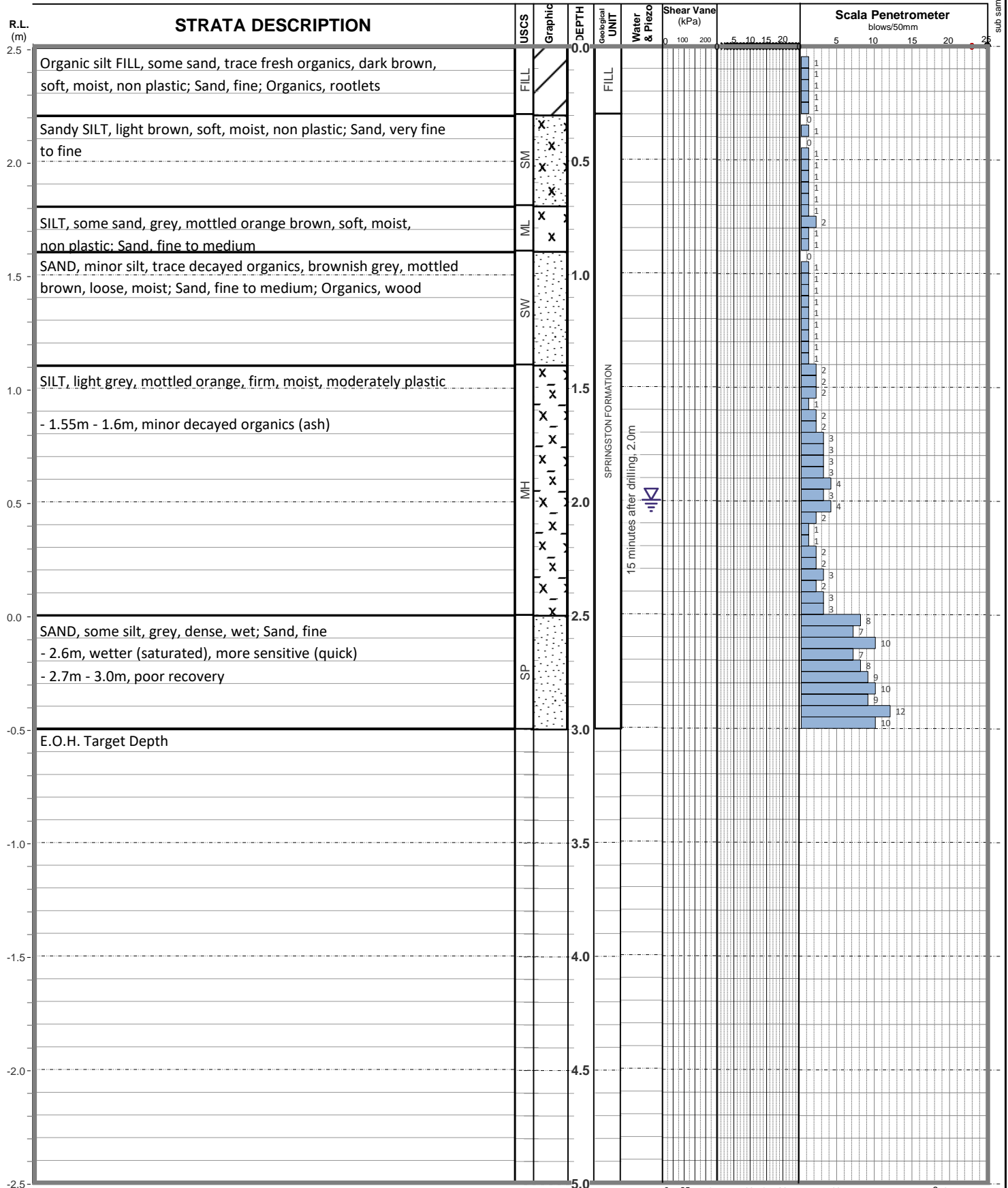


BOREHOLE LOG

Hole # **HA04/SP04**

Project: 19 Belfield Street
 For: KGA Geotechnical Group Ltd.
 Project #: K230406
 Co-ordinates: 1573400.699, 5182221.623
 Drill method: Hand Auger
 Hole depth: 3.00
 Grid system: NZTM2000 (E, N)
 Contractor: LFP
 Equipment: HA + SP

LFP Ref #: 1794
 Date started: 14/06/2023
 Date finished: 14/06/2023
 R.L.: 2.5 m NZVD(2016)
 Logged by: SAS
 Checked By: RBW





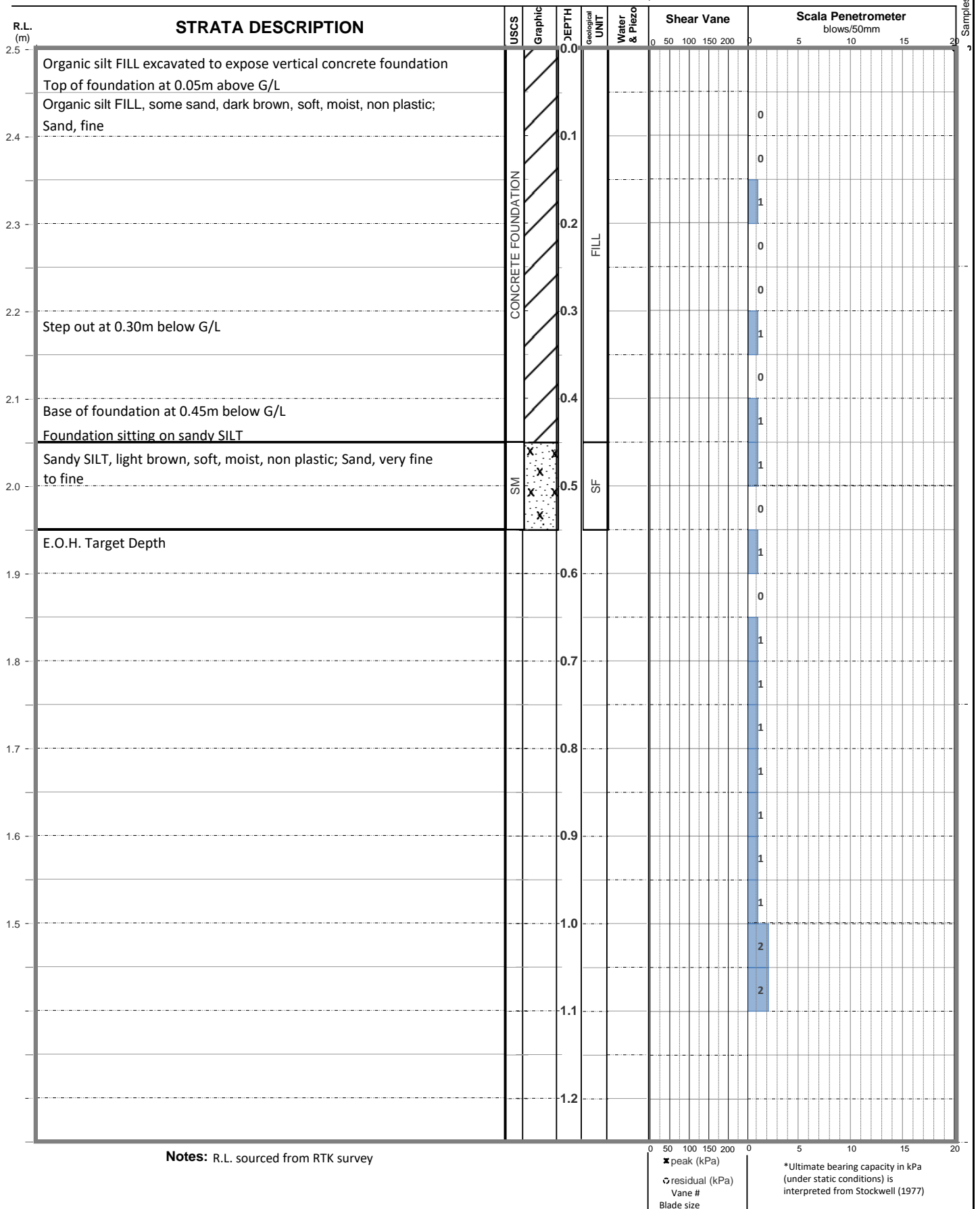
SHALLOW TRIAL PIT LOG

Hole # **HTP01/SP05**

Project: 19 Belfield Street
For: KGA Geotechnical Group Ltd.
Client Ref #: K230406
Co-ordinates: 1573396.477, 5182218.342
Drill method: Hand Dig & Scala
Hole depth: 0.55

Grid system: NZTM2000 (E, N)
Contractor: LFP
Equipment: Spade & Scala

Job #: 1794
Date started: 14/06/2023
Date finished: 14/06/2023
R.L.: 2.5 m NZVD(2016)
Logged by: CLS
Checked By: RBW



Borehole logged in accordance with the "Guidelines for the Classification and Description of Soil and Rock for Engineering Purposes" Dec 2005 NZGS.
R.L. is inferred and/or interpolated unless otherwise stated.

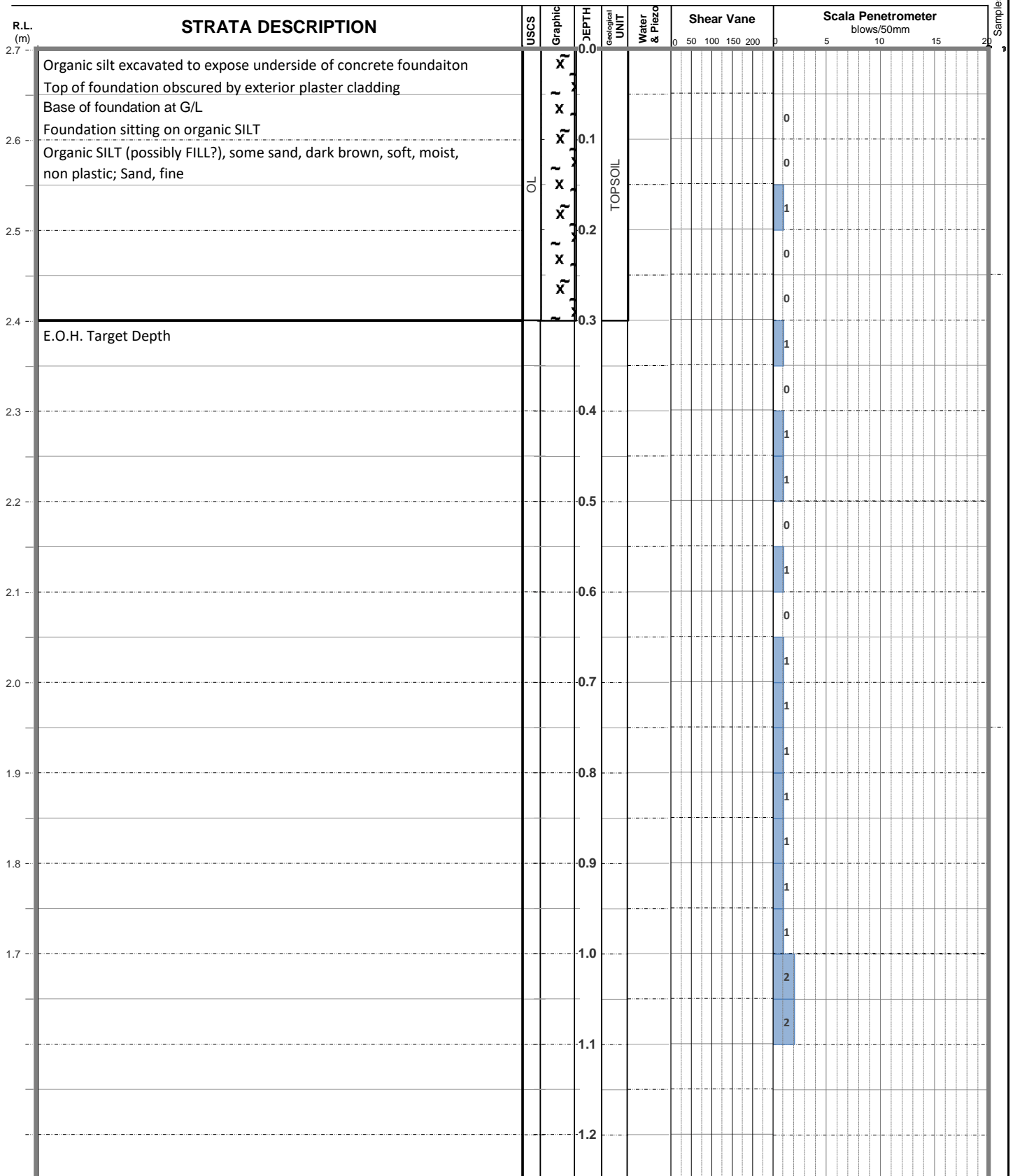
Shear Vane performed and corrected as per NZGS Guidelines.
Scala Penetrometer Test carried out to NZS 4402: Test 6.5.2 (recorded & reported as blows/50mm)



SHALLOW TRIAL PIT LOG

Hole # **HTP02/SP06**

Project: 19 Belfield Street
For: KGA Geotechnical Group Ltd.
Client Ref #: K230406
Co-ordinates: 1573396.305, 5182226.821
Drill method: Hand Dig & Scala
Hole depth: 0.30
Grid system: NZTM2000 (E, N)
Contractor: LFP
Equipment: Spade & Scala
Job #: 1794
Date started: 14/06/2023
Date finished: 14/06/2023
R.L.: 2.7 m NZVD(2016)
Logged by: CLS
Checked By: RBW



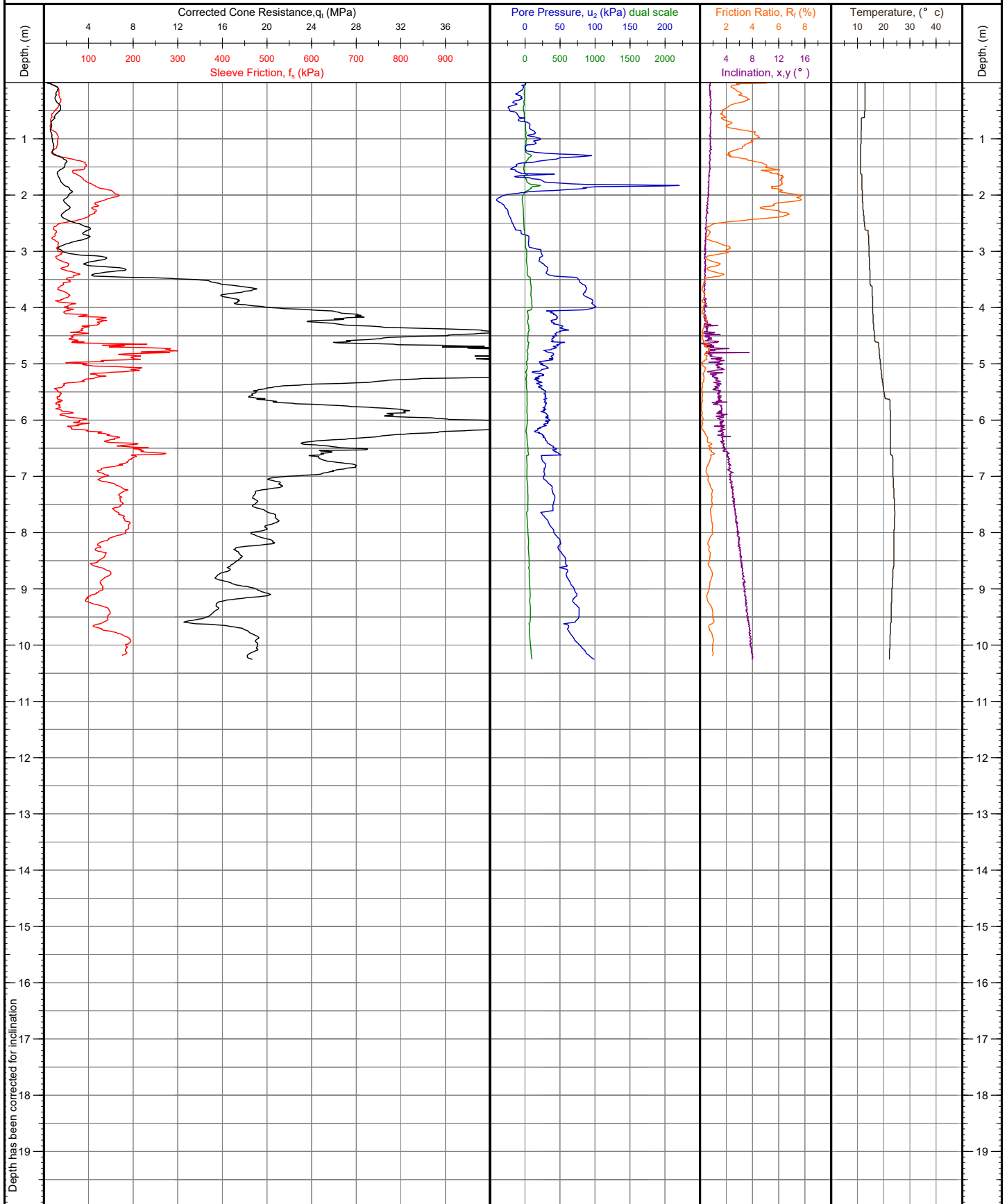
Notes: R.L. sourced from RTK survey

■ peak (kPa)
○ residual (kPa)
Vane #
Blade size
*Ultimate bearing capacity in kPa (under static conditions) is interpreted from Stockwell (1977)

Borehole logged in accordance with the "Guidelines for the Classification and Description of Soil and Rock for Engineering Purposes" Dec 2005 NZGS.
R.L. is inferred and/or interpolated unless otherwise stated.

Shear Vane performed and corrected as per NZGS Guidelines.
Scala Penetrometer Test carried out to NZS 4402: Test 6.5.2 (recorded & reported as blows/50mm)

CONE PENETRATION TEST (CPT) LOG

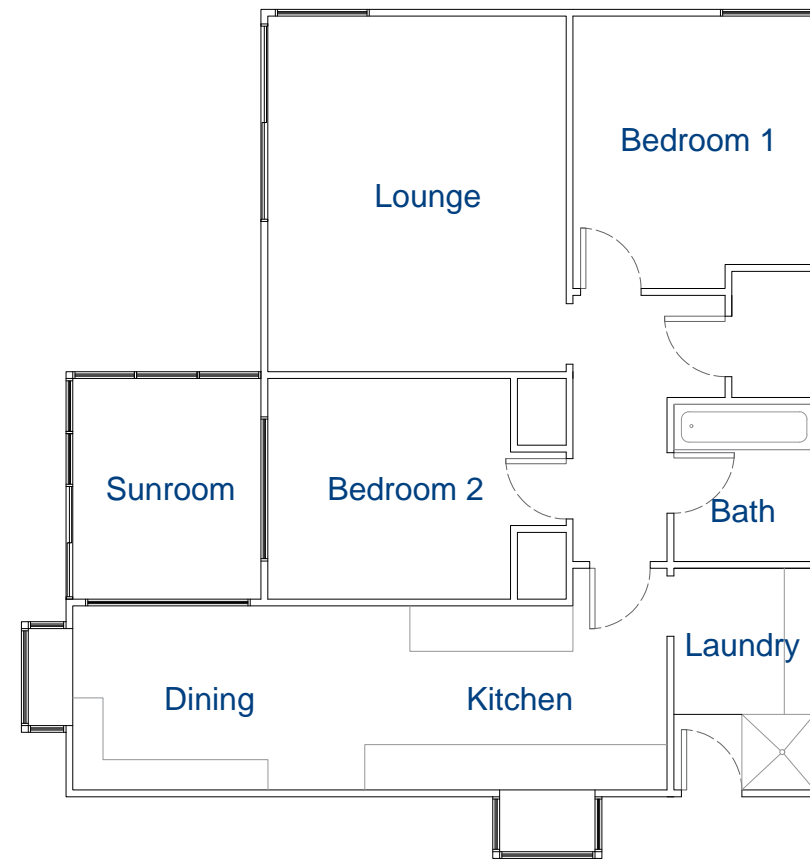


<p>Project: 19 Belfield Street</p> <p>Location: Dallington, Christchurch</p> <p>Comments:</p>	<p>NZTM 2000 N, E (m): 5182224.51, 1573383.20</p> <p>WGS84 (deg): -43.512439, 172.670697</p> <p>Location Method: Handheld GPS</p> <p>Elevation (m): Unknown</p>	<p>Operator: Adam Cron</p> <p>Cone Ref: 000309</p> <p>Cone Type: 10cm² Compression</p> <p>Date of Test: 14/06/2023</p> <p>Depth (m): 10.37</p> <p>Termination Reason: Target depth</p>	<p>Test Number:</p> <p>CPT-01</p> <p>G.I. Job Ref: 230533</p>
--	---	---	--


Where possible GWL is measured after testing, or estimated in the office. This may not represent the true GWL

APPENDIX A

Third Party Documents



EASTERN ELEVATION

 FLOOR LAYOUT - MAIN DWELLING
scale 1:100

ISSUE:

REVISION:

DRAWN BY: YR

SCALE: 1:100 @A3

PAGE:

FLOOR
LAYOUT PLAN

A01

March 2023

ISSUE:

REVISION:

DRAWN BY: YR

SCALE: 1:100 @A3

PAGE:

LEVEL SURVEY
PLAN

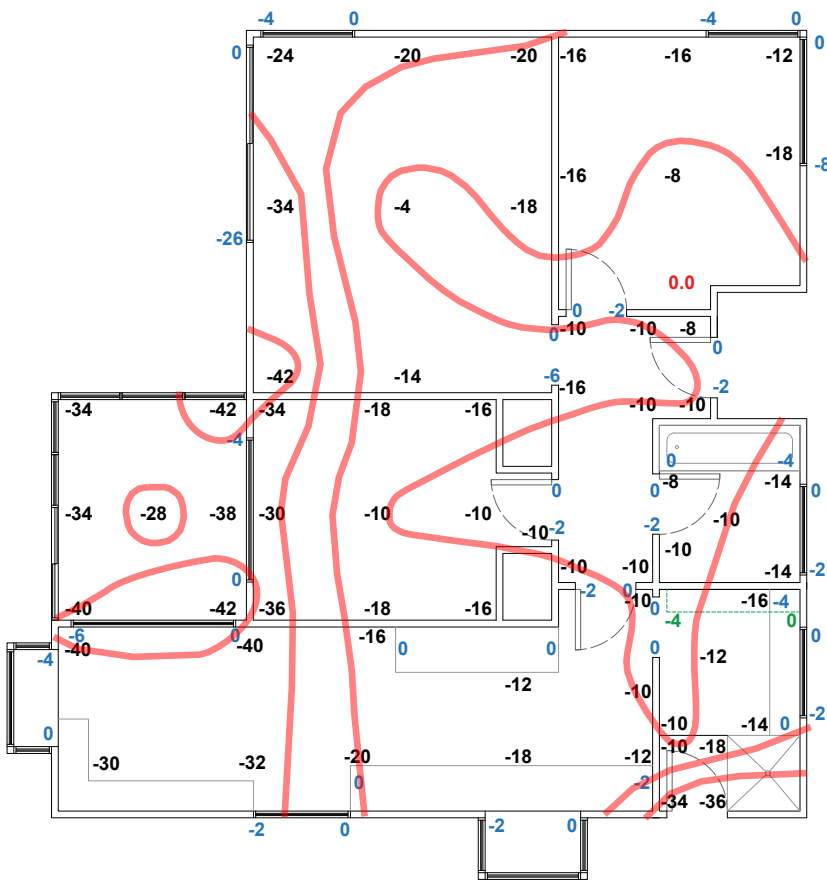
A02

March 2023

LEGEND

LEVELS TAKEN ON WINDOW SILLS, DOOR HEADS, LINTELS AND
BENCHES INDICATED IN BLUE

LEVELS UNDERNEATH THE CUPBOARDS INDICATED IN GREEN



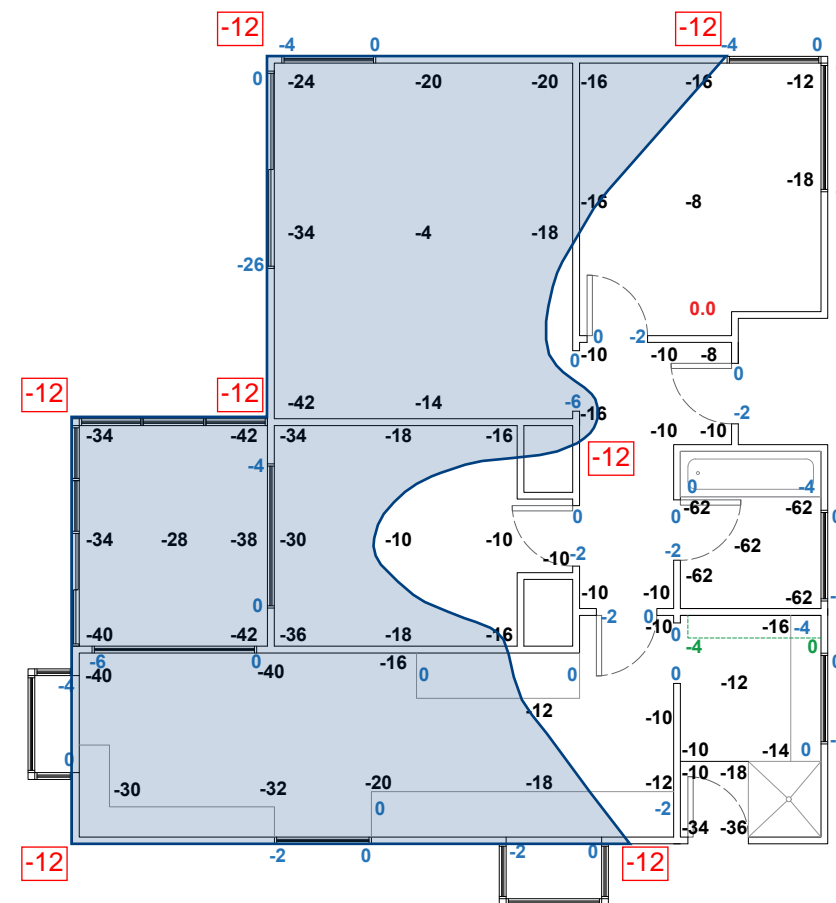
LEVEL SURVEY - MAIN DWELLING
scale 1:100




LEGEND

LEVELS TAKEN ON WINDOW SILLS, DOOR HEADS, LINTELS AND BENCHES INDICATED IN **BLUE**

LEVELS UNDERNEATH THE CUPBOARDS INDICATED IN **GREEN**



Legend:

 Releveling by underpinning the perimeter foundation and jacking and packing the piles
See A04 for underpinning details
See A05 for packing details

 Target levels

 **LEVEL SURVEY - MAIN DWELLING**
scale 1:100

Note: The recommendation to relevel and the proposed releveling strategy is subject to a geotechnical investigation.

ISSUE:

REVISION:

DRAWN BY: **YR**

SCALE: **1:100 @A3**

PAGE:

**FLOOR
RELEVELLING
PLAN**

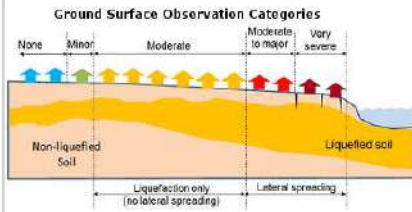
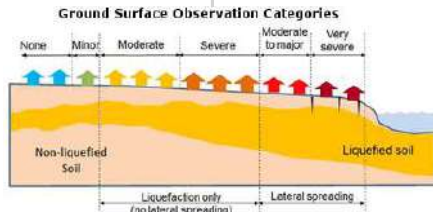
A03

March 2023

APPENDIX B

Background Information Documents

New Zealand Geotechnical Database: Property Summary Report

General Property Information					
Property Address	19 Belfield St				
QPID #	1210230	Suburb	Dallington		
Valuation Reference No	22371/13800	DPID #			
Legal Description	LOT 9 DP 16872				
Easting (NZTM)	1573392	Northing (NZTM)	5182223		
CERA Zone	Green	MBIE Technical Category	TC2		
Liquefaction Observations					
Earthquake	4 Sept 2010	22 Feb 2011	13 June 2011		
Liquefaction Observed [from aerial photos]	None	Moderate to Severe	Moderate to Severe		
Ground Surface Observation Category	None	Moderate Liquefaction	Refer to Road Map		
					
Discrepancies are possible between observations from aerial photography and ground based observations. Refer to notes 1 & 2.					
Property Surface Elevation from LiDAR Surveys (m LVD37)					
Survey Dates	Pre Quake	5 Sep 2010	8 Mar-30 May 2011	18 Jul - 3 Sep 2011	17 - 18 Feb 2012
Maximum Elevation	3.55	3.37	3.23	3.24	3.09
95 percentile	3.46	3.29	3.16	3.11	3.04
Mean Elevation	3.26	3.15	3.03	2.99	2.91
5 percentile	3.02	2.97	2.87	2.83	2.78
Minimum Elevation	2.97	2.89	2.75	2.72	2.58
Refer to note 3.					
Cumulative Property Elevation Changes from LiDAR Surveys (m LVD37)					
Period: Pre Quake -	to 5 Sep 2010	to 30 May 2011	to 3 Sep 2011	to 18 Feb 2012	
Surface Change	- 0.11	- 0.23	- 0.27	- 0.35	
Other Change	- 0.10	- 0.14	- 0.14	- 0.23	
Tectonic Change	- 0.01	- 0.09	- 0.13	- 0.12	
Refer to note 3.					
Interpolated Ground Water Surface Elevation at the time of each Earthquake (m LVD37)					
Earthquake	Sep 2010	Feb 2011	Jun 2011	Dec 2011	
Surface Elevation	0.56	0.67	0.59	0.63	
For back analysis purpose only. Refer to note 4.					
Design Ground Water Surface Elevations (m LVD37)					
	Median surface	Median with surrogates	85 percentile offset	15 percentile offset	
Surface Elevation	0.54	0.54	0.38	- 0.47	
Refer to note 5.					

CPT02 14 Belfield Street, Dallington, Christchurch - 02 December, 2022

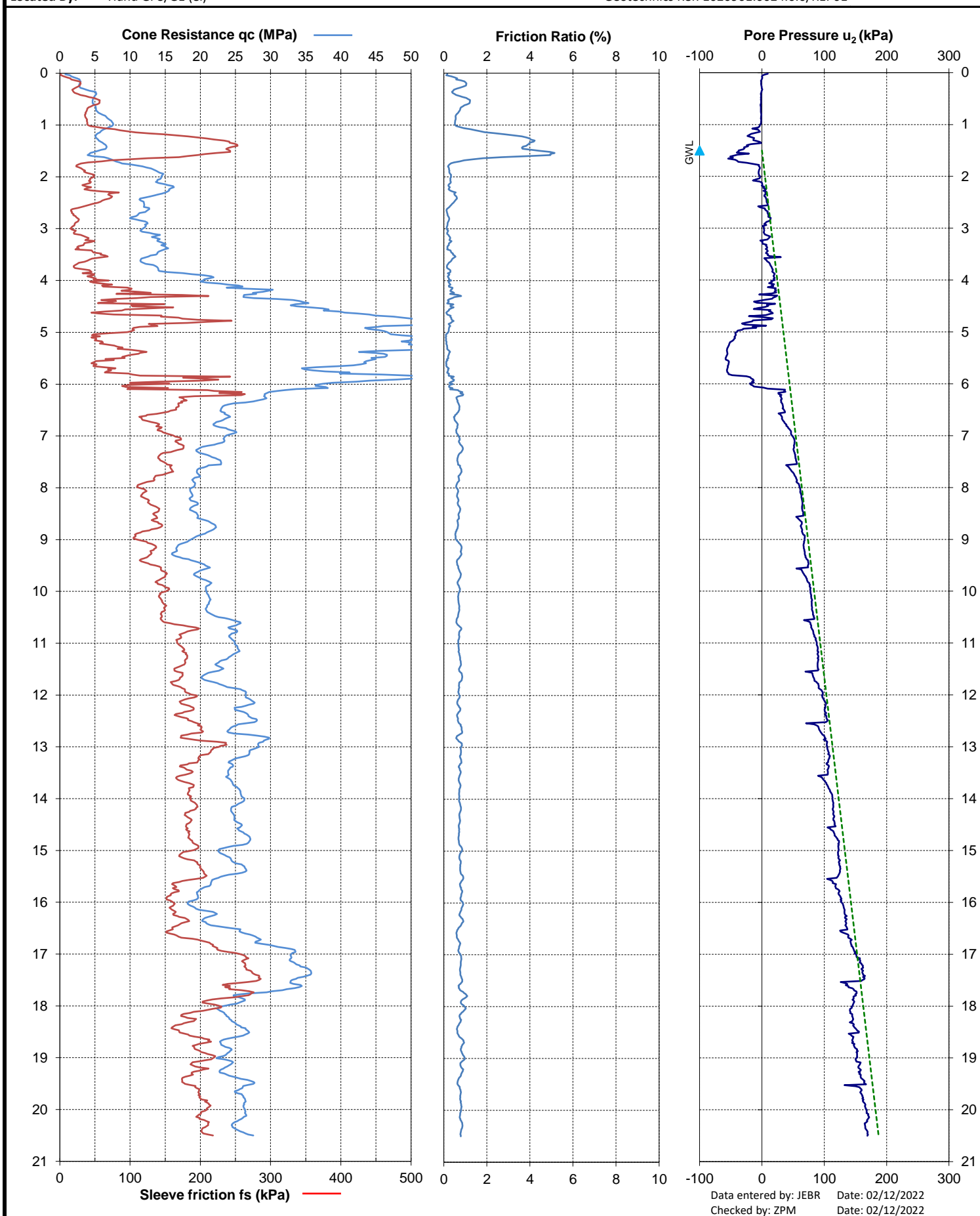
Pre-Drill: 0m NZTM 1573436mE 5182208mN 5m(amsl)
 Measured GWL: 1.5m (BGL) Other Tests: None
 Operator: JEBR Comments: Target depth reached
 Located By: Hand GPS/GE (el)

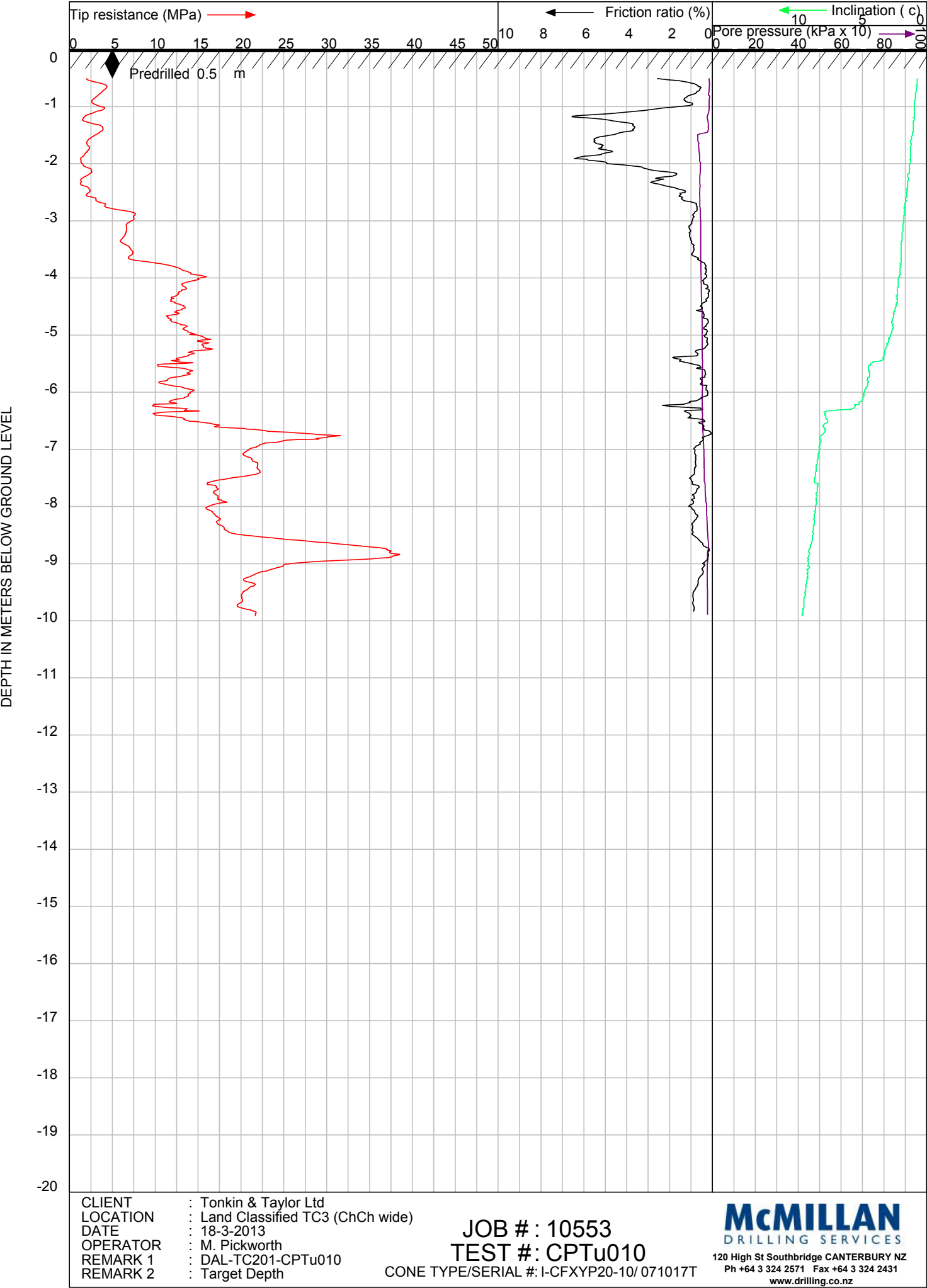
45a Parkhouse Rd, Christchurch
 e. christchurch@geotechnics.co.nz
 p.+64 (0)3 361 0300



Geotechnics Ref: 1020961.0024.0.0/REP01

GEOTECHNICS





Elizabeth Creek

From: FloorLevels <FloorLevels@ccc.govt.nz>
Sent: Friday, 16 June 2023 12:09 pm
To: Elizabeth Creek
Subject: 19 Belfield Street - Floor Levels - 16/06/2023

Kia Ora Elizabeth

Please find below a finished floor level (FFL) and flood assessment for 19 Belfield Street.

Finished Floor Levels Requirements

NZ Building Code:

Minimum FFL required for compliance with Clause E1 of the New Zealand Building Code based on providing protection from a 1 in 50 year flood event with sea level rise allowance (0.45m or 0.5m) and 400mm freeboard.

This FFL may not be required for all structures and is for building code performance purposes only. Where a specific FFL is not required, compliance with the Building Code can be established using the solutions in E1/AS1.

The FFL requirement is currently: **11.98 m RL**.

Please contact the duty Building Consent Officer dutyBCO@ccc.govt.nz for more information.

Christchurch District Plan:

Property or parts of it in District Plan Flood Management Area: **Yes**

Property or parts of it in District Plan Fixed Minimum Floor Level Overlay: **Yes**

Minimum FFL required for compliance with [Chapter 5.4](#) Flood Hazard Rules of the District Plan for properties located within the Flood Management Area. Resource consent is required if the minimum FFL is not met. A limited number of structures are exempt from meeting this FFL.

The FFL requirement is currently: **12.30 m RL**.

Flood Management Area FFLs are set using criteria set out in [Chapter 5.4](#) of the Christchurch District Plan. Please contact the Duty Planner (03 941 8999 or dutyplanner@ccc.govt.nz) for more information.

Recommended Floor Level (May be required as a condition of a resource consent in some circumstances*):

The extent of the Flood Management Area and minimum FFL set by the District Plan Flood Management Area rules are based on flood predictions that include tide information. New tide and flooding information is now available that has not yet been used to propose amendments to the extent of the Flood Management Area and Fixed Minimum Floor Levels in the District Plan. The recommended FFL will achieve the level of flood protection that is intended by the District Plan, but is not a mandated requirement of the District Plan Flood Management Area rules or Clause E1 of the Building Code. The recommended FFL has been calculated, using the new tide or flooding information, based on the currently predicted 1 in 200 year flood level with 1.0m sea level rise allowance plus 400mm freeboard, or the level of 12.56m, whichever is higher. District Plan recession plane exemptions can only apply as if the ground level is the District Plan Flood Management Area Floor Level, not the recommended FFL.

**This FFL may be required to be met for developments requiring resource consent in some circumstances, please contact the Duty Planner for more information.*

The FFL recommendation is currently **12.56 m RL**.

Please contact floorlevels@ccc.govt.nz for more information.

Predicted Flood Levels

Predicted **1 in 50 year** water level: **11.58 m RL**

This is the predicted maximum water level in a 1 in 50 year flood event. The prediction allows for sea level rise (0.45m or 0.5m) and an increase in rainfall intensities as a result of climate change. This level is based on the current flood hazard information and may be updated once new data becomes available.

Predicted **1 in 200 year** water level: **11.79 m RL**

This is the predicted maximum water level in a 1 in 200 year flood event. The prediction allows for 1.0 m sea level rise and an increase in rainfall intensities as a result of climate change. This level is based on the current flood hazard information and may be updated once new data becomes available.

Estimated Ground Levels

Our latest LiDAR information indicates that the average ground elevation at the property is approximately **12.01 m RL**, ranging between **11.76 m RL** and **12.25 m RL**.

Disclaimer

- i. All levels are provided in [Christchurch Drainage Datum](#).
- ii. Please note that any Flood Level estimate(s) may differ from observed levels in previous or future events.
- iii. The FFL assessment is for flood limitation purposes only, and does not include consideration for other building consent aspects such as on-site drainage or service connections.
- iv. Any consent application lodged for this site will be assessed based on the most recent flood modelling information available at the time of lodgement, and the above level is subject to change if the flood modelling information for this area is updated.
- v. The content of this email does not constitute a 'Minimum Floor Level Certificate' as defined in the District Plan ([Rule 5.4.1.2](#)). To request one, submit a [P-022 form](#), located within the District Plan Certificates tab [here](#).

Further information regarding [floor level requirements](#), [flooding](#) and [floor levels map](#) is available on the CCC website. If you have any further floor level queries, contact the team at floorlevels@ccc.govt.nz.

Ngā mihi,

Jig Dhakal

Assistant Engineer

Asset Planning - Stormwater & Waterways
(she/her)



03 941 5426



Jigyasa.Dhakal@ccc.govt.nz



Te Hononga Civic Offices, 53 Hereford Street, Christchurch



PO Box 73014, Christchurch 8154



ccc.govt.nz

From: Elizabeth Creek <Elizabeth@kga.co.nz>
Sent: Wednesday, June 14, 2023 3:24 PM
To: FloorLevels <FloorLevels@ccc.govt.nz>
Subject: 19 Belfield Street, Dallington

Please provide finished floor level information for 19 Belfield Street for the purposes of a geotechnical report.

Thanks so much,

Elizabeth Creek
Geotechnical Engineer

PLEASE NOTE: I am away on leave from Thursday 15th June, returning Monday the 26th. Please contact my colleagues Jonathan Shelley at jonathan@kga.co.nz or Judy Park at judy@kga.co.nz if you have an urgent inquiry on these days.



KGA GEOTECHNICAL GROUP LIMITED

M 027 655 4410 | E elizabeth@kga.co.nz | www.kga.co.nz
CHRISTCHURCH | (03) 343 5302 ex 304
3/201 Opawa Road | Hillsborough | Christchurch
PO Box 7630 | Sydenham | CHRISTCHURCH 8240

AUCKLAND | (09) 478 6655
7A William Pickering Drive | Albany | Auckland
PO Box 302 361 | North Harbour | AUCKLAND 0751

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If you are not the correct recipient of this email please advise the sender and delete the email.

LLUR Extract:







Listed Land Use Register (LLUR)

The Listed Land Use Register (LLUR) is a publicly available database of sites where hazardous activities and industries have been located throughout Canterbury. Environment Canterbury has identified these sites and maintained the database for some years. Research projects into historical land use are conducted on a district-by-district basis, starting in 2014 and due to finish in 2023.

Start your LLUR search here

Type into the search bar below to find properties by address or legal description. Alternatively you can search using the interactive map.



You have the following **Land Parcel** selected. These are being used to search for intersecting records in the Listed Land Use Register.

Legal Description	Title	Valuation No.	
19 Belfield Street			
Lot 9 DP 16572	QB407414	2227113800	X

Explore further...
You can explore your selected area further in some of Environment Canterbury's other websites. Click on the links below to get started.

Thank you for your enquiry

[Need help understanding these results?](#)

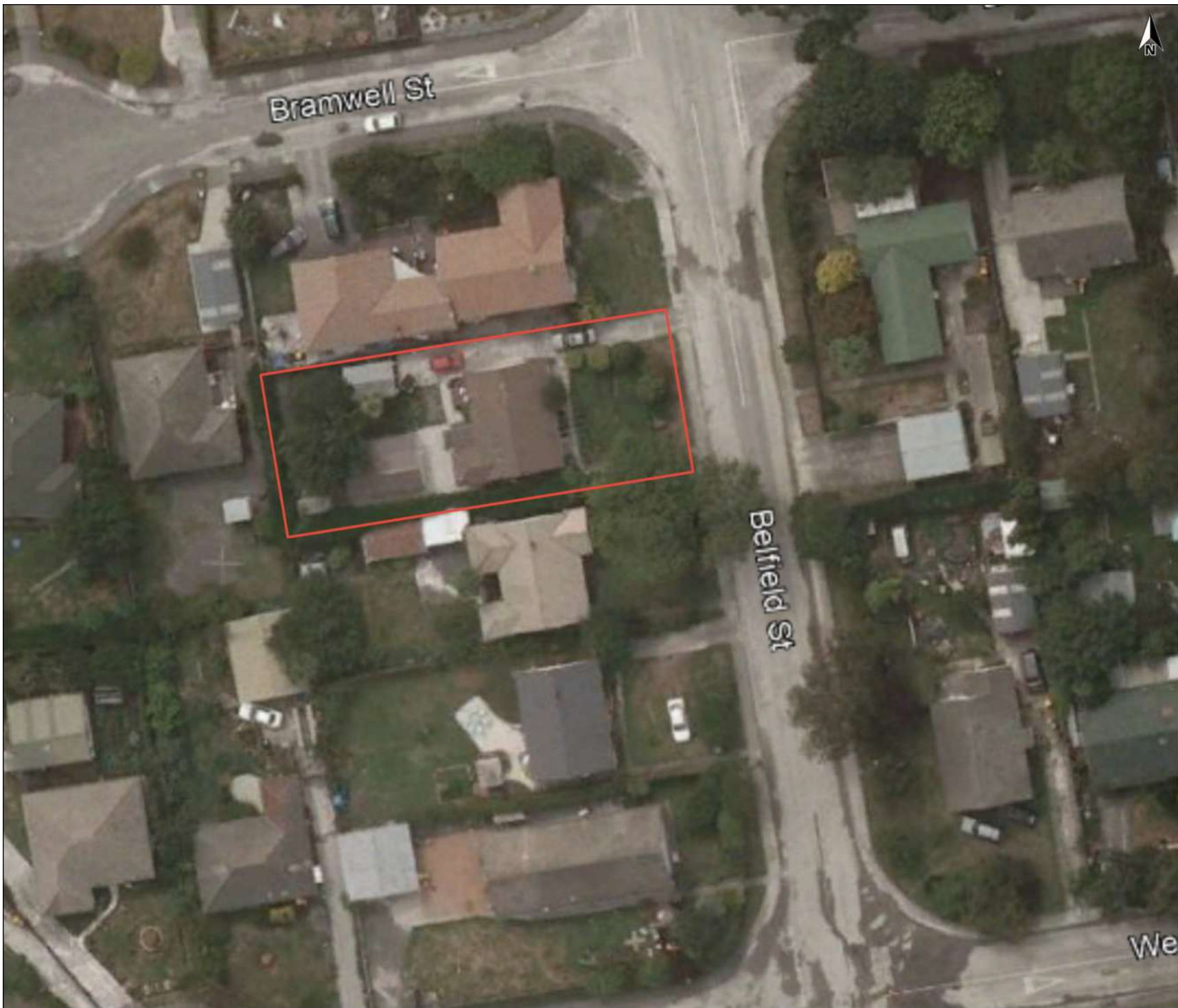
Summary

The Listed Land Use Register does not currently have any information about a Hazardous Activities and Industries List site on your selected land parcel. If you would like a property statement, please click on the **Request a Property Statement** button below.



I would like to...

APPENDIX C

Site Photographs



Legend

-  Site Boundary
-  Aerial Photograph, February 2011 (NZGD)

0 5 m 10 m
LINZ CC BY 4.0 © Imagery Basemap contributors



Produced by [Datanest.earth](https://www.datanest.com/)

Title: Aerial Photograph, February 2011

Client:
Viden Consulting Engineers Ltd

Project:
19 Belfield Street

Drawn: EC

Figure No.: 2
Size: A4

Date:
29-06-2023

Checked:
AN

Proj No.:
K230406

Scale: 1:500

Version:
FINAL

Site Photographs:



Front of dwelling



HTP02 location



Northwestern patio



Southwestern extension



Sunroom (centre of western elevation)



Southeastern corner of dwelling

APPENDIX D

Event-Specific Liquefaction Analyses

LIQUEFACTION ANALYSIS REPORT

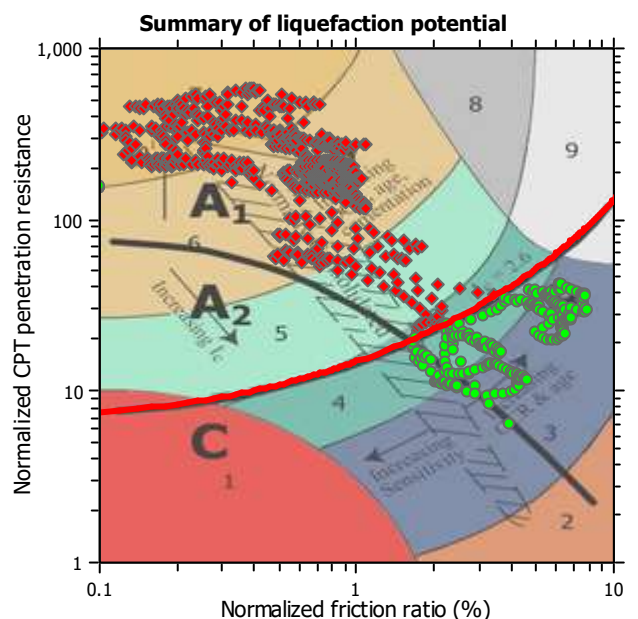
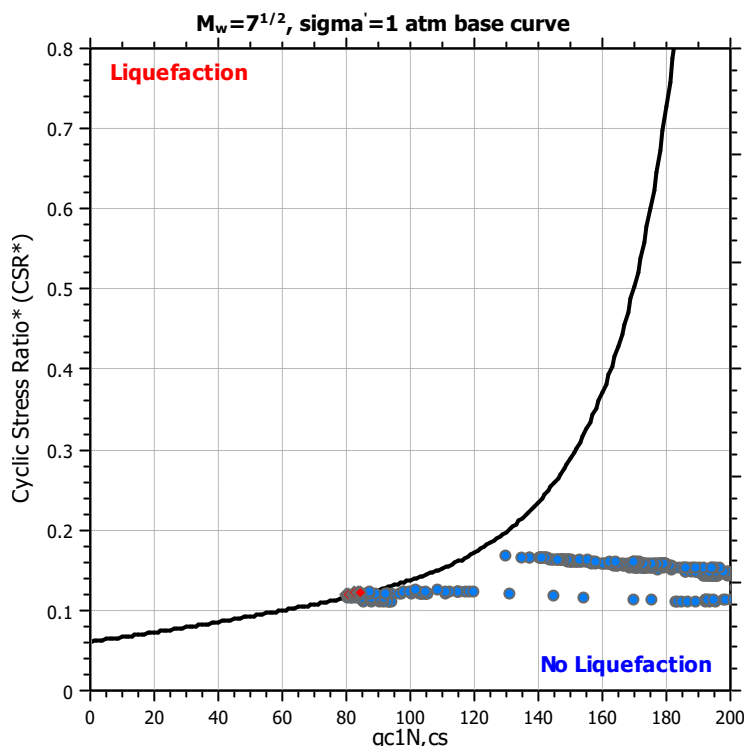
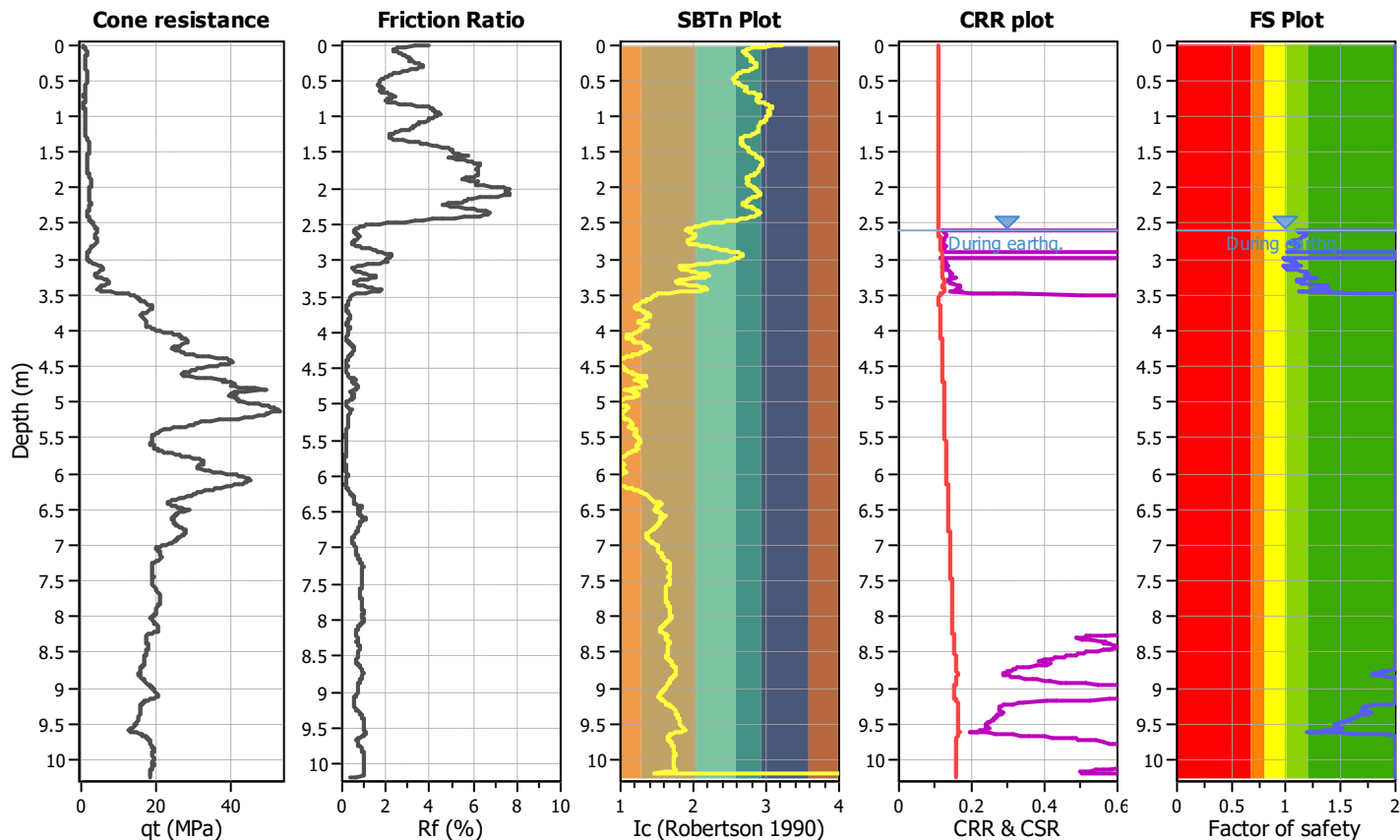
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT-01 Sept 2010

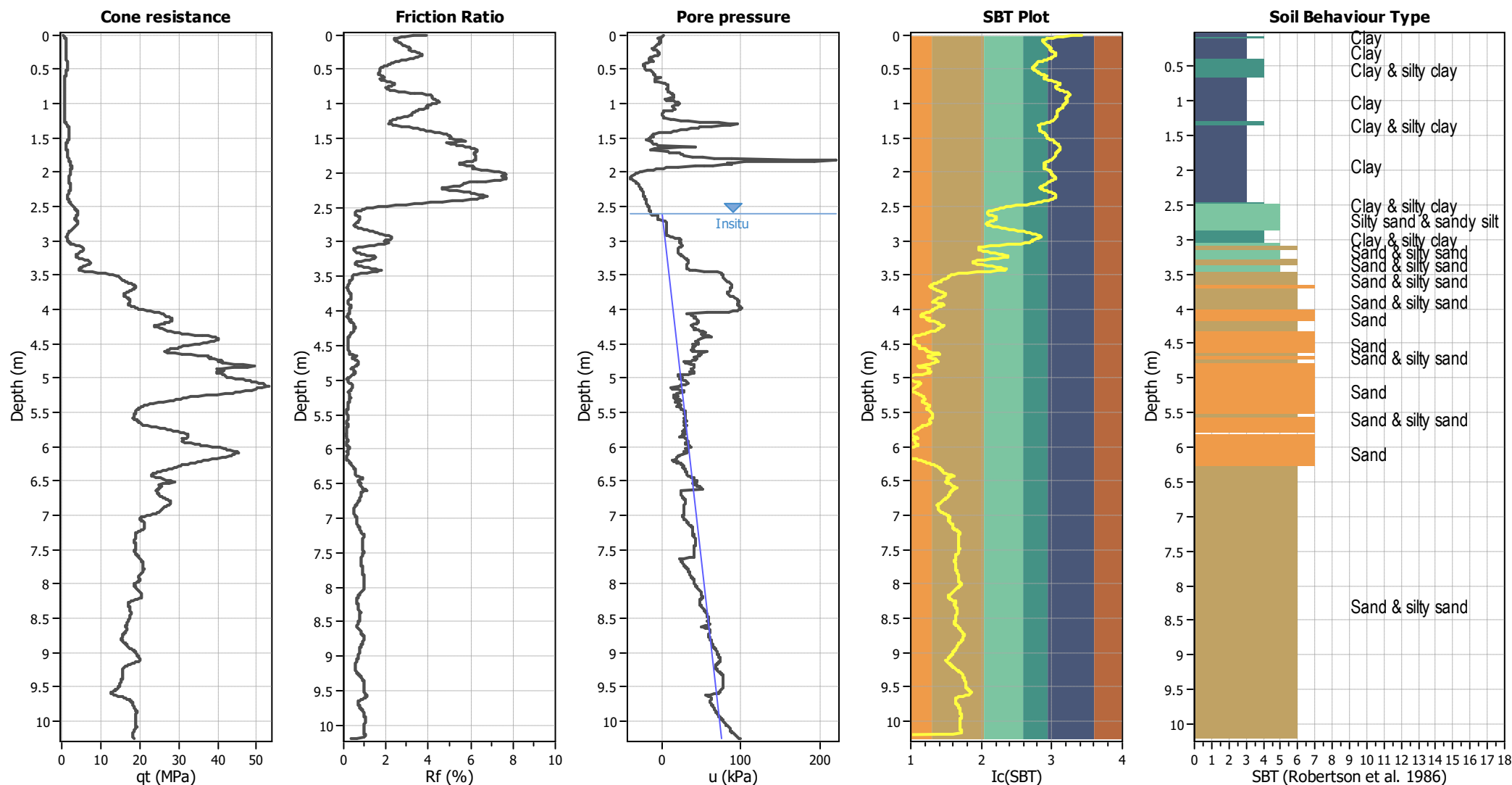
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.60 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.60 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Pore pressure

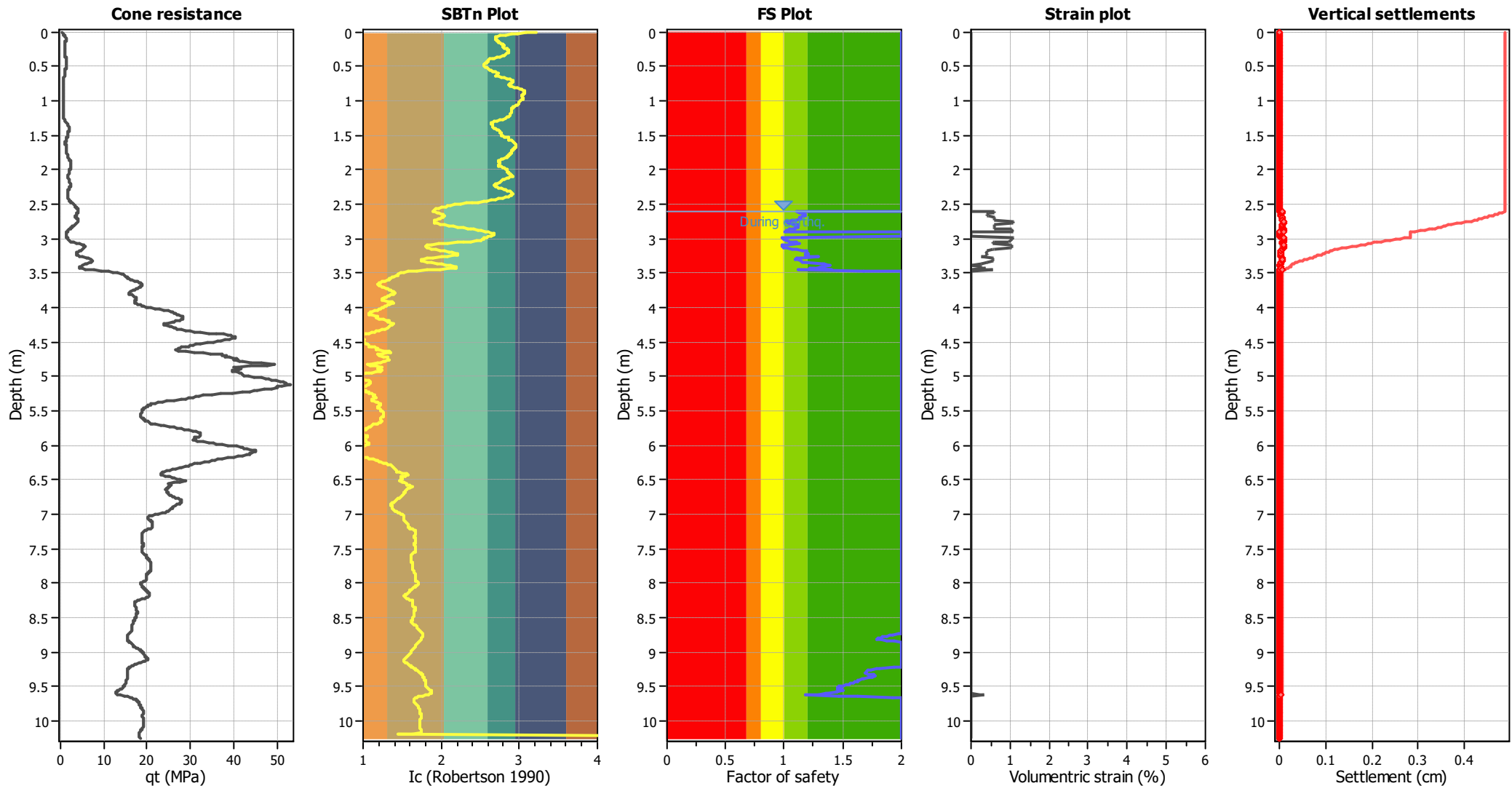


Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w :	7.10
Peak ground acceleration:	0.19
Depth to water table (insitu):	2.60 m

Depth to GWT (erthq.):	2.60 m	Fill weight:	N/A
Average results interval:	3	Transition detect. applied:	No
Ic cut-off value:	2.60	K _c applied:	Yes
Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Use fill:	No	Limit depth applied:	No
Fill height:	N/A	Limit depth:	N/A

	1. Sensitive fine grained		4. Clayey silt to silty		7. Gravely sand to sand
	2. Organic material		5. Silty sand to sandy silt		8. Very stiff sand to
	3. Clay to silty clay		6. Clean sand to silty sand		9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

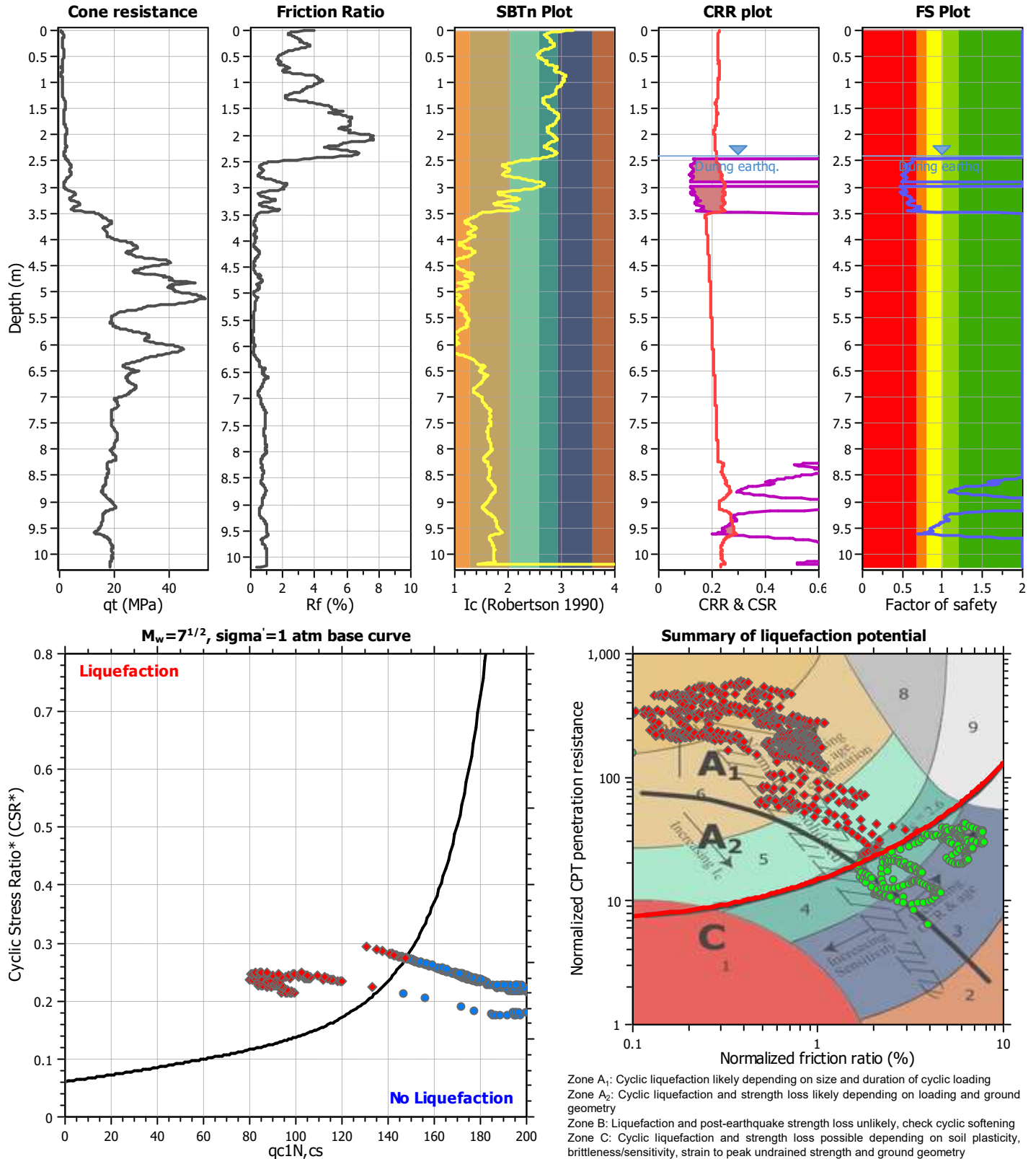
Project title : K230406

Location : 19 Belfield Street

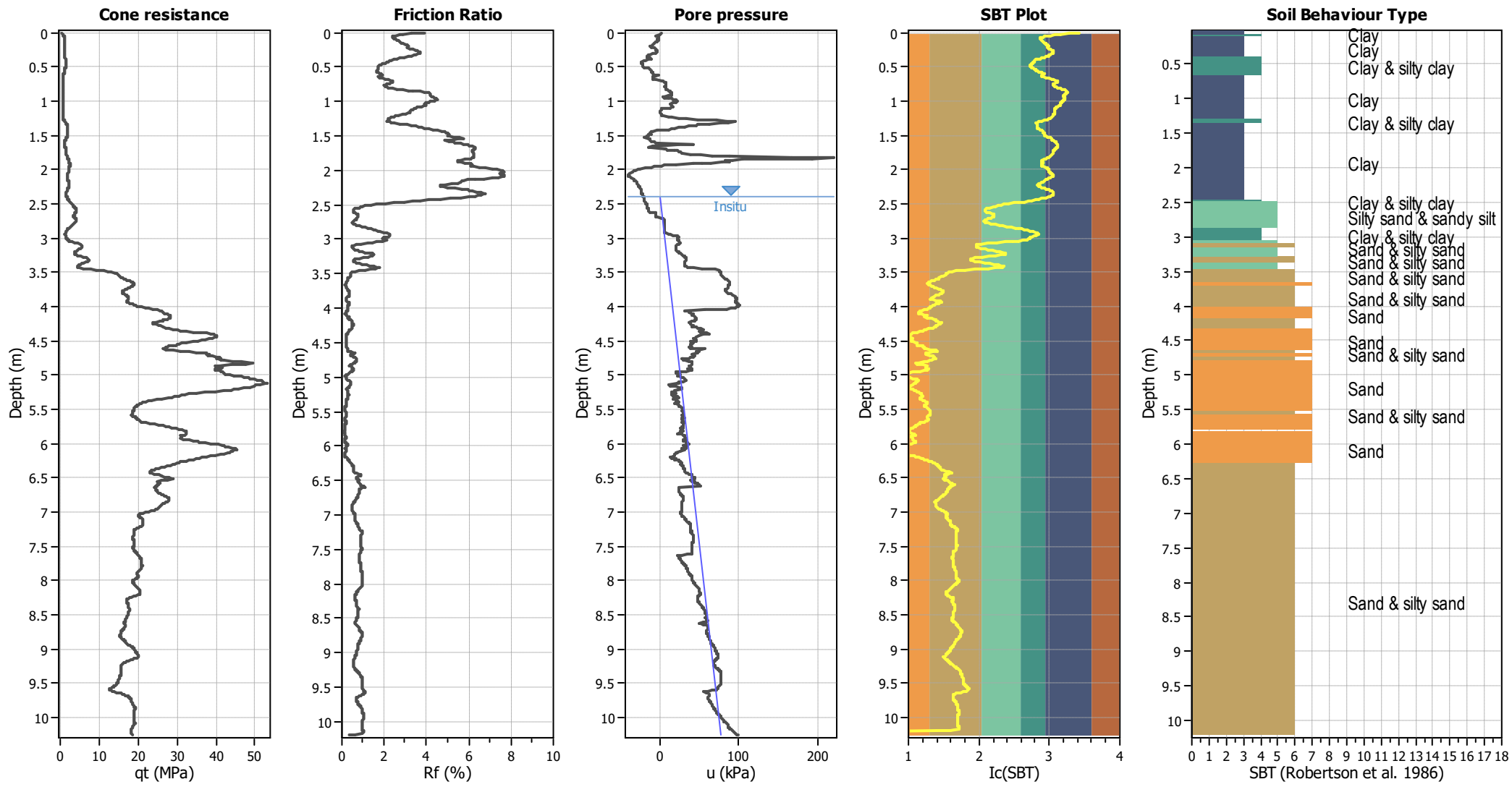
CPT file : CPT-01 Feb 2011

Input parameters and analysis data

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.40 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.20	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.41	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



CPT basic interpretation plots



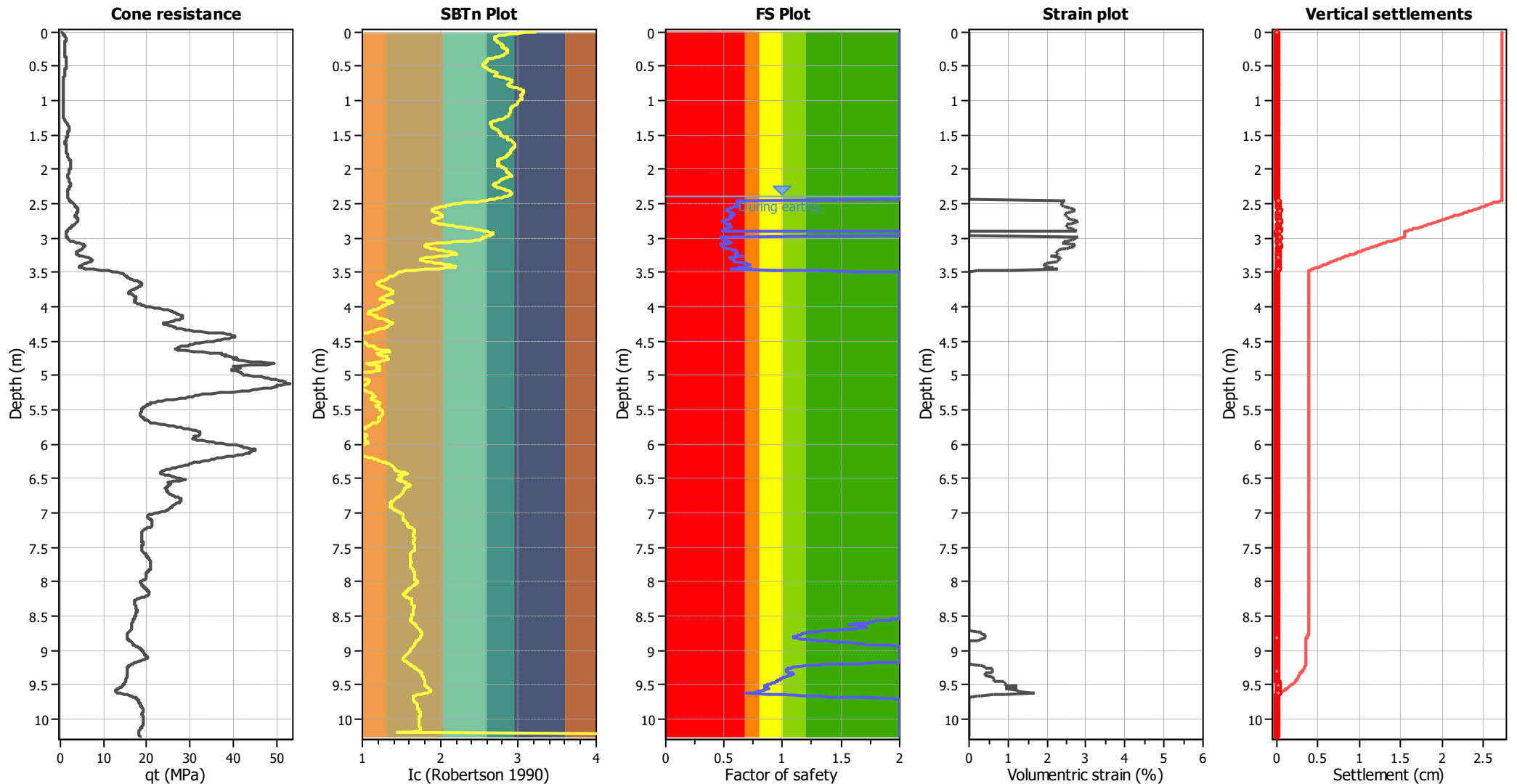
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.40 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 :	6.20	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.41	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.40 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

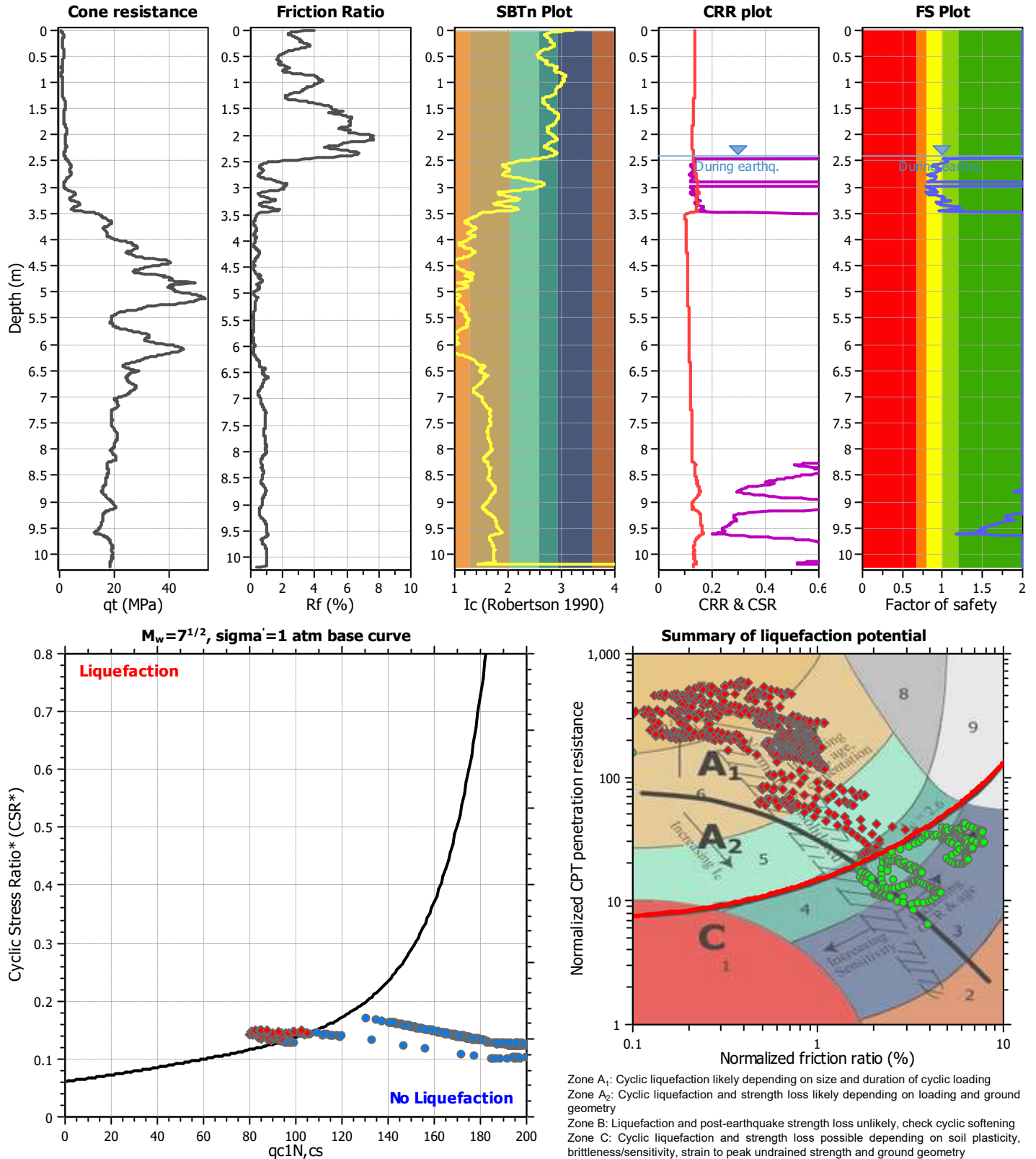
Project title : K230406

Location : 19 Belfield Street

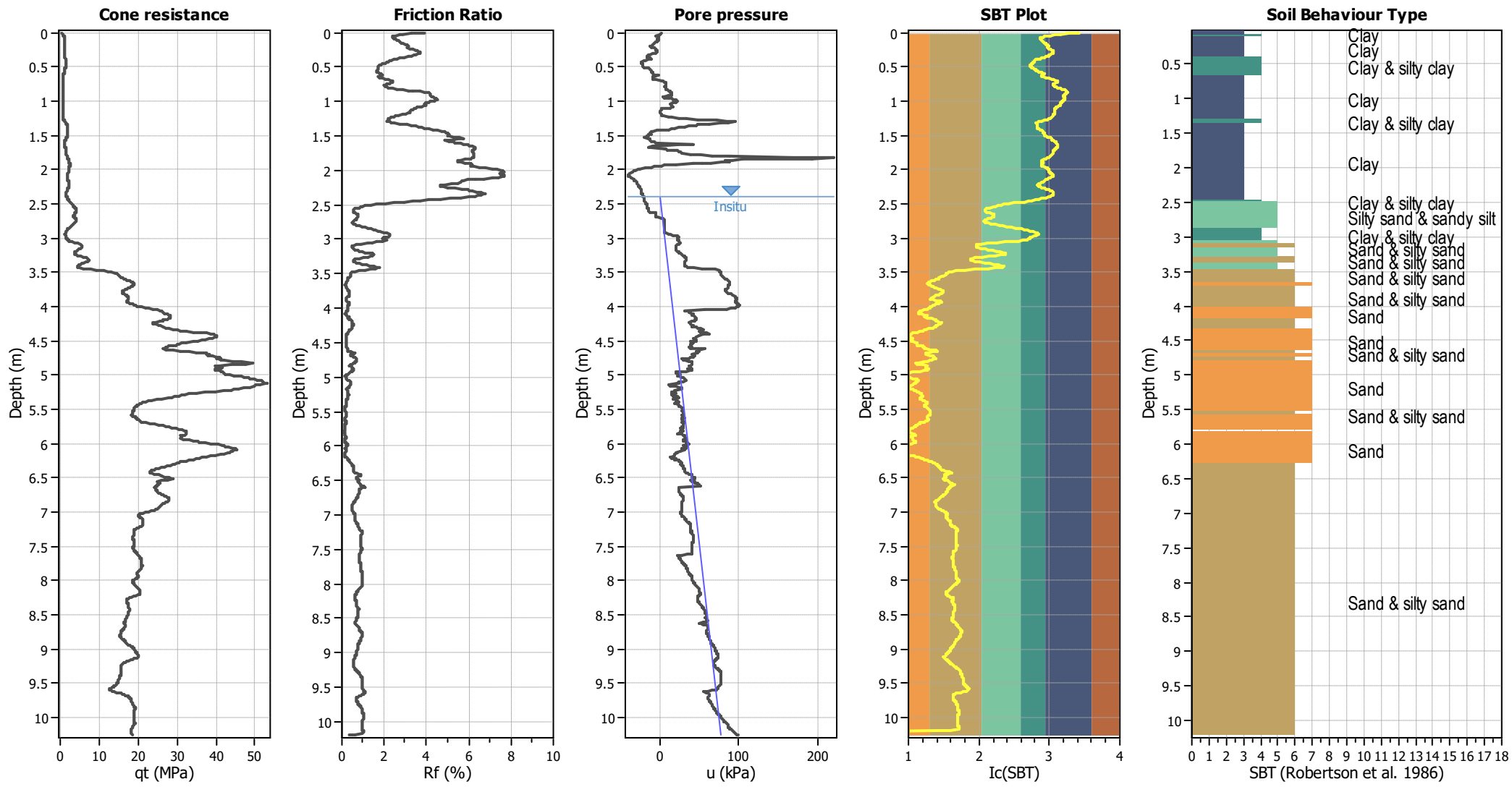
CPT file : CPT-01 June 2011

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.40 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.40 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.25	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



CPT basic interpretation plots



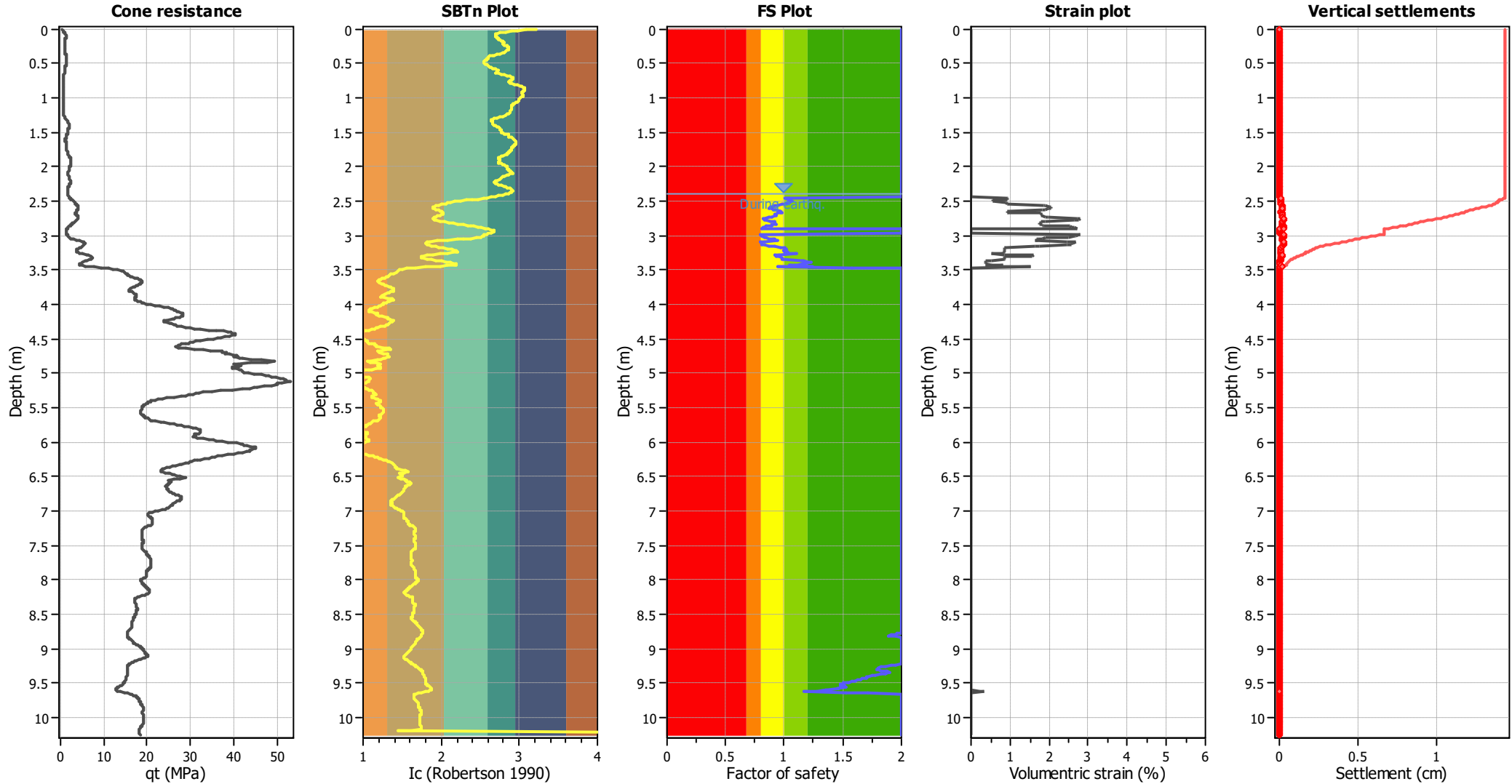
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.40 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 ₀ applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.40 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

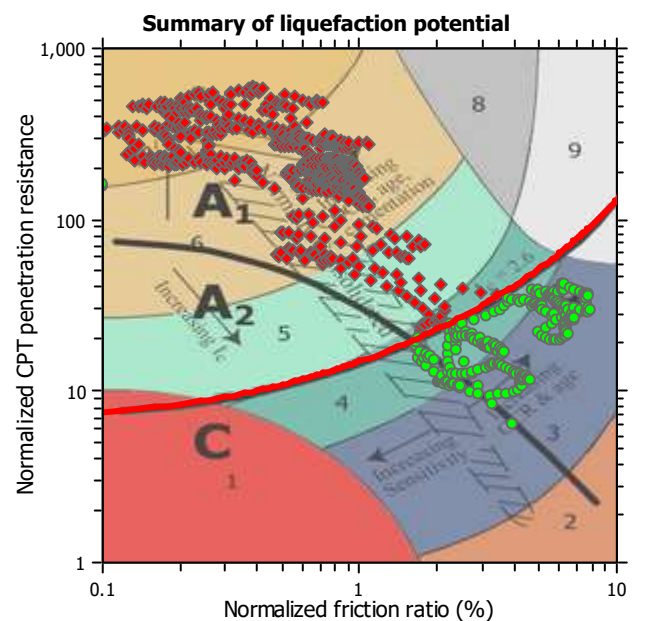
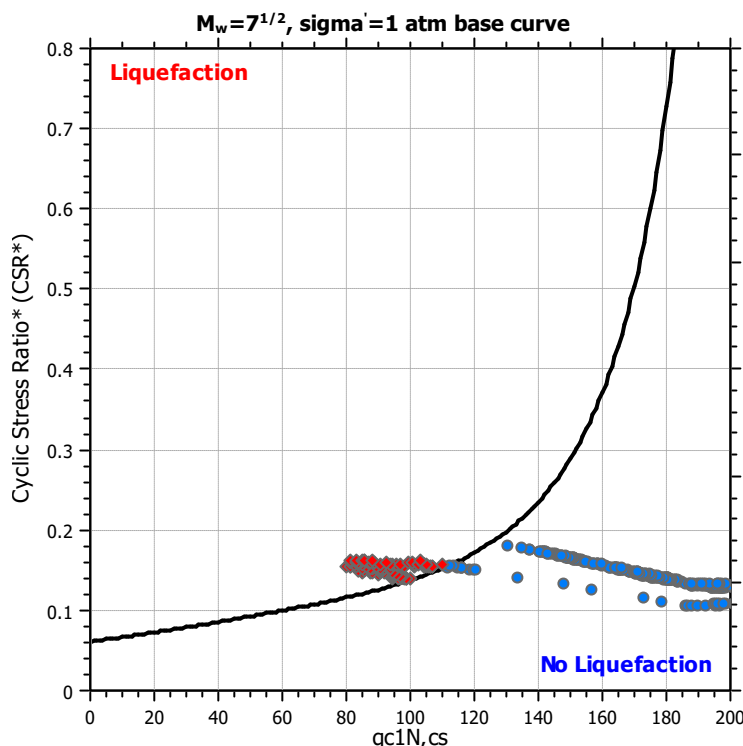
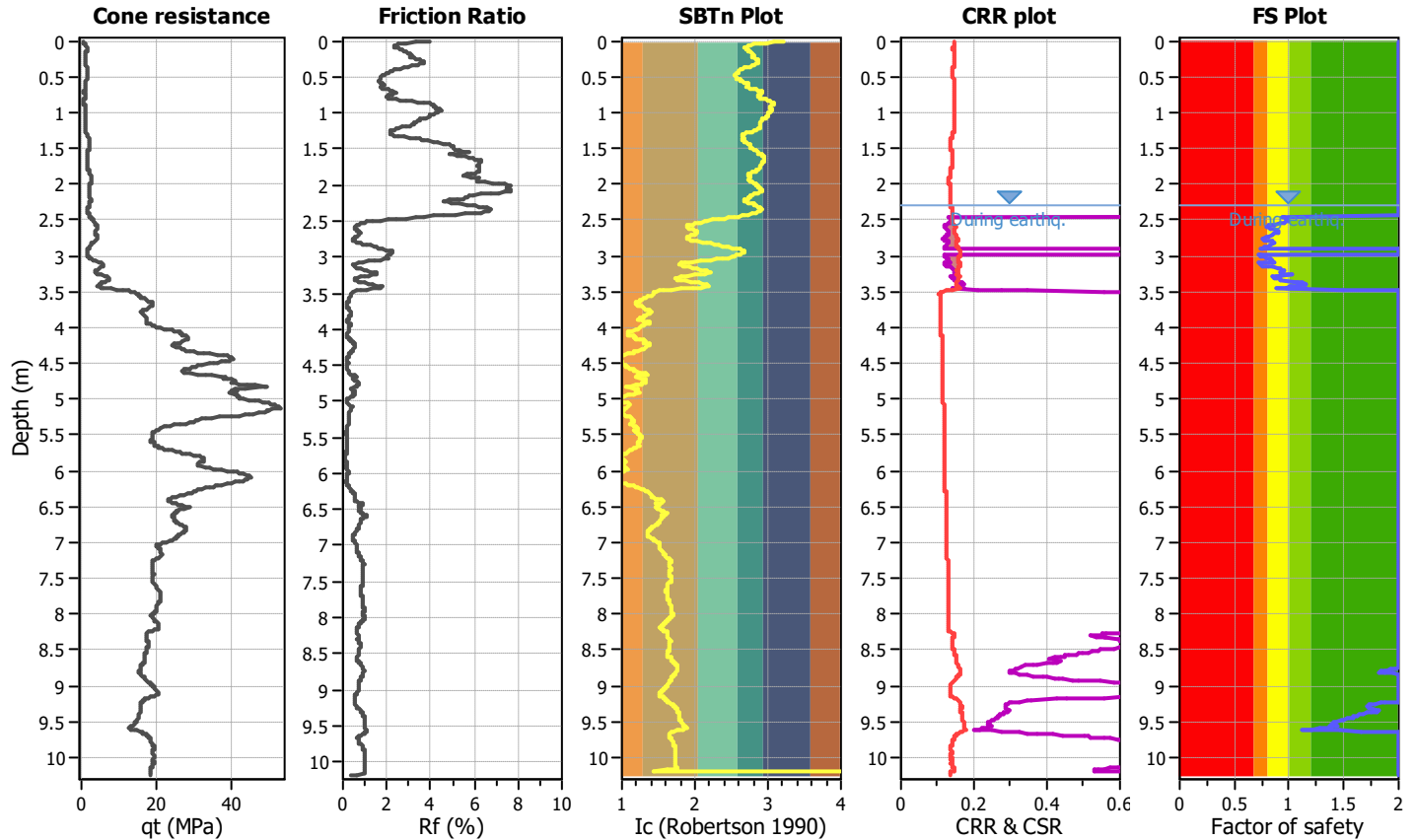
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT-01 Dec 2011

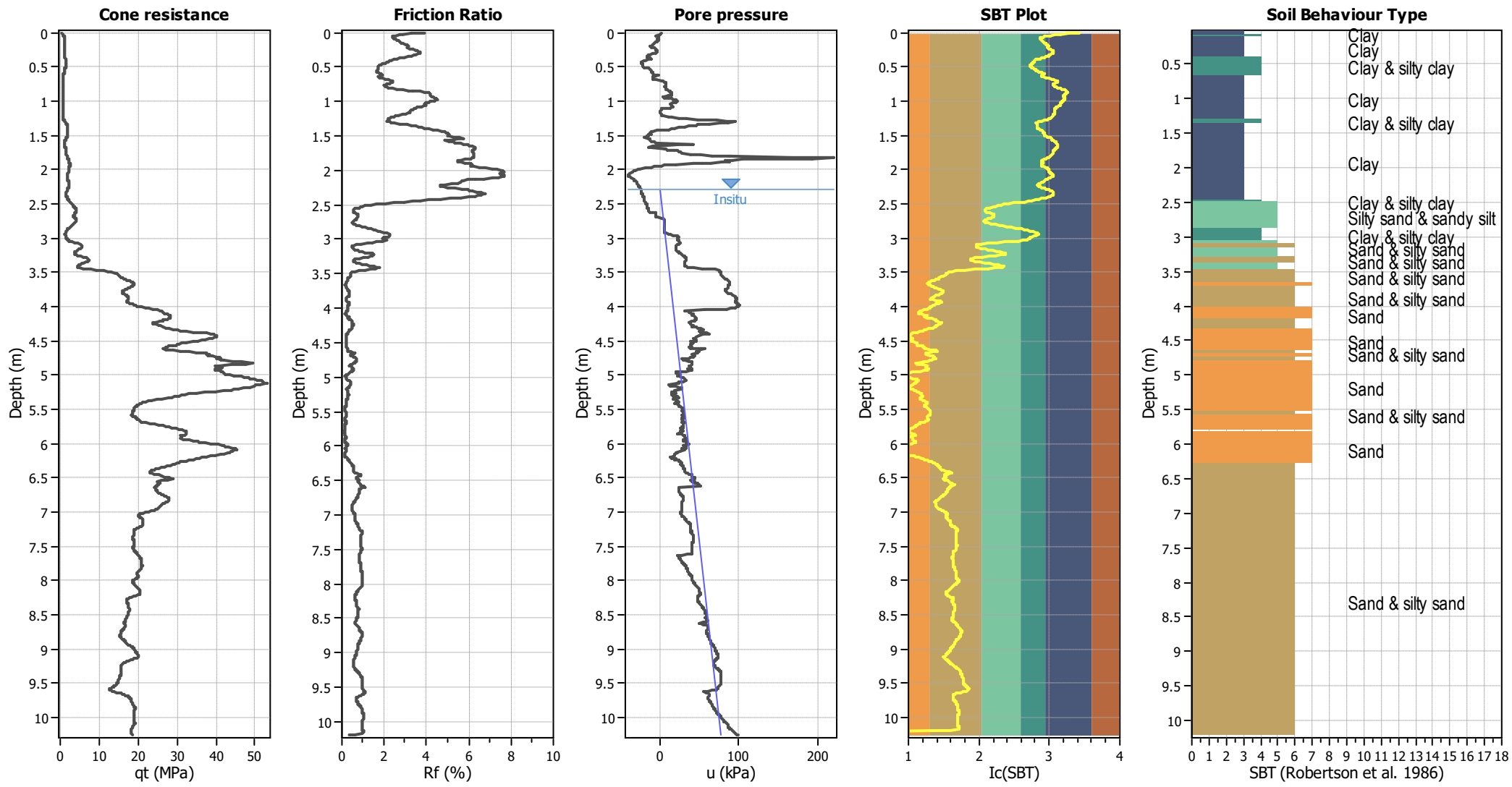
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.30 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.30 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.27	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



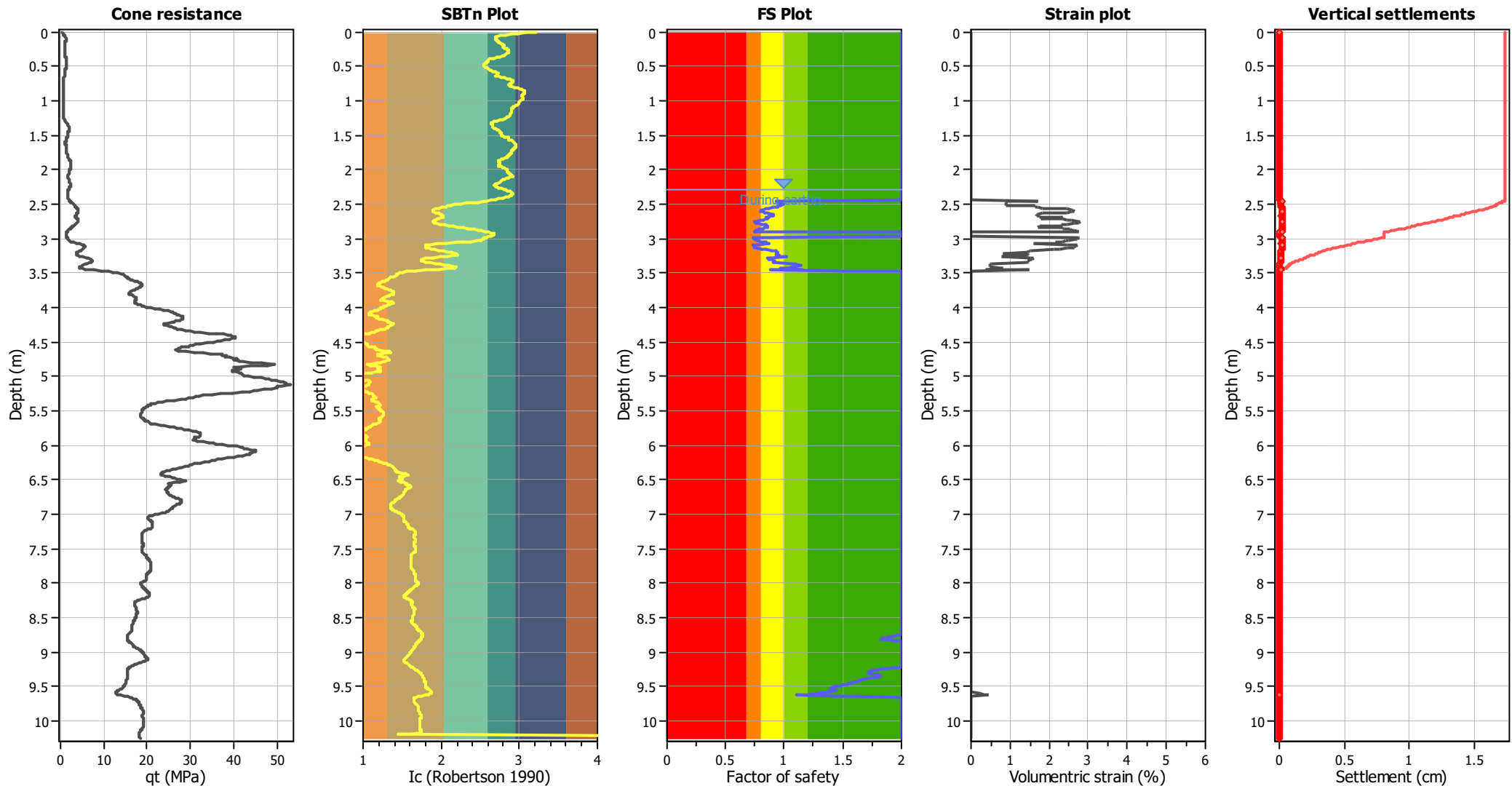
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.30 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 :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.30 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

APPENDIX E

SLS & ULS Liquefaction Analyses

LIQUEFACTION ANALYSIS REPORT

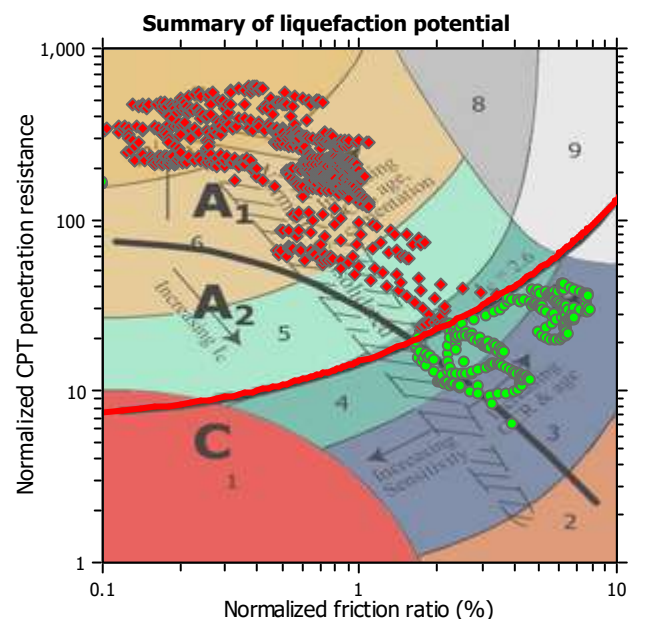
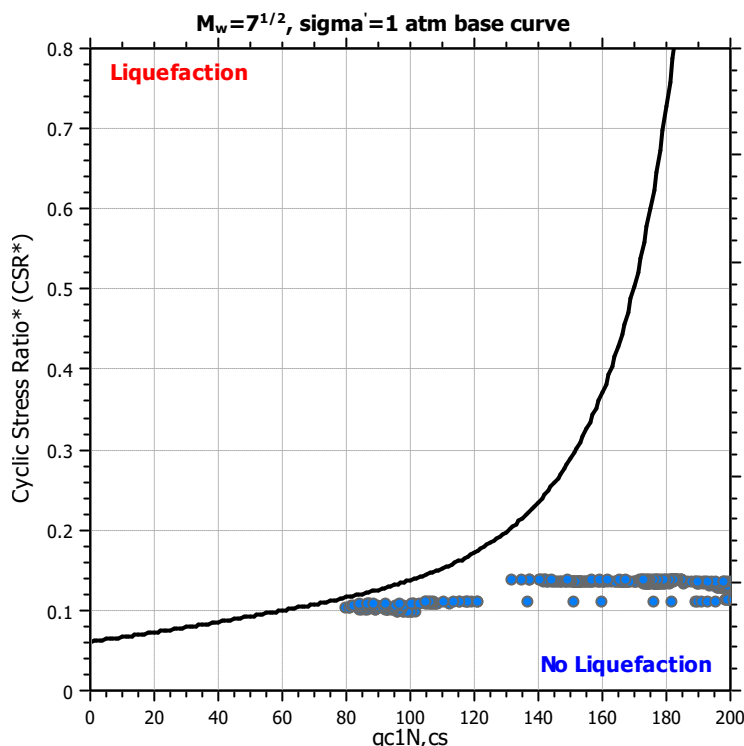
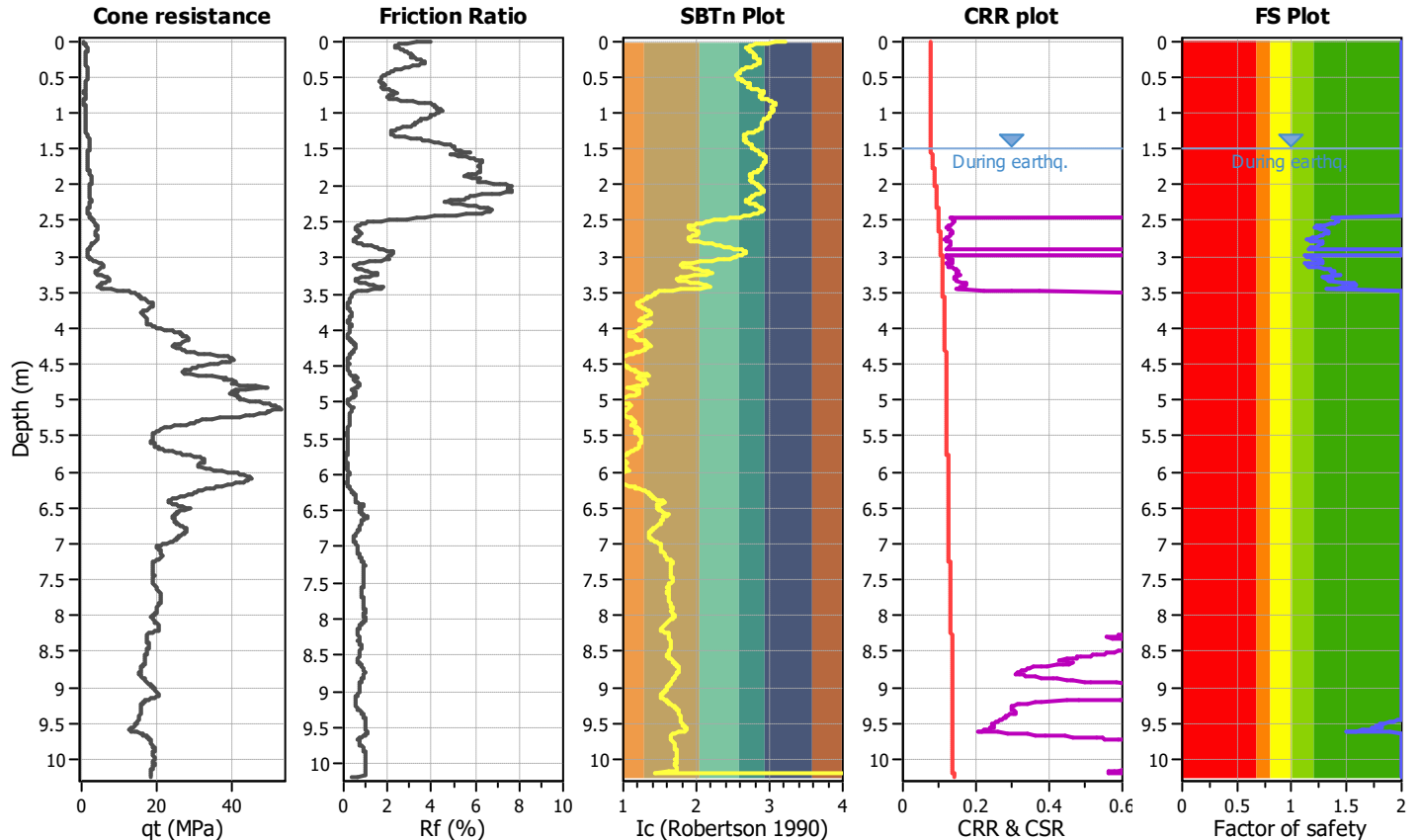
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT-01 SLS(A)

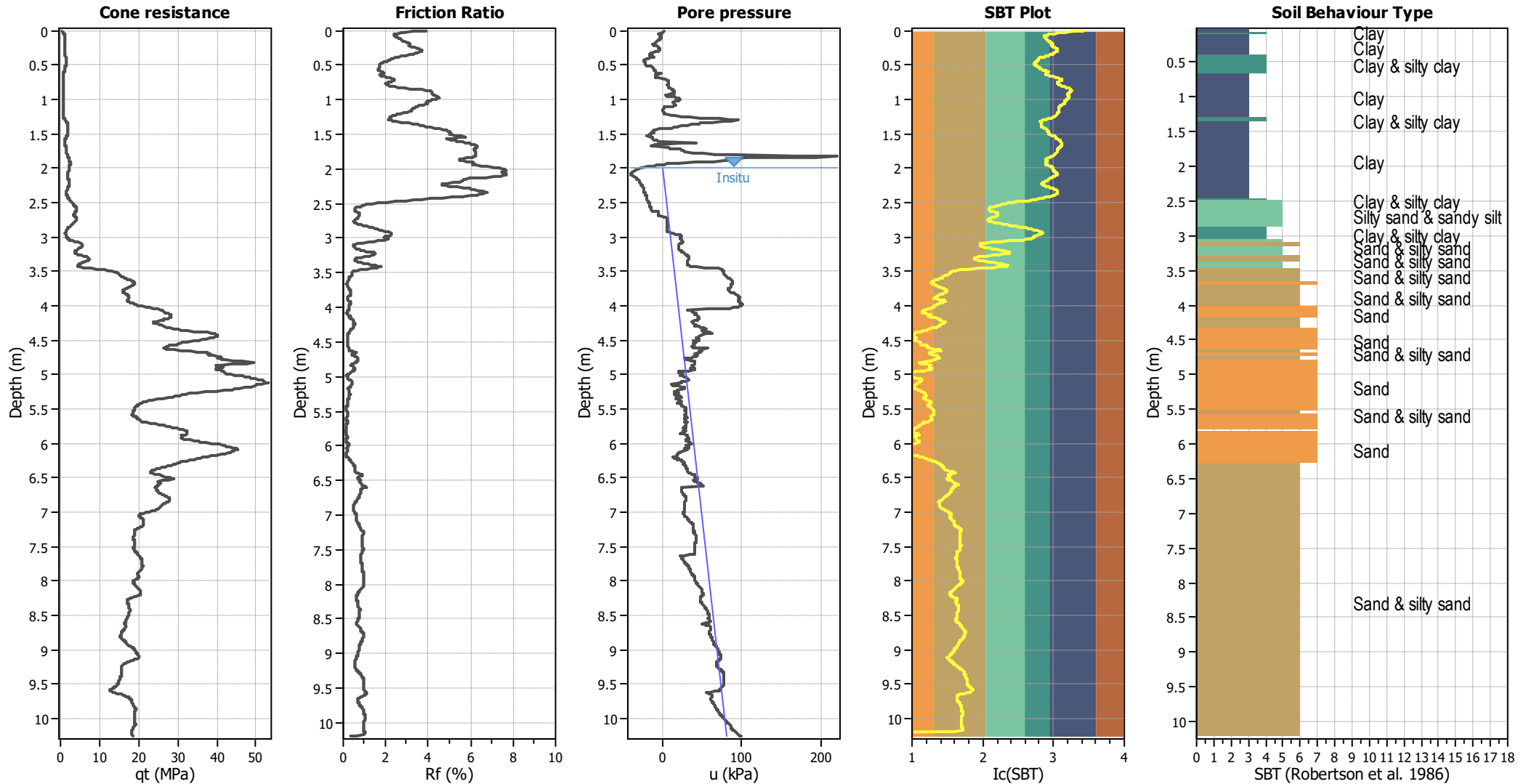
Input parameters and analysis data

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



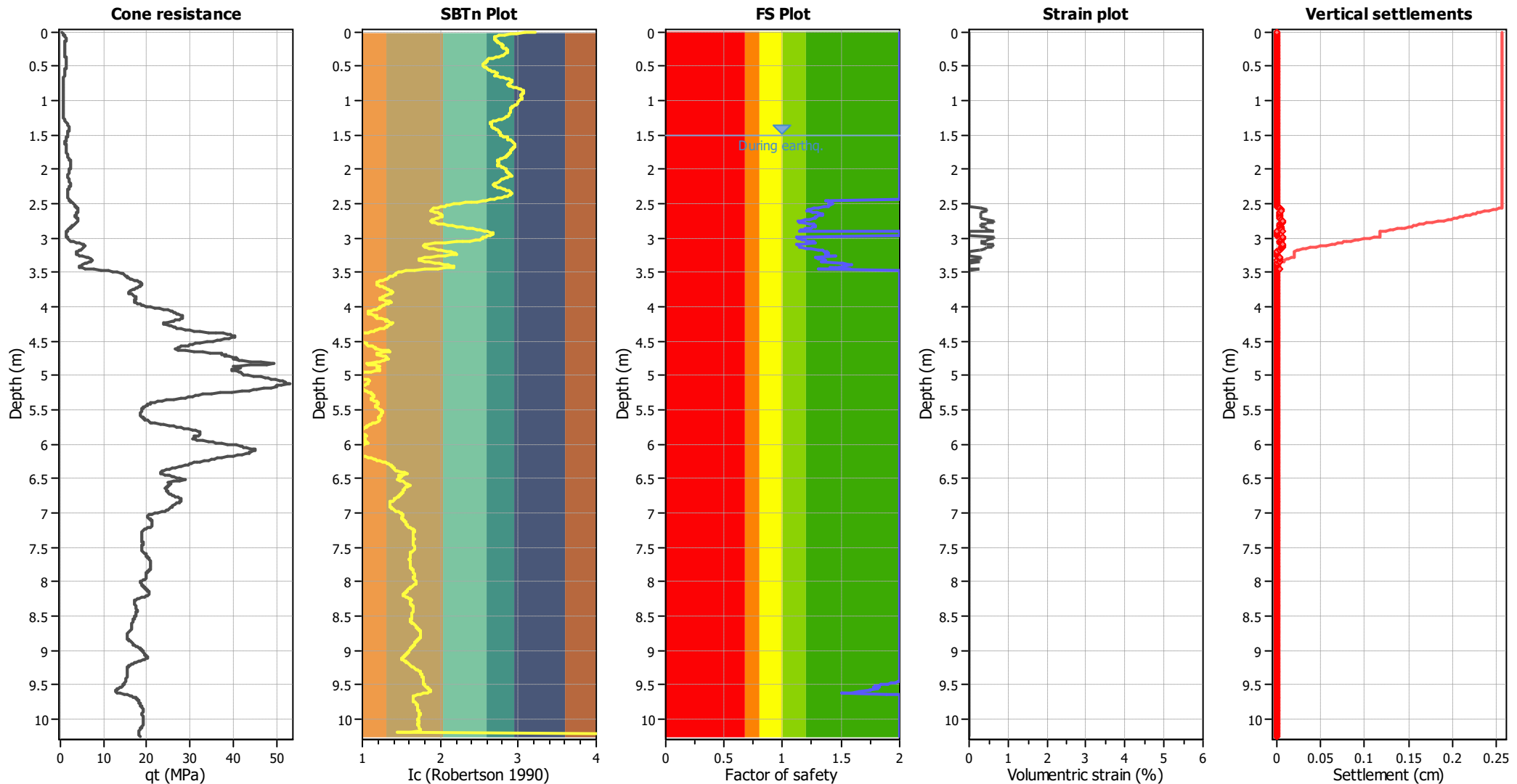
Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_f applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

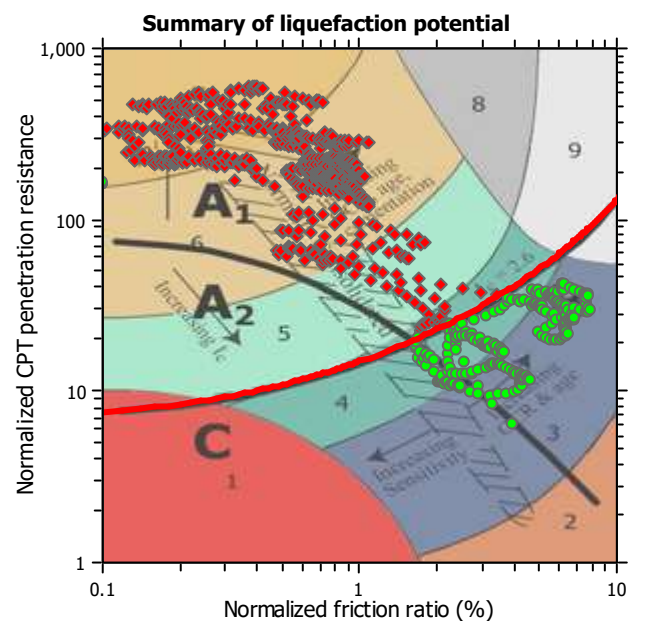
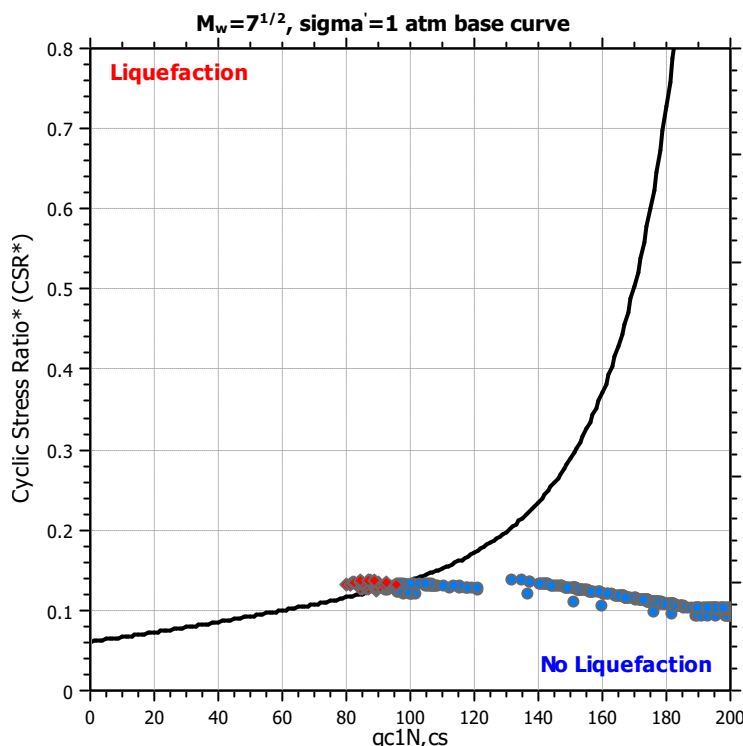
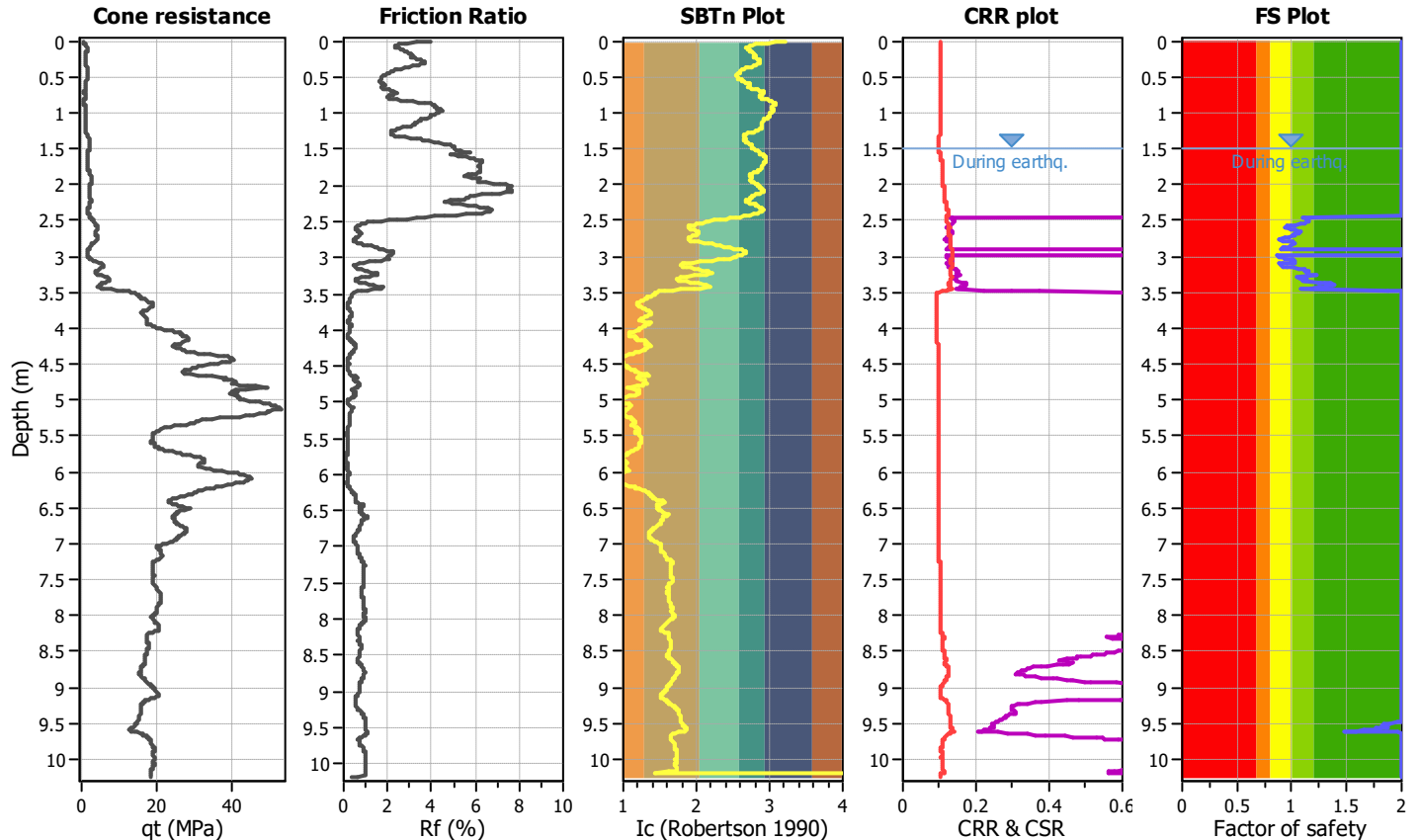
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT-01 SLS(B)

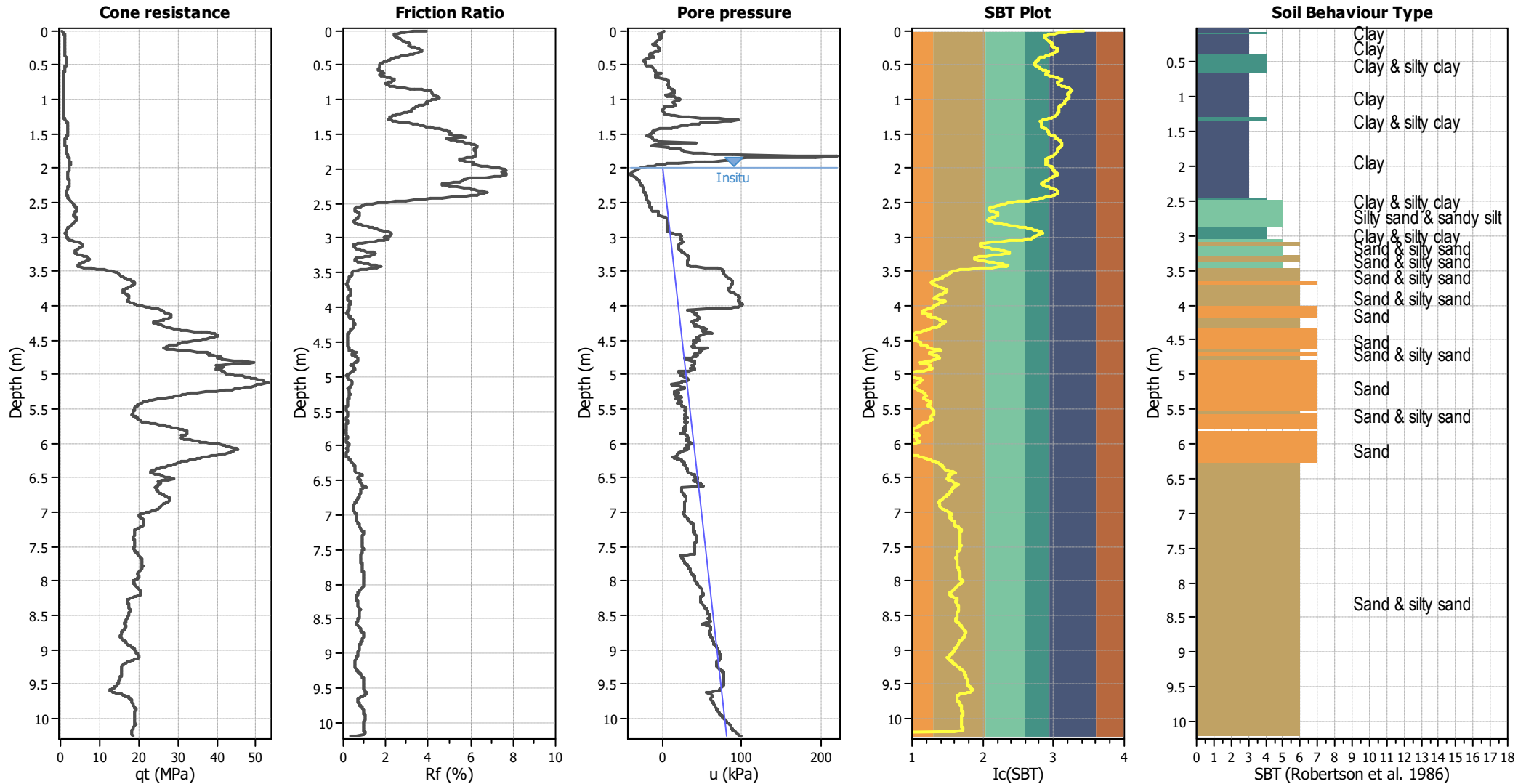
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



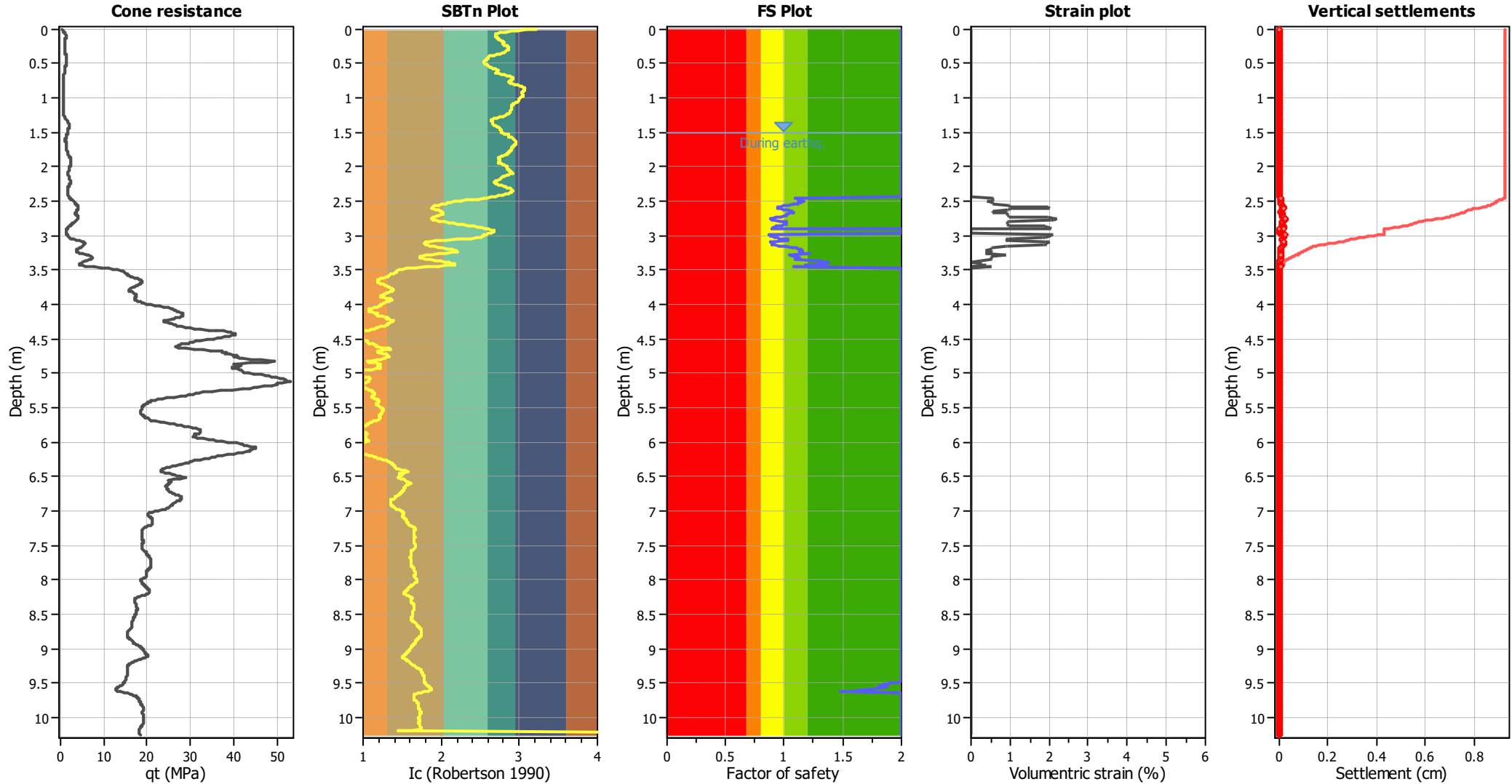
Input parameters and analysis data

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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 _g applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

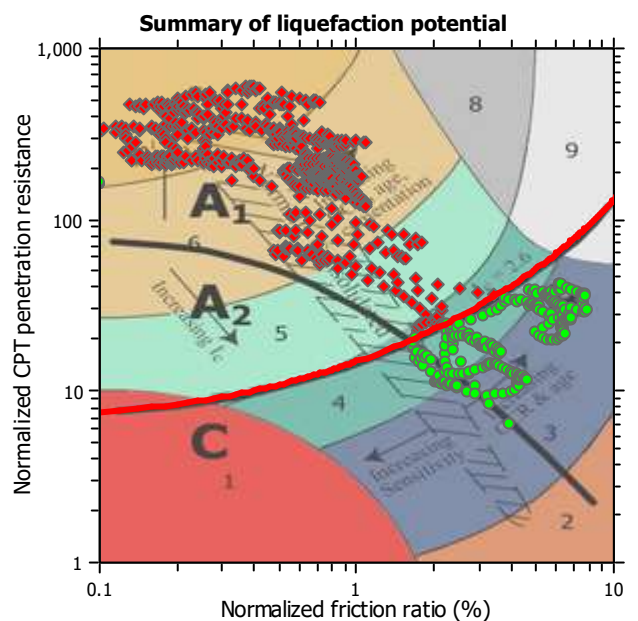
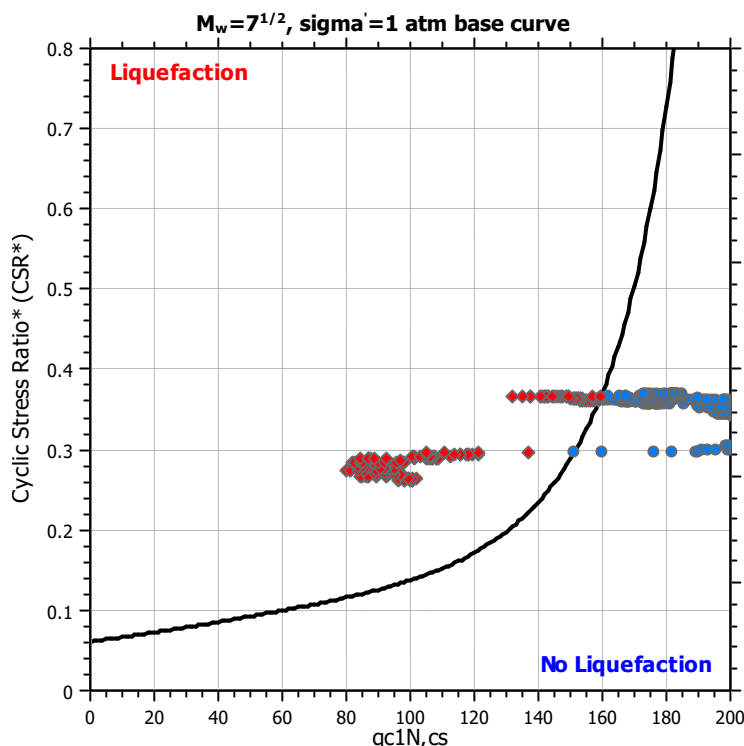
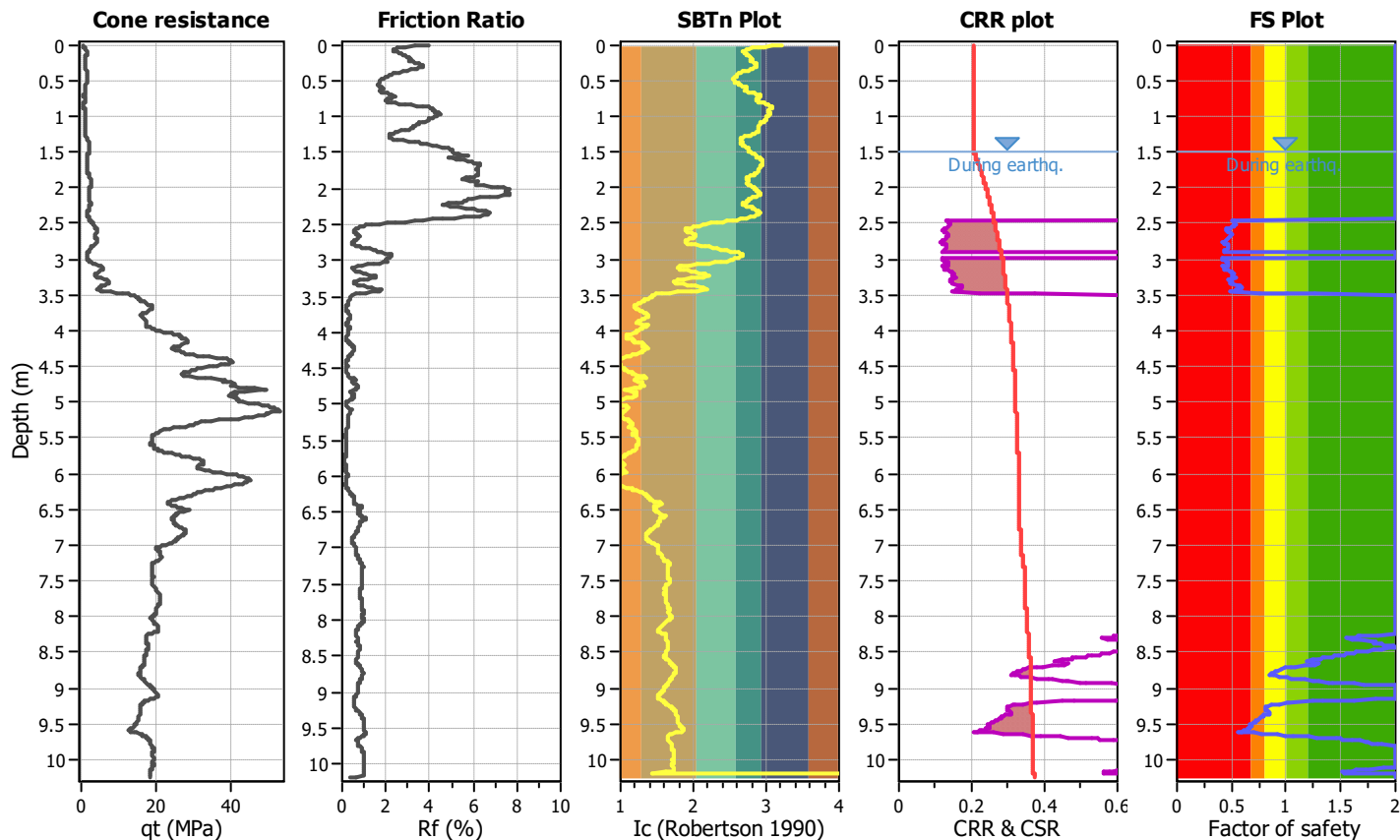
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT-01 ULS

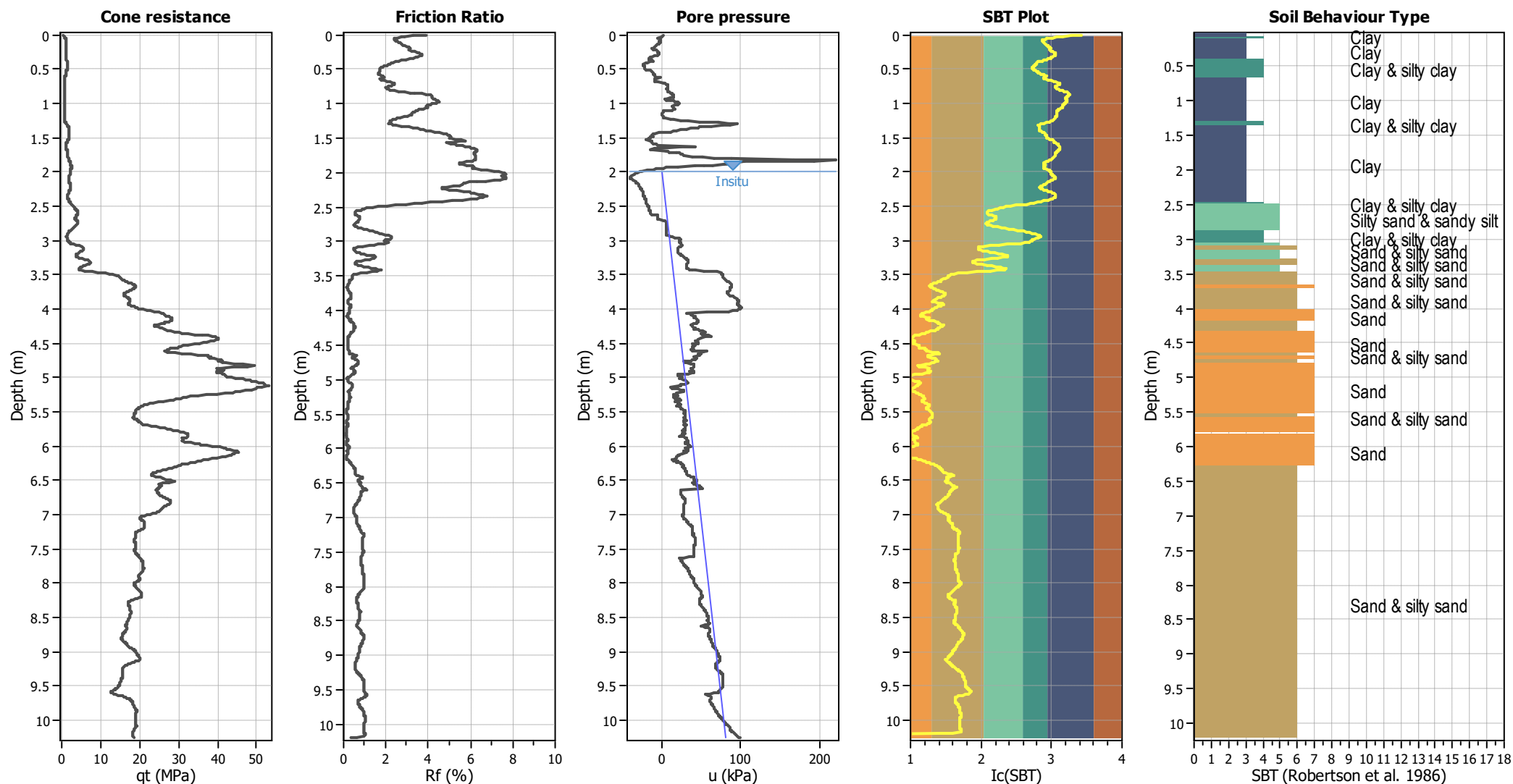
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry










Pore pressure



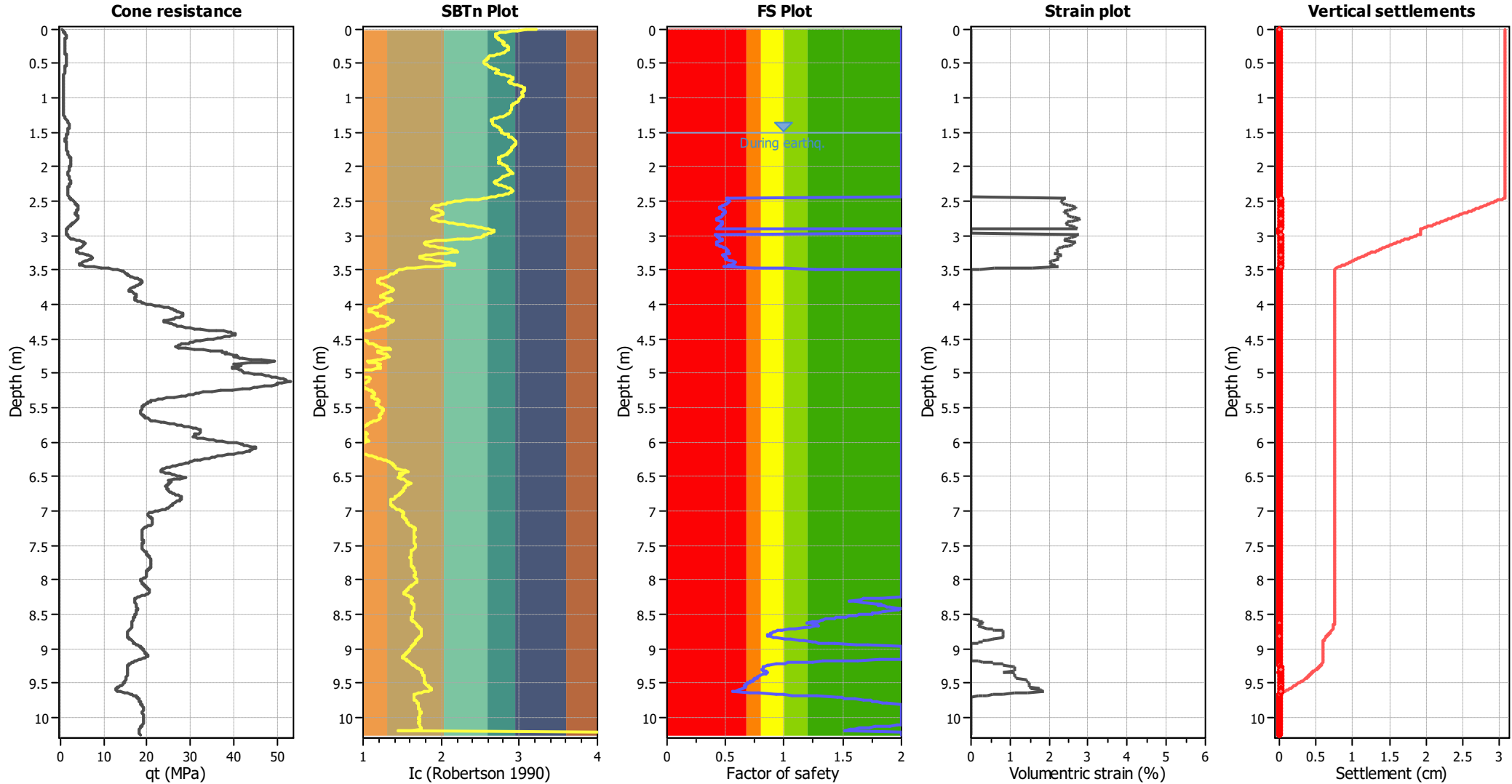
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

- | | | | | | |
|---|---------------------------|---|-----------------------------|---|----------------------------|
|  | 1. Sensitive fine grained |  | 4. Clayey silt to silty |  | 7. Gravely sand to sand |
|  | 2. Organic material |  | 5. Silty sand to sandy silt |  | 8. Very stiff sand to |
|  | 3. Clay to silty clay |  | 6. Clean sand to silty sand |  | 9. Very stiff fine grained |

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

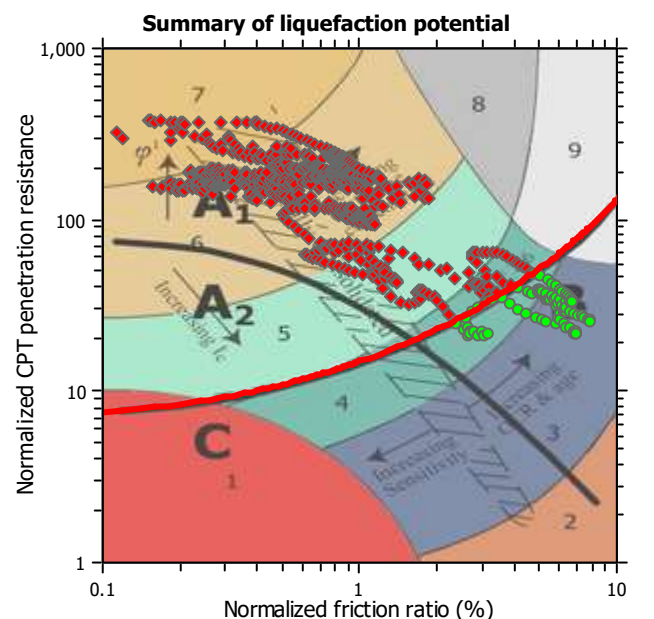
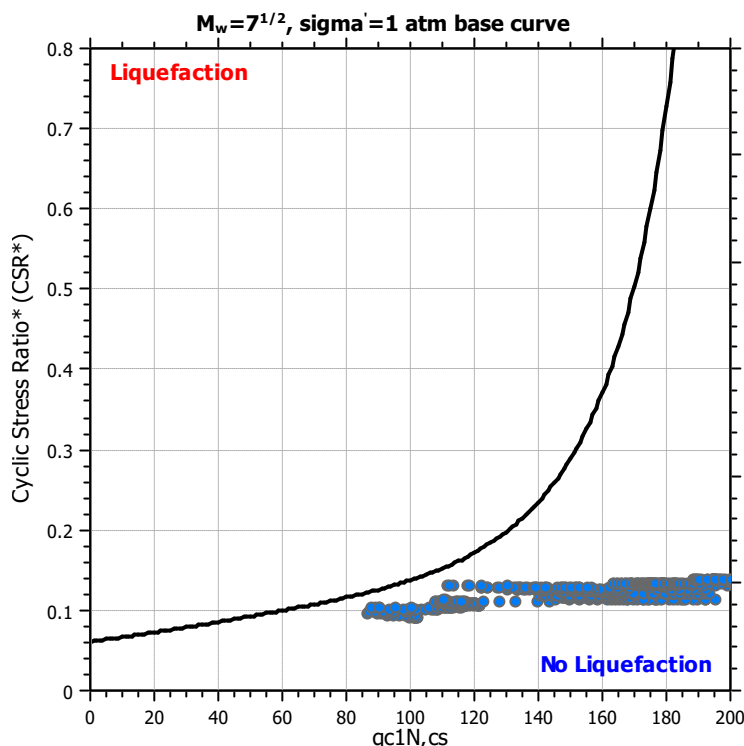
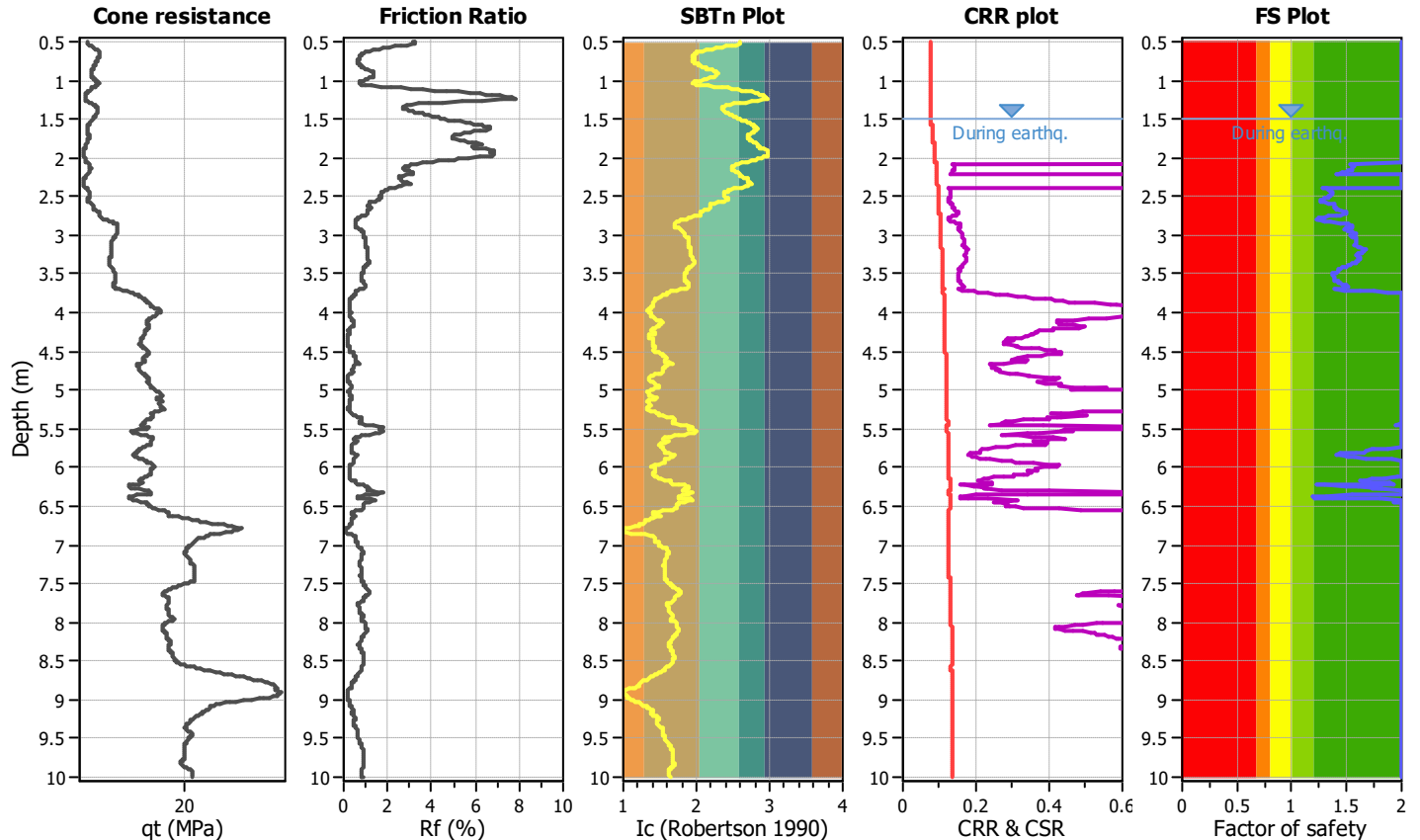
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT_19781 SLS(A)

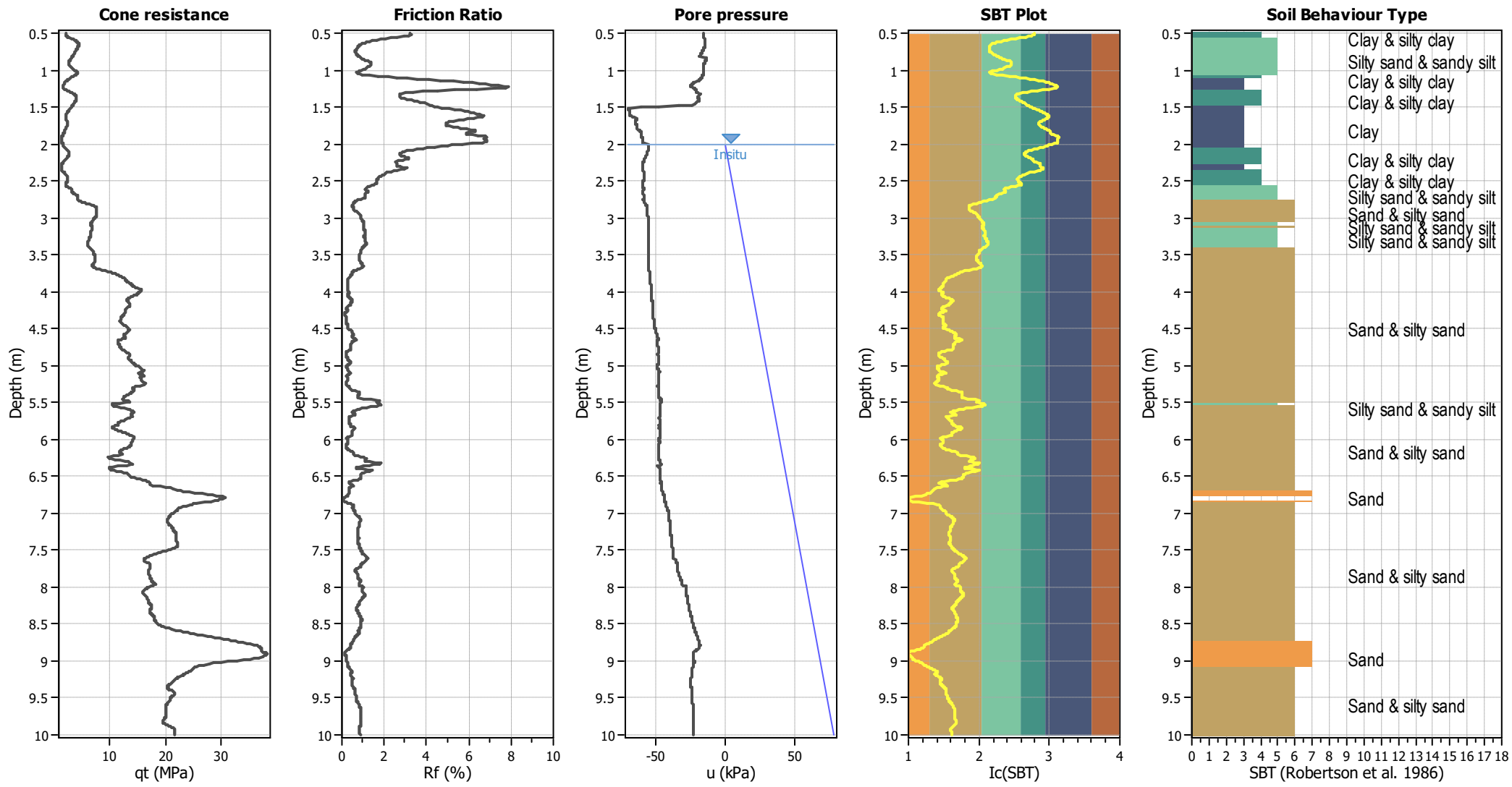
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



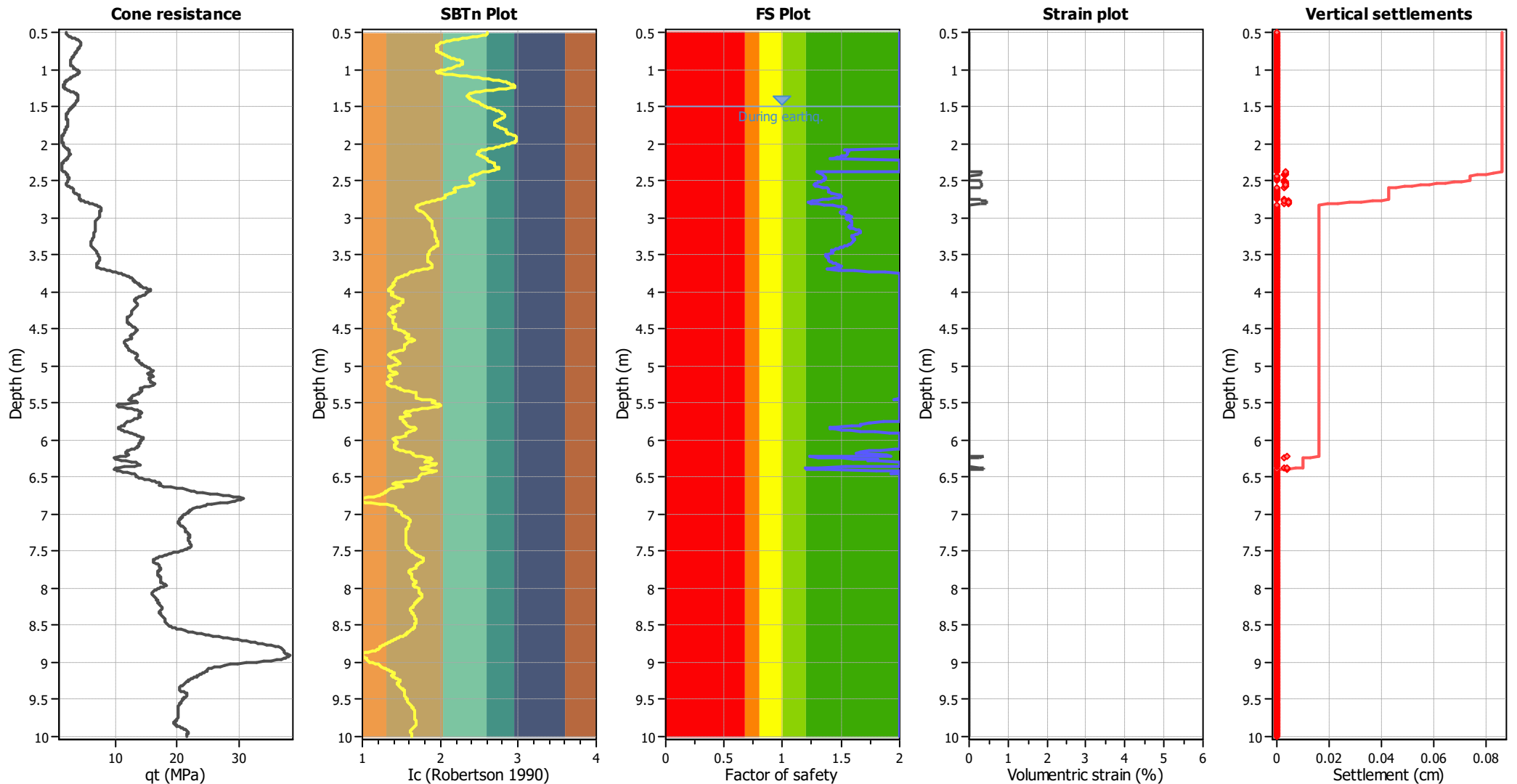
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

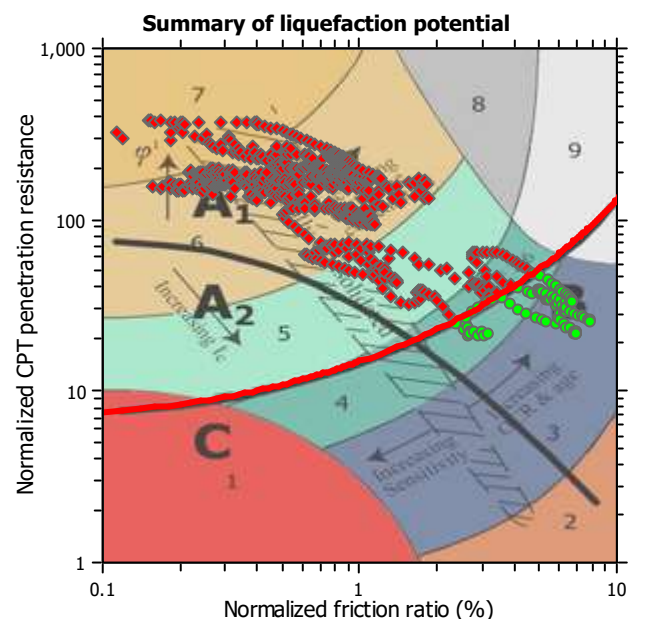
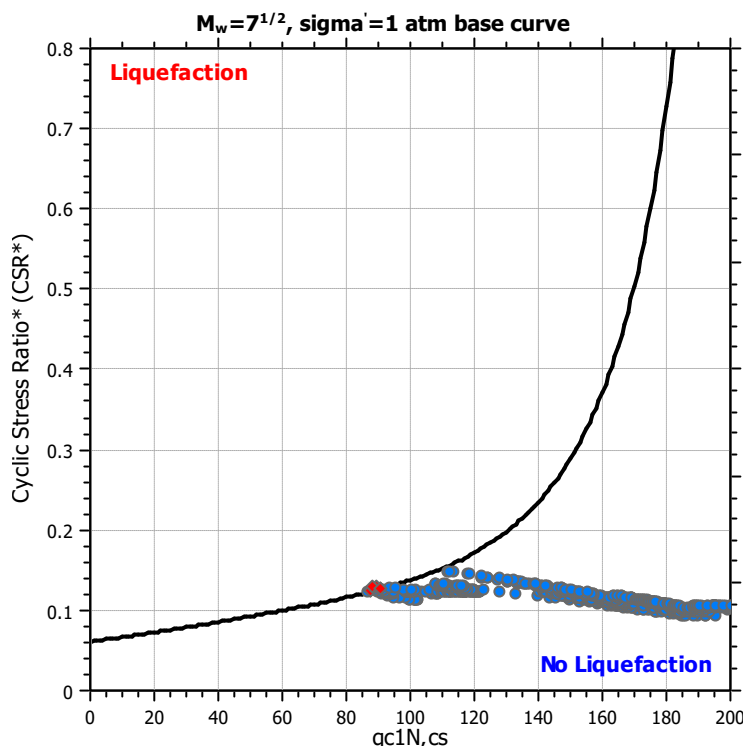
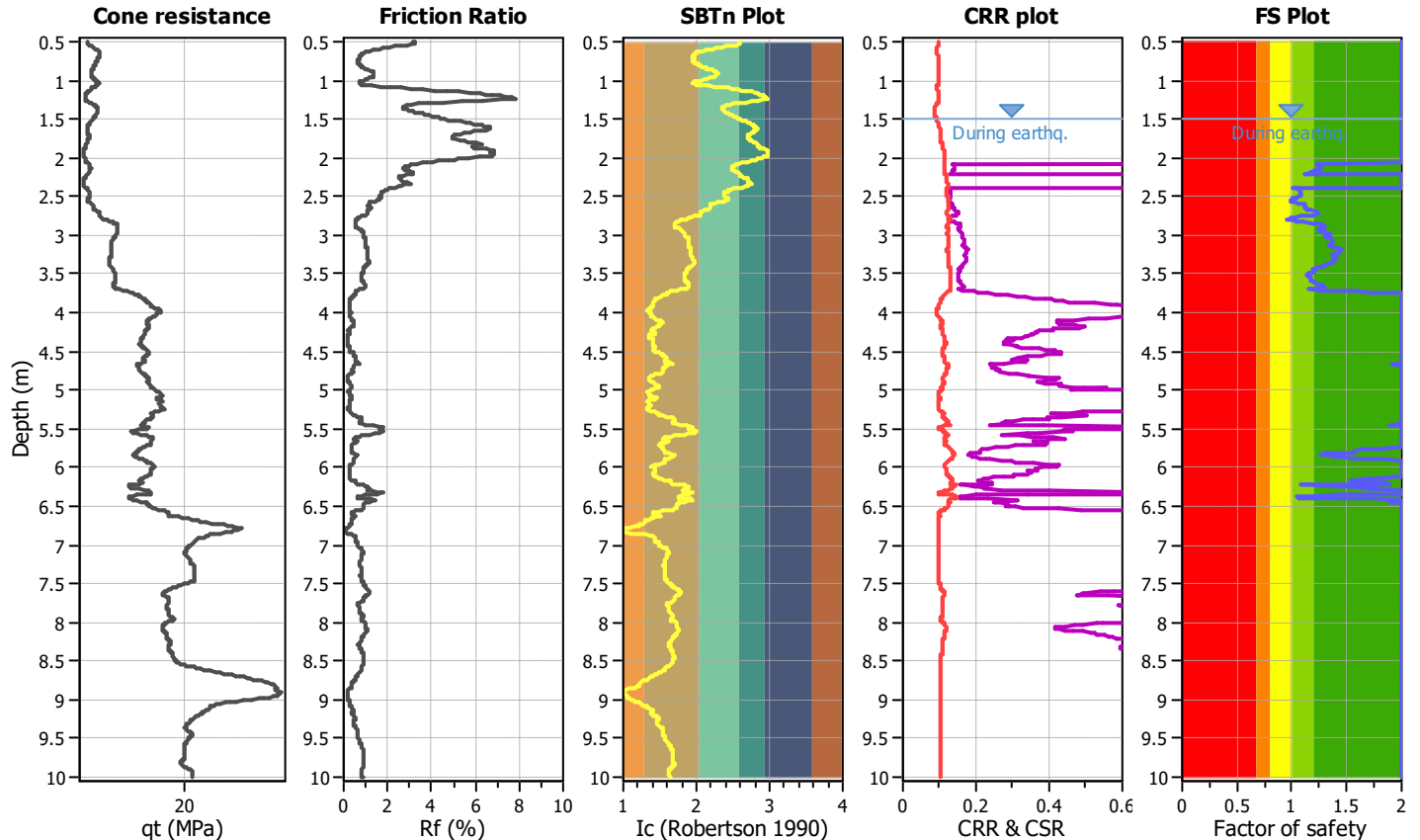
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT_19781 SLS(B)

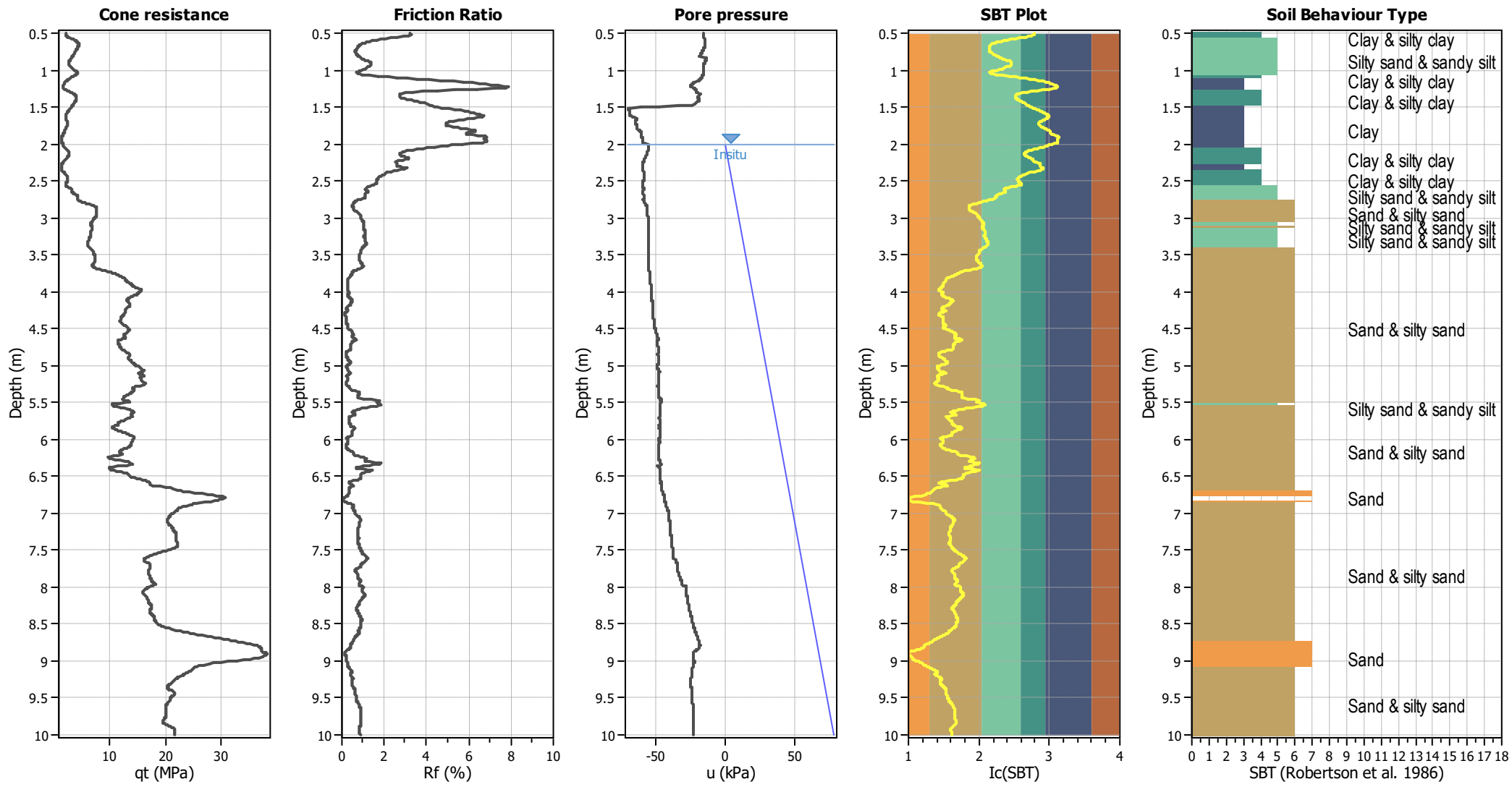
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



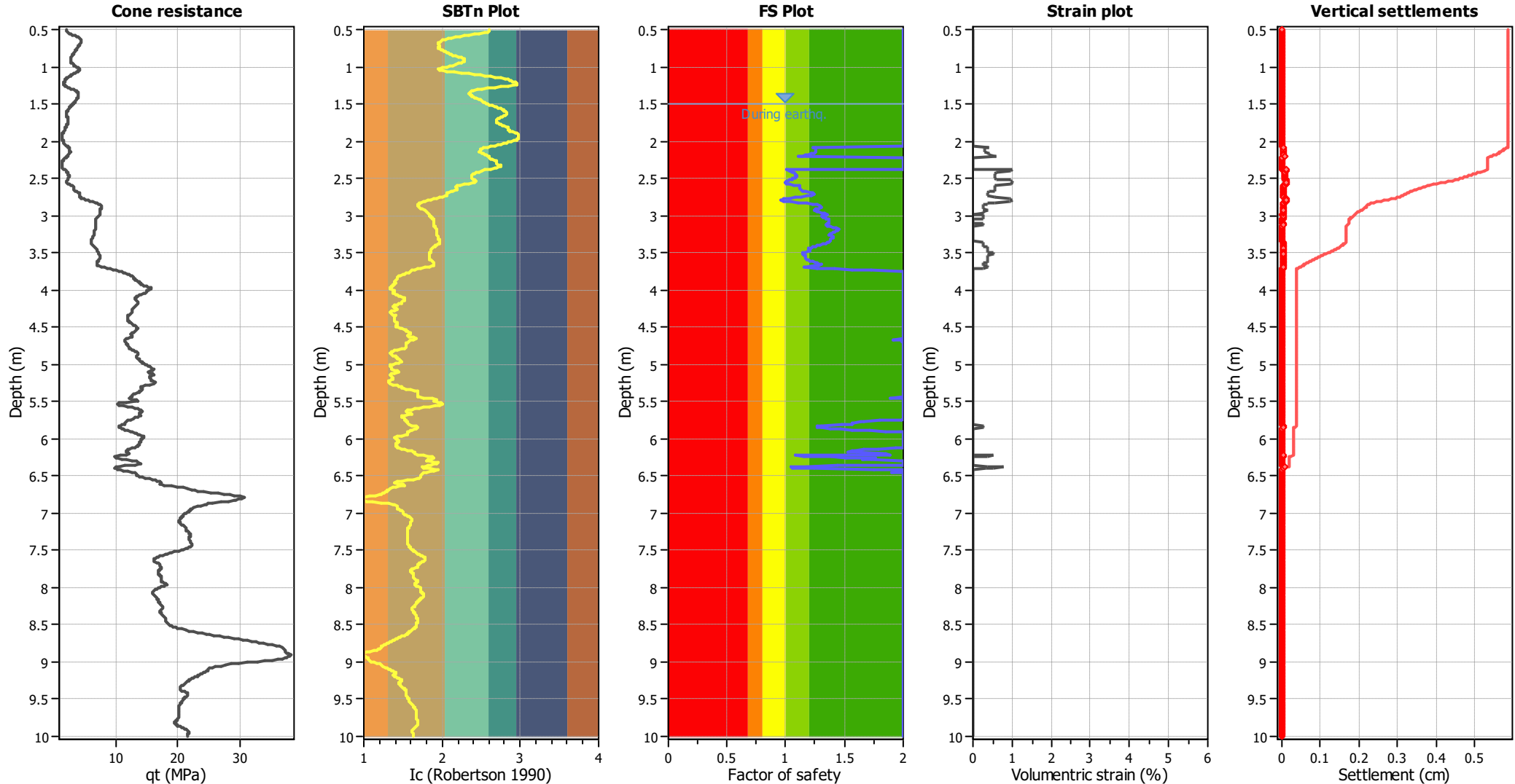
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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

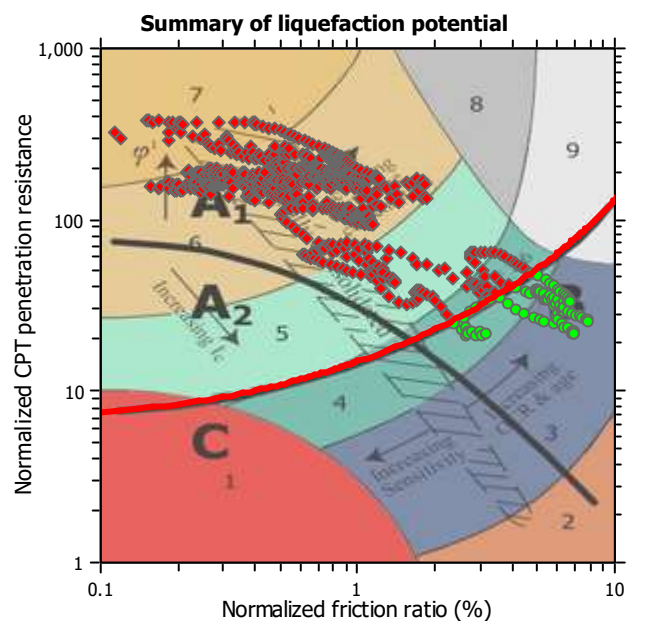
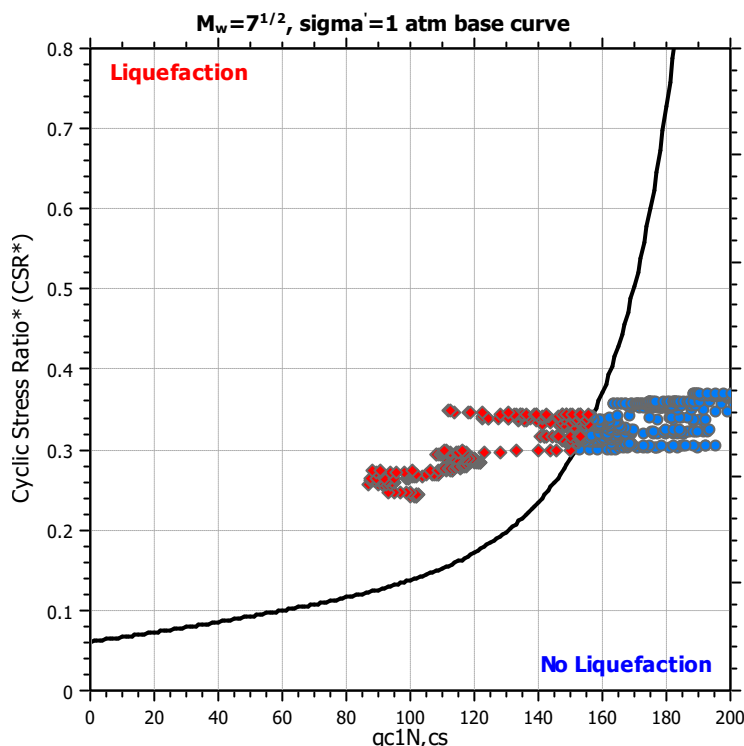
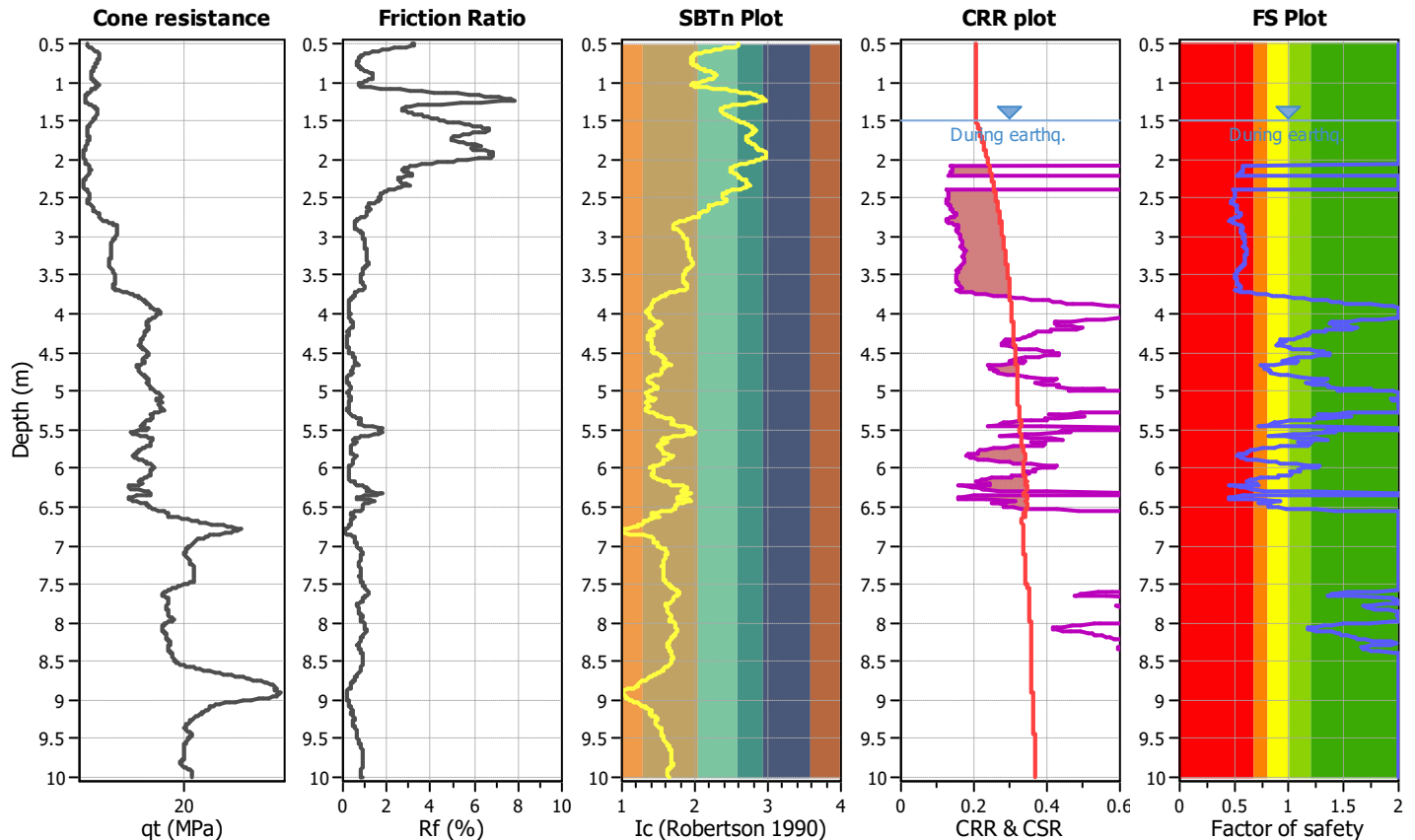
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT_19781 ULS

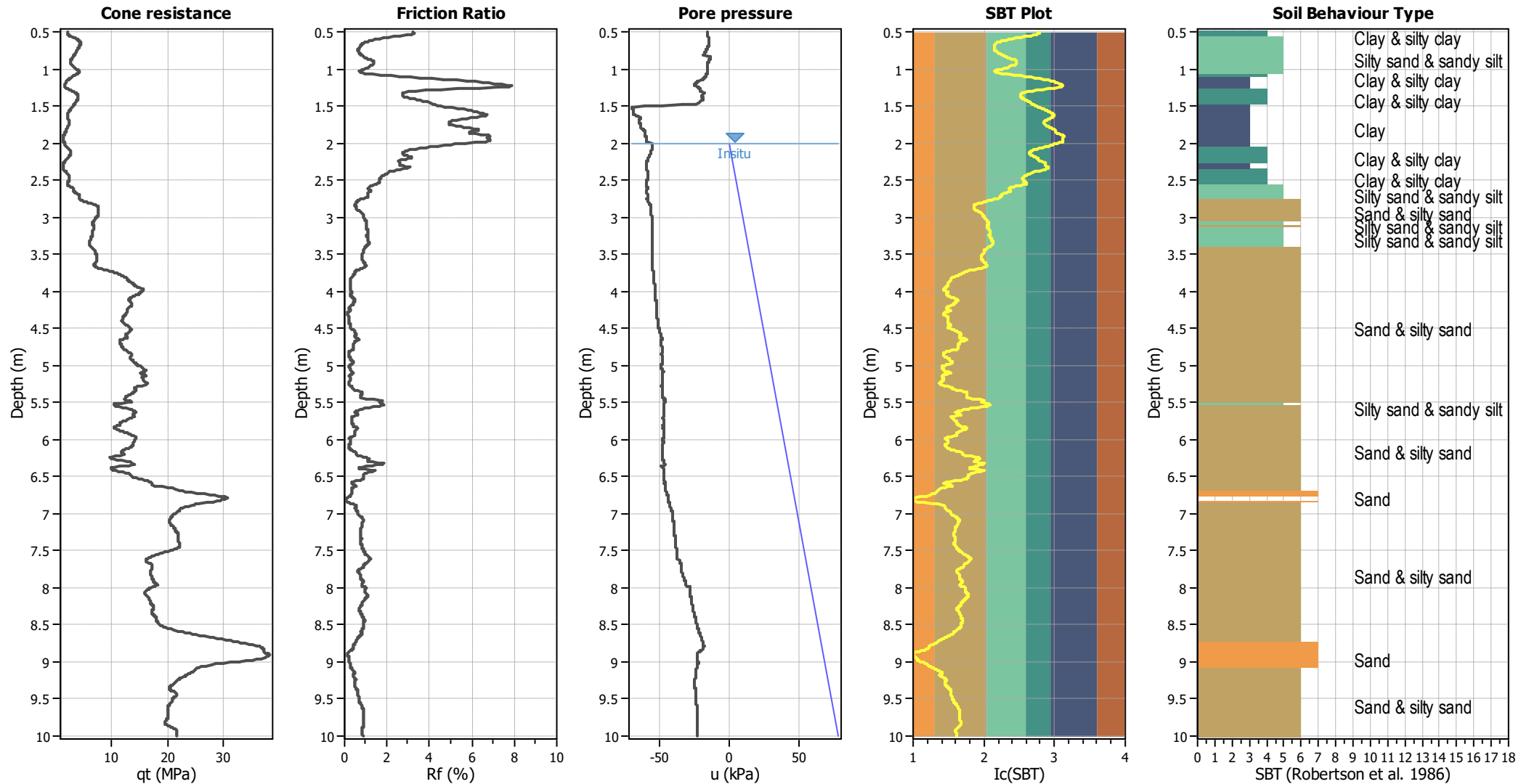
Input parameters and analysis data

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Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



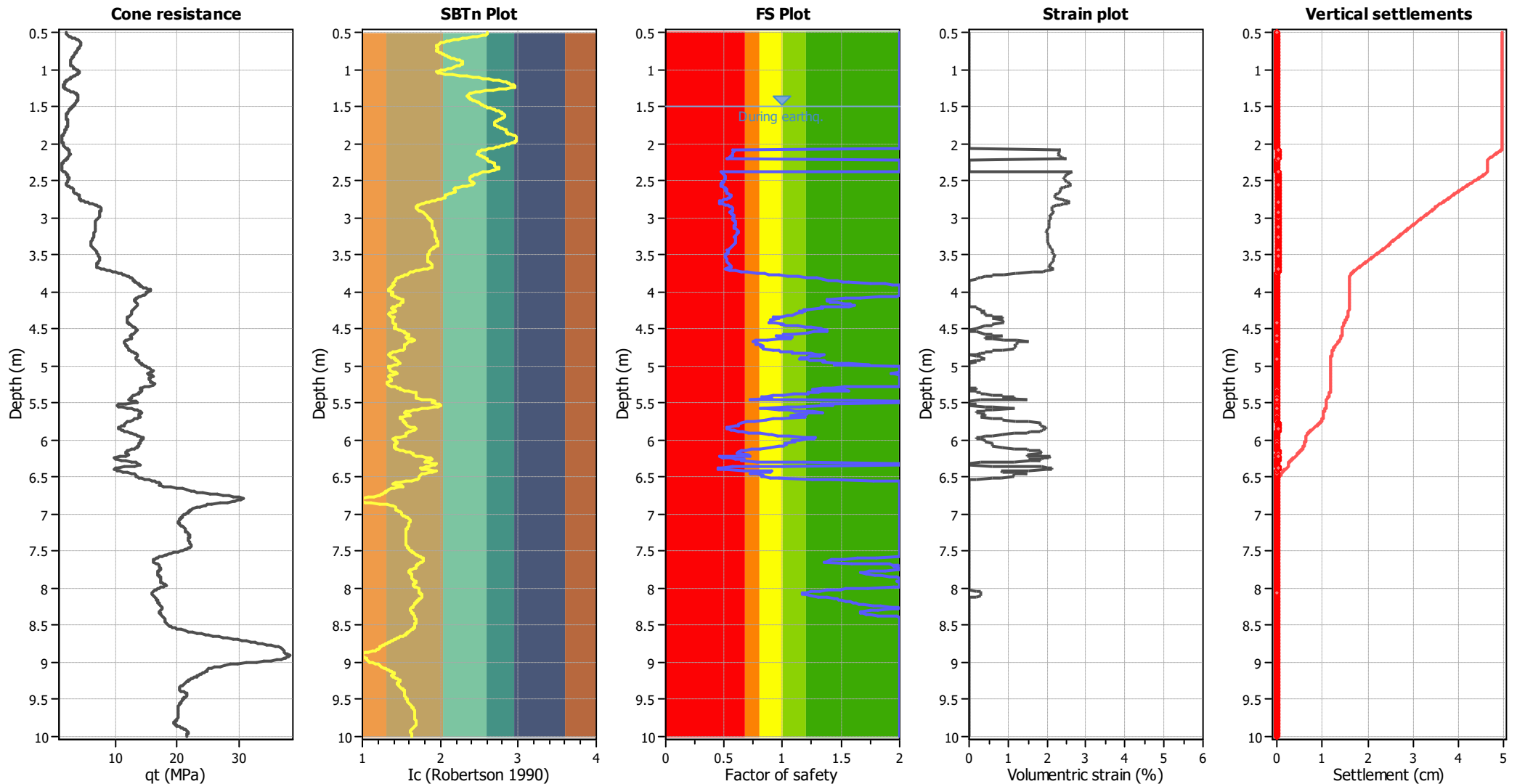
Input parameters and analysis data

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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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	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):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

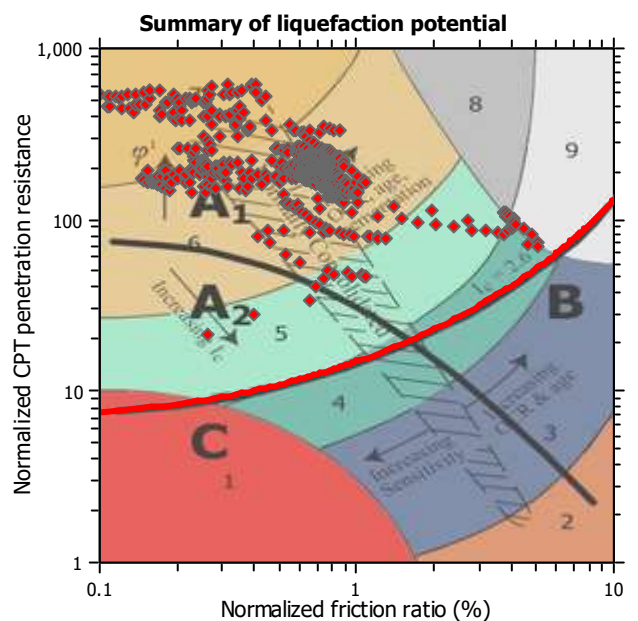
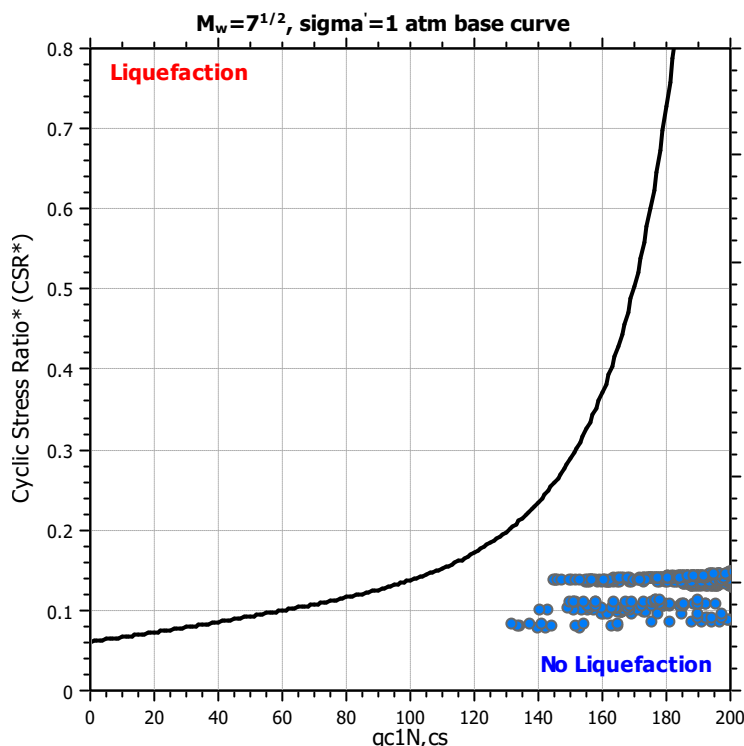
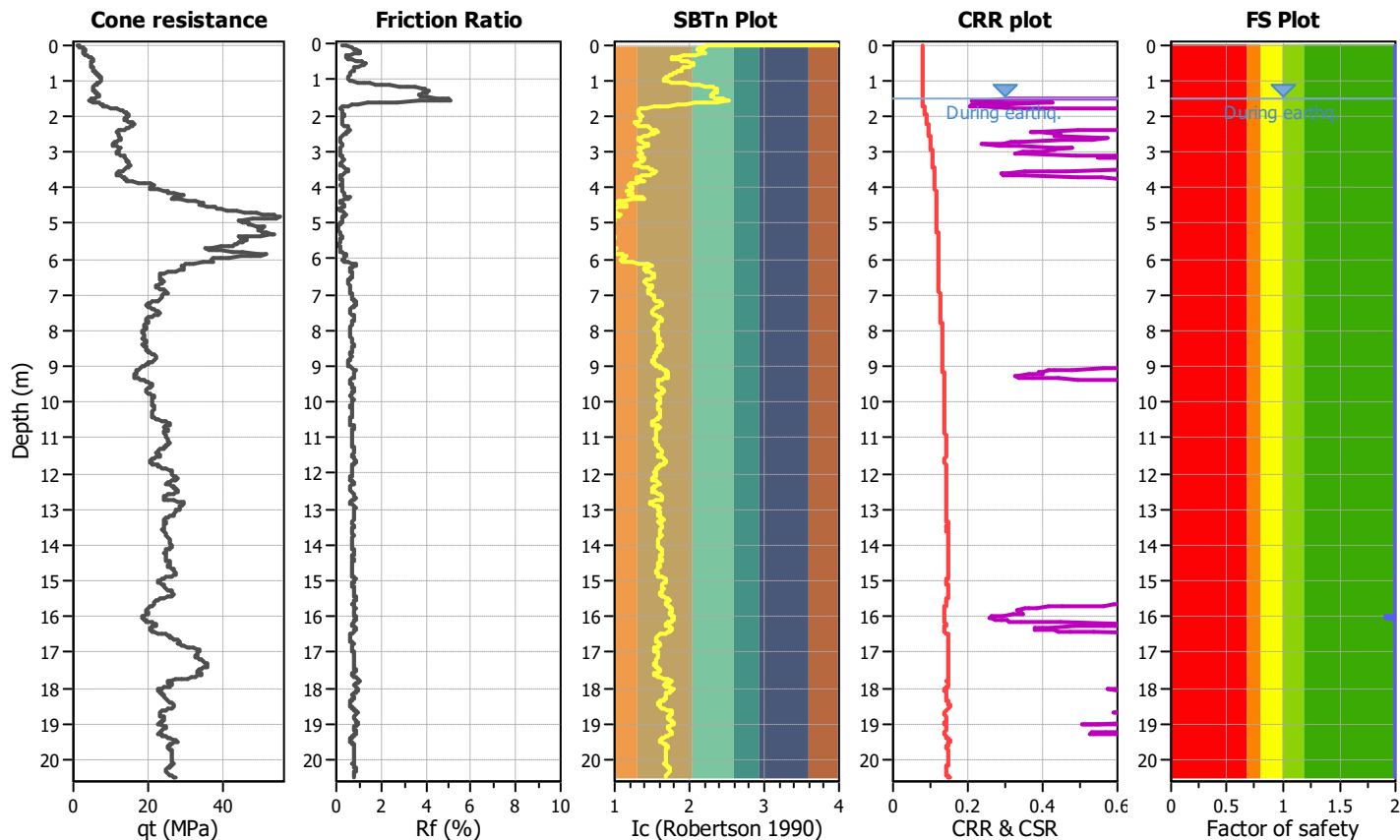
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CPT file : CPT_189374 SLS(A)

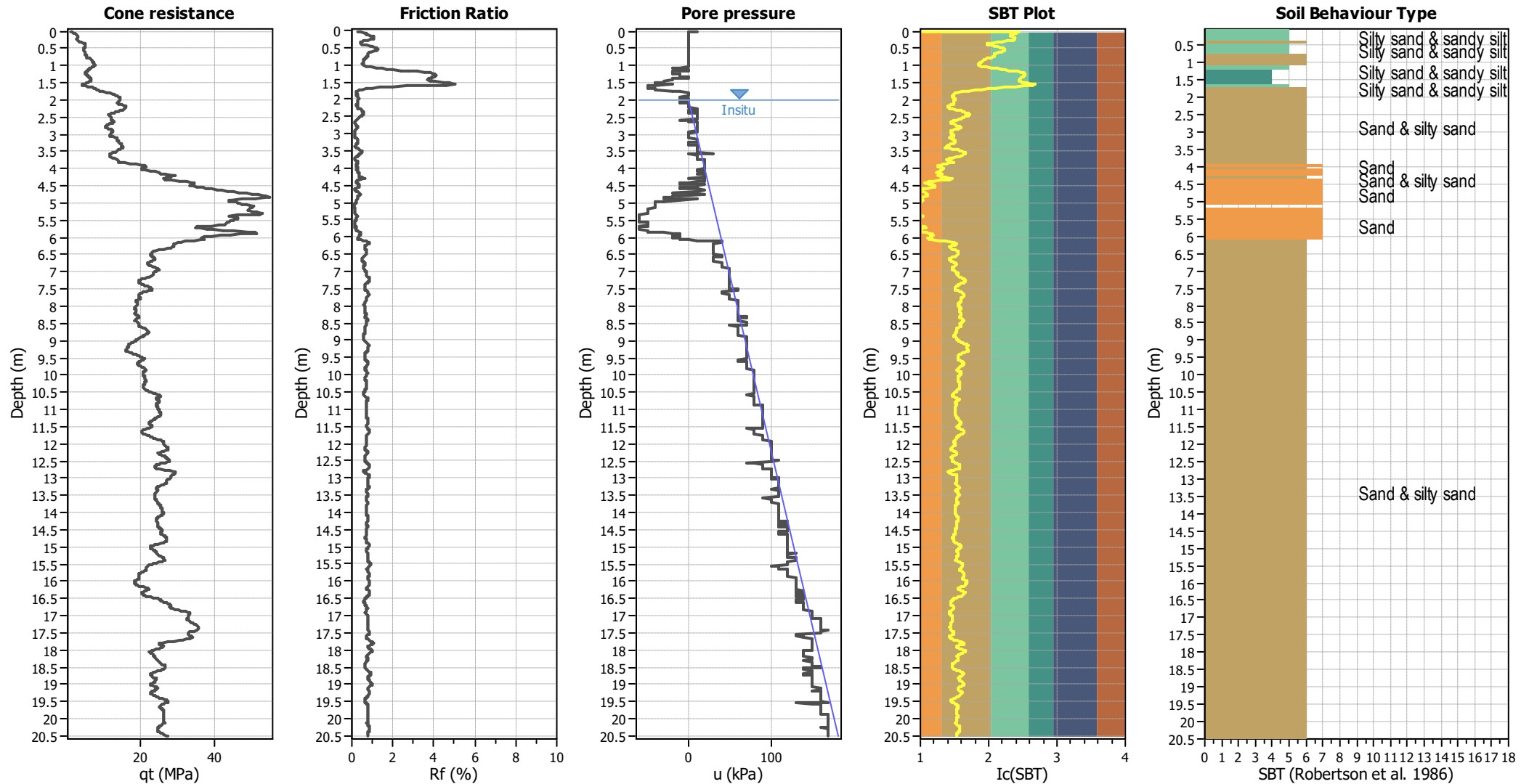
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



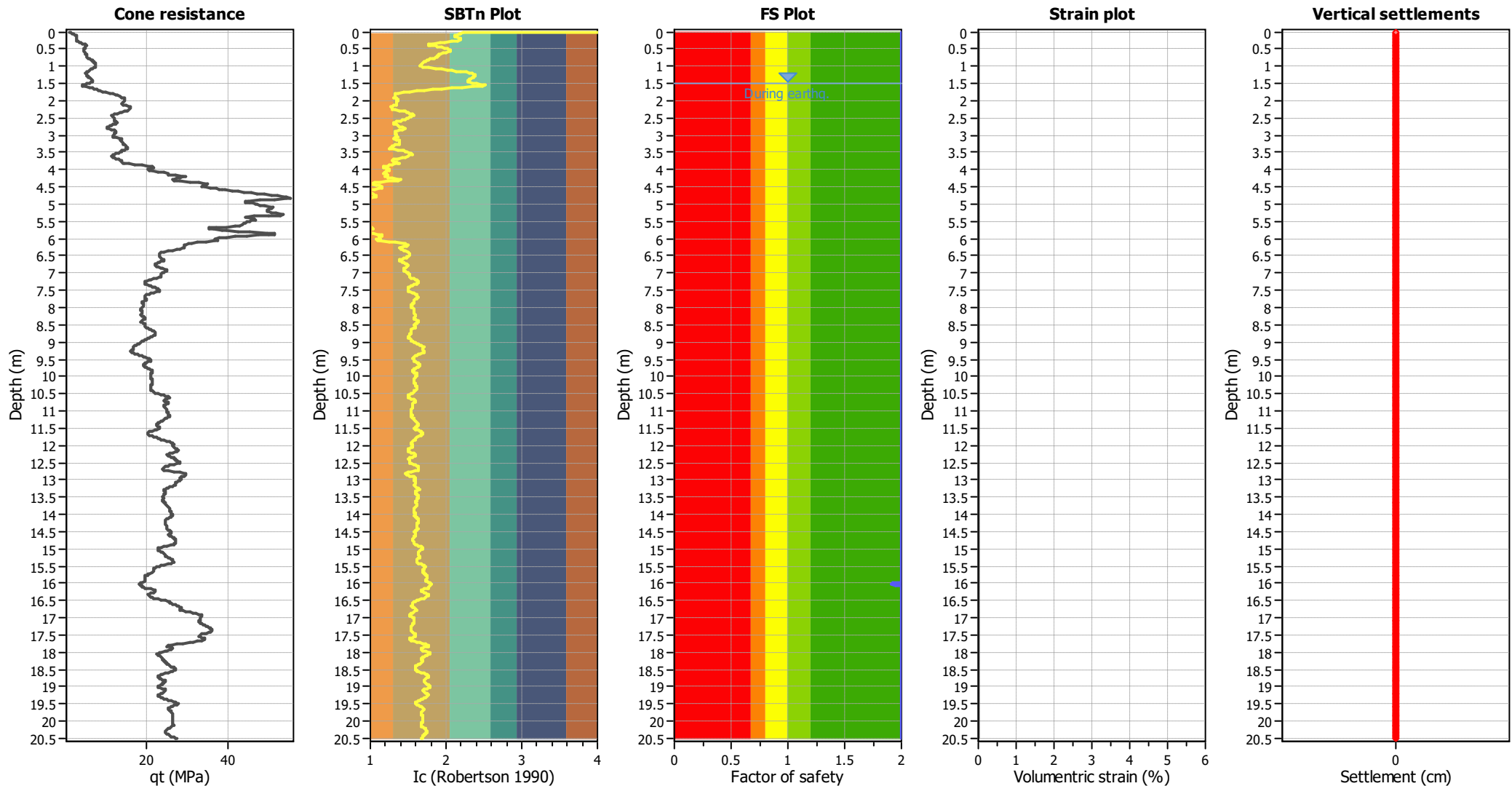
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

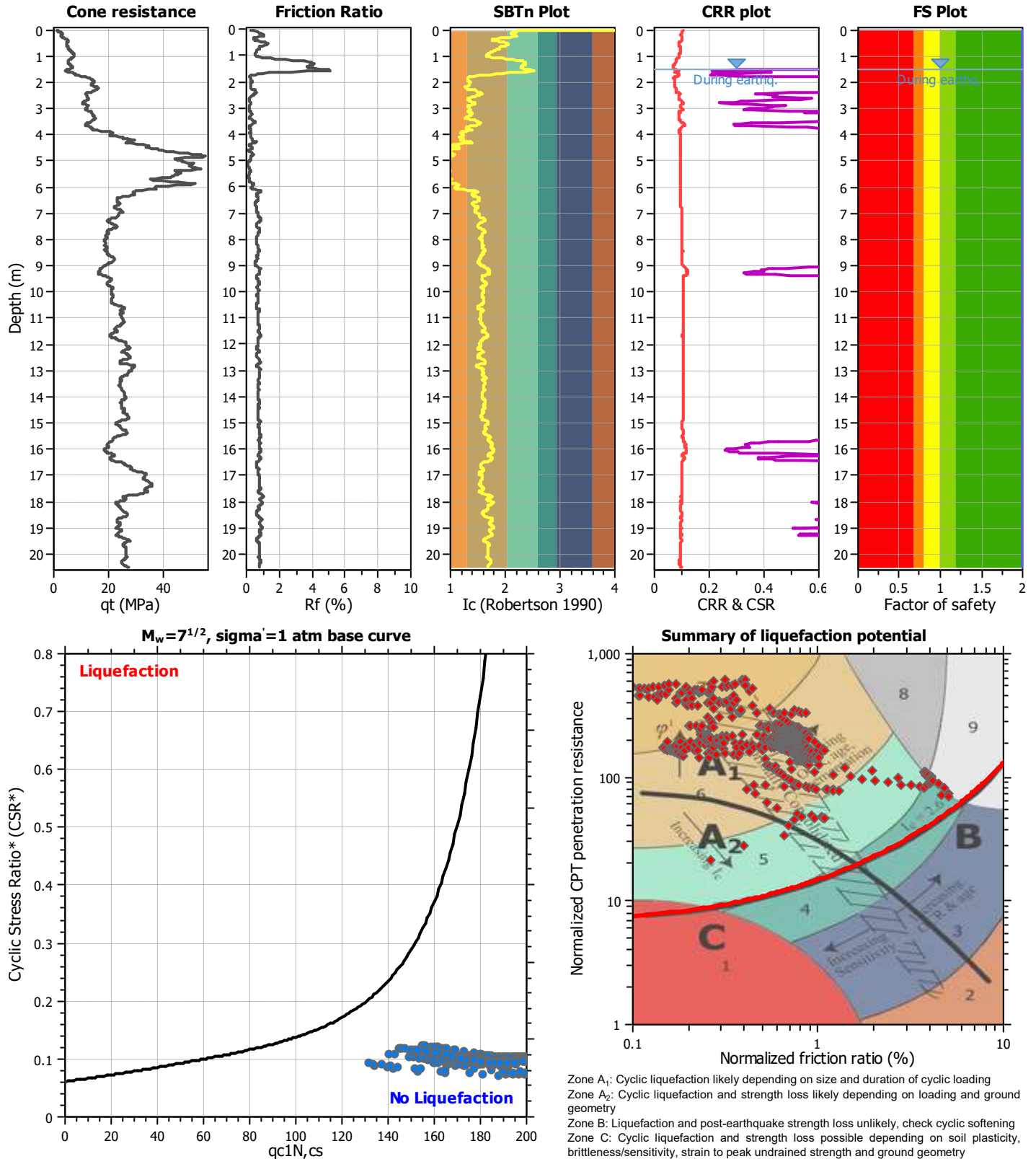
Project title : K230406

Location : 19 Belfield Street

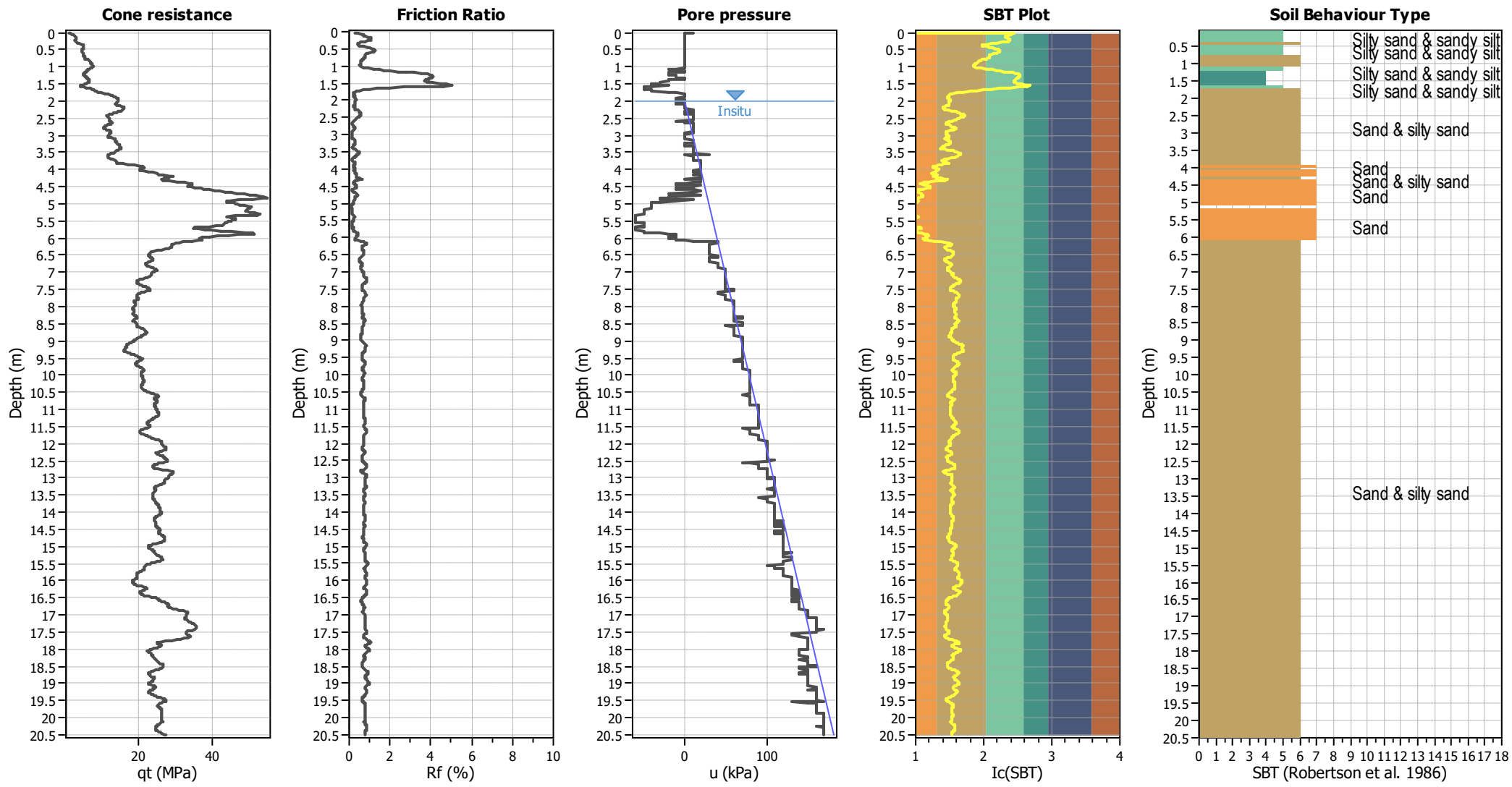
CPT file : CPT_189374 SLS(B)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



CPT basic interpretation plots



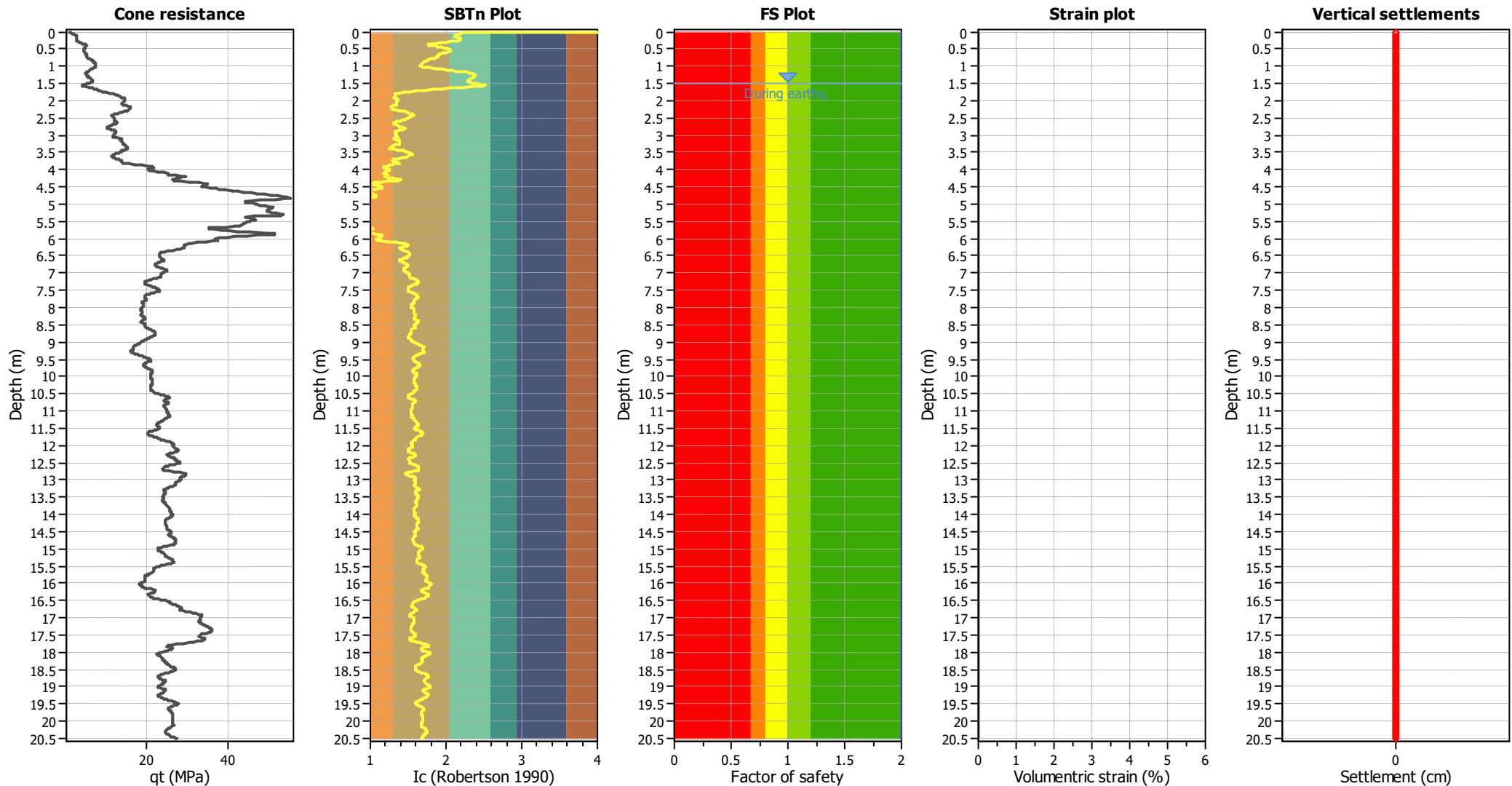
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 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 :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

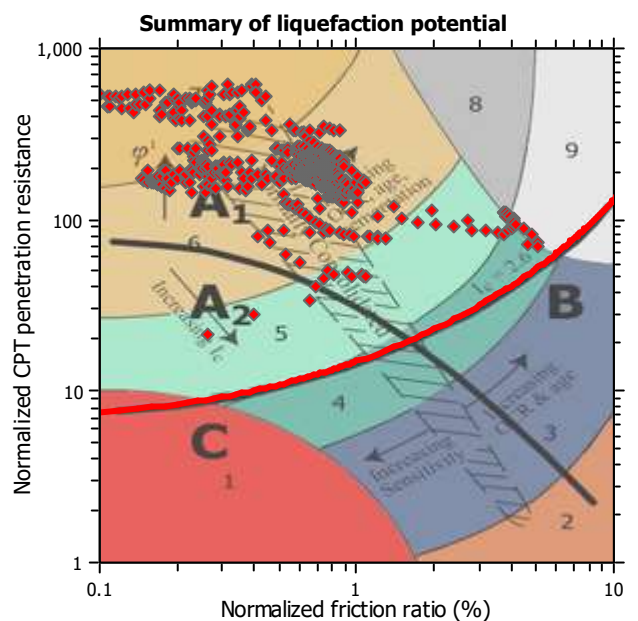
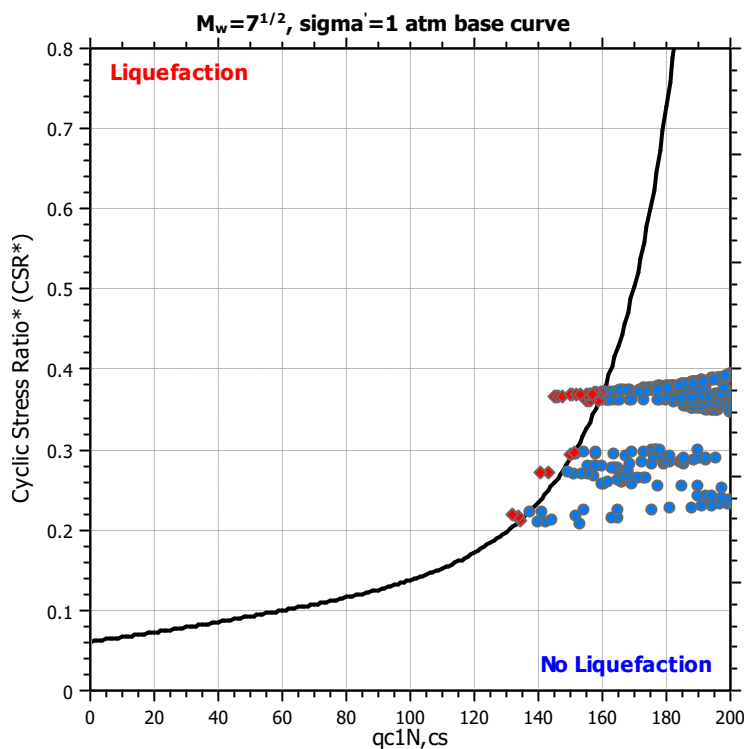
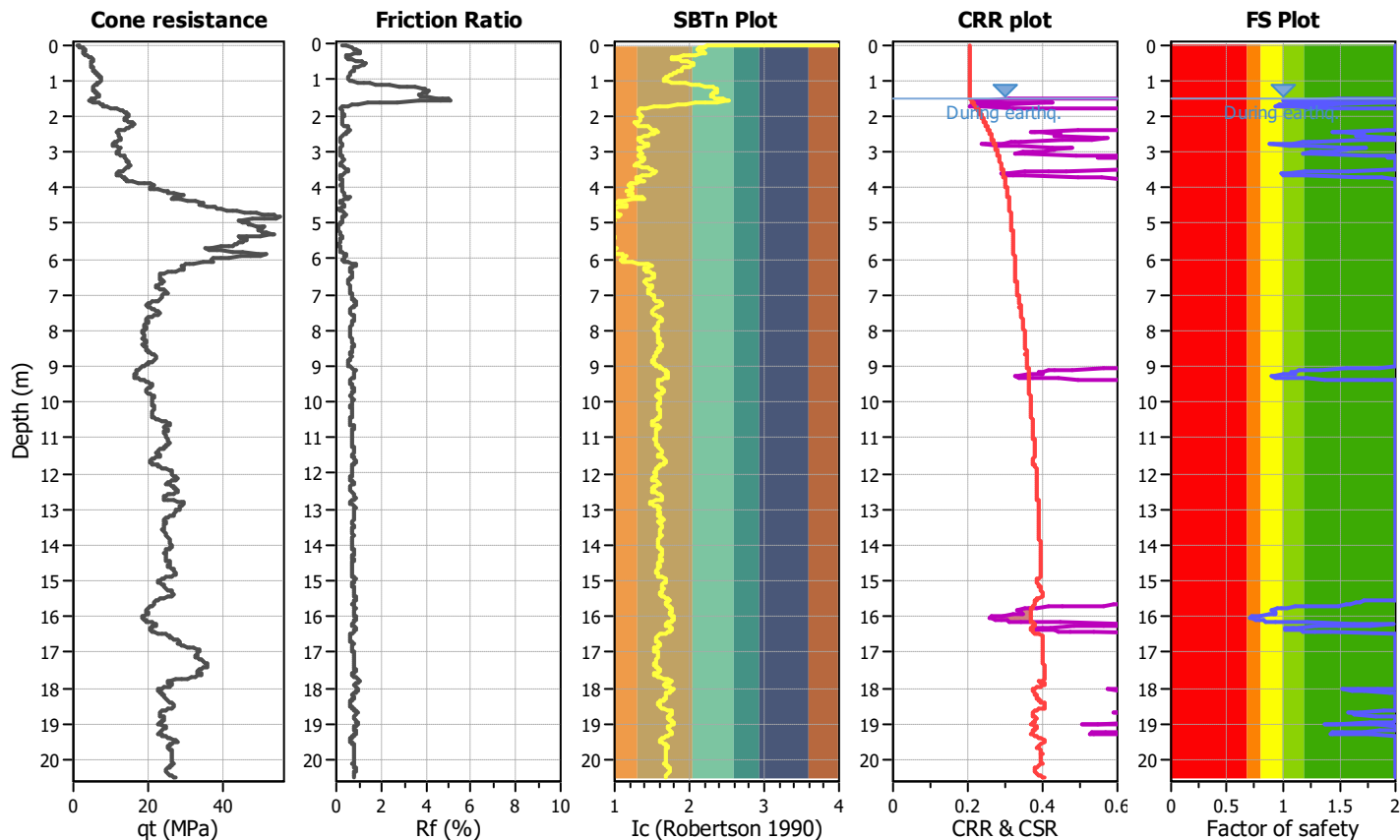
Project title : K230406

Location : 19 Belfield Street

CPT file : CPT_189374 ULS

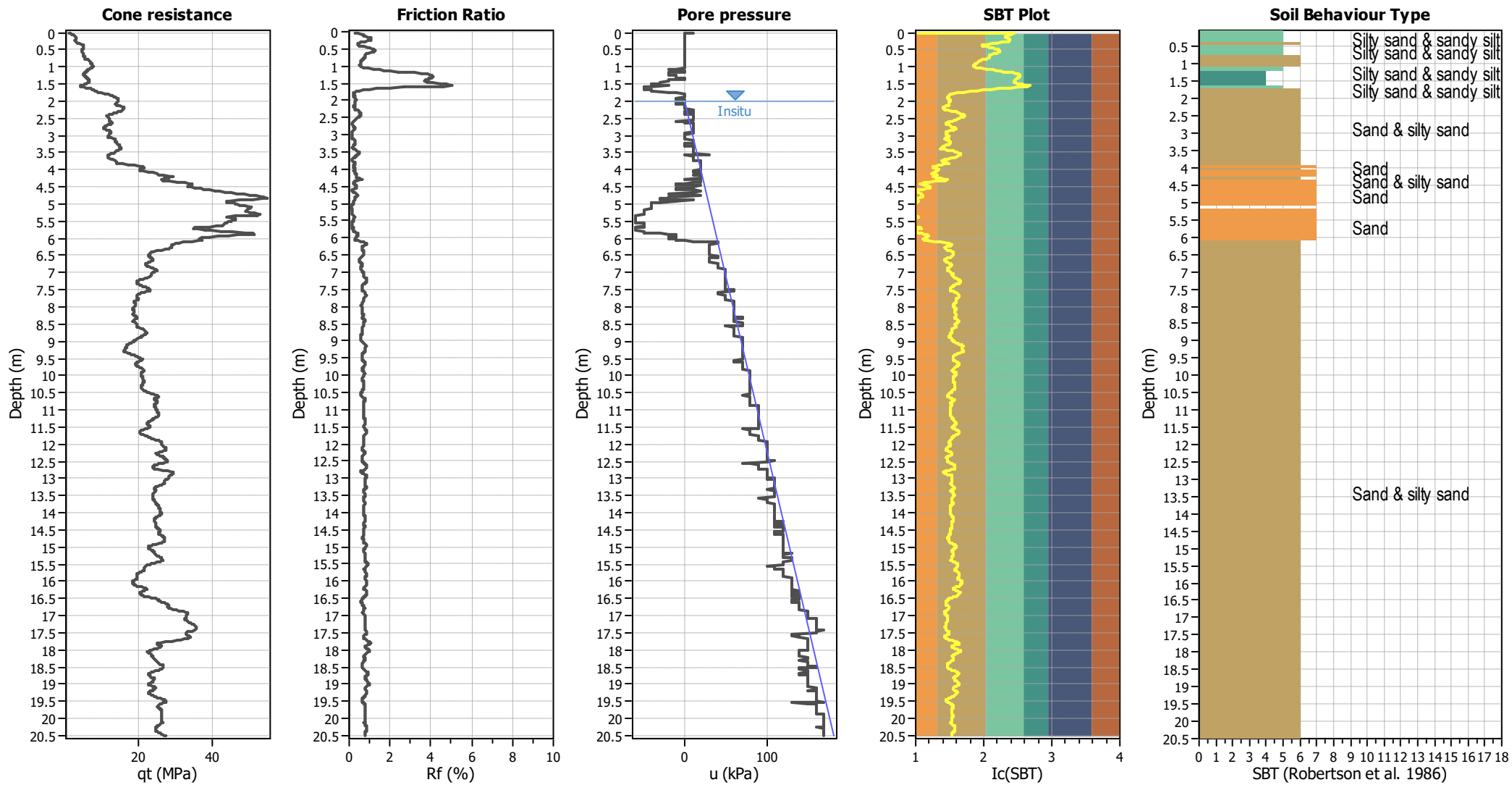
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



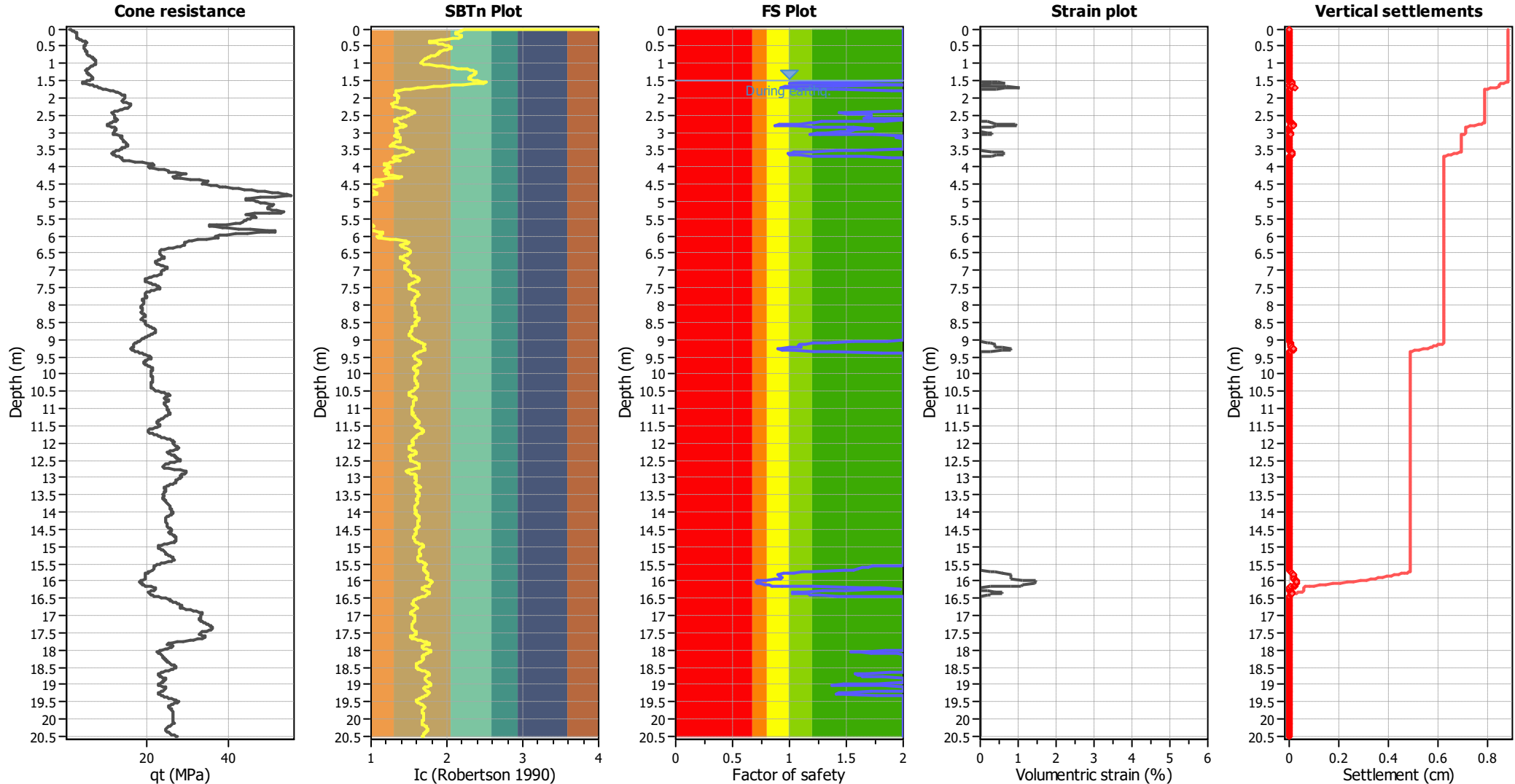
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
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- Volumetric strain: Post-liquefaction volumetric strain

Cavity Critter

Under floor Inspections

www.underfloorinspections.co.nz

106 Raddens Road

Ohoka

RD2 Kaiapoi 7692

021 343156

gideon@underfloorinspections.co.nz

Report prepared for: EQC

Property address: 19 Belfield Street, Dallington

Date: 6 February 2023

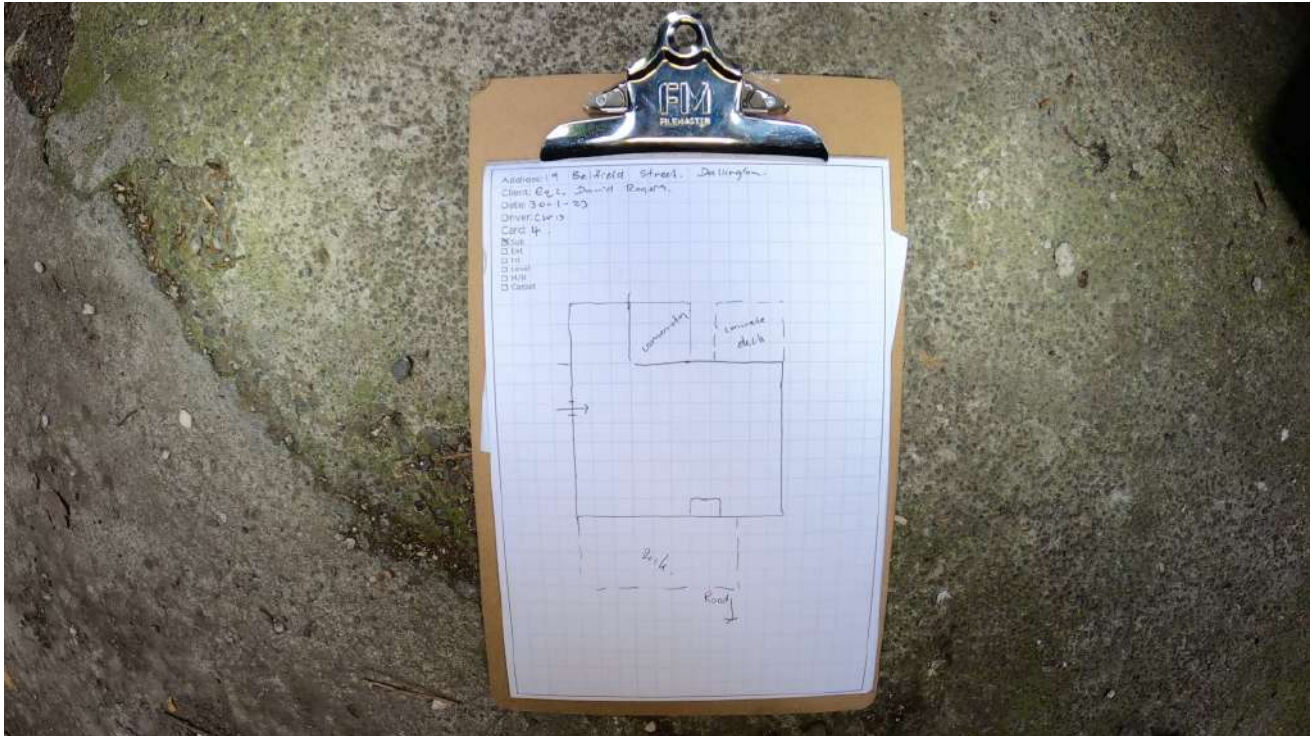
Prepared by: Gideon Couper

Numbers corresponded to floor layout plan. Arrows represent which direction the photo was taken from.



Cavity Critter

1: Photo for legal purposes, showing who did the job and when.



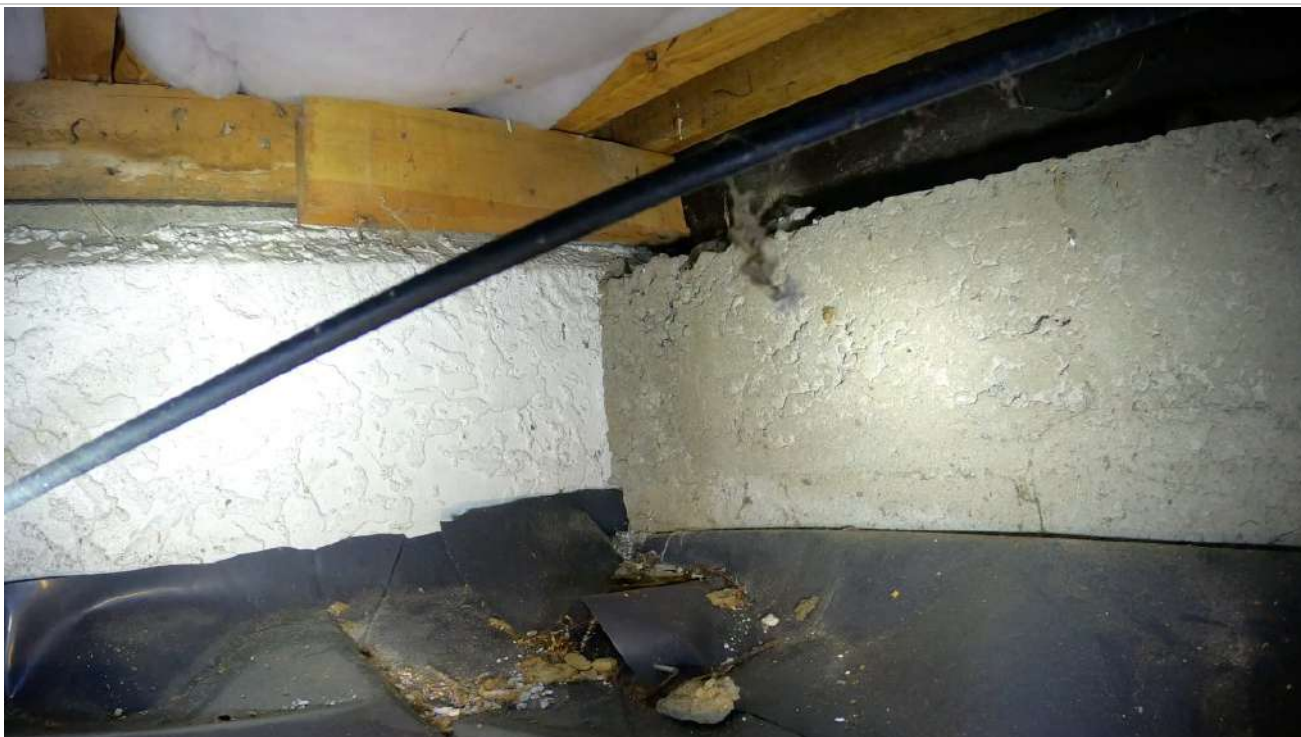
2: The foundations are average quality type "A" foundations with concrete strip foundations at the corners.



3: The home has cast in place concrete piles around the outside. Here the home has been extended.



4: View of foundation join.



5: View of bearer meeting ring foundation.



6: Precast concrete pile with connection.



7: View of bearer meeting ring foundation.



8: View of ring foundation. There are some non-compliant issues with the wiring seen in this home. They could also be a significant hazard to anybody operating under the floor. This relates specifically to unclipped wires. An electrical inspector could be consulted regarding this. The communication cable has also not been laid in a compliant manner and would easily be damaged by people accessing the subfloor.



9: View of ring foundation.



10: View of ring foundation.



11: View of foundation and pile to the right.



12: Cast in place concrete pile.



13: Cast in place concrete pile.



14: Cast in place concrete pile.



15: Cast in place concrete pile.



16: View of foundation.



17: Cast in place concrete pile.



18: The home has precast concrete piles. These maybe concreted into the ground but the polythene obscures this. They are connected to the bearers with stapled off wire ties. We do see a couple of broken ones.



19: Precast concrete pile with connection.



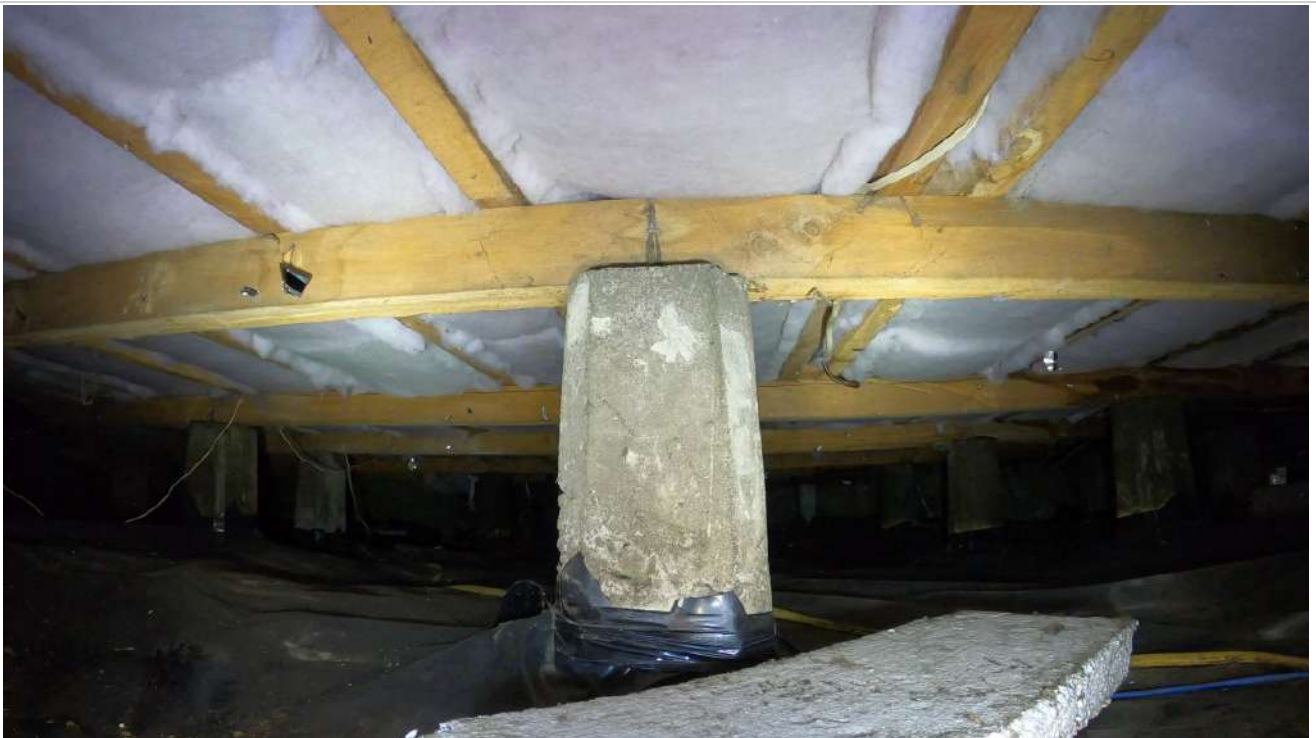
20: Precast concrete pile with connection.



21: Precast concrete pile with connection.



22: Precast concrete pile with connection.



23: Precast concrete pile with connection.



24: Cast in place concrete pile.



25: Cast in place concrete pile.



26: Precast concrete pile with connection.



27: Precast concrete pile with connection.



28: Precast concrete pile with connection.



29: Precast concrete pile with connection. The ground must be fairly damp in this area and the water is making its way up the pile into the bearer.



30: Precast concrete pile with connection.



31: Precast concrete pile with connection.



32: Cast in place concrete pile.



33: Cast in place concrete pile.



34: View of concrete base.



35: View of concrete base.



36: Here we see that the bearer has been notched and not reinforced. The bearer has also cracked. We can't see it here but in shot 48 of the other side of this pile we see that it is cracked.



37: Precast concrete pile with connection.



38: Precast concrete pile with connection.



39: Precast concrete pile with connection.



40: Cast in place concrete pile. There has been a water leak in this area which may have been fixed but the timber has been damaged.



41: These pipes are under stress and bending significantly.



42: Cast in place concrete pile.



43: View of concrete base.



44: Cast in place concrete pile.



45: Cast in place concrete pile.



46: Cast in place concrete pile.



47: Cast in place concrete pile.



48: This pile is cracked.



49: Precast concrete pile with connection.



50: View of concrete base.



51: Precast concrete pile with connection.



52: Cast in place concrete pile.



53: Cast in place concrete pile.



54: This pile is cracked. It is possible that there are other cracked piles we can't see due to the polythene.



55: Precast concrete pile with connection.



56: View of concrete base.



57: View of concrete base.



58: Cast in place concrete pile.



59: View of foundation.



60: Precast concrete pile with connection.



61: Precast concrete pile.



62: There has been a water leak in this area which may have been fixed but the timber has been damaged.



63: Precast concrete pile.



64: Precast concrete pile and concrete base.



65: Precast concrete pile and concrete base.



66: View of foundation with concrete base to the right.



67: View of foundation with cracking. Note that the taped waste.



68: View of foundation with concrete base to the left.



69: View of concrete base.



70: View of toilet stump.



71: Cast in place concrete pile.

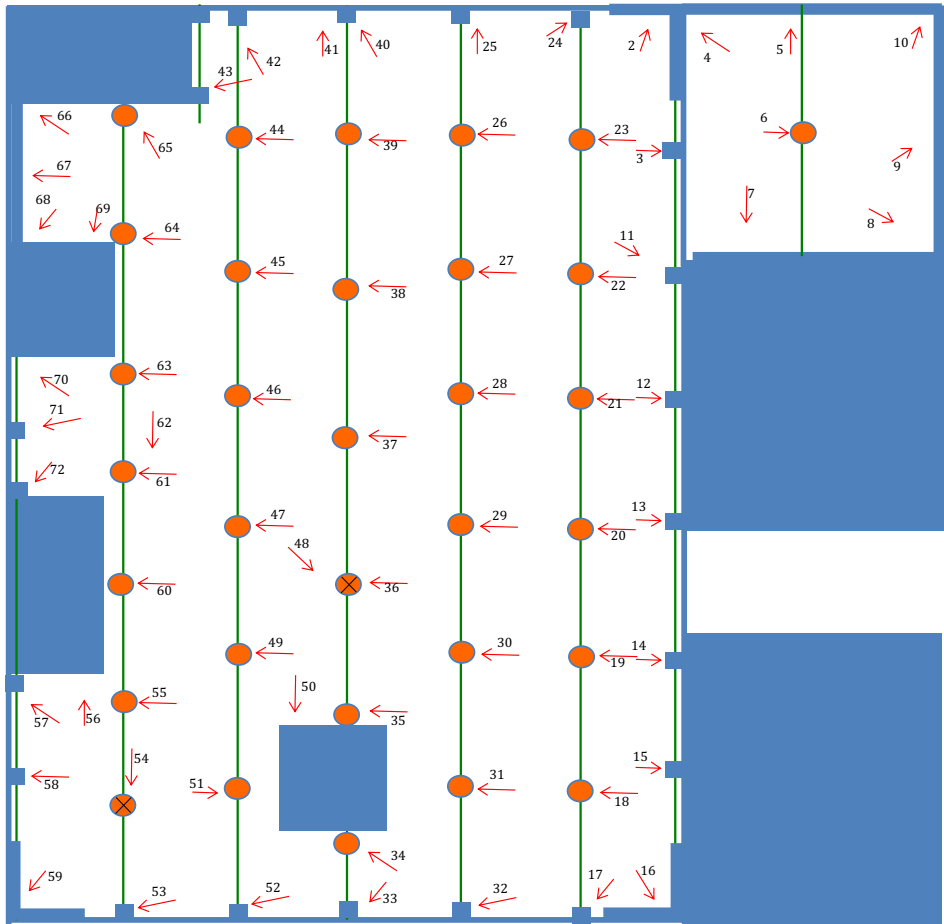


72: View of concrete base.



House floor plan

Numbers corresponded to floor layout plan. Arrows represent which direction the photo was taken from. Plan is also supplied as a separate file to assist with reading of the report.



× Cracked pile.

Subfloor plan 19 Belfield Street, Dallington

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