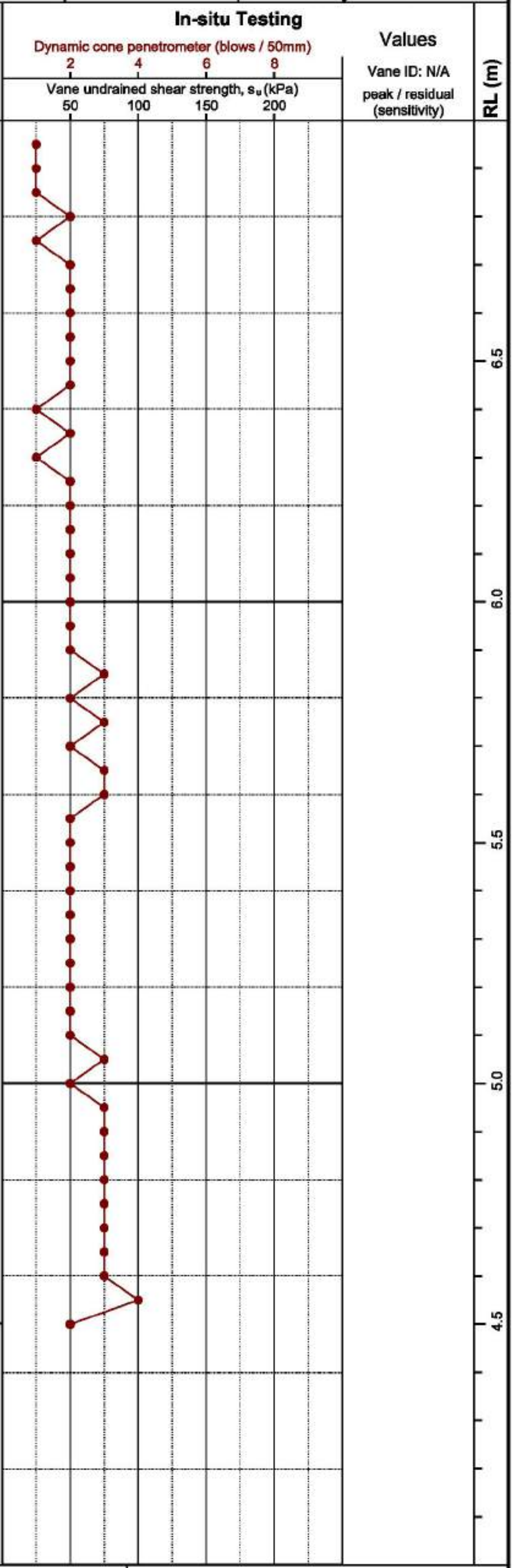
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	HA11		
Project ID:	24477		
Sheet:	1 of 1		
Client:	NZHG	**Coordinates:**	5709865mN, 2036106mE
Project:	Geotechnical Investigation	**System:**	NZTM
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map
Test Date:	12/09/2023		
Logged By:	SS		
Prepared By:	SS		
Checked By:	RH		

Depth (m)	Geology	Material Description	Water
	Uncontrolled Fill / Topsoil	SAND, with trace silt and gravel; dark brown. Loose; moist; sand, fine to medium; gravel, fine to medium, subrounded to subangular.	Groundwater not encountered
0.5 1.0 1.5 2.0 2.5	Holocene Beach Deposits	SAND; brownish orange. Medium dense; moist; sand, fine to medium. 2.30m: Wet.	



Hole Depth: 2.50m	**Termination:** TARGET DEPTH	
Remarks:		

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

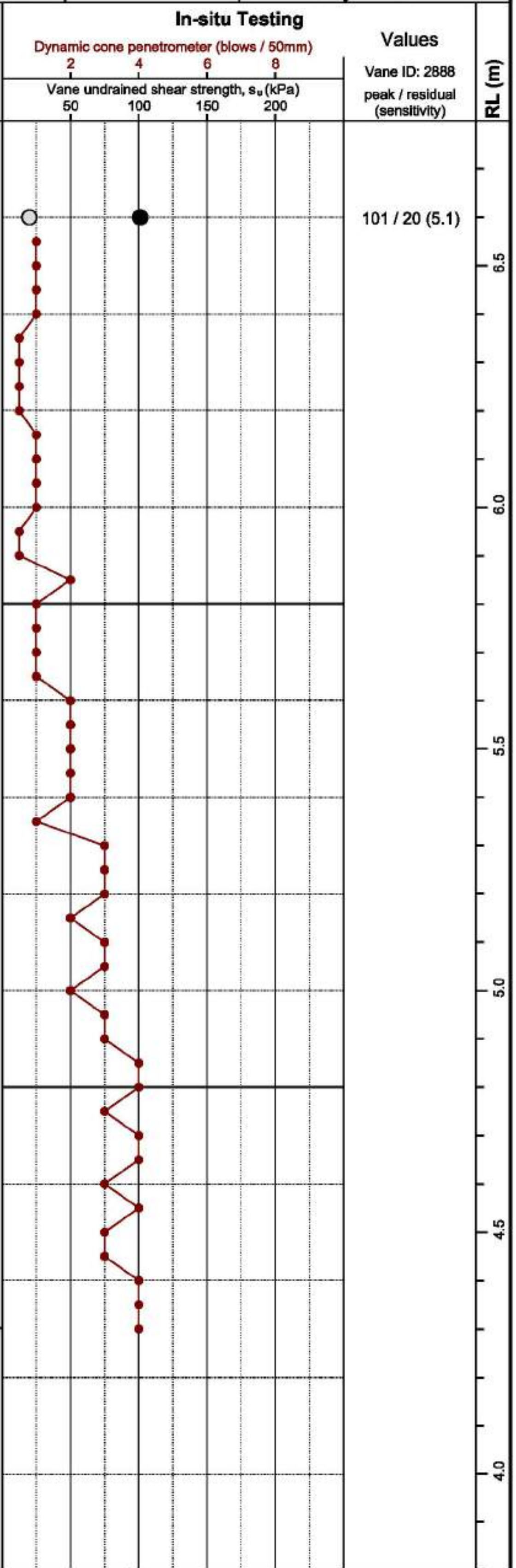
Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	HA12	**Project ID:**	24477	**Sheet:**	1 of 1
Client:	NZHG	**Coordinates:**	5709880mN, 2036108mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water
0.0 – 0.5	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine. 0.30m: SAND, with minor silt. Sand, fine to medium. 0.40m: Black.	
0.5 – 2.5	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium. 2.00m: Wet. 2.50m: Saturated.	▼ 2.5



Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

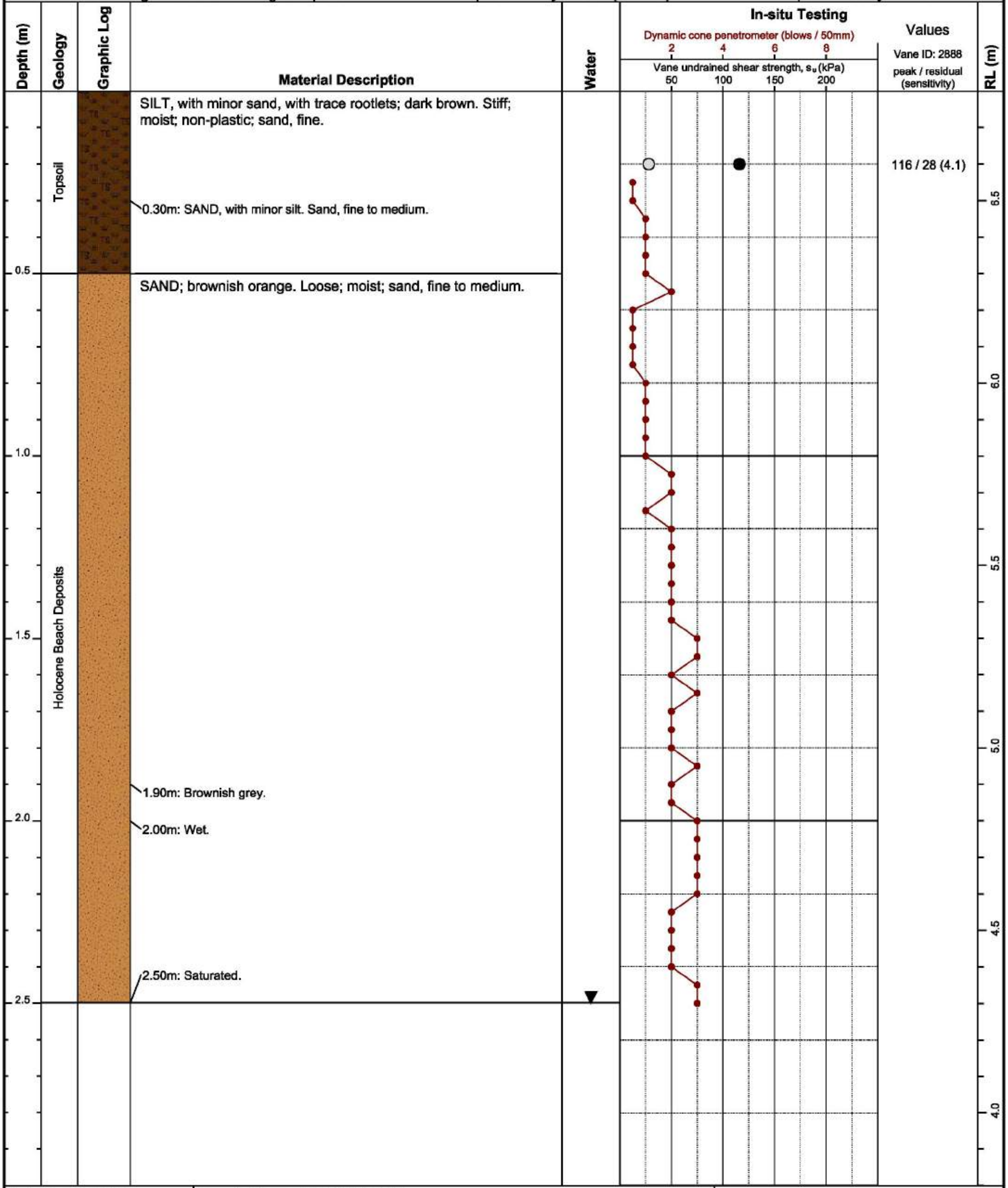
Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA13
Project ID: 24477
Sheet: 1 of 1

Client:	NZHG	**Coordinates:**	5709882mN, 2036101mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH



SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.

0.30m: SAND, with minor silt. Sand, fine to medium.

SAND; brownish orange. Loose; moist; sand, fine to medium.

1.90m: Brownish grey.

2.00m: Wet.

2.50m: Saturated.

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

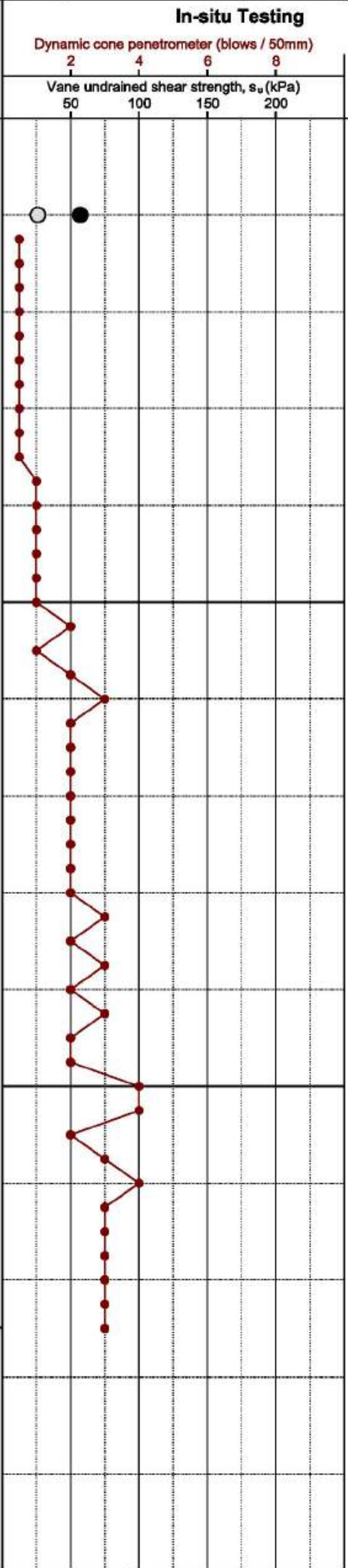
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA14**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709887mN, 2036103mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	Values Vane ID: 2888 peak / residual (sensitivity)
	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Firm; moist; non-plastic; sand, fine.		57 / 26 (2.2)
	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium.		
		1.60m: Brownish grey.		
		1.90m: Wet.		
2.5		2.50m: Saturated.	▼	



Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5

RL (m): 6.5, 6.0, 5.5, 5.0, 4.5, 4.0

Hole Depth: 2.50m	**Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow
UTP = Unable to Penetrate

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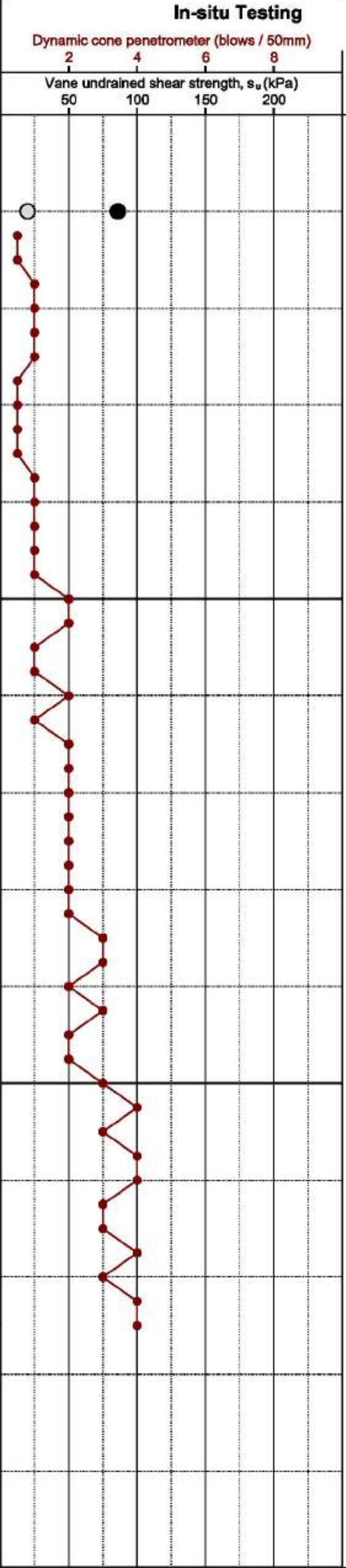
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA15**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709885mN, 2036111mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	Values: Vane ID: 2888 peak / residual (sensitivity)
0.00	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.		86 / 20 (4.3)
0.40		0.40m: SAND, with minor silt. Sand, fine to medium.		
0.60	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium.		
2.00		2.00m: Brownish grey. Wet.		
2.40		2.40m: Saturated.	▼	



Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5

RL (m): 6.5, 6.0, 5.5, 5.0, 4.5, 4.0

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

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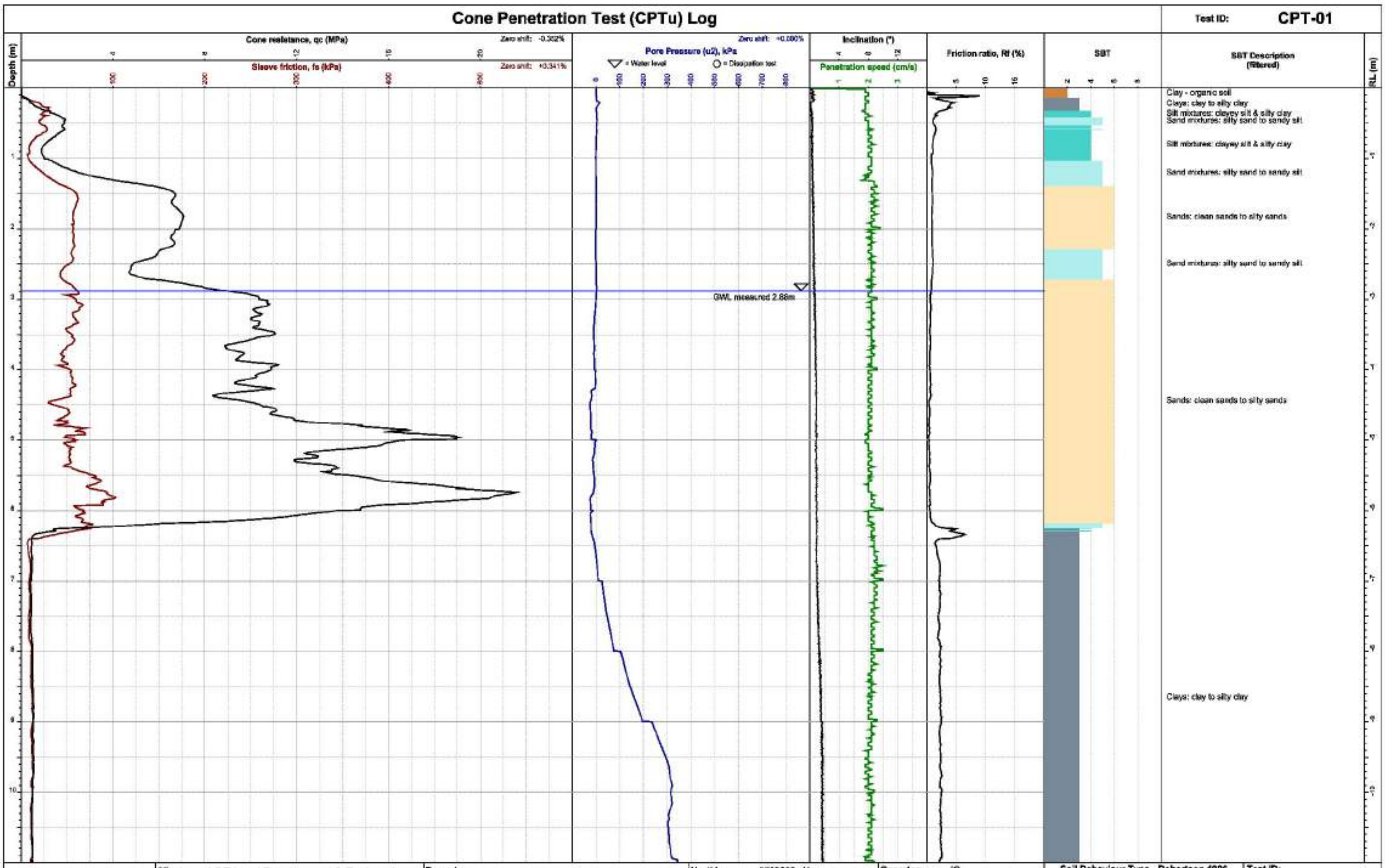
APPENDIX C

CONE PENETRATION TEST LOGS

Cone Penetration Test (CPTu) Log

Test ID: CPT-01



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709883mN
Easting: 2036106mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

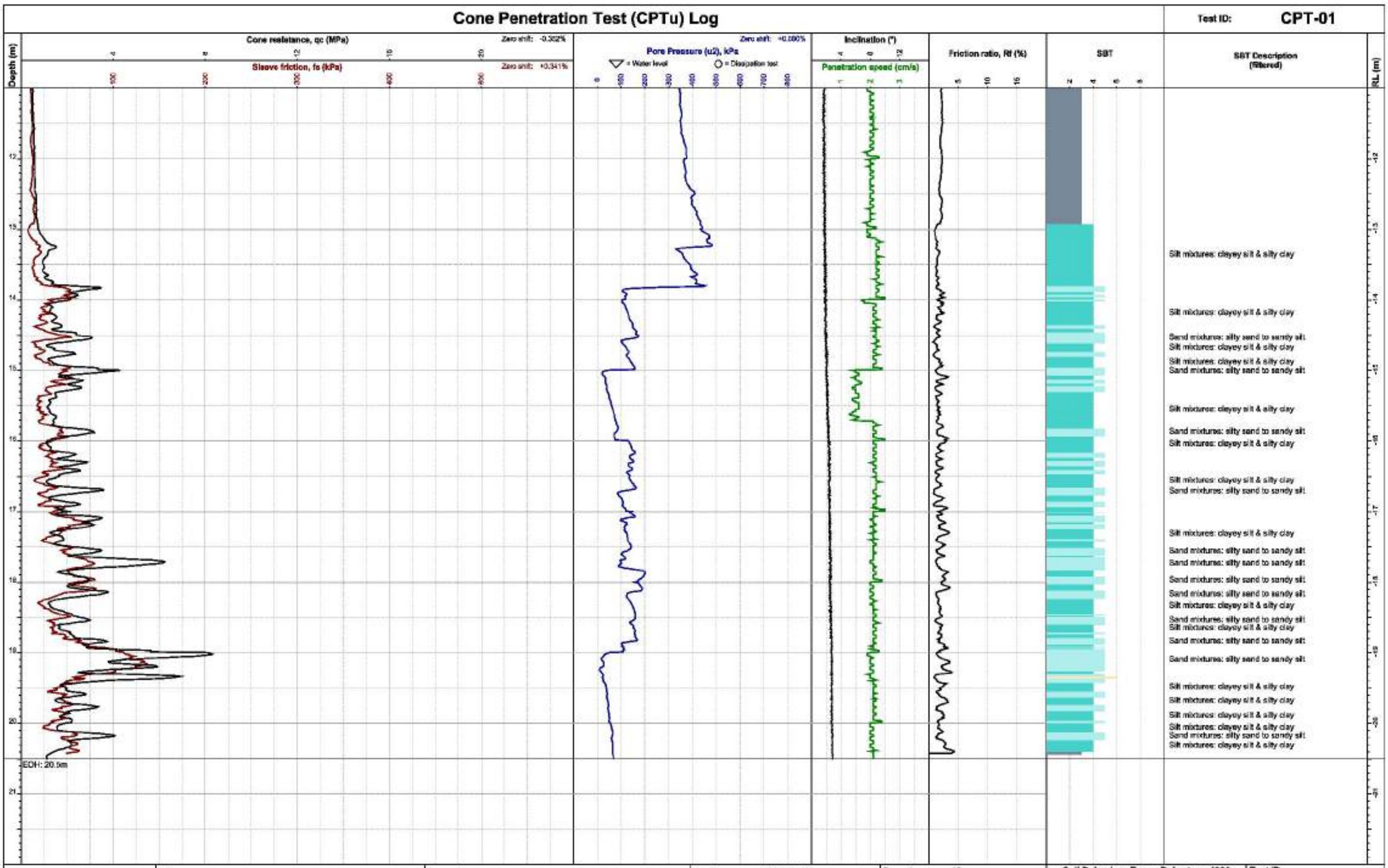
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-01
Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:04 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-01



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709883mN
Easting:	2036106mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

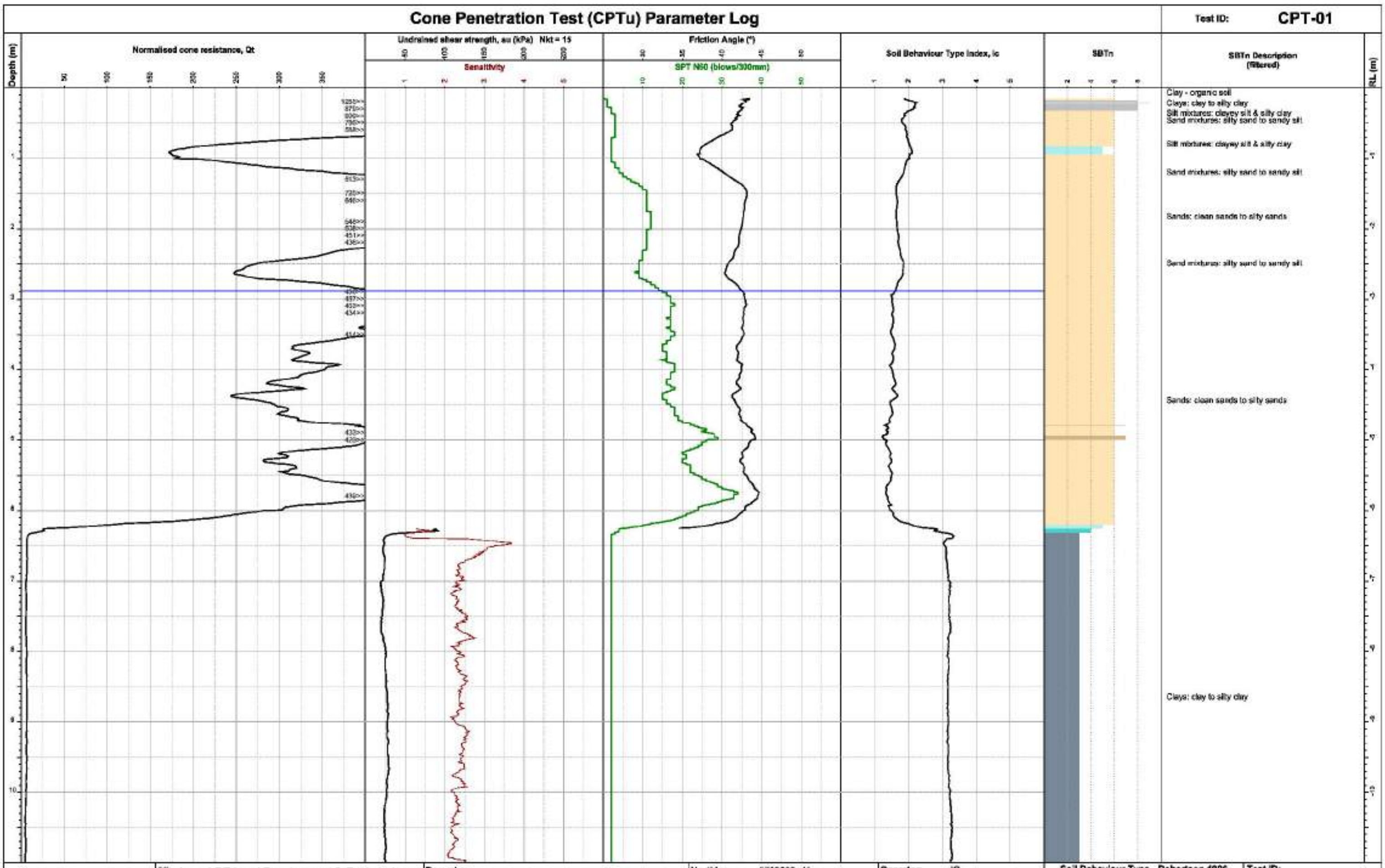
Test ID: CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:04 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-01



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709883mN
Easting: 2036106mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

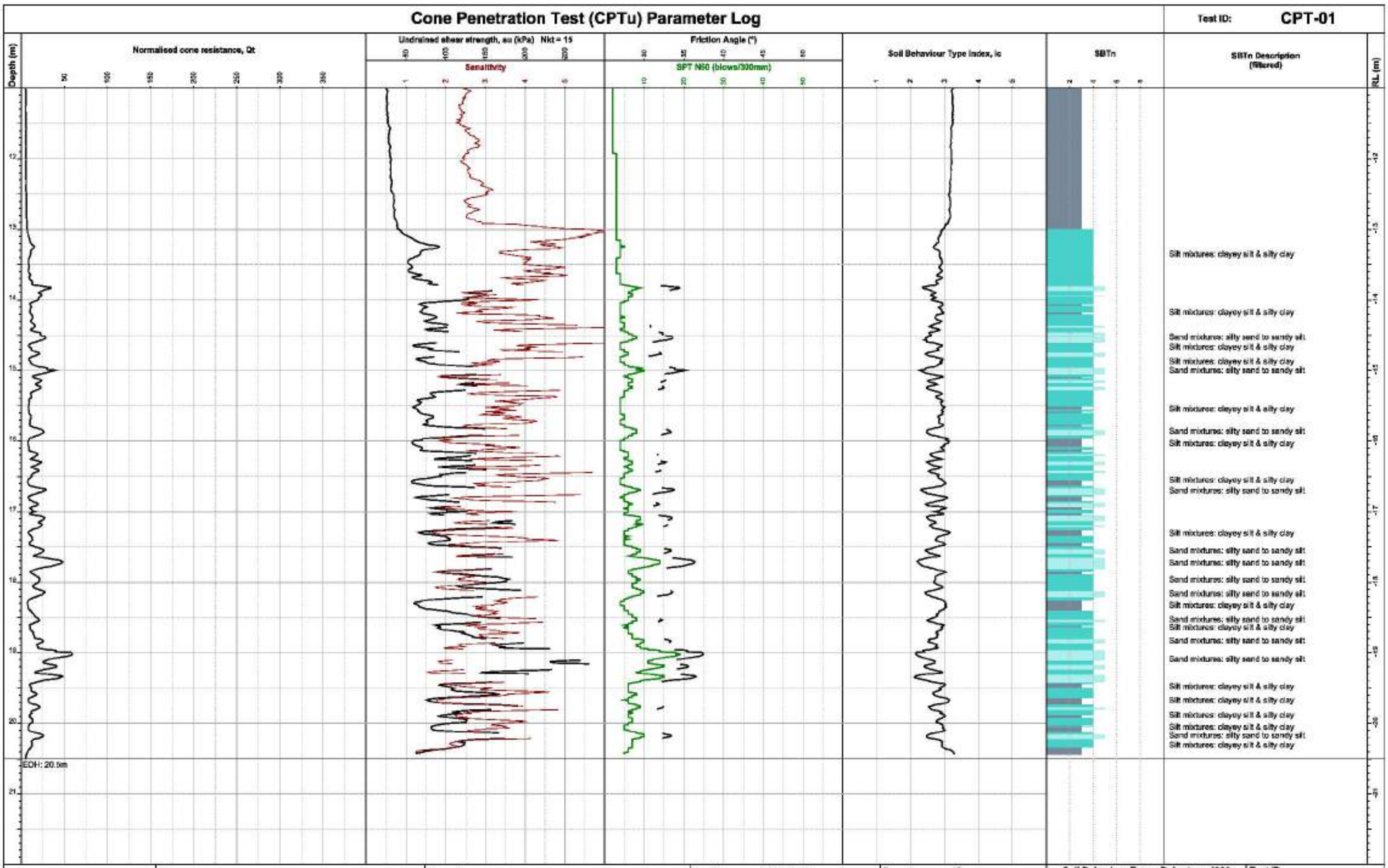
- 0 Undefined
- 1 Sensitive fine-grained
- 2 Clay - organic soil
- 3 Clays: clay to silty clay
- 4 Silt mixtures: clayey silt & silty clay
- 5 Sand mixtures: silty sand to sandy silt
- 6 Sands: clean sands to silty sands
- 7 Dense sand to gravelly sand
- 8 Stiff sand to clayey sand
- 9 Stiff fine-grained

Test ID: CPT-01
Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:04 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-01



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Aberdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709883mN
Easting:	2036106mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

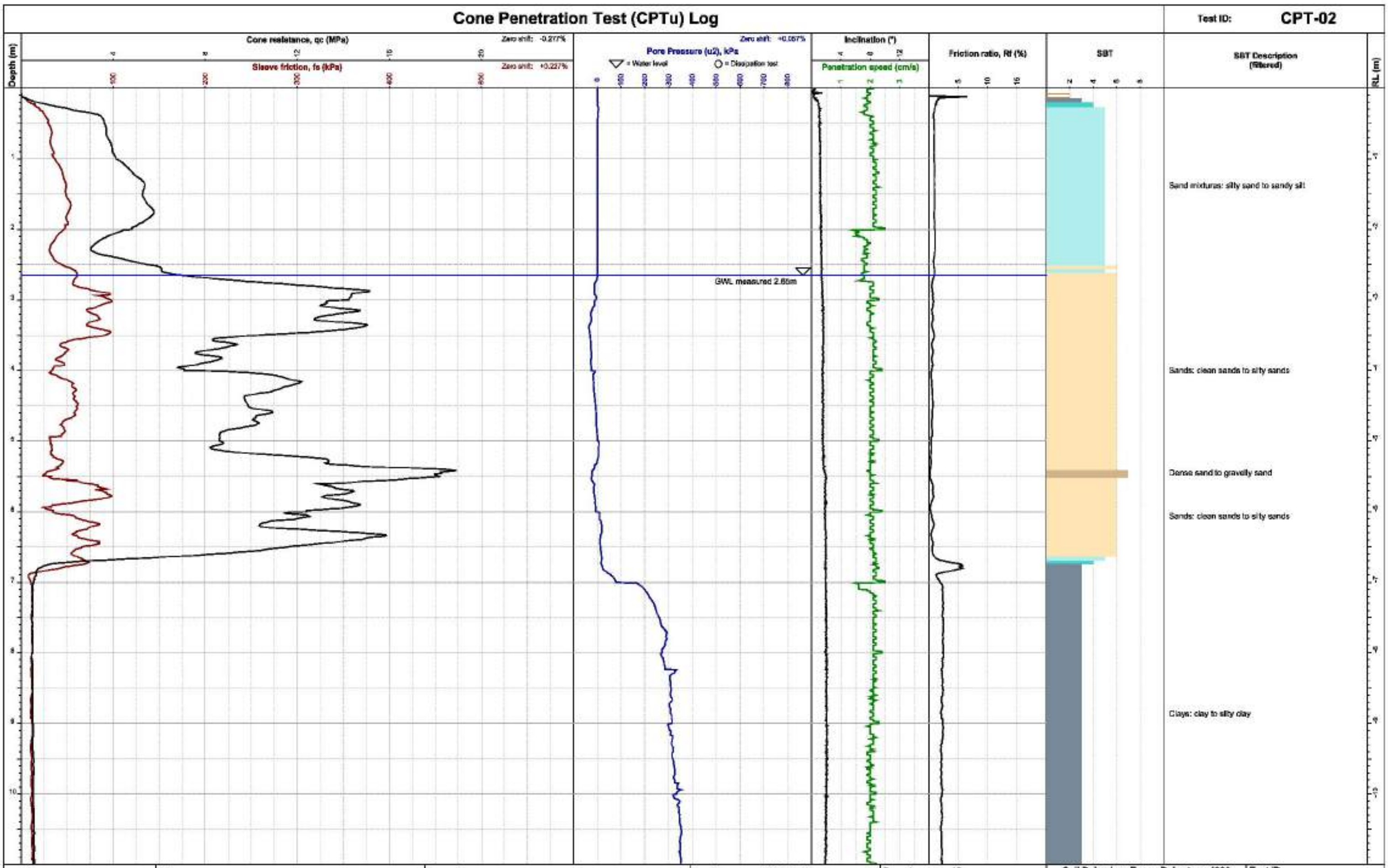
Test ID:
CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:35 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-02



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:06 am

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709858mN
Easting: 2036112mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

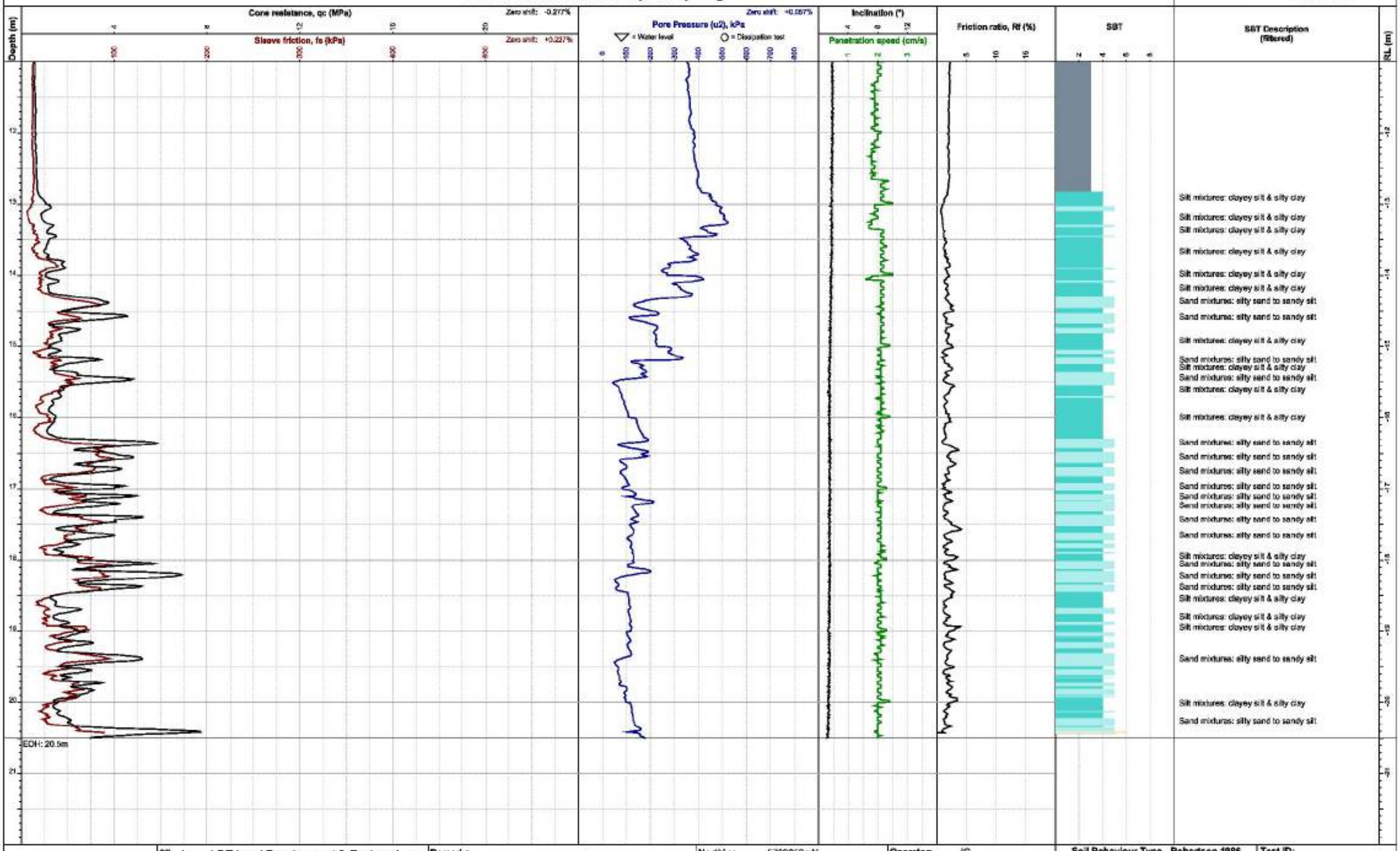
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-02
Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-02



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709858mN
Easting: 2036112mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

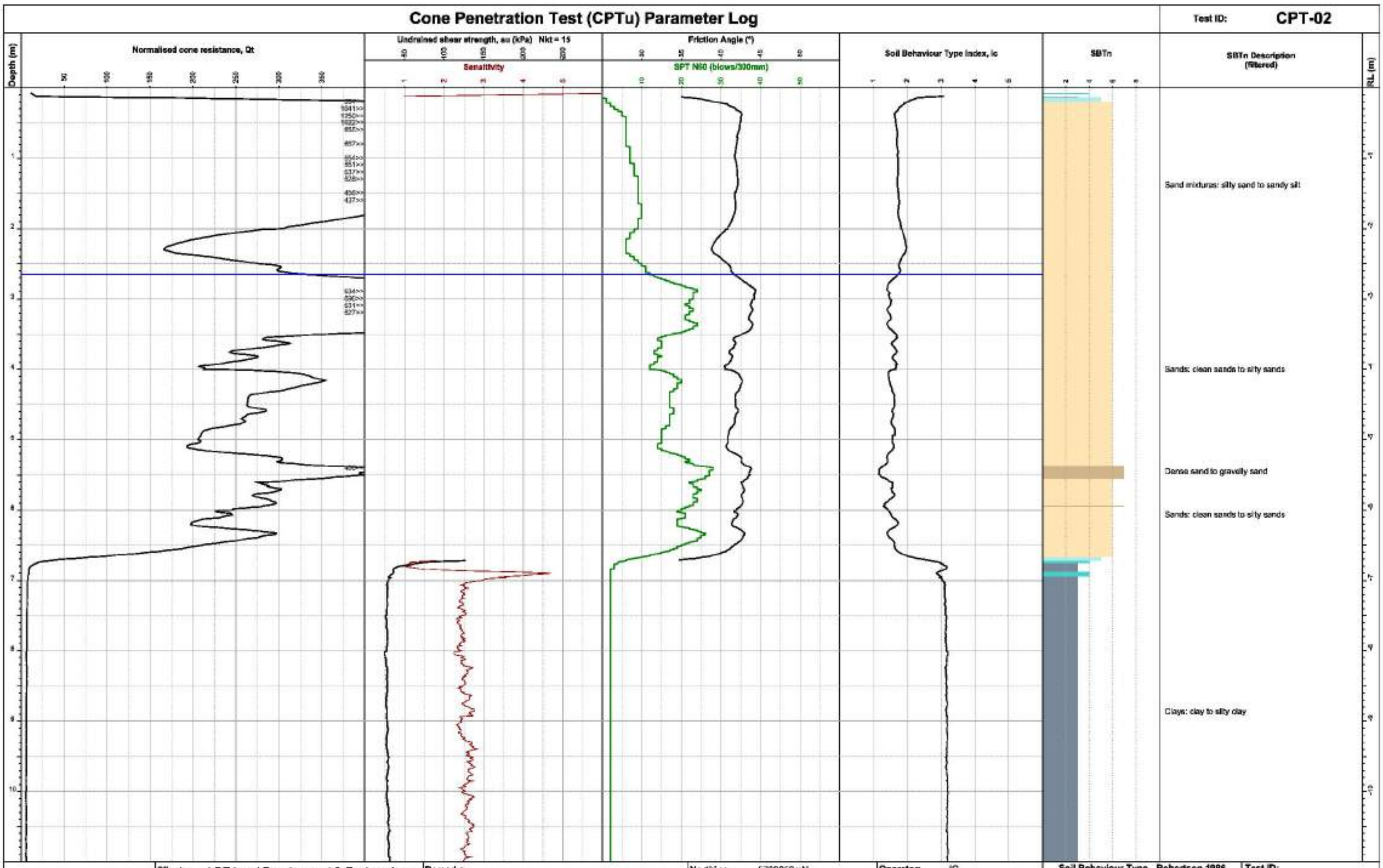
Test ID: CPT-02

Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-02



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036112mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined
1	Sensitive fine-grained
2	Clay - organic soil
3	Clays: clay to silty clay
4	Silt mixtures: clayey silt & silty clay
5	Sand mixtures: silty sand to sandy silt
6	Sands: clean sands to silty sands
7	Dense sand to gravelly sand
8	Stiff sand to clayey sand
9	Stiff fine-grained

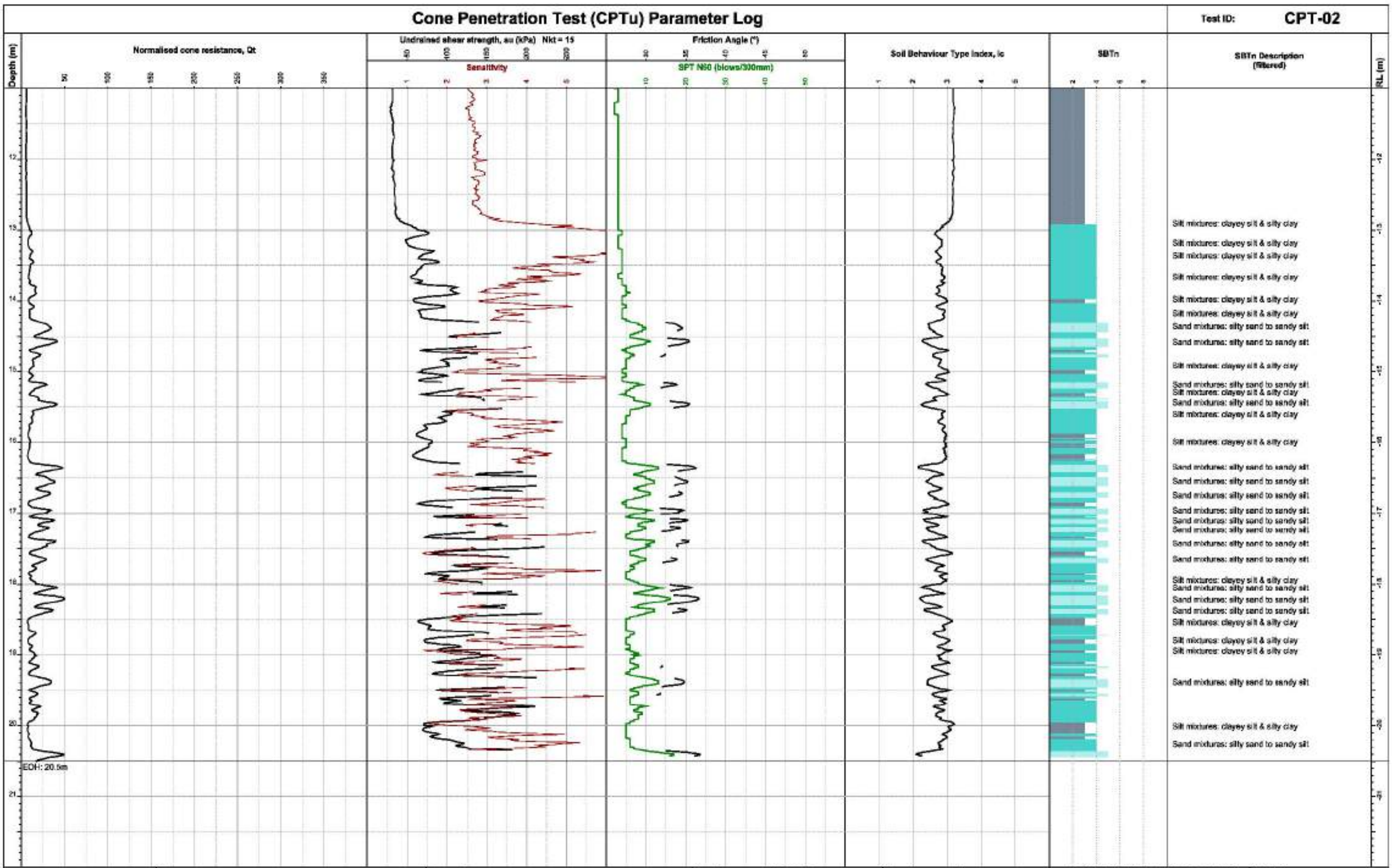
Test ID: CPT-02

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-02**



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036112mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

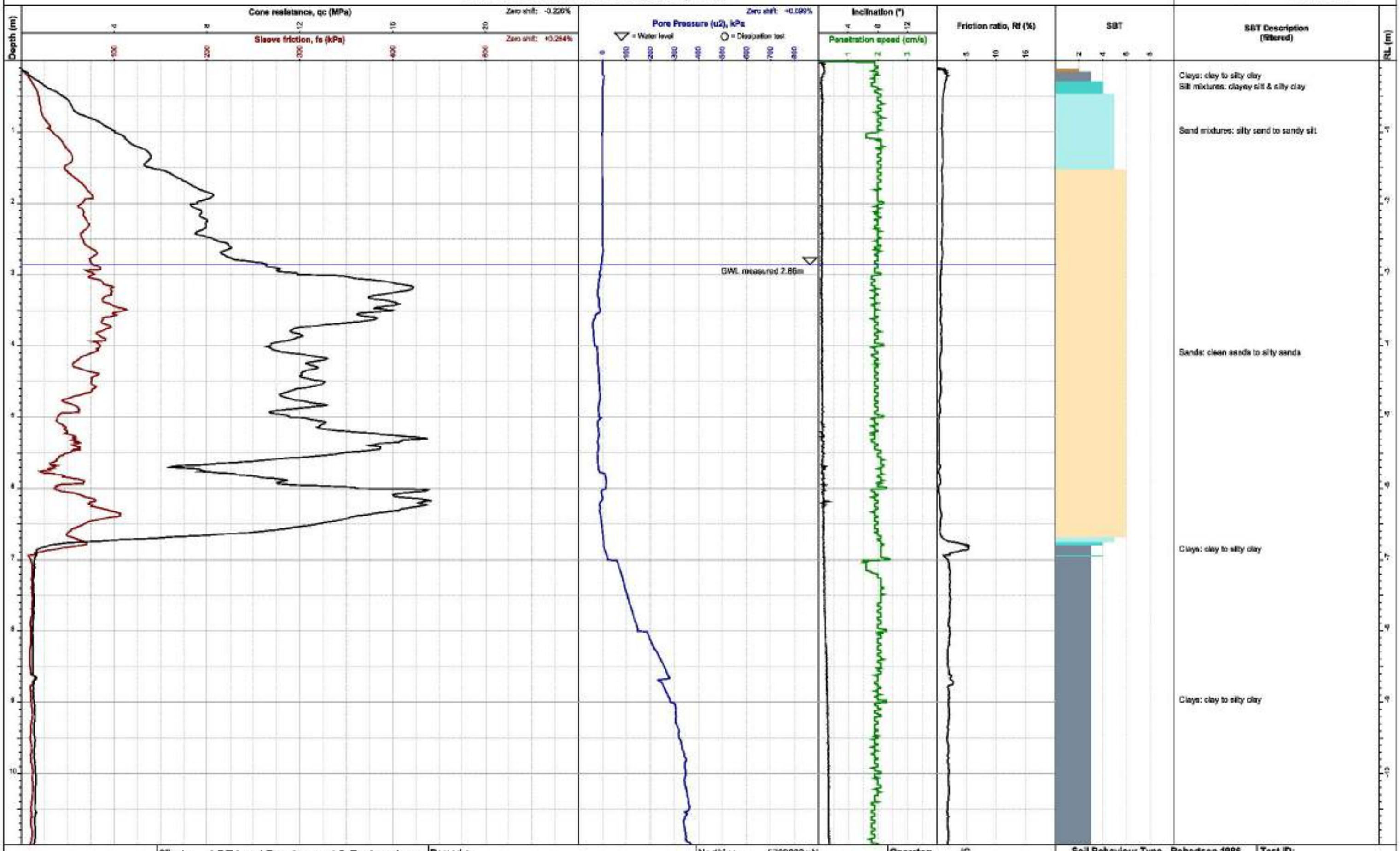
Test ID: **CPT-02**

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-03



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709866mN
Easting:	2036135mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

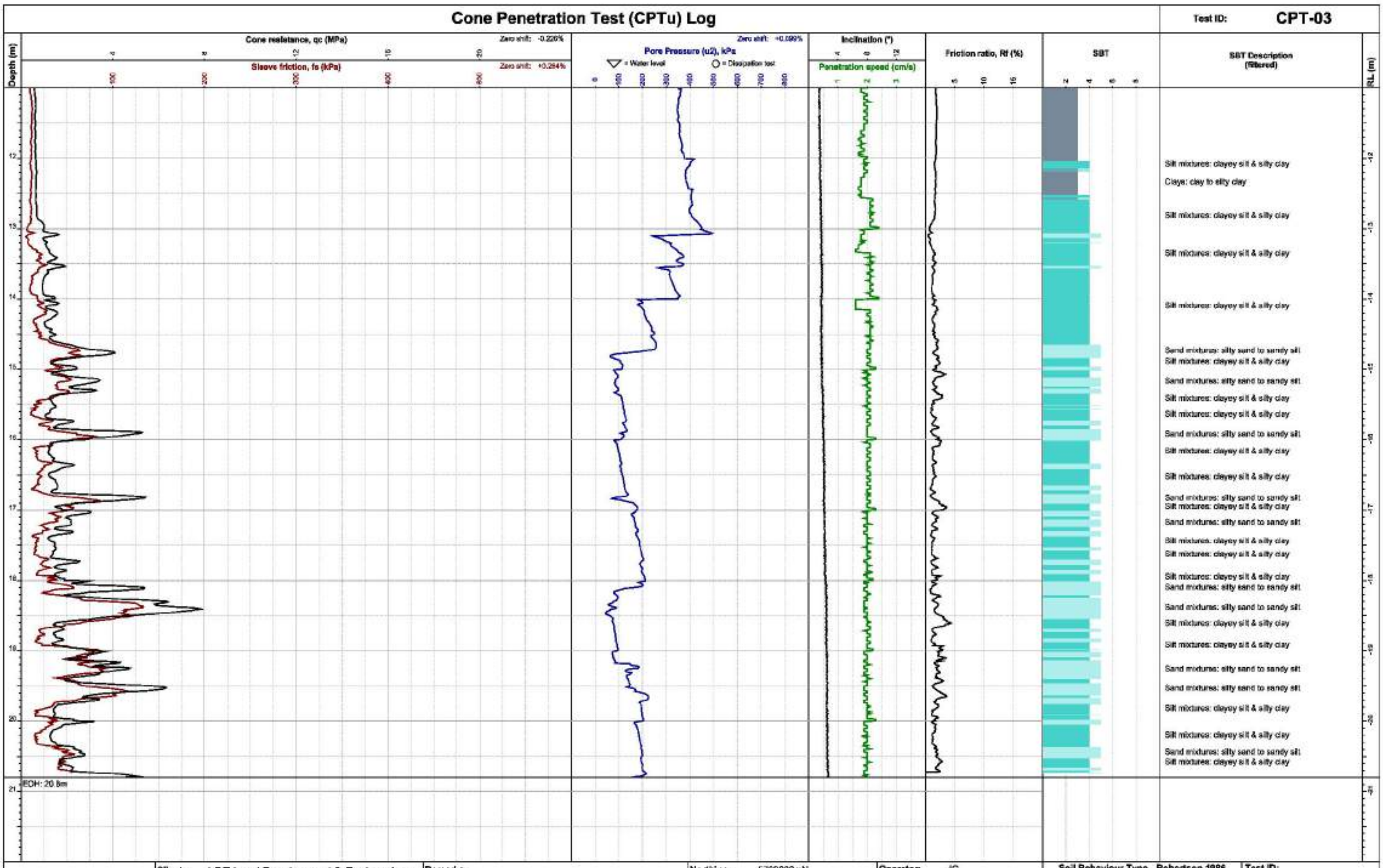
Test ID: CPT-03

Project ID:	24477
Depth:	20.8m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:39 am

Cone Penetration Test (CPTu) Log

Test ID: **CPT-03**



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:10 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709866mN
Easting:	2036135mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

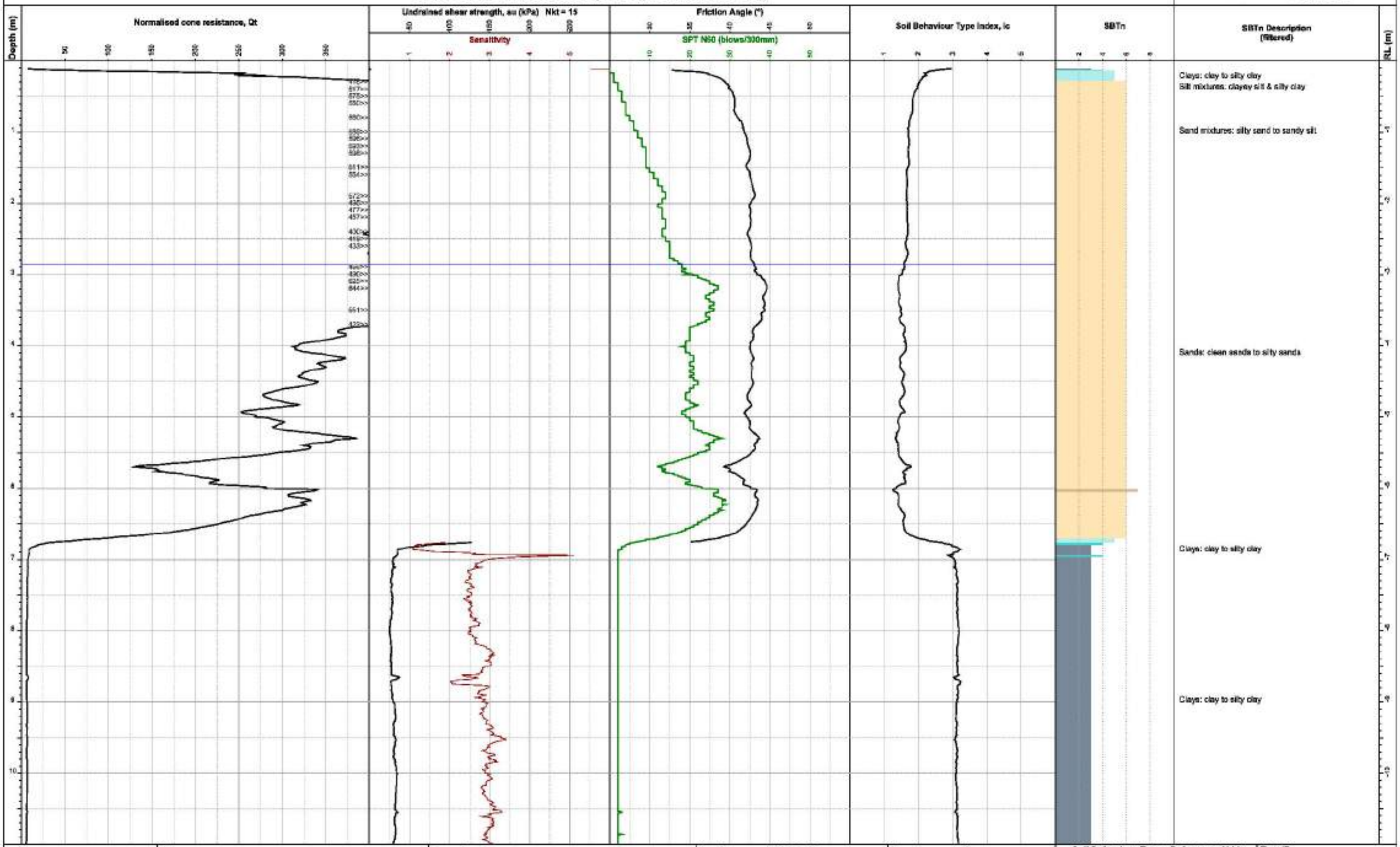
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:
CPT-03

Project ID:	24477
Depth:	20.8m
Sheet:	2 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-03



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:10 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036135mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pageni TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

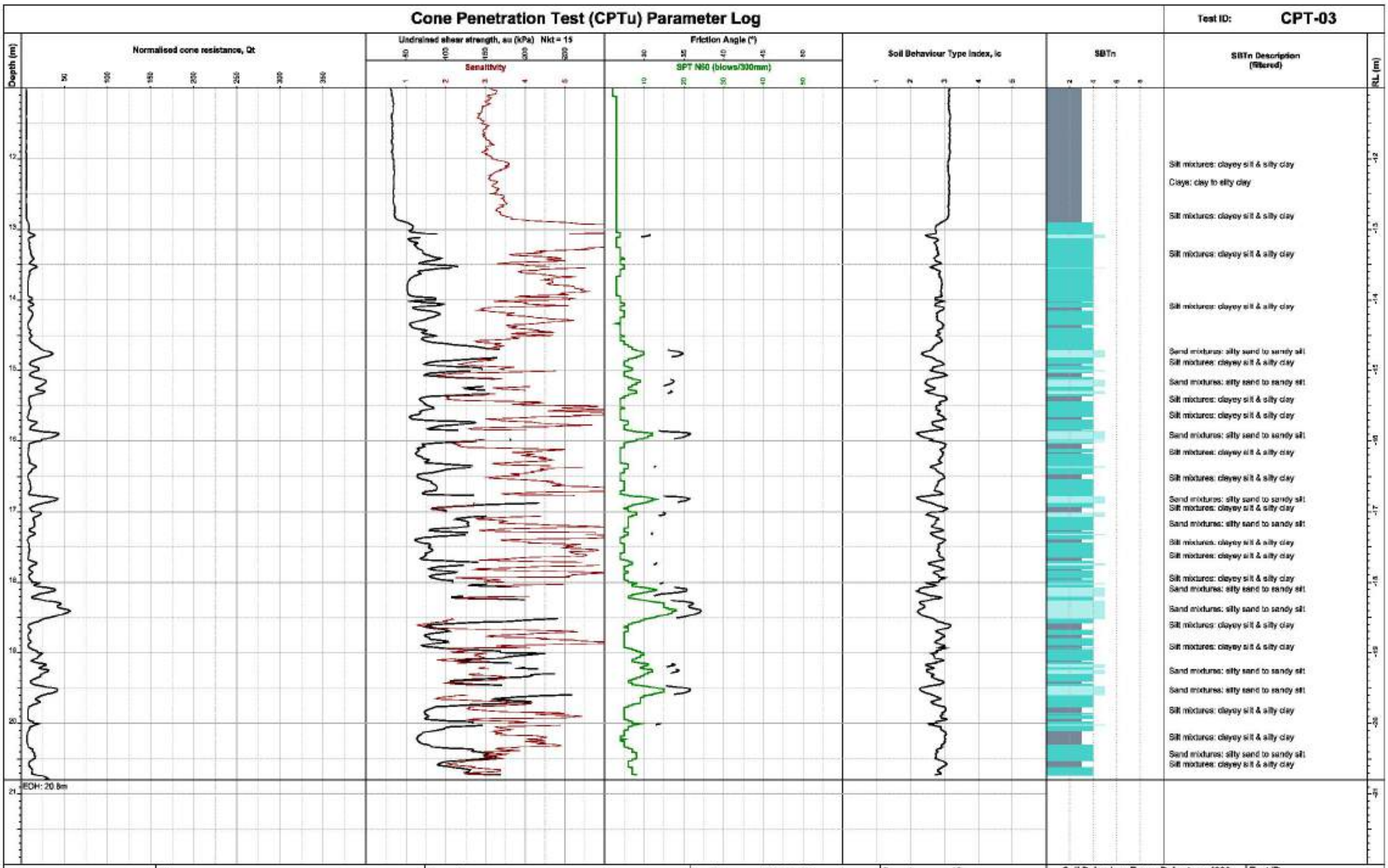
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-03

Project ID: 24477
Depth: 20.8m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-03



Silt mixtures: clayey silt & silty clay
Clays: clay to silty clay
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036135mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

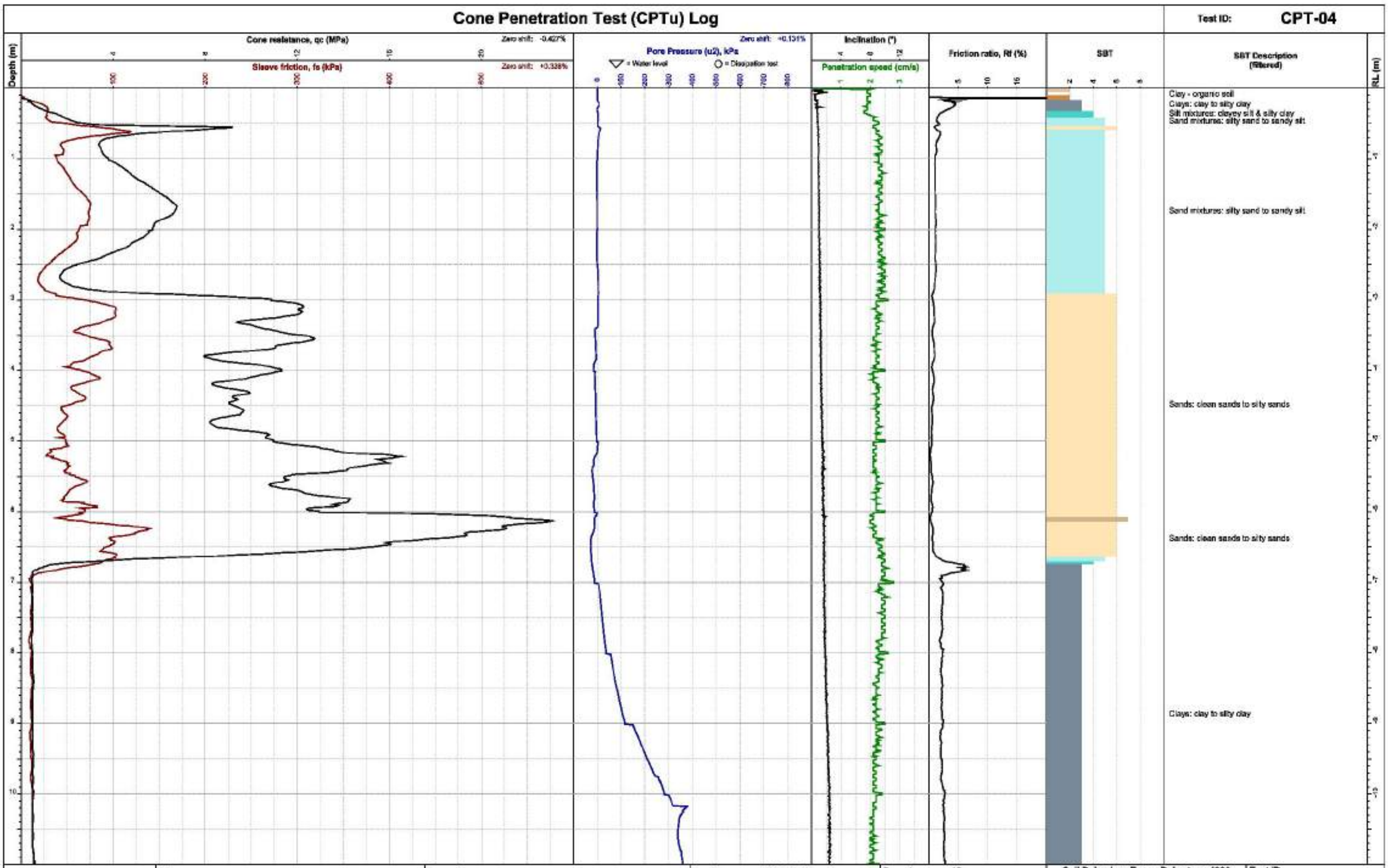
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-03
Project ID: 24477
Depth: 20.8m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: **CPT-04**



Client:	LDE Land Development & Engineering	**Northing:**	5709856mN	**Operator:**	JC	**Test ID:**	**CPT-04**
Project:	geotechnical Investigation	**Easting:**	2036093mE	**Rig:**	Pagani TG63-150	**Project ID:**	24477
Location:	556-560 Abeerdeen Rd, Gisborne	**System:**	NZTM	**Cone ID:**	Mks1042	**Depth:**	20.5m
		Elevation:	Ground	**Type:**	Comp. piezo cone	**Sheet:**	1 of 2
		Located By:	Phone GPS	**Cone Area:**	10 cm²	**Date:**	30/05/2023
		Location:	As per site plan	**Sleeve Area:**	150 cm²		
				Area Ratio:	0.8		

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Soil Behaviour Type - Robertson 1986

0 Undefined	5 Sand mixtures: silty sand to sandy silt
1 Sensitive fine-grained	6 Sands: clean sands to silty sands
2 Clay - organic soil	7 Dense sand to gravelly sand
3 Clays: clay to silty clay	8 Stiff sand to clayey sand
4 Silt mixtures: clayey silt & silty clay	9 Stiff fine-grained

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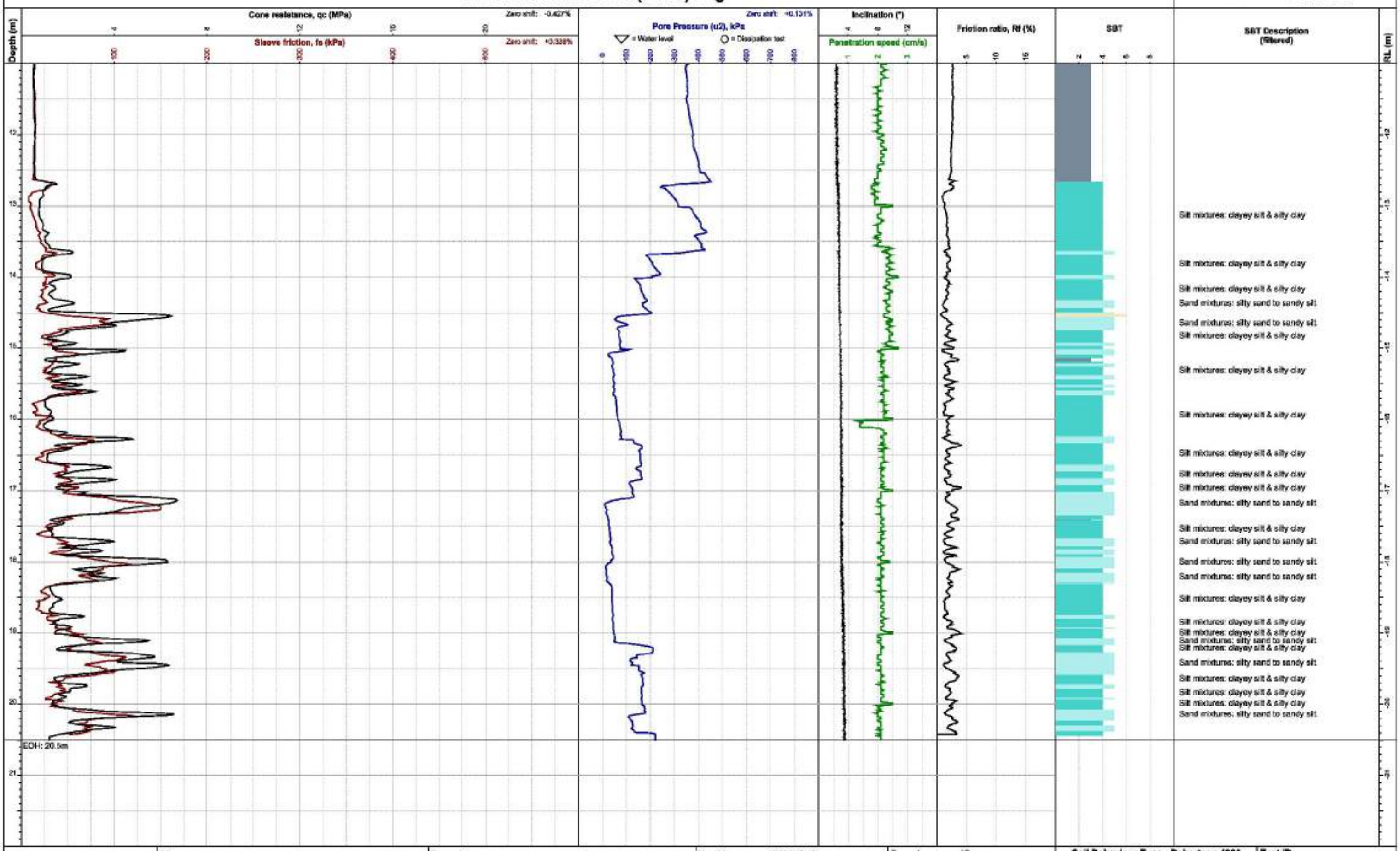
Cone Penetration Test (CPTu) Log

Test ID: CPT-04



Client:	LDE Land Development & Engineering	**Remarks:**	Ground water level located at 2.34m Test according to ISO 22476-1:12 (Class 2)
Project:	geotechnical Investigation	**Termination Reason:**	Target depth
Location:	556-560 Abeerdeen Rd, Gisborne		

Northing:	5709858mN	**Operator:**	JC
Easting:	2036093mE	**Rig:**	Pagani TG63-150
System:	NZTM	**Cone ID:**	Mks1042
Elevation:	Ground	**Type:**	Comp. piezo cone
Located By:	Phone GPS	**Cone Area:**	10 cm²
Location:	As per site plan	**Sleeve Area:**	150 cm²
		Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

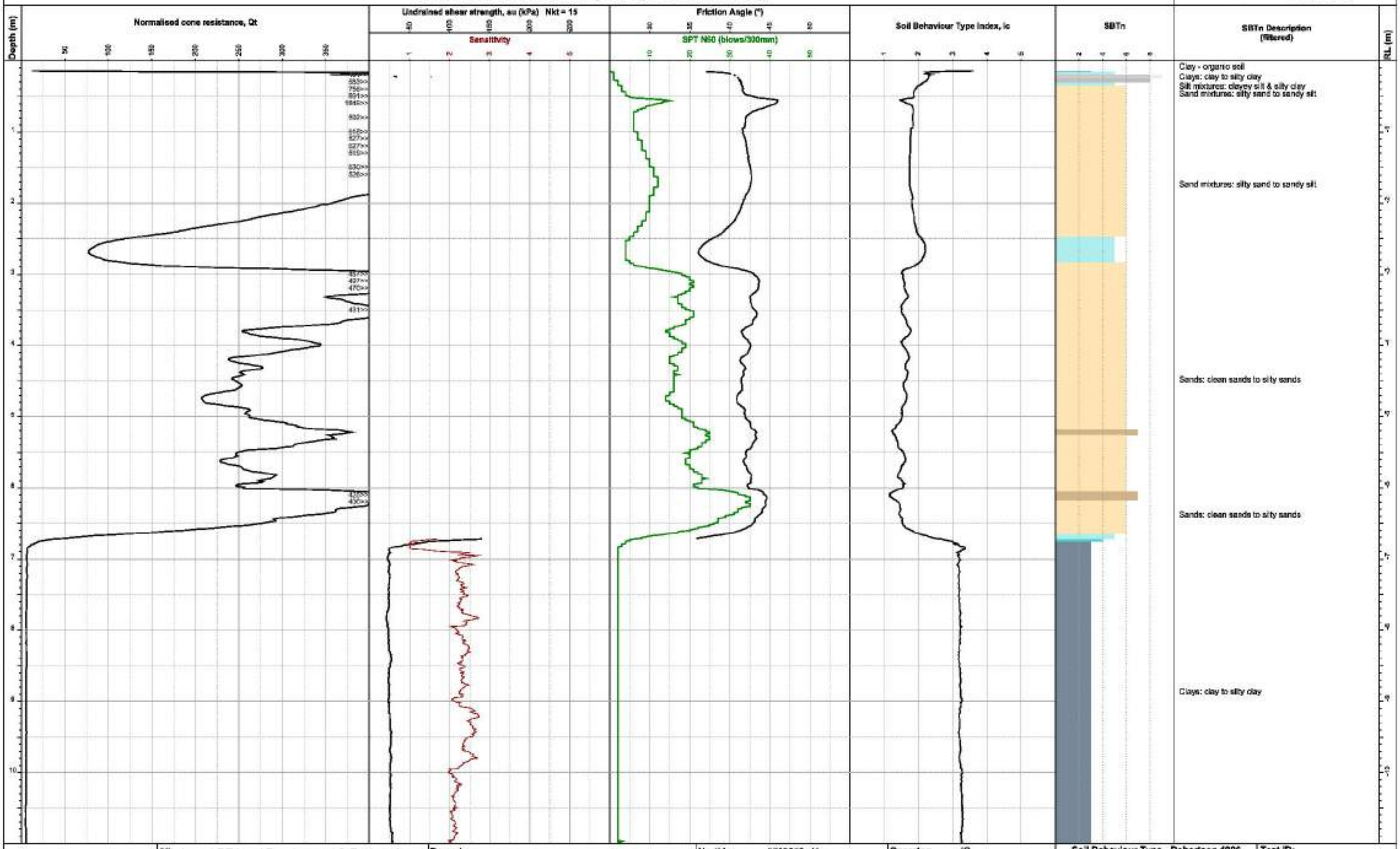
Test ID: CPT-04

Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Generated with CORE GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:12 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-04



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709856mN
Easting: 2036093mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

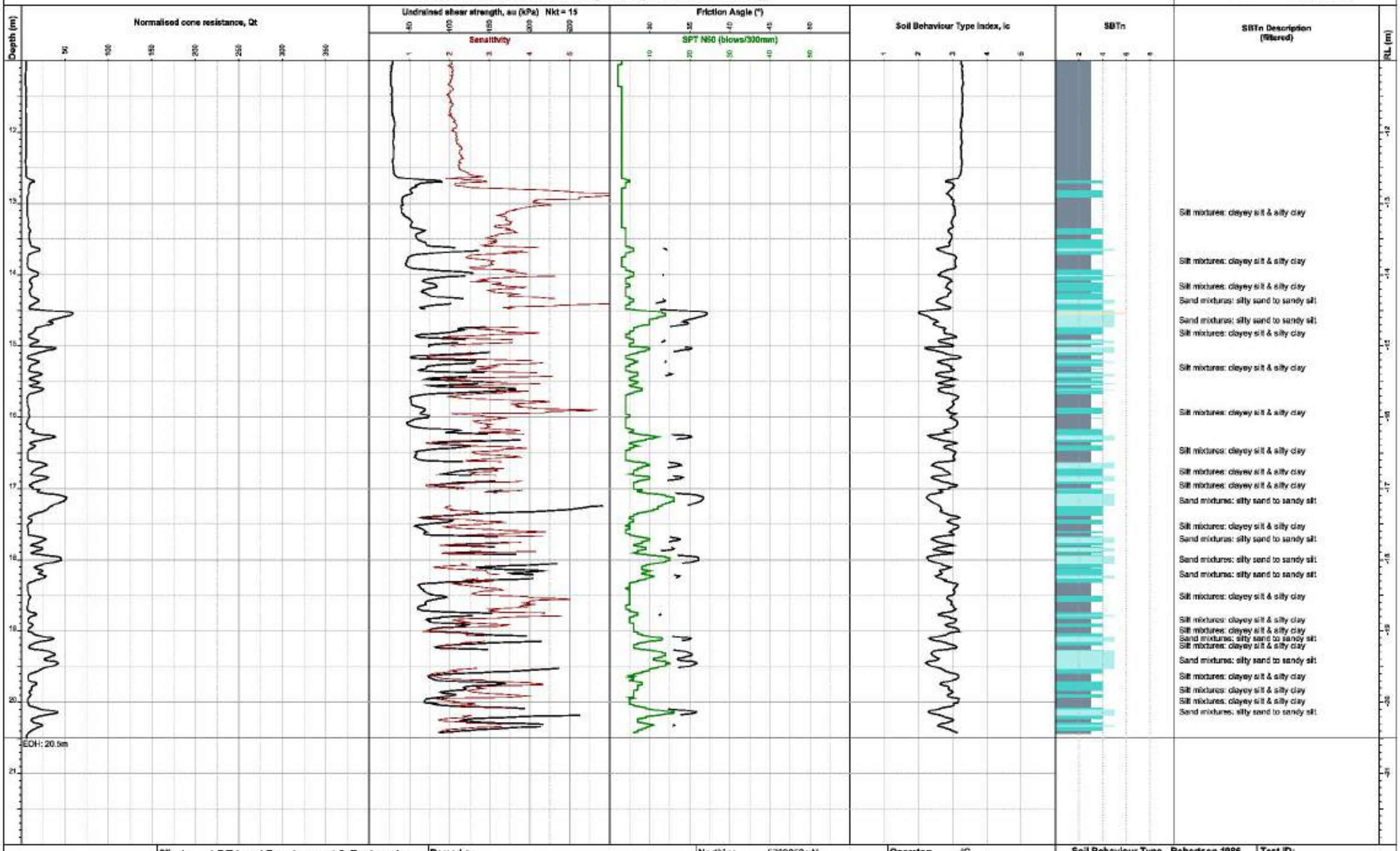
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-04
Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:12 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-04



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709858mN
Easting: 2036093mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

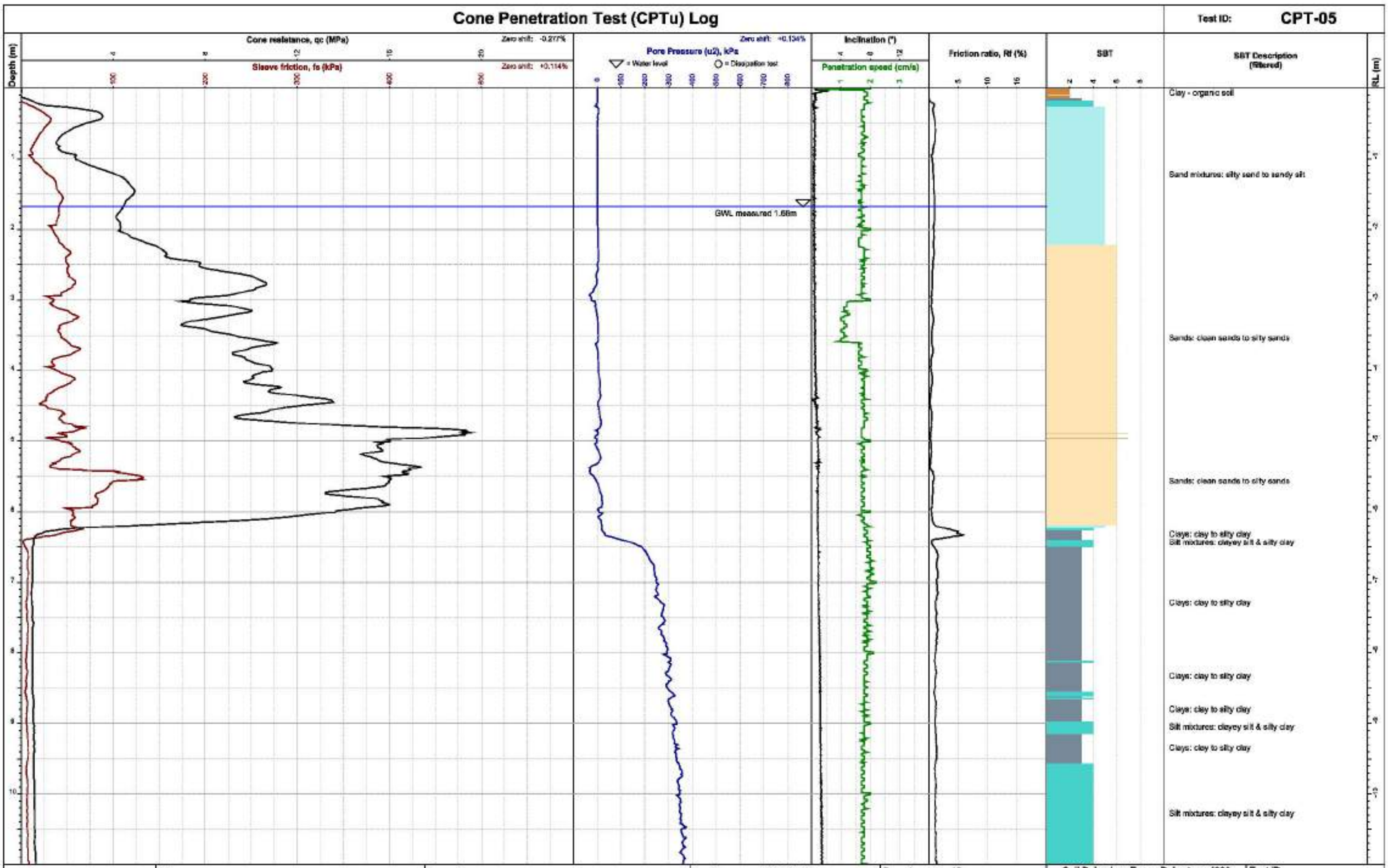
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-04
Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-05



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

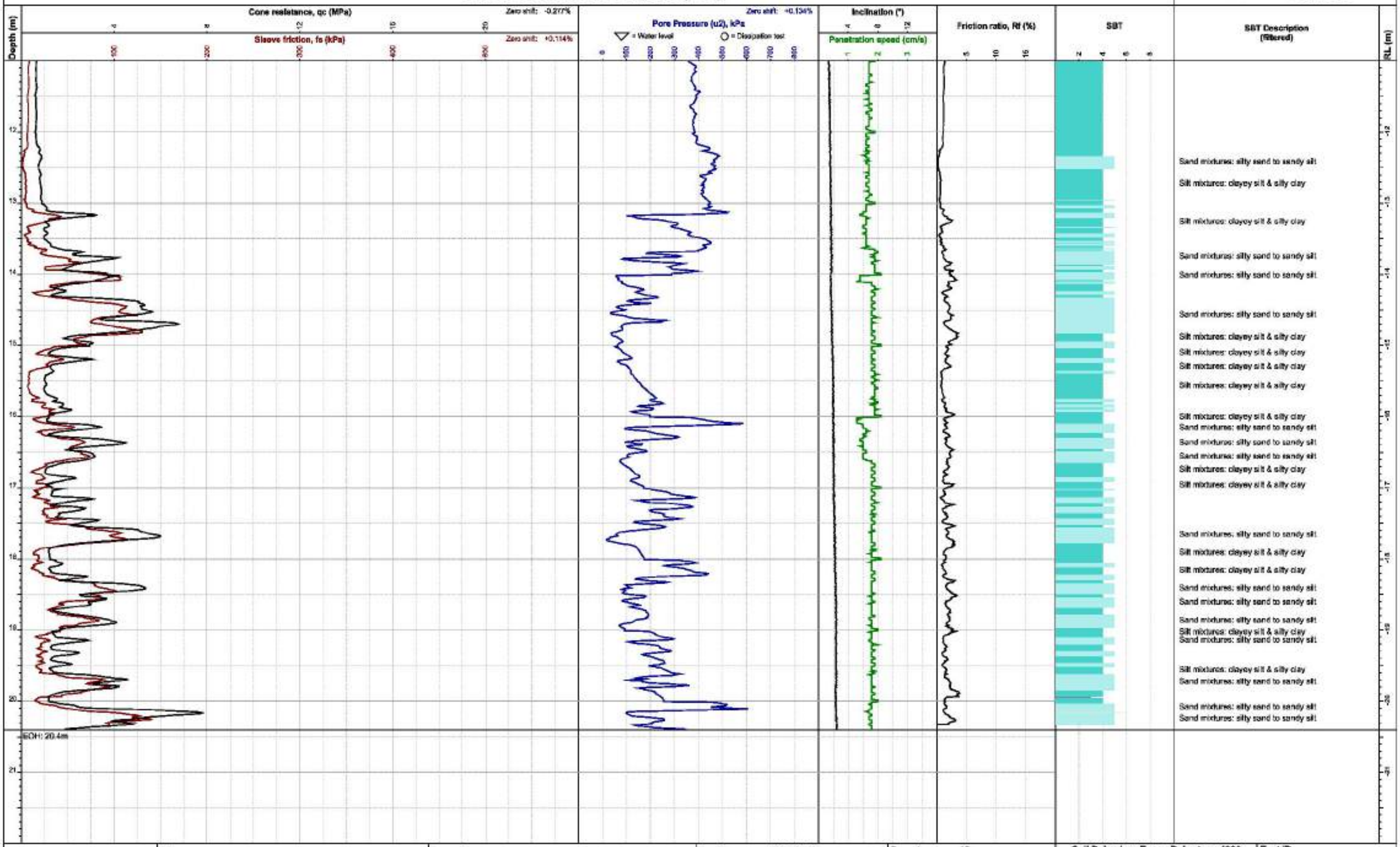
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-05



DEVELOPMENT & ENGINEERING LAND

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709840mN
Easting: 2036107mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

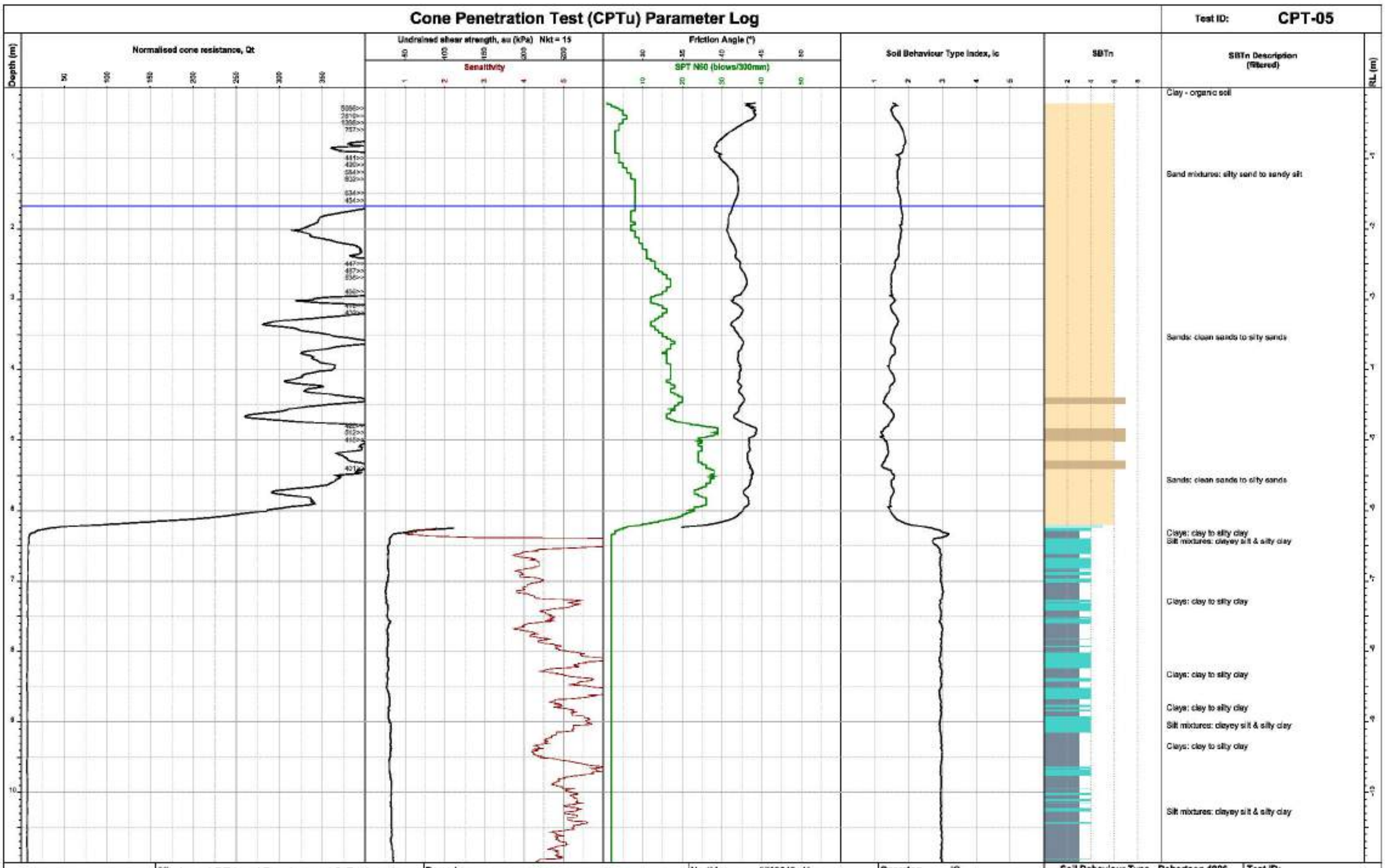
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-05
Project ID: 24477
Depth: 20.4m
Sheet: 2 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:15 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-05



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:

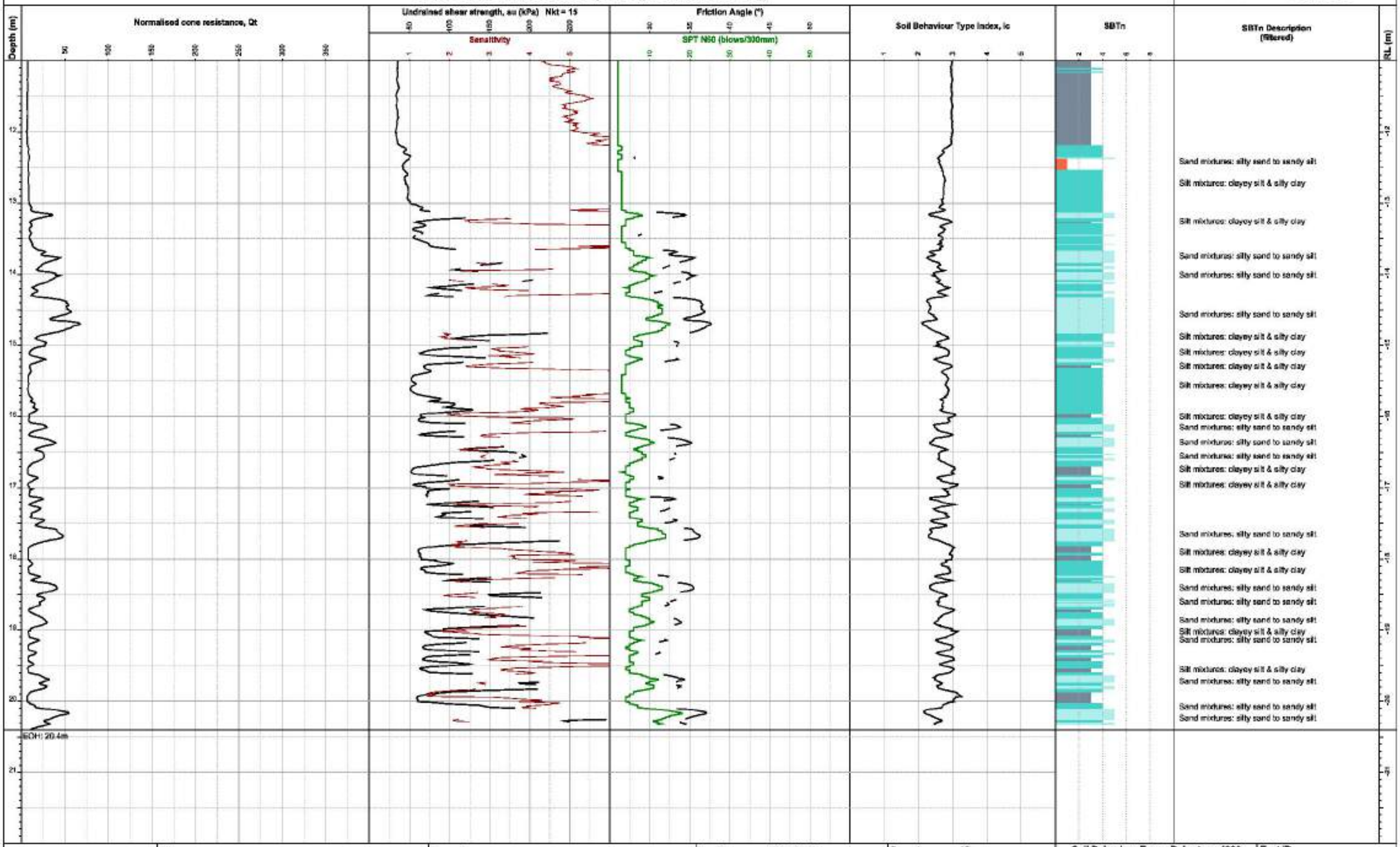
CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:15 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-05**



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:16 am

Client:	LDE Land Development & Engineering	**Remarks:**	Ground water level located at 1.68m Test according to ISO 22476-1:12 (Class 2)
Project:	geotechnical Investigation	**Termination Reason:**	Target depth
Location:	556-560 Abeerdeen Rd, Gisborne		

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

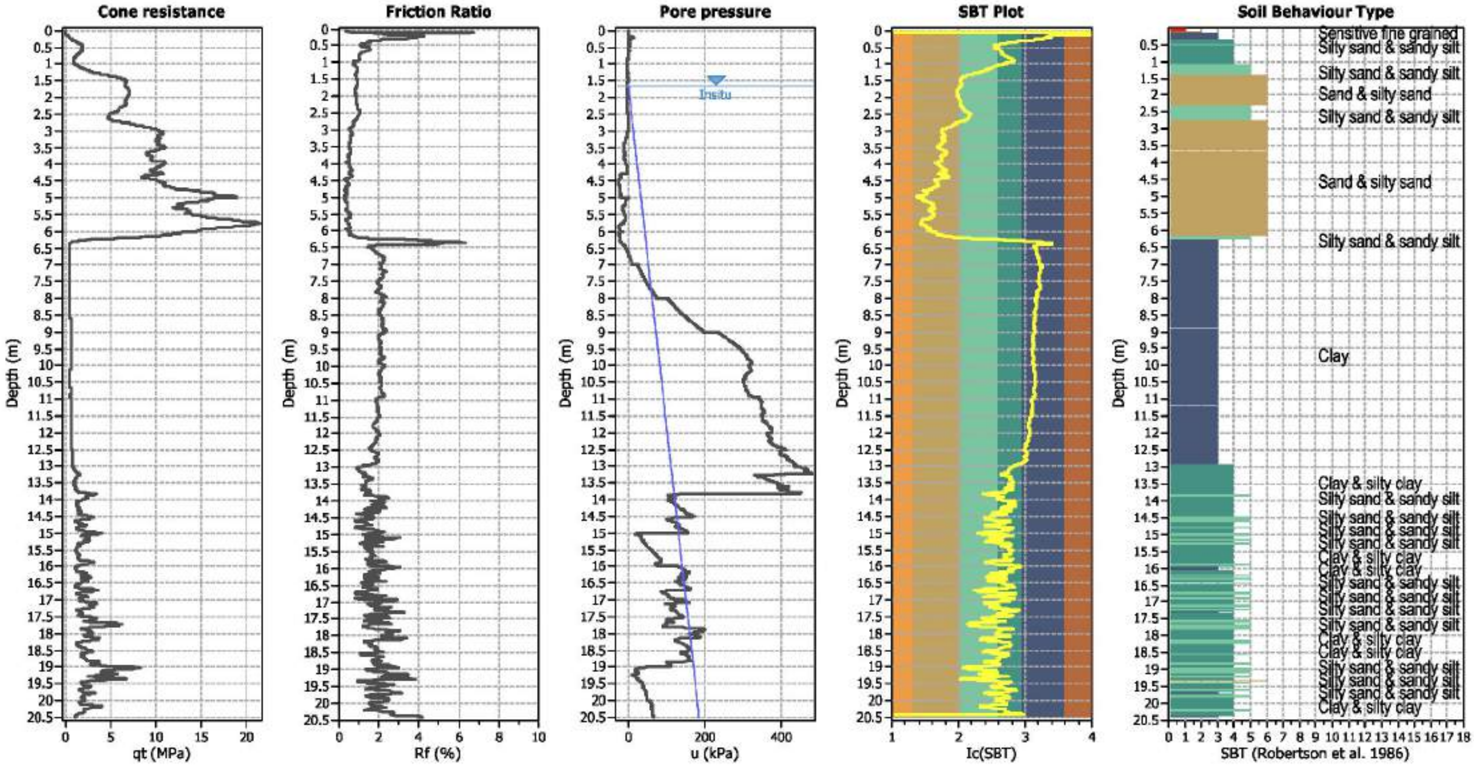
Test ID: **CPT-05**

Project ID:	24477
Depth:	20.4m
Sheet:	2 of 2
Date:	30/05/2023

APPENDIX D

LIQUEFATION ANALYSIS RESULTS

CPT basic interpretation plots



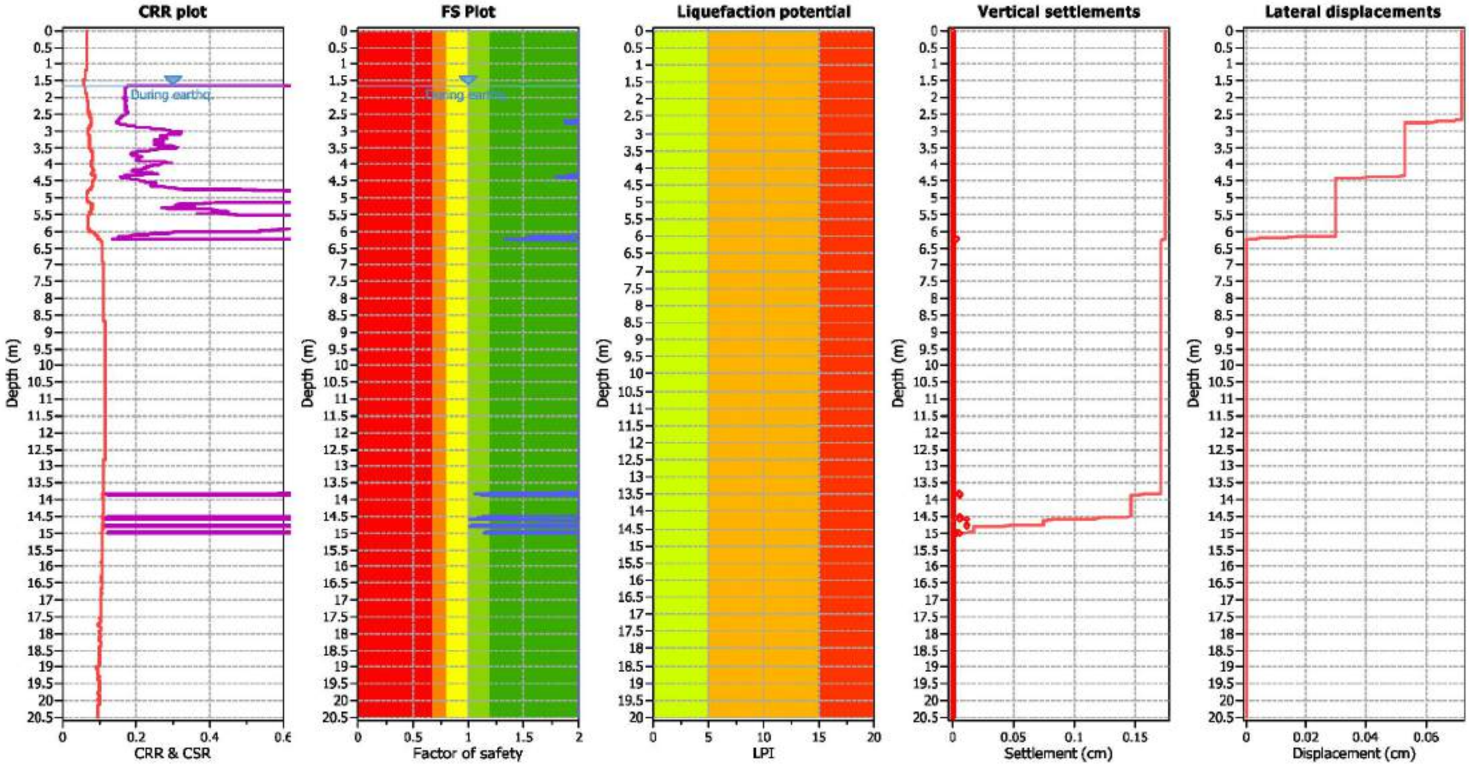
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

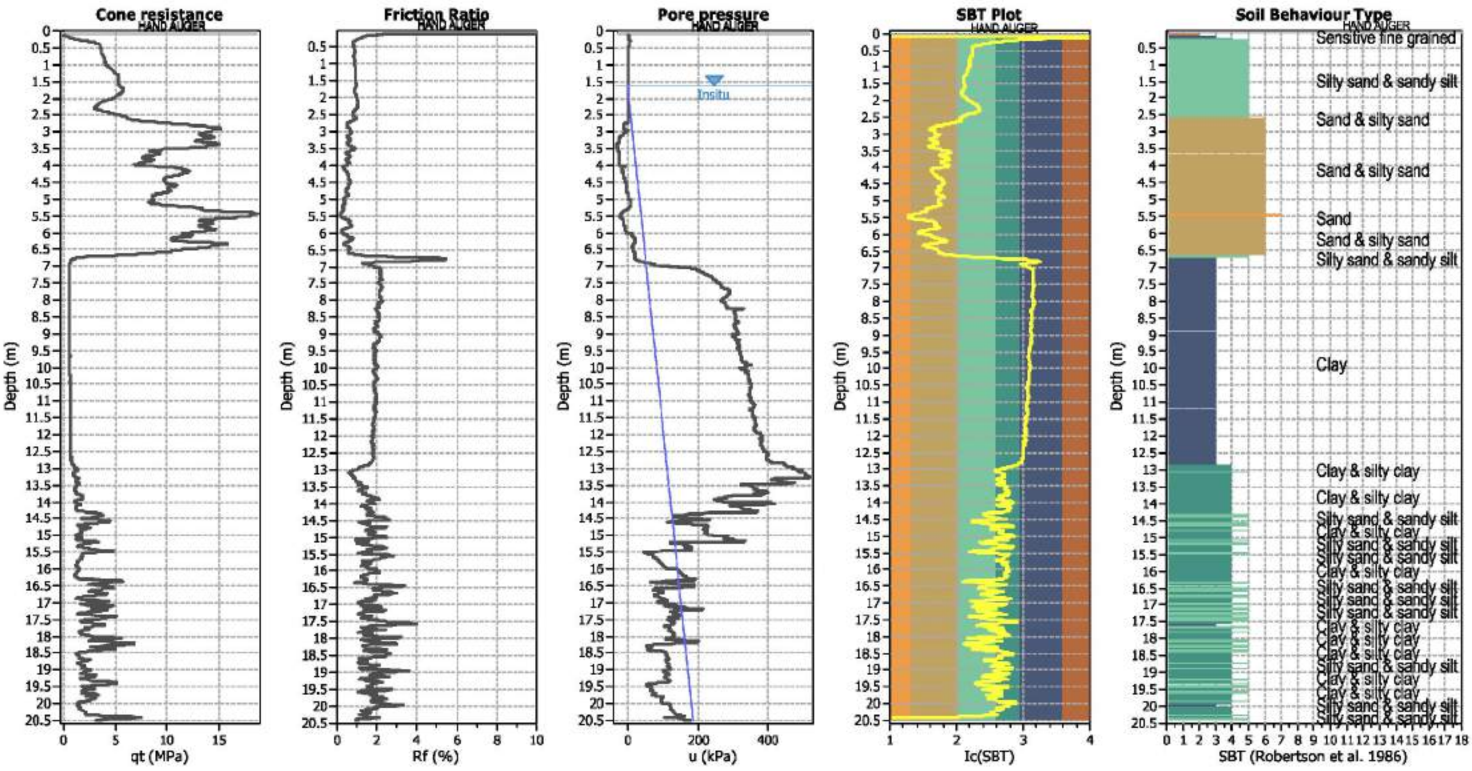
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



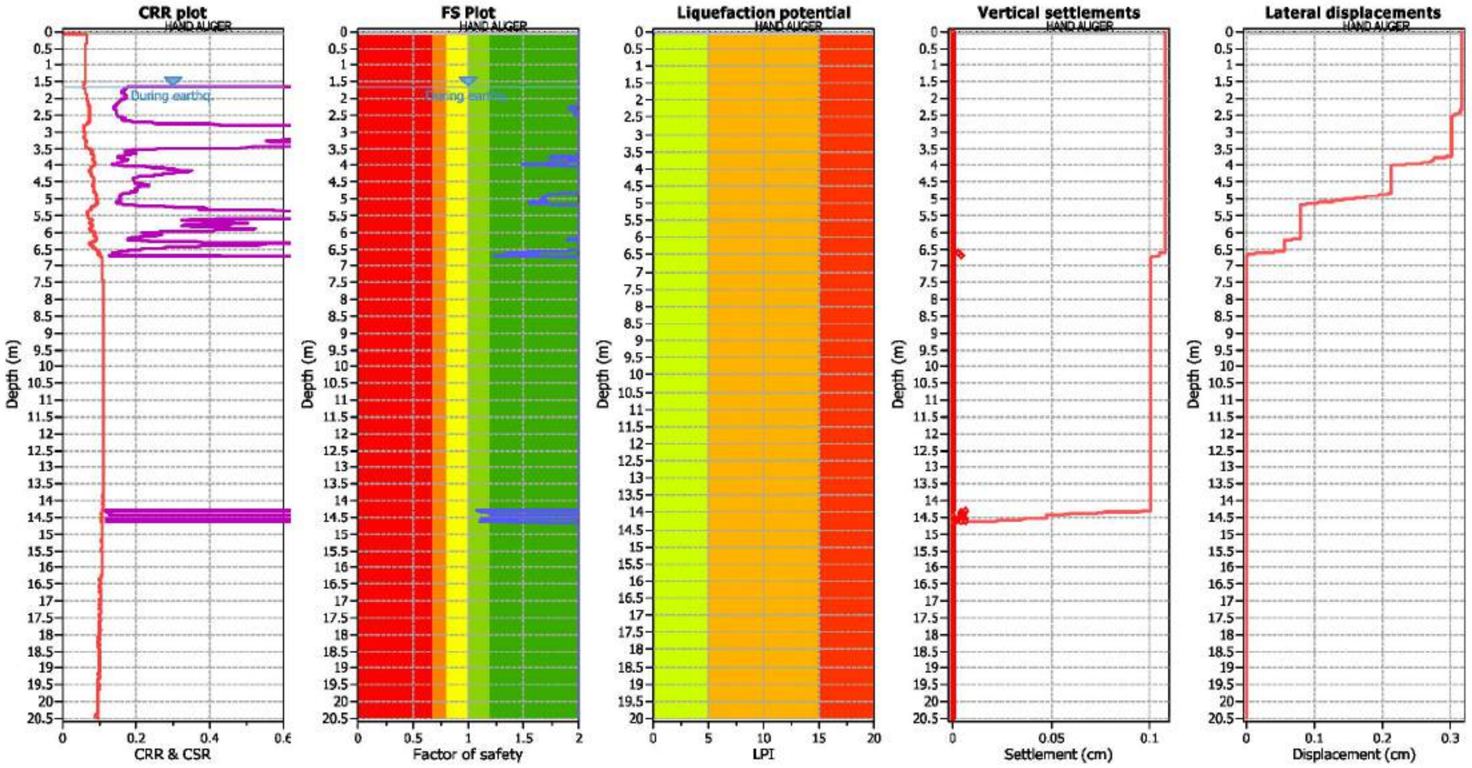
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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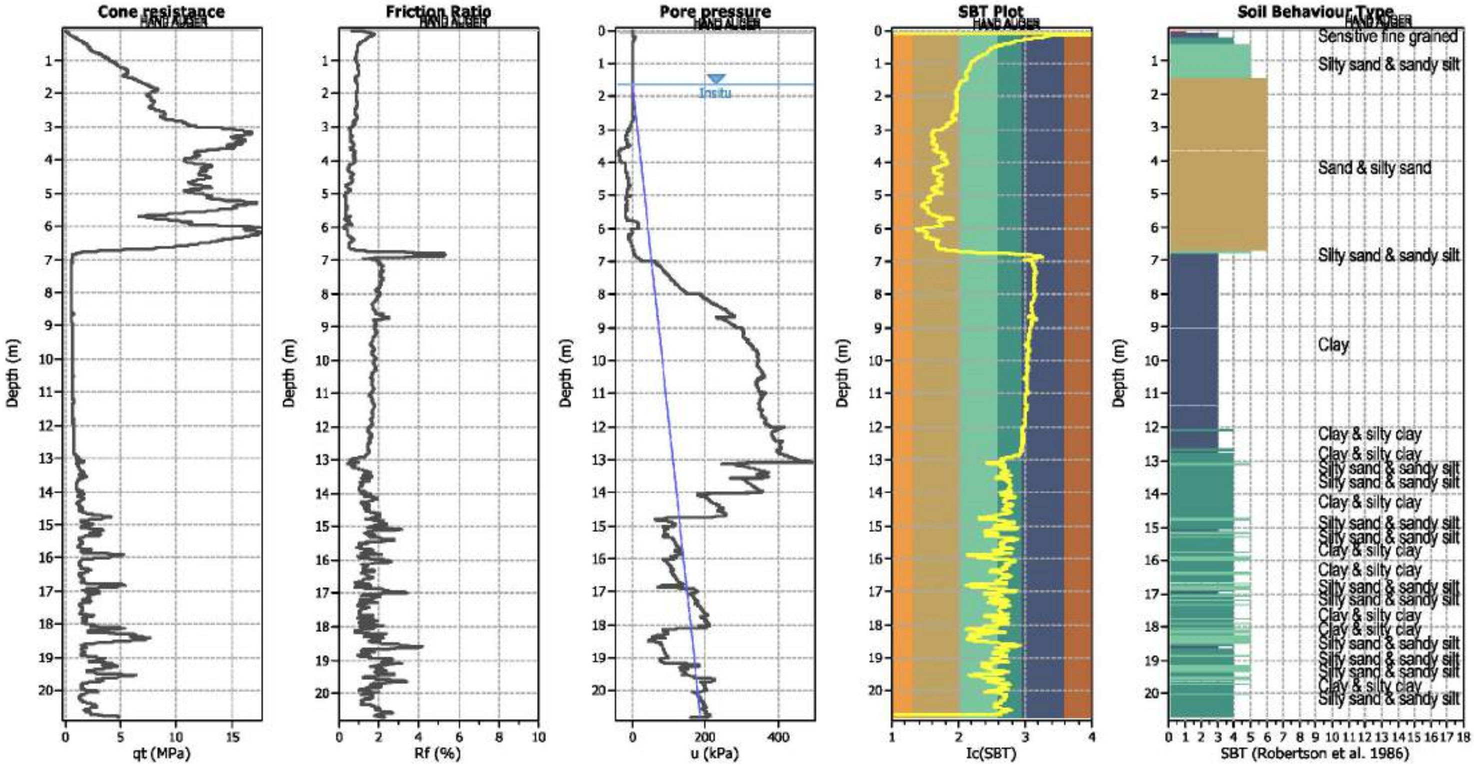
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

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

CPT basic interpretation plots



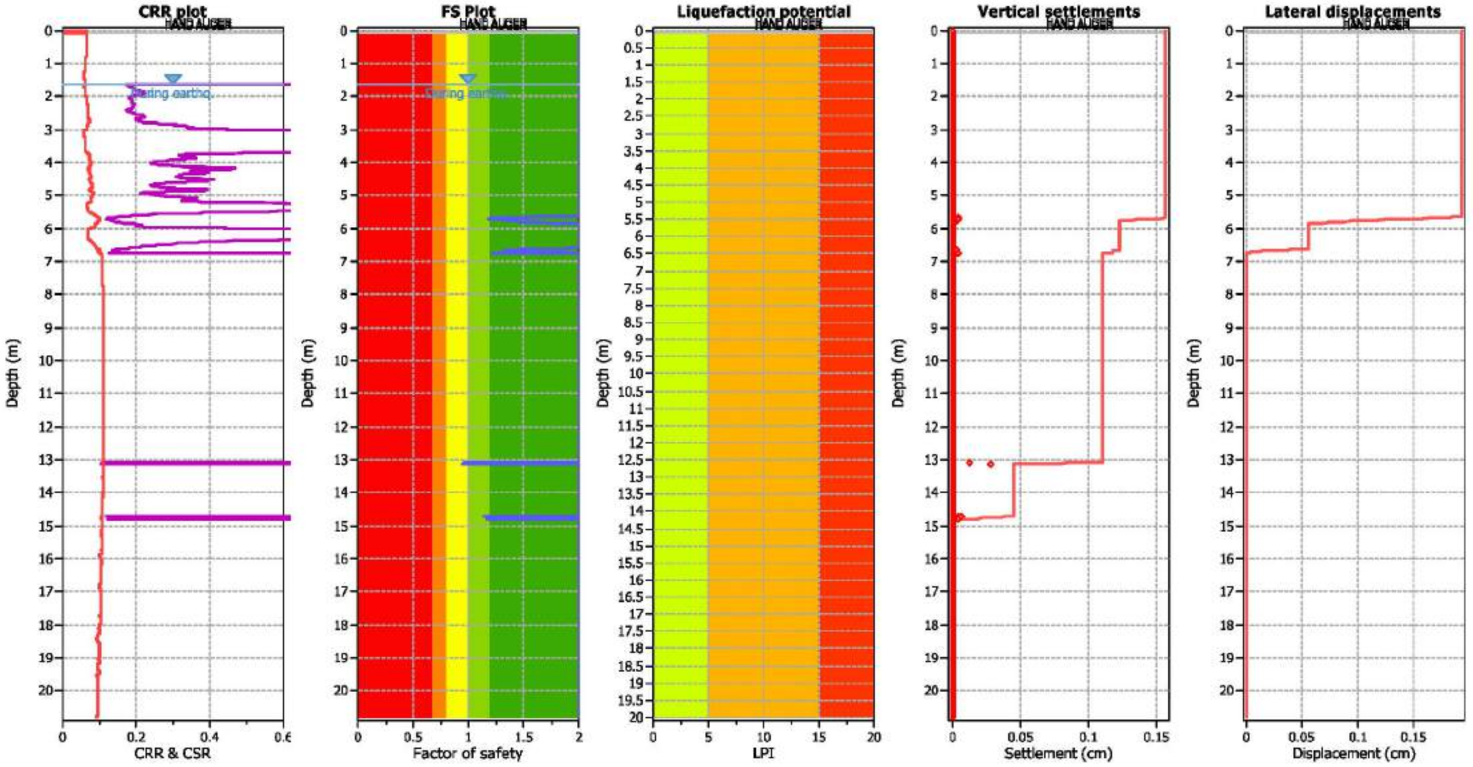
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
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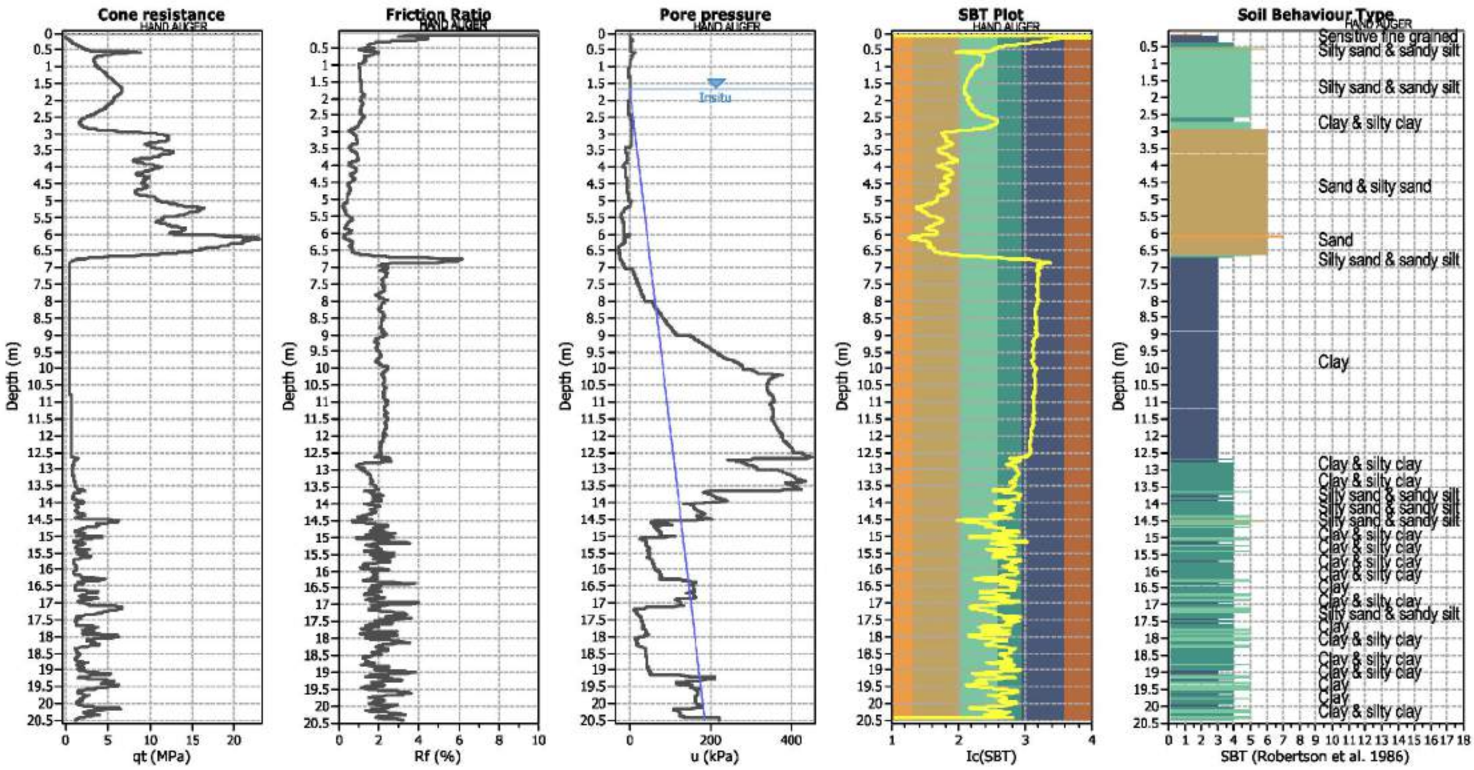
LPI color scheme

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

CPT basic interpretation plots



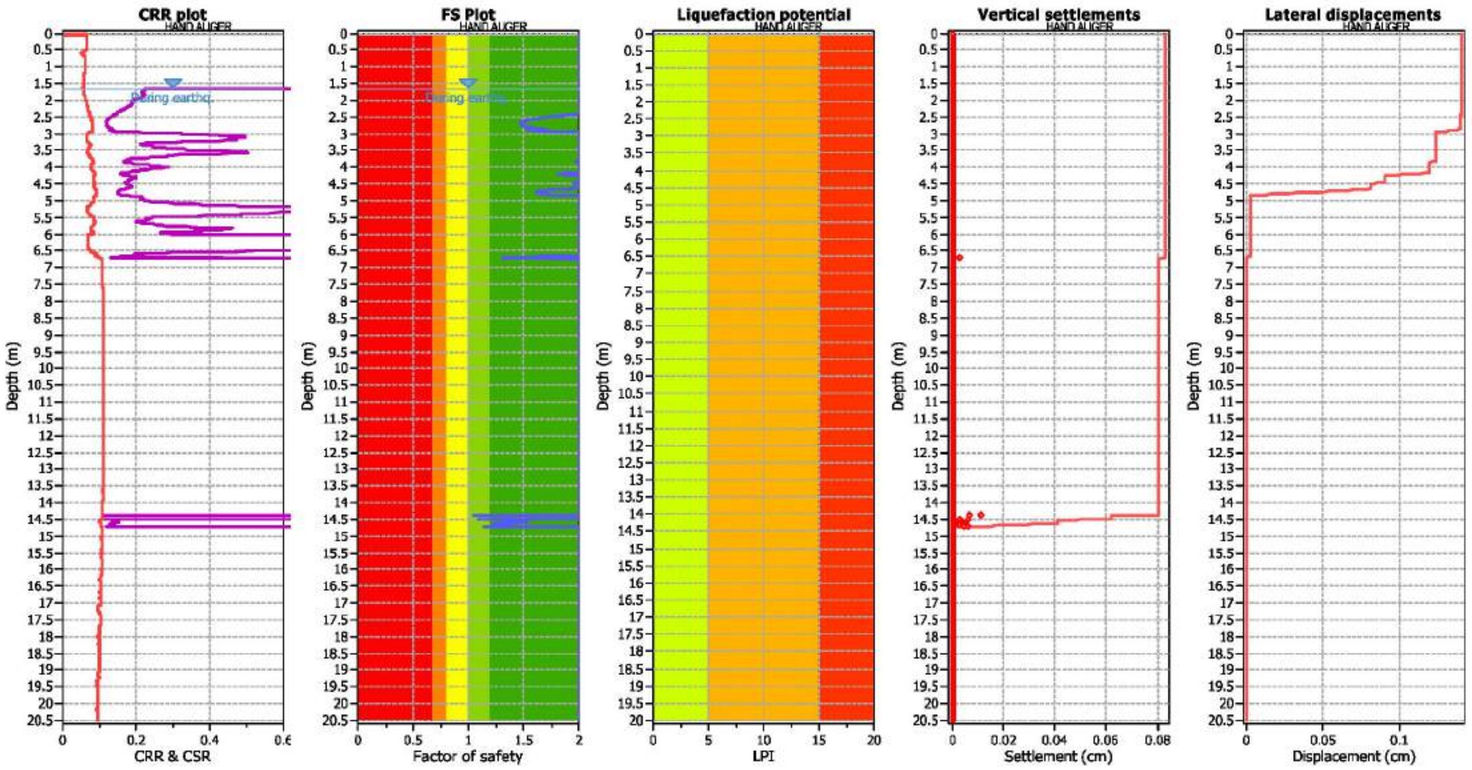
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to
⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

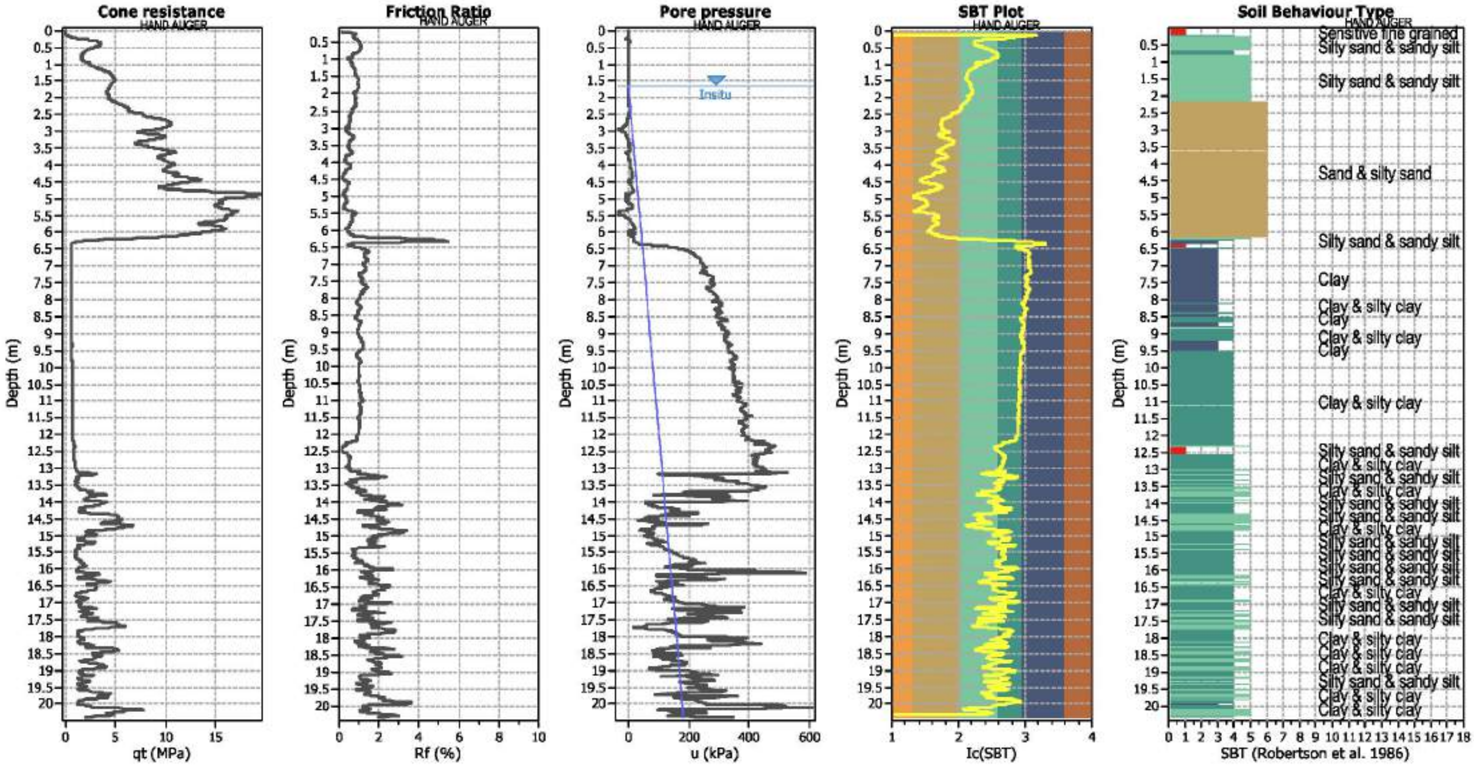
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



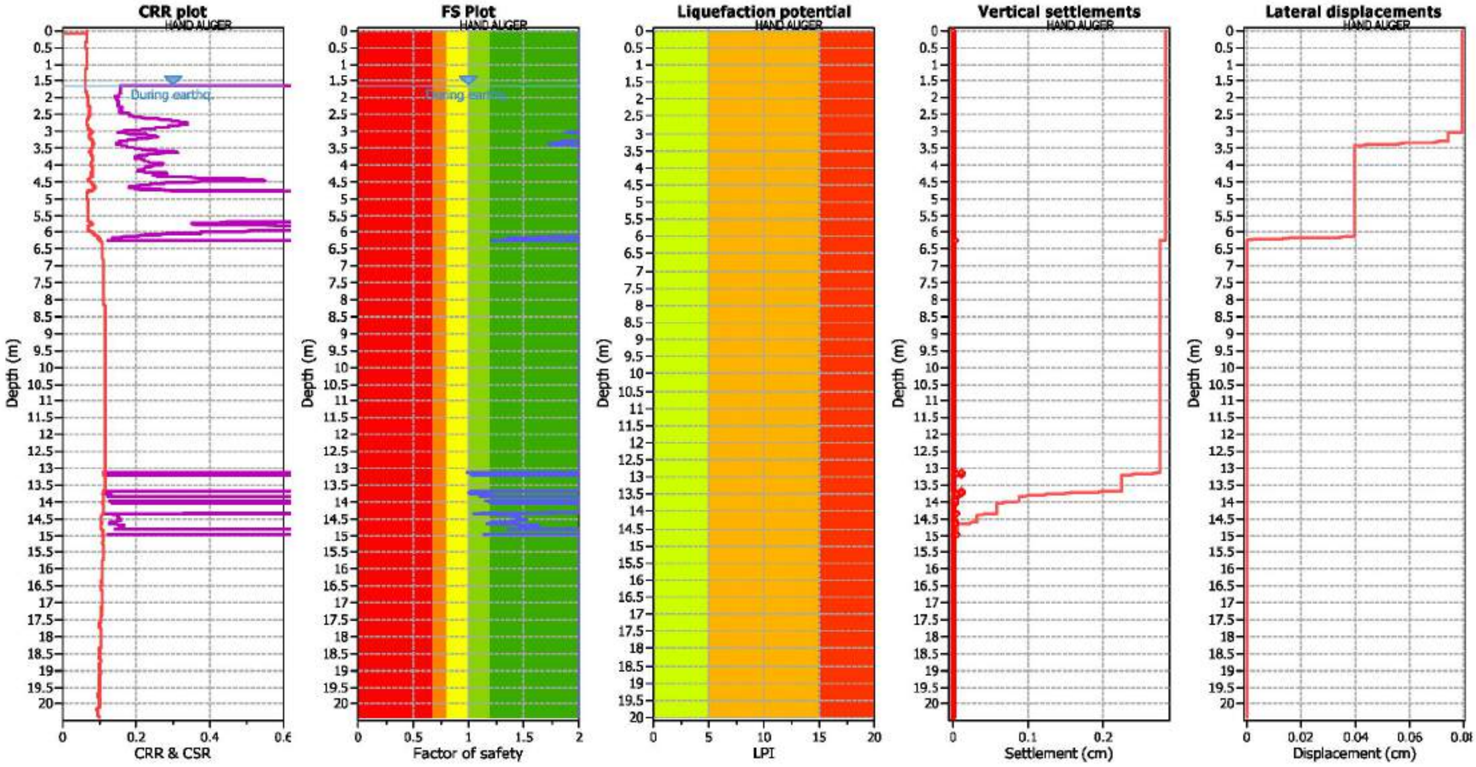
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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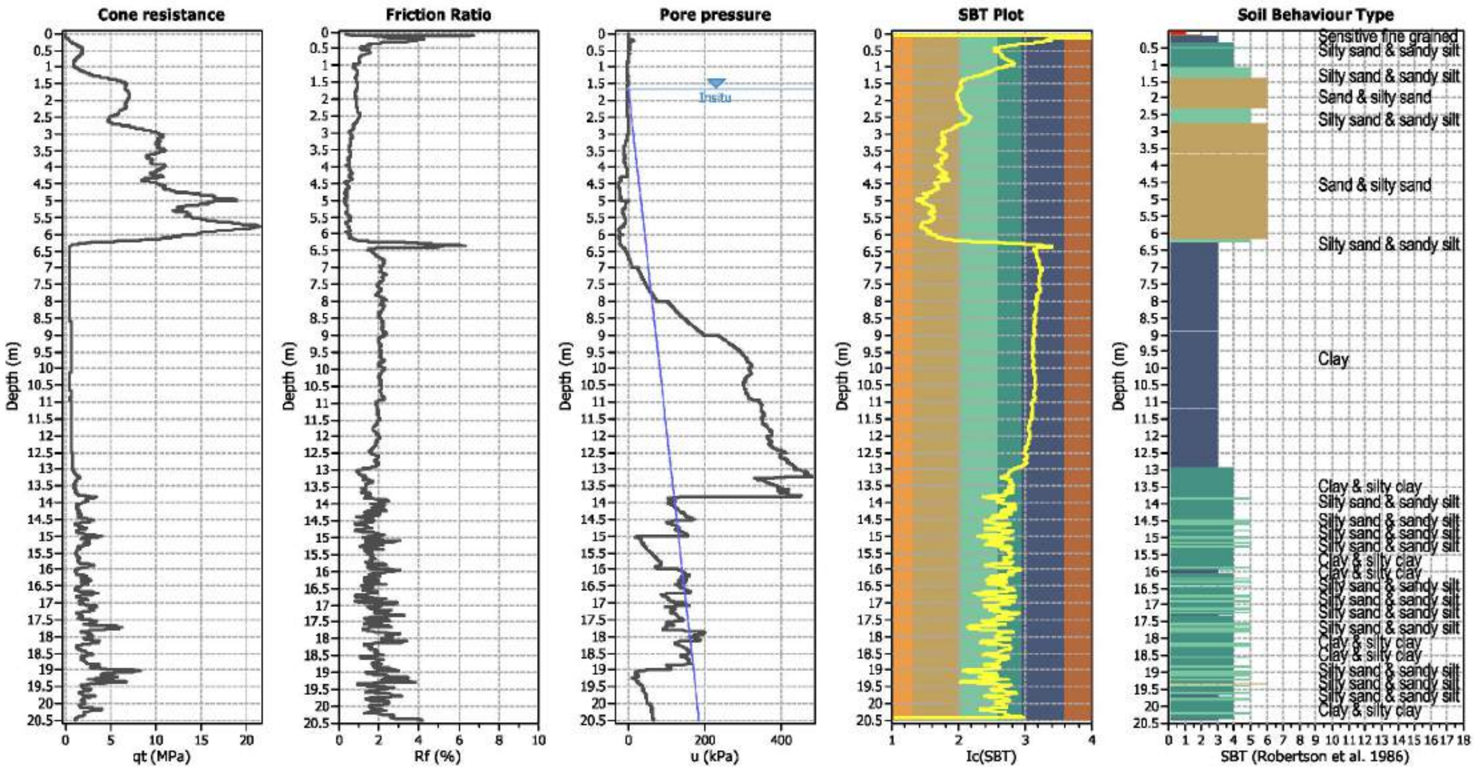
CPT basic interpretation plots



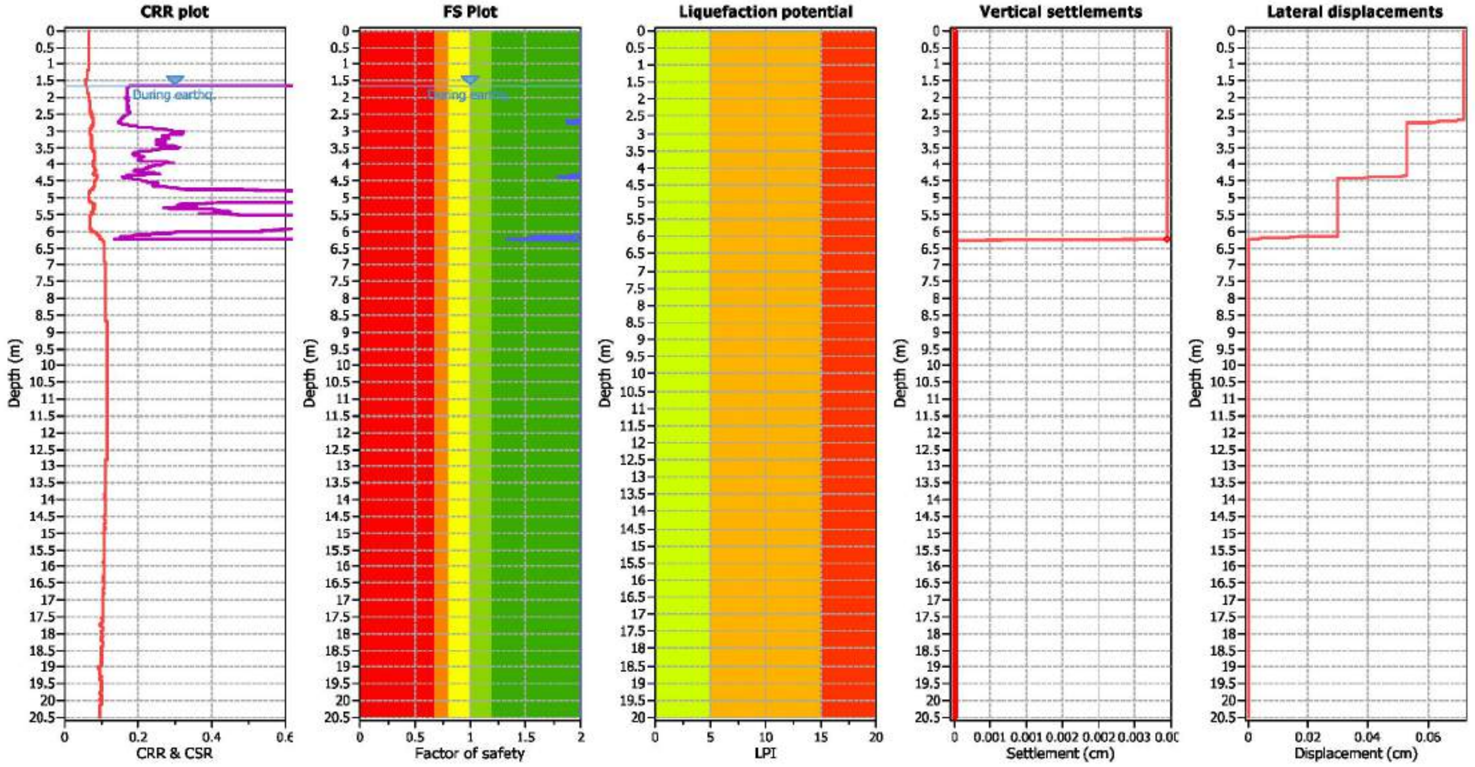
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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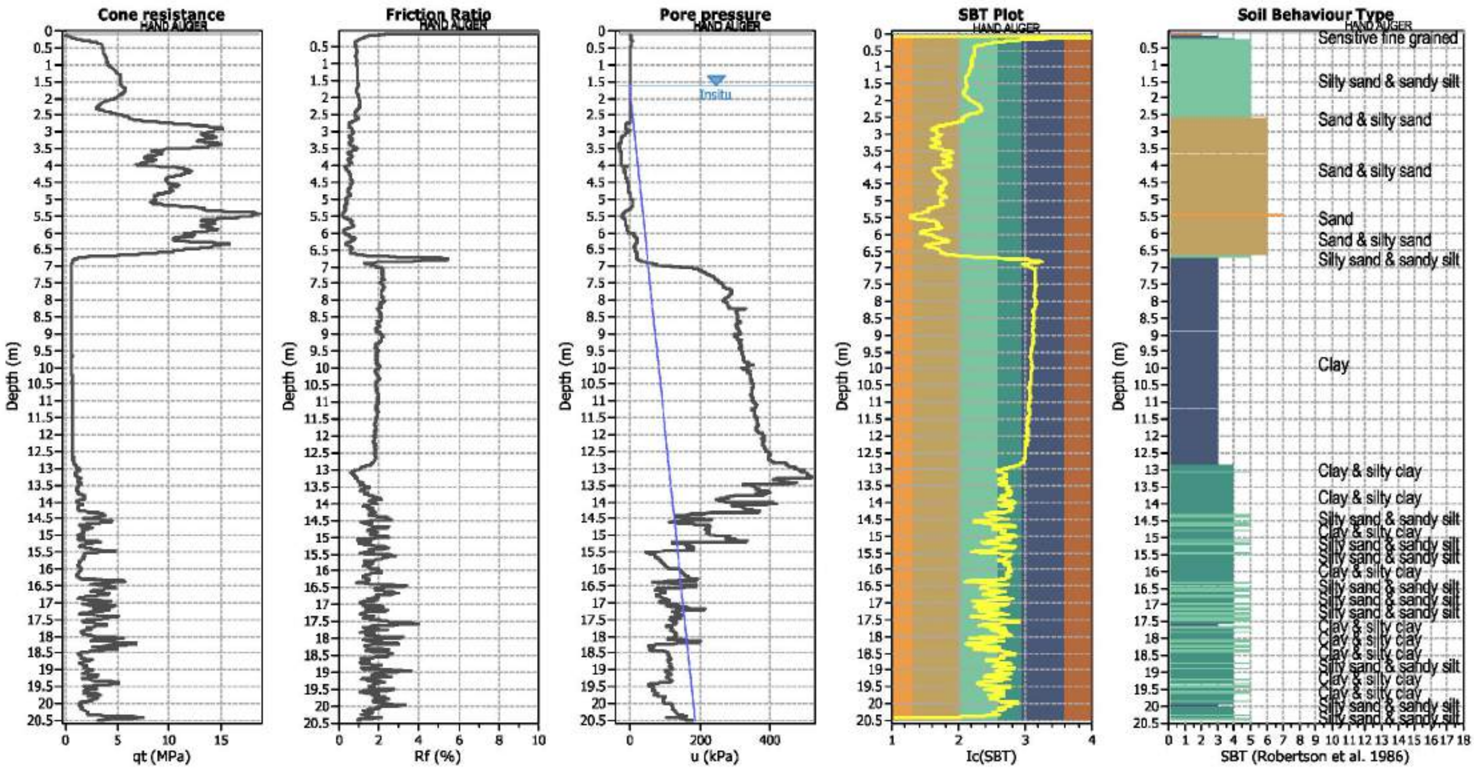
CPT basic interpretation plots



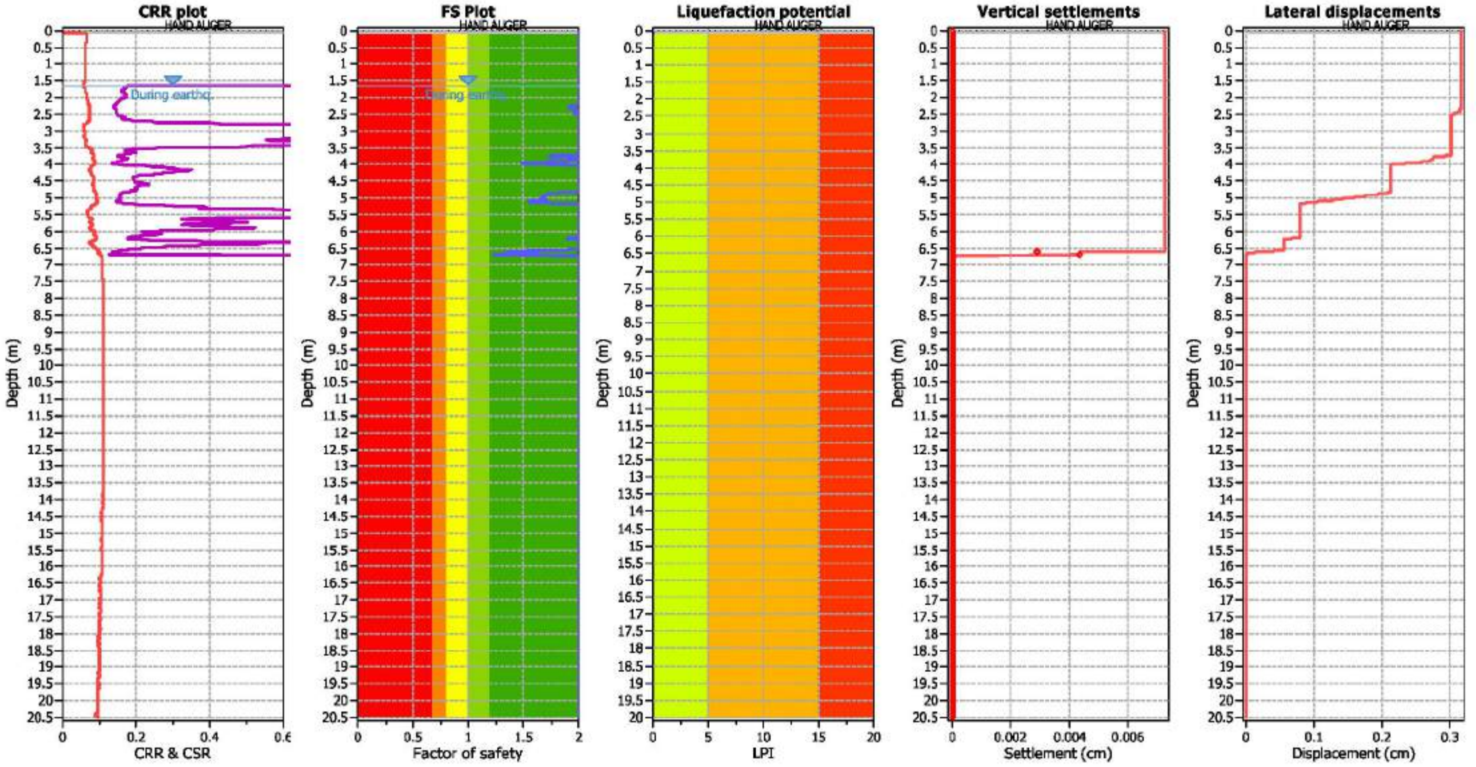
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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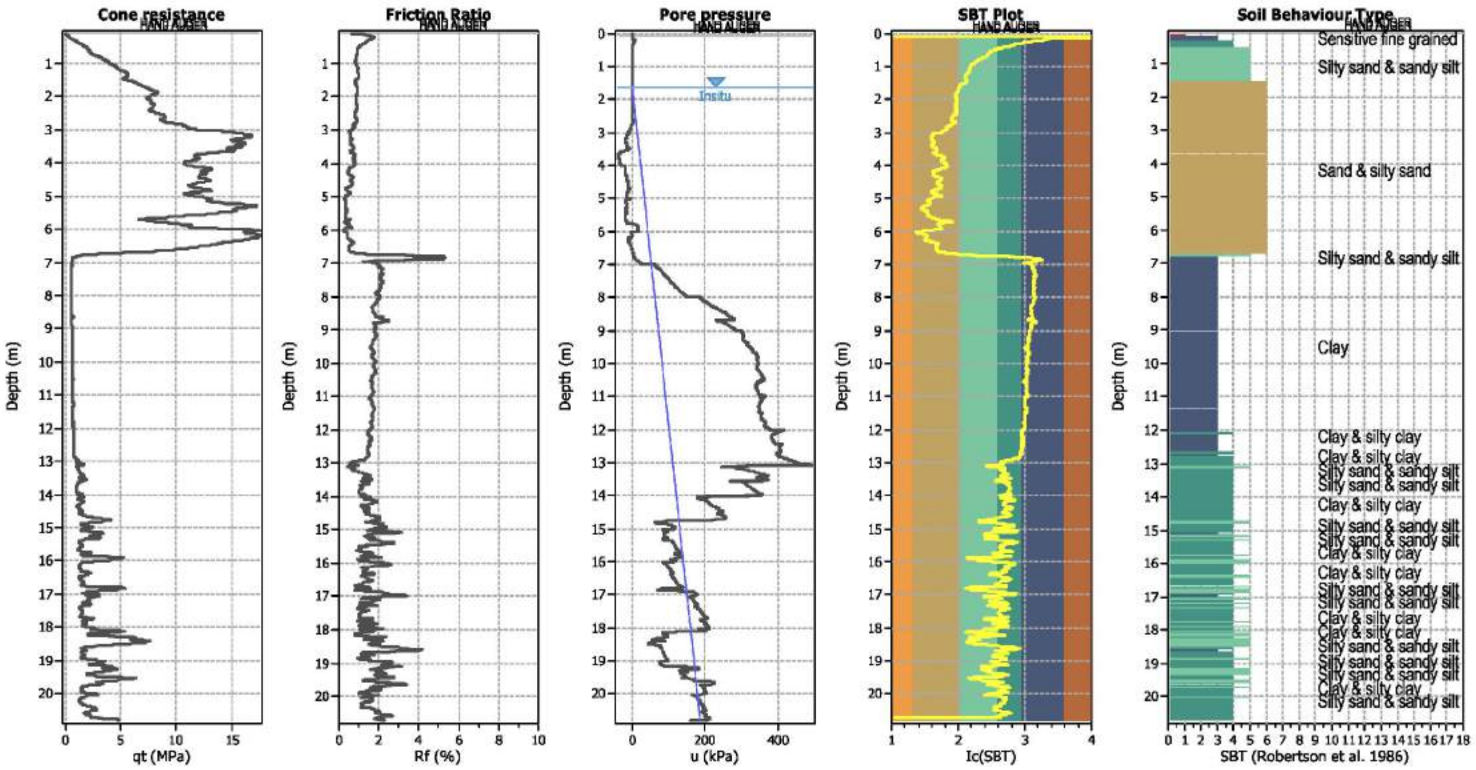
CPT basic interpretation plots



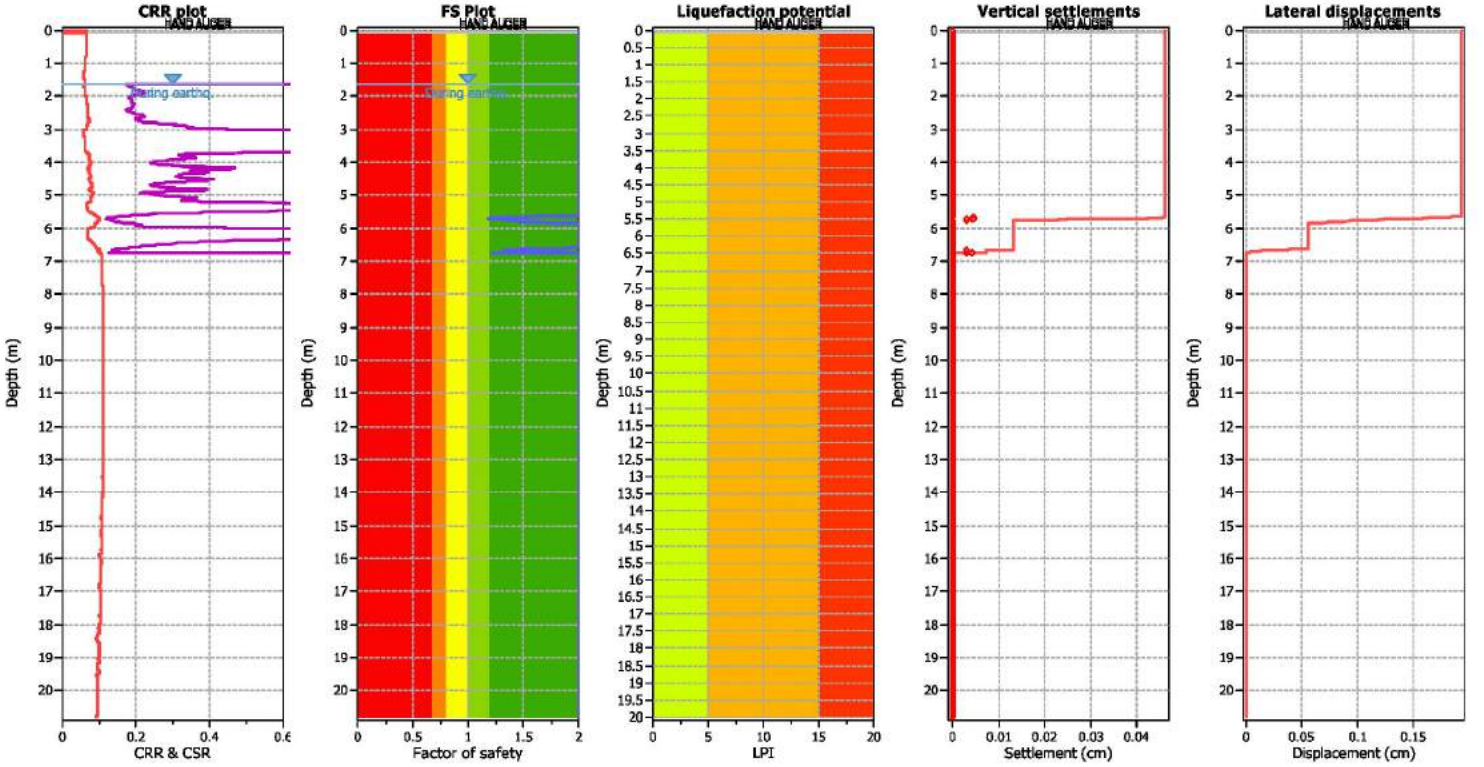
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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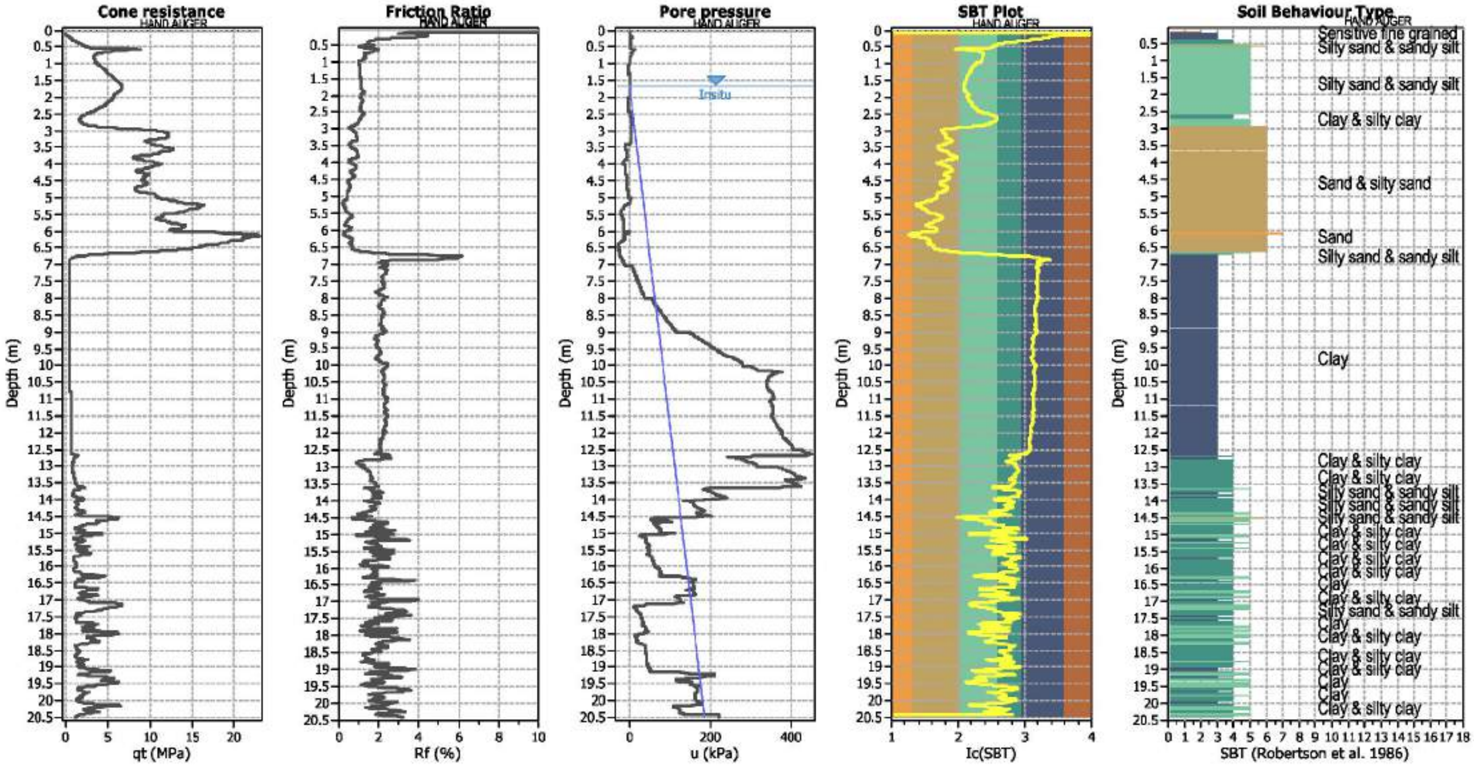
CPT basic interpretation plots



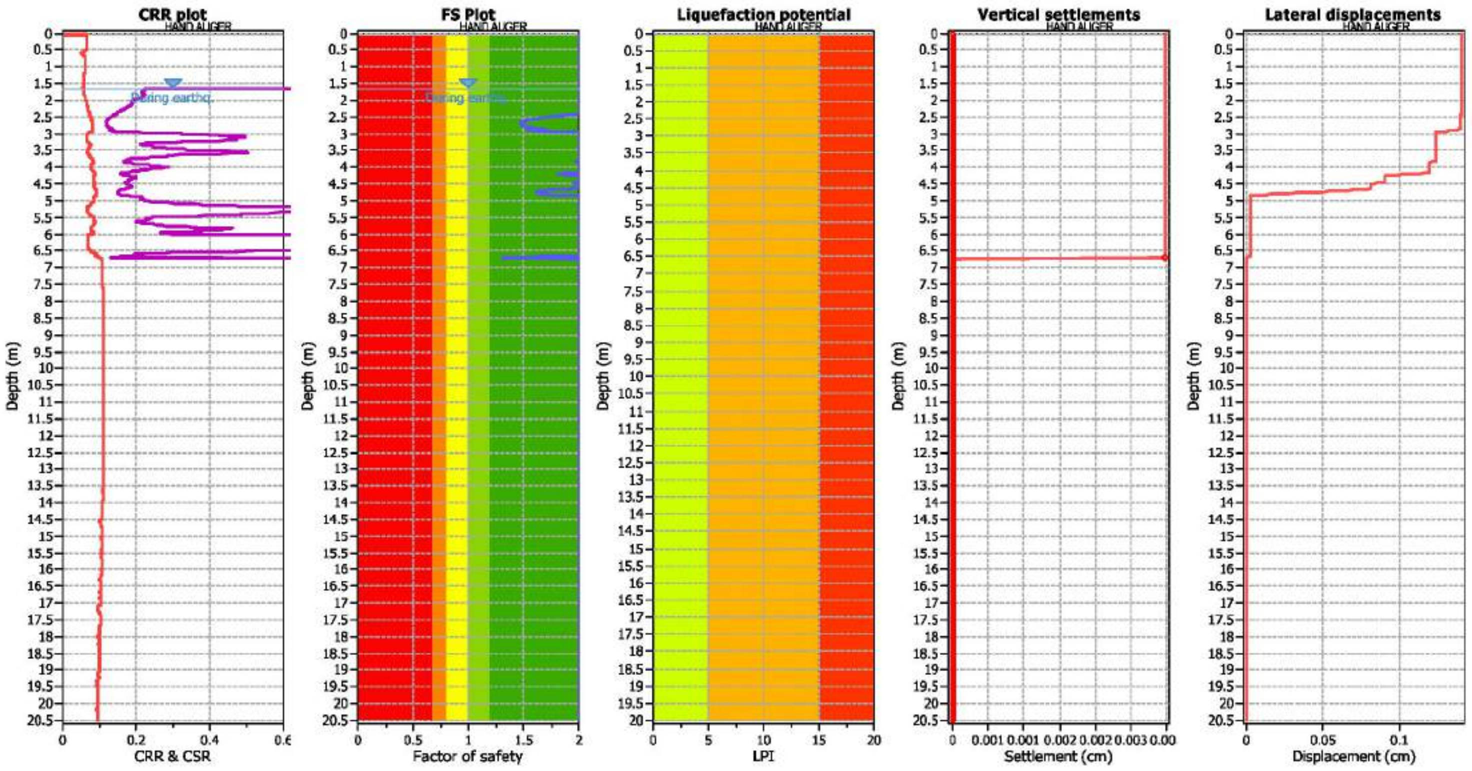
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	6.30
Peak ground acceleration:	0.12
Depth to water table (insitu):	1.65 m
Depth to GWT (erthq.):	1.65 m
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT
Use fill:	No
Fill height:	N/A
Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

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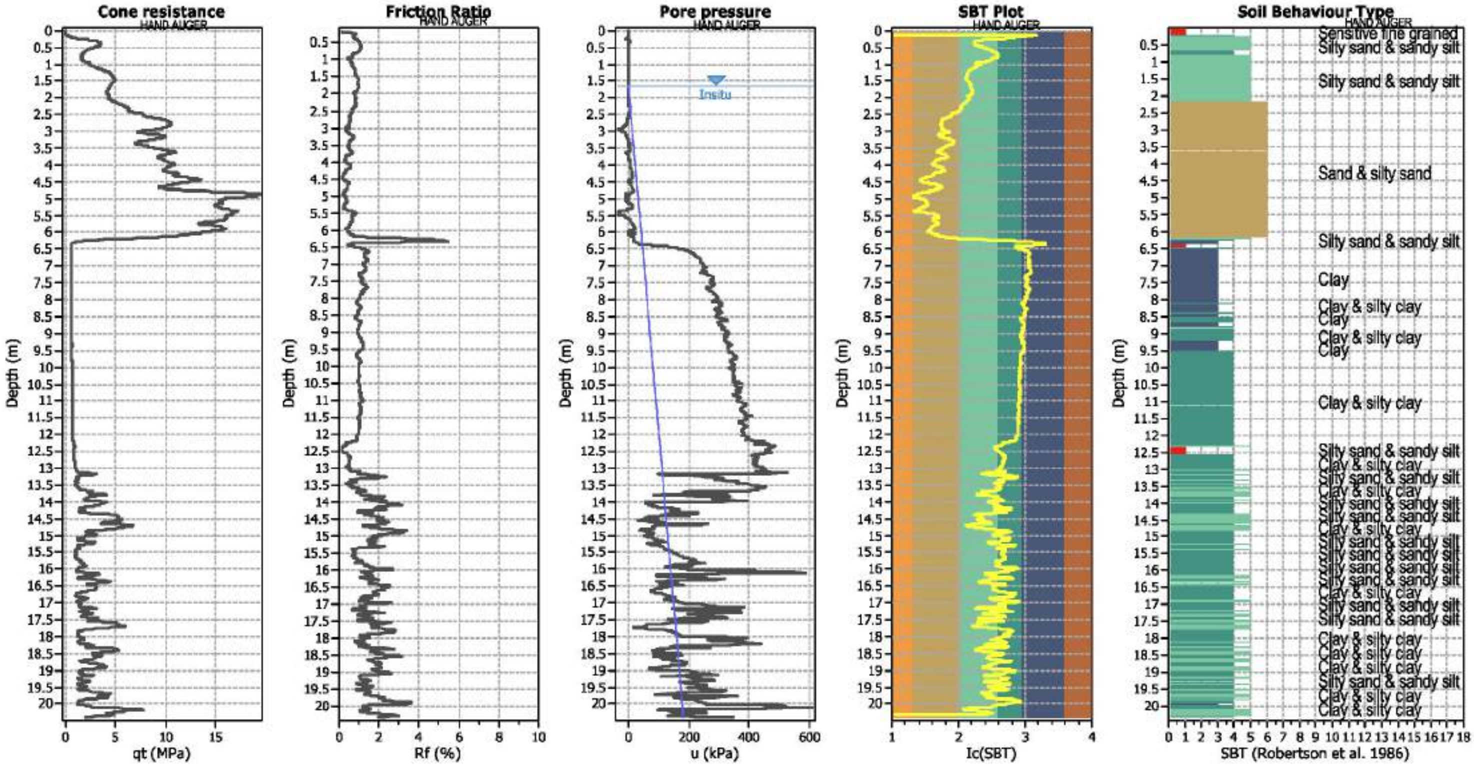
CPT basic interpretation plots



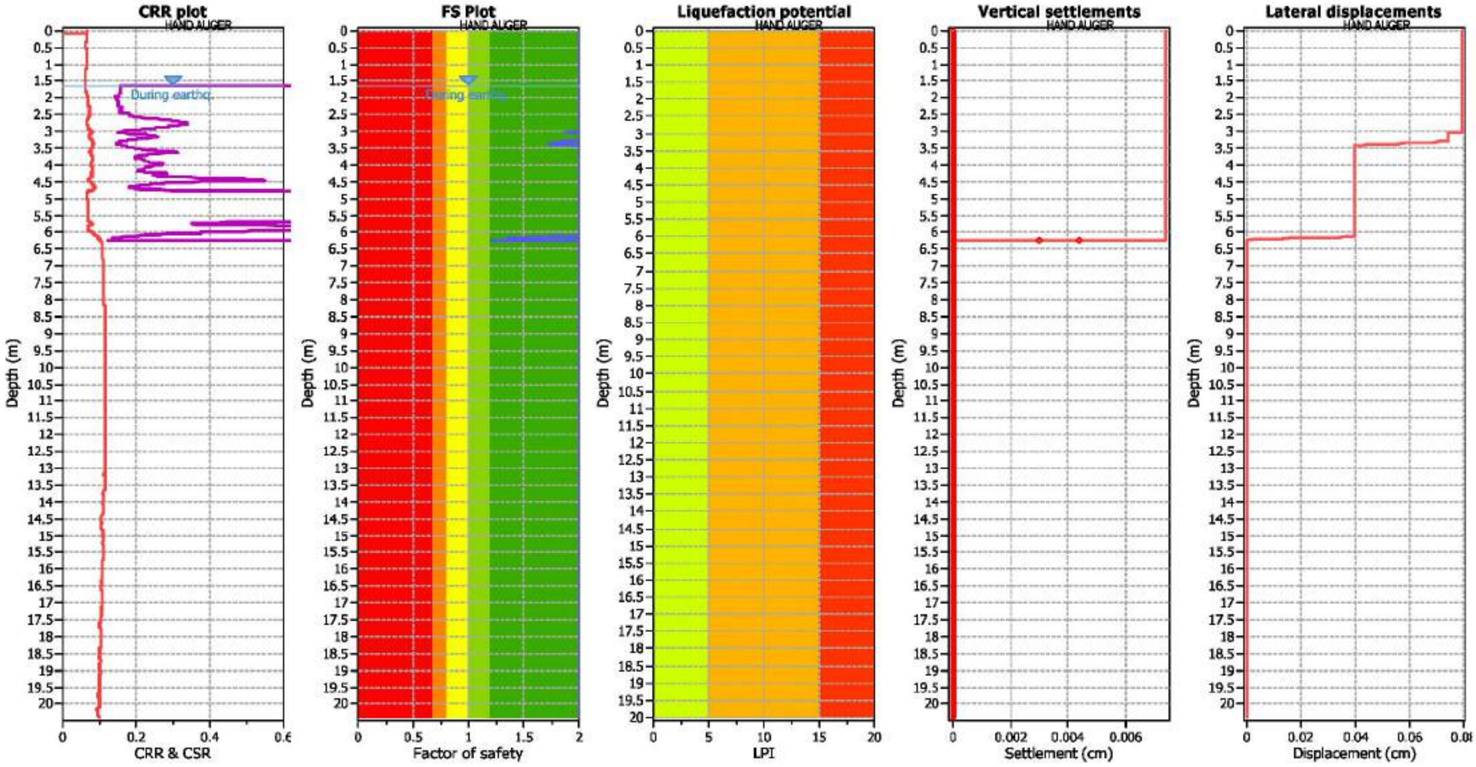
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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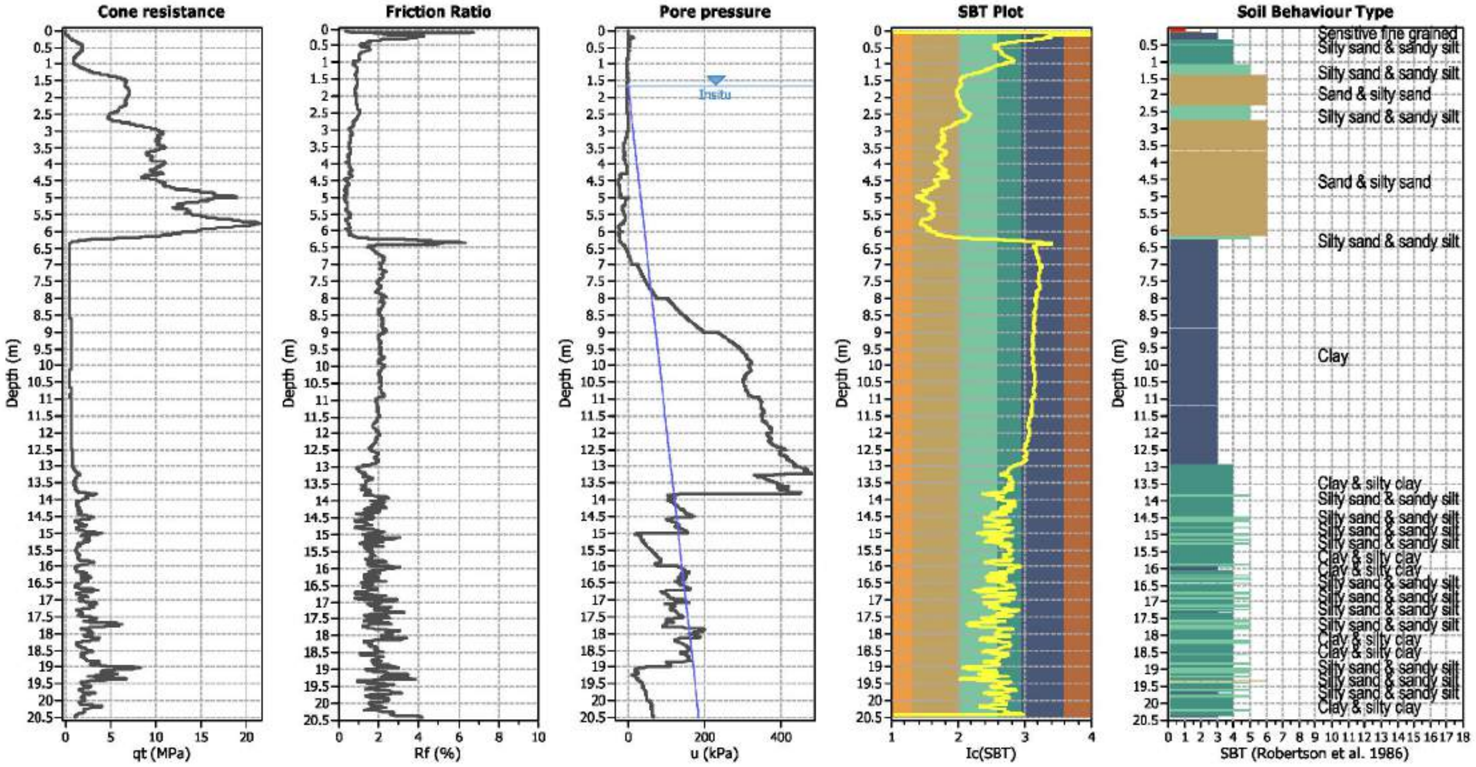
CPT basic interpretation plots



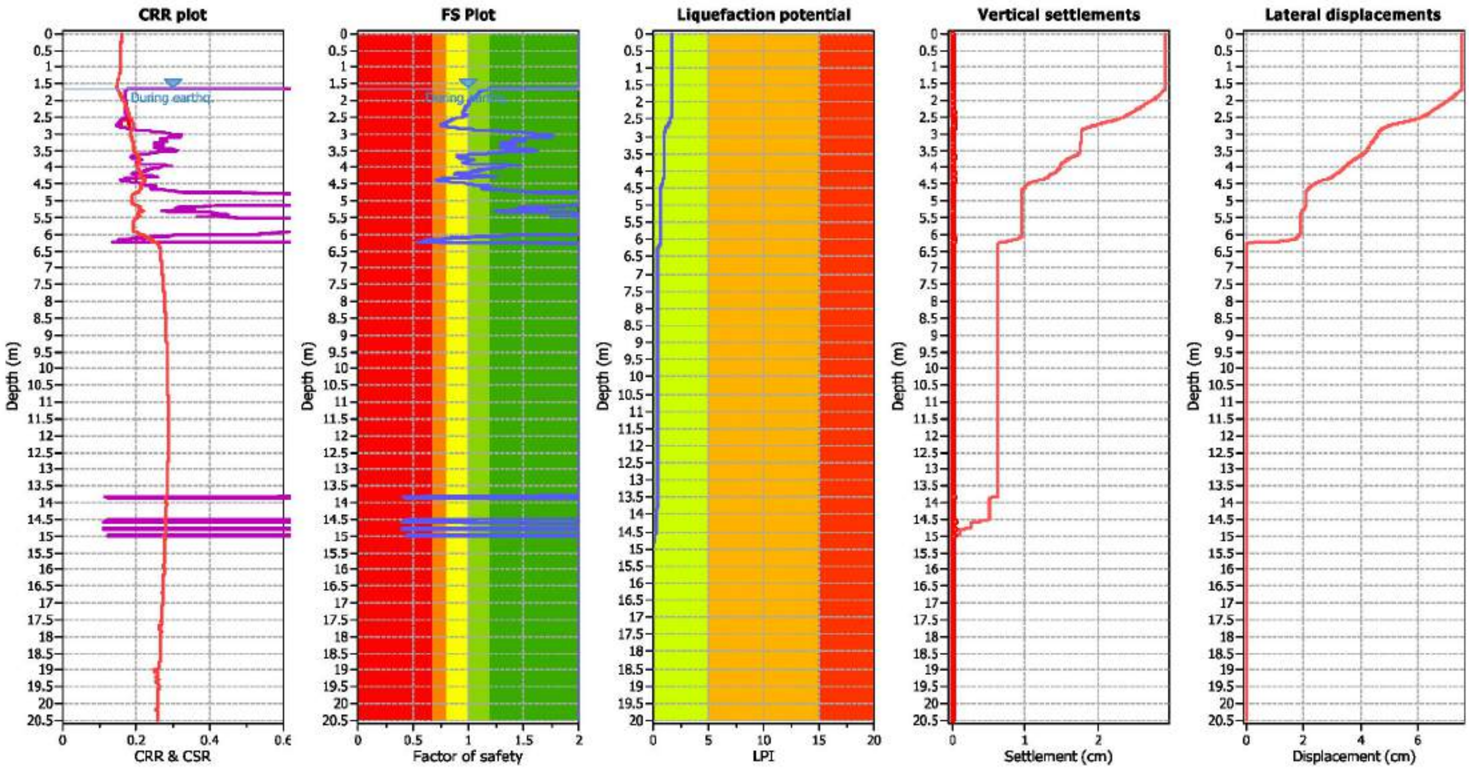
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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LPI color scheme

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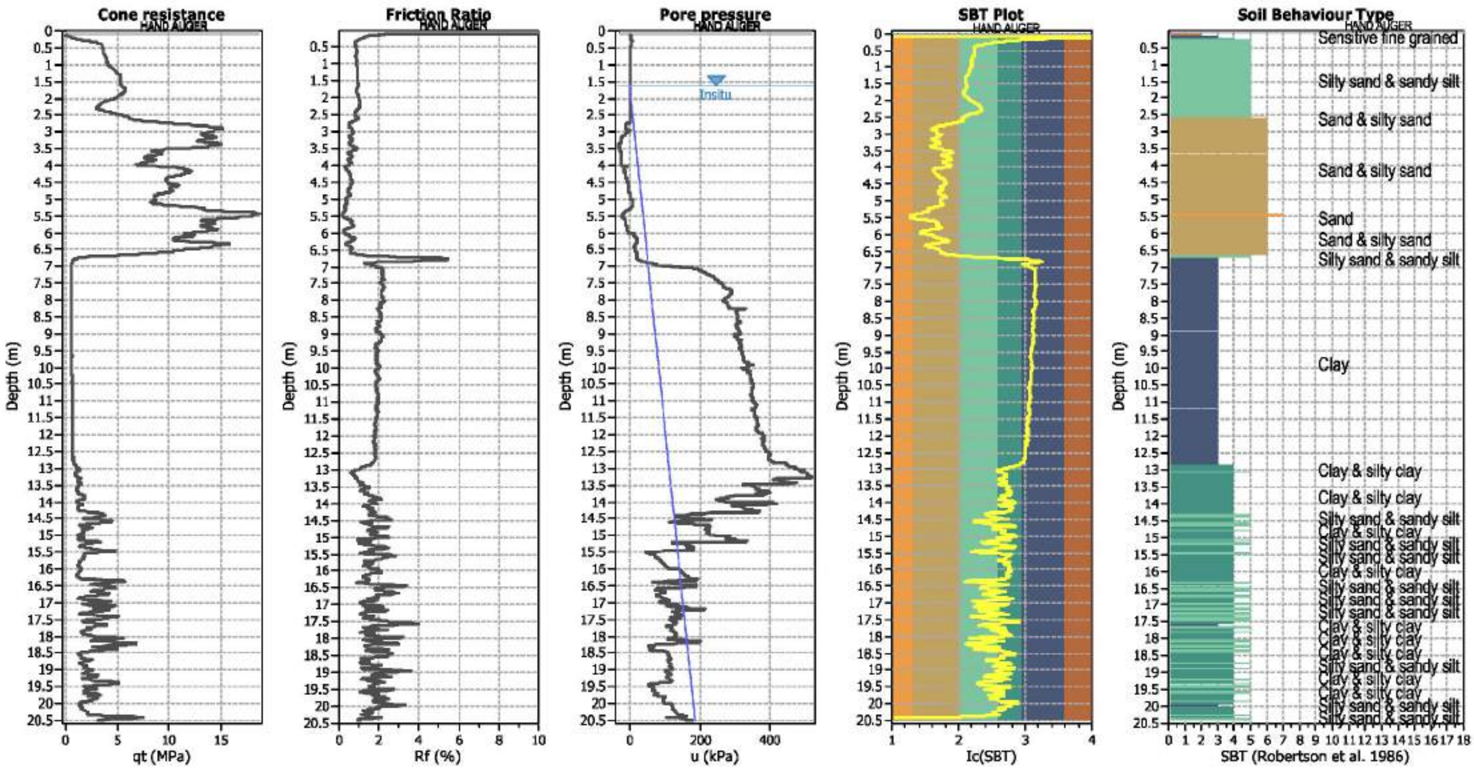
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
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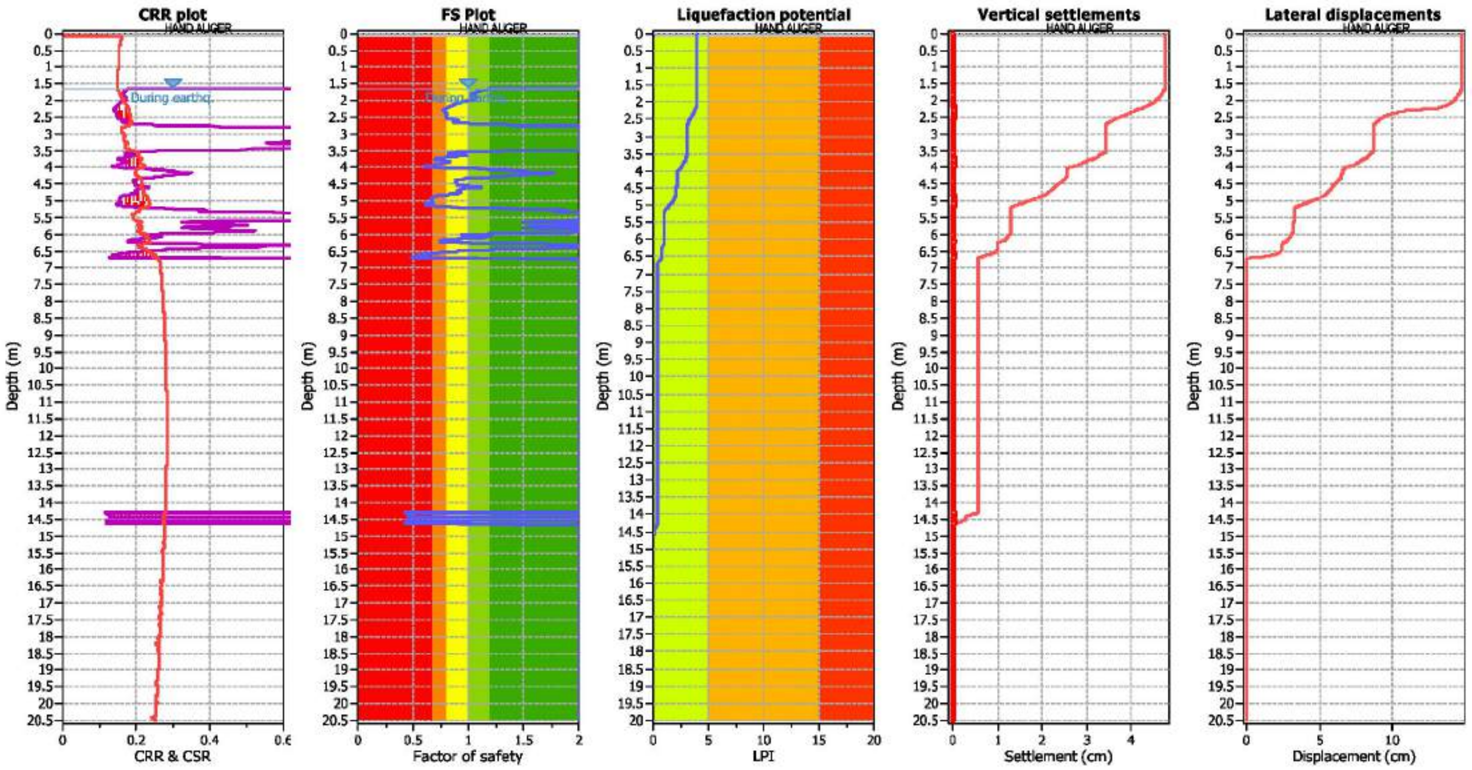
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
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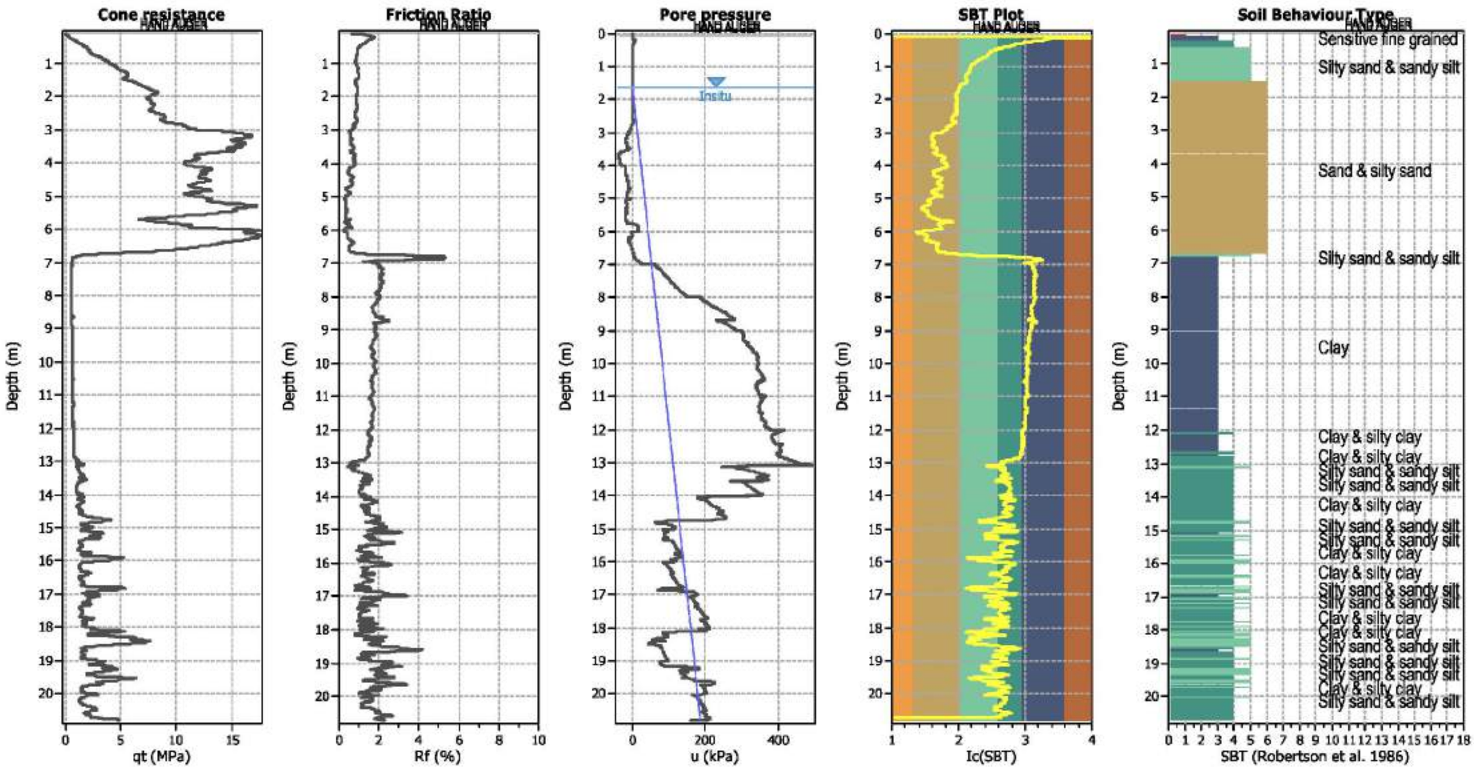

Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Earthquake magnitude M_w:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

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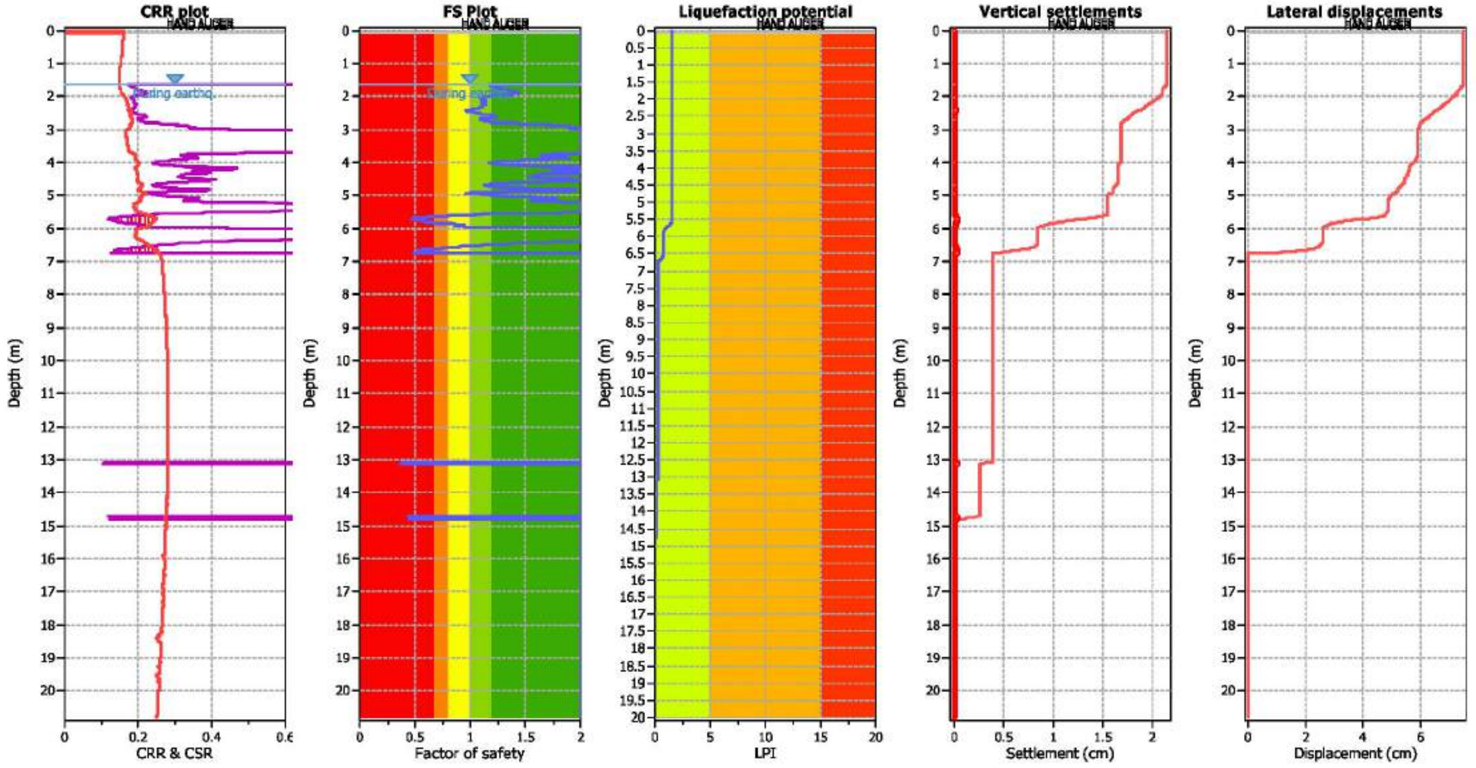
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

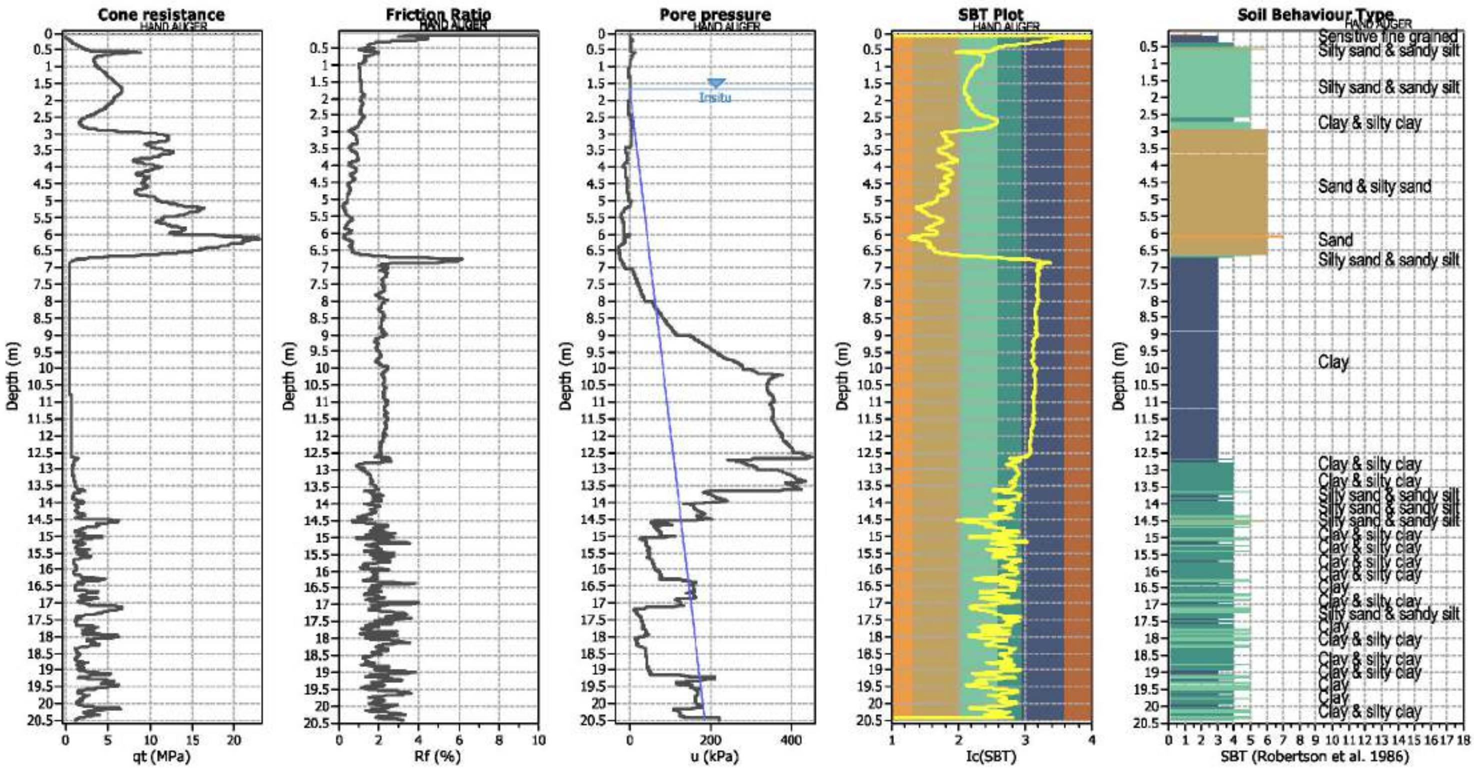
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



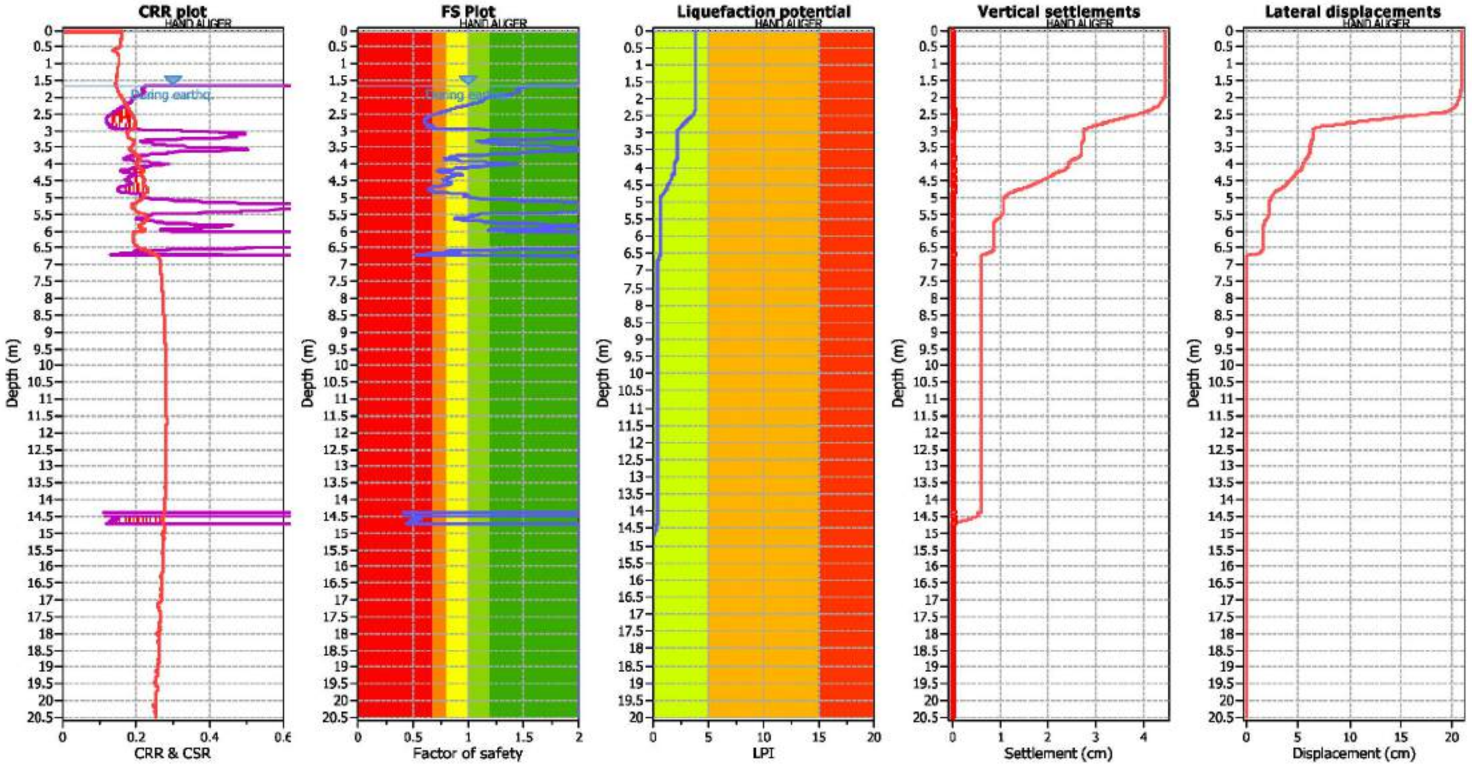
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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LPI color scheme

- 🟥 Very high risk
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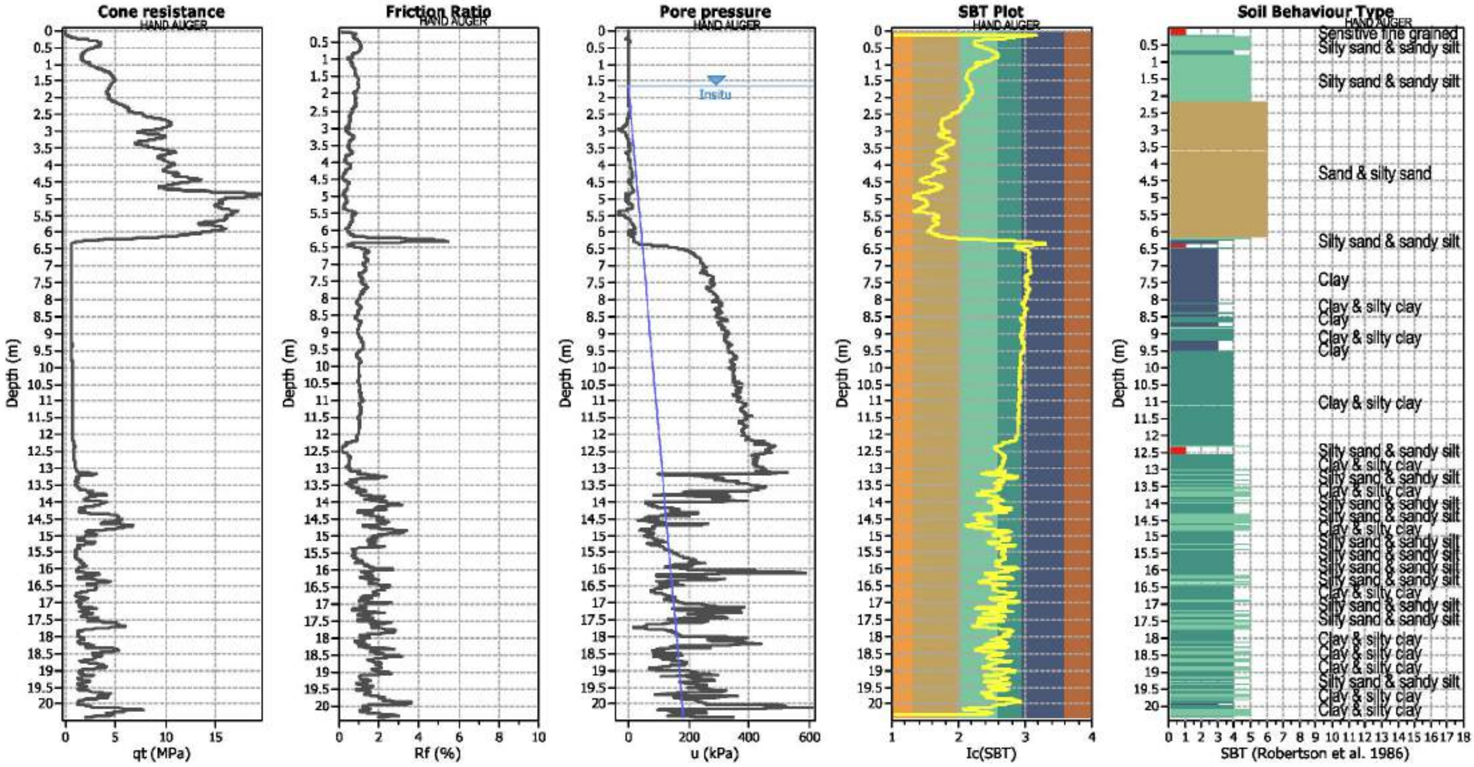
CPT basic interpretation plots



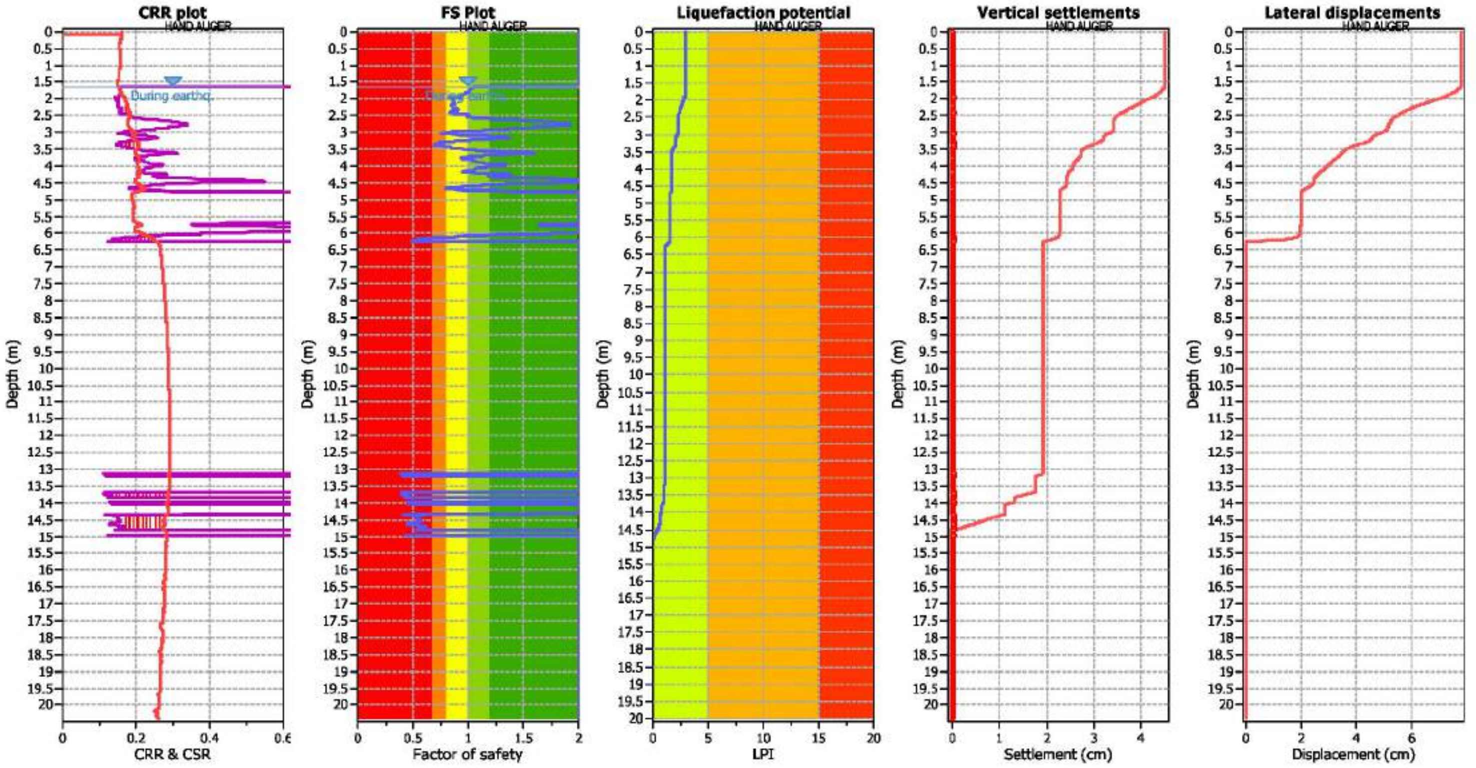
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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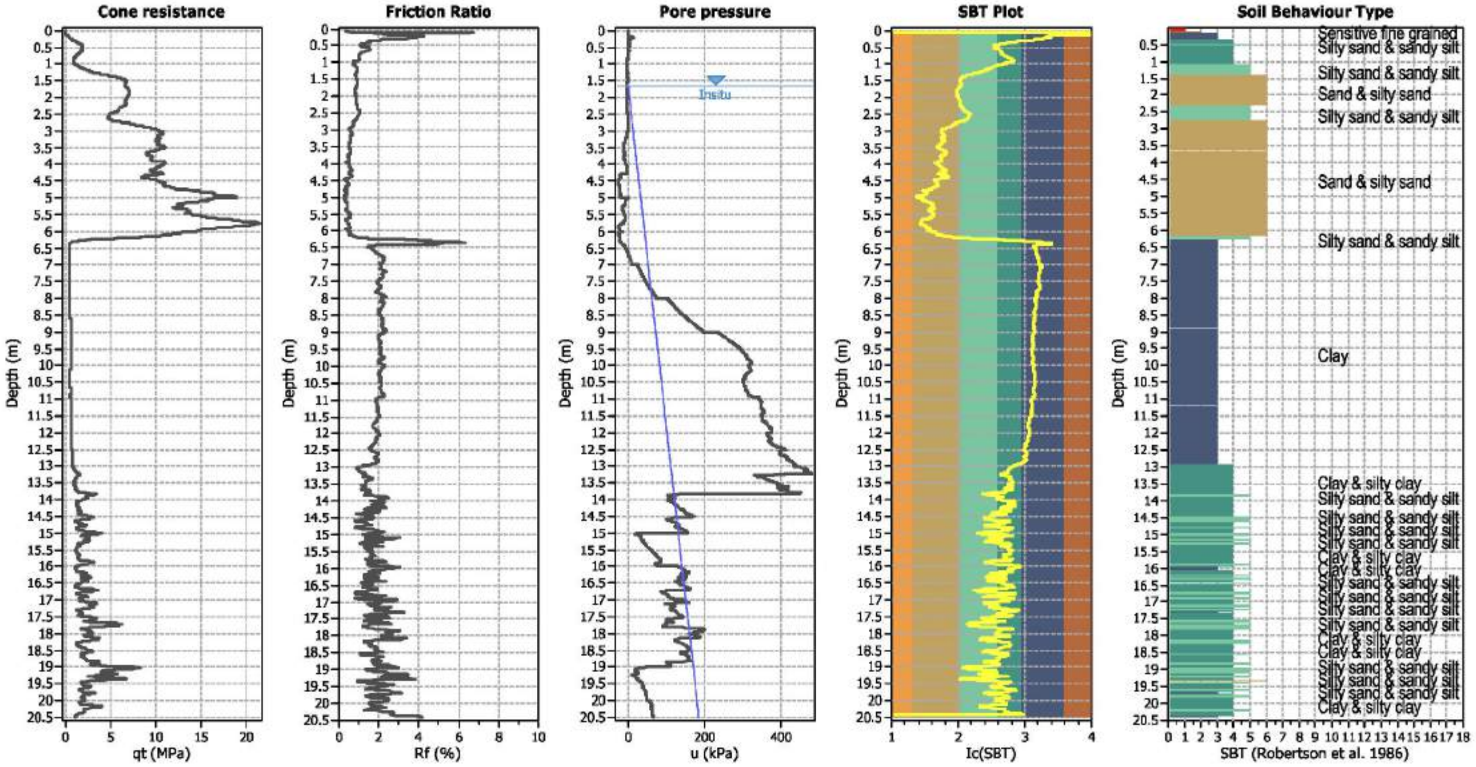
CPT basic interpretation plots



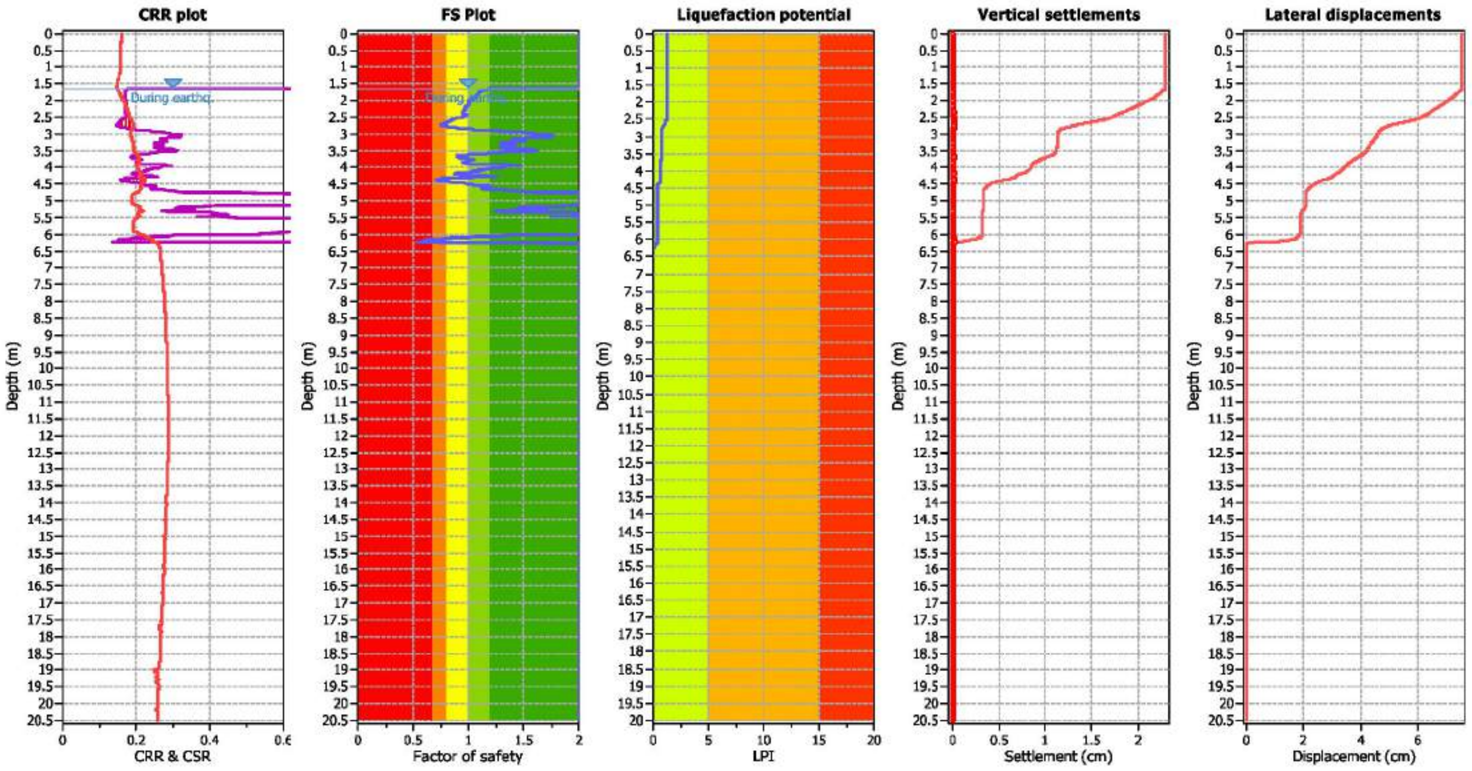
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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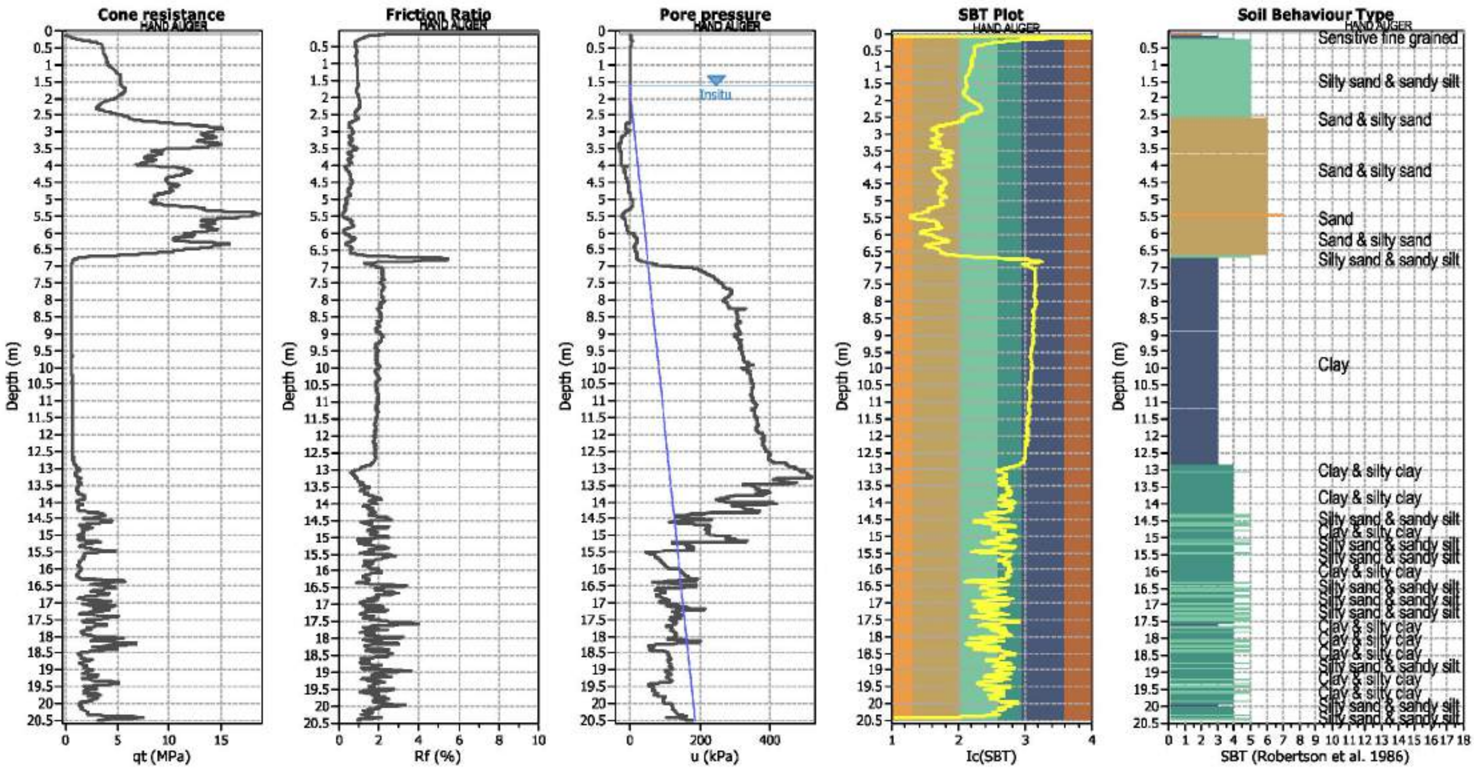
CPT basic interpretation plots



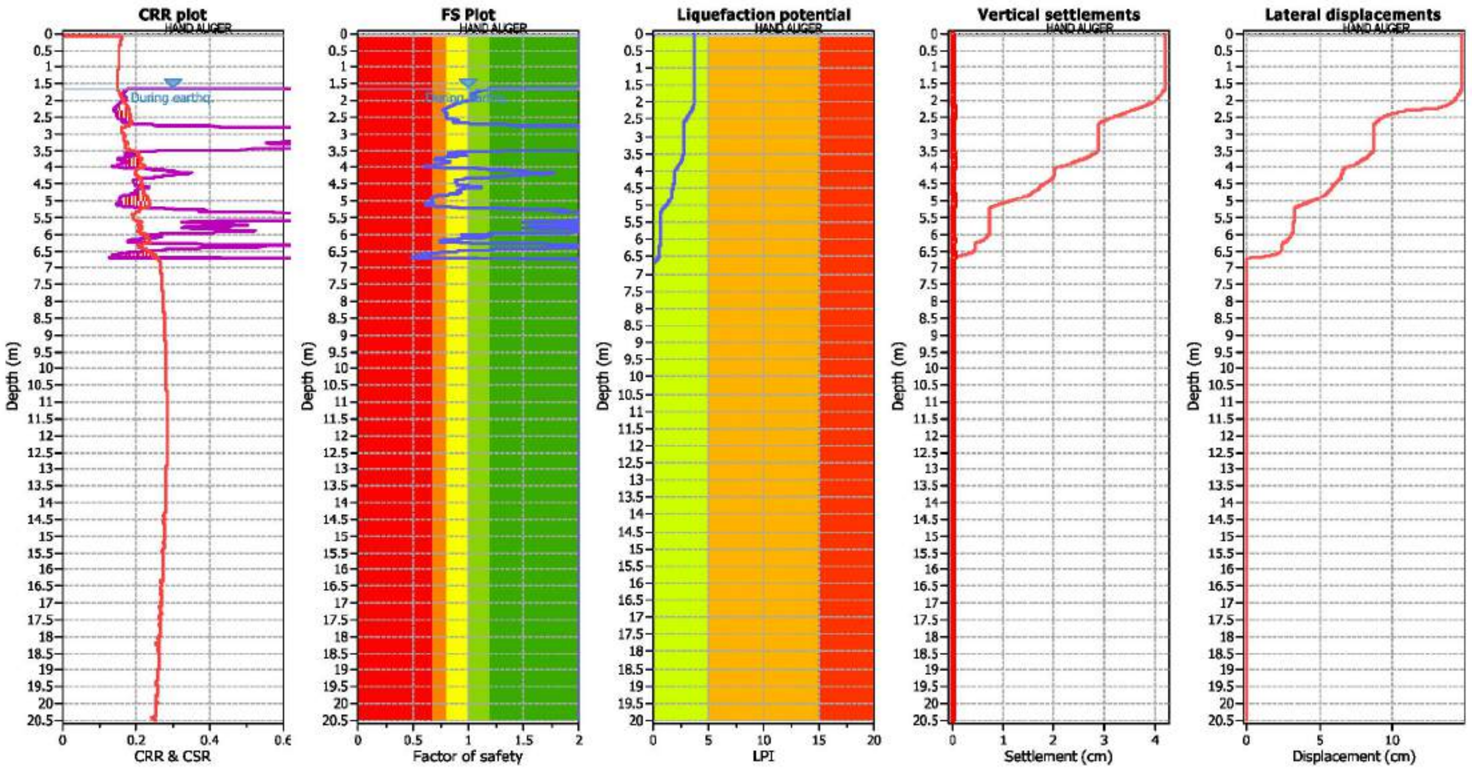
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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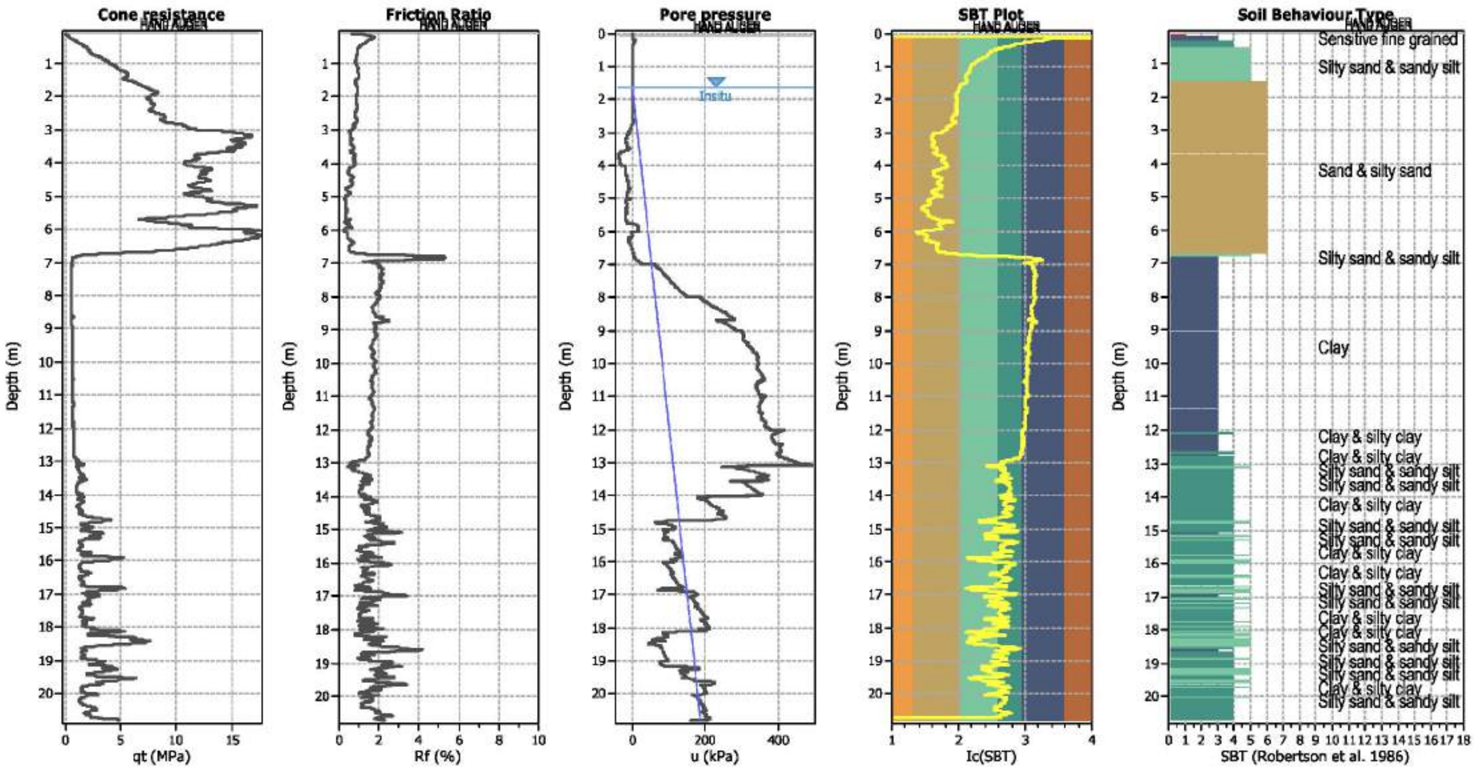
CPT basic interpretation plots



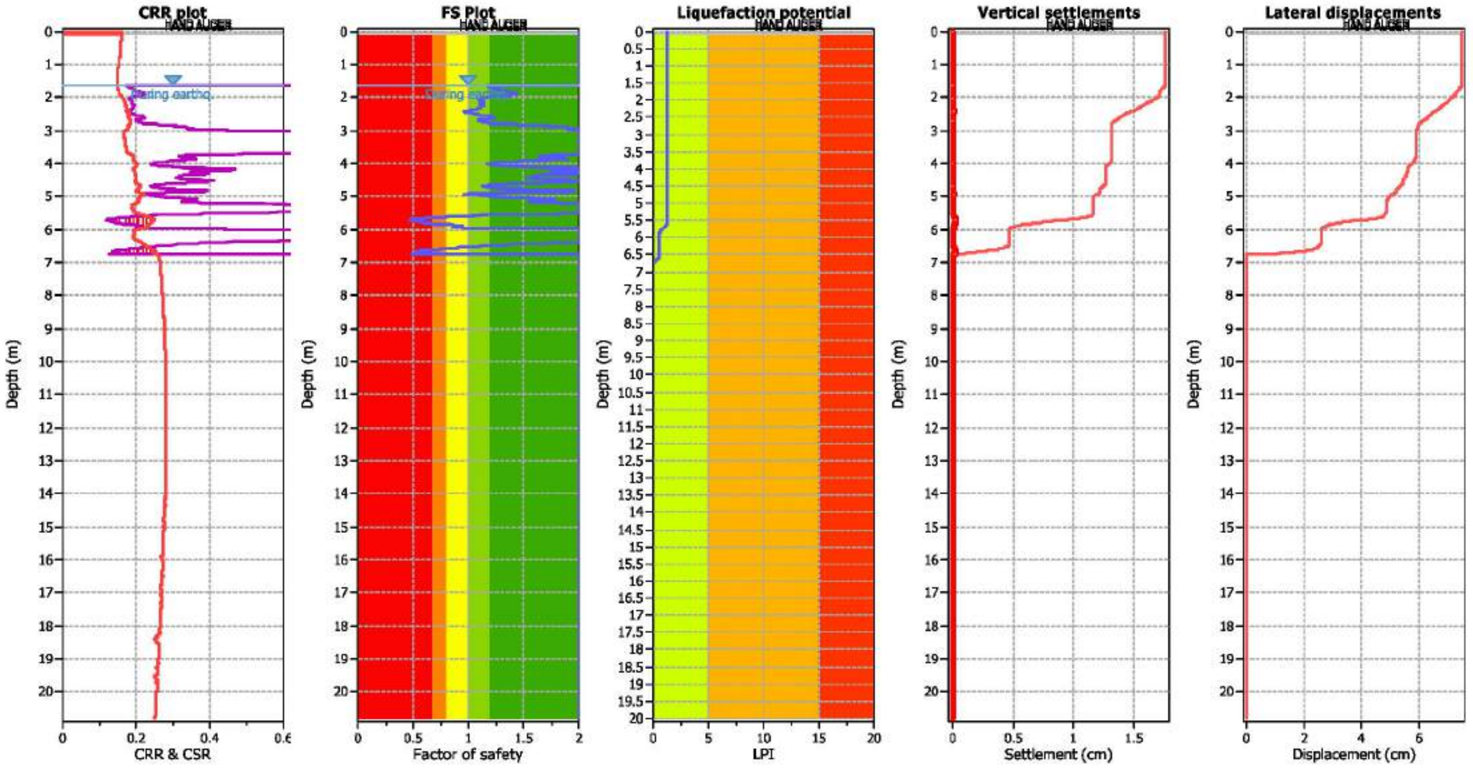
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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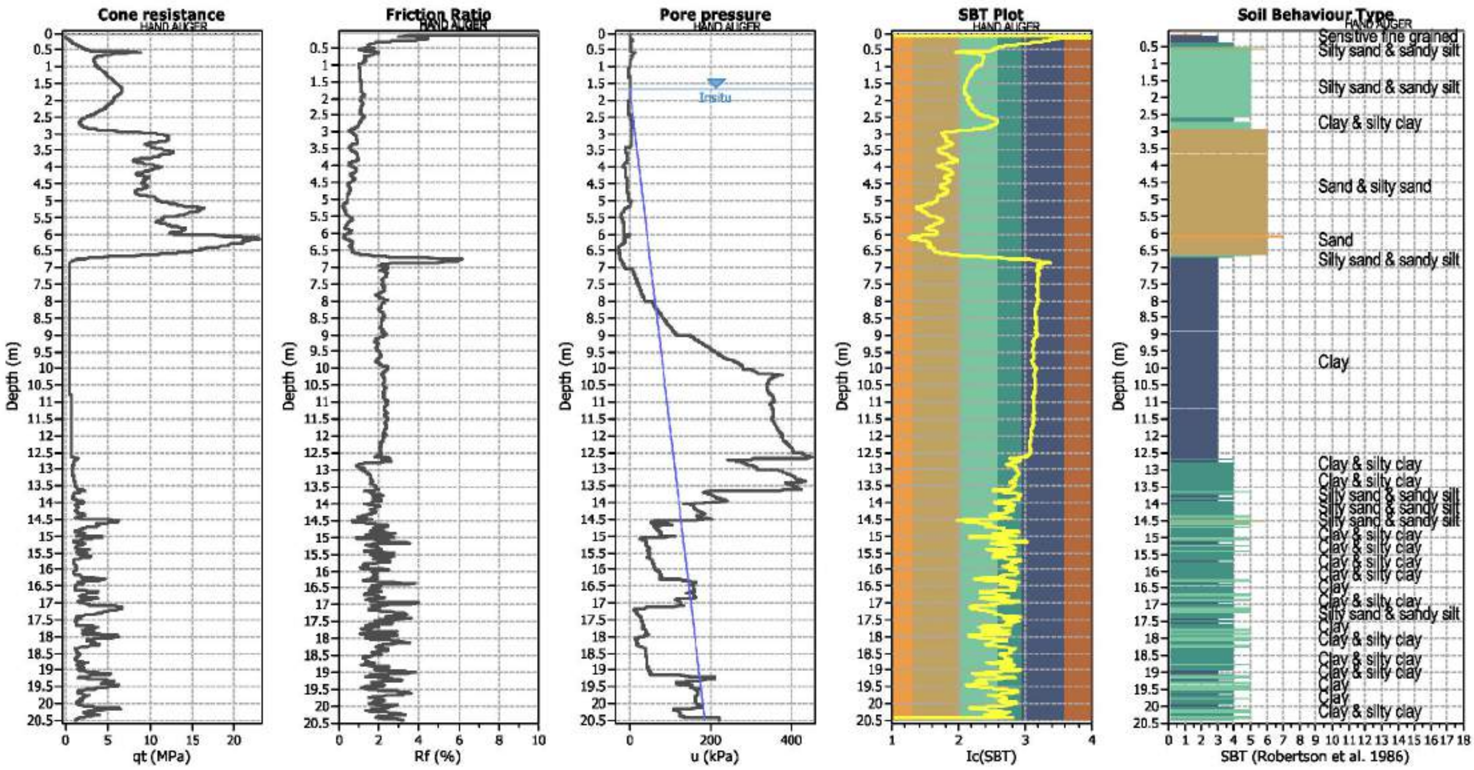
CPT basic interpretation plots



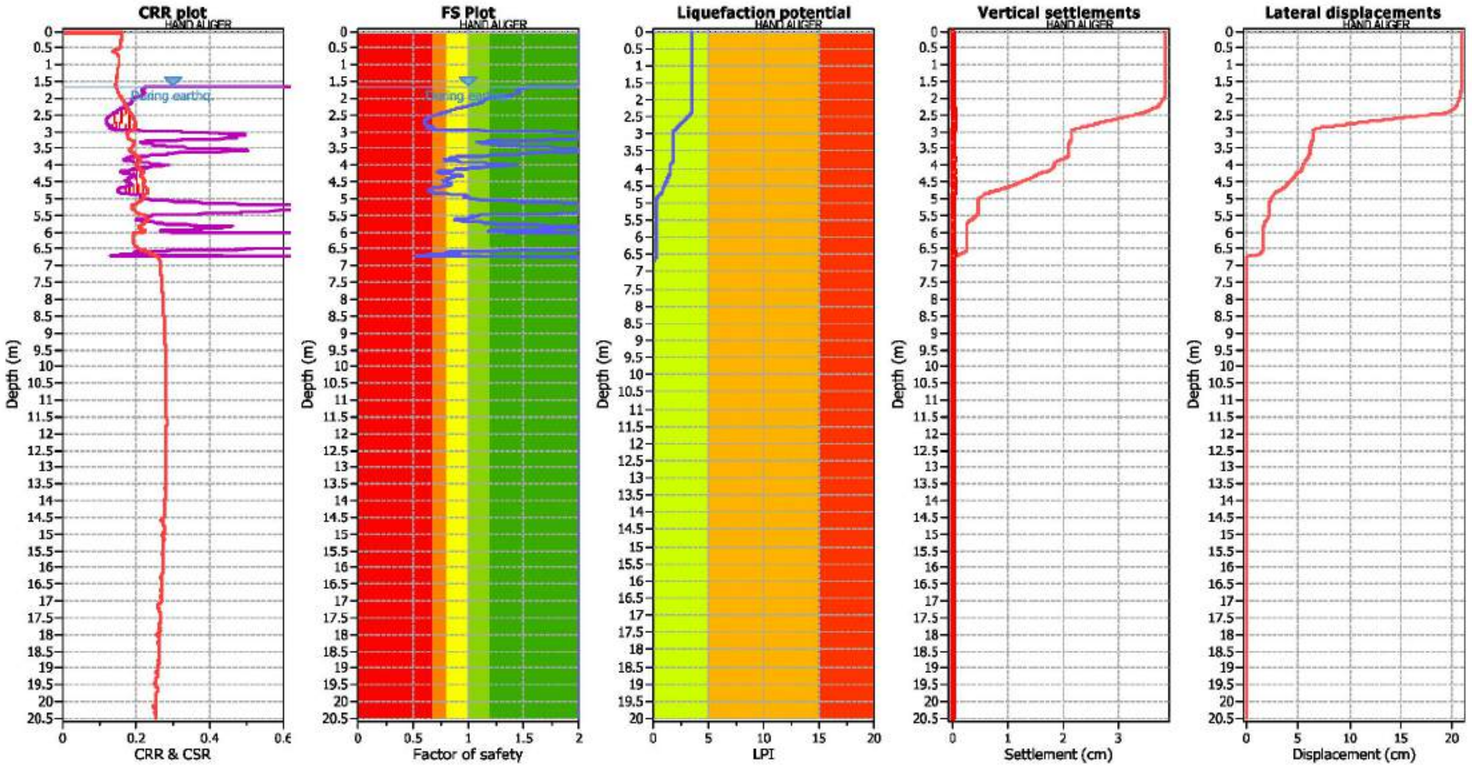
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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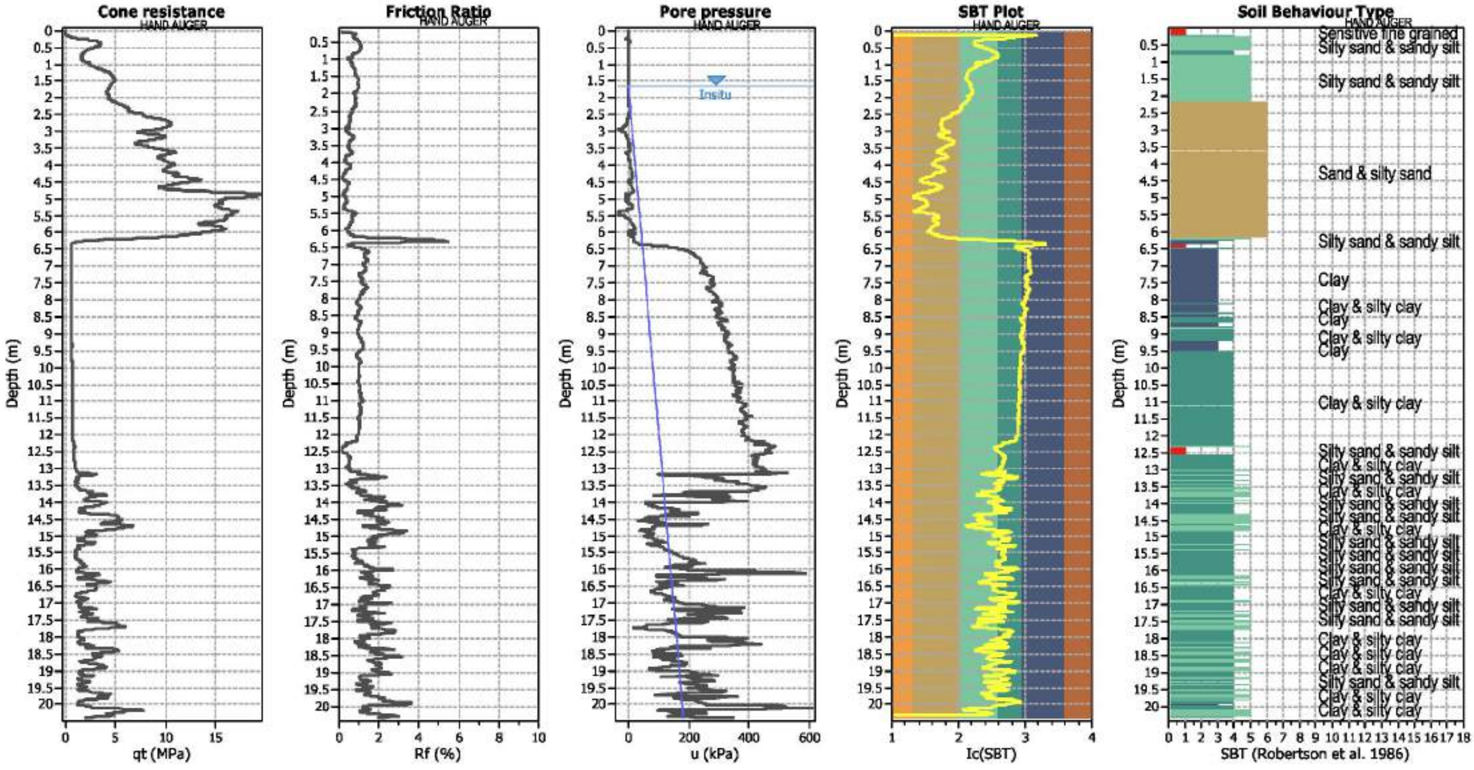
CPT basic interpretation plots



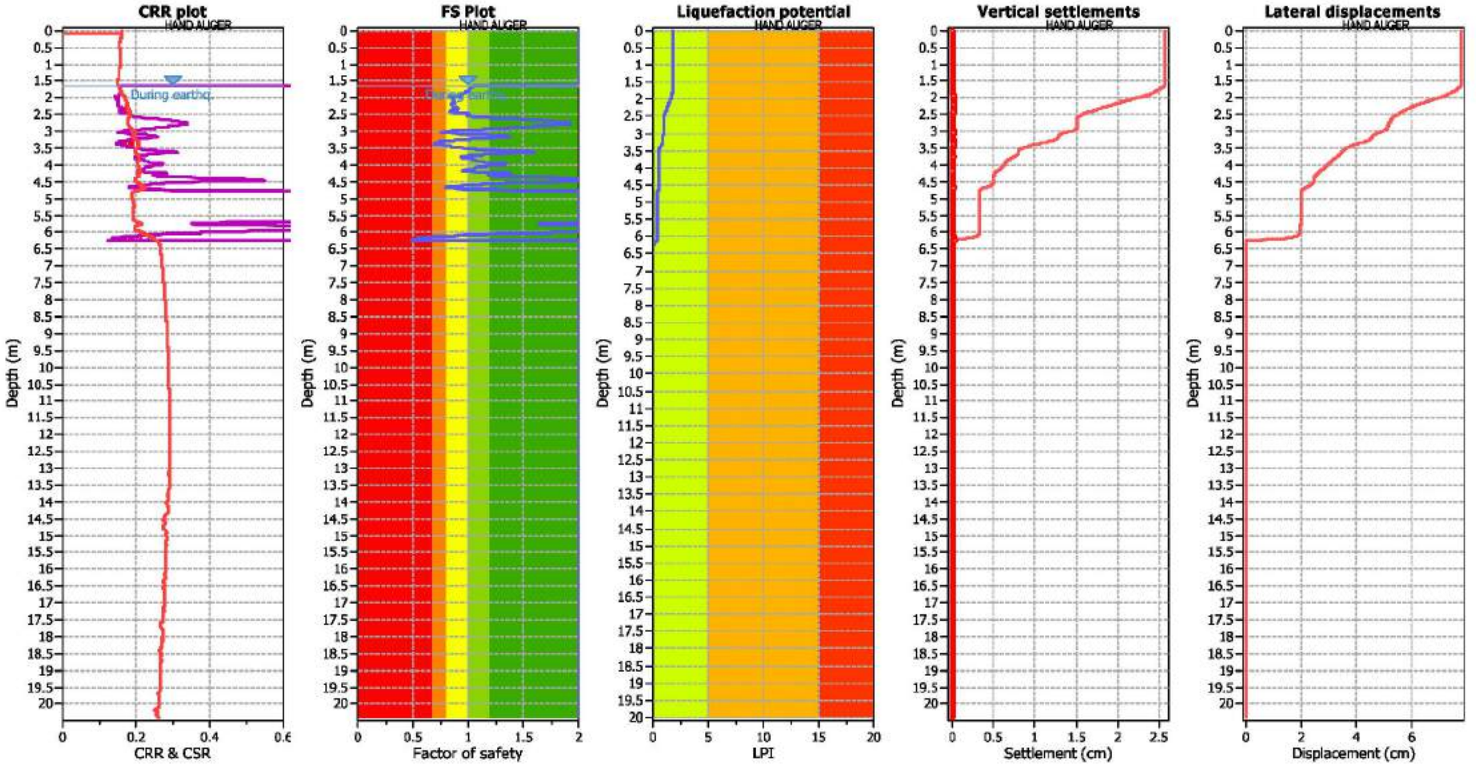
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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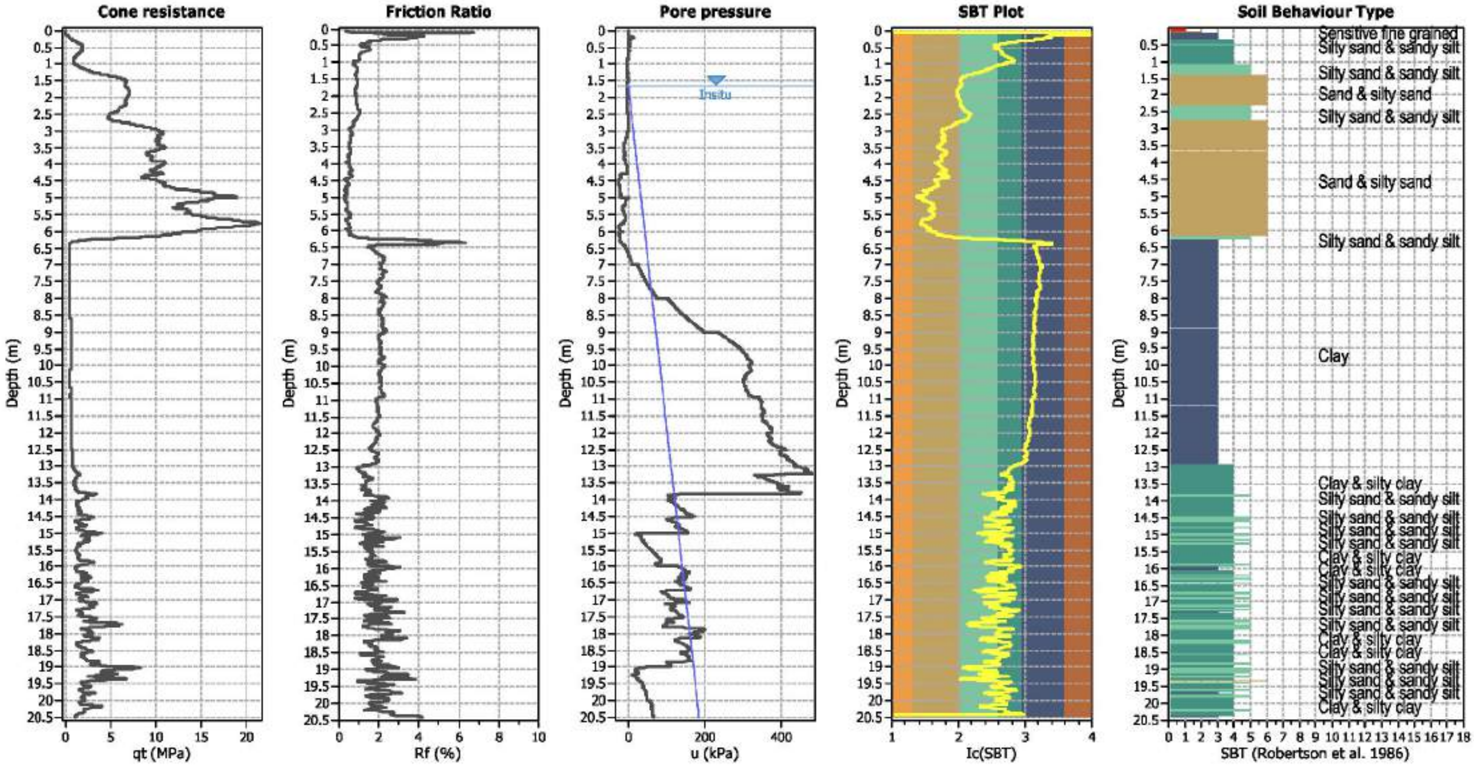
CPT basic interpretation plots



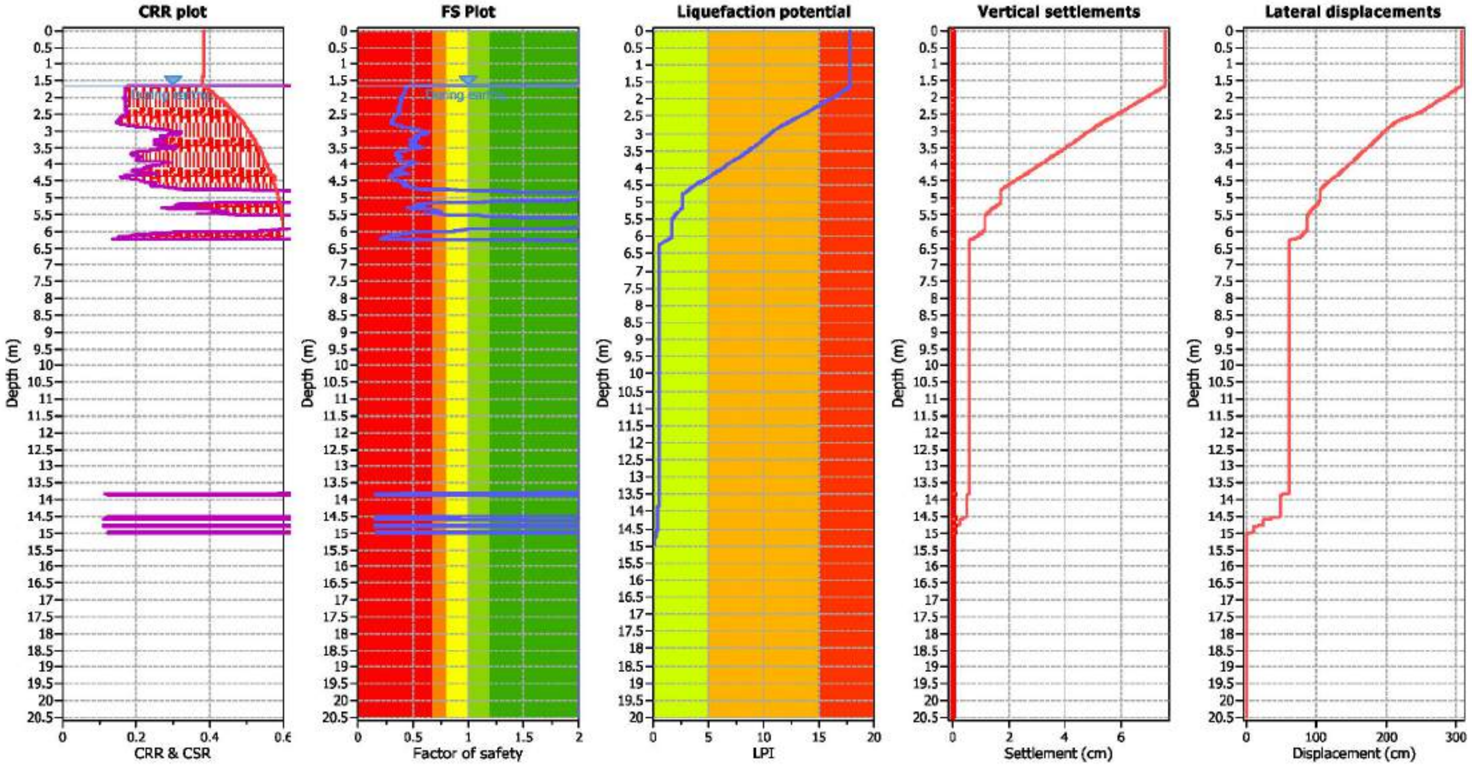
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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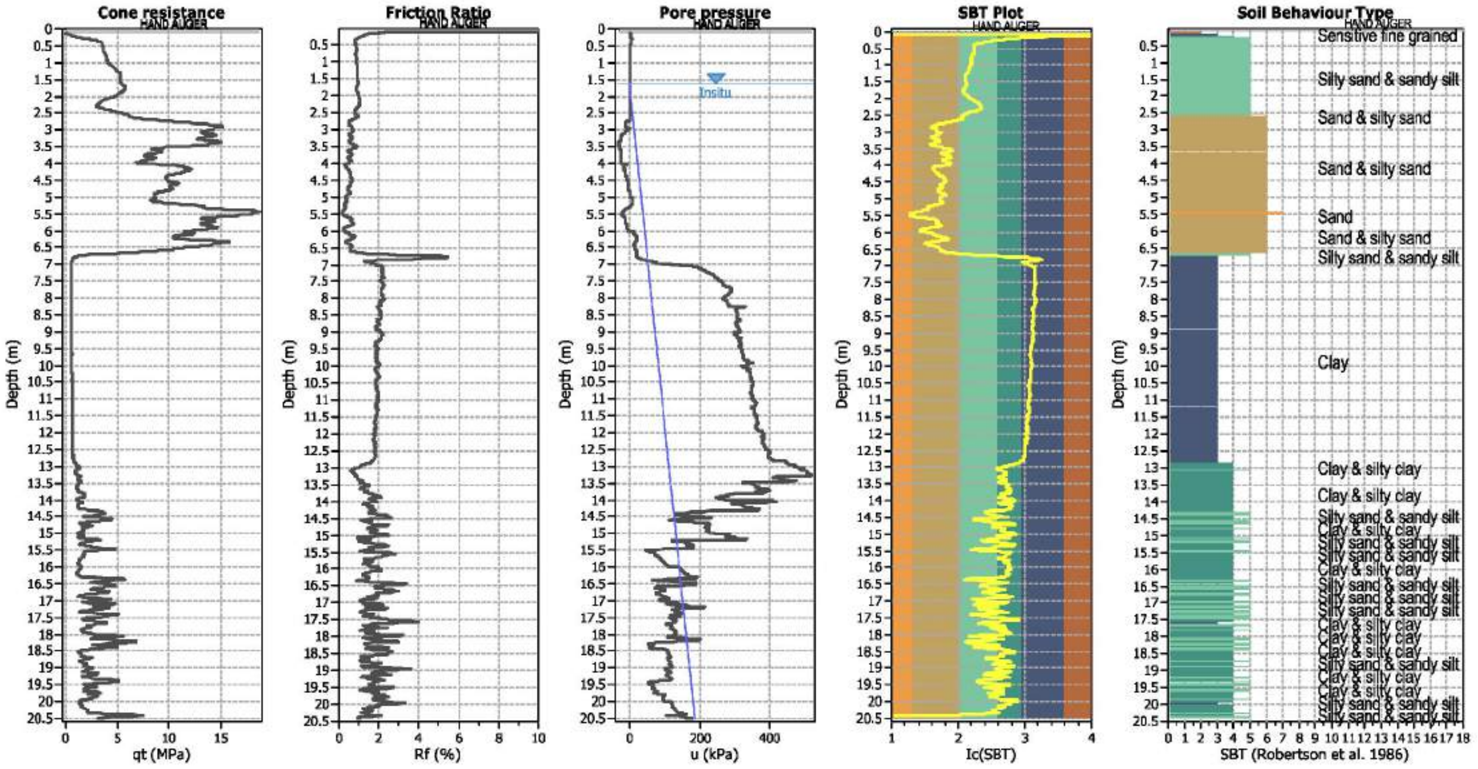
CPT basic interpretation plots



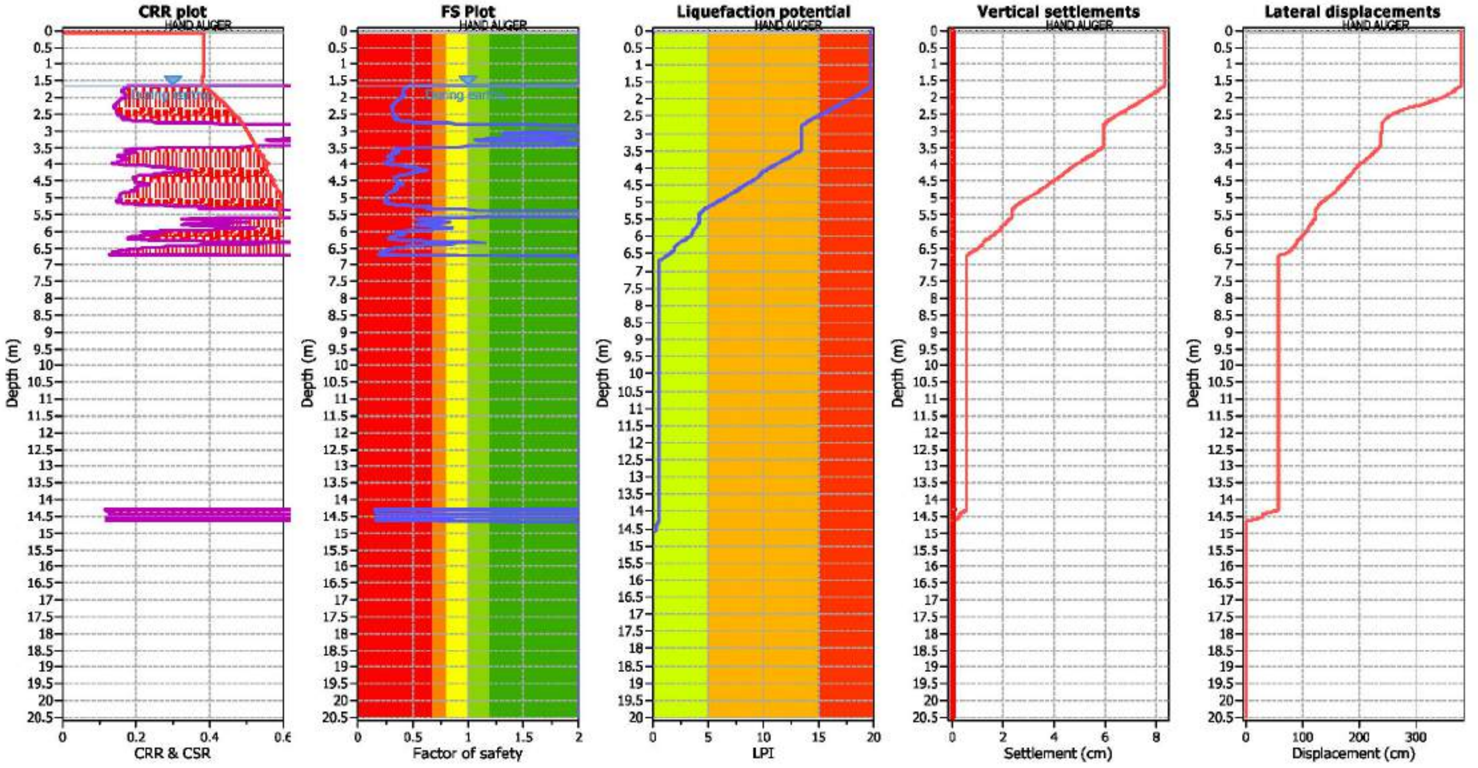
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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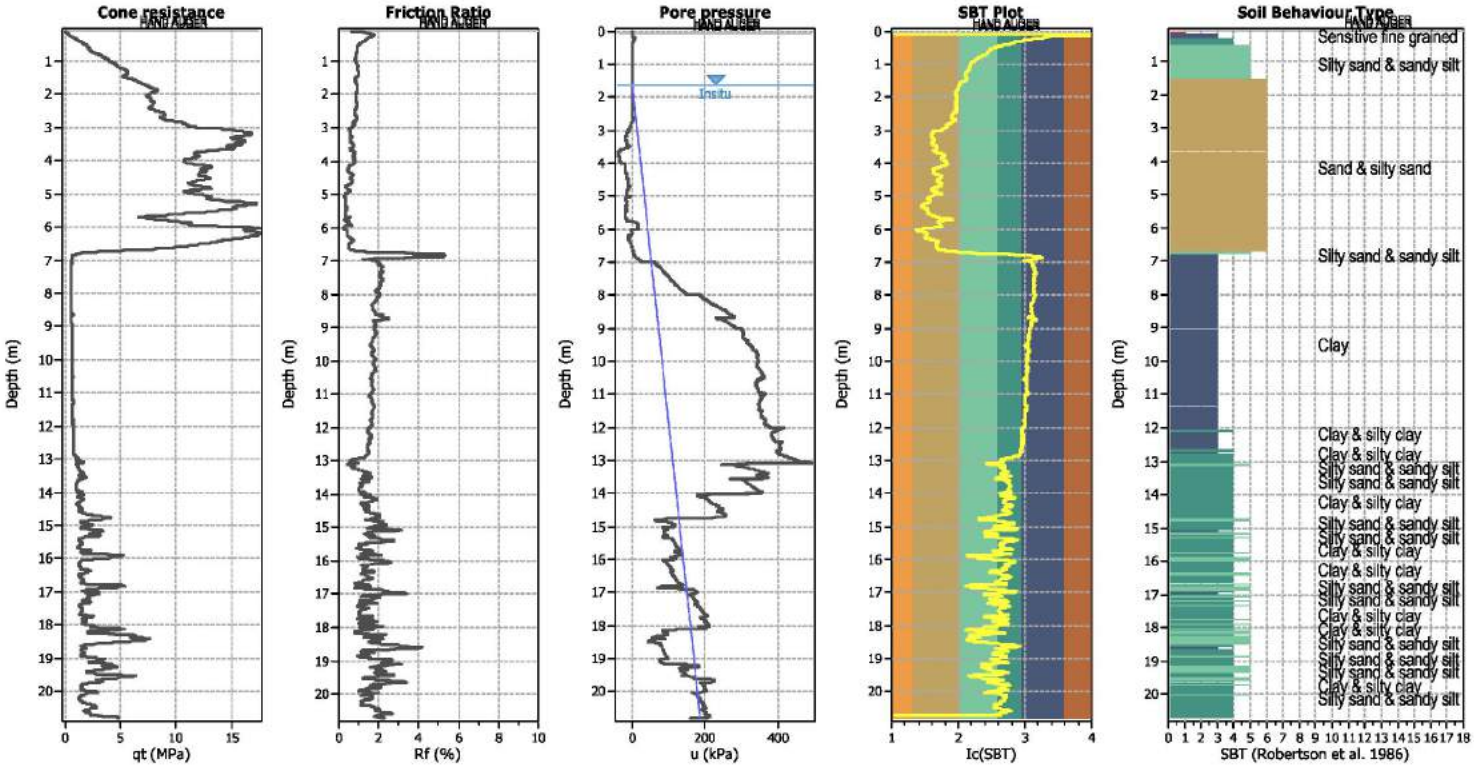
CPT basic interpretation plots



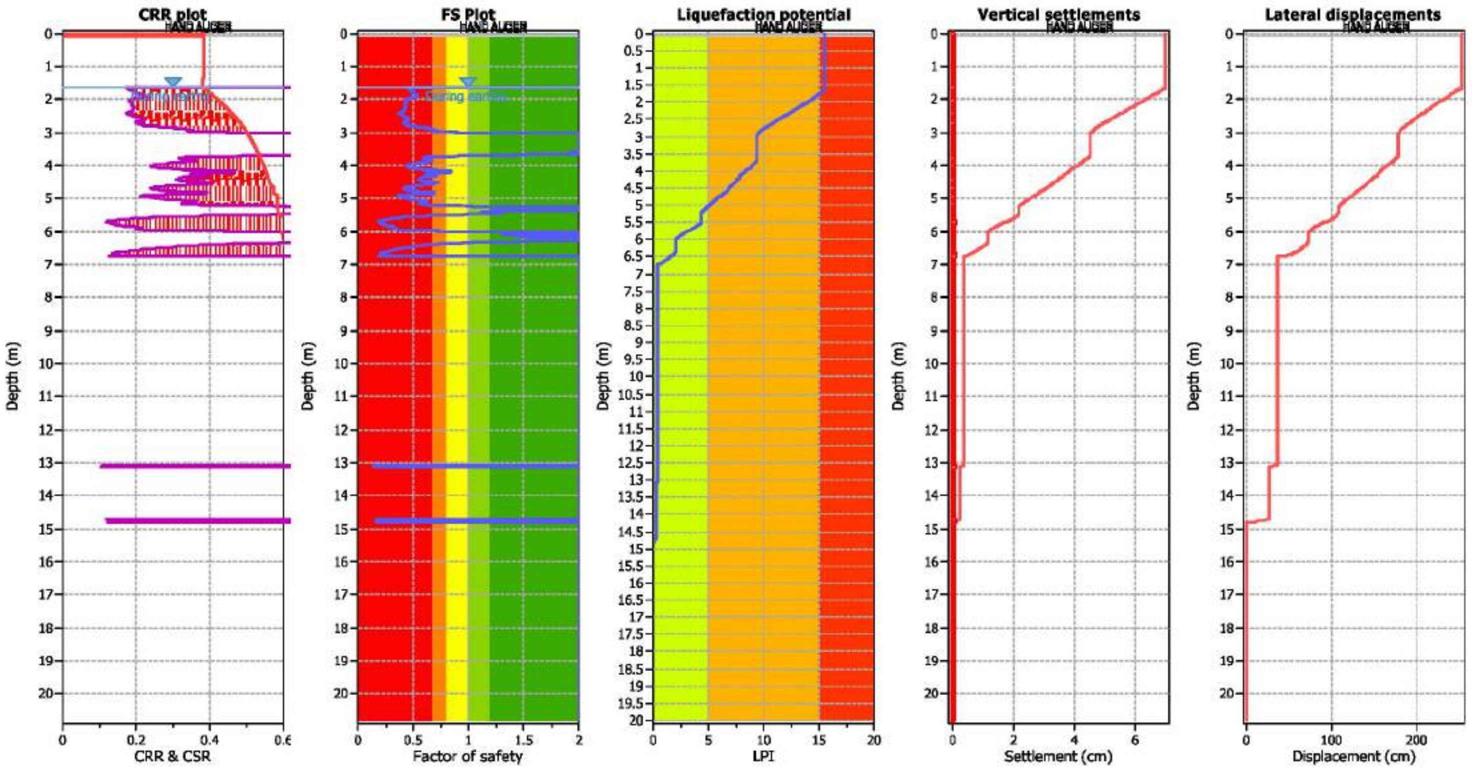
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

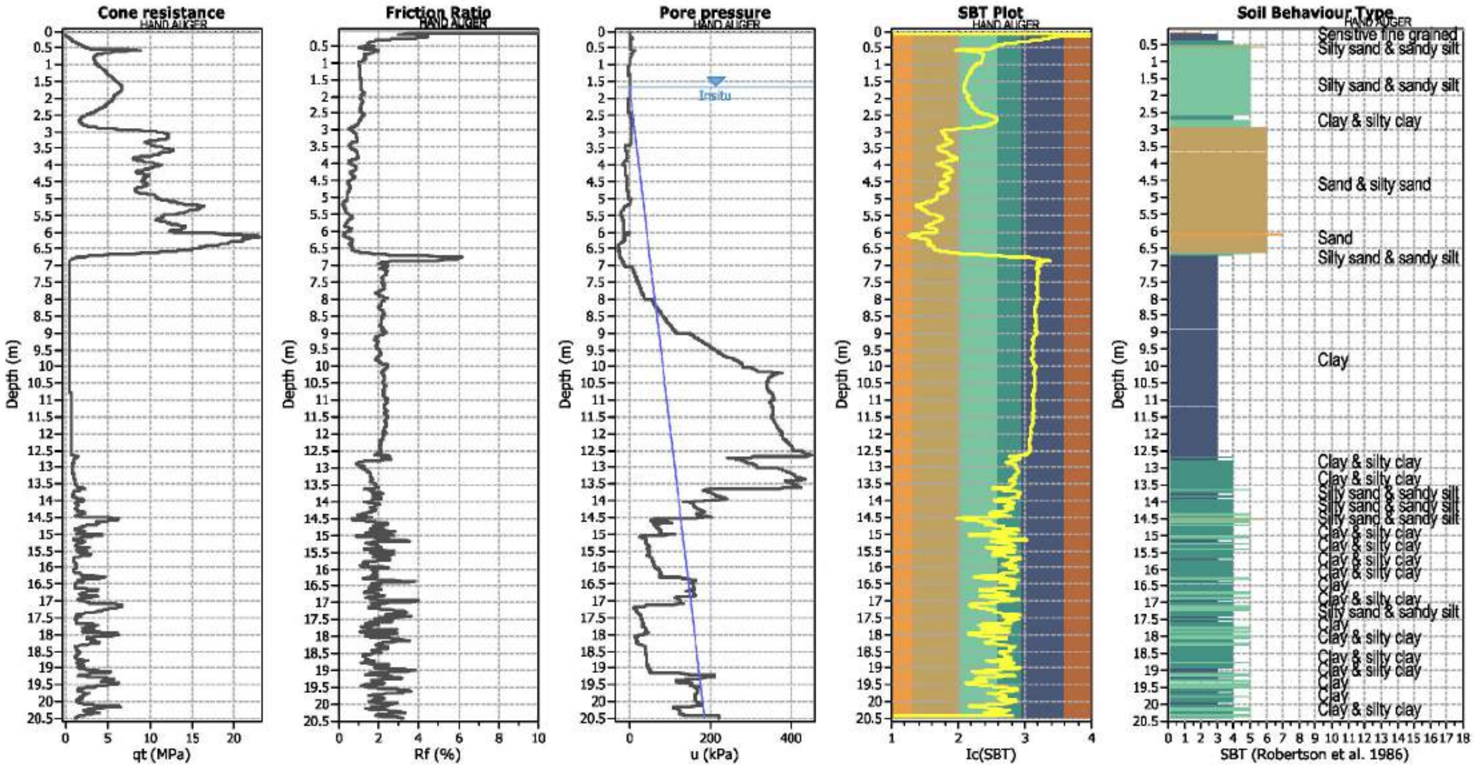
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



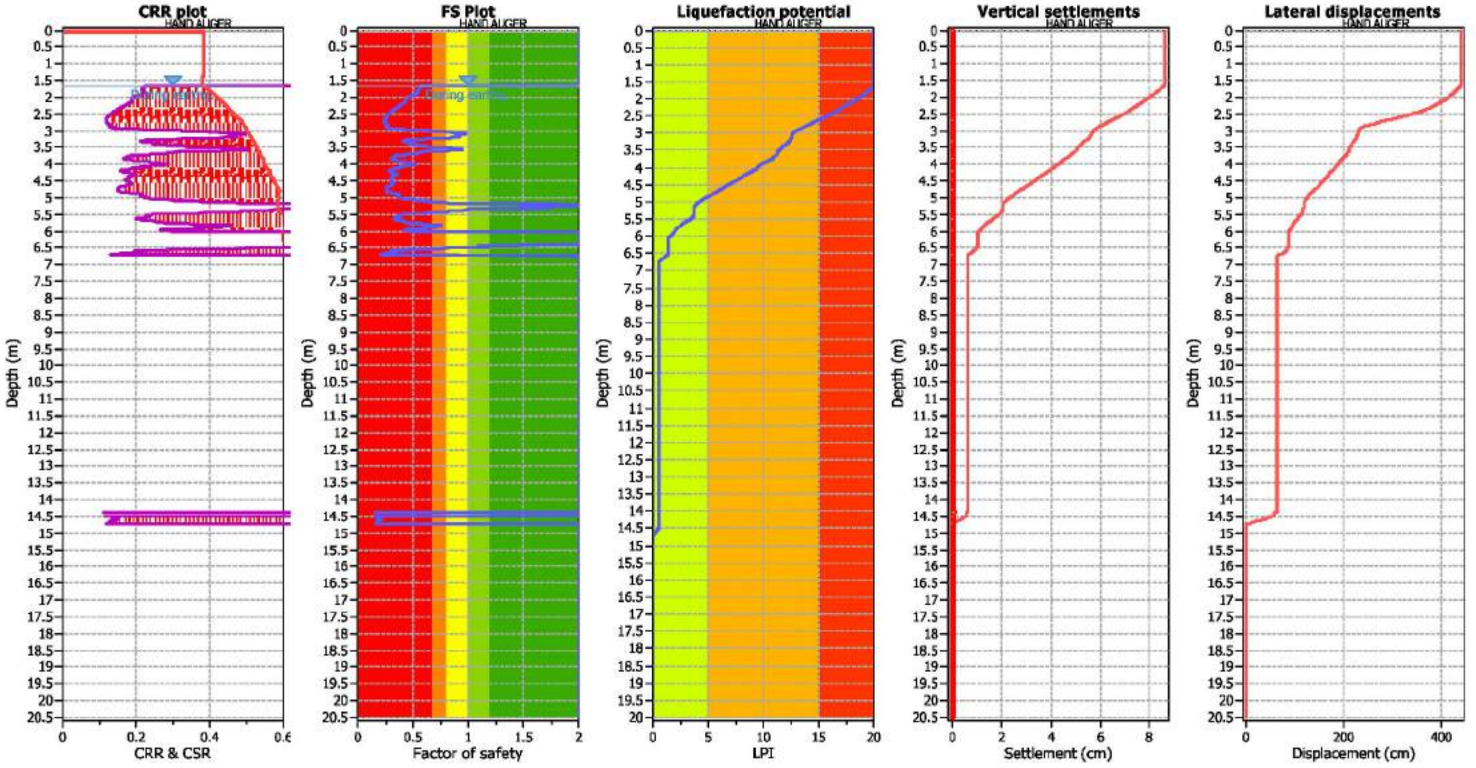
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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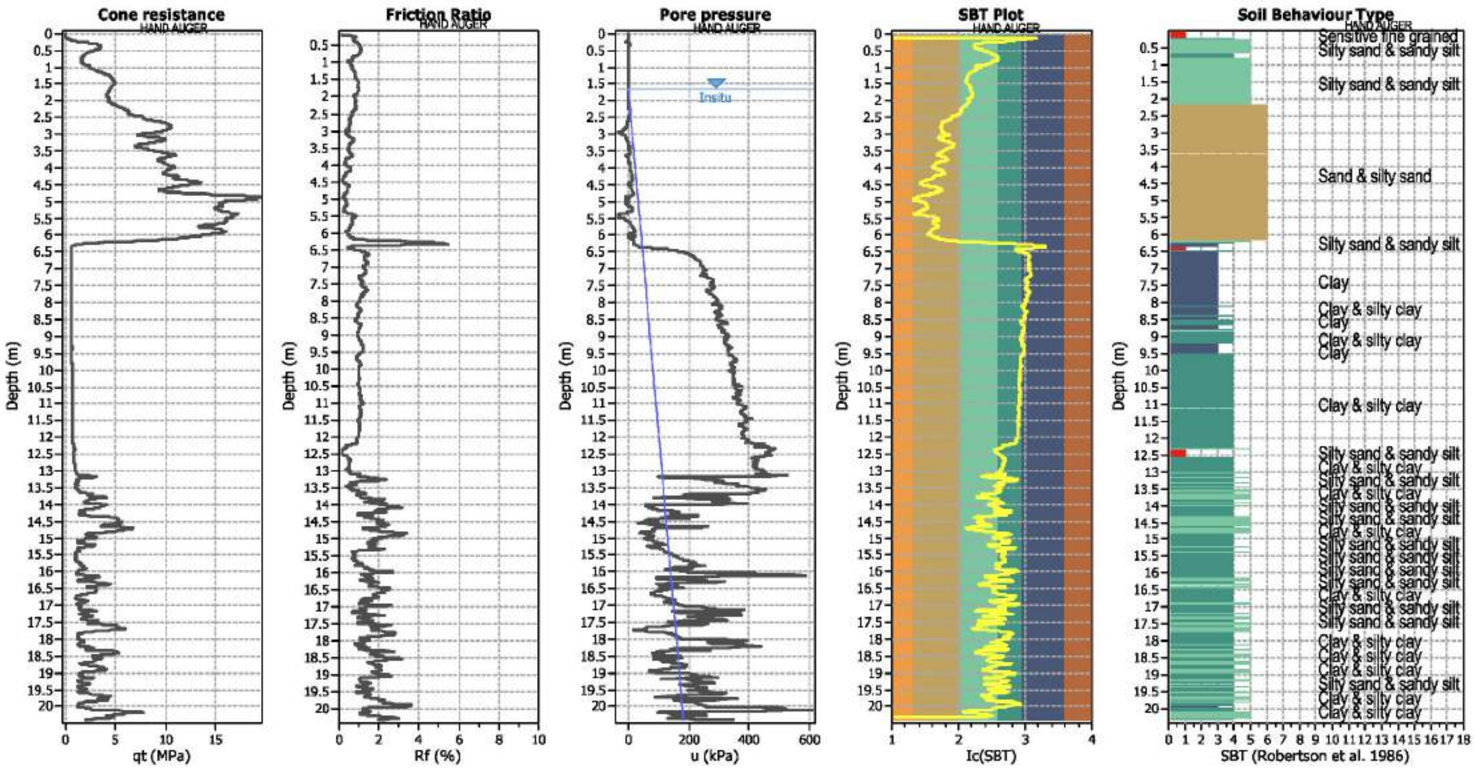
CPT basic interpretation plots



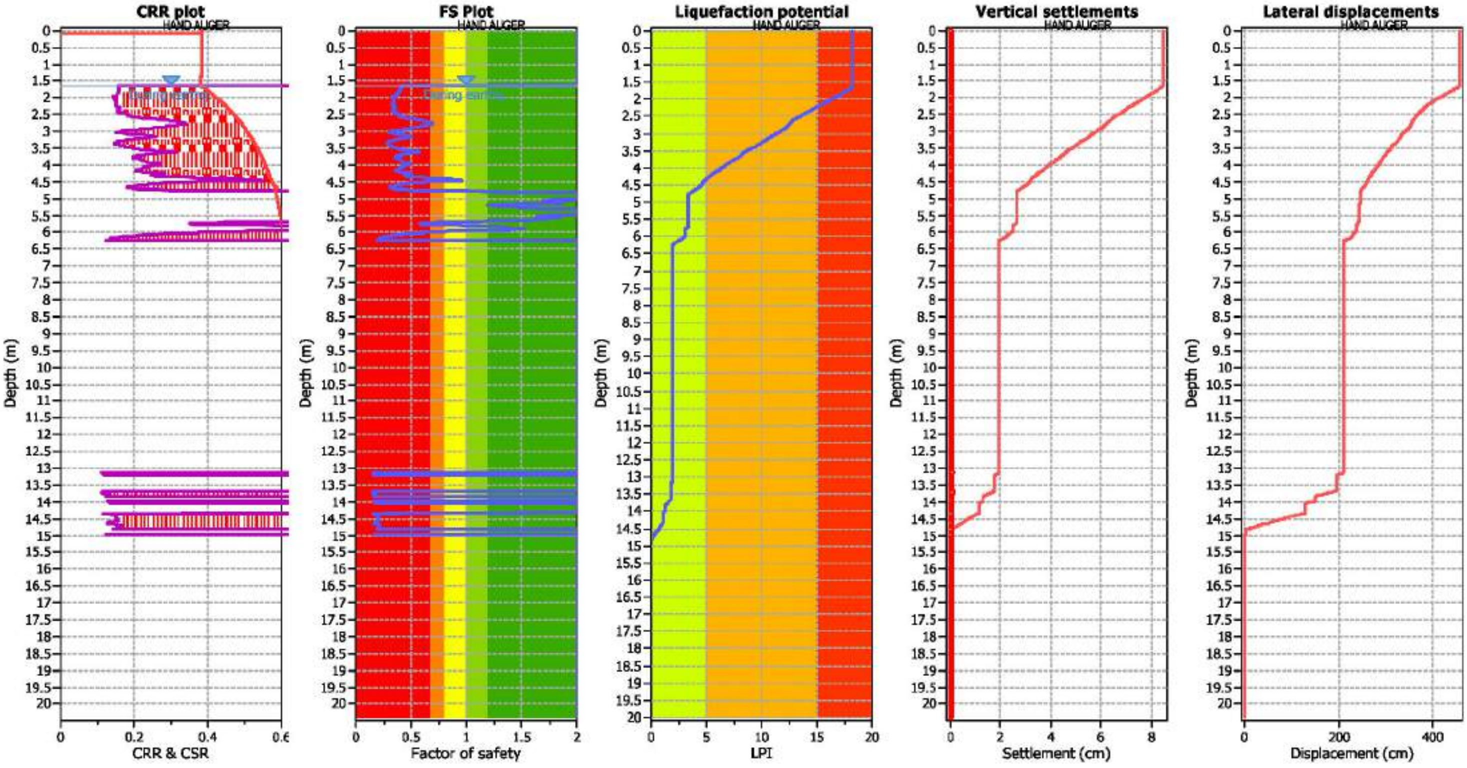
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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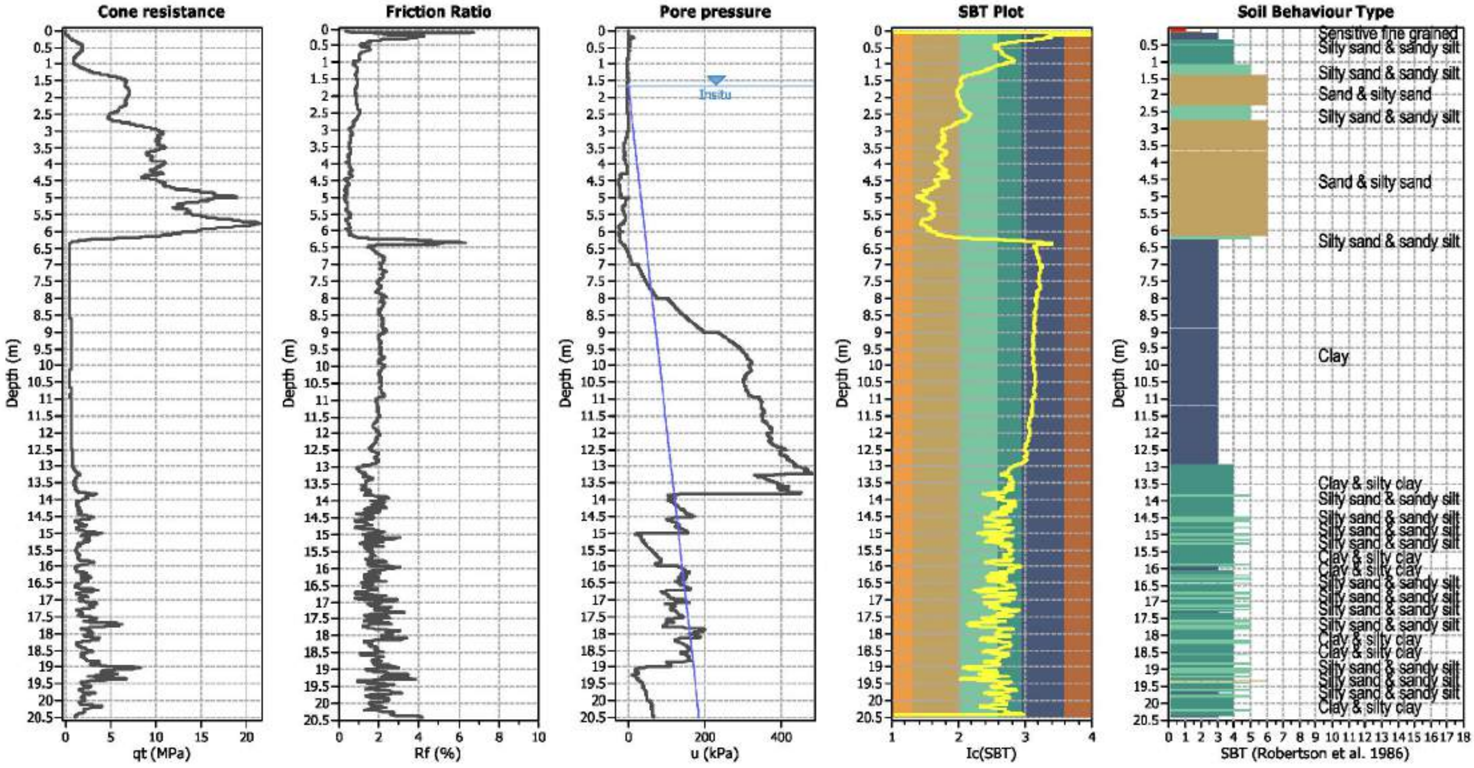
CPT basic interpretation plots



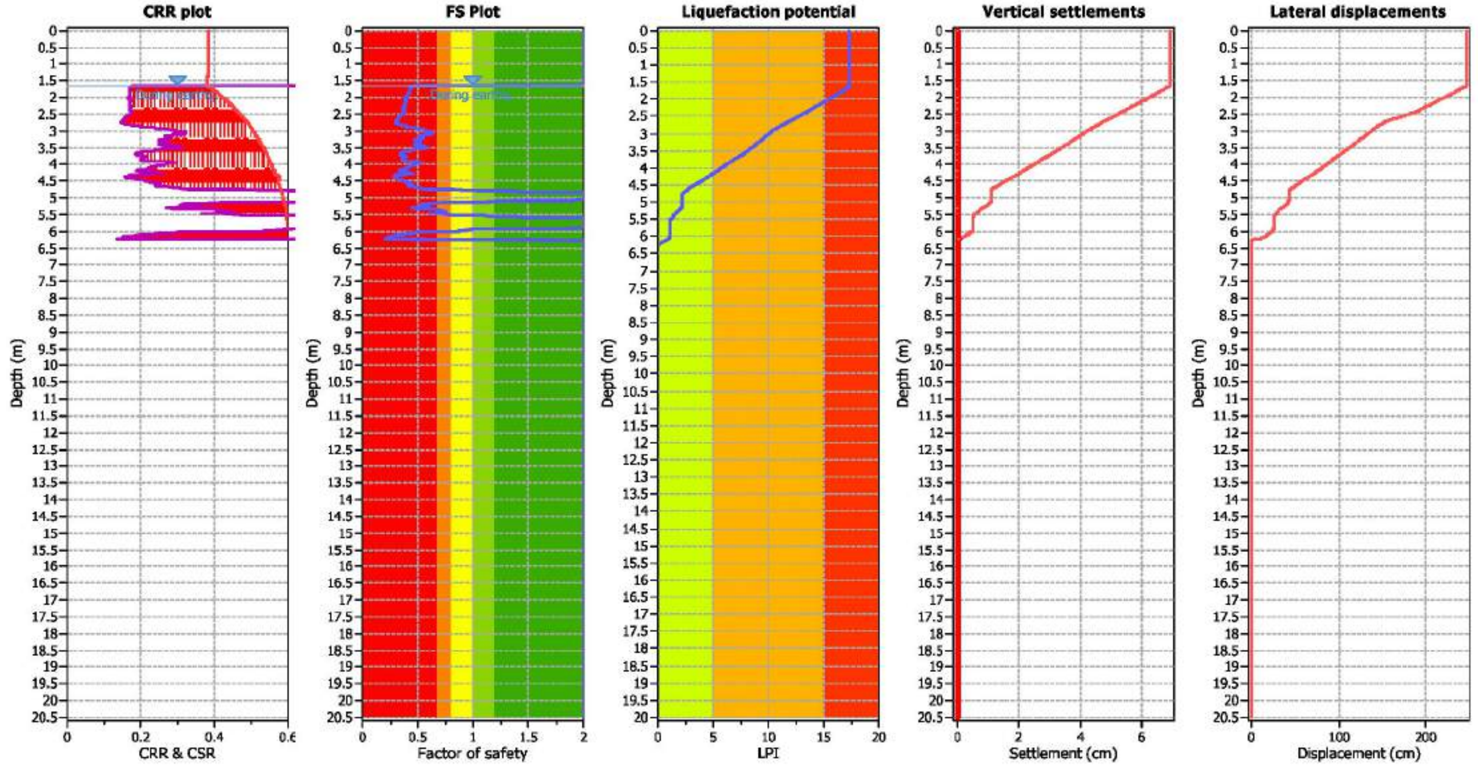
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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LPI color scheme

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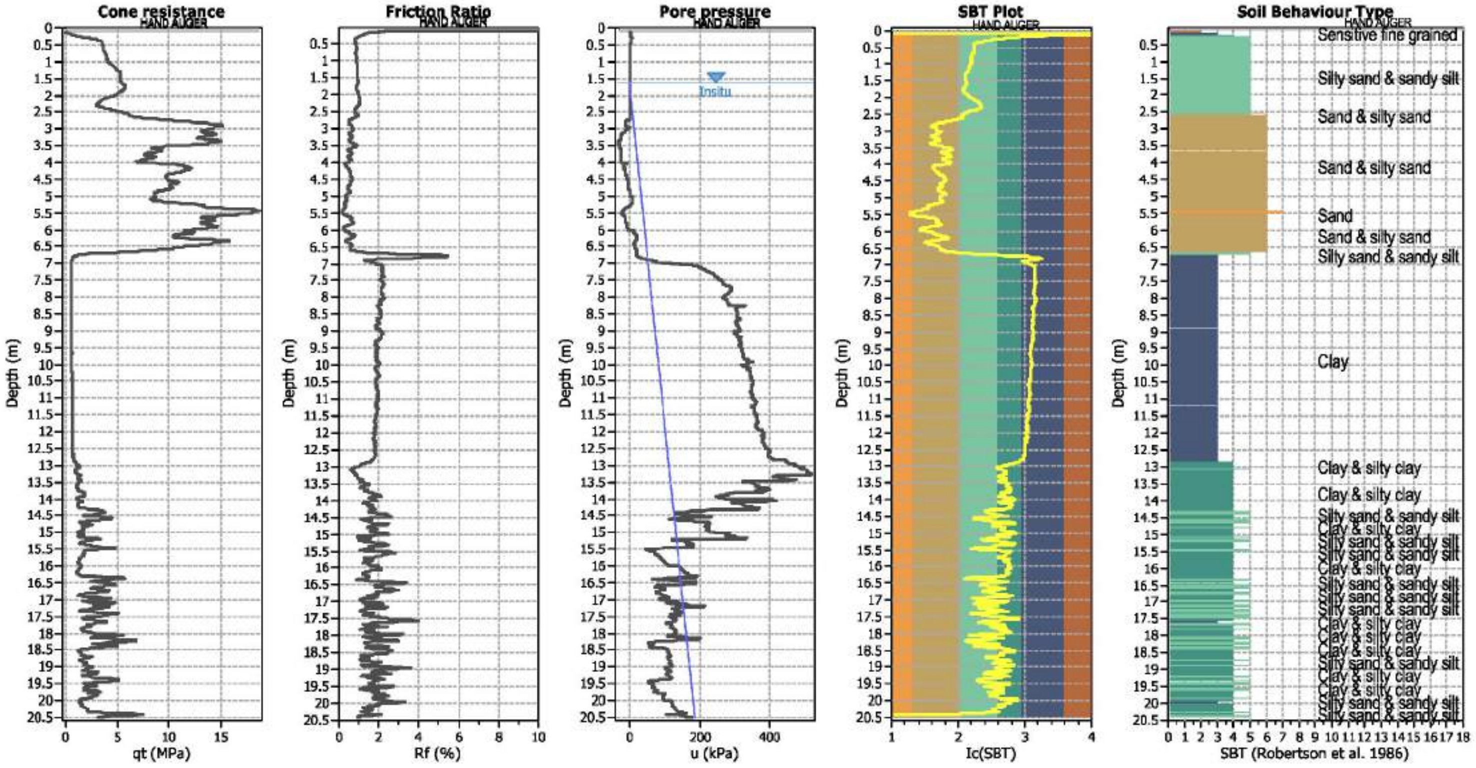
CPT basic interpretation plots



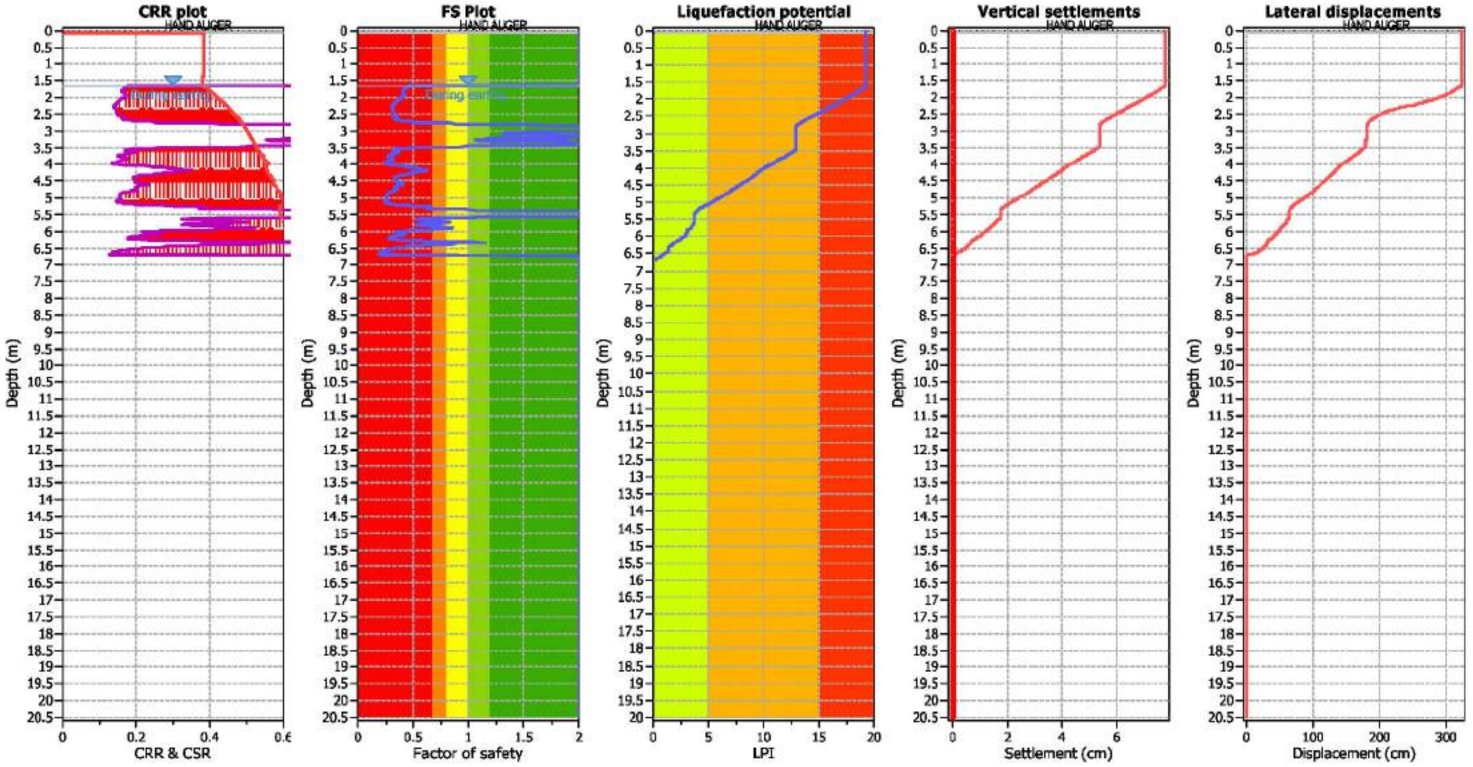
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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LPI color scheme

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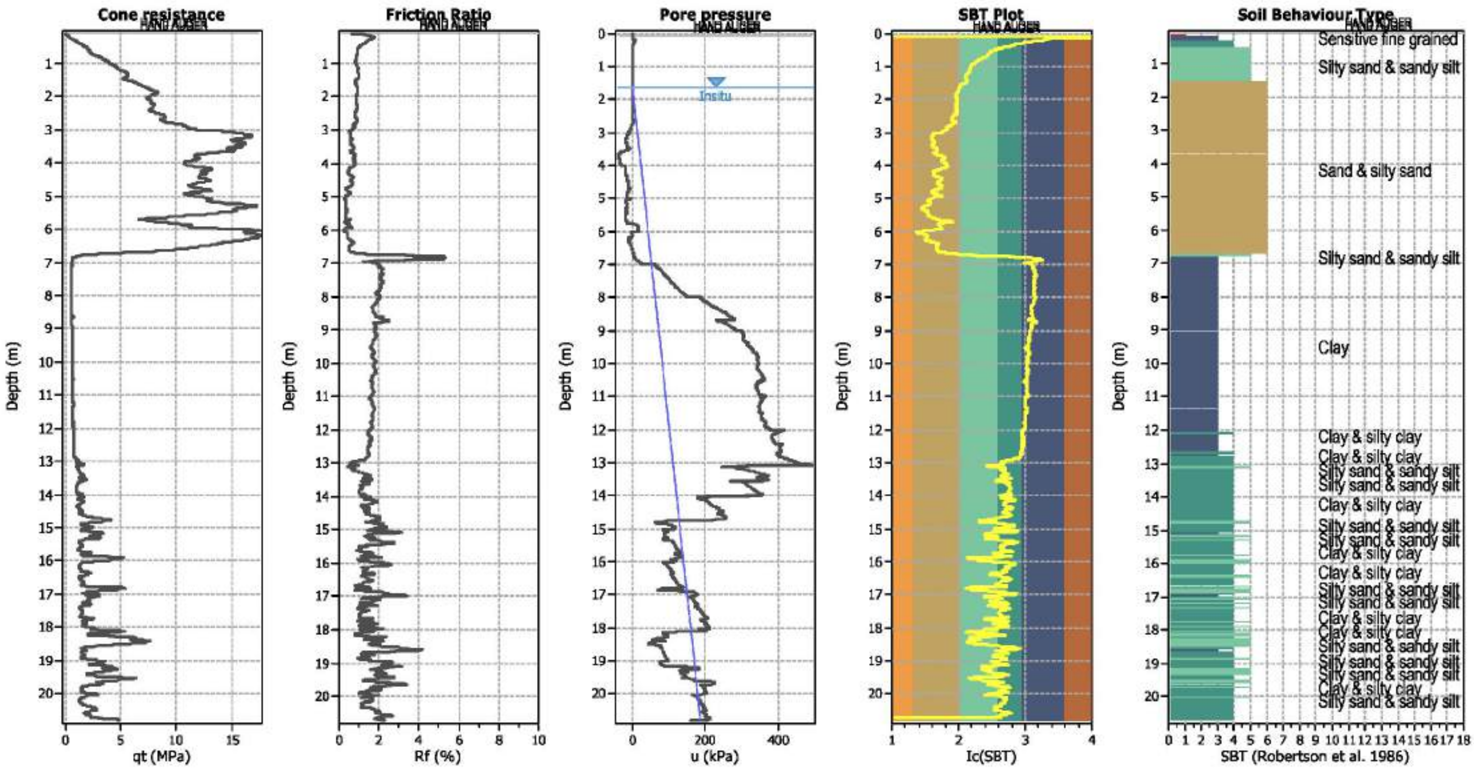
CPT basic interpretation plots



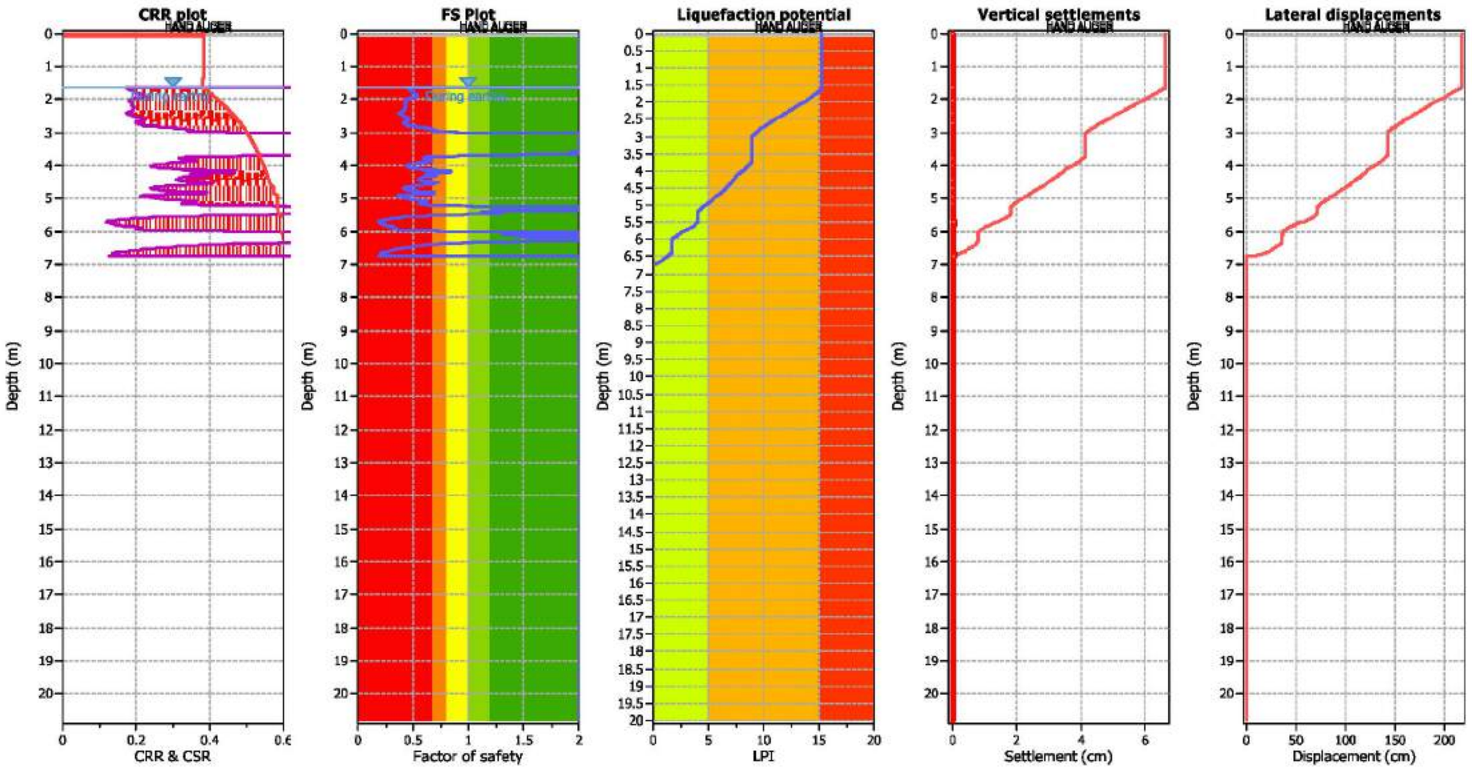
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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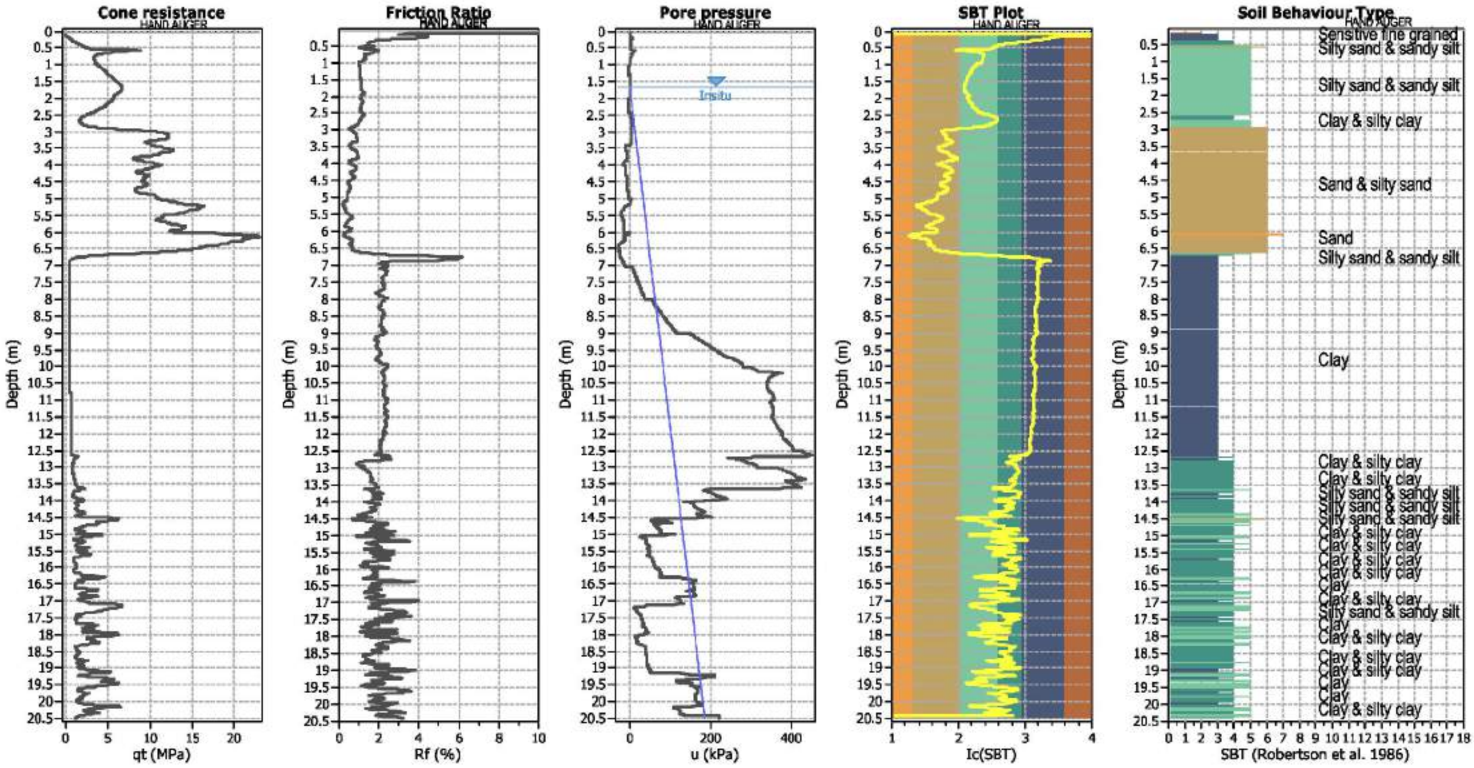
CPT basic interpretation plots



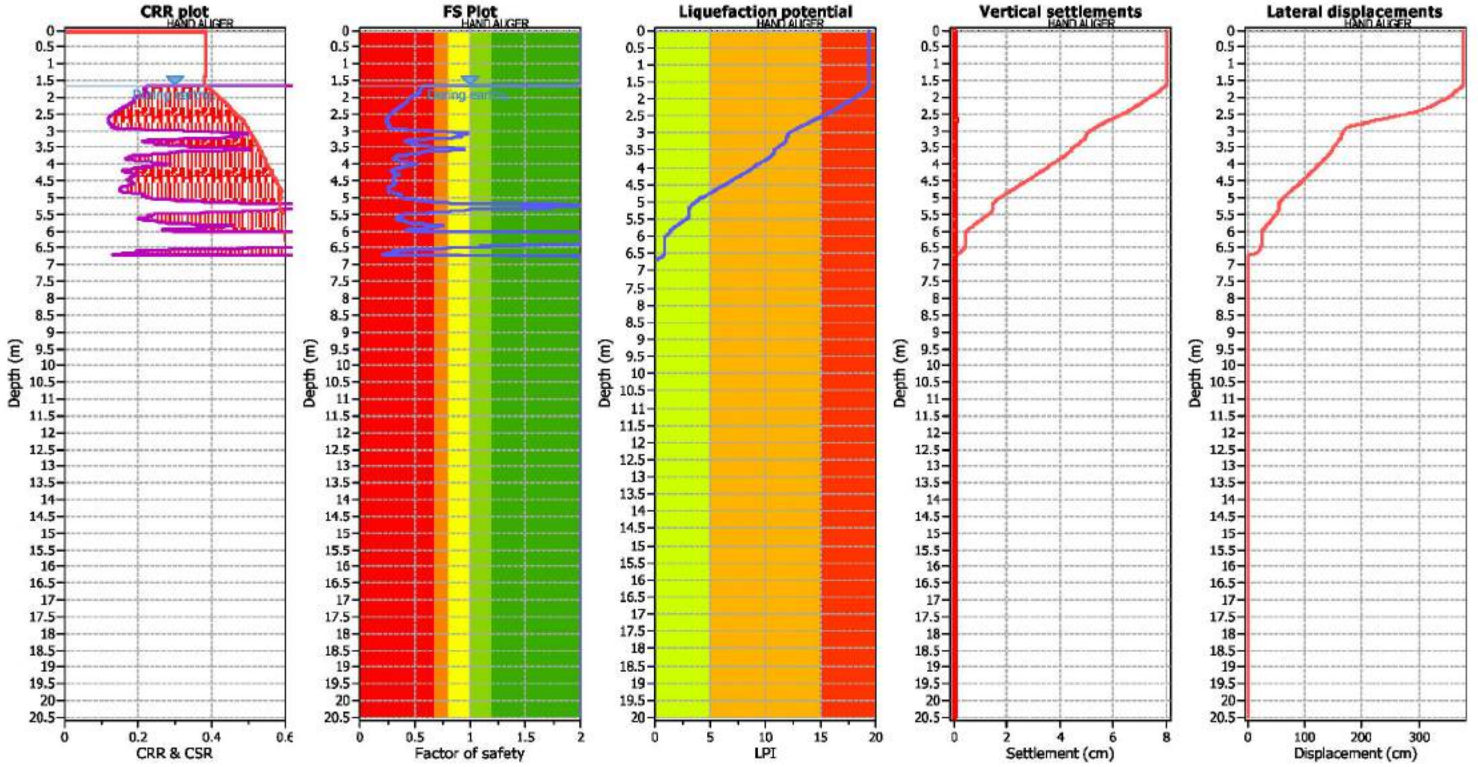
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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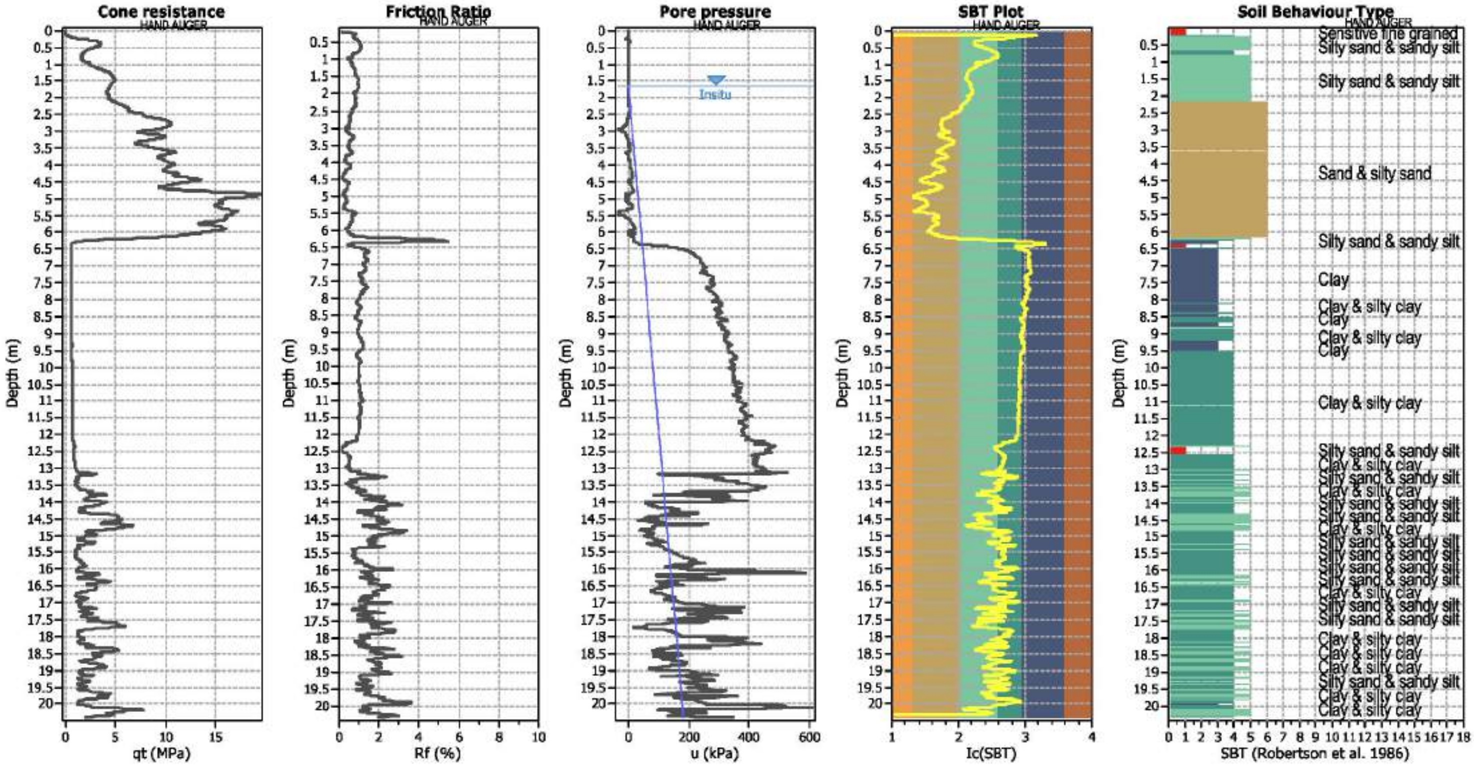
CPT basic interpretation plots



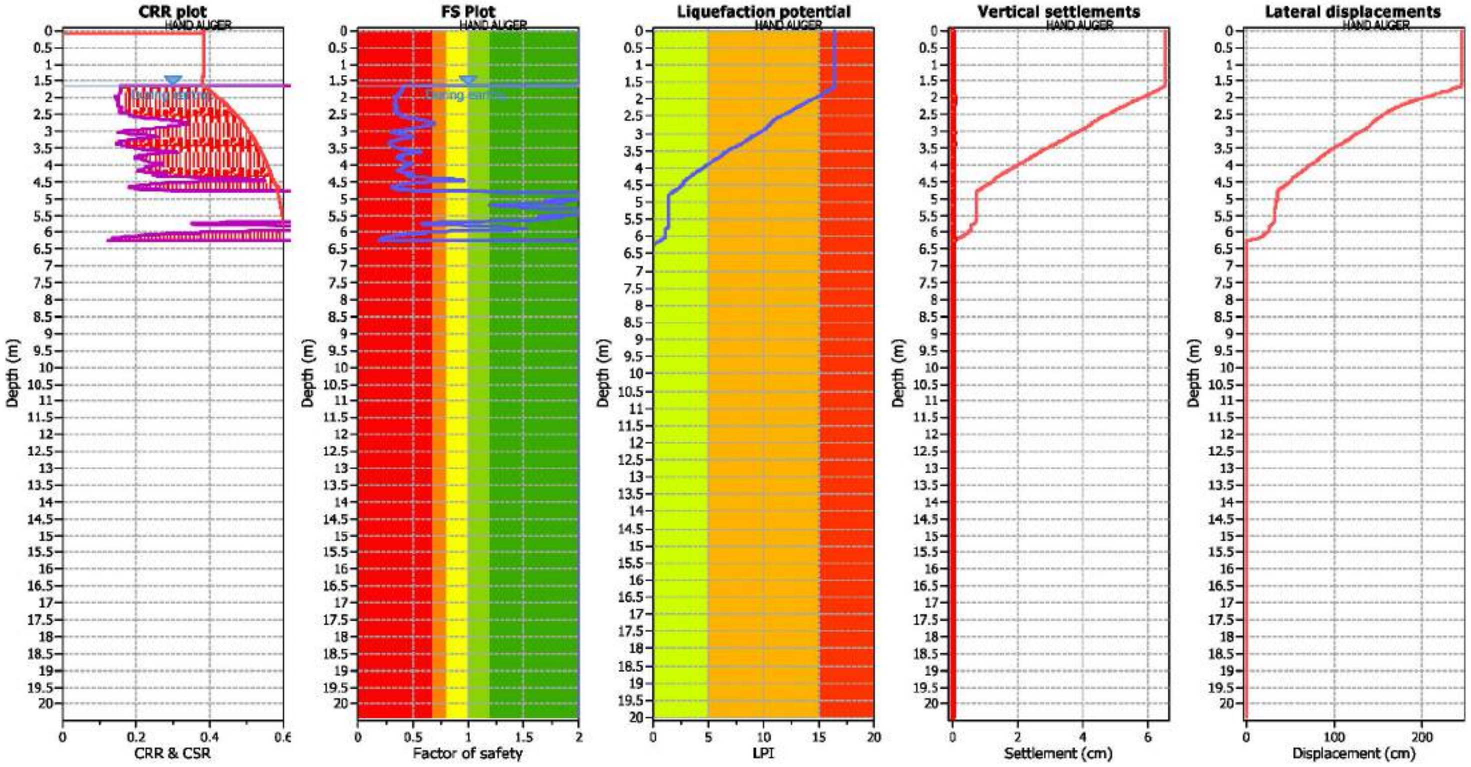
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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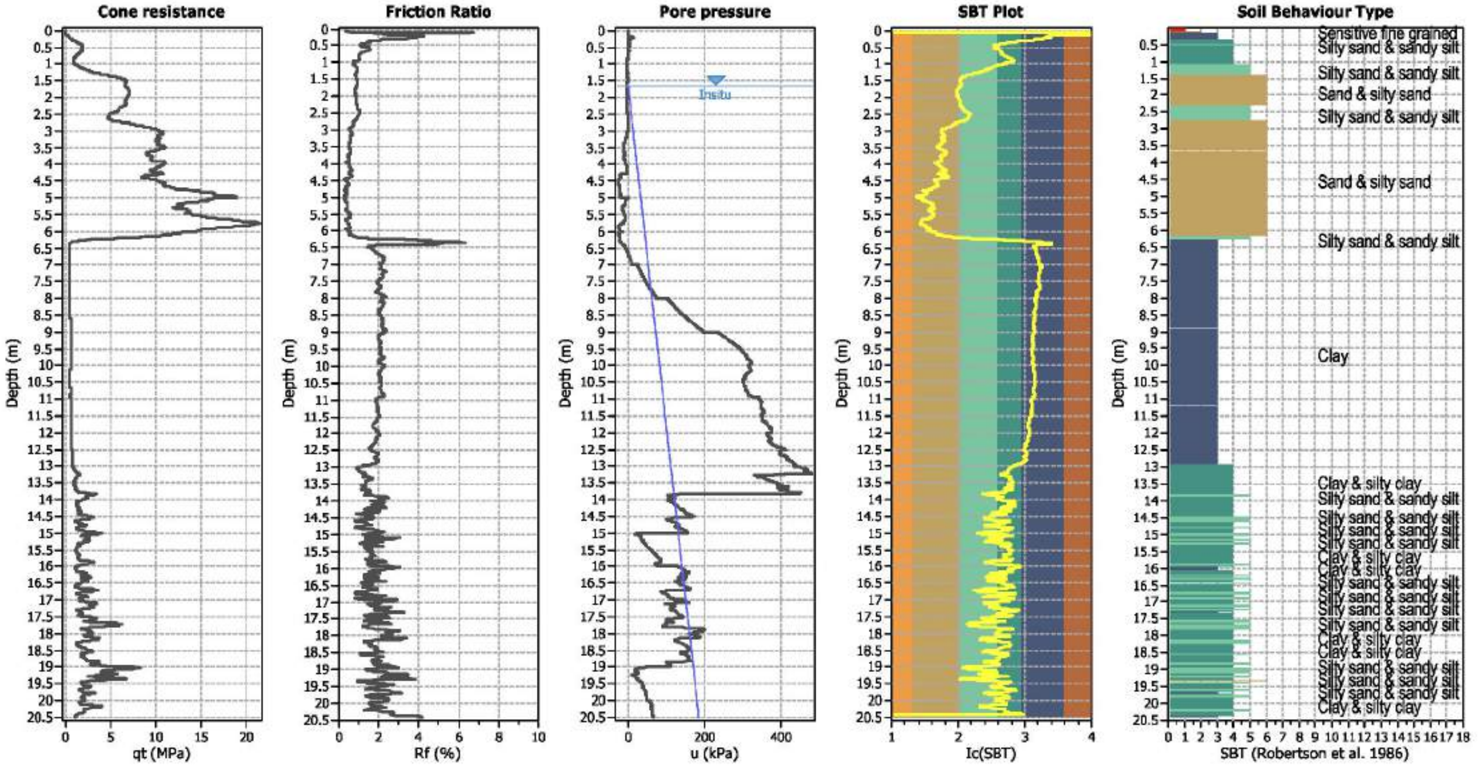
CPT basic interpretation plots



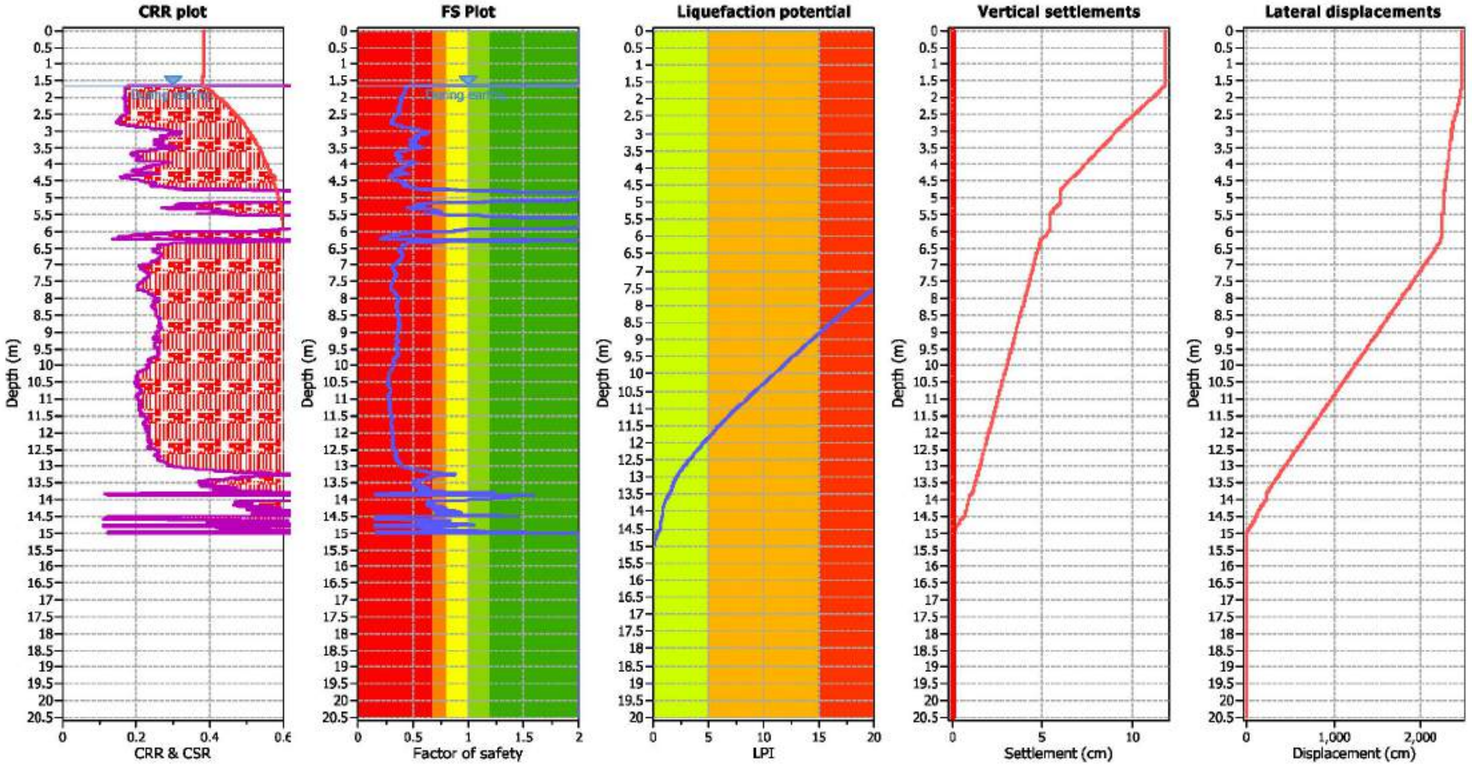
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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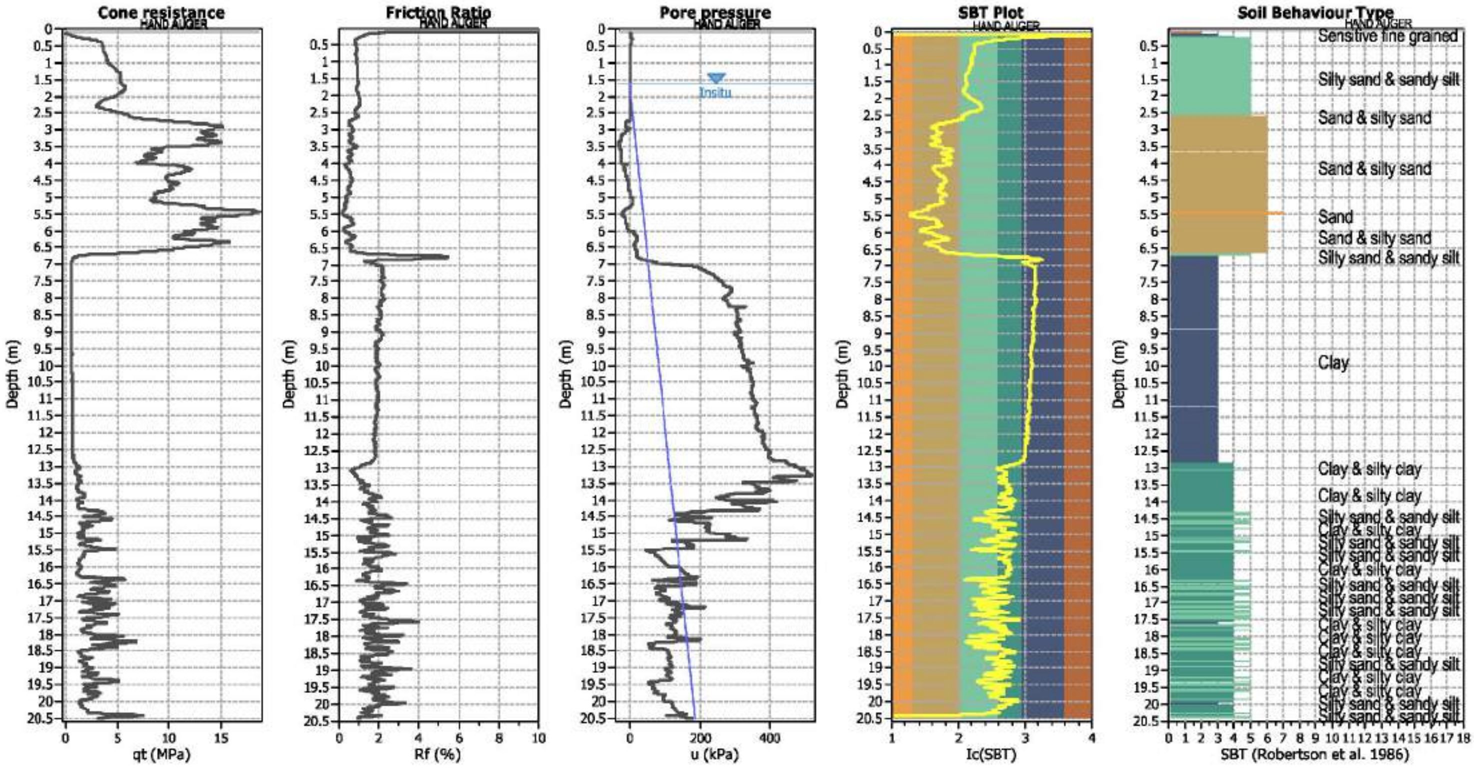
CPT basic interpretation plots



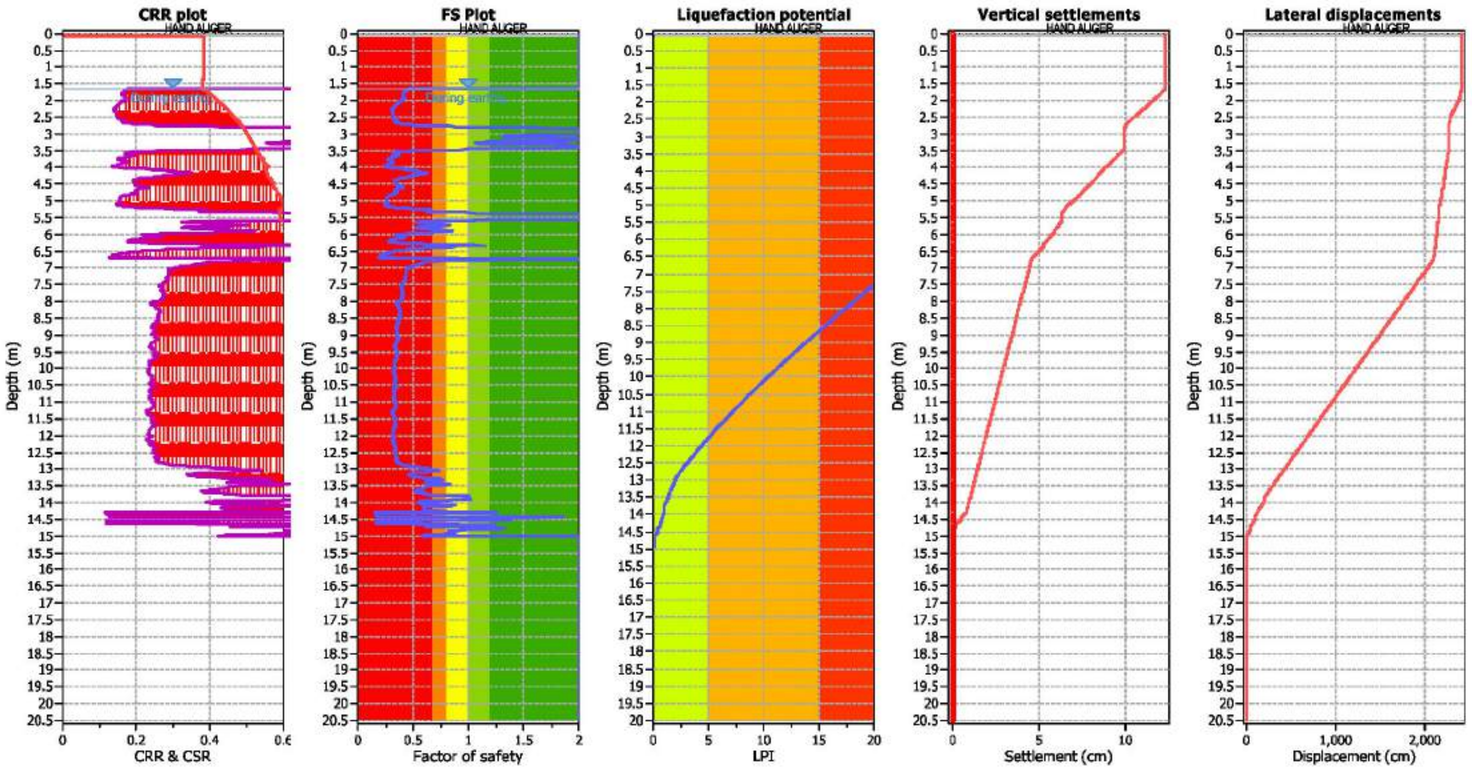
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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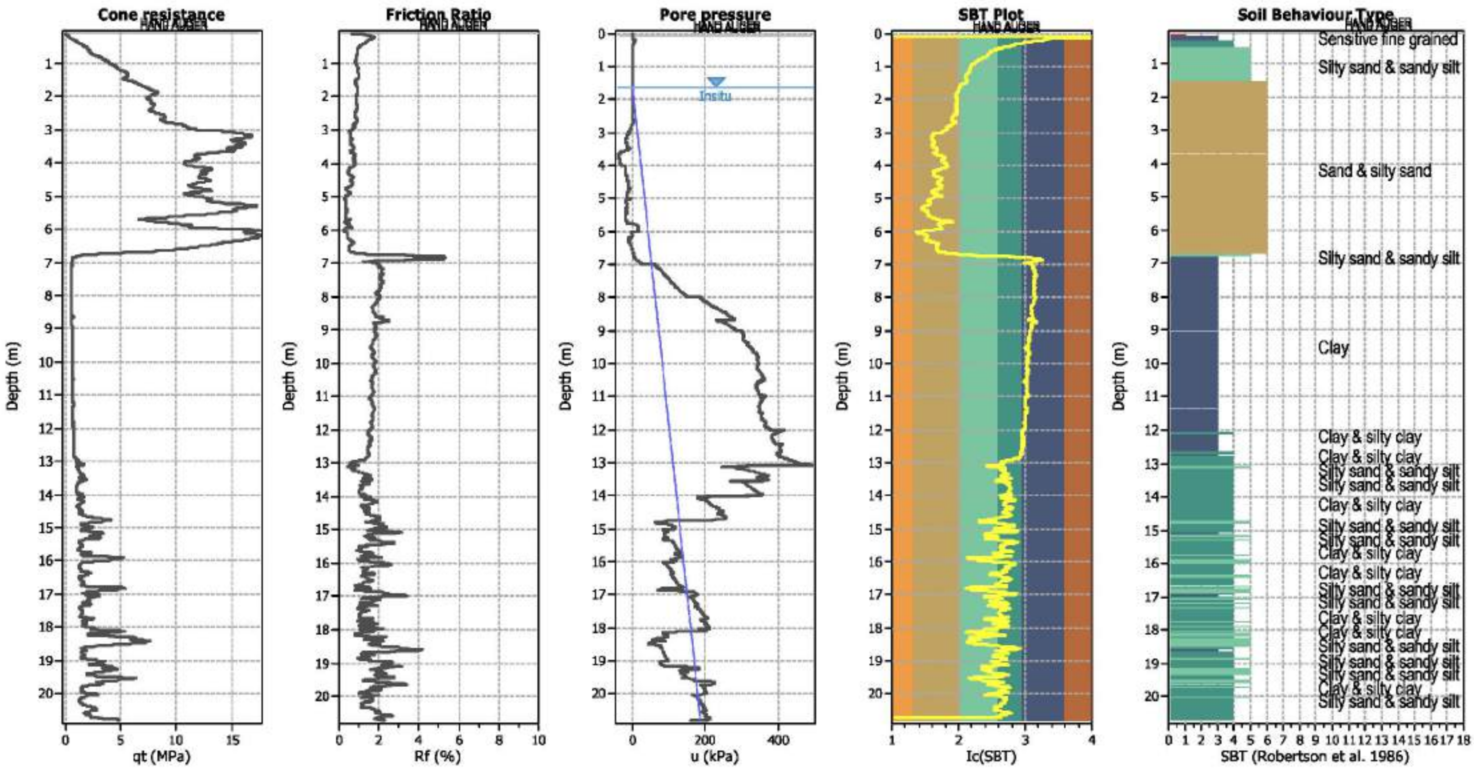
CPT basic interpretation plots



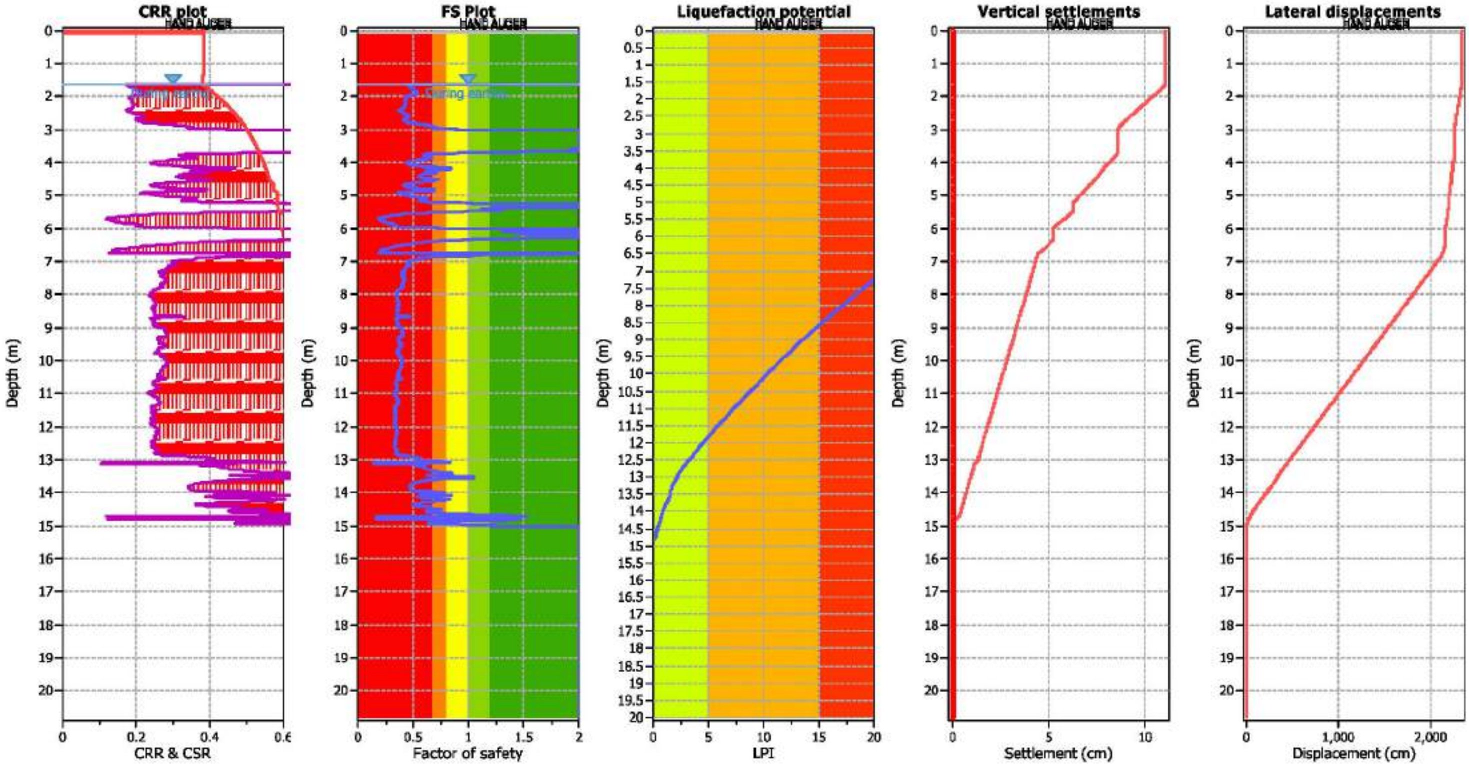
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

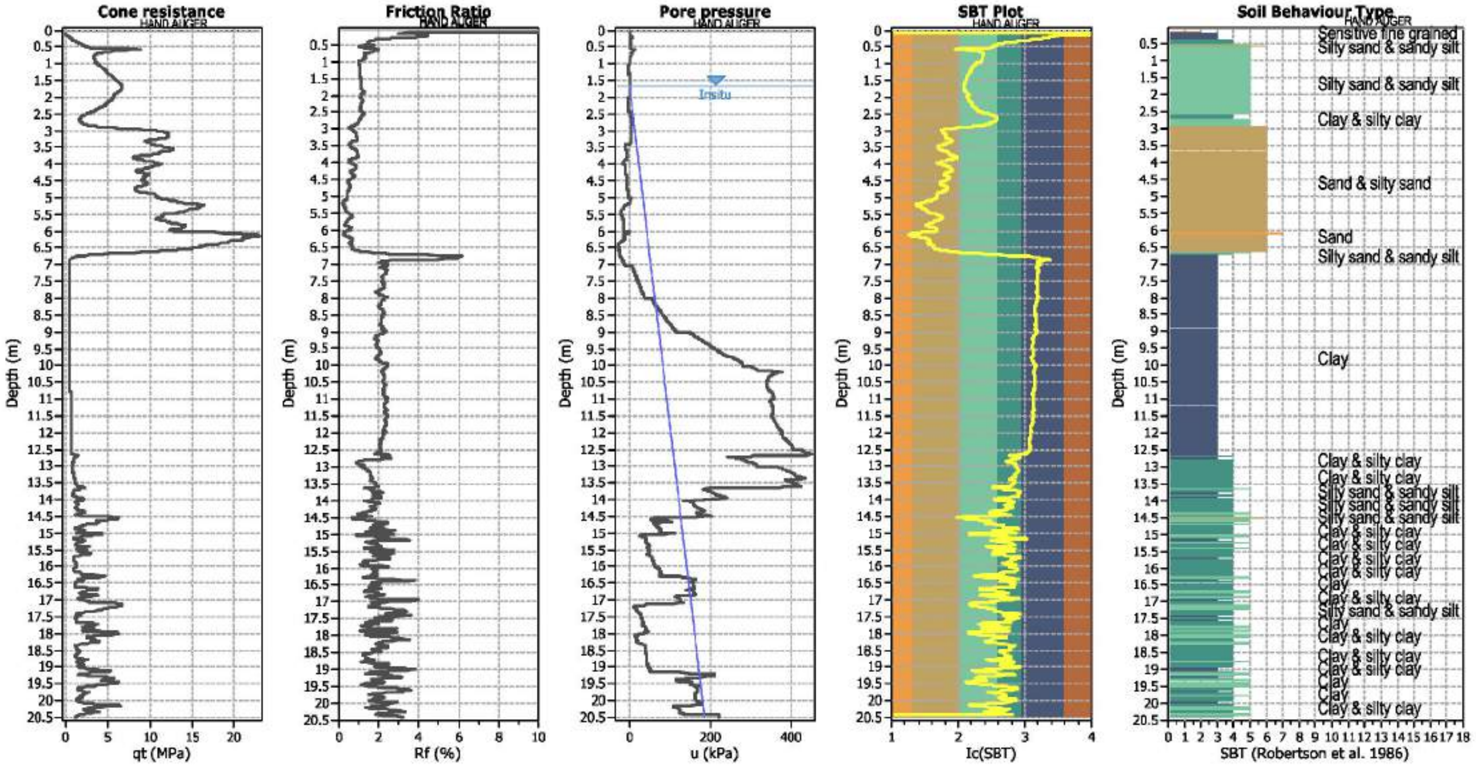
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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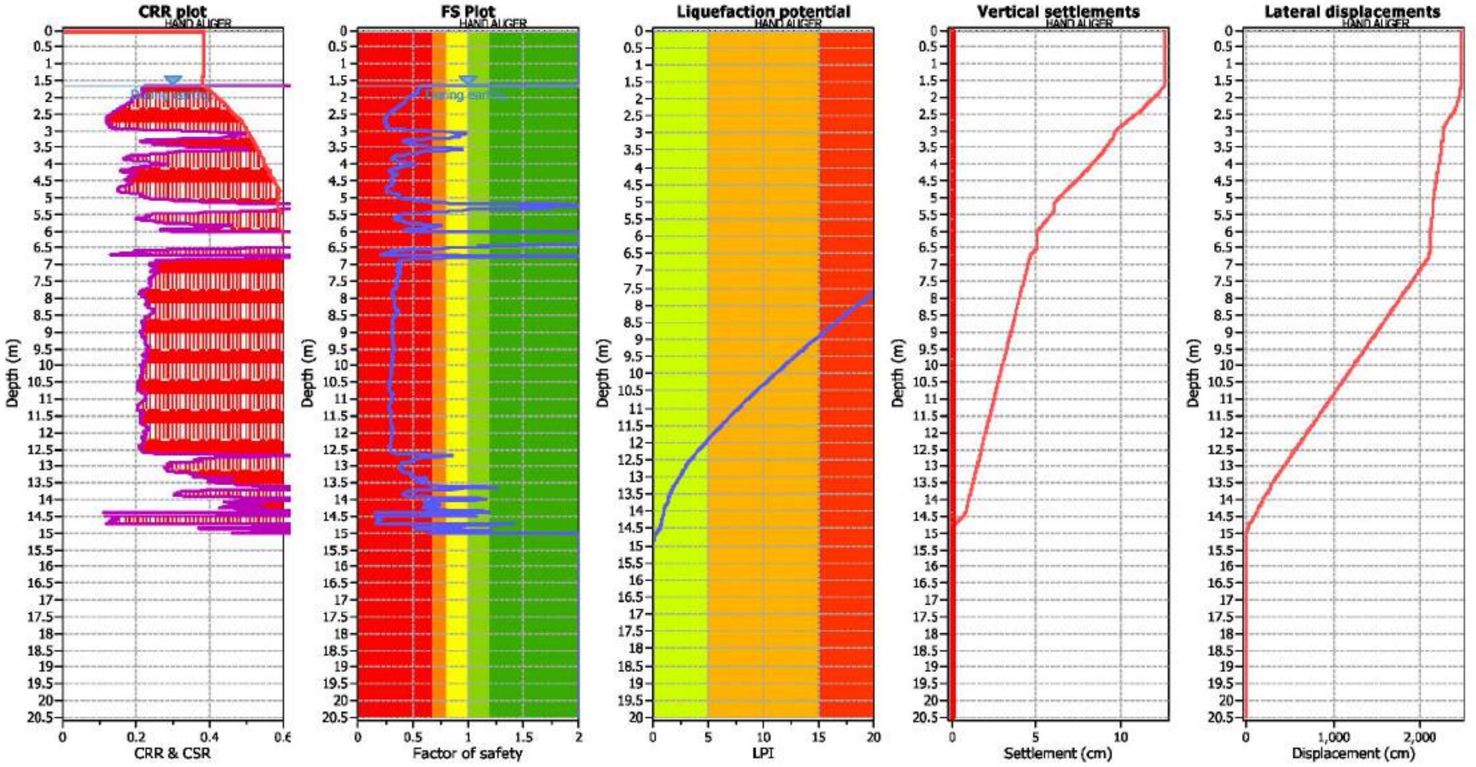
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
Limit depth: 15.00 m

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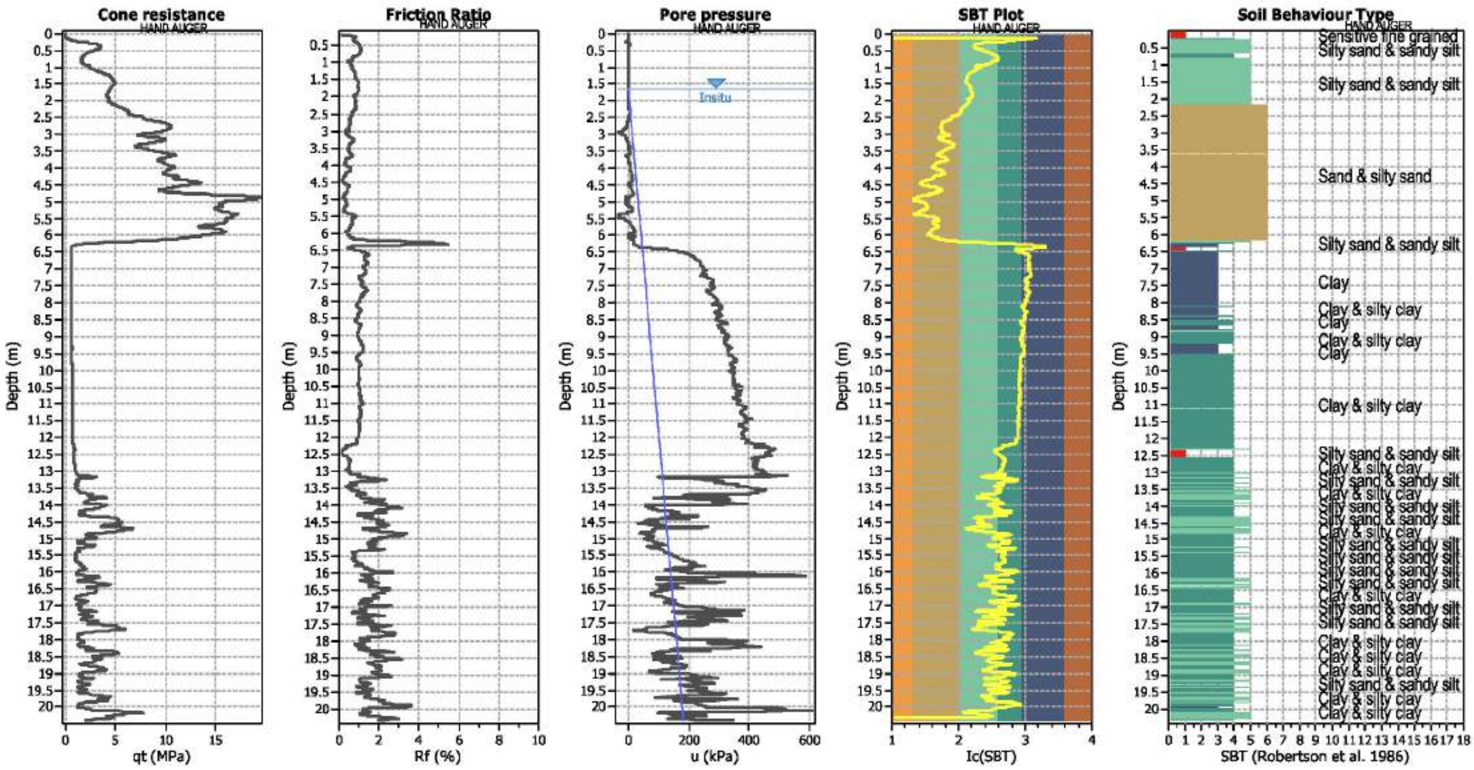

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
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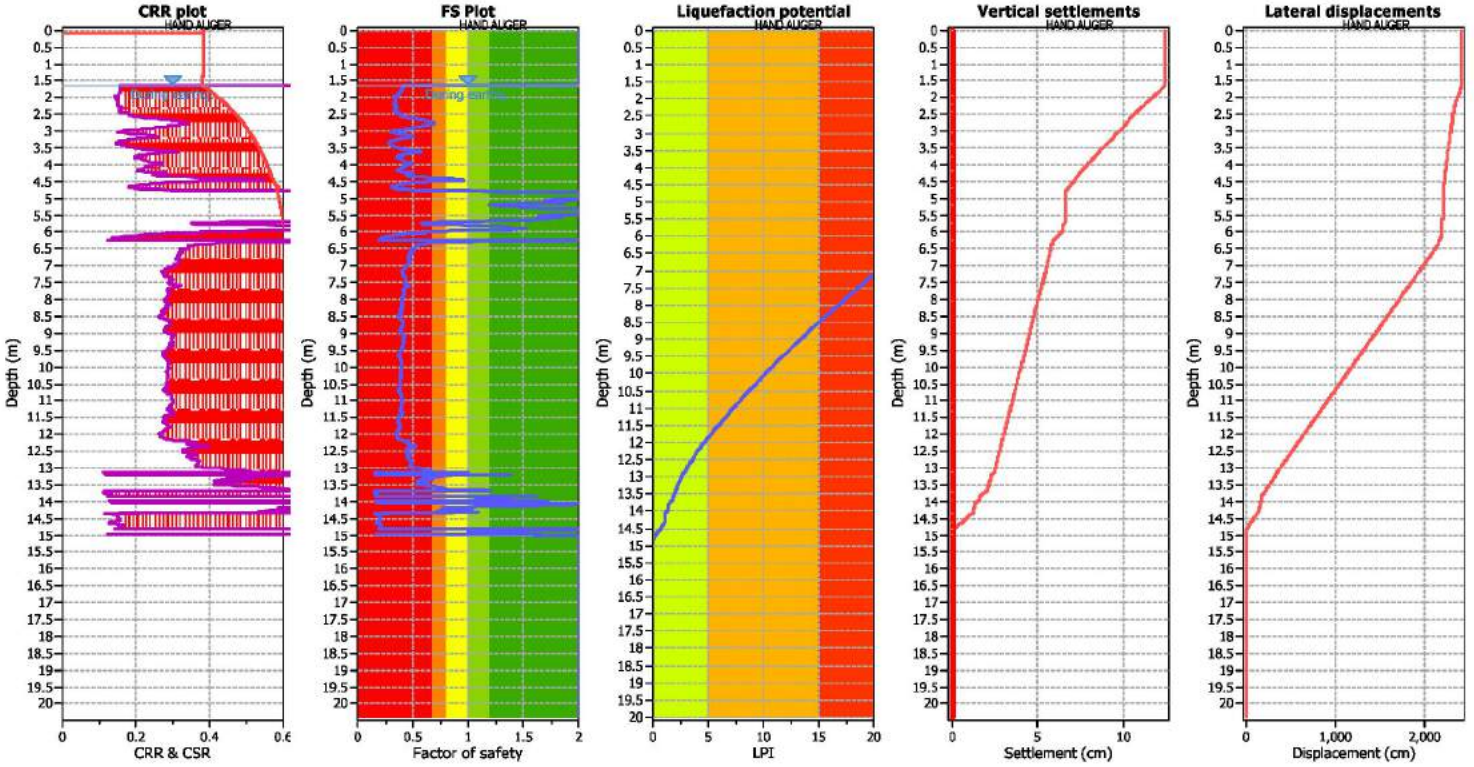
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
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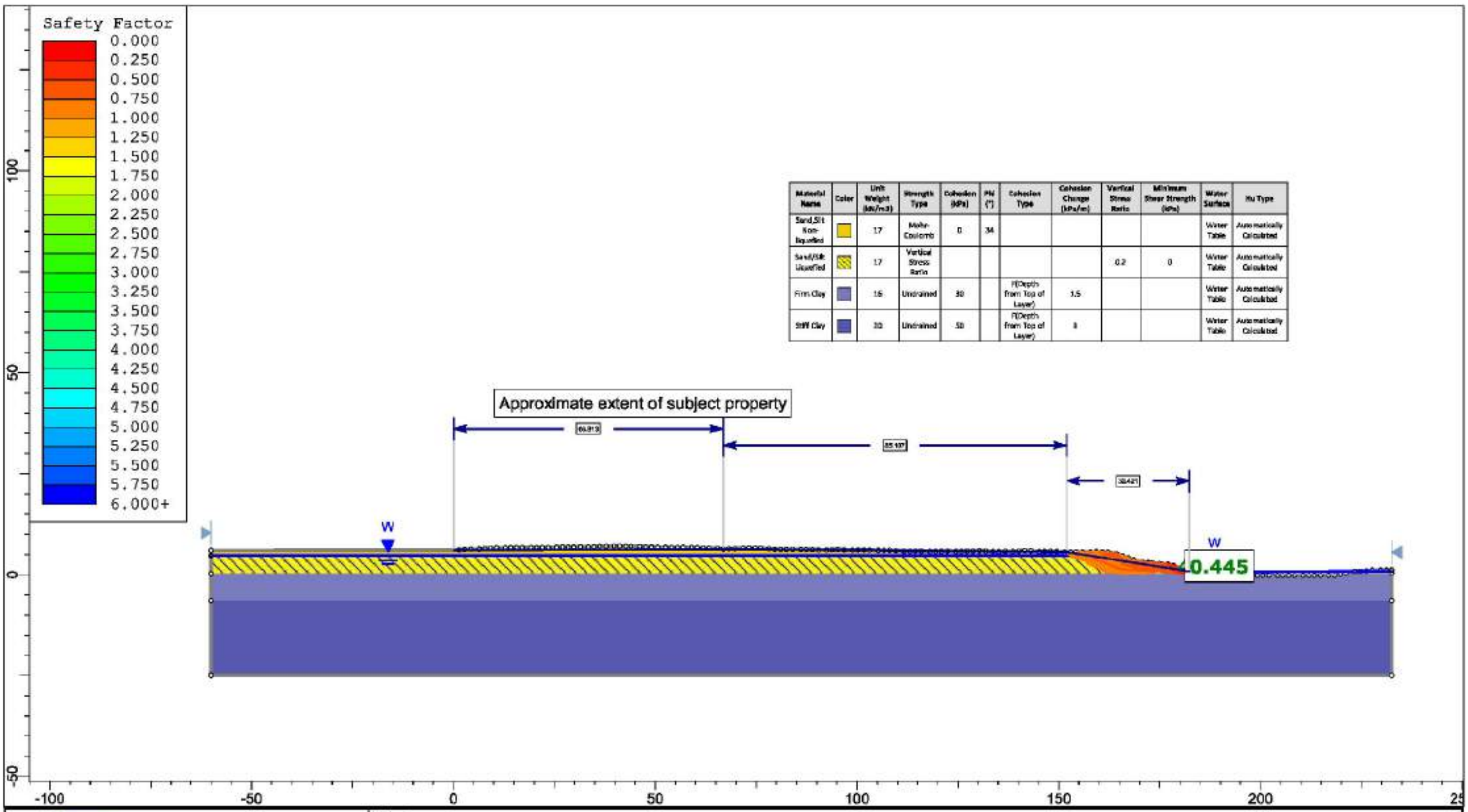
APPENDIX E

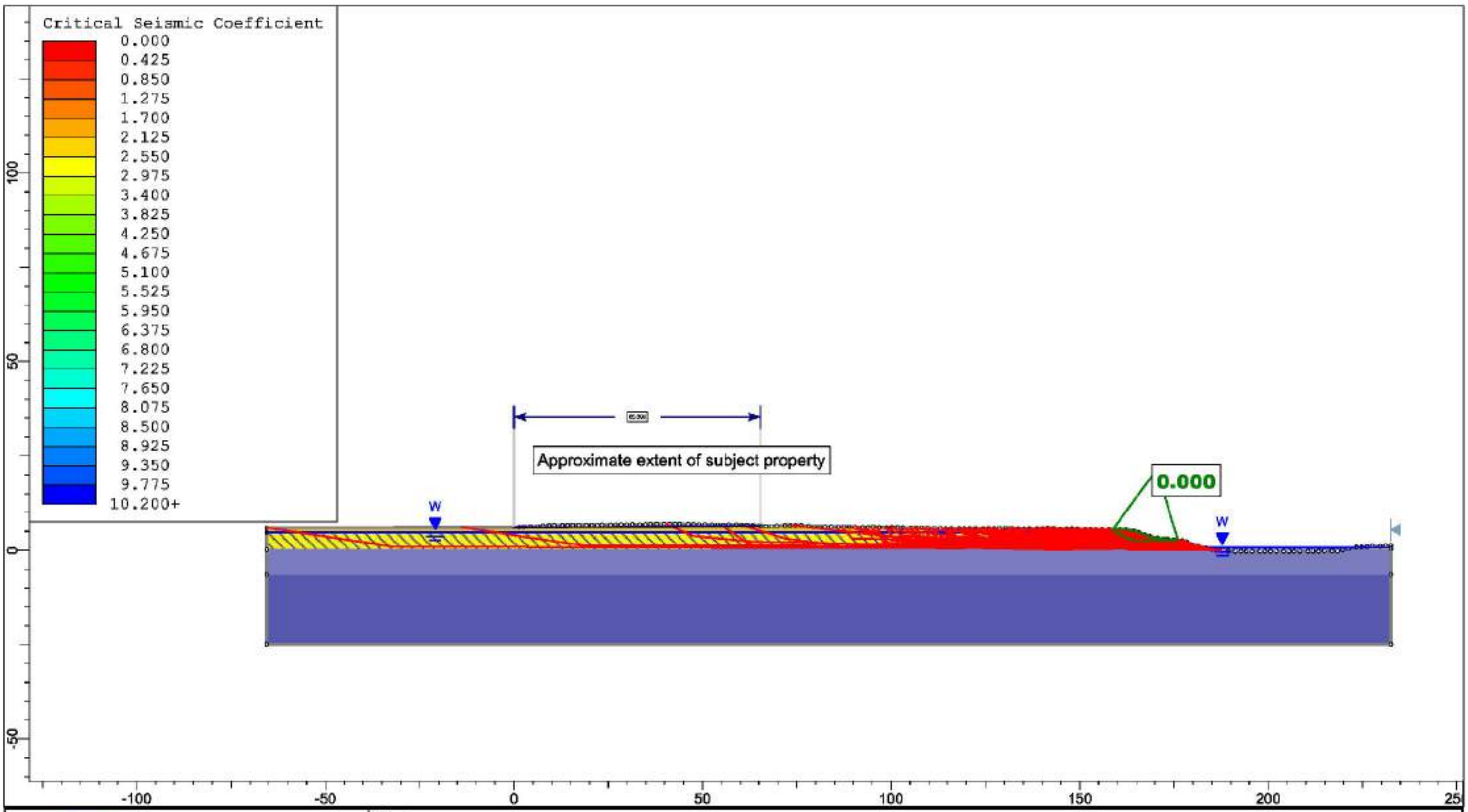
SLOPE STABILITY OUTPUTS



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Cohesion Change (kPa/m)	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type
Sand,Silt Non-liquefied	🟨	17	Mohr-Coulomb	0	34					Water Table	Automatically Calculated
Sand/Silt Liquefied	▨	17	Vertical Stress Ratio					0.2	0	Water Table	Automatically Calculated
Firm Clay	🟪	16	Undrained	30		f(Depth from Top of Layer)	1.5			Water Table	Automatically Calculated
Stiff Clay	🟦	20	Undrained	50		f(Depth from Top of Layer)	8			Water Table	Automatically Calculated

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 1	*Scenario*	T/S ratio 0.2 - Static Flow
Drawn By	SS	*Company*	LDE Ltd
Date	31/08/2023	*File Name*	Lateral Spreading Analysis.slmd



LAND DEVELOPMENT & ENGINEERING

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 4	Scenario	T/S ratio 0.2 - Yield Seismic
Drawn By	SS	Company	LDE Ltd
Date	31/08/2023	File Name	Lateral Spreading Analysis.slmd

NZHG Gisborne Limited

GEOTECHNICAL ASSESSMENT REPORT FOR PROPOSED RESIDENTIAL DWELLING, LOT 5 AND LOT 6

556-560 Aberdeen Road, Te Hapara, Gisborne

Project Reference: 24477
October 13, 2023

DOCUMENT CONTROL

Version	Date	Comments
01	13/10/2023	Issued for Resource Consent. Plan review required prior to submission for Building Consent.

Version	Issued For	Date	Prepared By	Reviewed & Authorised By
01	Issued for Design	13/10/2023	Sahil Sathwara *B.Tech (Civil), MEngNZ* Geotechnical Engineer	Dan Bond *CMEngNZ, PEngGeol.* Associate Engineering Geologist

CONTENTS

1 INTRODUCTION

Land Development & Engineering Ltd (LDE) was engaged by NZHG Gisborne Limited to undertake a geotechnical investigation of a site located at 556 & 560 Aberdeen Road, Gisborne (Figure 1).

The 2,700m² site is proposed to be subdivided into 12 Lots for residential development (Figure 1). This geotechnical report pertains to proposed Lot 5 and Lot 6, 556 & 560 Aberdeen Road, Gisborne.

Figure 1 556-560 Aberdeen Road (outlined in blue), with the proposed subdivision outlined in yellow, Lot 5 and 6 highlighted in white. Image source: Tairāwhiti Maps (Gisborne District Council, 2023) Accessed: September 2023

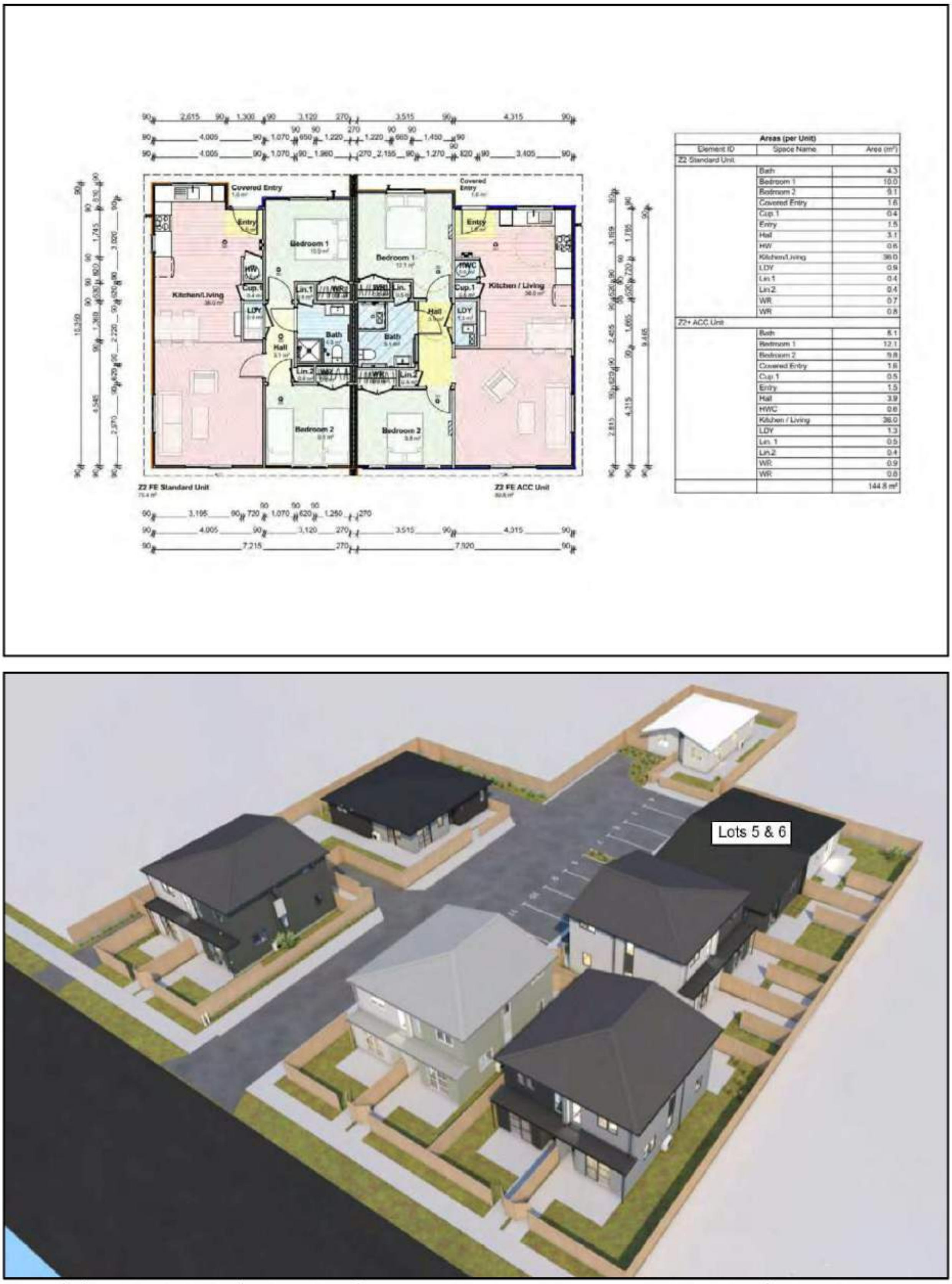
2 PROPOSED DEVELOPMENT

A 12-lot subdivision is proposed at 556 & 560 Aberdeen Road across the property with the legal description Lot 2 DP 1585, PT Lot 1 DP 1585, and Lot 1 DP 1817. The proposed development consists of 7 structures formed of four double-storey duplex buildings, one single-storey building and two standalone dwellings (Figure 1).

The proposed driveway is located centrally of the site to provide access between lots and Aberdeen Road. Proposed access and building platform locations are shown in Figure 1 and Appendix A.

A 156.2m² single storey building is proposed across Lot 5 and 6 (Figure 2), with timber framing in accordance with NZS3604 (2011), with weatherboard and sheet wall cladding, profiled metal roofing and a concrete floor or suspended timber floor.

The purpose of this investigation was to determine and assess the nature of the ground beneath the building site to inform our geotechnical recommendations for site development and design of the building's foundations. The investigation was completed to satisfy the requirements of Gisborne District Council (2022) for Resource and Building Consent.



Areas (per Unit)		
Element ID	Space Name	Area (m²)
Z2 Standard Unit		
	Bath	4.3
	Bedroom 1	10.0
	Bedroom 2	9.1
	Covered Entry	1.6
	Cup.1	0.4
	Entry	1.5
	Hall	3.1
	HW	0.6
	Kitchen/Living	36.0
	LDY	0.9
	Lin.1	0.4
	Lin.2	0.4
	WR	0.7
	WR	0.8
Z2+ ACC Unit		
	Bath	5.1
	Bedroom 1	12.1
	Bedroom 2	9.8
	Covered Entry	1.6
	Cup.1	0.5
	Entry	1.5
	Hall	3.9
	HWC	0.6
	Kitchen / Living	36.0
	LDY	1.3
	Lin. 1	0.5
	Lin.2	0.4
	WR	0.9
	WR	0.6
		144.8 m²

Figure 2: (From top to bottom): Floor plans for proposed duplex building across Lot 5 and Lot 6, alongside the architect's drawing (Lot 5-6 is labelled). Image Source: Client supplied.

3 SITE STUDY

3.1 Site Description

The site is located within the established suburb of Te Hapara, Gisborne, approximately 2.0km northwest of the Gisborne CBD. The site is generally flat and is elevated between 6m and 7m (New Zealand Vertical Datum (NZVD) 2016). 556 (LOT 2 PT 1 DP 1585) & 560 (LOT 1 DP 1817) Aberdeen Road, occupy a combined area of approximately 2,700m^2.

3.2 Geomorphology and Geology

556 & 560 Aberdeen Road, occupy flat lying ground which, at one time, comprised the historic foreshore of Tūranganui-a-Kiwa (Poverty Bay). The 1:250,000 geological map of the region (Mazengarb & Speden, 2000) indicates the site is underlain by Holocene aged beach deposits which consist predominantly of sand. The Taruheru River is located approximately 120m to the north; elevation falls relatively gently towards the river until the riverbank, which falls around 6m over some 25m laterally.

The GNS Active Fault Database does not identify any active fault traces or any fault buffer zones affecting the site. The nearest mapped active fault is the Repongaere Fault, located approximately 14 km to the north-west of the properties (GNS Science, 2020).

3.3 Geotechnical Risks

Our review of Gisborne District Council's (GDC) GIS viewer, Tairāwhiti Maps (Gisborne District Council, 2023), and GNS Science's Active Faults Database (GNS Science, 2020) revealed the following:

- 556 & 560 Aberdeen are mapped as being within an area of moderate liquefaction risk.
- The nearest active fault is the Repongaere Fault, located approximately 14km to the north-west of the properties.
- The site is mapped as yellow tsunami evacuation zone.

In addition to the risk of liquefaction, the nearby riverbanks of the Taruheru River presents the possibility of lateral spreading in a liquefaction-inducing earthquake event.

Our review of the 2023 aerial photographs indicates that the properties were not severely impacted by flooding associated with Cyclone Gabrielle.

3.4 Historical Aerial Photographs

Historical aerial imagery was reviewed as part of this investigation using Retrolens and Google earth aerial

photography, which revealed the following: -

- Residential dwellings were constructed at both properties prior to 1942 (the earliest available aerial photograph with sufficient resolution).
- In the 1942 aerial photograph there appears to be some form of structure/s, a pile of material, or disturbance to the ground beneath the southwest corner of 556 Aberdeen Road. However, the resolution of the aerial photography is not sufficient to reliably determine what occupied the southwest corner of the property.
- A large shed was constructed in the southwest corner of 556 Aberdeen Road sometime between 1942 and 1966, along with smaller auxiliary structures at both properties.
- Several small structures or 'lean-tos' were constructed between 1966 and 1988 across both properties.
- A shed/garage was constructed in the south-east corner of 560 Aberdeen Road.
- Between 1988 and 2021 additions were carried out to the garage/shed in the south-east corner of 560, and the large shed in the southwest corner of 556. The water tank for 560 Aberdeen Road was removed, along with several of the smaller auxiliary structures across both properties.

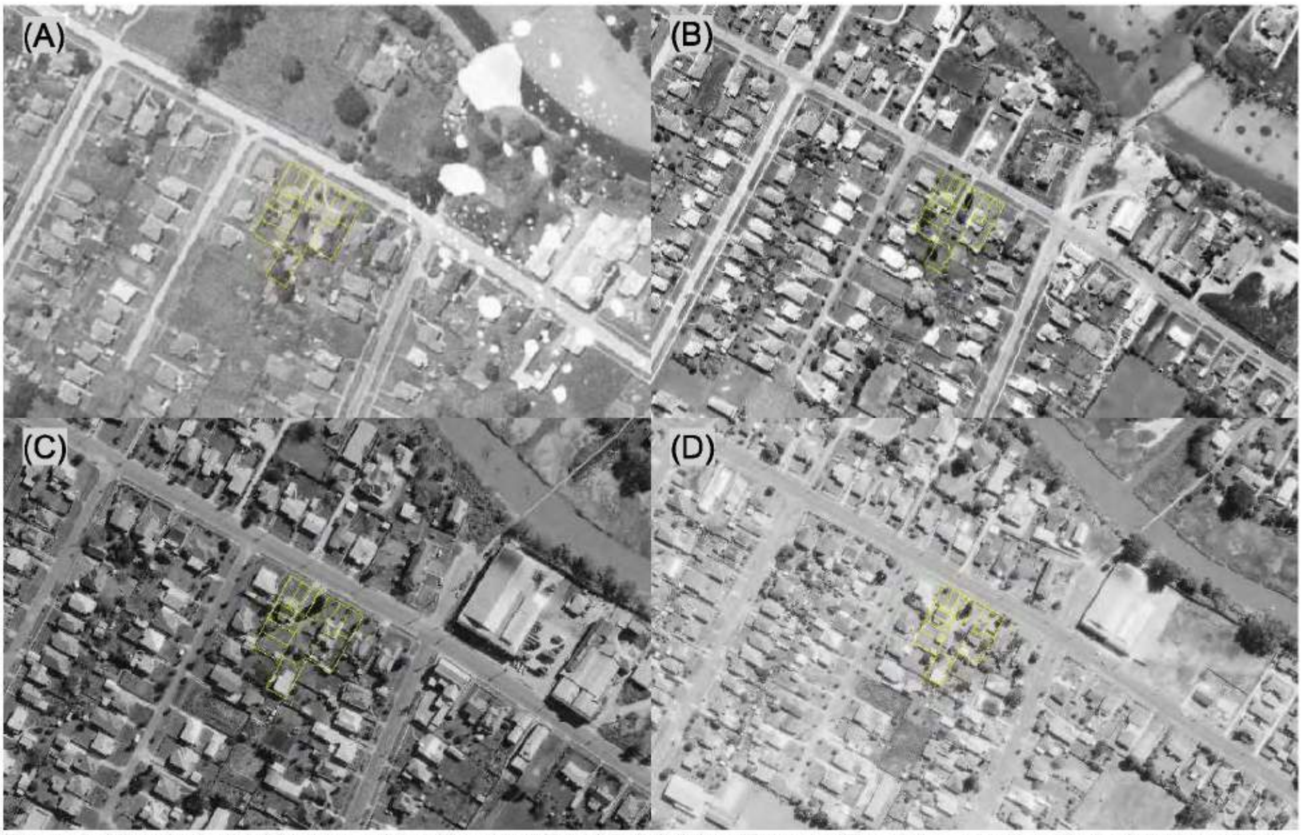


Figure 3: Historical aerial imagery of the Aberdeen Road Subdivision (Source: (Retrolens.co.nz)), with the location of the individual lots marked in yellow. (a) Aerial imagery from 1942, (b)1966, (c) 1977, (d) 1988.

4 GEOTECHNICAL INVESTIGATION

4.1 Development wide Investigation Scope

Our investigation of the entire site included the following: -

- A walkover assessment of the site and immediate surrounding area to assess its geomorphology and identify any features which may influence our engineering recommendations, or the long-term performance of the ground.
- 15No. 50mm diameter, hand auger boreholes drilled to refusal or 2.5m target depth at the proposed building locations, with measurements of undrained shear strength taken every 0.2m, and associated DCP's to the 2.5m target depth.
- Complete liquefaction analysis of the Five CPTs which were undertaken across the site during the due diligence phase, three at 556 Aberdeen Road and two at 560 Aberdeen Road (Figure 4).

4.2 Lot 5 and Lot 6 Investigation Scope

The investigation of the site, completed on 12 September 2023 included the following work: -

- Three, 50mm diameter, hand-auger boreholes (HA08, HA09 and HA10), reached target depth of 2.5m below ground level (bgl). Associated DCP tests were carried out at each test location to the 2.5m target depth within granular materials.
- Measurements of groundwater levels within invasive subsurface test holes, following hole completion.

The test locations are shown on the Geotechnical Investigation Plan (Figure 4), and as Appendix A. Logs with details of the relevant testing completed are presented as Appendices B and C.

Figure 4: Geotechnical Investigation Plan for proposed development, Lot 5 & 6 highlighted in white.

5 GROUND CONDITIONS

This section addresses the ground conditions encountered during our investigations.

5.1 Site Stratigraphy

5.1.1 Development Wide

Ground conditions are reasonably consistent across the site. Typically, the property is underlain by topsoil and/or fill to a depth between 0.3m and 0.8m below ground level (bgl), which overlies sand/ silt mixtures to a depth of 1.0m. Underlying this, medium dense to dense sand was encountered to around 6.5m to 7.0m.

Deposits of firm clay were encountered from around 6.5m to 7.0m, with stiff silt/clay mixtures extending to depth from approximately 13m.

A copy of the test logs is provided as Appendix B.

5.1.2 Lot 5 and Lot 6 Site Specific Nuances

Topsoil/Fill was encountered in each hand auger borehole from the existing ground surface to depths of 0.3m, 0.6m and 0.7m in HA08, HA09 and HA10 respectively.

Dynamic penetrometer testing in hand auger boreholes typically ranged between 1 and 4 blows per 50mm penetration below the topsoil.

5.2 Groundwater

Groundwater was encountered at depths of between 1.50m and 2.88 m across the site. A low-bound groundwater level of 1.65m bgl was adopted in our assessments. Given that testing was completed in the wettest year on record for Gisborne, the groundwater level adopted is considered significantly elevated from typical levels and no further allowance has been applied for seasonal variations.

6 NATURAL HAZARDS

6.1 Definition & Legislation

This section summarises our assessment of the natural hazards that might affect the site including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding, that might affect the property, as generally defined in Section 106 of the Resource Management Act., as well as the hazards as defined in Section 71(3) of the Building Act (2004), including erosion (including coastal erosion, bank erosion, and sheet erosion), falling debris (including soil, rock, snow and ice), subsidence, inundation (including flooding, overland flow, storm surge, tidal effects and ponding), and slippage.

6.2 Seismic Hazard

6.2.1 Surface Fault Rupture

The GNS NZ Geology Web-map and Active Faults Database (GNS Science, 2020) do not show any faults passing beneath the subject site. There also does not appear to be any surface expressions which would indicate the presence of an active fault beneath or within close proximity to the site. We therefore consider the surface fault rupture risk to be low.

6.2.2 Site Subsoil Class

Based on the published geological information for the region, discussed in Section 3.2, and obtained site-specific CPT data, we consider that a seismic site subsoil classification of D- "Deep or Soft Soil" is appropriate as defined by NZS 1170.5 (2004).

6.2.3 Seismic Actions

In accordance with the NZ Building Code and NZS 1170.5 (2004) the structure proposed is considered Importance Level 2 (IL2) with a design working life of 50 years, therefore:

- The Serviceability Limit State (SLS) design earthquake has an annual exceedance probability (AEP) of 1/25, and;
- The Ultimate Limit State (ULS) design earthquake has an AEP of 1/500.

An intermediate state event (ILS) has been considered in accordance with Gisborne District Council's (GDC's) requirements. This design case has an AEP of 1/100.

The modules of the Earthquake Geotechnical Engineering Practice series jointly published by Ministry of Business Innovation and Employment (MBIE) and the New Zealand Geotechnical Society (NZGS) (2021) provides guidance under Section 175 of the Building Act (2004), to assist with ensuring compliance with the Act. We have adopted the ground motions published within Module 1 (2021) for geotechnical design which are summarised in Table 1.

Table 1 - Summary of adopted seismic parameters.

Seismic Parameters	SLS	ILS	ULS
Horizontal Peak Ground Accelerations (PGA), g	0.12	0.28	0.65
Effective magnitude, Mw	6.3	6.8	7.5

6.3 Liquefaction and Cyclic Softening Assessments

6.3.1 Liquefaction

Liquefaction is the term used to describe the temporary, but substantial, loss of strength and stiffness which can occur in saturated, unconsolidated soils that are subjected to strong shaking. In addition to near-total strength loss, liquefaction may also result in the expulsion of sediment and water at the surface, ground, and structure settlement, and in lateral (spreading) displacement of the ground.

The liquefaction potential was assessed with site-specific CPT data using specialist geotechnical software (CLiq Ver.3.3.1.13) in general accordance with NZGS/ MBIE Module 3 Guidance (2021).

Liquefaction triggering was assessed using the method proposed by Boulanger and Idriss (2014).

Liquefaction-induced, free-field, vertical, volumetric strains were estimated using the method proposed by Zhang et al (2002)

A low-bound groundwater level of 1.65m bgl was adopted as discussed in Section 5.2.

6.3.2 Cyclic-Softening

Cyclic softening is a phenomenon that occurs when the strength and stiffness of a soil decreases due to repeated cyclic loading such as that resulting from strong seismic shaking. Relatively soft clay soils are commonly susceptible to this phenomenon, which can be accentuated where these soils are sensitive i.e., there is a significant difference between the soil's peak and residual shear strength.

Due to the presence of the clay rich estuarine soils at this site, we have undertaken a cyclic softening analysis for the ULS design case. The Gisborne 2007 earthquake was of comparable magnitude and PGA to the ILS design case. No liquefaction or induced settlements were identified within the proximity of the subject site because of this earthquake. Accordingly, cyclic softening has been assessed for the ULS design case only.

Our assessments assumed:

- An N_{kt} value of 14 for the clay-like soils, based on previous work undertaken proximally by LDE within the estuarine deposits.
- An estimate of the maximum, post-liquefaction, volumetric strain based on the work by Robertson and Cabal (Robertson & Cabal, 2014) which recommends a default value of 0.5% for clay-like soils.

6.3.3 Liquefaction and Cyclic Softening Results

The results of our analyses are summarised in Table 2; detailed outputs are included as Appendix D.

The Liquefaction Potential Index (LPI) and Liquefaction Severity Number (LSN) are indices used to assess the general performance level of liquefied deposits in accordance with the NZGS/MBIE Module 3 Guidance (2021).

Our analyses indicate that liquefaction-induced settlements are likely to be negligible (<5mm) in a design SLS seismic event.

Under the ILS design case, liquefaction-induced settlements are estimated to be between 20mm and 50mm. As discussed in Section 6.3.2, no liquefaction, or liquefaction-induced settlements were identified within the proximity of the subject site as a result of the Gisborne 2007 earthquake, which had almost identical ground motions. Accordingly, we consider it unlikely that liquefaction would be realised under ILS seismic shaking and conclude that the software is likely to be over-estimating liquefaction potential.

Table 2 - Summary of liquefaction analysis results.

Limit State / AEP	CPT ID	LPI	LSN	Estimated Seismic Volumetric Settlements (mm) [Limited to 10m] (3)			Effects of Liquefaction
				Liquefaction	Cyclic Softening	Total Seismic Settlement	
SLS 1/25 year	CPT-01	0	0	<5 [<5]	-	**<5 [<5]**	**L0**
	CPT-02	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-03	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-04	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-05	0	0	<5 [<5]	-	**<5 [<5]**	
ILS 1/100 year	CPT-01	2	8	~30 [~25]	-	**~30 [~25]**	**L2**
	CPT-02	4	12	~50 [~45]	-	**~50 [~45]**	
	CPT-03	2	5	~20 [~20]	-	**~20 [~20]**	
	CPT-04	4	12	~45 [~40]	-	**~45 [~40]**	
	CPT-05	3	10	~45 [~30]	-	**~45 [~30]**	
ULS 1/500 year	CPT-01	18	23	~75 [~70]	~45	**~120 [~70]**	**L3**
	CPT-02	18	23	~85 [~75]	~40	**~125 [~75]**	
	CPT-03	16	19	~70 [~65]	~40	**~110 [65]**	
	CPT-04	20	24	~85 [~80]	~40	**~125 [65]**	
	CPT-05	18	23	~85 [~65]	~40	**~125 [65]**	
Effects of liquefaction Key	**L0: Insignificant**		**L1: Mild**	**L2 Moderate**	**L3: High**	**L4 Severe**	**L5: Very Severe**

Notes:

- Liquefaction triggering Boulanger and Idriss (2014) methodology limited to upper 15m. Limited to 10m of soil profile shown in square brackets [ ].
- Settlements are free-field estimated settlements and do not include any building-induced settlements.
- Effects of Liquefaction based on NZGS Module 3 (New Zealand Geotechnical Society (NZGS) & Ministry of Business, Innovation and Employment (MBIE), 2021)

Under design ULS seismic shaking, settlements in the order of 110mm to 125mm are estimated. However, given the rationalisation to the Gisborne 2007 earthquake, discussed above, we consider that total, free-field, seismic settlements are likely to less than 100mm.

6.4 Lateral Spreading and Lateral Stretch

Lateral spreading typically occurs in sloping ground or level ground close to slopes or waterways and is most commonly caused by loss of strength due to earthquake-induced liquefaction. Typically, the degree of lateral movement diminishes as the distance from the waterway, or free face, increases.

Liquefaction-induced lateral displacements were estimated in CLiq software using the method proposed by Zhang et al (2004). utilising an I_c cut-off of 2.6, clean sand and overburden corrections, and inferred soil unit weights.

The methods available to predict lateral displacements from CPT data. Both these methods are based upon limited case studies and as such have inherent limitations for broader application. They are known to be highly inaccurate with predictions versus empirical data varying by a factor of two (NZGS Module 3 (2021)) or possibly more. Accordingly, lateral spreading potential was also assessed through numerical modelling, using Slide 2 (Version 9.027) by Rocscience Inc., to provide a more reliable estimate and allow sensitivity analyses to be undertaken.

Both methods, and associated results are discussed below.

6.4.1 CLiq Assessment

Our CLiq assessment adopted the 'Level ground with a free face' approach, because the alternative option (gently sloping ground) was found to estimate lateral displacements in excess of 600mm under the ILS design case.

Our assessment was based on the sites closest proximity to the Taruheru River (117m) and a free face height of 7m (elevation relief from the site to the river) and was completed for each CPT.

Table 3 presents the results of these analyses.

Table 3 - Summary of Lateral Spreading Displacements

CPT ID	SLS 1/25 year (mm)	ILS 1/100 year (mm)	ULS 1/500 year (mm)	Global Lateral Movement (ULS)
CPT01	<5	~105	~315	**Major**
CPT02	<5	~170	~390	**Major**
CPT03	<5	~100	~275	**Minor to Moderate**
CPT04	<5	~250	~460	**Major**
CPT05	<5	~180	~380	**Major**
Global lateral movement categories	**Minor to Moderate** **0 to 300mm**	**Major** **300 to 500mm**	**Severe** **>500mm**	

Notes:

- Free-face method adopted limits of lateral spreading to 2H. Chu et al (2006) have compared predicted values of lateral spread using the Zhang et al model with actual measurements of lateral displacement following the 1999 Chi Chi earthquake. They found that predicted values better matched observed values when liquefaction calculations in the CPT profile were limited to a depth of twice the free face height (2H).
- Global lateral movement categories based on MBIE Guidance for TC3 (Ministry of Business Innovation and Employment Hīkina Whakatutuki, 2015)

6.4.2 Numerical Modelling Assessment

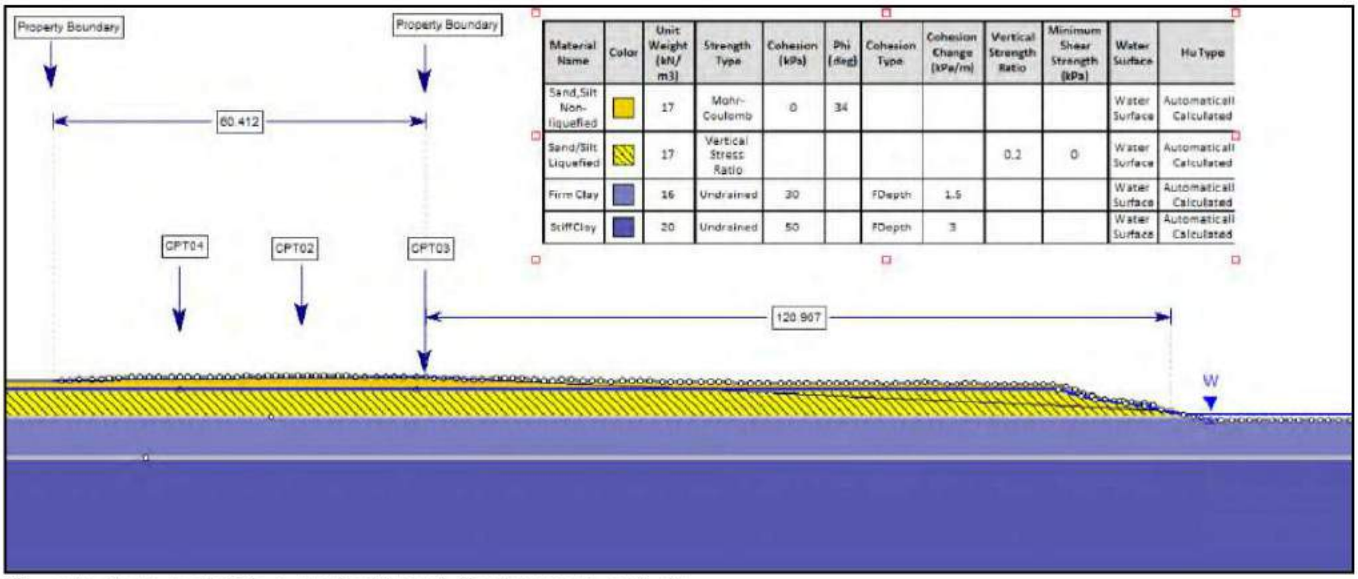
Numerical modelling was used to assess the potential for lateral displacements using Slide 2 as discussed above.

Our modelling assessed non-circular slip surfaces using the 'Cuckoo" search method and adopting the 'Vertical Strength Ratio' material strength model for the liquefied layer.

From past projects and general geological knowledge of this area, it is our experience that the Holocene beach sand transitions to clay-rich deposits towards the river, likely due to a combination of river migration and overbank deposition. In many areas along the Taruheru river a relic river terrace can be clearly identified, however this area had been developed prior to the earliest available historic aerial imagery and consequently the terrace boundary could not be identified.

Accordingly, we have adopted a conservative 'what if.' scenario in our modelling where the liquefied layer has been extended at consistent thickness and elevation to the river.

Figure 5 shows the base model, the surface profile of which was plotted from recent LiDAR data. Note the left side of the model has been manually extended to check the potential for more critical slip surfaces.



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Cohesion Change (kPa/m)	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type
Sand,Silt Non-liquefied	🟨	17	Mohr-Coulomb	0	34					Water Surface	Automaticall Calculated
Sand/Silt Liquefied	▨	17	Vertical Stress Ratio					0.2	0	Water Surface	Automaticall Calculated
Firm Clay	🟦	16	Undrained	30		FDepth	1.5			Water Surface	Automaticall Calculated
StiffClay	🟦	20	Undrained	50		FDepth	3			Water Surface	Automaticall Calculated

Figure 5: Base model for numerical lateral displacement analysis

The liquefied shear strength to overburden stress (Tau/ Sigma) ratio was derived for the sand/ silt mixtures from statistical analysis of CPT data. The Tau/ Sigma Ratio was found to vary significantly, ranging from 0.08 to 0.98; a value of 0.2 was adopted to provide a moderately conservative estimate for the body of liquefied material. Figure 6 shows a plot of Tau/ Sigma ratio with depth for CPT04.

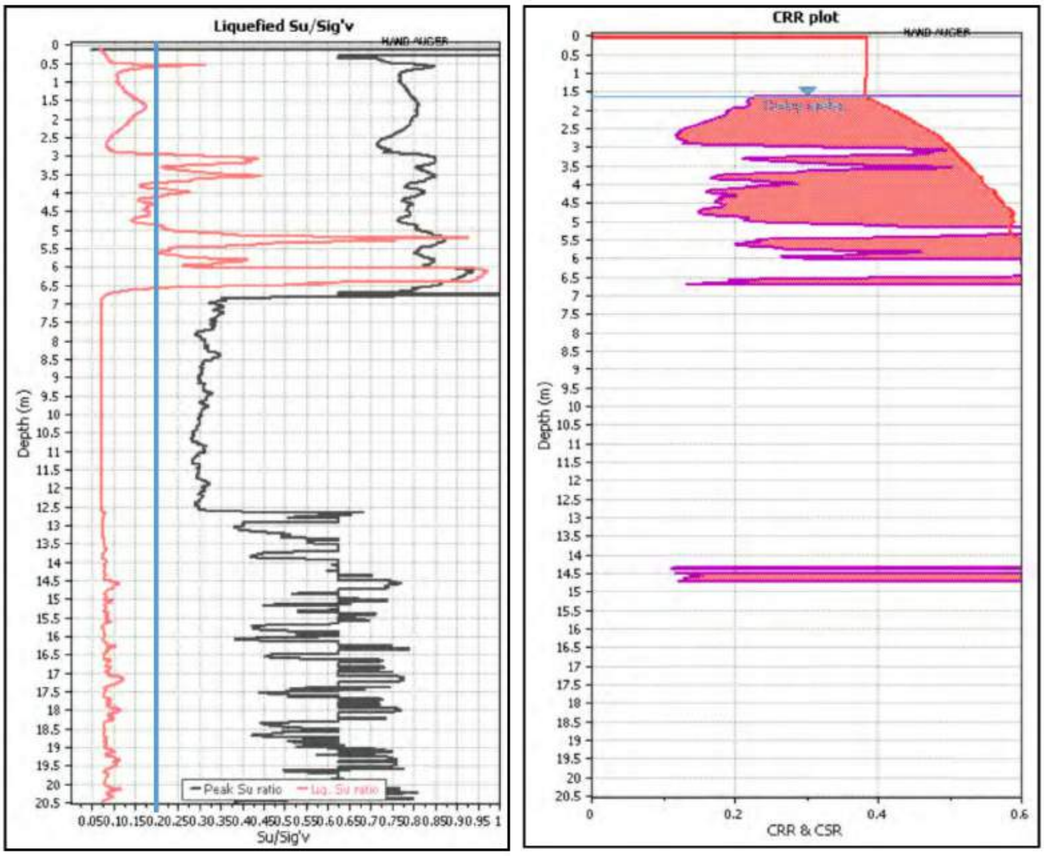


Figure 7: Tau/ Sigma ratio plot for CPT04 and plot showing depth of liquefiable material. Blue line shows value adopted in our modelling.

Two design cases were assessed:

1. Static Flow

   This design case models a post seismic liquefied case to assess the potential for flow failures to impact the subject property.

2. Seismic Yield

   This assessment determines the PGA required for the site to be affected by lateral displacements considering seismic action coincident with the fully liquefied condition. A magnitude of 0.1g was considered reasonable to represent an aftershock occurring within the short-term, liquefied timeframe.

6.4.2.1 Results

The results suggest that the property will not be affected in the static flow scenario with failures extending to a maximum of around 31m from the riverbank, some 85m from the subject property.

Under the seismic yield design case the subject property is estimated to be affected with a PGA of around 0.11g. Accordingly, lateral displacements are not anticipated in this scenario.

Full results are presented in Appendix E.

6.4.3 Conclusions

Numerical modelling indicates that lateral displacements of the magnitude estimated by CLiq are only achieved when full seismic PGAs are applied in the fully liquefied condition. Such a scenario is considered to be of very low probability, and highly conservative. We consider however that there is a reasonable probability of an aftershock occurring during this timeframe.

We conclude that the numerical modelling provides a more realistic estimate of ground performance, particularly given the apparent overestimation of liquefaction affects, discussed in Section 6.3.3. Accordingly, we consider that the subject site has low lateral spreading potential.

6.4.3.1 Lateral Stretch

Lateral stretch is a metric of the amount of differential extension that a portion of land may experience during an episode of lateral spreading. The lateral stretch across a foundation is a main factor in foundation damage due to liquefaction and lateral spreading as a result of a large earthquake.

Given the results of our numerical analyses, discussed above, lateral stretch is not anticipated at the subject site under the design cases assessed.

6.5 Liquefied Bearing

Liquefaction may lead to foundation bearing failure, by either 'punch through' failure or a reduction in bearing capacity when liquefaction occurs within the zone of influence of load bearing foundations.

A preferred foundation option has not been identified for the proposed structures at the time of writing and we have completed liquefied bearing assessments for both raft-type surface structures and piled foundations.

A unit weight of 17kN/m^3 was adopted for both the non-liquefied and liquefied soil layers. An angle of internal friction of 34 degree was adopted for the non-liquefied material.

The Tau/sigma ratio for these assessments was based on site-specific CPT data and taken as 0.075 for the liquefied material within the zone of influence of the foundations.

A low-bound groundwater level was taken as 1.65m, as discussed in Section 5.2.

A reduction factor of 0.75 was applied to the ultimate capacities calculated for the proposed, two-storey, duplex buildings, in accordance with MBIE Module 5 (2021) for moderately loaded structures.

6.5.1 Pile Foundation Assessment

Our assessment of pile foundations assumed:

- Ordinary piles embedded to a minimum depth of 0.5m at 0.3m diameter (including concrete cover), and

- Anchor piles embedded to a minimum depth of 0.9m at 0.4m diameter (including concrete cover), and
- 100kPa design load.

Both projected area and 'punch-through' failure mechanisms were assessed.

6.5.1.1 Results

The design load was found to be acceptable in both design cases. Note that our calculations are dependent on the assumptions listed within this Section. Should the pile diameter, pile embedment depth or design loads change, the liquefied bearing capacities will need to be reassessed.

6.5.2 Raft type Surface Structure Foundation Assessment

For the raft-type surface structures assessments were completed for the single-storey and two-storey buildings assuming:

- Foundation widths as presented in the 15% architectural drawings, and
- An embedment depth of 0.2m.

6.5.2.1 Results

Liquefied bearing capacities were calculated to be 19kPa for the proposed single-story buildings and 14kPa for the proposed two-storey duplex structures.

The values presented above are dependent on the assumptions listed. Should the foundation breadth, embedment depth or design loads change, the liquefied bearing capacities will need to be reassessed.

6.6 Equivalent MBIE Technical Category

Considering the rationalisation provided in Section 6.3.3, we consider that seismic ground performance at this site would be equivalent to a TC2 classification in accordance with Table 15.6 of the MBIE Guidance (2015).

6.7 Flood Hazard

The site is not located in a mapped flood hazard zone. GDC aerial imagery post cyclone Gabrielle does not indicate this site experienced significant impacts.

6.8 Tsunami

The Gisborne / East Cape coastline is classified as being at the highest risk in the country of being affected by tsunami. Modelling for the Gisborne region (GNS Science Te Pū Ao, 2016) indicates that the site is sufficiently elevated and is unlikely to be inundated in 1:100, 1:500, and 1:2500-year return period tsunami events, respectively. Civil defence tsunami inundation maps show that the site mapped as a yellow zone, which may be subject to tsunami

hazard in the case of a severe (ie M8.9) local earthquake on the Hikurangi subduction margin (Gisborne District Council Te Kaunihera o Te Tairāwhiti, 2019) .

6.9 Expansive Soils

Cohesive soils containing significant proportions of certain clay minerals can be subject to appreciable volume change caused by variations in soil moisture content, most notably between seasons or from the uptake of water through the root systems of trees and shrubs. This is referred to as soil reactivity or shrink-swell behaviour.

The surficial soils at this site are granular in nature and therefore not subject to expansivity.

6.10 Consolidation Settlement

The topsoil across the site is expected to be subject to consolidation with applied load and is not suitable to support structural loads.

The firm clay beneath the site may also be subject to consolidation settlement depending on the foundation option selected and the structural loads applied. The potential for consolidation settlement within this material should be assessed once the foundation type and structural loads have been determined.

6.11 Natural Hazards Summary

From our assessment of the natural hazards and ground deformation risks presented to the proposed development we consider that the proposed structures can be safely located on the site, provided that the recommendations given in Section 7 are adopted.

7 ENGINEERING RECOMMENDATIONS

7.1 Site Contouring and Topsoiling

The finished ground level should be graded so that water cannot pond against, beneath or around the buildings for the economic life of structure. To achieve this, it will be important that the building platform beneath the topsoil grades away from the site. Contouring should avoid the potential for concentration and discharge of surface water over point locations which could result in soil erosion or instability.

7.2 Access Road Construction

Access is proposed from Aberdeen Road. No major/ significant earthworks are anticipated to form access to the proposed dwellings.

7.3 Foundation Recommendations

7.3.1 Foundation Type

Based on the site investigation and analysis, we consider that foundations comprising pile foundations or raft-type surface structures are suitable for the site conditions providing the recommendations and limitations presented within this section are addressed in design.

7.3.2 Design Considerations

Based on the scope of work completed, the following aspects need to be considered in detailed design:

- Site Class - Class D - Deep or soft soil
- Liquefaction-induced vertical settlements - TC2 equivalent
- Relatively high groundwater level
- Liquefied bearing capacity
- Potential for consolidation settlement

7.3.3 Bearing Capacity and Founding Depth

Foundations must extend beneath any topsoil, uncontrolled fill, organic and/ or otherwise unsuitable material.

For the Lot 5/6 duplex structure we anticipate that a static geotechnical ultimate bearing capacity of 210kPa will be available from 0.7m depth. A reduction factor of 0.45 should be applied to this value to give the design bearing strength (q_{dbs}).

A short-term, post-seismic (static), liquefied bearing capacity, equivalent to the values presented in Section 6.5, should be assessed in structural design. Note that these liquefied bearing capacities are contingent on the assumptions listed within Section 6.5. Should these assumptions change in design, the liquefied bearing capacities will need to be reassessed. This may require some iterative design between the geotechnical and structural engineers.

7.4 Surface Water

Surface water from roof, impermeable surfaces, or any slopes should be collected and discharged away from the building to mitigate against flooding, erosion, soil expansivity, and/ or potential instability. The site will be connected to the reticulated network. Rainwater will be collected from the roof and all paved surfaces including parking areas and discharged into the GDC reticulated stormwater network.

7.4.1 Service Pipes

All service pipes, stormwater structures should be designed and constructed to ensure adequate capacity, strength, and water tightness to prevent leakage into the platform through blockage, running under pressure, or structural failure.

All service pipes installed within any fill should be flexible, or flexibly joined, so that they may deflect without breaking if the ground settles.

A record should be kept of the position, type, and size of all subsoil drains, and in particular of their outlets.

7.5 Trees and Shrubs

There are trees within the vicinity scattered across the property which might potentially cause damage through heaving as a result of root growth and/or settlement resulting from soil shrinkage from the moisture uptake of the roots. To reduce the chance of damage to the foundations, we recommend one of the following options:

- Any Trees/ plants that at their mature high will not be a minimum of that height away from the foundation should be removed including its major root structure.
- A root barrier should be designed and installed between the offending plant and the structure.
- Foundation should be taken to a depth no less than 1.0m where damage from the roots of a plant is unlikely.

If new trees, shrubs, or gardens are established near the structure, care should be taken to ensure:

- The vegetation does not interfere with any subfloor ventilation or services to the structure.
- Over-watering of the vegetation does not saturate the ground near the foundations.
- Trees or shrubs with the potential to develop significant root systems should be planted a minimum distance equal to the mature height of the plant away from the foundations.

8 SUSTAINABILITY

Considering sustainability as early as possible in a project's development, could lead to significant project opportunities and wider positive outcomes. Geotechnical opportunities for increased sustainability for this project include:

- Striping and stocking topsoil for reuse (dependant on presence/ levels of contaminants).
- Designing for cut and fill balance where possible.
- Reuse of site won materials, or using materials won from other sites including use of recycled crushed concrete aggregate for hard fill.
- Contributing site investigation data to the New Zealand Geotechnical Database (NZGD) to help reduce the site investigations needed in the future.

- Using local consultants and contractors to reduce transport related emissions.

9 CONCLUSIONS

Following development of the site in accordance with our recommendations, we consider that: -

a) The land in respect of which a consent is sought, or any structure on the land built in accordance with our recommendations, is unlikely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; and

b) Any subsequent use that is likely to be made of the land is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; and

c) Sufficient provision has been made for physical access to each allotment to be created by the subdivision.

10 PLAN REVIEW

Prior to an application for Building Consent, it is important we are given the opportunity to review the final development drawings to ensure the recommendations contained within this report have been followed and interpreted correctly. Following successful review of the development drawings, we are able to update this report to support an application for Building Consent.

11 VERIFICATION

Verification requirements will be provided once the form of the foundations has been determined.

12 LIMITATIONS

This report should be read and reproduced in its entirety including the limitations to understand the context of the opinions and recommendations given.

This report has been prepared exclusively for NZHG Gisborne Limited in accordance with the brief given to us or the agreed scope and they will be deemed the exclusive owner on full and final payment of the invoice. Information, opinions, and recommendations contained within this report can only be used for the purposes with which it was intended. LDE accepts no liability or responsibility whatsoever for any use or reliance on the report by any party other than the owner or parties working for or on behalf of the owner, such as local authorities, and for purposes beyond those for which it was intended.

This report was prepared in general accordance with current standards, codes and best practice at the time of this report. These may be subject to change.

Opinions given in this report are based on visual methods and subsurface investigations at discrete locations designed to the constraints of the project scope to provide the best assessment of the environment. It must be appreciated that the nature and continuity of the subsurface materials between these locations are inferred and that actual conditions could vary from that described herein. We should be contacted immediately if the conditions are found to differ from those described in this report.

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14 GLOSSARY

Compressible Soils:	Compressible soils are those that will undergo a reduction in volume under an imposed load, such as the weight of fill or a structure. This occurs firstly as a result of the expulsion of air and water from the soil void spaces (primary settlement) and secondly due to a restructuring of the soil skeleton to take the load (secondary settlement).
Cyclic Softening:	Cyclic-softening is a related condition to liquefaction can also affect clay soils when subjected to cyclic-loading. Clay soils may significantly soften and led to bearing capacity failure, in addition to post-earthquake consolidation settlements may occur as a result of the earthquake shaking.
Expansive Soils:	Cohesive soils containing significant proportions of certain clay minerals can be subject to appreciable volume change caused by variations in soil moisture content, most notably between seasons or from the uptake of water through the root systems of trees and shrubs. This is also often referred to as soil reactivity or shrink-swell behaviour.
Lateral Spread:	Lateral spread of liquefied soils is the lateral displacement of blocks of land moving laterally towards a free edge (for example a riverbank) or within sloping ground. More lateral movement tends to occur closest to the edge with less movement further back. Lateral spreading may result in large permanent ground displacements including cracks, fissures, vertical officesets and overall settlement of the ground.
Lateral Stretch:	Lateral stretch is the amount of differential extension that a portion of land may experience during an episode of lateral spreading. The lateral stretch across a foundation is a main factor in foundation damage due to liquefaction and lateral spreading because of a large earthquake.
LiDAR	Light Detection and Ranging (LiDAR) is a method of remote sensing topographical survey.
Limit States:	Seismic design criteria for performance-based design. SLS, SLS2 & ULS are prescribed in NZS1170.5 (Standards New Zealand Te Mana Tautikanga O Aotearoa, 2004) • **Serviceability Limit State (SLS):** Functional requirements for the serviceability limit state are assumed to be met if the structure or part can continue to be used as originally intended without the need for repair (SLS1) or can remain operational or continue to be occupied as appropriate (SLS2). SLS earthquakes are considered highly likely to occur during the lifetime of the structure. • **Ultimate Limit State (ULS):** Functional requirements for the ultimate limit state are assumed to be met if: a) People within, and adjacent to the structure are not endangered by the structure or part.

b) Displacements of the structure are such that there is no contact between any parts of a structure for which contact is not intended, or between separate structures on the same site, if such contact would damage the structures or parts to the extent that persons would be endangered, or detrimentally alter the response of the structure(s) or parts, or reduce the strength of structural elements below the required strength.

c) The structure does not deflect beyond a site boundary adjacent to which other structures can be built or collision between the structure and any adjacent existing structures cannot occur.

d) There is no loss of structural integrity in either the structure or part.

- **Intermediate Limit State (ILS)**: ILS is an intermediate seismic event between SLS & ULS although is not a code requirement. The behaviour of soils and geotechnical systems under earthquake shaking may be highly non-linear and even exhibit a pronounced 'step change' in performance with increasing intensity of shaking. For such cases, only considering performance at the SLS and ULS levels of shaking would fail to identify potentially poor and unacceptable performance at intermediate return periods of shaking.

Liquefaction:	Liquefaction is the term used to describe the temporary, but substantial, loss of strength and stiffness which can occur in saturated, unconsolidated soils that are subjected to strong shaking. In addition to near-total strength loss, liquefaction may also result in the expulsion of sediment and water at the surface, ground and structure settlement, and in lateral (spreading) displacement of the ground.
LPI	Liquefaction potential index is a liquefaction damage index. LPI ranges between 0 and 100 and sites with an LPI of 5 indicate a high liquefaction risk and sites with LPI greater than 15 indicate very high risk (Iwasaki et al, 1982). Not to be used as a precise measure of liquefaction-induced ground damage but as an indicator of the general level of liquefaction severity.
LSN	Liquefaction Severity Number is a liquefaction damage index. LSN varies from 0 (representing no liquefaction vulnerability) to more than 100 (representing very high liquefaction vulnerability (van Ballegooy et al, 2013). LSN places greater importance (than LPI) on the thickness of the non-liquefied crust when the groundwater table is close to the ground surface. Not to be used as a precise measure of liquefaction-induced ground damage but as an indicator of the general level of liquefaction severity. LNS was developed based on the observations/ investigations from the Canterbury earthquake sequence
PGA:	Peak Ground Acceleration (PGA) is the maximum ground acceleration during an earthquake as a proportion of gravity.
Punch Through Failure:	Punch through failure occurs when a foundation punches through a crust of non-liquefiable material due to underlying liquefaction occurring and can lead to potential damage to foundations and/ or large settlements.

Technical Category: Following the 2010 -2011 Canterbury earthquake sequence the Ministry of Business Innovation and Employment (MBIE) assigned three technical categories (TC1, TC2, TC3) across the residential 'green zone' for foundation investigation and design guidance focusing on one and two storey timber-framed dwellings. These categories are broadly defined as below:

- **TC1:** Liquefaction damage is unlikely in future large earthquakes. Standard residential foundation assessment and construction is appropriate.
- **TC2:** Liquefaction damage is possible in future large earthquakes. Standard enhanced foundation repair and rebuild options in accordance with MBIE guidance are suitable to mitigate against this possibility.
- **TC3:** Liquefaction damage is possible in future large earthquakes. Individual engineering assessment is required to select the appropriate foundation repair or rebuild option.
- **TC2/ TC3 Hybrid:** A site that straddles liquefaction settlement limits of TC2 and TC3 where the SLS settlements are assessed as being less than 50 mm but the ULS settlements are assessed at greater than 100mm.

Whilst this guidance is intended for residential buildings in the Canterbury region, they have been widely adopted to convey liquefaction vulnerability across New Zealand.

The Modules: The New Zealand Geotechnical Society (NZGS) and MBIE jointly published a series of guidelines for Earthquake Geotechnical Engineering Practice. Revision 1 of the Modules was published in November 2021 and they provide guidance under section 175 of the Building Act 2004 to assist parties to comply with their obligations under the Building Act 2004. The following modules currently form the collection:

- **Module 1:** Overview of the guidelines
- **Module 2:** Geotechnical investigation for earthquake engineering
- **Module 3:** Identification, assessment, and mitigation of liquefaction hazards
- **Module 4:** Earthquake resistant foundation design
- **Module 5:** Ground improvement
- **Module 5A:** Specification of ground improvement for residential properties in the Canterbury region
- **Module 6:** Retaining walls

APPENDIX A

SITE PLAN

LEGEND

Project Data

🟨	Proposed Lots Boundary
🟥	Proposed Building Platform
—	Proposed Accessway
●	Hand Auger + DCP
▽	CPT (Due Diligence)

0 6 12 18 24 m

SCALE A3: 1:350

NOTES

1. Aerial basemap and property boundaries sourced from LINZ Data Service (CC-BY 4.0).
2. Investigation locations shown approximately only.

CLIENT

NZHG Gisborne Limited

PROJECT

Geotechnical Investigation for proposed subdivision
556-560 Aberedeen Road, Te Hapara
Gisborne

DRAWING TITLE

Geotechnical Investigation Plan

LAND DEVELOPMENT & ENGINEERING

PROJECT REF	DRAWING REF	REVISION
24477	GIP	A
DATE	**PREPARED BY**	**CHECKED BY**
29/09/2023	SS	RH

FILE PATH

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APPENDIX B

HAND AUGER TEST LOGS

LDE LAND DEVELOPMENT & ENGINEERING

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA01
Project ID: 24477
Sheet: 1 of 1

Client: NZHG
Project: Geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne
Test Site: Refer to geotechnical investigation plan

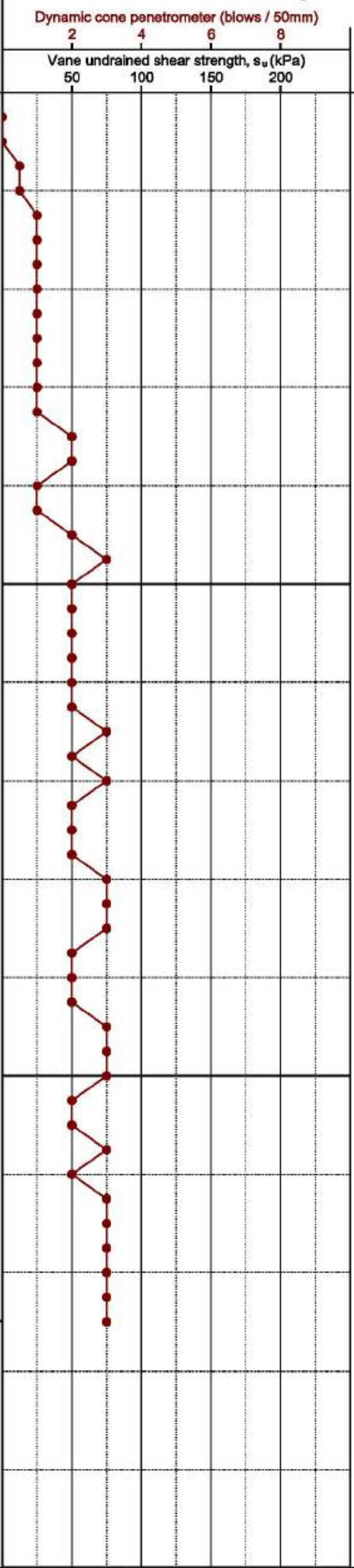
Coordinates: 5709871mN, 2036134mE
System: NZTM
Elevation: 6.5m (NZVD2016)
Located By: Site plan/map

Test Date: 12/09/2023
Logged By: SS
Prepared By: SS
Checked By: RH

Depth (m)	Geology	Material Description	Water	RL (m)
0.0–0.3	TS	SAND, with trace rootlets and silt; dark brown. Very loose; moist; sand, fine to medium.	Groundwater not encountered	
0.3–2.5	Holocene Beach Deposits	SAND; brown. Loose; moist; sand, fine to medium. 1.80m: Light grey. 2.20m: Grey with orange mottles. 2.40m: Wet.		

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5
RL (m): 6.0, 5.5, 5.0, 4.5, 4.0

In-situ Testing



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.50m
Termination: TARGET DEPTH
Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow
UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

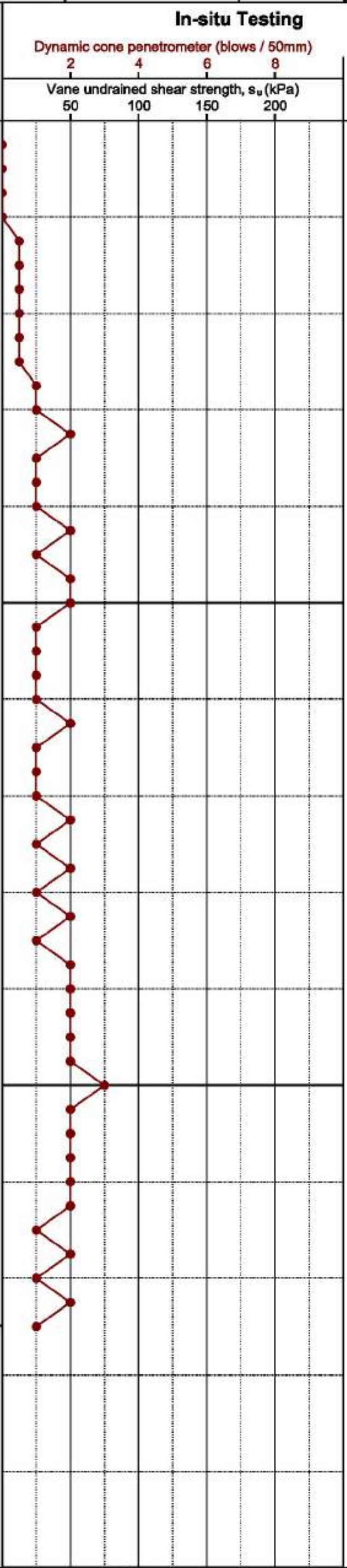
Test ID: HA02
Project ID: 24477
Sheet: 1 of 1

Client: NZHG
Project: Geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne
Test Site: Refer to geotechnical investigation plan

Coordinates: 5709864mN, 2036136mE
System: NZTM
Elevation: 6.5m (NZVD2016)
Located By: Site plan/map

Test Date: 12/09/2023
Logged By: SS
Prepared By: SS
Checked By: RH

Depth (m)	Geology	Graphic Log	Material Description	Water	RL (m)
	TS	TS	SAND, with minor silt, with trace rootlets; dark brown. Very loose; moist; sand, fine to medium.		
0.5	Holocene Beach Deposits		SAND; brown. Loose; moist; sand, fine to medium.	Groundwater not encountered	6.0
1.0					5.5
1.5			1.50m: Grey with orange mottles.		5.0
			1.70m: Light grey.		
2.0					4.5
			2.40m: Wet.		
2.5					4.0



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.50m
Termination: TARGET DEPTH

Remarks:

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow
UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

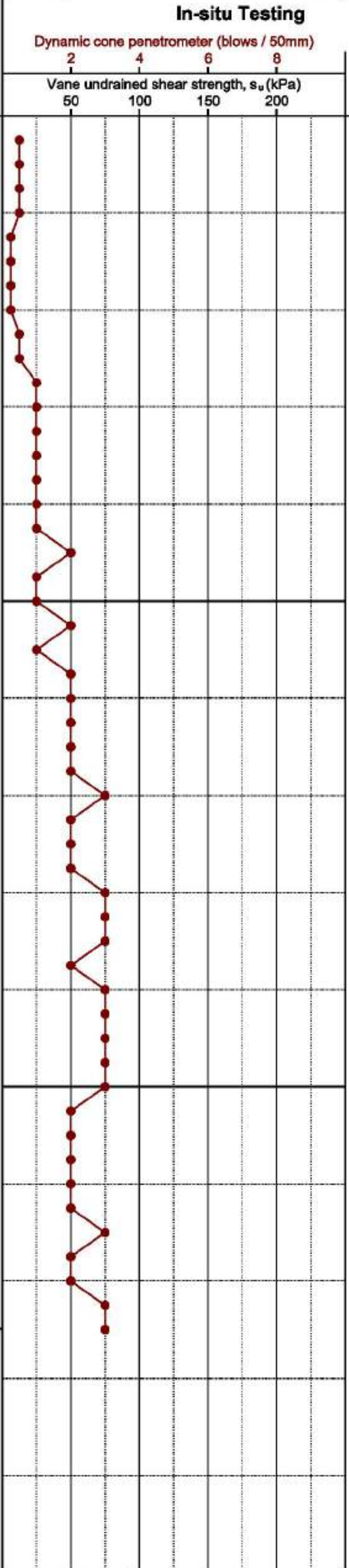
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA03**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709847mN, 2036129mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water
0.00–0.55	Uncontrolled Fill / Topsoil	SAND, with minor silt, with trace rootlets; dark brown. Very loose; moist; sand, fine to medium; trace metal fragments.	
0.55–2.50	Holocene Beach Deposits	SAND; brown. Loose; moist; sand, fine to medium. 1.80m: Grey with orange mottles. 1.90m: Wet. 2.40m: Saturated.	▼ 2.40



Values
Vane ID: N/A
peak / residual (sensitivity)

RL (m): 6.5 (0.5 m), 6.0 (1.0 m), 5.5 (1.5 m), 5.0 (2.0 m), 4.5 (2.5 m)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

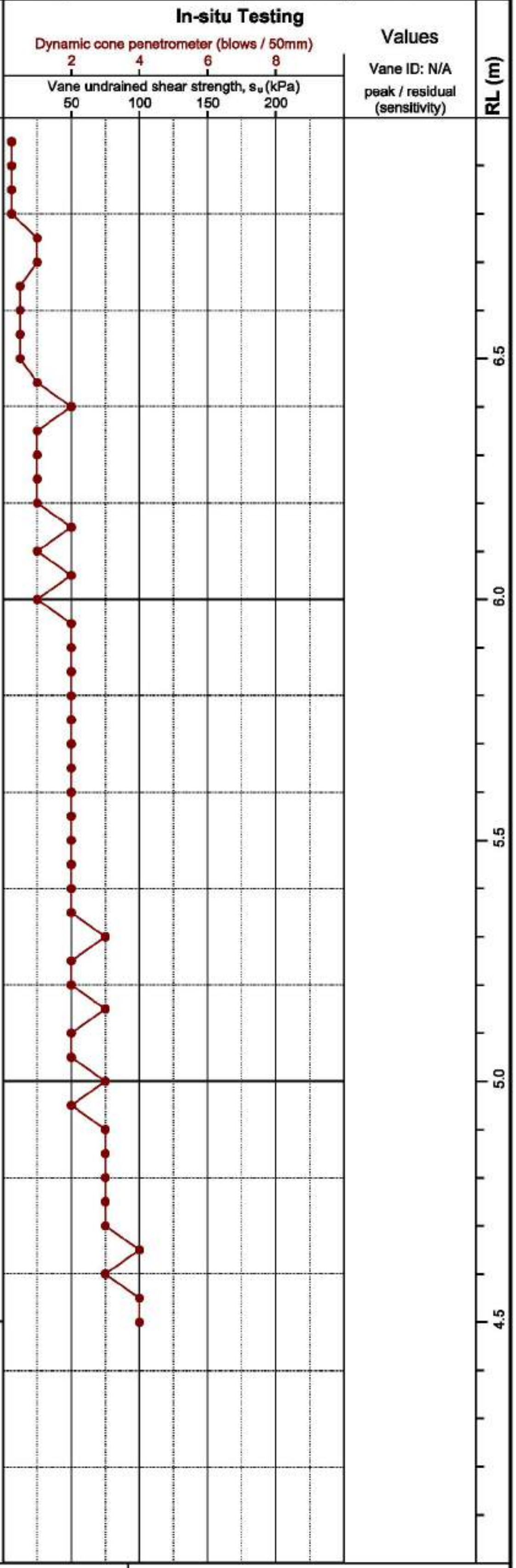
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA04
Project ID: 24477
Sheet: 1 of 1

Client:	NZHG	**Coordinates:**	5709842mN, 2036126mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Graphic Log	Material Description	Water
0.0–0.4	TS	TS	SAND, with minor silt, with trace rootlets; dark brown. Loose; moist; sand, fine to medium.	
0.4–2.5	Holocene Beach Deposits		SAND; brown. Loose; moist; sand, fine to medium. 1.90m: Wet. 2.20m: Saturated.	▼ (2.20)



Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

LDE LAND DEVELOPMENT & ENGINEERING

Hand Auger Borehole Log

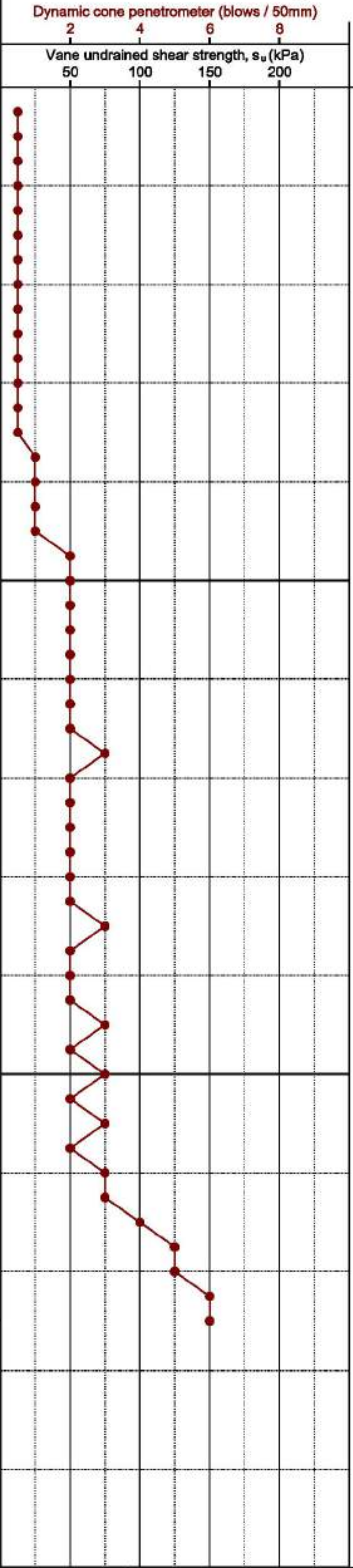
Method: 50mm Hand Auger

Test ID:	**HA05**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709846mN, 2036121mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Graphic Log	Material Description	Water	RL (m)
0.0–0.5	Uncontrolled Fill / Topsoil	TS	SAND, with minor silt, with trace rootlets and gravel; dark brown. Loose; moist; sand, fine to medium; gravel, fine to medium, subrounded to subangular.		
0.5	Holocene Beach Deposits		SAND; brown. Loose; moist; sand, fine to medium.		6.5
1.0					6.0
1.5					5.5
1.80			1.80m: Brownish grey.		
1.90			1.90m: Wet.		
2.0					5.0
2.40			2.40m: Saturated.	▼	
2.5					4.5

In-situ Testing



Values

Vane ID: N/A

peak / residual (sensitivity)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

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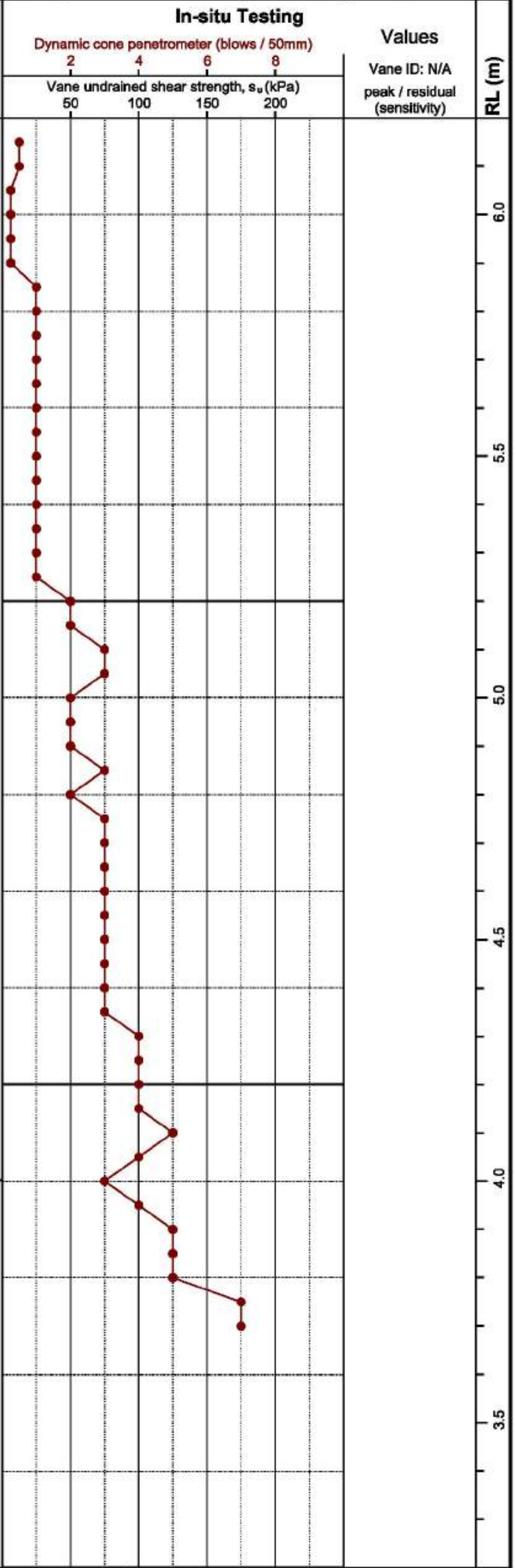
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA06
Project ID: 24477
Sheet: 1 of 1

Client:	NZHG	**Coordinates:**	5709835mN, 2036107mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.2m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Graphic Log	Material Description	Water
	Uncontrolled Fill / Topsoil	TS	SAND, with minor silt, with trace rootlets and gravel; dark brown. Very loose; moist; sand, fine to medium; gravel, fine, subangular.	
0.5 1.0 1.5	Holocene Beach Deposits		SAND; brownish orange. Loose; moist; sand, fine to medium.	
			1.60m: Wet.	
			1.80m: Heavy orange mottling.	
			1.90m: Brownish grey. Saturated.	▼
2.0			2.00m: Brownish grey with orange mottles. Poor recovery > 50%.	
2.5				



Hole Depth: 2.20m
Termination: HOLE COLLAPSE

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

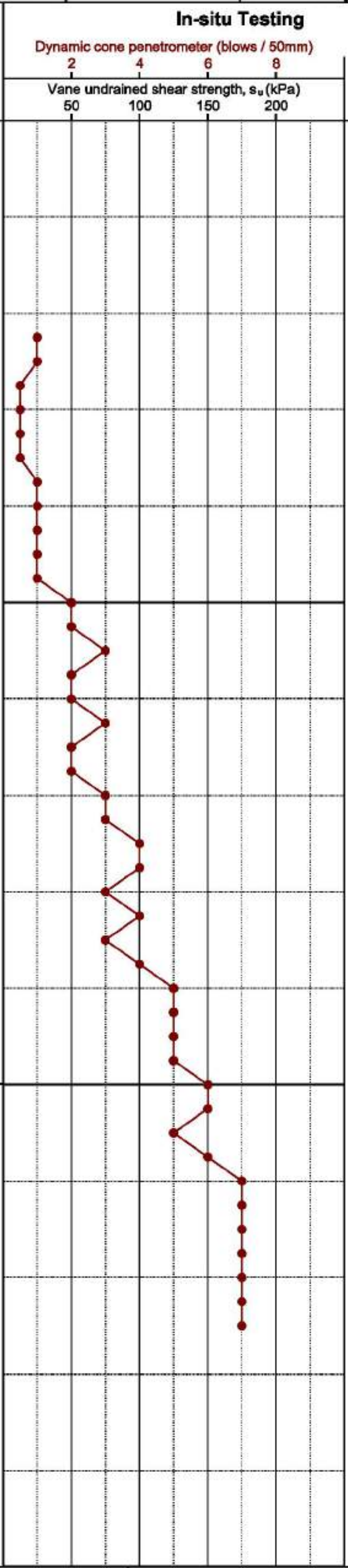
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA07**				
Project ID:	24477				
Sheet:	1 of 1				
Client:	NZHG	**Coordinates:**	5709824mN, 2036090mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	RL (m)
0.0	Uncontrolled Fill / Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine to medium; trace charcoal. 0.40m: Sandy. Sand, fine to medium.		
0.5				5.5
0.8	Holocene Beach Deposits	SAND; light brown with orange mottles. Loose; moist; sand, fine to medium. 1.00m: Brownish grey with orange streaks. 1.20m: Wet. 1.50m: Saturated. 1.70m: Poor recovery > 30%.		
1.0				5.0
1.5			▼	4.5
2.0				4.0
2.5				3.5

In-situ Testing



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.00m **Termination:** HOLE COLLAPSE

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

Hand Auger Borehole Log

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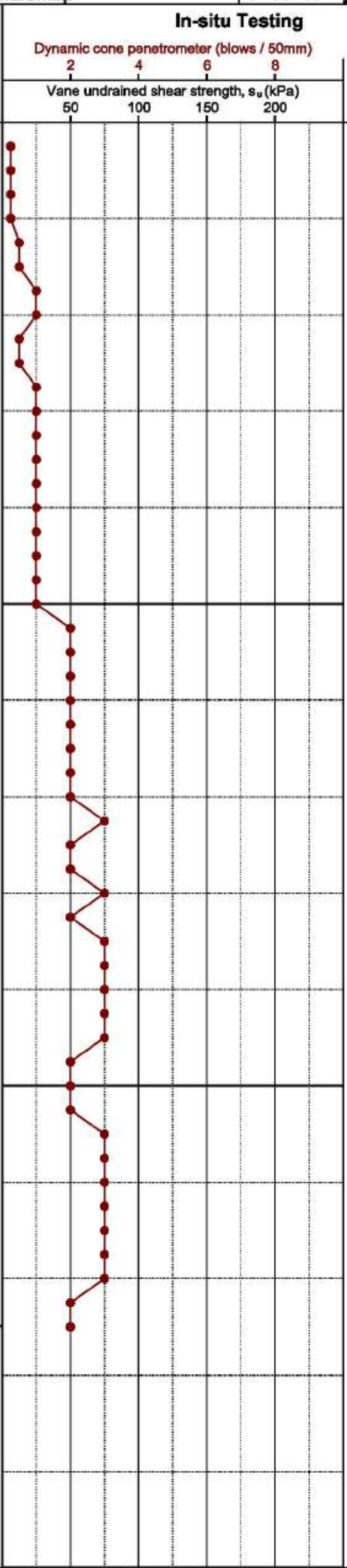
Method: 50mm Hand Auger

Test ID:	**HA08**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709850mN, 2036087mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Graphic Log	Material Description	Water	RL (m)
0.0–0.3	Topsoil	TS	SAND, with minor silt, with trace rootlets; dark brown. Very loose; moist; sand, fine to medium.		
0.3–2.5	Holocene Beach Deposits		SAND; light brown. Loose; moist; sand, fine to medium.		
0.5					6.0
1.0					5.5
1.5					5.0
1.60			1.60m: Brownish grey.		
1.80			1.80m: Brownish grey orange streaks.		
2.0			2.00m: Dark brown. Wet.		4.5
2.30			2.30m: Brownish grey.		
2.40			2.40m: Saturated.	▼	
2.5					4.0



Values

Vane ID: N/A

peak / residual (sensitivity)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

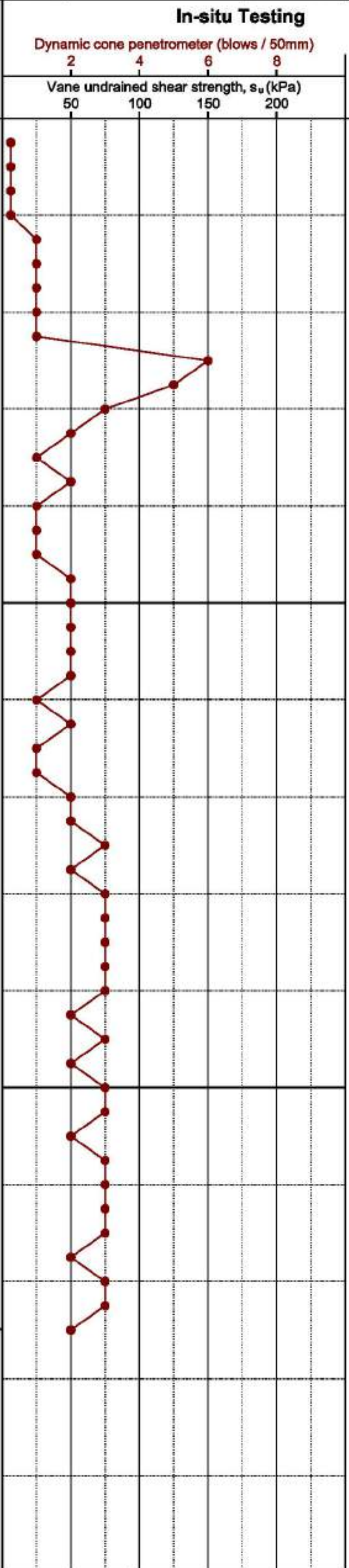
UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	HA09		
Project ID:	24477		
Sheet:	1 of 1		
Client:	NZHG	**Coordinates:**	5709853mN, 2036094mE
Project:	Geotechnical Investigation	**System:**	NZTM
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map
Test Date:	12/09/2023		
Logged By:	SS		
Prepared By:	SS		
Checked By:	RH		

Depth (m)	Geology	Material Description	Water	RL (m)
0.00	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.		
		0.20m: SAND, with minor silt. Sand, fine to medium; trace brick fragments.		
0.5				6.0
0.60	Holocene Beach Deposits	SAND; brownish orange. Loose; moist; sand, fine to medium.		
1.0				5.5
1.5		1.50m: Brownish grey.		5.0
2.0		2.00m: Wet.		4.5
		2.40m: Saturated.	▼	
2.5				4.0



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.50m	**Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

LDE LAND DEVELOPMENT & ENGINEERING

Hand Auger Borehole Log

Method: 50mm Hand Auger

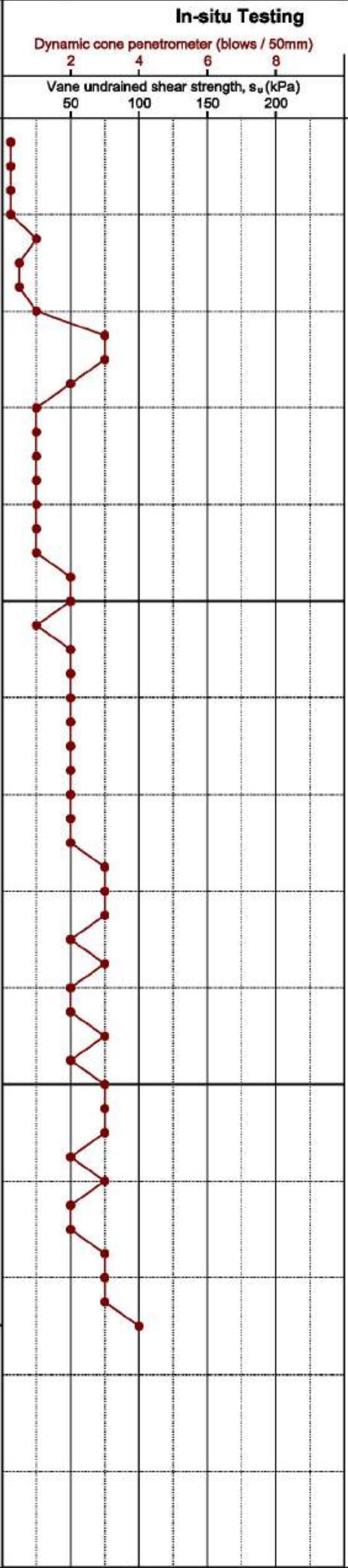
Test ID:	HA10
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709860mN, 2036093mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	RL (m)
0.00–0.70	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine. 0.20m: SAND. Sand, fine to medium.		
0.70–2.50	Holocene Beach Deposits	SAND; brownish orange. Loose; moist; sand, fine to medium. 1.70m: Brownish grey. 2.00m: Wet. 2.40m: Dark brown. Saturated.	▼ (2.40m)	

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5

RL scale: 6.0, 5.5, 5.0, 4.5, 4.0



Values

Vane ID: N/A

peak / residual (sensitivity)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

● Vane peak ▼ Standing water level

○ Vane residual ◁ Groundwater inflow

◆ Vane UTP ▷ Groundwater outflow

UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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Hand Auger Borehole Log

Method: 50mm Hand Auger

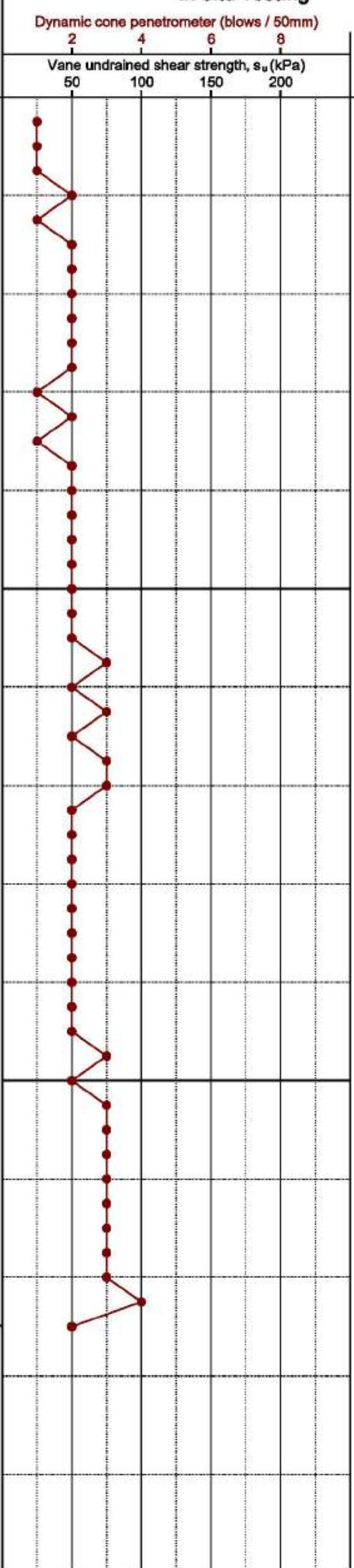
Test ID:	**HA11**				
Project ID:	24477				
Sheet:	1 of 1				
Client:	NZHG	**Coordinates:**	5709865mN, 2036106mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Geology	Graphic Log	Material Description	Water
Uncontrolled Fill / Topsoil	TS	SAND, with trace silt and gravel; dark brown. Loose; moist; sand, fine to medium; gravel, fine to medium, subrounded to subangular.	Groundwater not encountered
Holocene Beach Deposits		SAND; brownish orange. Medium dense; moist; sand, fine to medium. 2.30m: Wet.	

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5

RL (m): 6.5, 6.0, 5.5, 5.0, 4.5

In-situ Testing



Values

Vane ID: N/A

peak / residual (sensitivity)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

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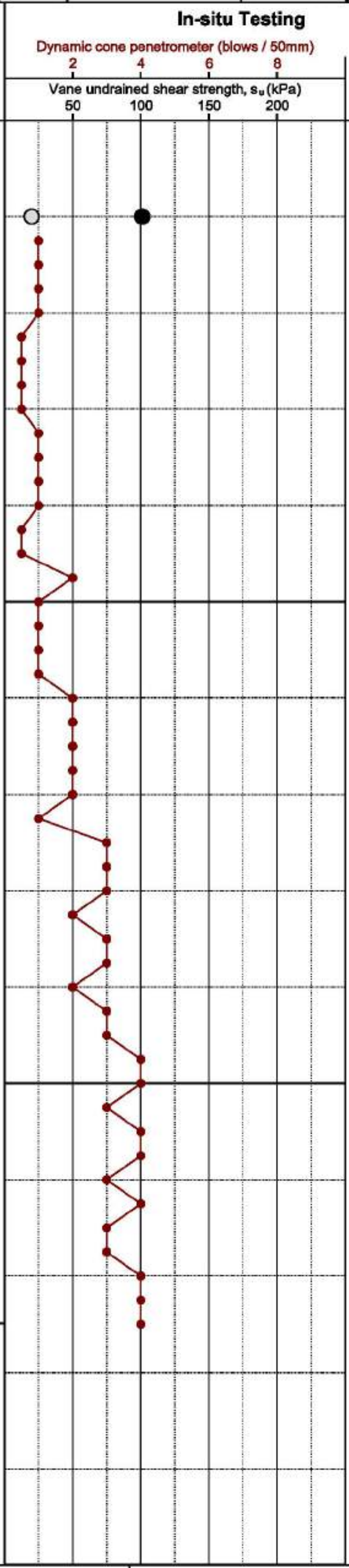
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA12
Project ID: 24477
Sheet: 1 of 1

Client:	NZHG	**Coordinates:**	5709880mN, 2036108mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	Values Vane ID: 2888 peak / residual (sensitivity)
0.0	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.		
0.2				101 / 20 (5.1)
0.30		0.30m: SAND, with minor silt. Sand, fine to medium.		
0.40		0.40m: Black.		
0.5	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium.		
2.00		2.00m: Wet.		
2.50		2.50m: Saturated.	▼	



RL (m): 6.5, 6.0, 5.5, 5.0, 4.5, 4.0

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

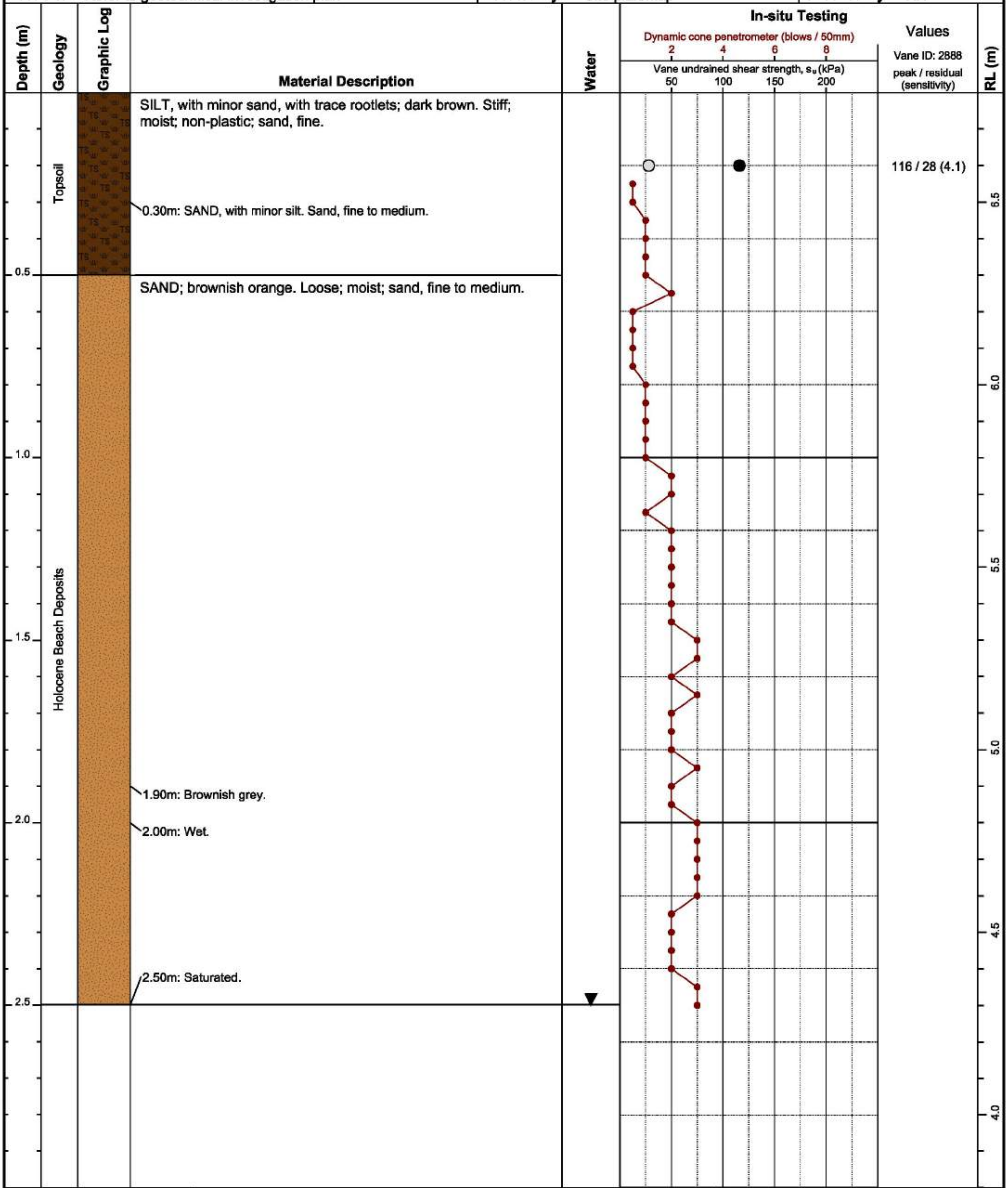
● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA13**		
Project ID:	24477		
Sheet:	1 of 1		
Client:	NZHG	**Coordinates:**	5709882mN, 2036101mE
Project:	Geotechnical Investigation	**System:**	NZTM
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map
Test Date:	12/09/2023		
Logged By:	SS		
Prepared By:	SS		
Checked By:	RH		



SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.

0.30m: SAND, with minor silt. Sand, fine to medium.

SAND; brownish orange. Loose; moist; sand, fine to medium.

1.90m: Brownish grey.

2.00m: Wet.

2.50m: Saturated.

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

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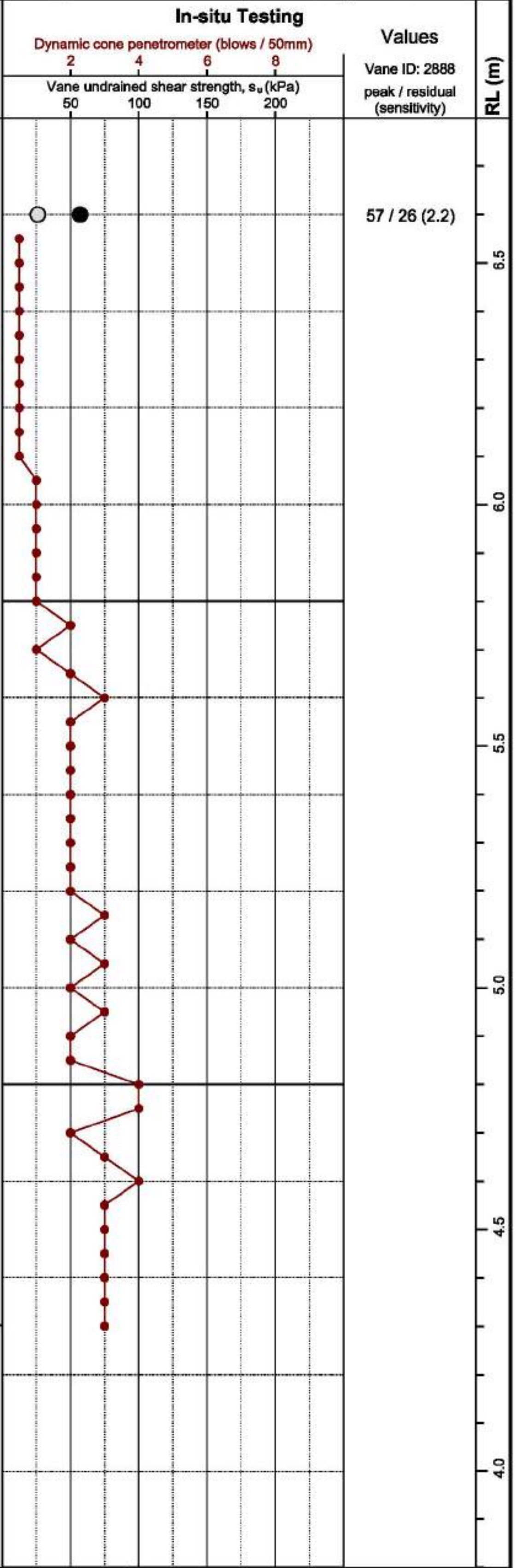
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA14**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709887mN, 2036103mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water
0.0 – 0.3	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Firm; moist; non-plastic; sand, fine.	
0.3 – 2.5	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium. 1.60m: Brownish grey. 1.90m: Wet. 2.50m: Saturated.	▼ 2.5



Hole Depth: 2.50m	**Termination:** TARGET DEPTH

Remarks:

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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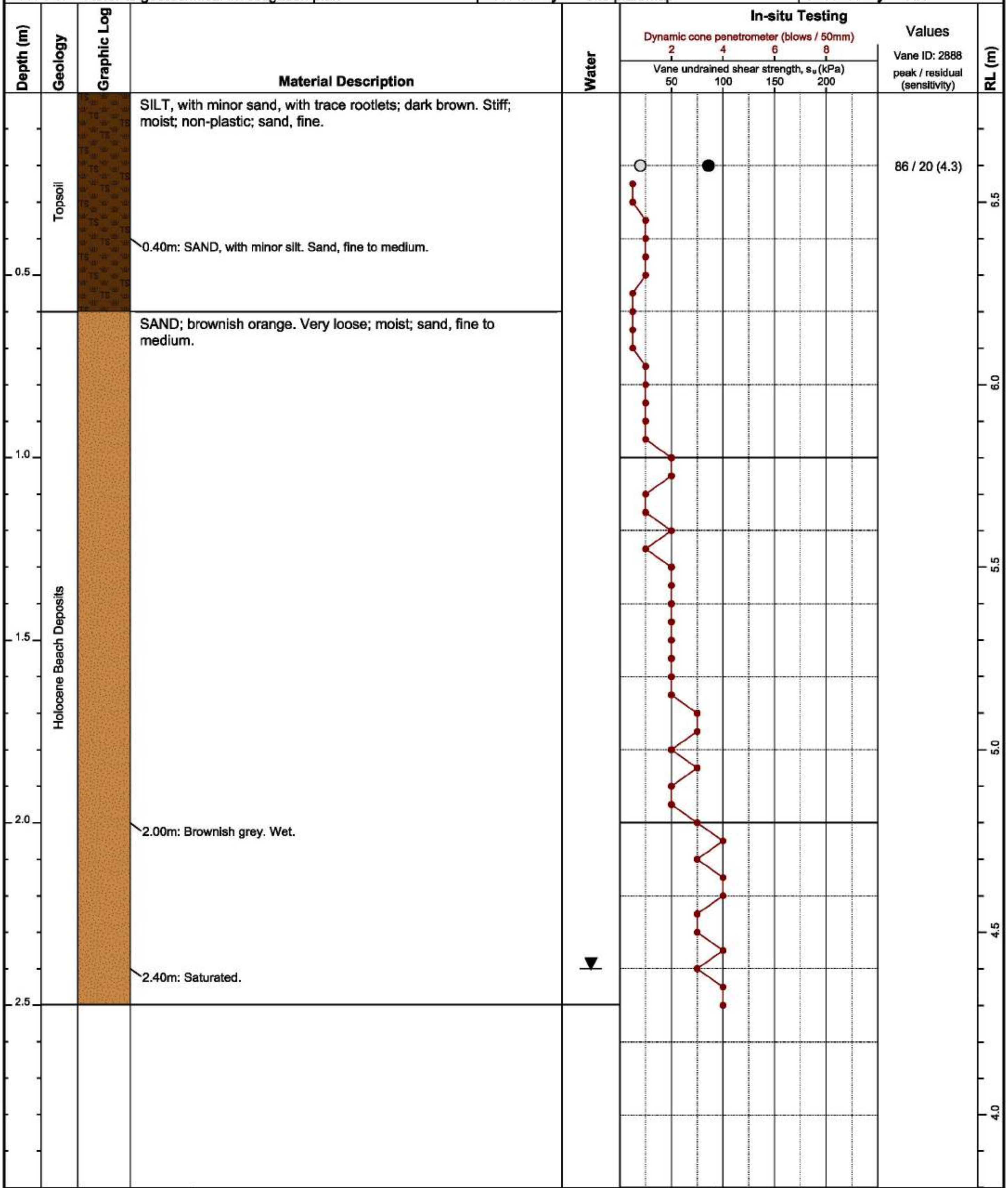
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA15**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709885mN, 2036111mE
Project:	Geotechnical Investigation	**System:**	NZTM
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map

Test Date:	12/09/2023
Logged By:	SS
Prepared By:	SS
Checked By:	RH



SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.

0.40m: SAND, with minor silt. Sand, fine to medium.

SAND; brownish orange. Very loose; moist; sand, fine to medium.

2.00m: Brownish grey. Wet.

2.40m: Saturated.

86 / 20 (4.3)

Hole Depth: 2.50m	**Termination:** TARGET DEPTH	● Vane peak	▼ Standing water level
Remarks:		○ Vane residual	◁ Groundwater inflow
		◆ Vane UTP	▷ Groundwater outflow

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

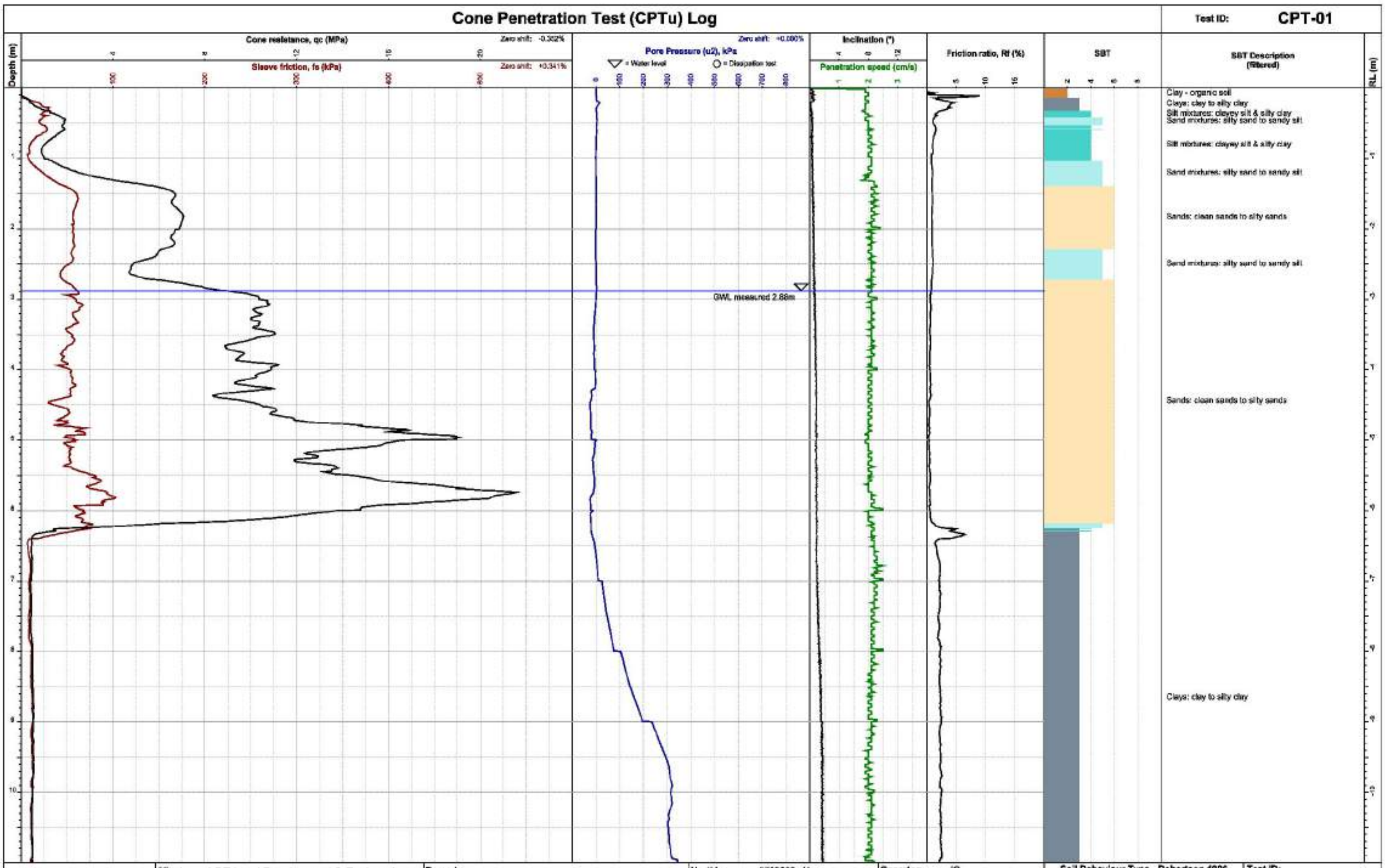
UTP = Unable to Penetrate

APPENDIX C

CONE PENETRATION TEST LOGS

Cone Penetration Test (CPTu) Log

Test ID: CPT-01



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:04 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709883mN
Easting: 2036106mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

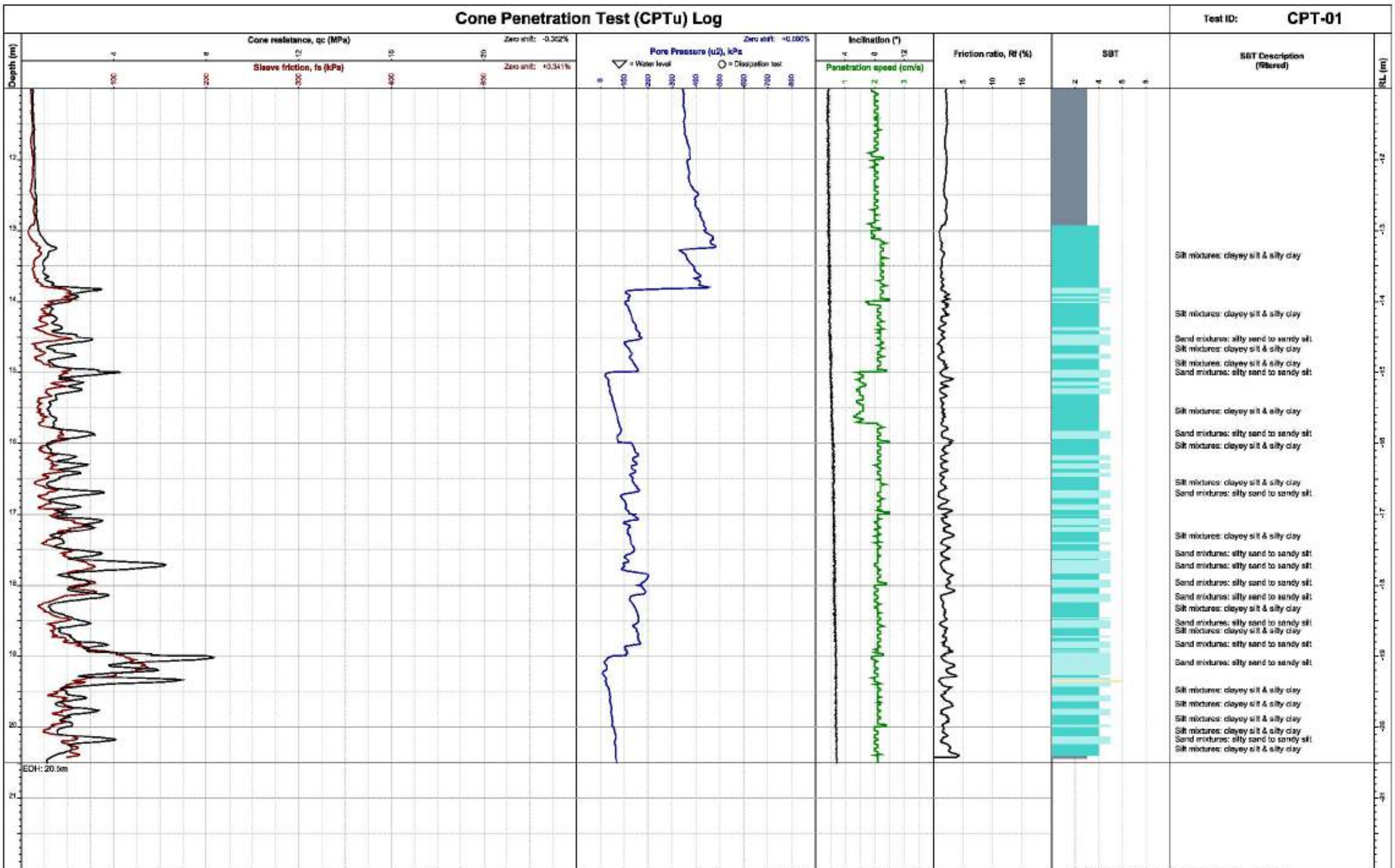
Soil Behaviour Type - Robertson 1986

0 Undefined
1 Sensitive fine-grained
2 Clay - organic soil
3 Clays: clay to silty clay
4 Silt mixtures: clayey silt & silty clay
5 Sand mixtures: silty sand to sandy silt
6 Sands: clean sands to silty sands
7 Dense sand to gravelly sand
8 Stiff sand to clayey sand
9 Stiff fine-grained

Test ID: CPT-01
Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-01



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709883mN
Easting:	2036106mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

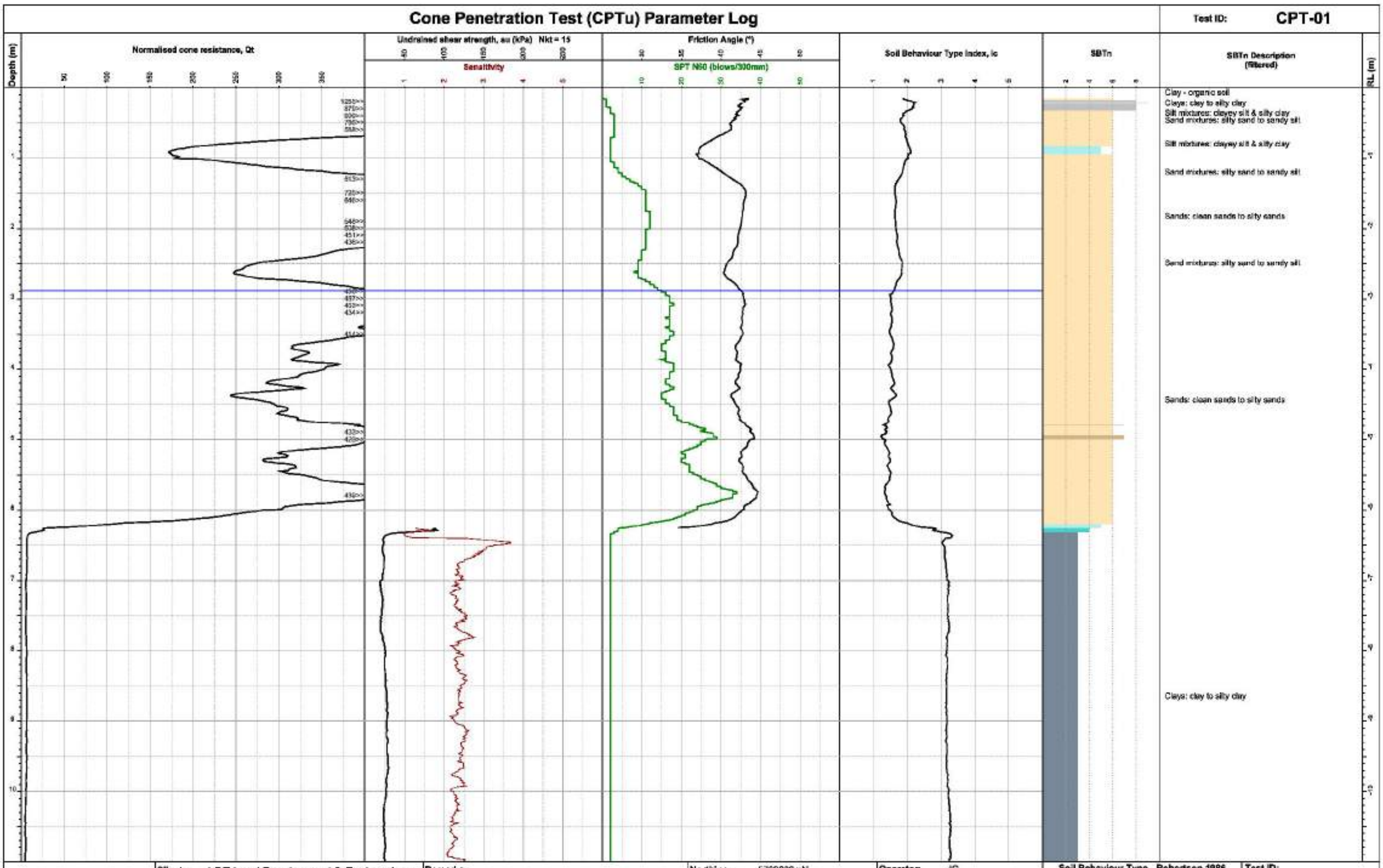
Test ID:

CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-01



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709883mN
Easting: 2036106mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

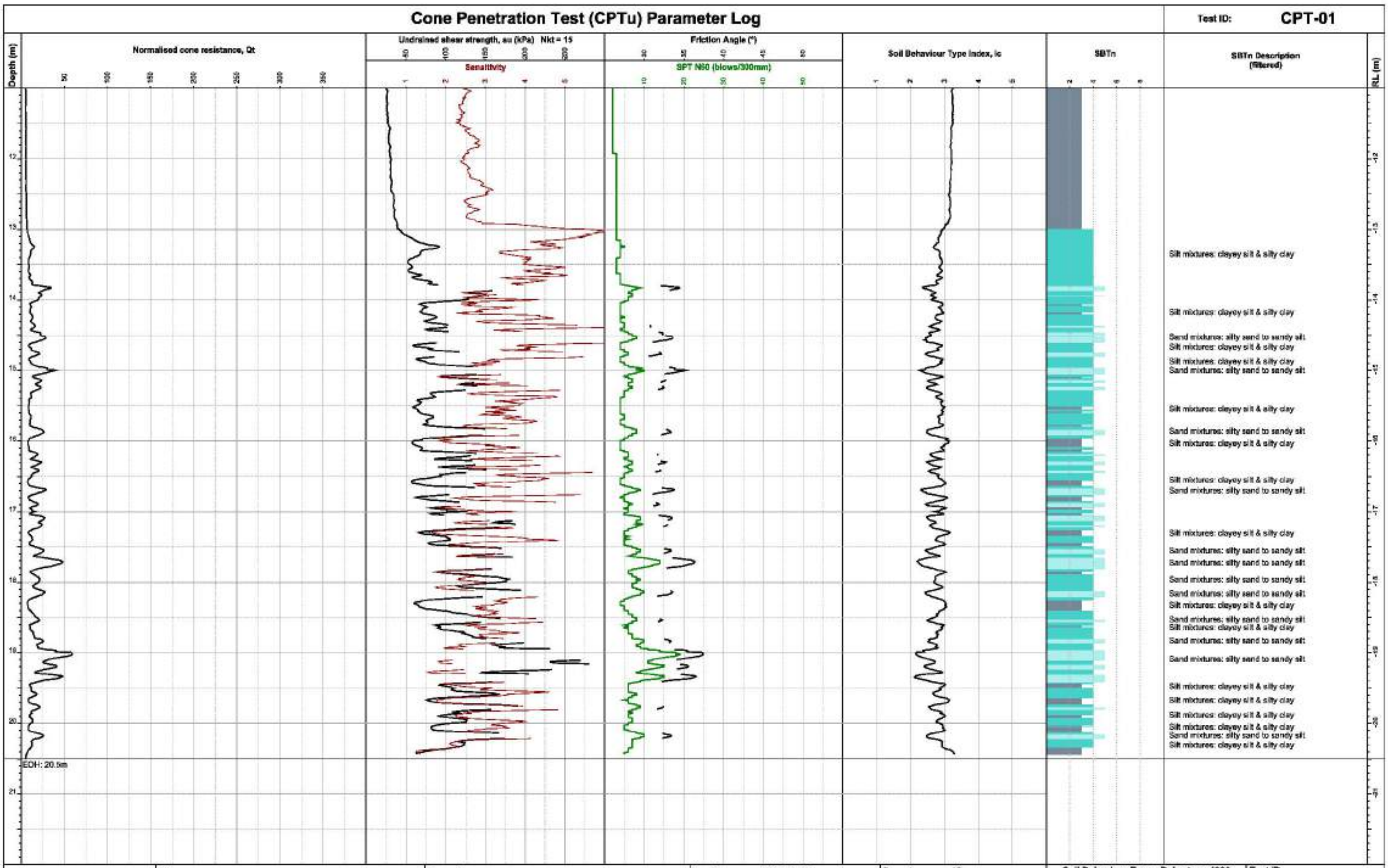
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-01

Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-01**



Generated with CORE GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:35 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709883mN
Easting:	2036106mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

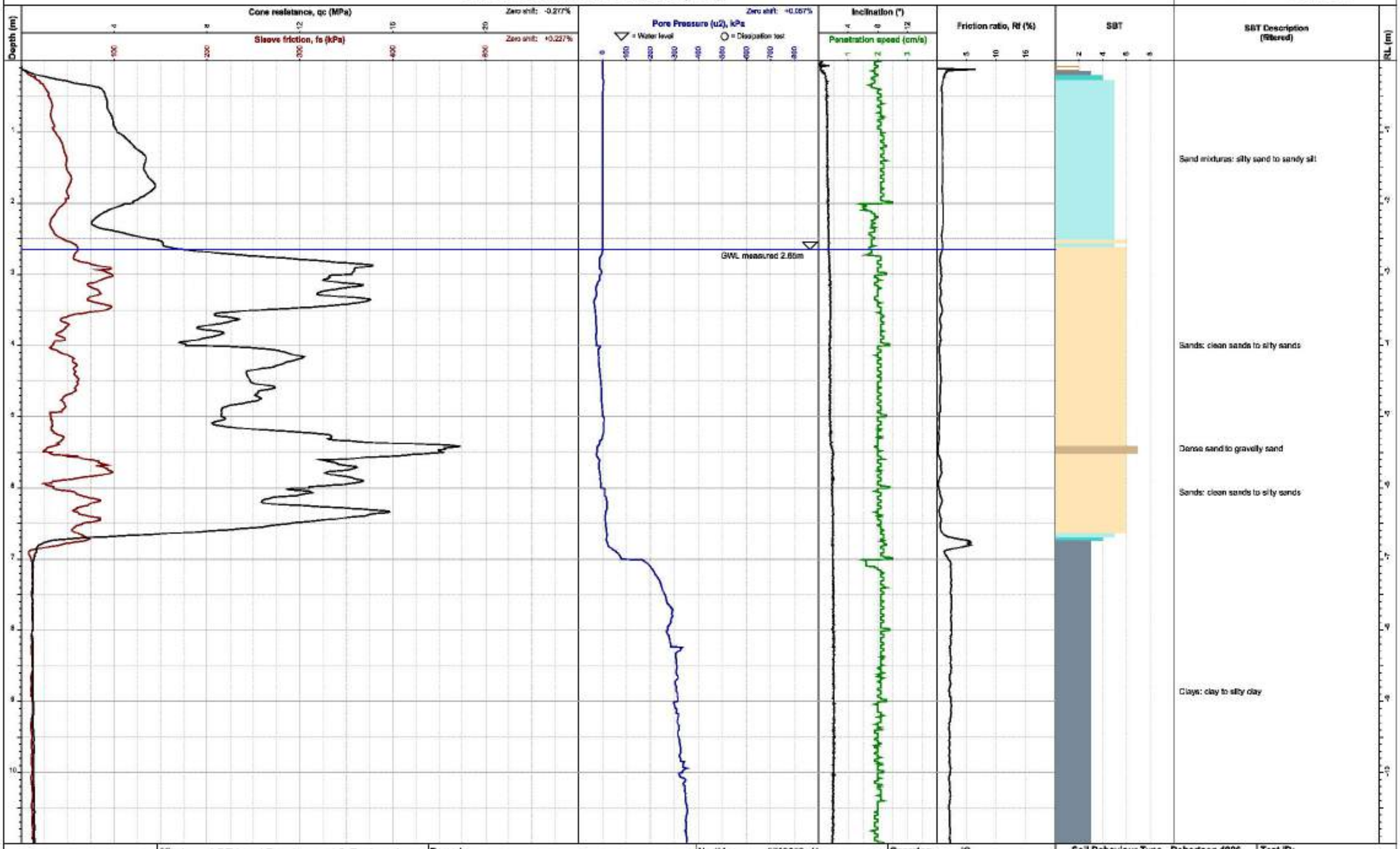
Test ID:

CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-02



Client:	LDE Land Development & Engineering	**Remarks:**	Ground water level located at 2.65m Test according to ISO 22476-1:12 (Class 2)
Project:	geotechnical Investigation	**Termination Reason:**	Target depth
Location:	556-560 Abeerdeen Rd, Gisborne		

Northing:	5709858mN	**Operator:**	JC
Easting:	2036112mE	**Rig:**	Pagani TG63-150
System:	NZTM	**Cone ID:**	Mks1042
Elevation:	Ground	**Type:**	Comp. piezo cone
Located By:	Phone GPS	**Cone Area:**	10 cm²
Location:	As per site plan	**Sleeve Area:**	150 cm²
		Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

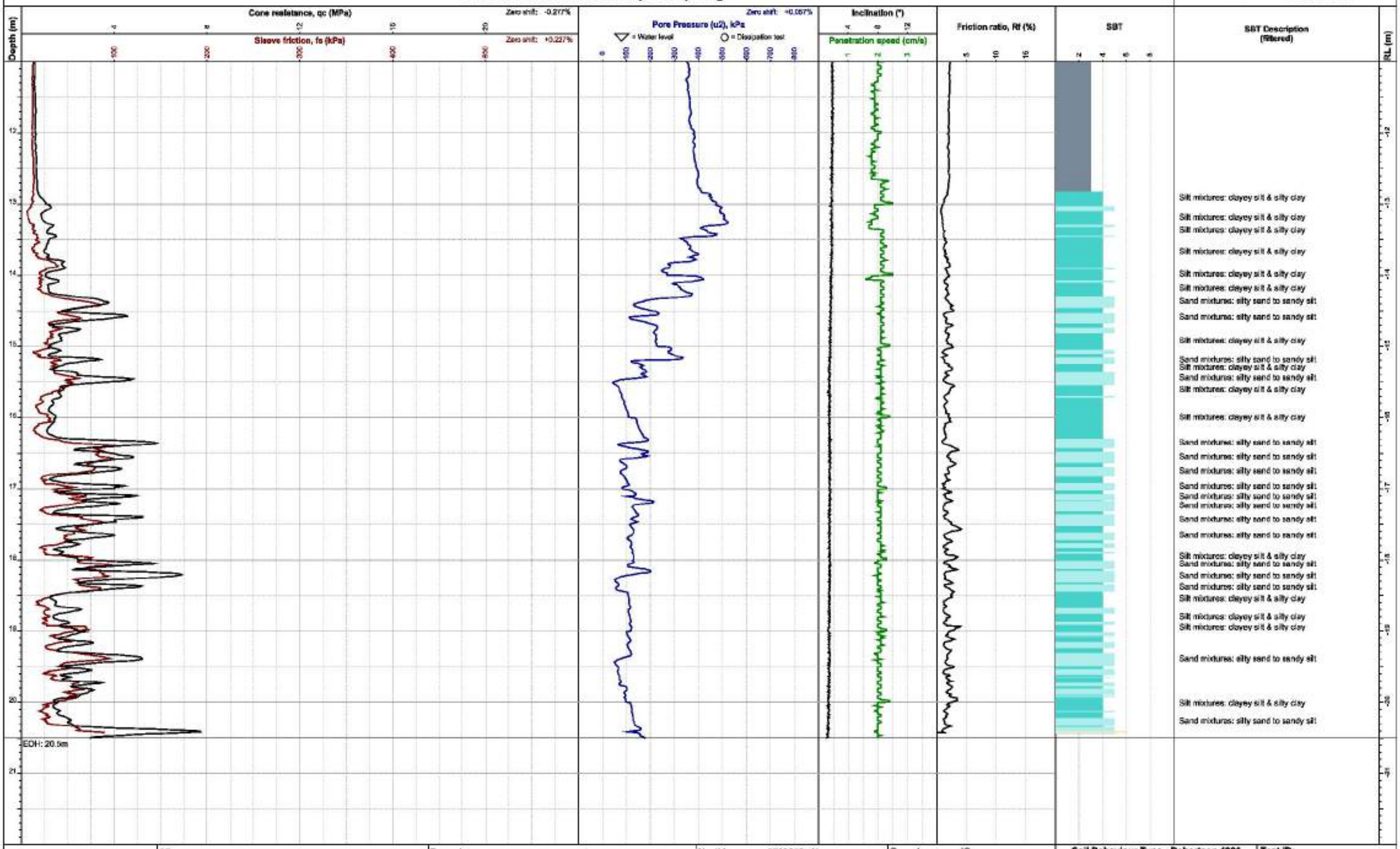
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-02

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-02



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036112mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

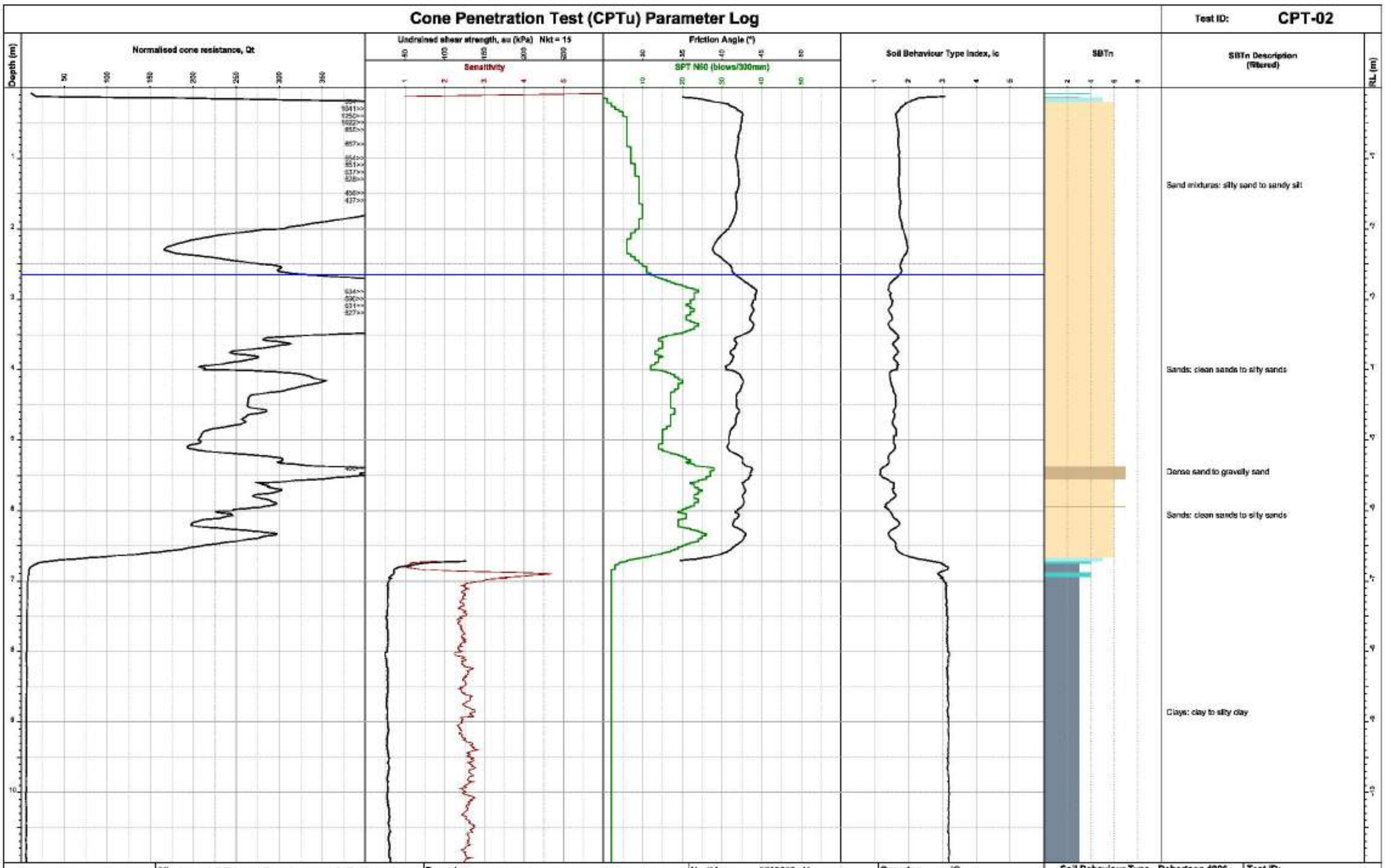
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:
CPT-02

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-02



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036112mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:

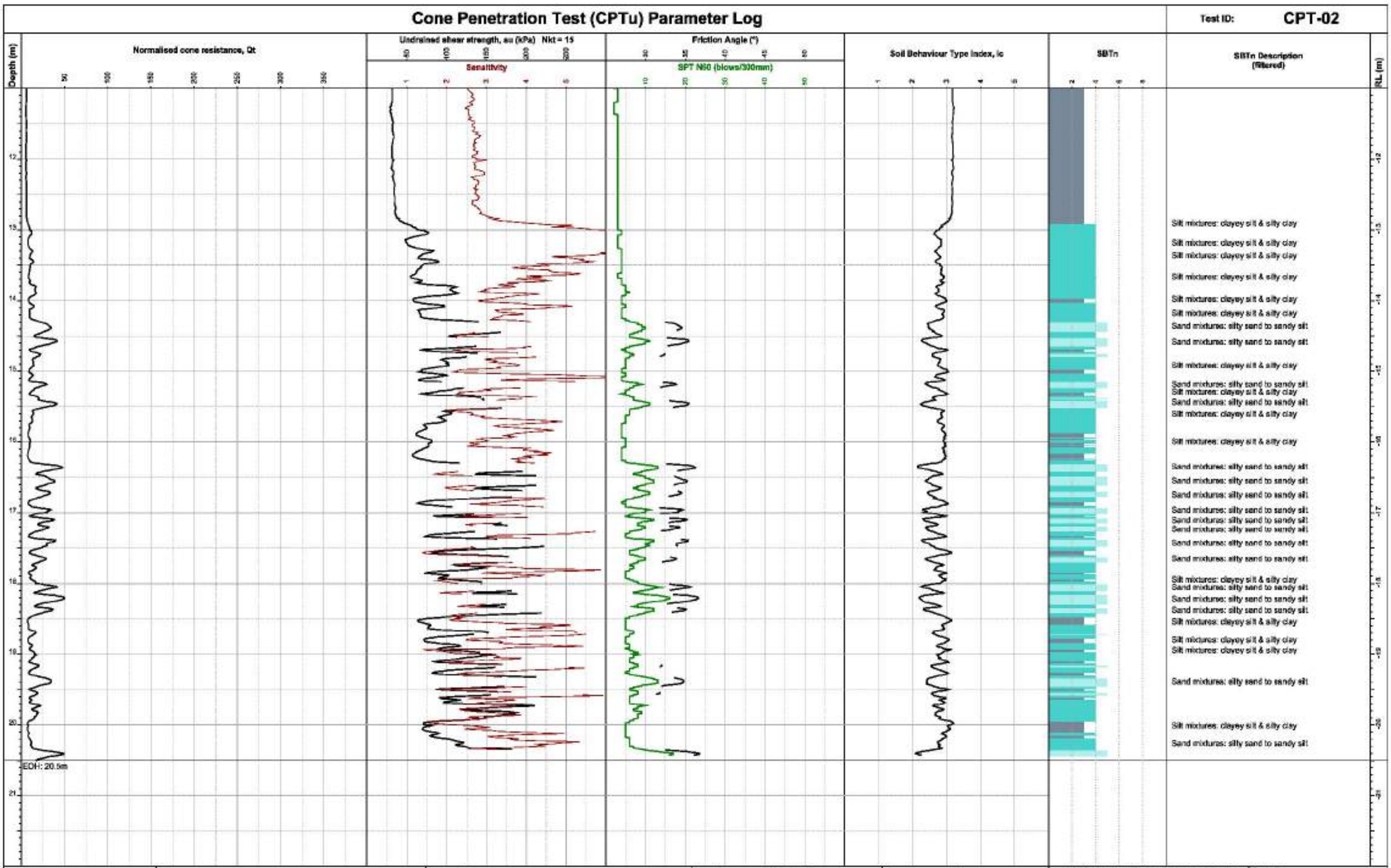
CPT-02

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-02**



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709858mN
Easting: 2036112mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

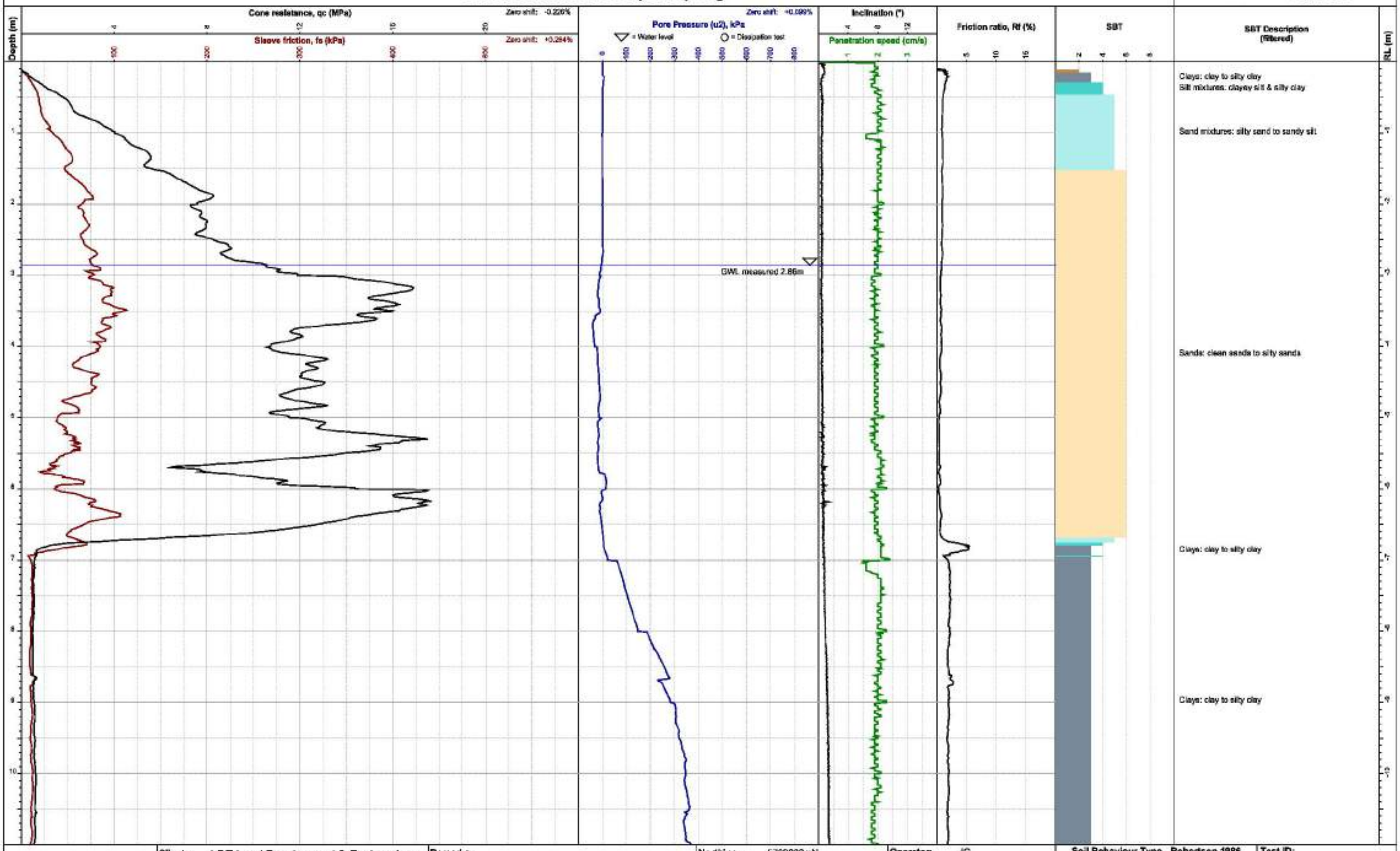
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: **CPT-02**
Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-03



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709866mN
Easting:	2036135mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

- 0 Undefined
- 1 Sensitive fine-grained
- 2 Clay - organic soil
- 3 Clays: clay to silty clay
- 4 Silt mixtures: clayey silt & silty clay
- 5 Sand mixtures: silty sand to sandy silt
- 6 Sands: clean sands to silty sands
- 7 Dense sand to gravelly sand
- 8 Stiff sand to clayey sand
- 9 Stiff fine-grained

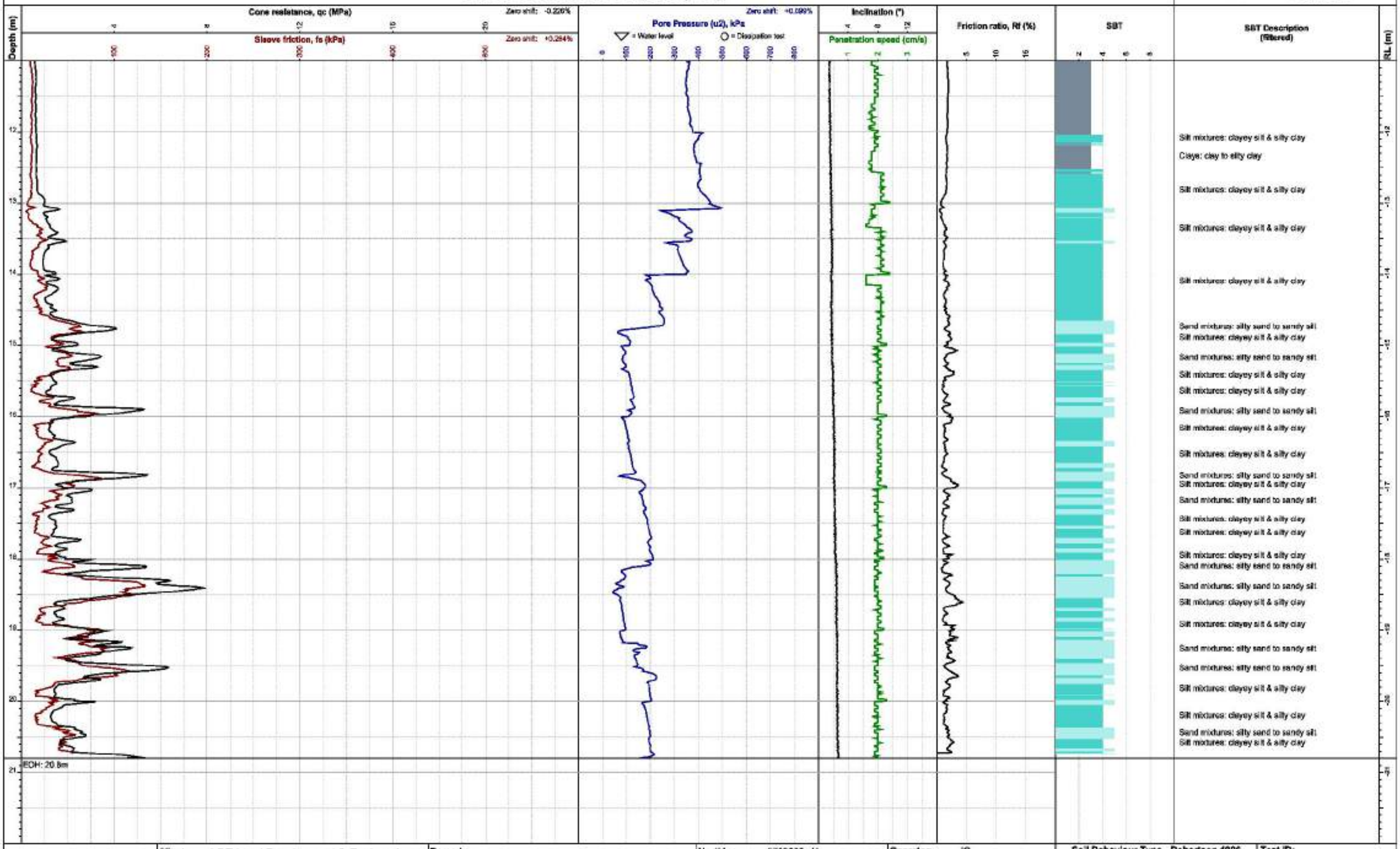
Test ID: CPT-03

Project ID:	24477
Depth:	20.8m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:09 am

Cone Penetration Test (CPTu) Log

Test ID: **CPT-03**



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:10 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036135mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

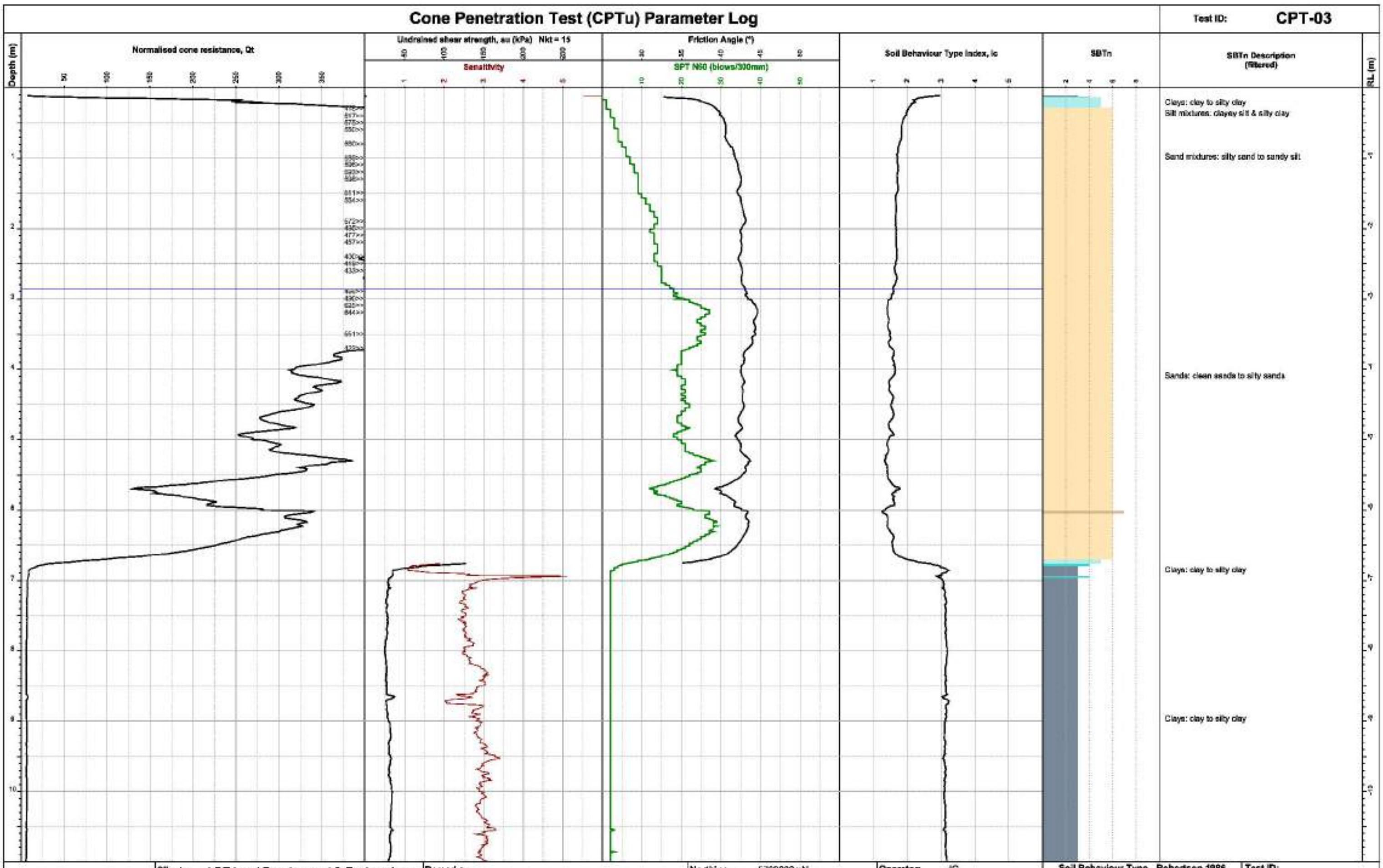
- 0 Undefined
- 1 Sensitive fine-grained
- 2 Clay - organic soil
- 3 Clays: clay to silty clay
- 4 Silt mixtures: clayey silt & silty clay
- 5 Sand mixtures: silty sand to sandy silt
- 6 Sands: clean sands to silty sands
- 7 Dense sand to gravelly sand
- 8 Stiff sand to clayey sand
- 9 Stiff fine-grained

Test ID:
CPT-03

Project ID: 24477
Depth: 20.8m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-03



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:10 am

Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709866mN
Easting:	2036135mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

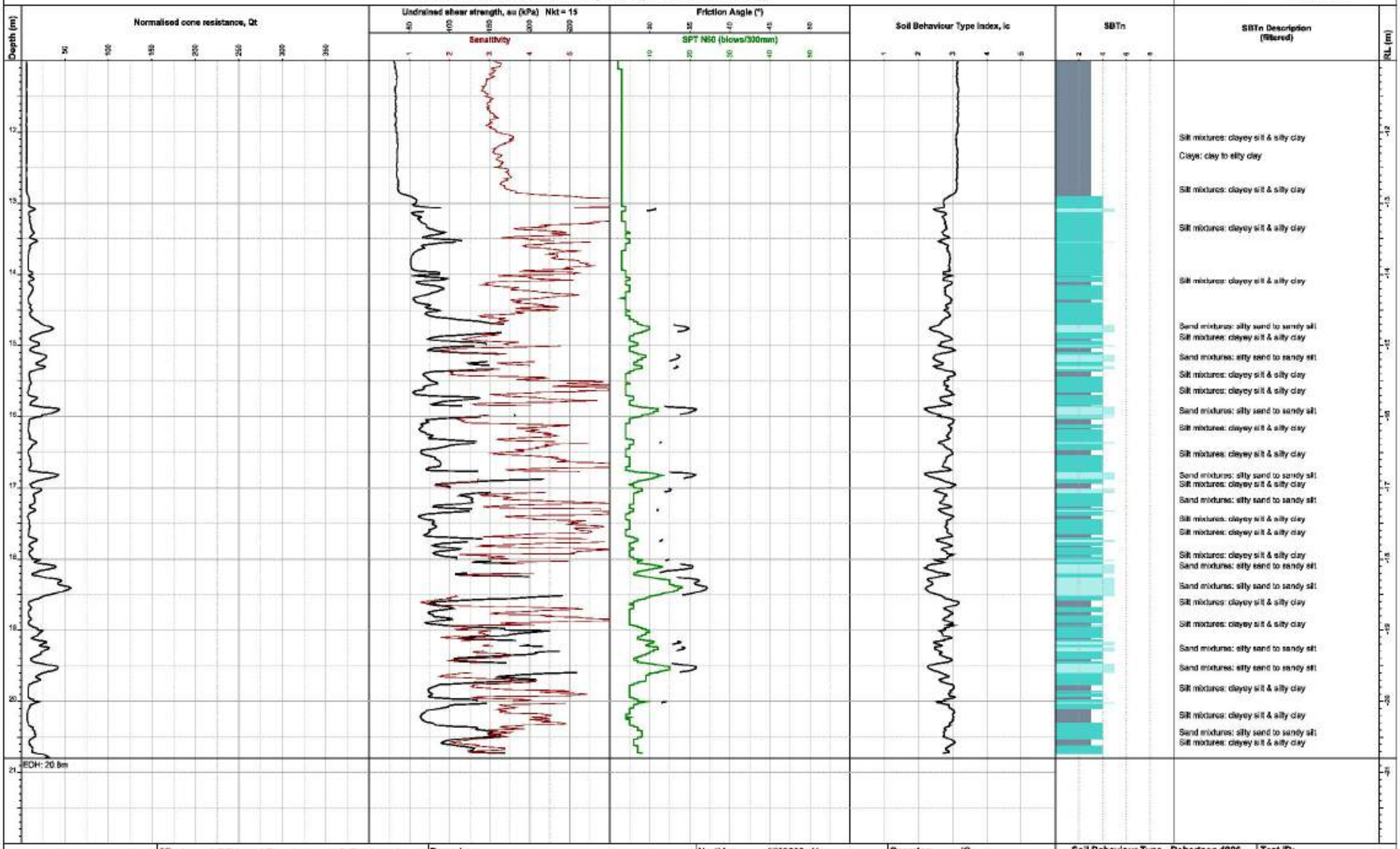
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-03

Project ID:	24477
Depth:	20.8m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-03



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036135mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

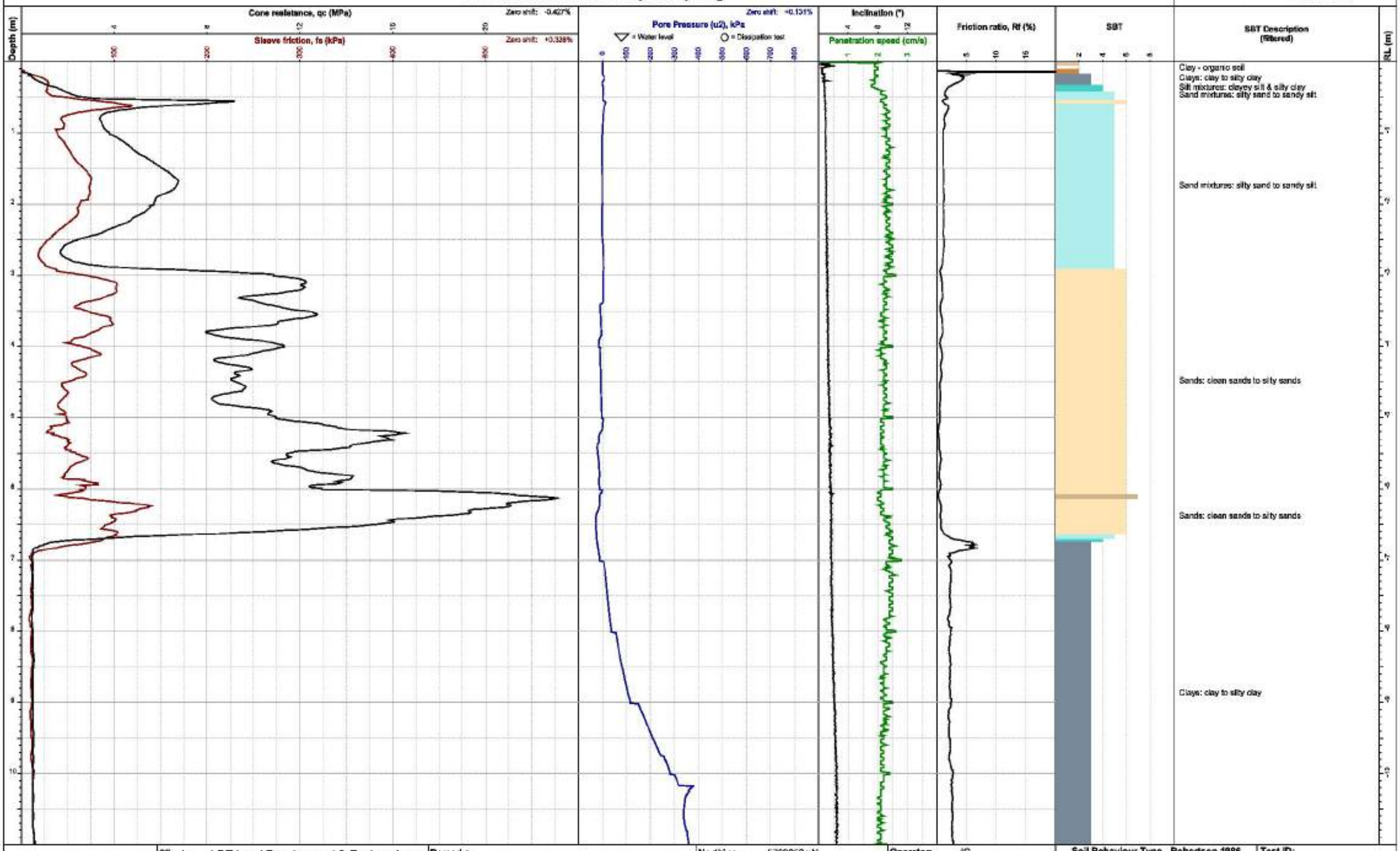
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-03
Project ID: 24477
Depth: 20.8m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-04



Generated with CORE GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:12 am

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709856mN
Easting: 2036093mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

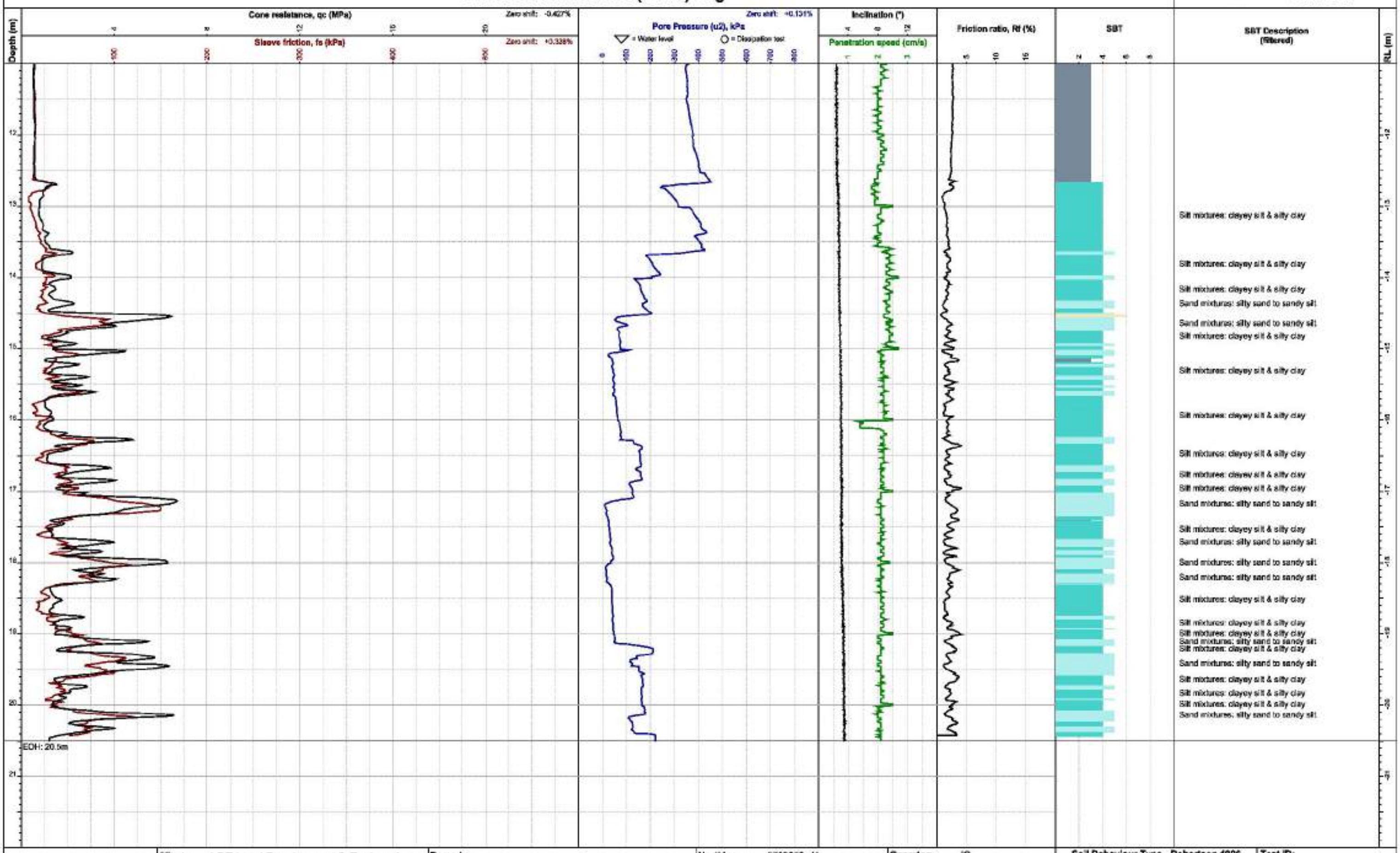
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-04

Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: **CPT-04**



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:12 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709856mN
Easting:	2036093mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

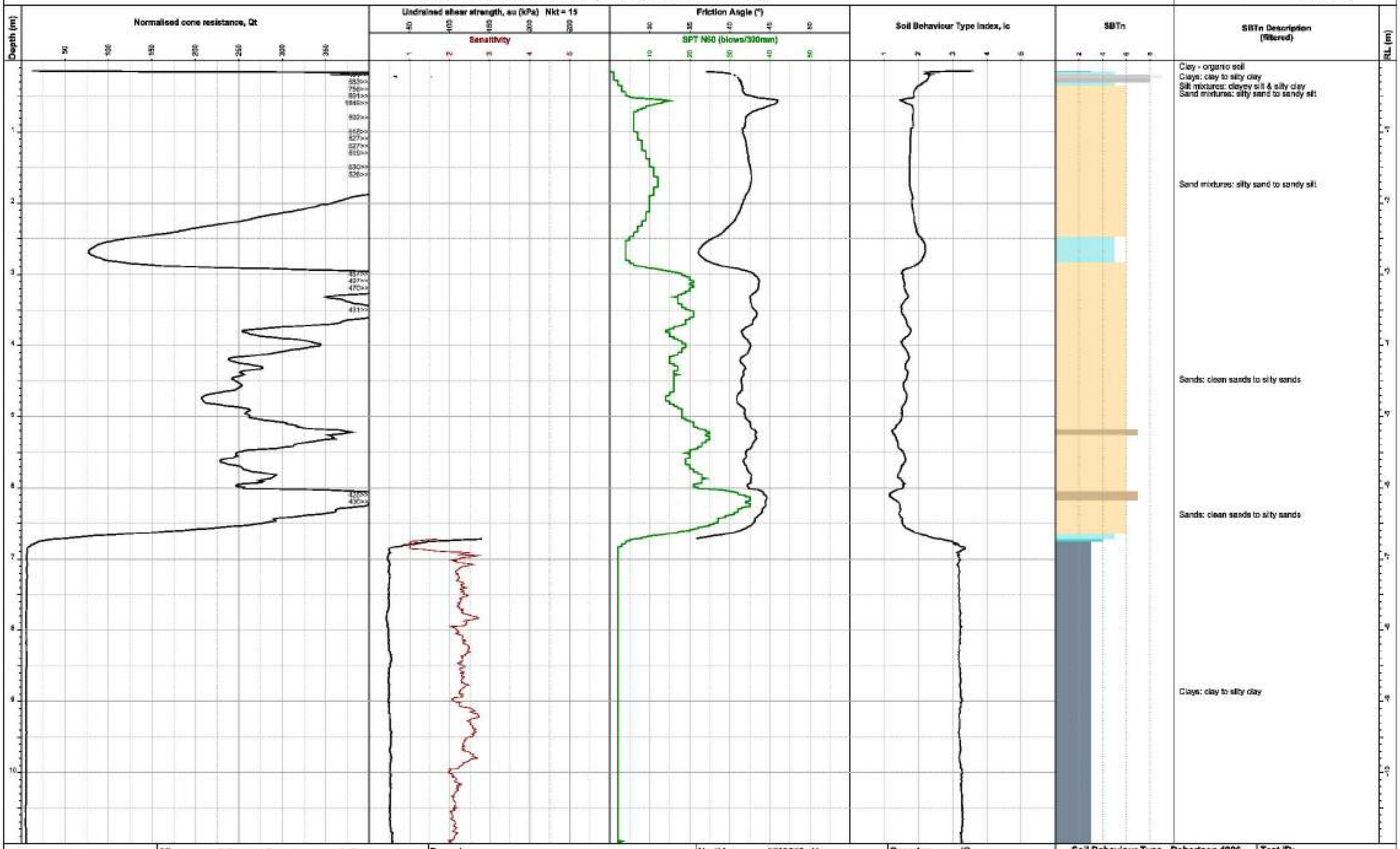
0	Undefined
1	Sensitive fine-grained
2	Clay - organic soil
3	Clays: clay to silty clay
4	Silt mixtures: clayey silt & silty clay
5	Sand mixtures: silty sand to sandy silt
6	Sands: clean sands to silty sands
7	Dense sand to gravelly sand
8	Stiff sand to clayey sand
9	Stiff fine-grained

Test ID: **CPT-04**

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-04



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036093mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

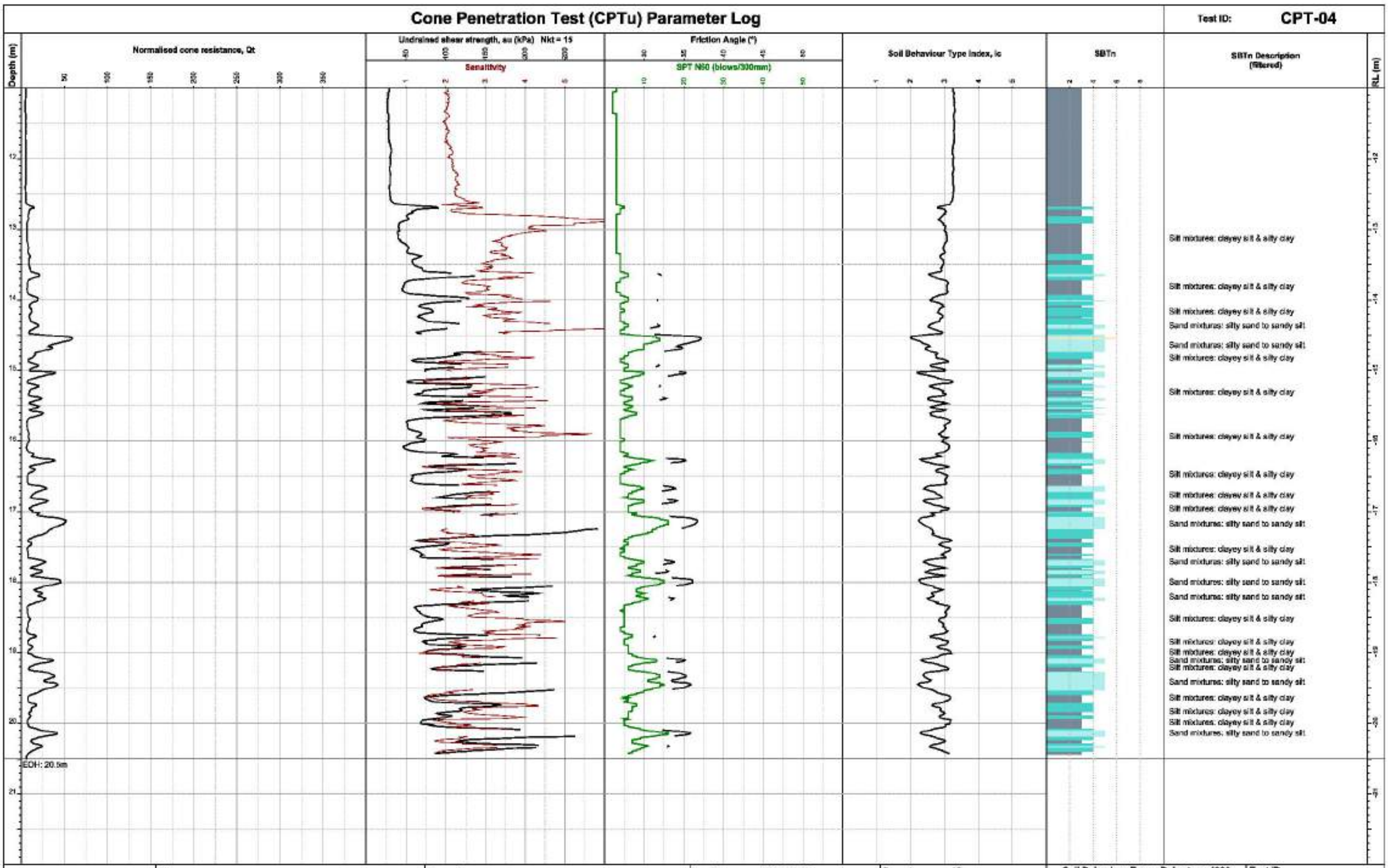
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-04

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-04



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709856mN
Easting: 2036093mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

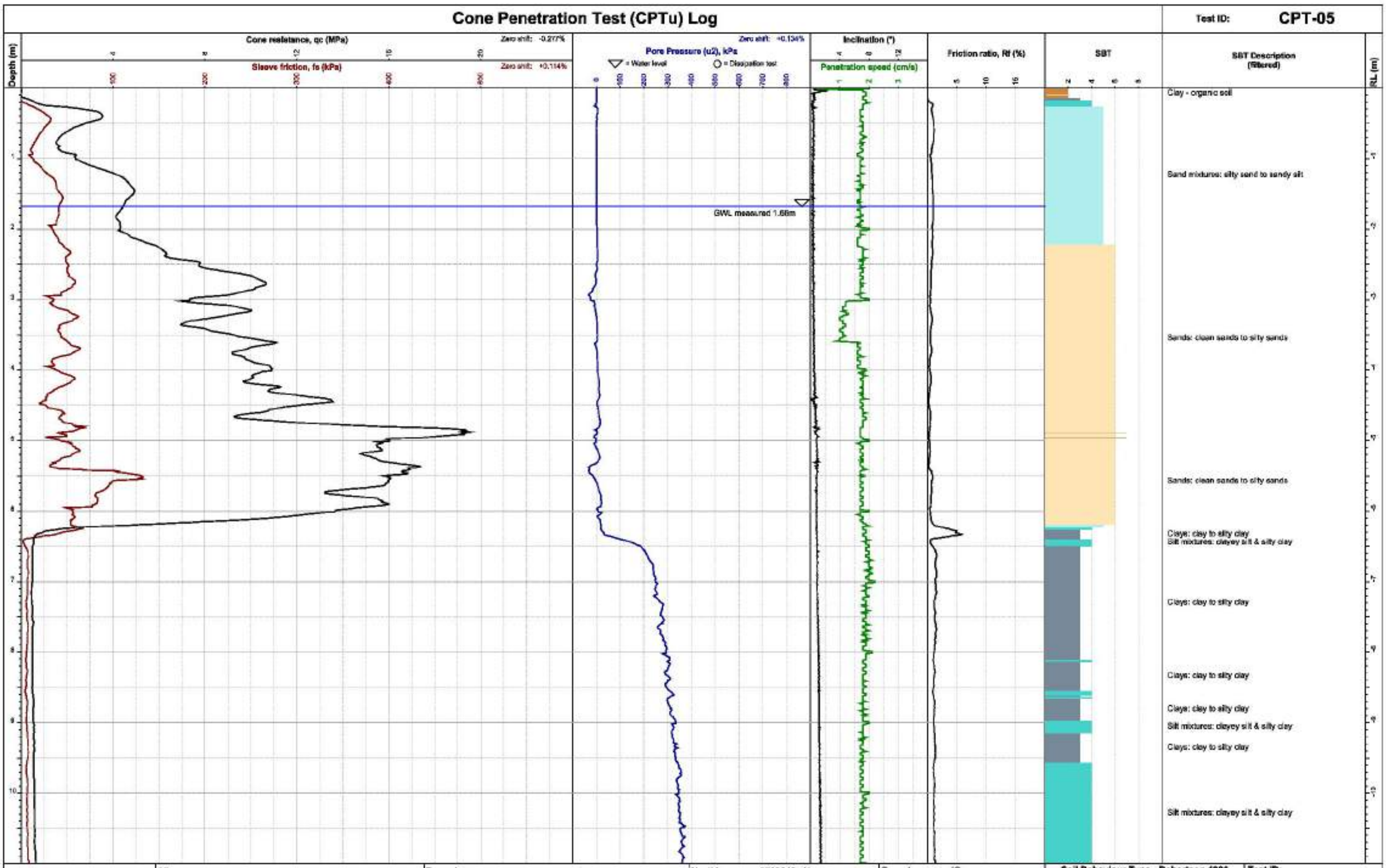
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:
CPT-04

Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-05



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709840mN
Easting: 2036107mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

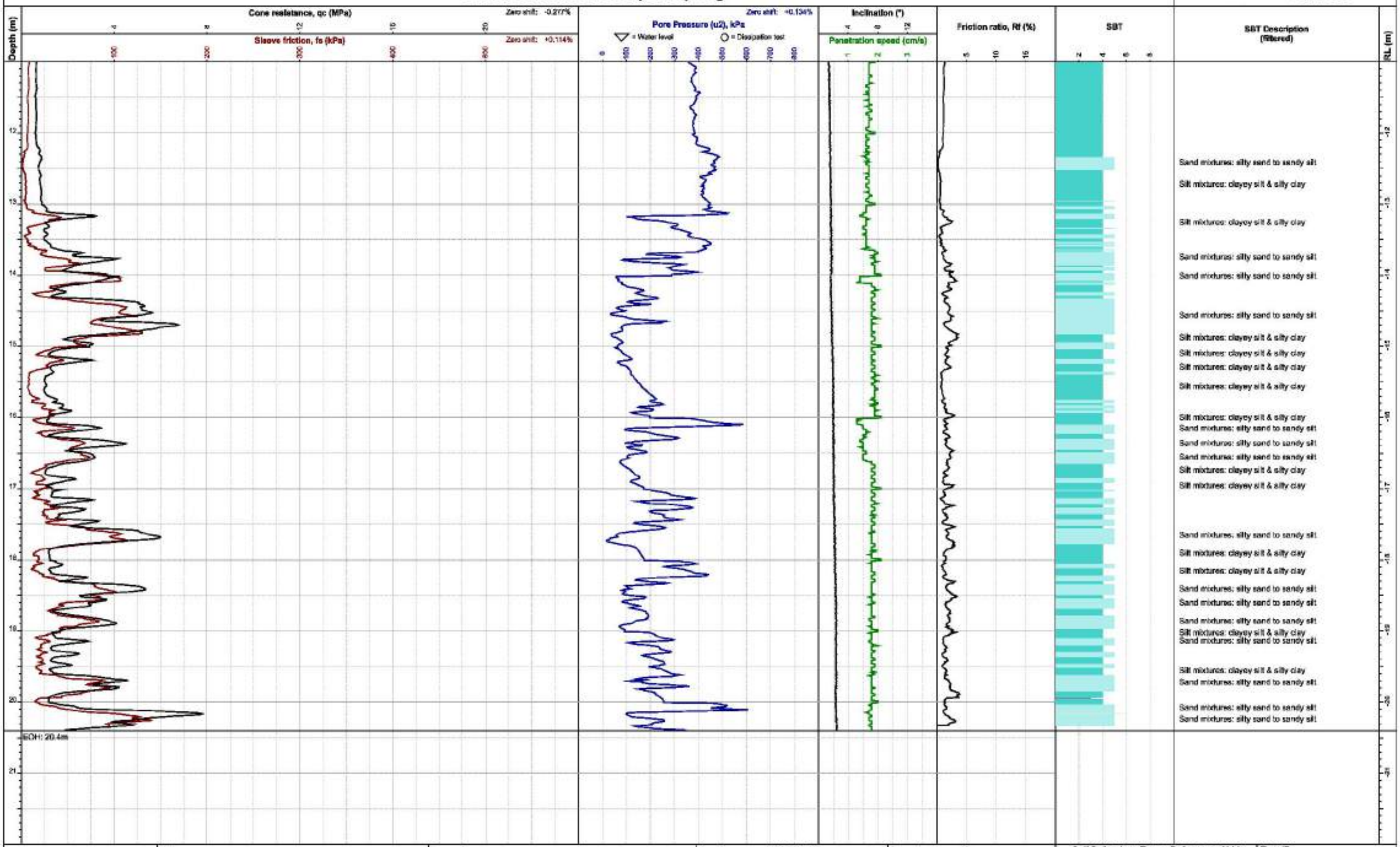
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-05
Project ID: 24477
Depth: 20.4m
Sheet: 1 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:15 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-05



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709840mN
Easting: 2036107mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

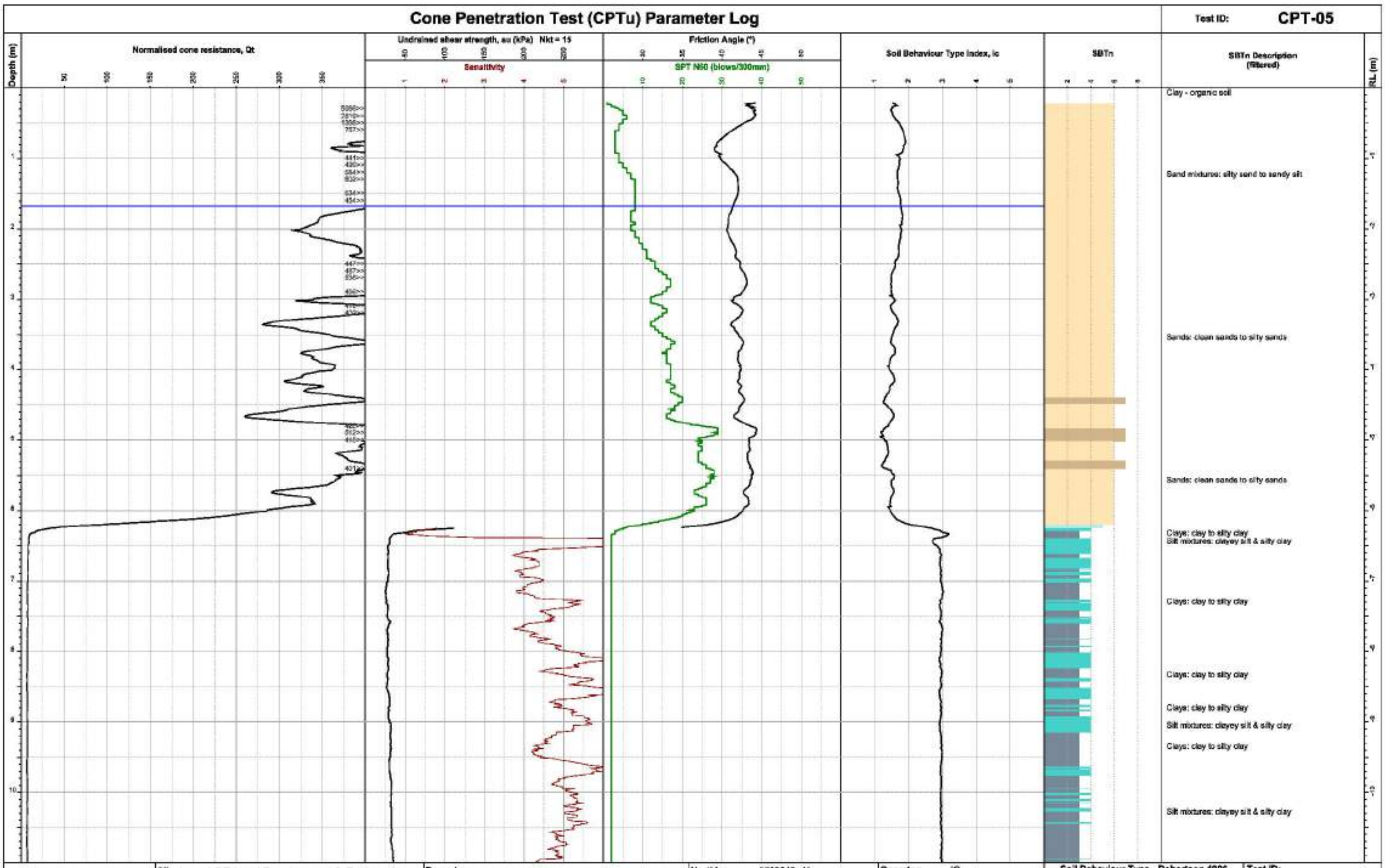
Soil Behaviour Type - Robertson 1986

0 Undefined	5 Sand mixtures: silty sand to sandy silt
1 Sensitive fine-grained	6 Sands: clean sands to silty sands
2 Clay - organic soil	7 Dense sand to gravelly sand
3 Clays: clay to silty clay	8 Stiff sand to clayey sand
4 Silt mixtures: clayey silt & silty clay	9 Stiff fine-grained

Test ID: CPT-05
Project ID: 24477
Depth: 20.4m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-05



LDE LAND DEVELOPMENT & ENGINEERING

Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Aberdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

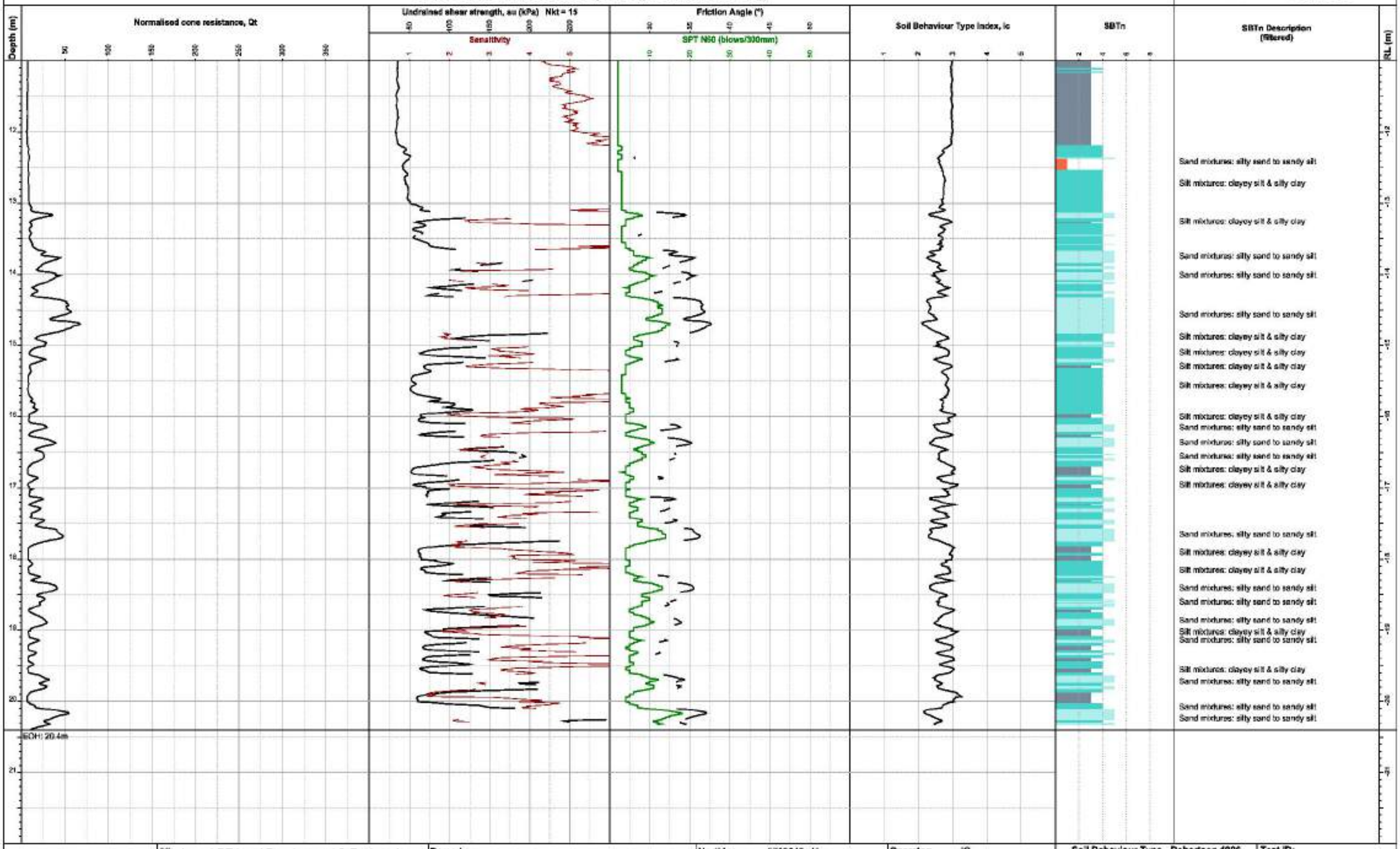
Test ID: CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:18 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-05**



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:16 am

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

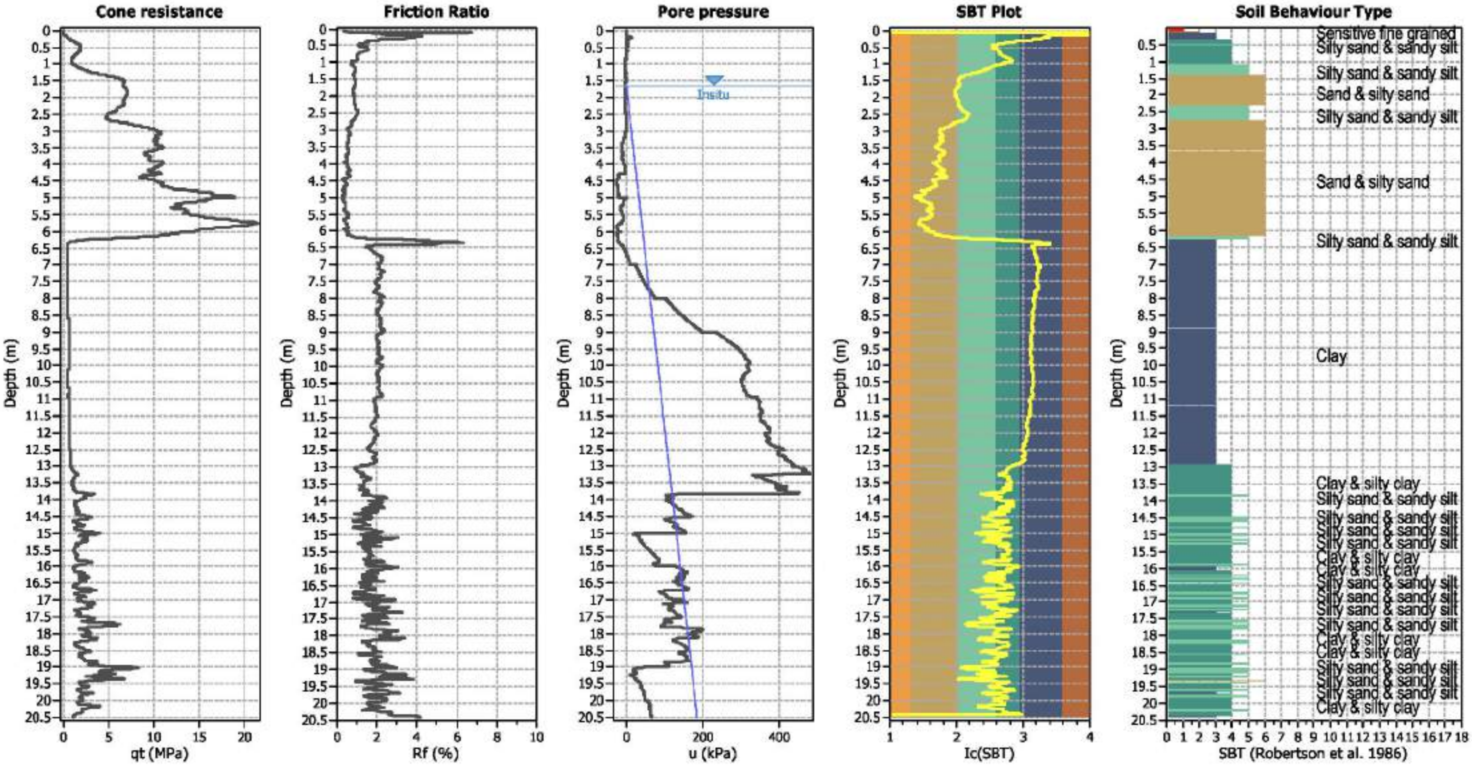
Test ID: CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	2 of 2
Date:	30/05/2023

APPENDIX D

LIQUEFATION ANALYSIS RESULTS

CPT basic interpretation plots



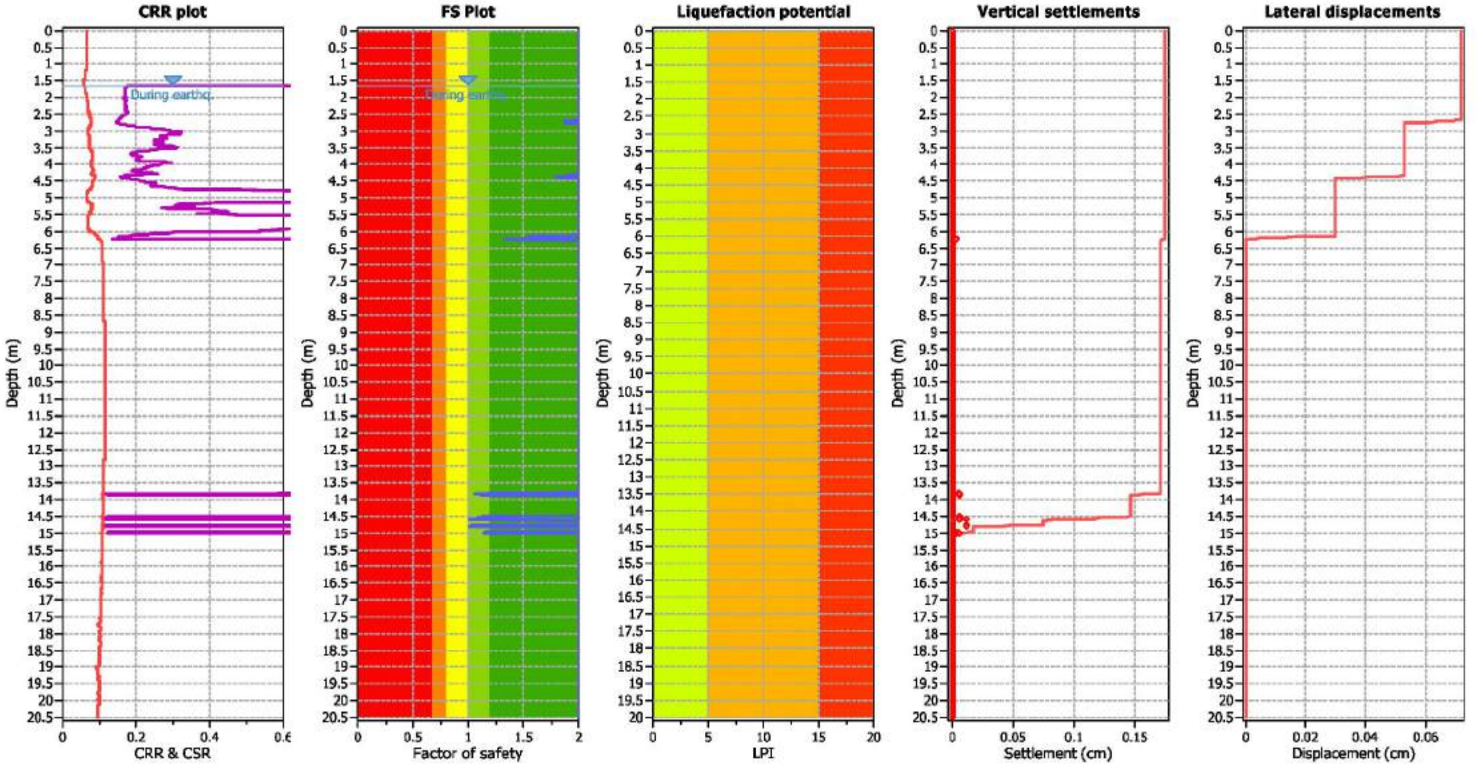
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

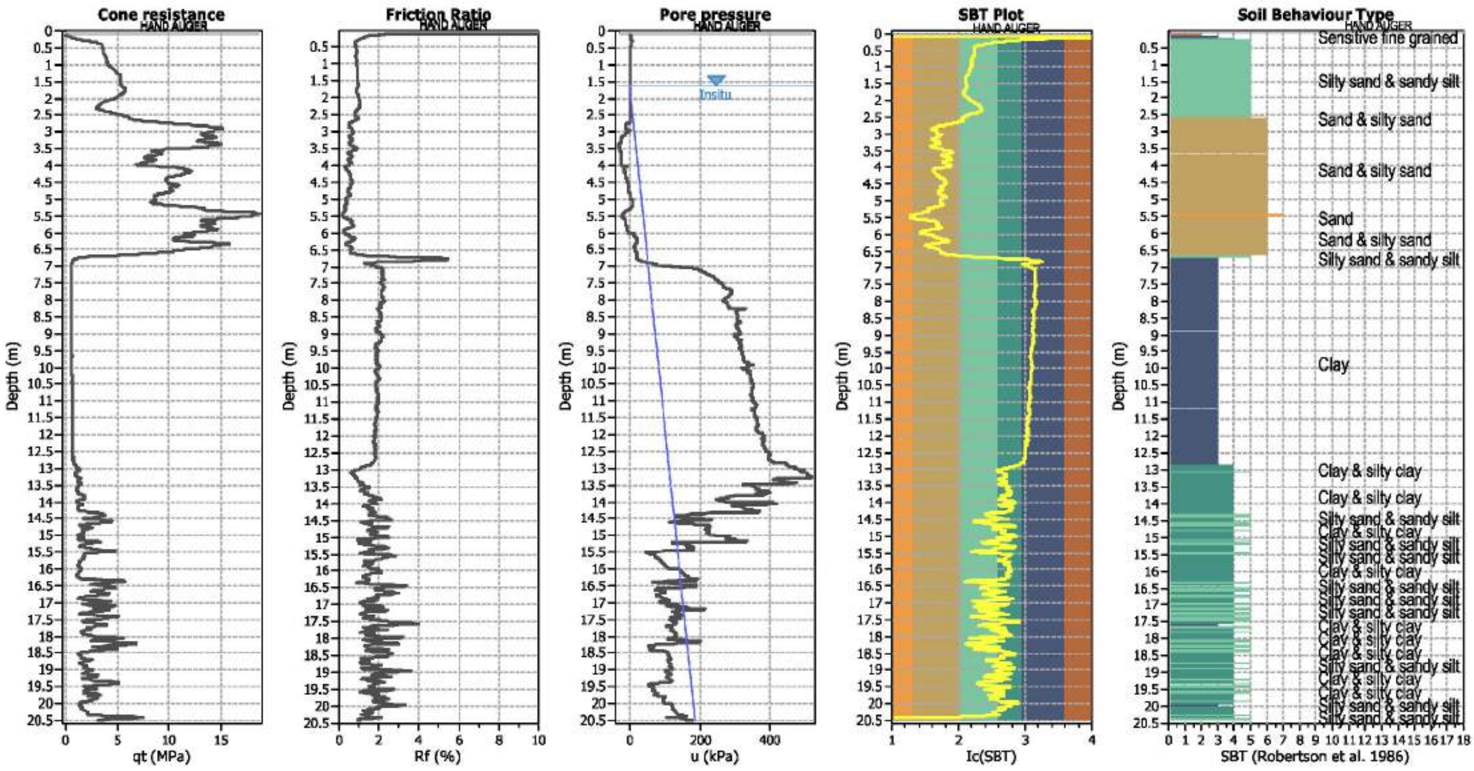
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



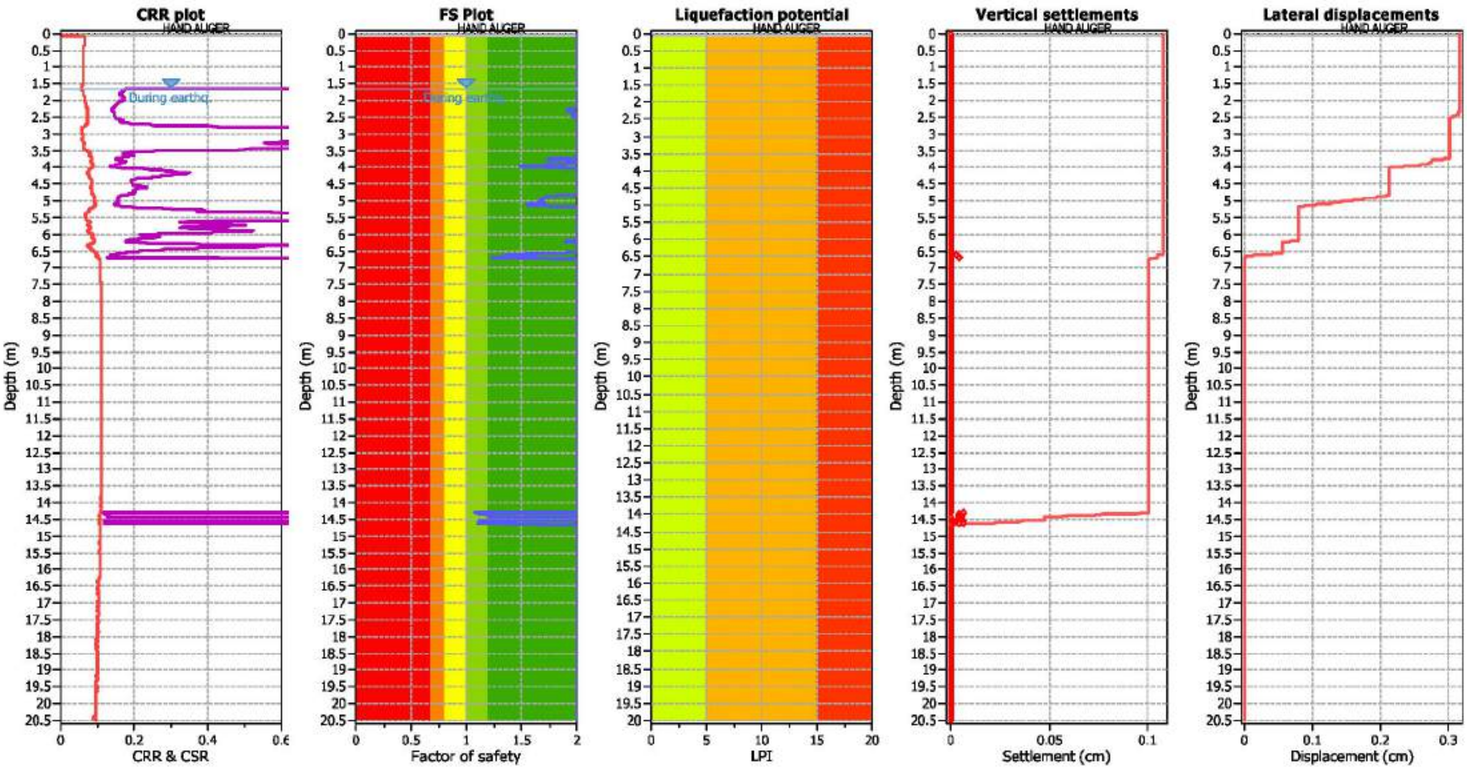
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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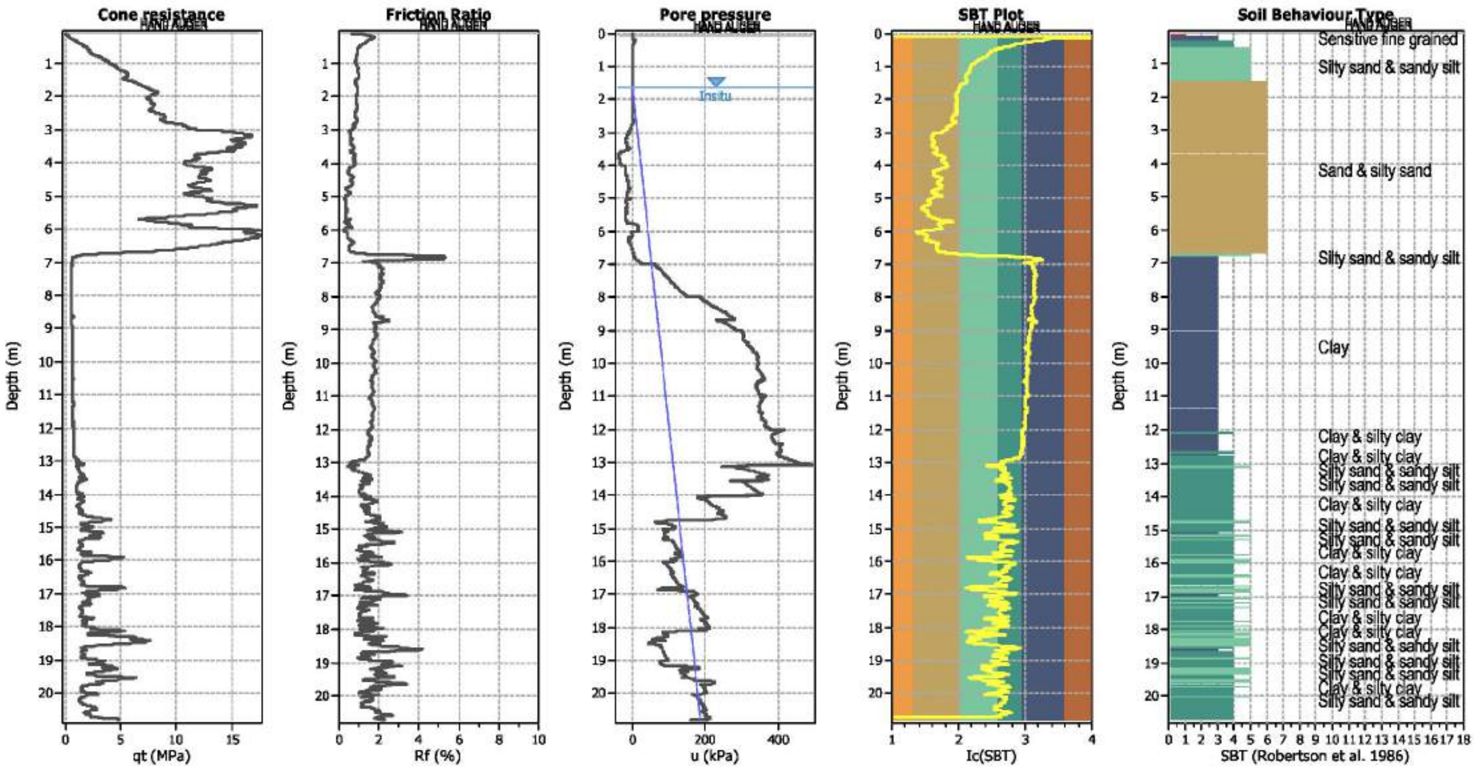
LPI color scheme

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

CPT basic interpretation plots



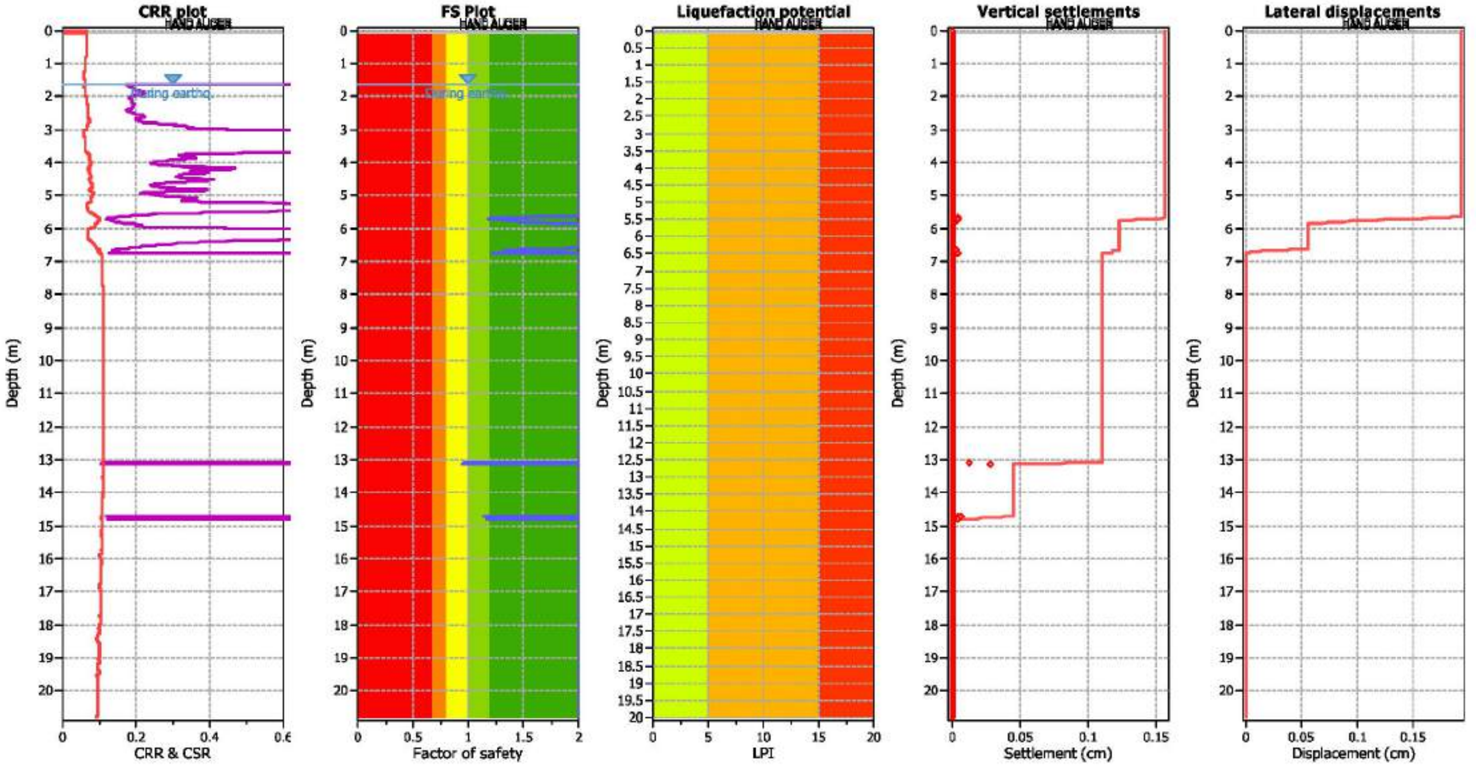
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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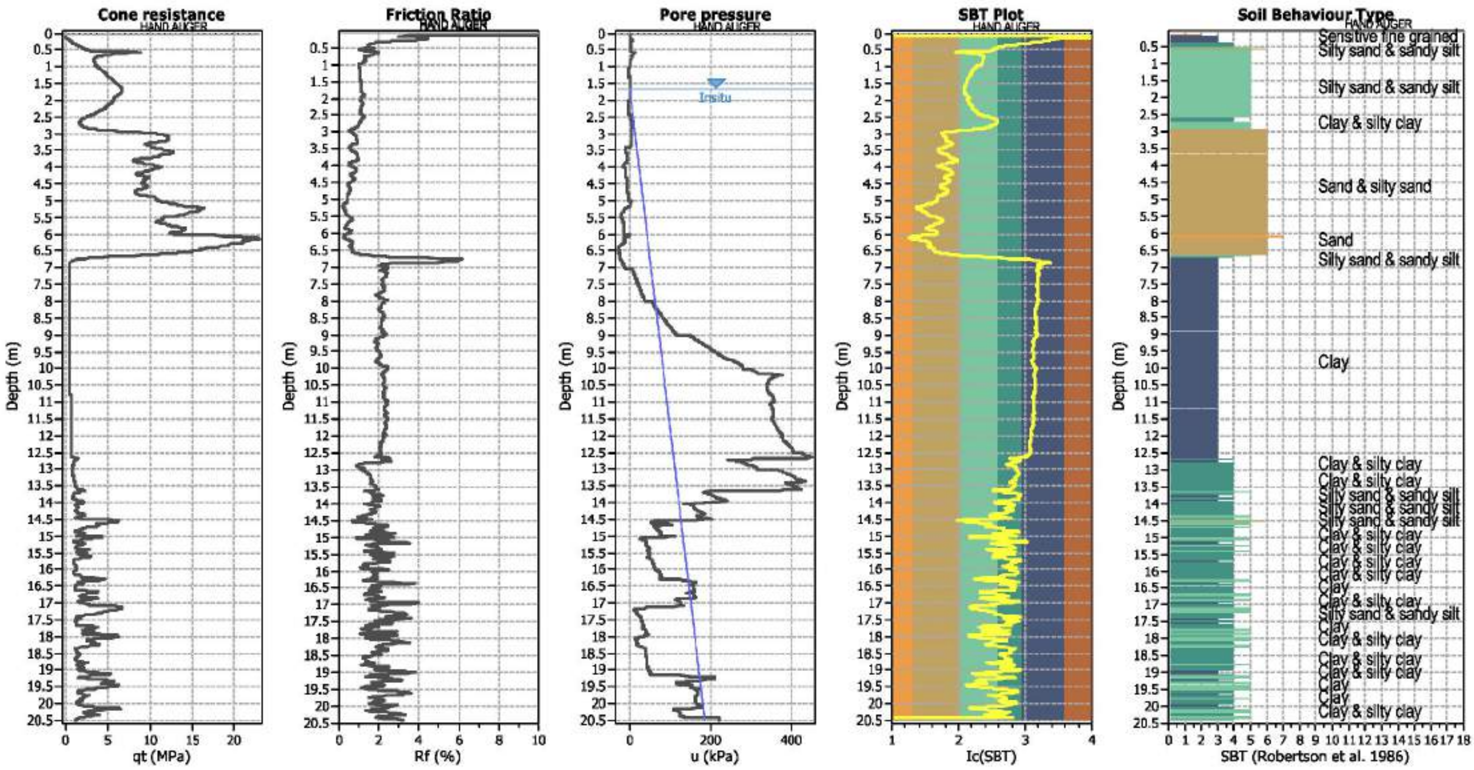
LPI color scheme

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

CPT basic interpretation plots



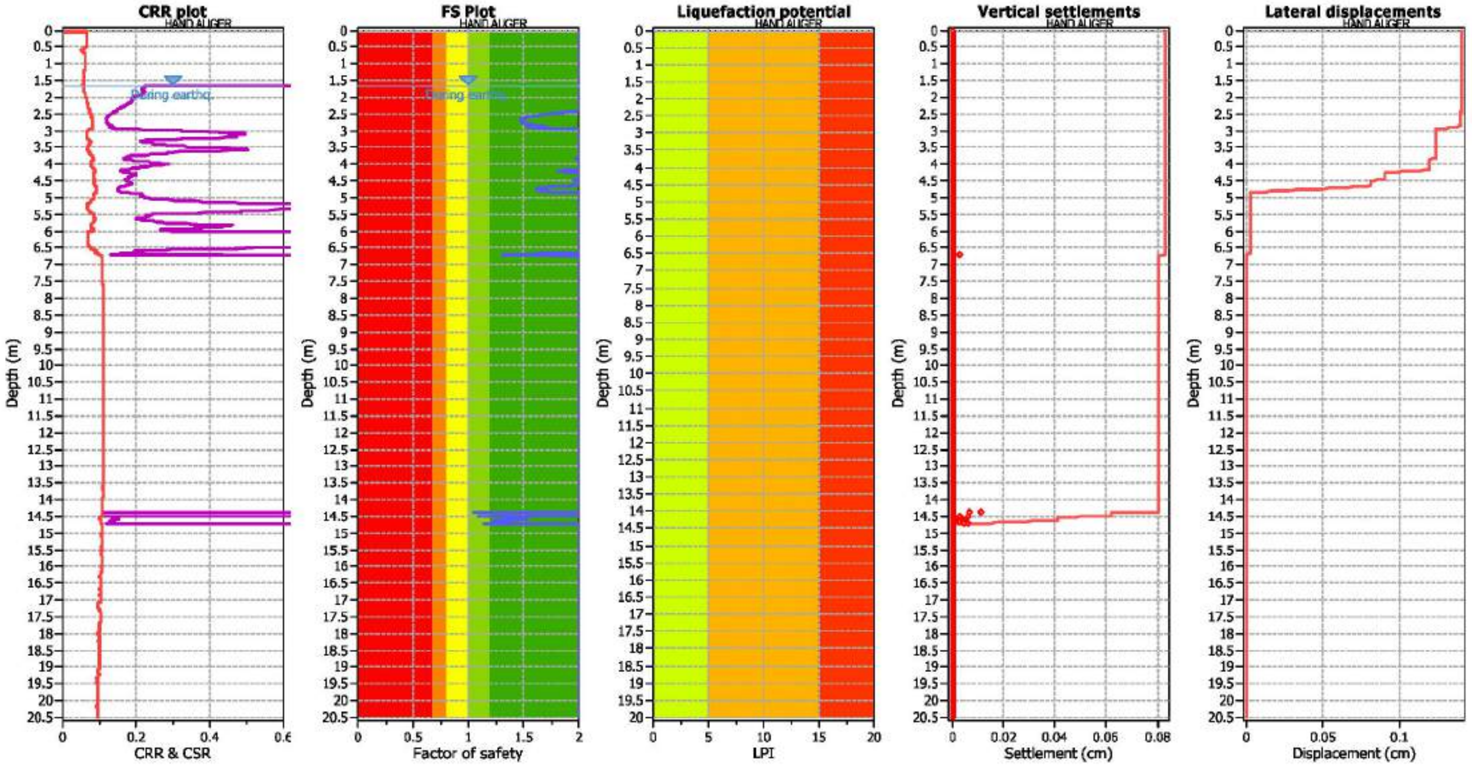
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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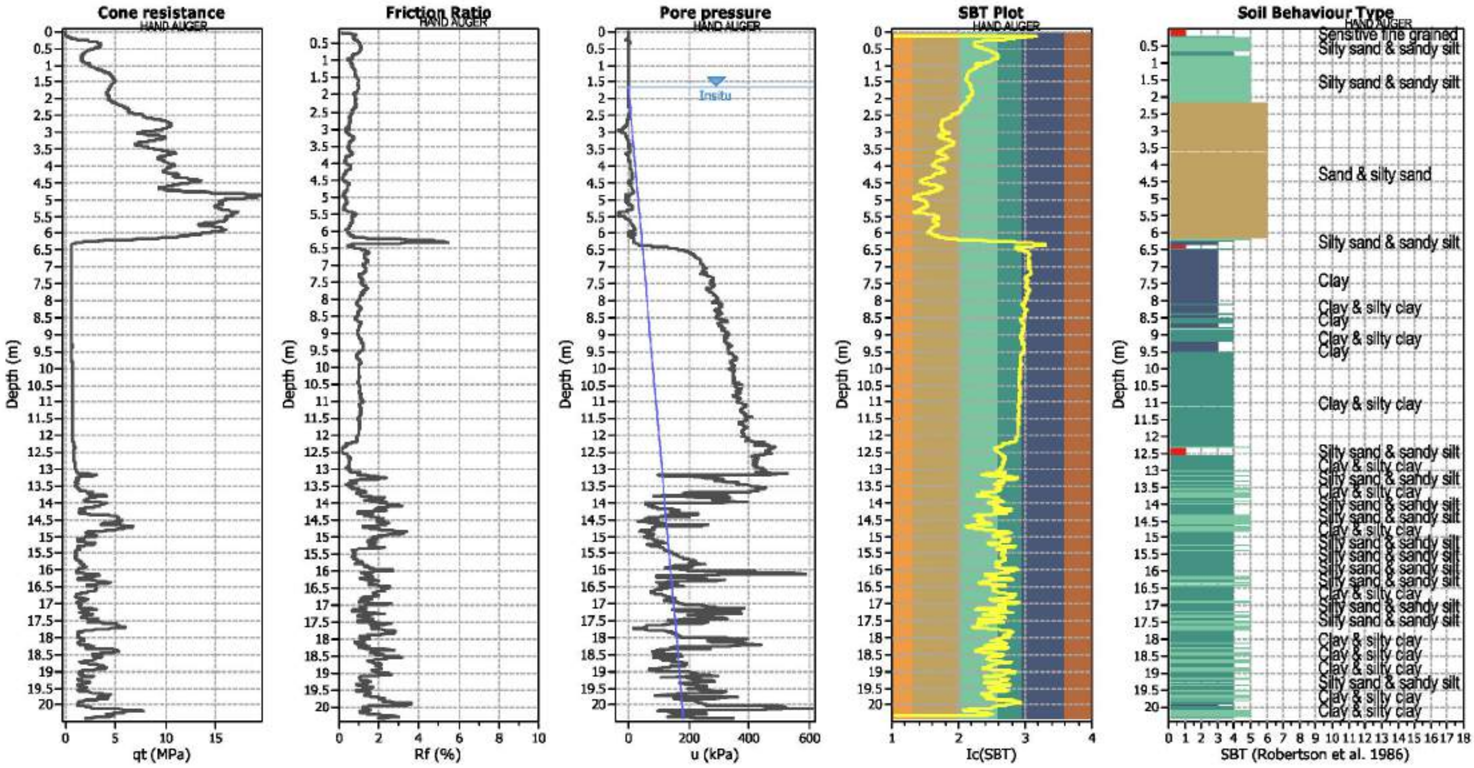
- 🟨 Low risk

CPT basic interpretation plots



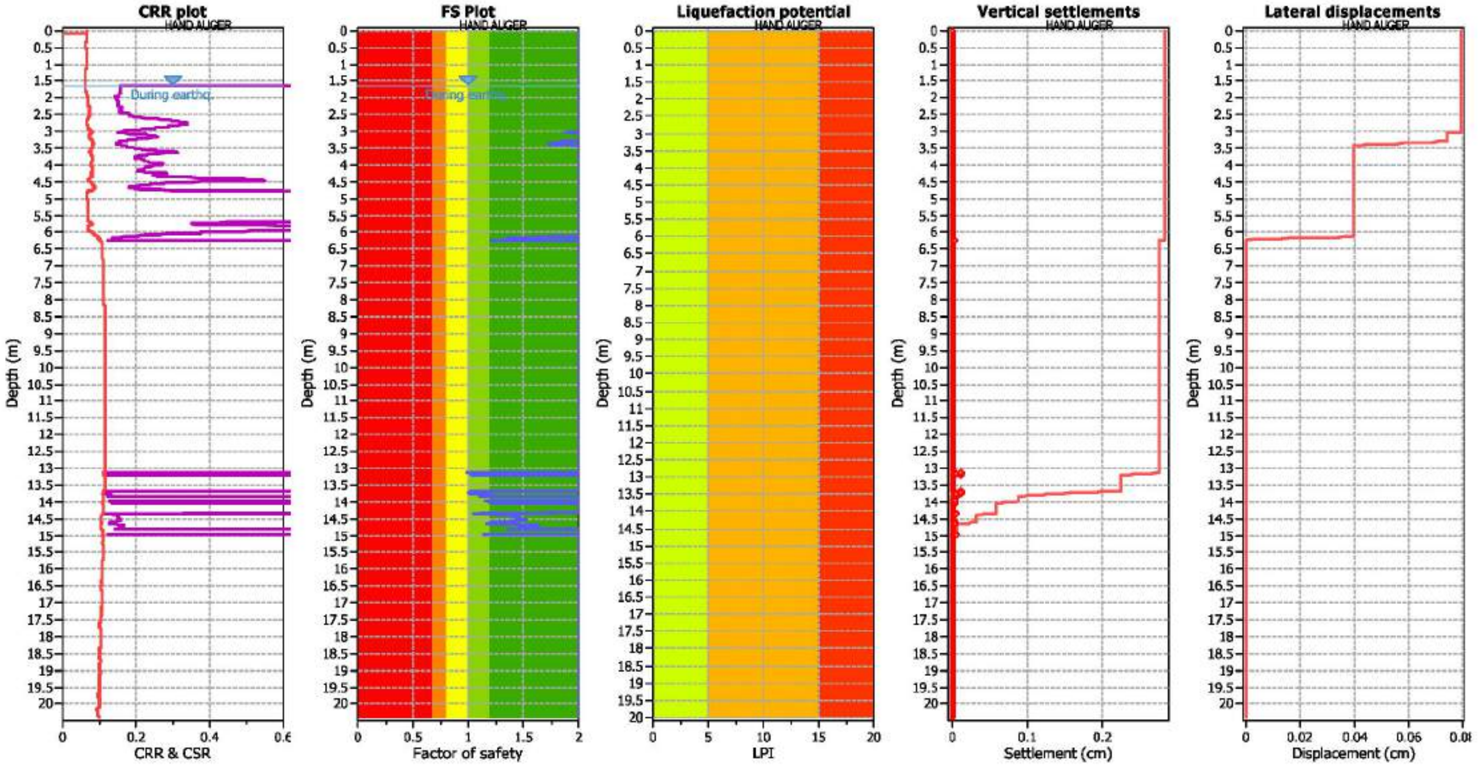
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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LPI color scheme

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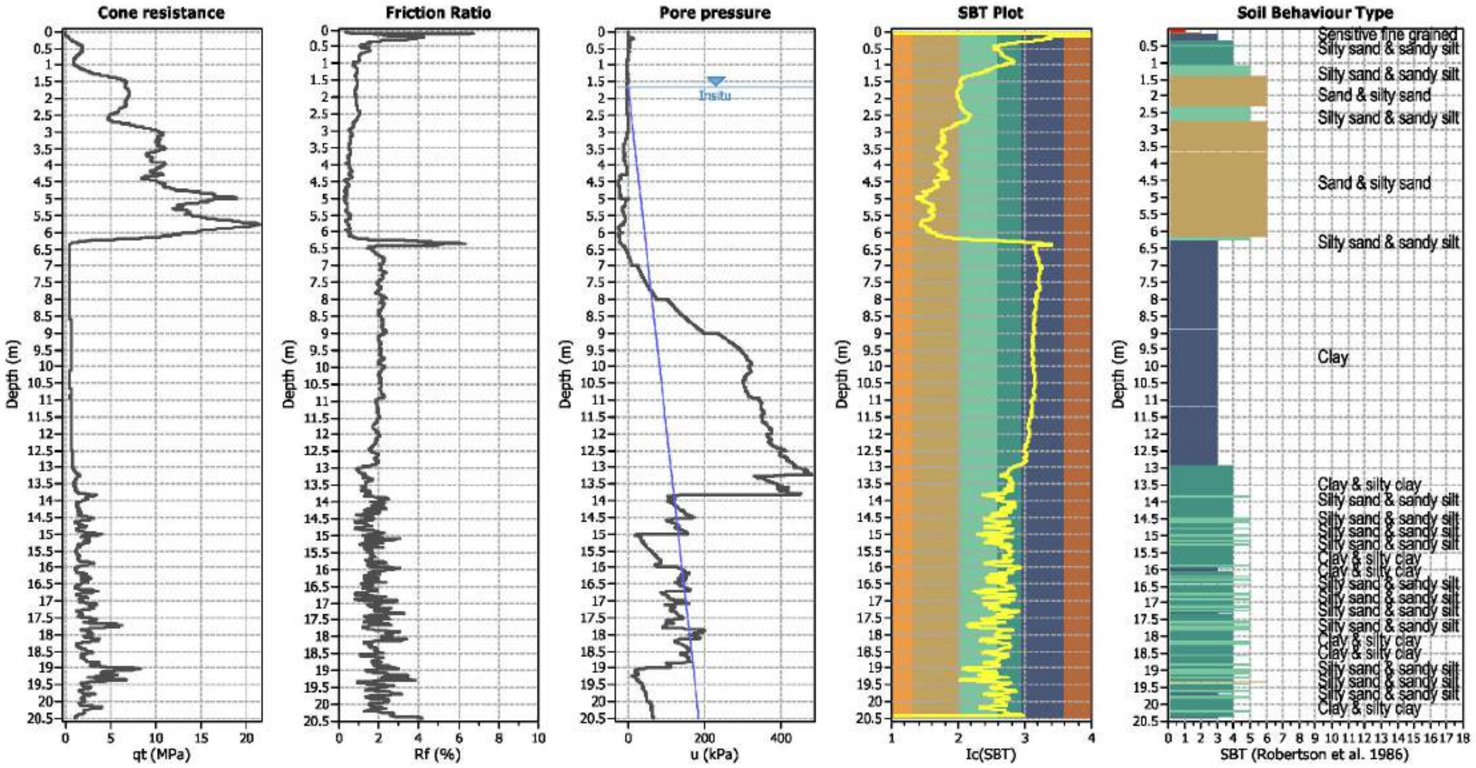
CPT basic interpretation plots



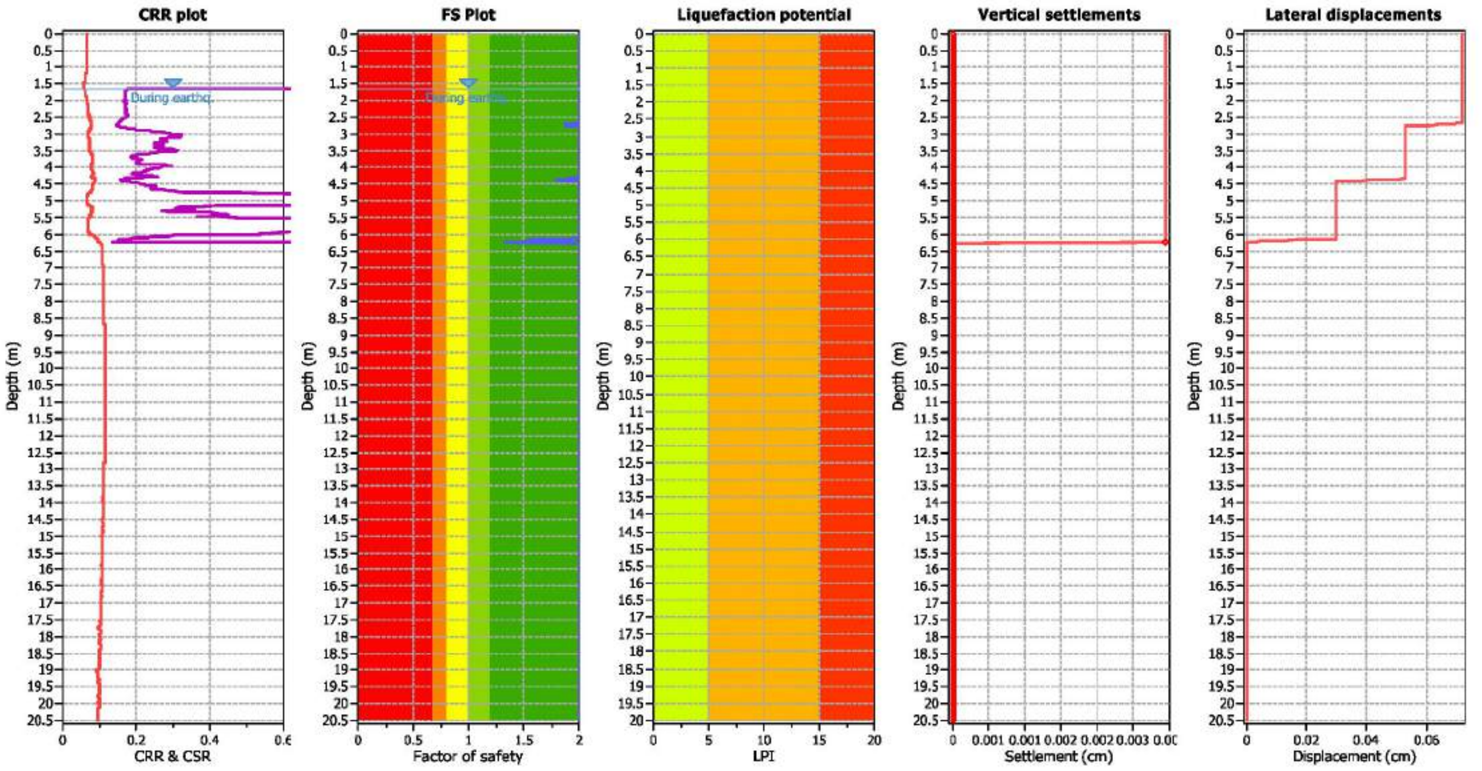
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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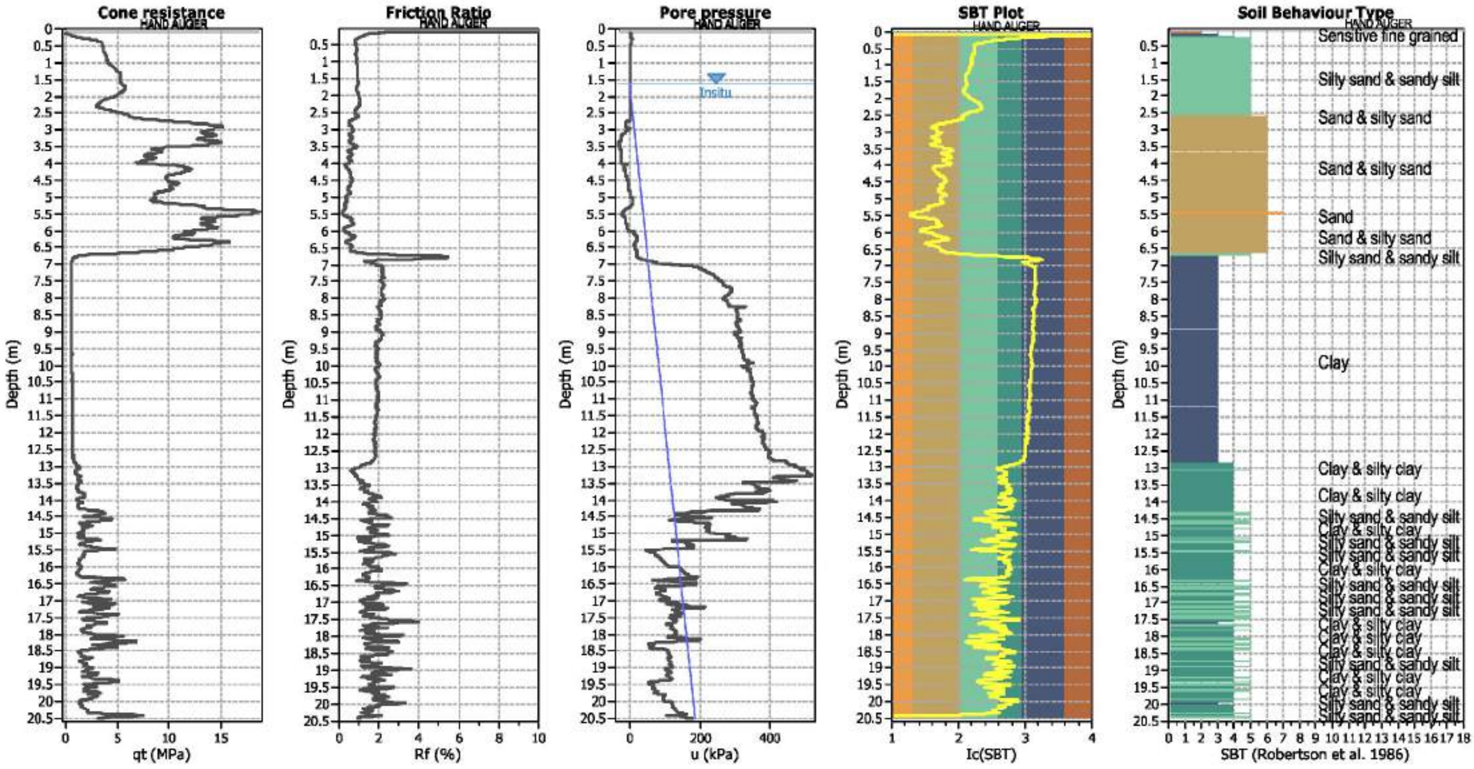
CPT basic interpretation plots



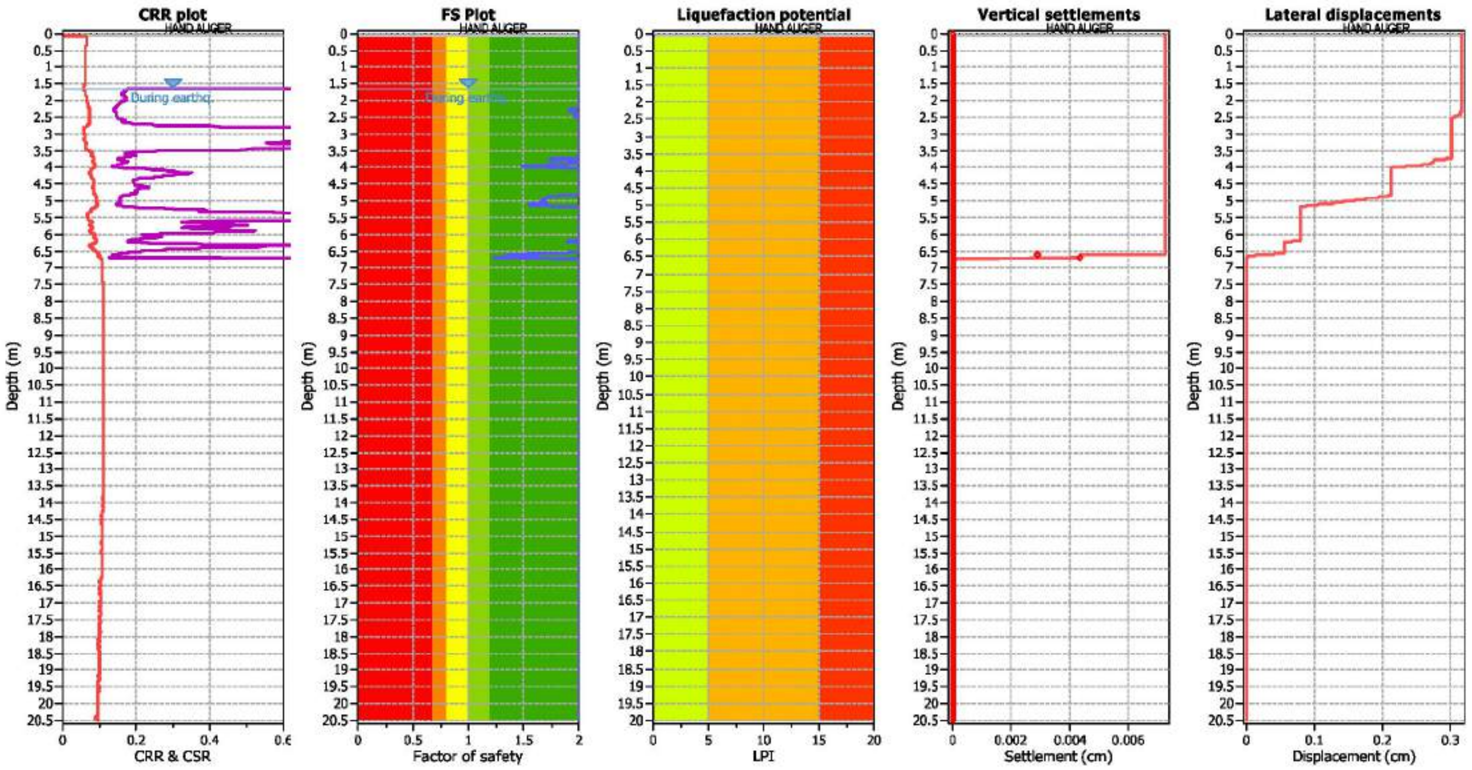
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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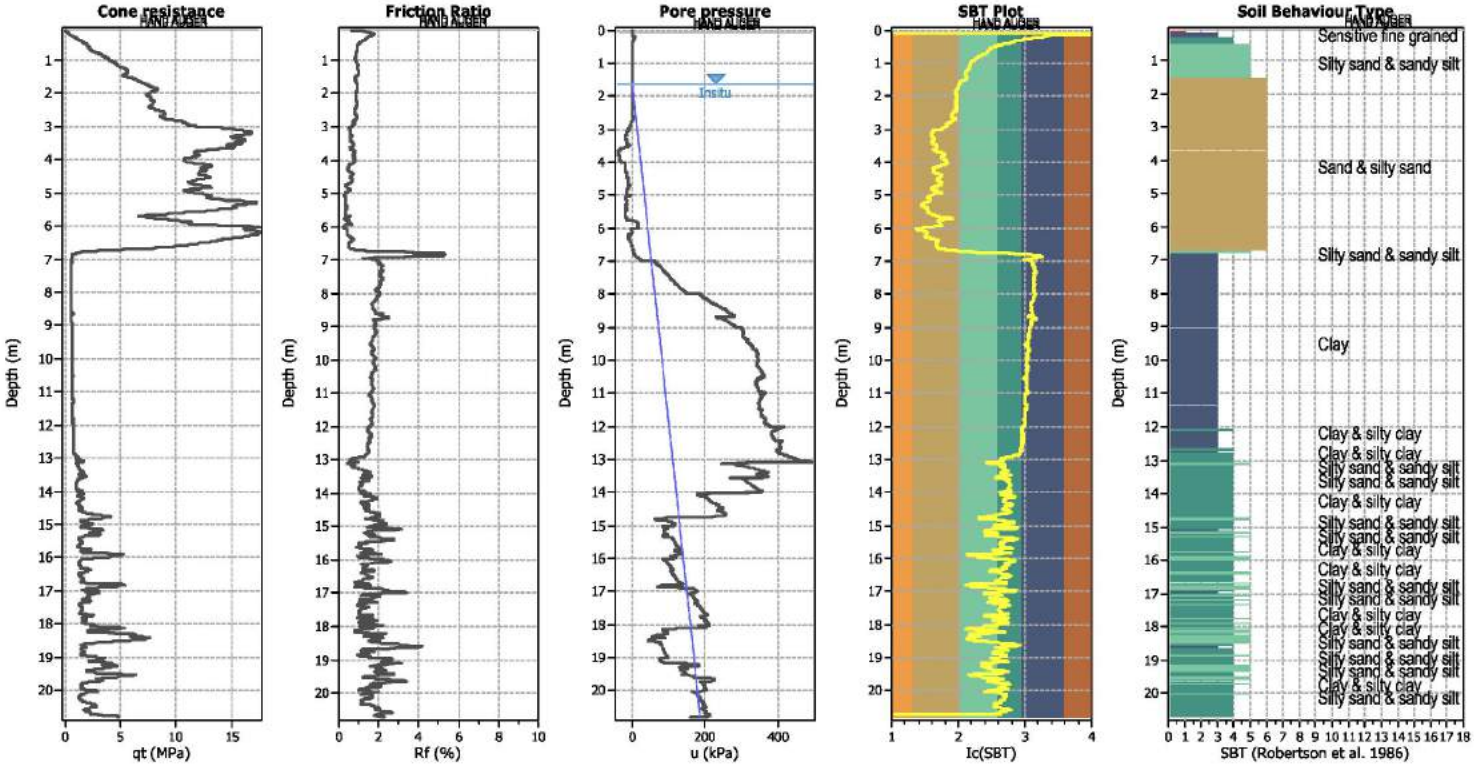
- 🟨 Low risk

CPT basic interpretation plots



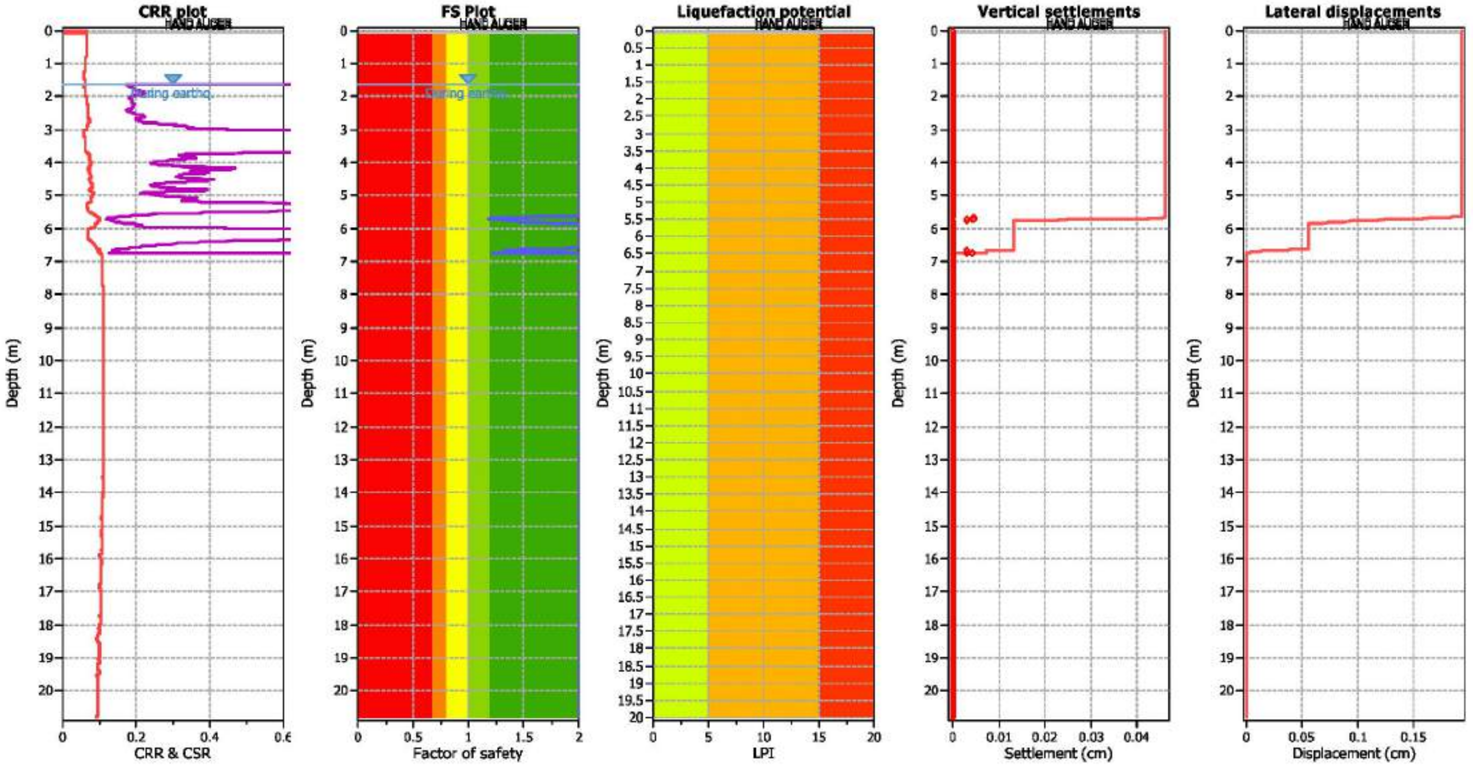
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

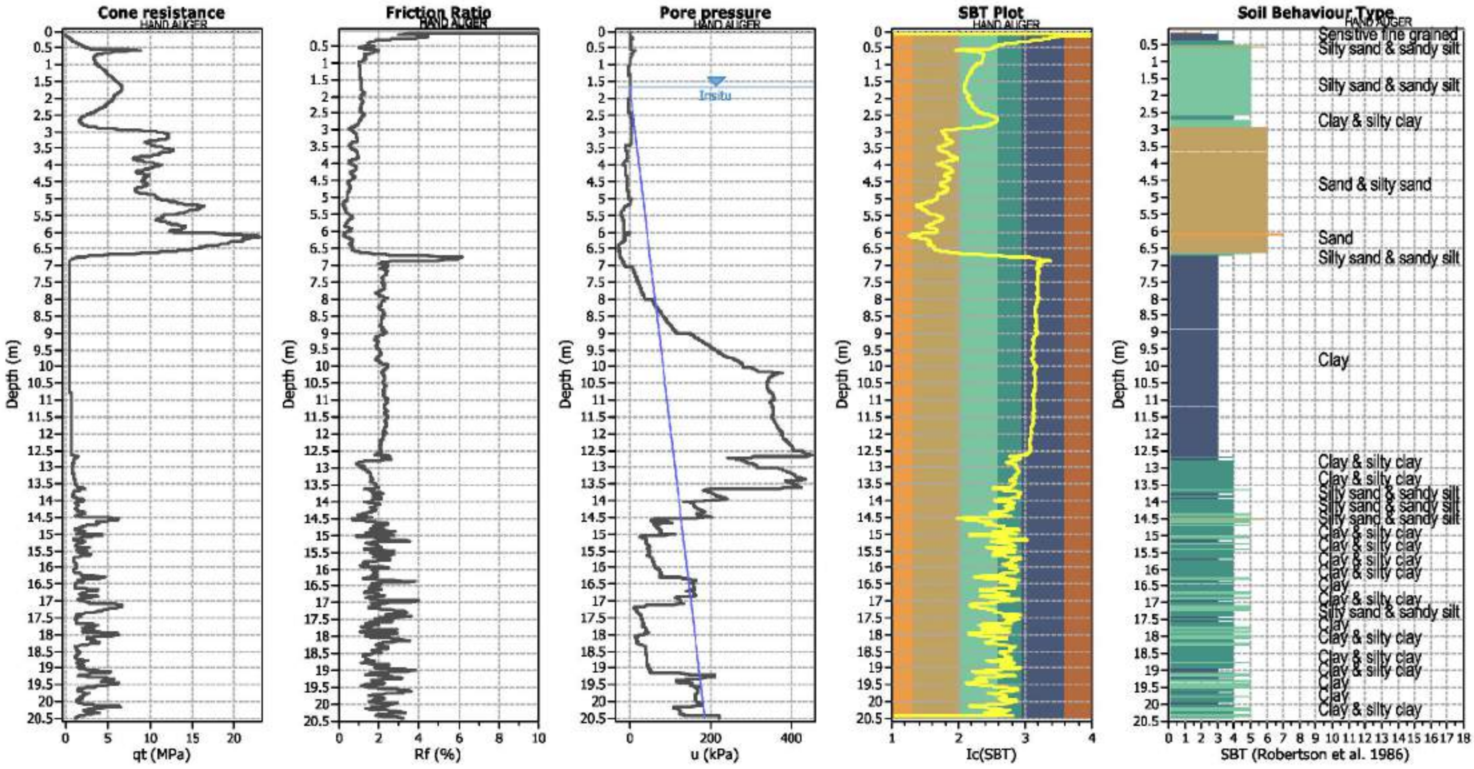
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



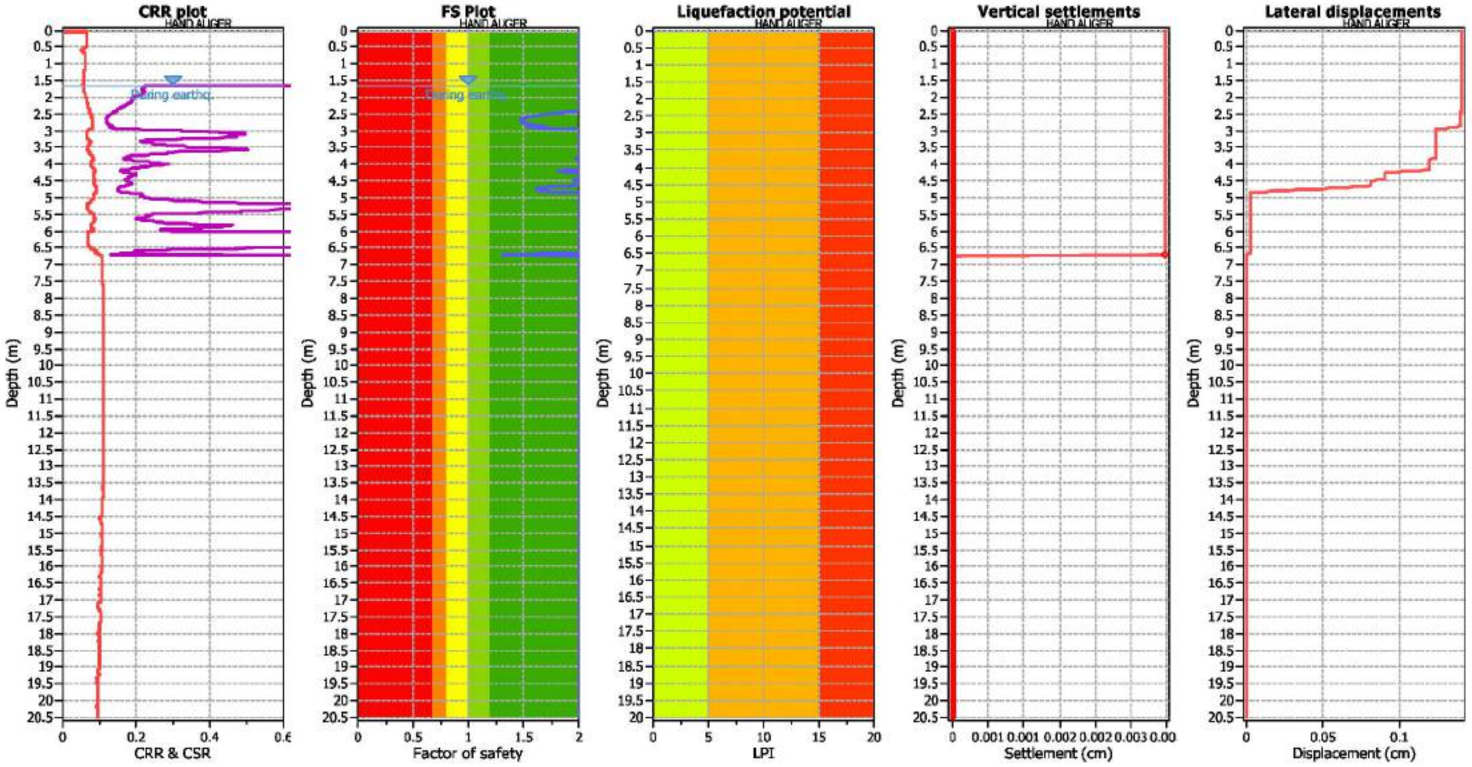
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



CRR plot

FS Plot

Liquefaction potential

Vertical settlements

Lateral displacements

Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	6.30
Peak ground acceleration:	0.12
Depth to water table (insitu):	1.65 m
Depth to GWT (erthq.):	1.65 m
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT
Use fill:	No
Fill height:	N/A
Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
Limit depth:	10.00 m

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LPI color scheme

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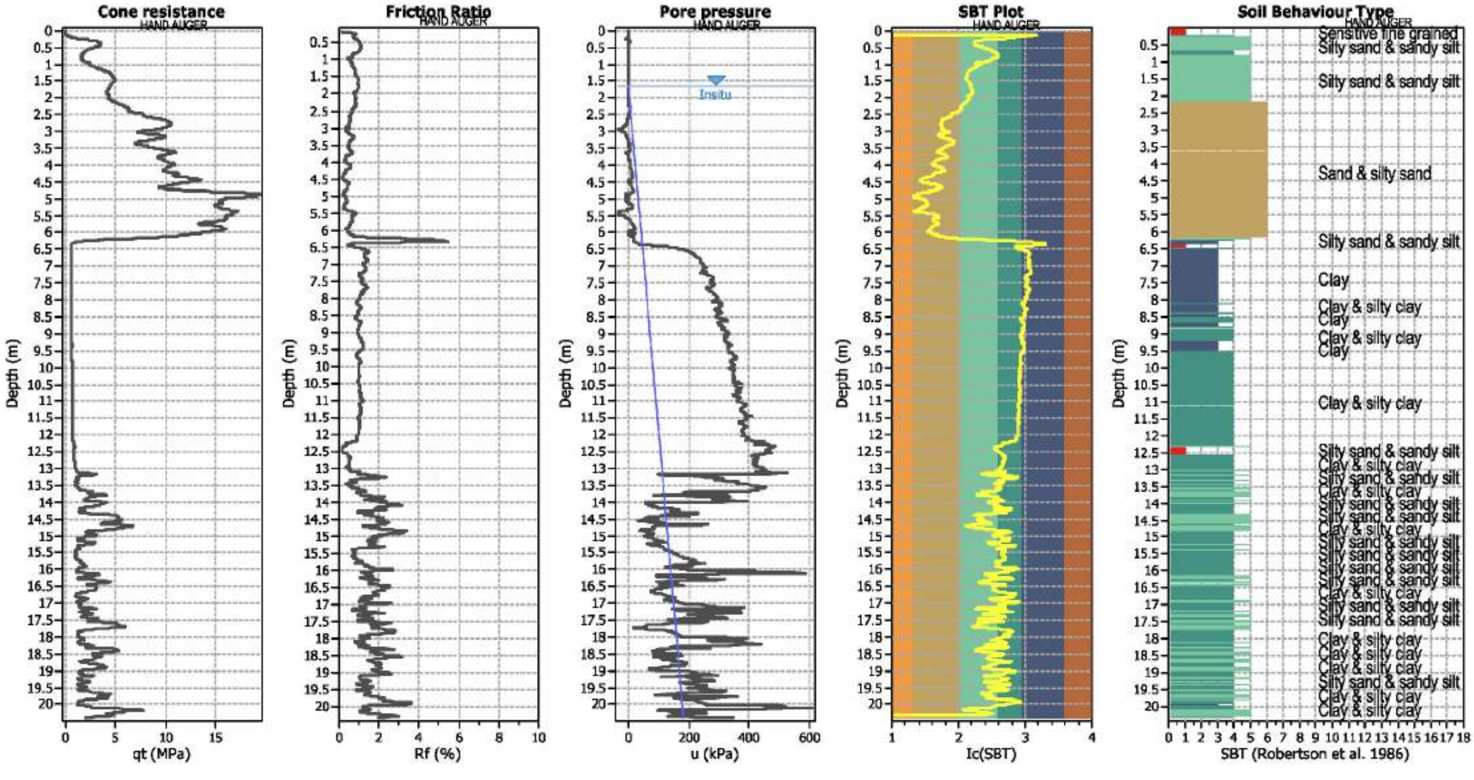
CPT basic interpretation plots



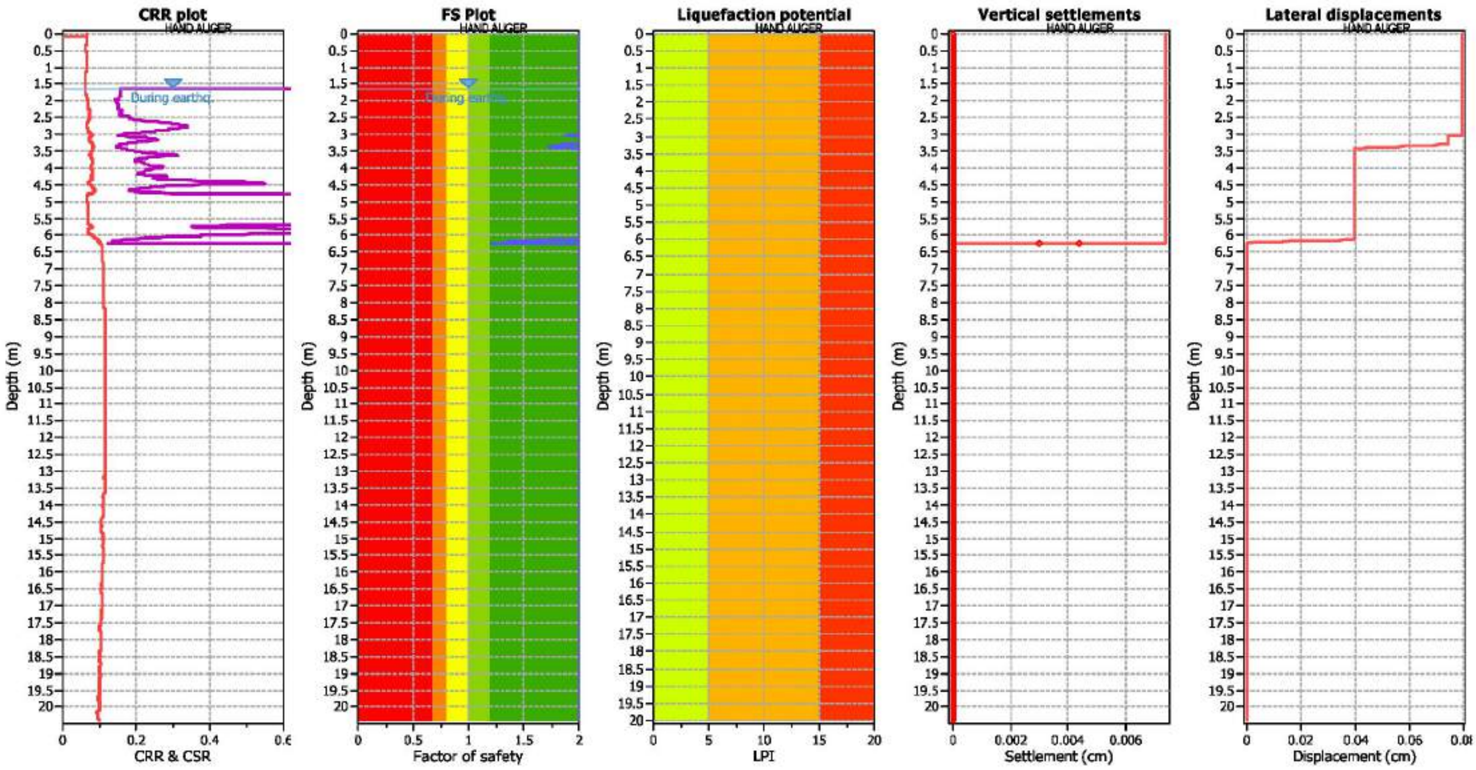
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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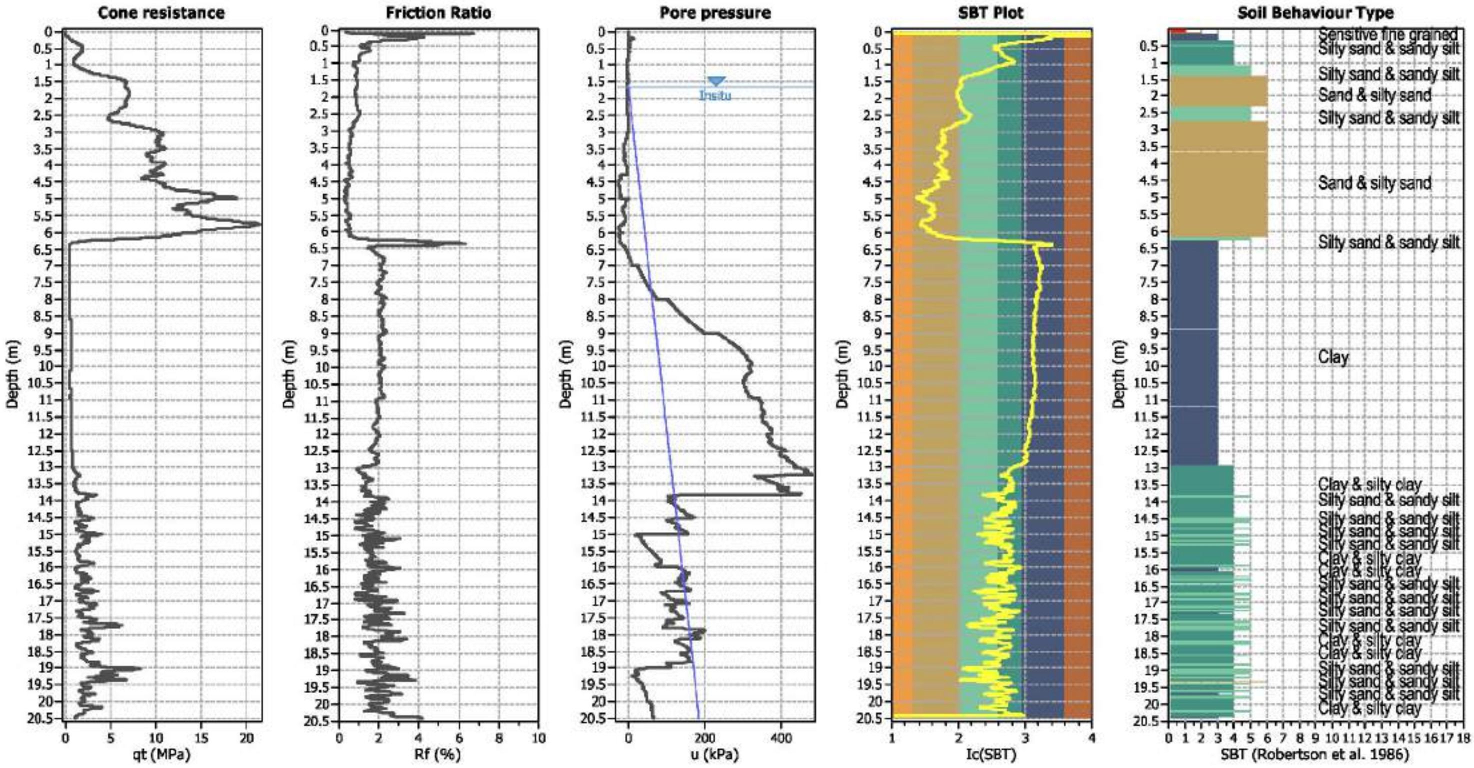
CPT basic interpretation plots



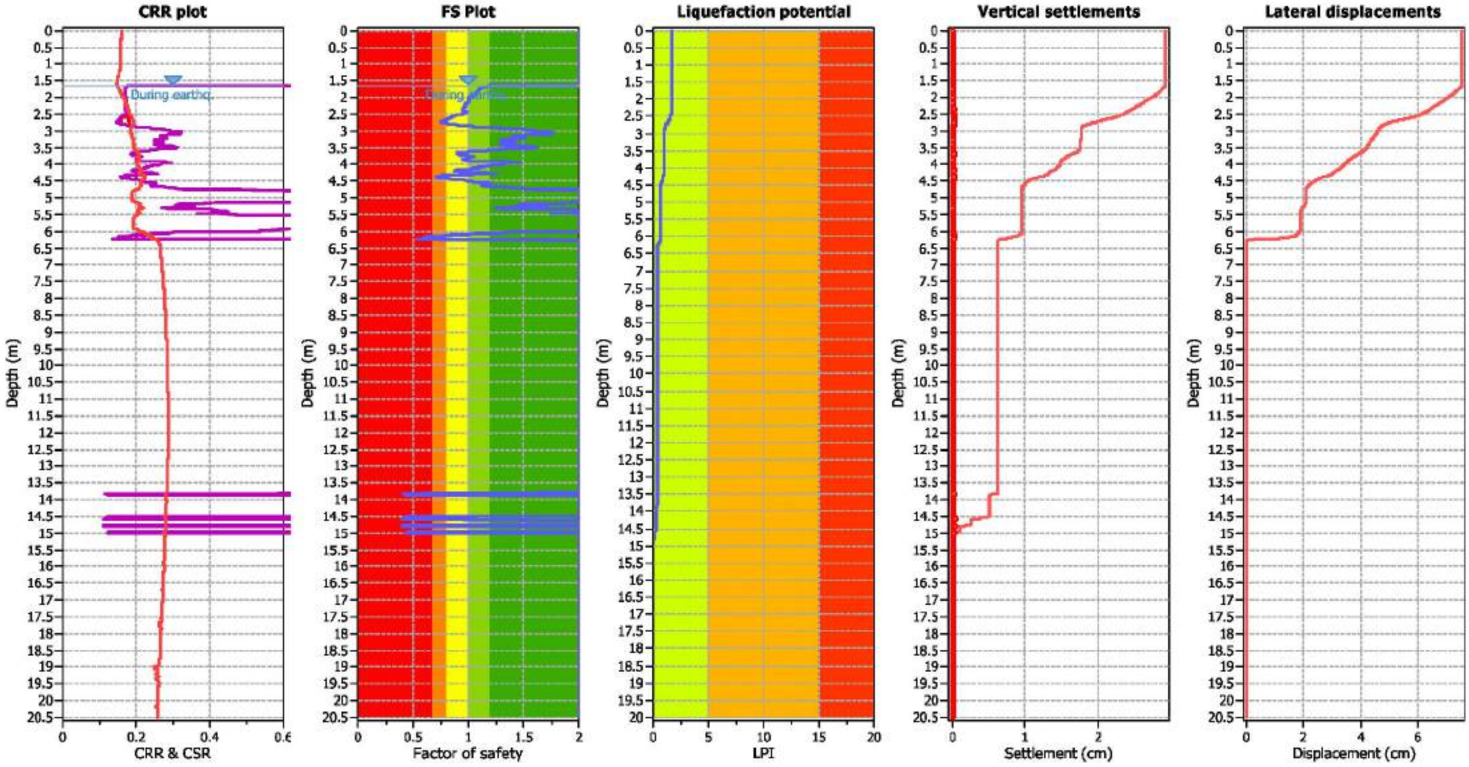
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

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LPI color scheme

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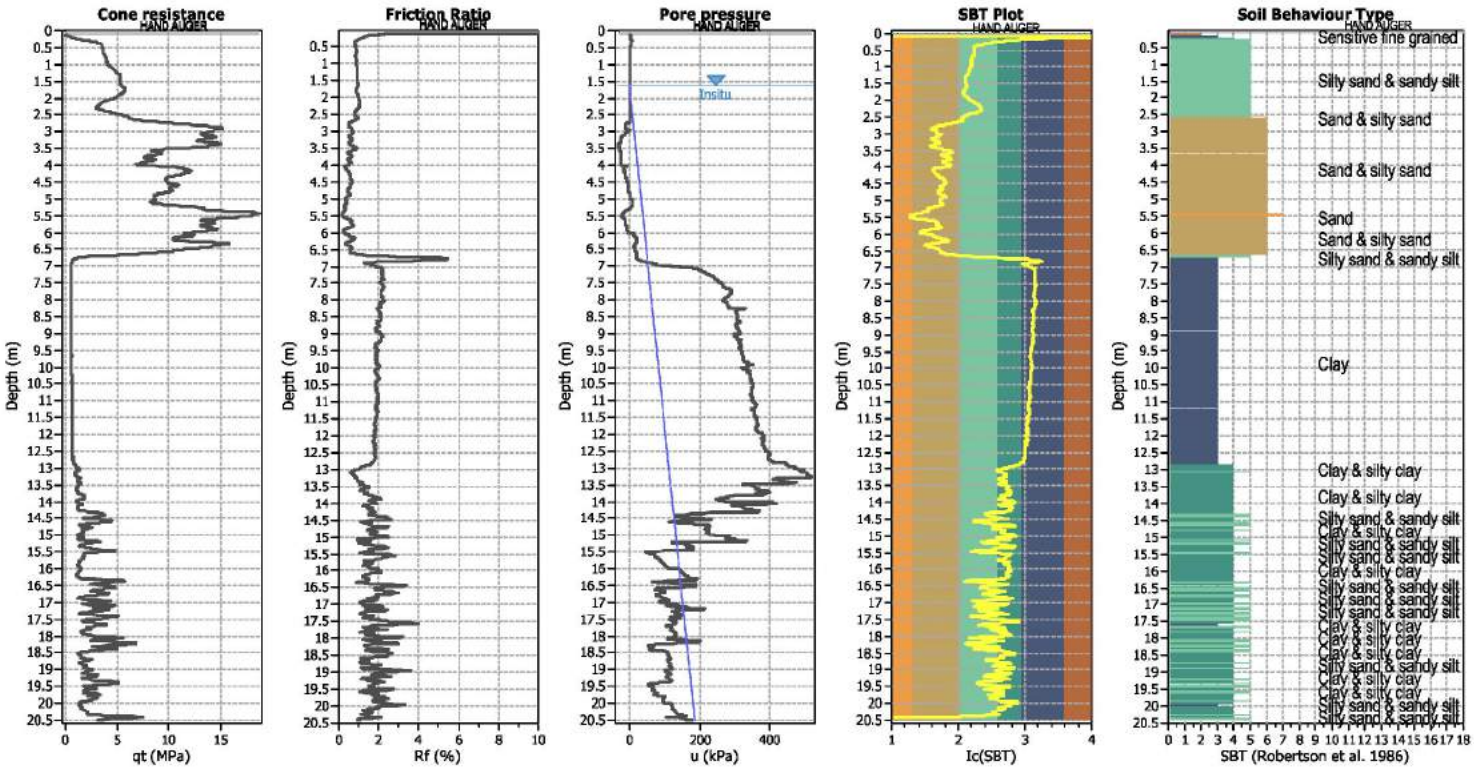
CPT basic interpretation plots



Input parameters and analysis data

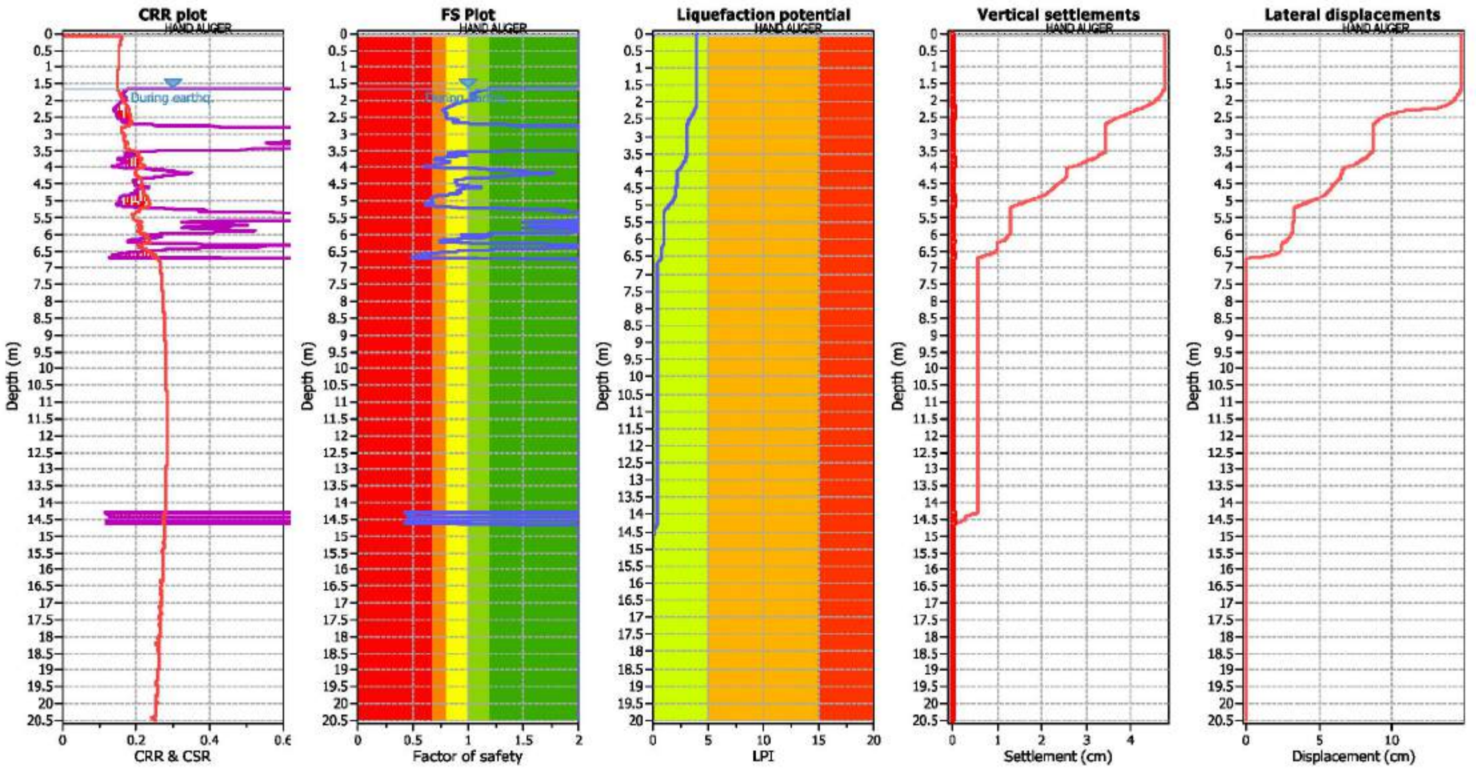
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

CPT name: ILS- CPT02

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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LPI color scheme

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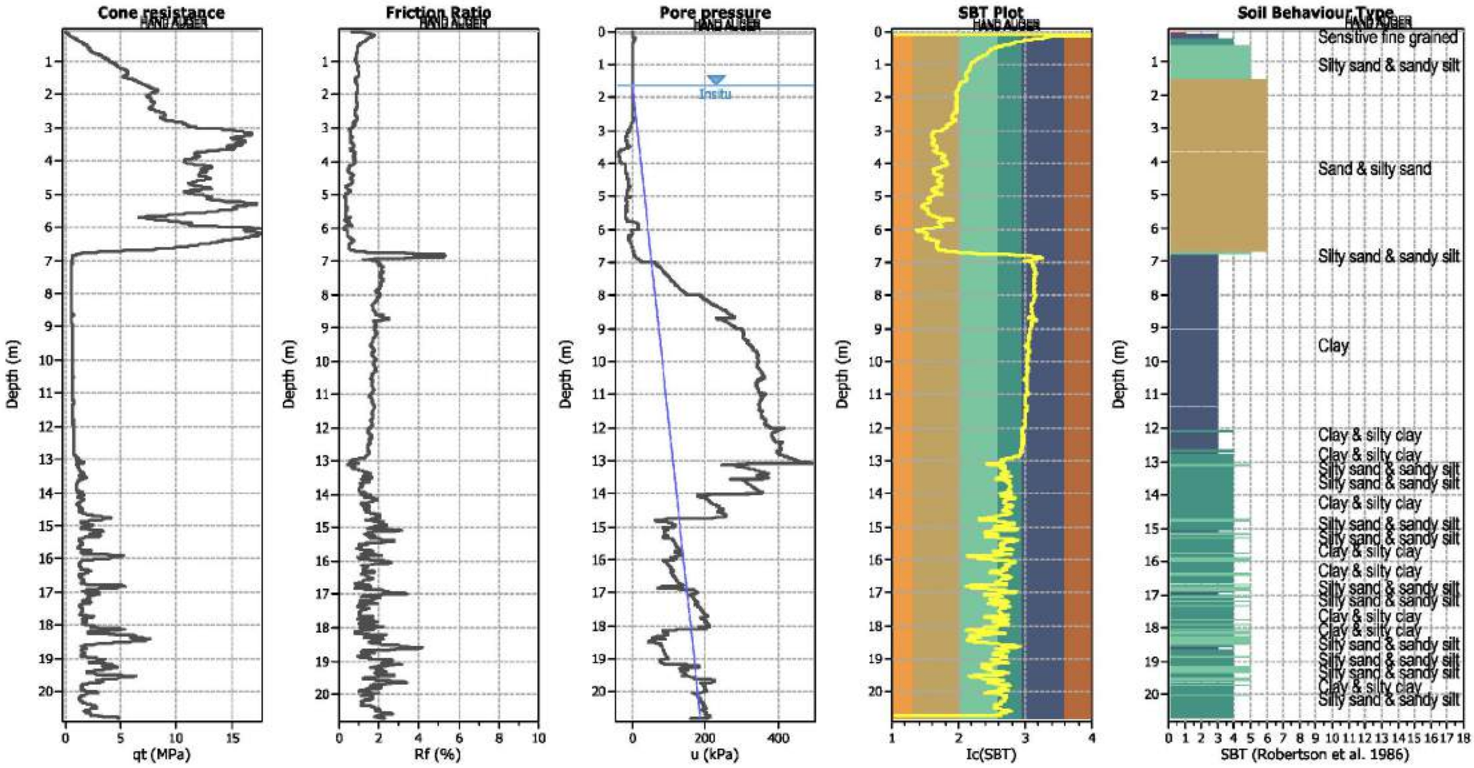
CPT basic interpretation plots



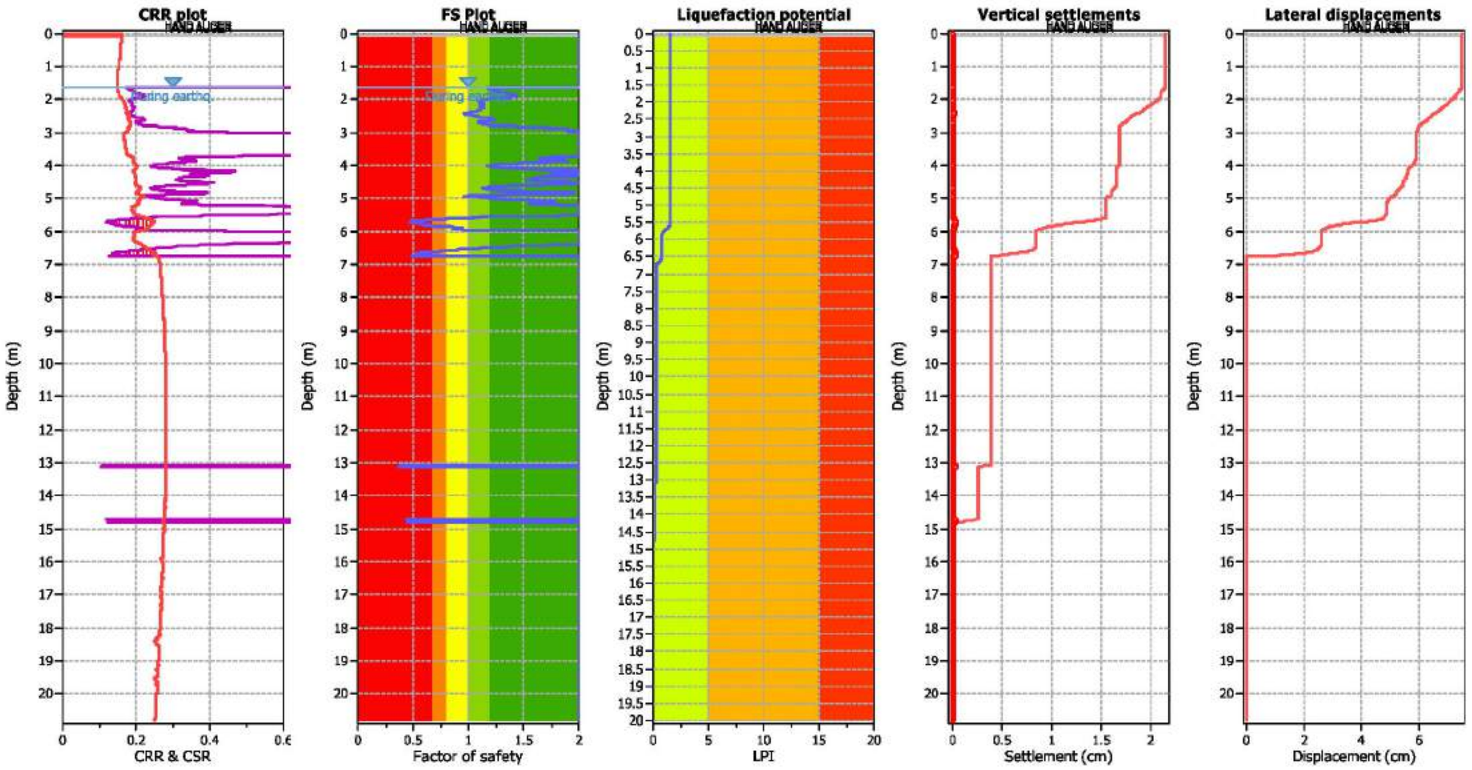
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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LPI color scheme

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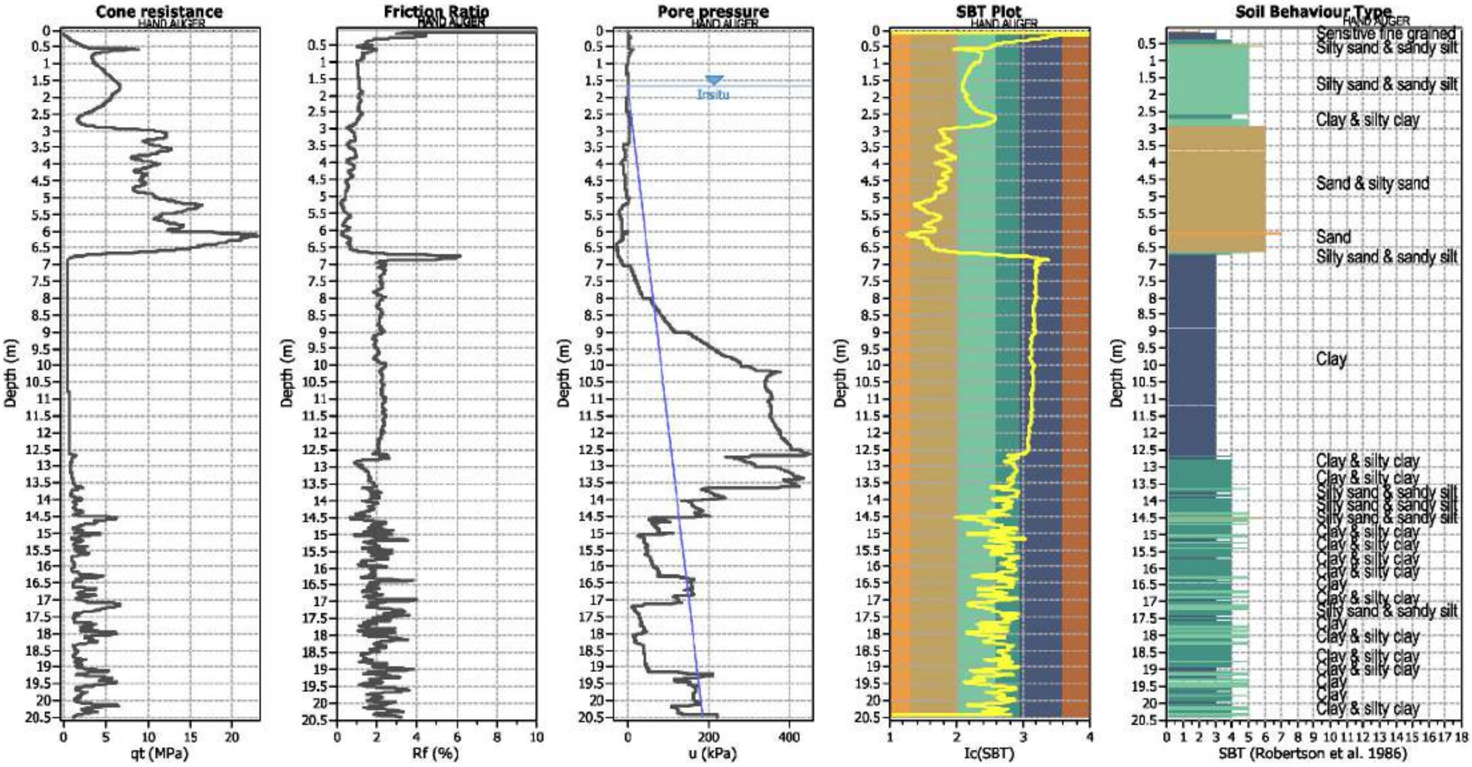
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

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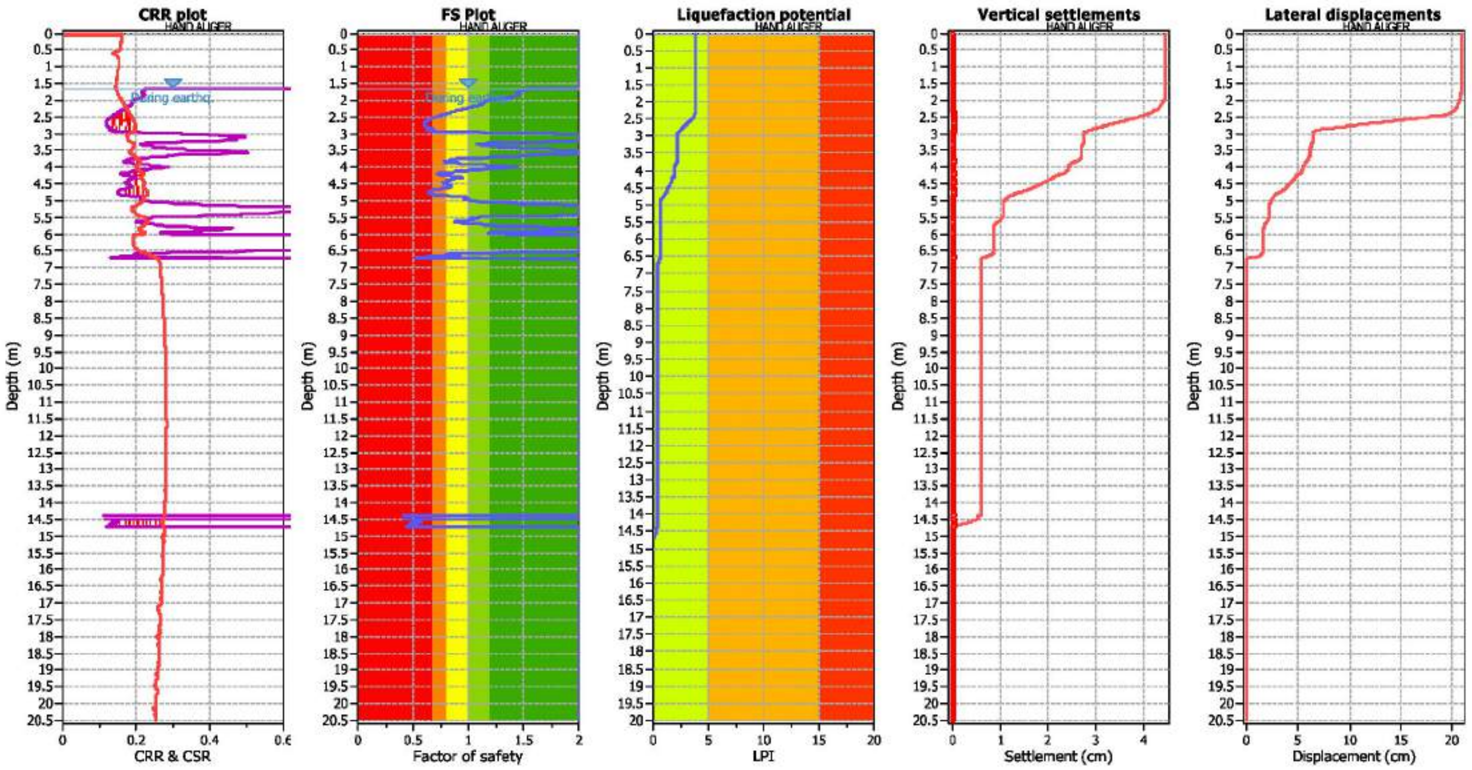
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
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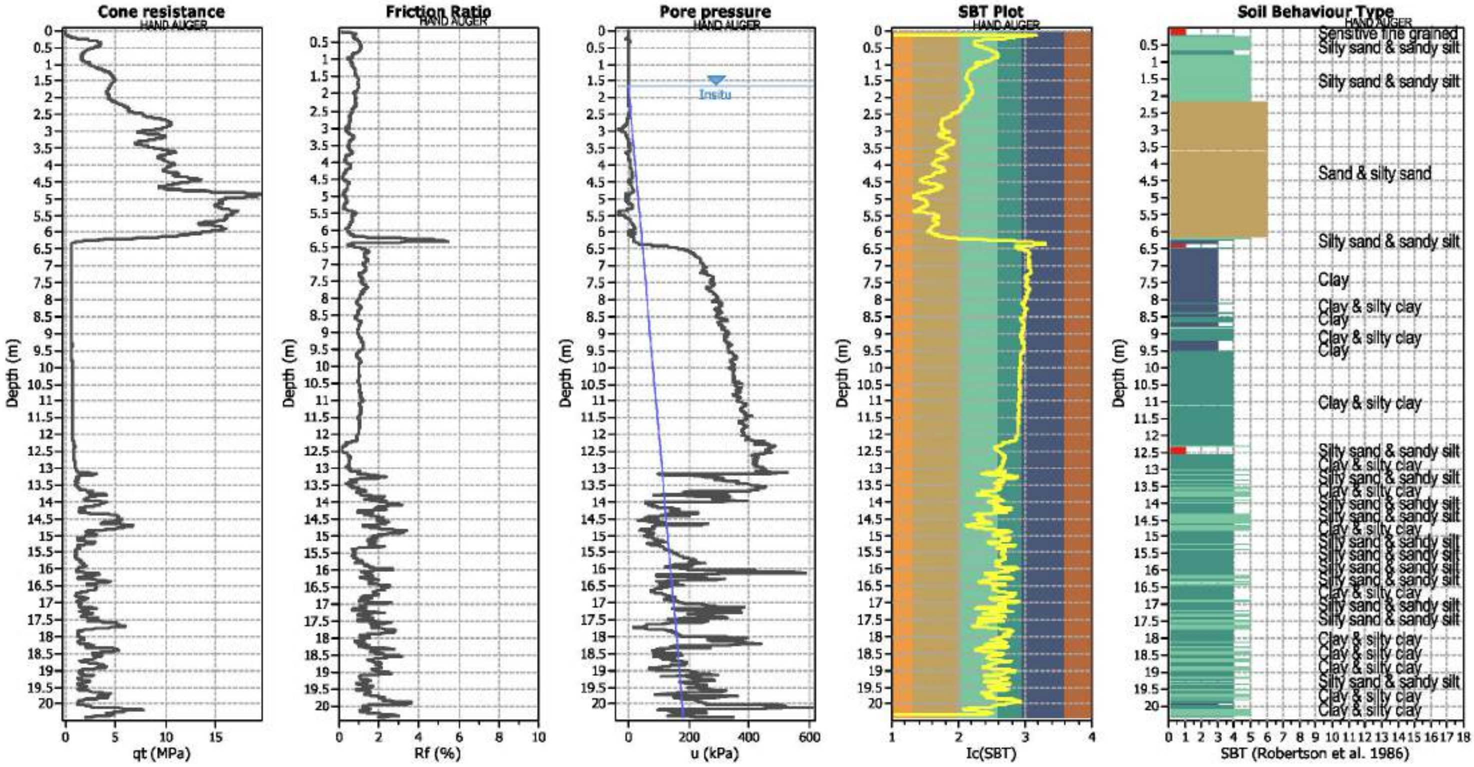
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

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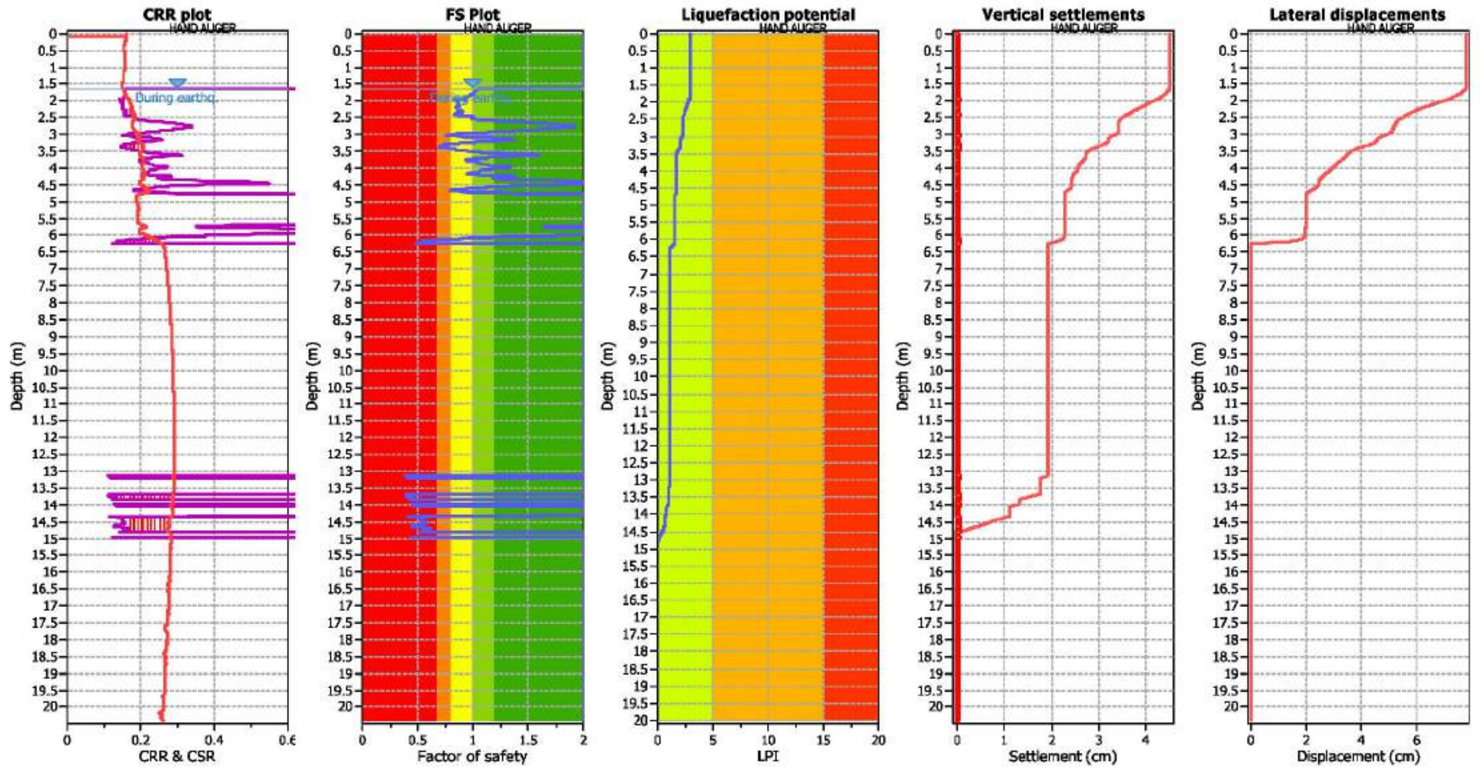
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
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Fill height: N/A

Fill weight: N/A
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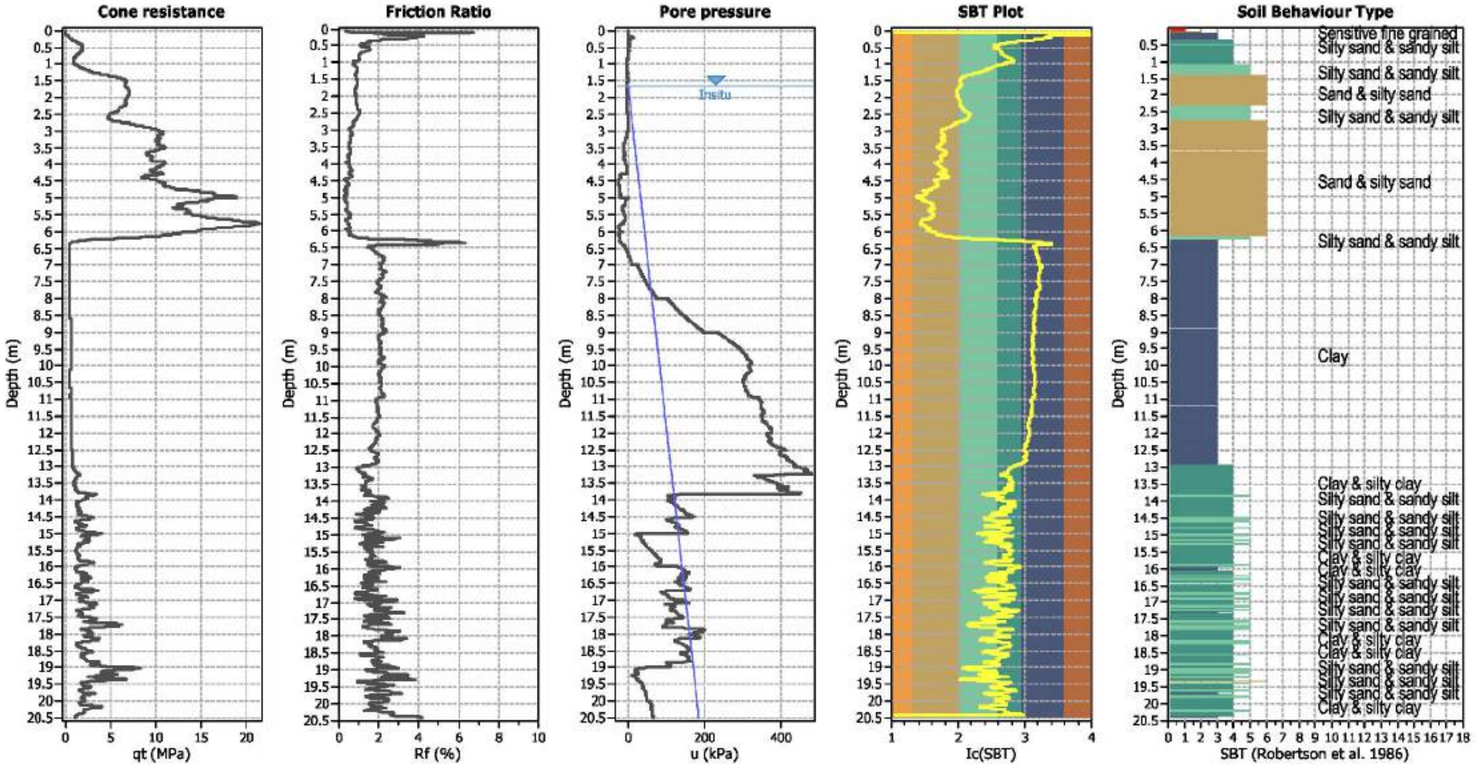
CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
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Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
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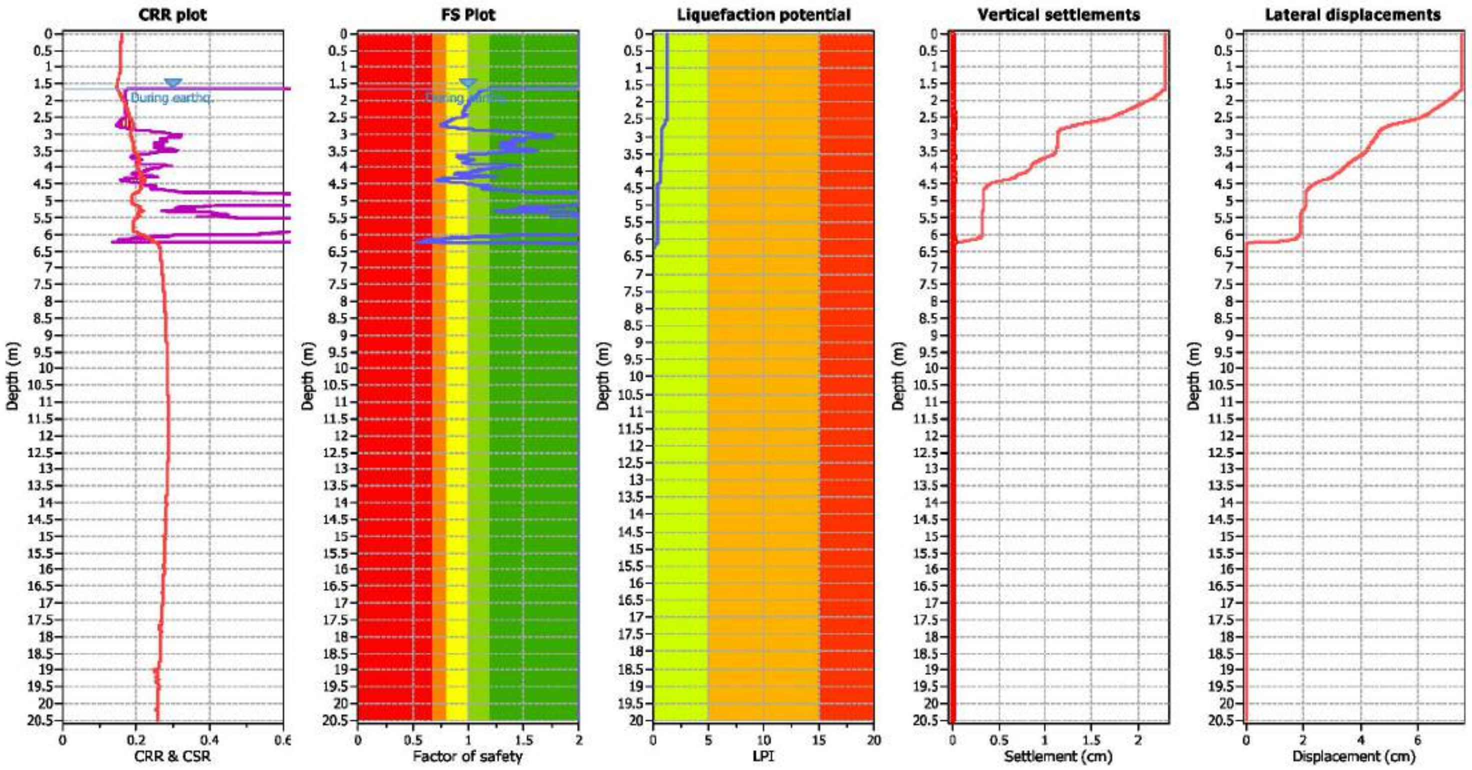
Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
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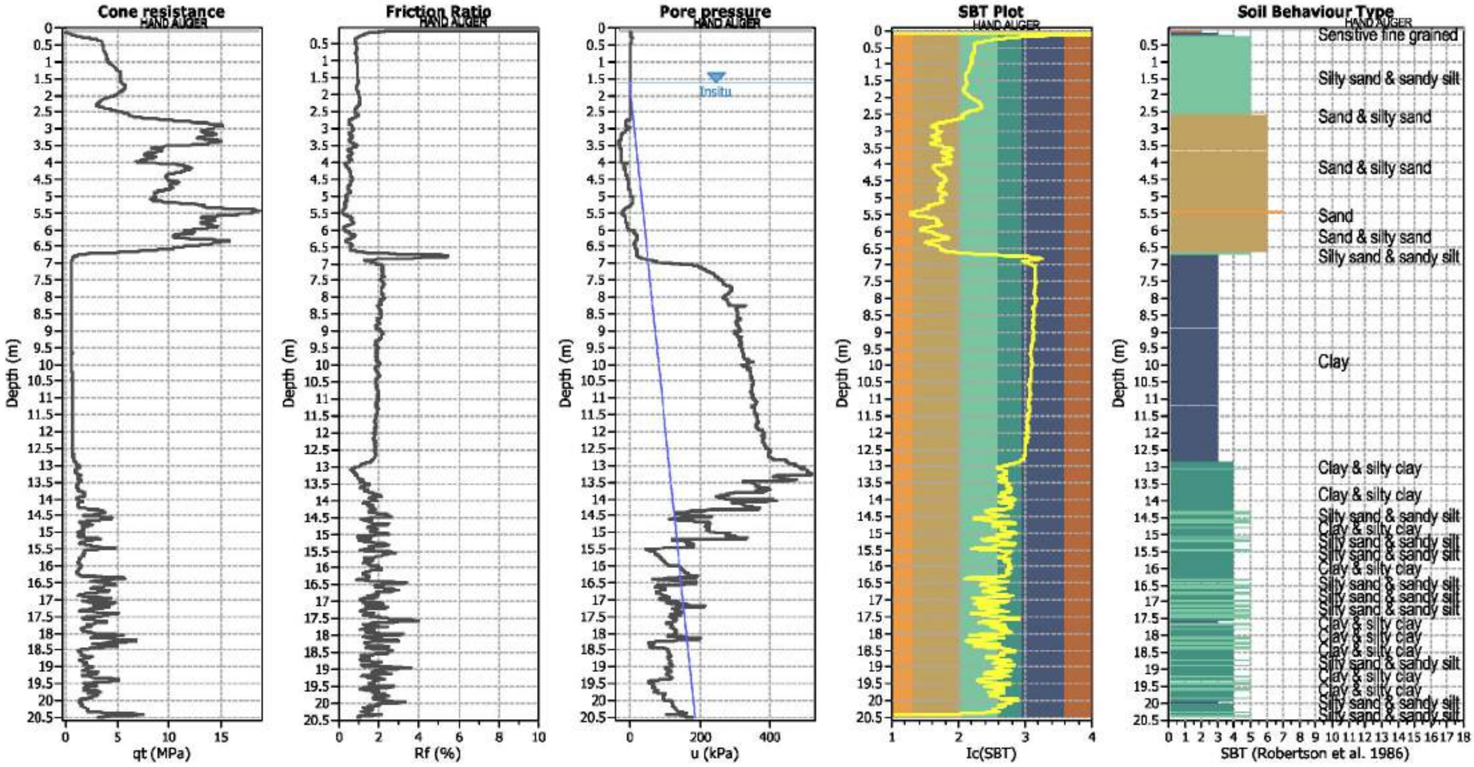
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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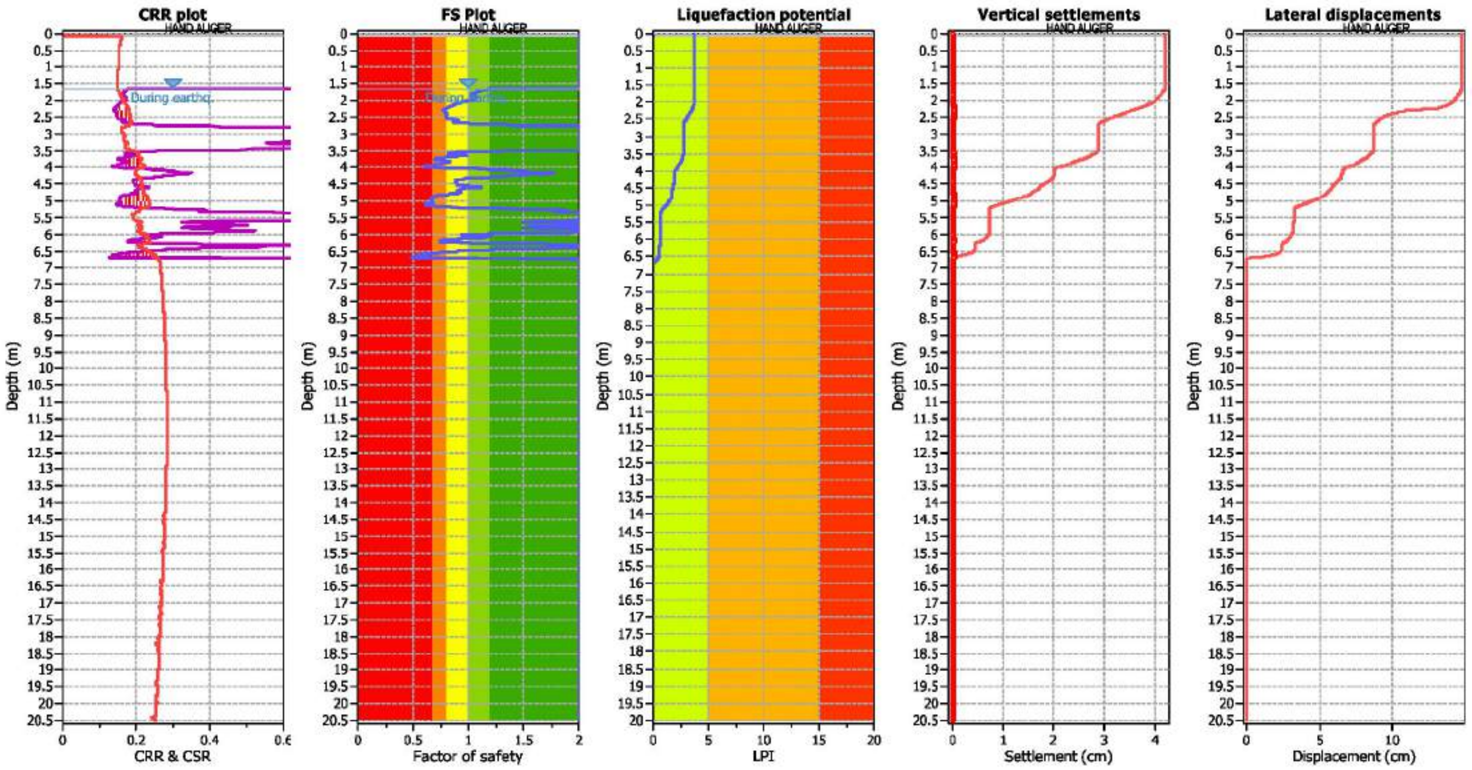
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	▨ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	☐ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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

LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
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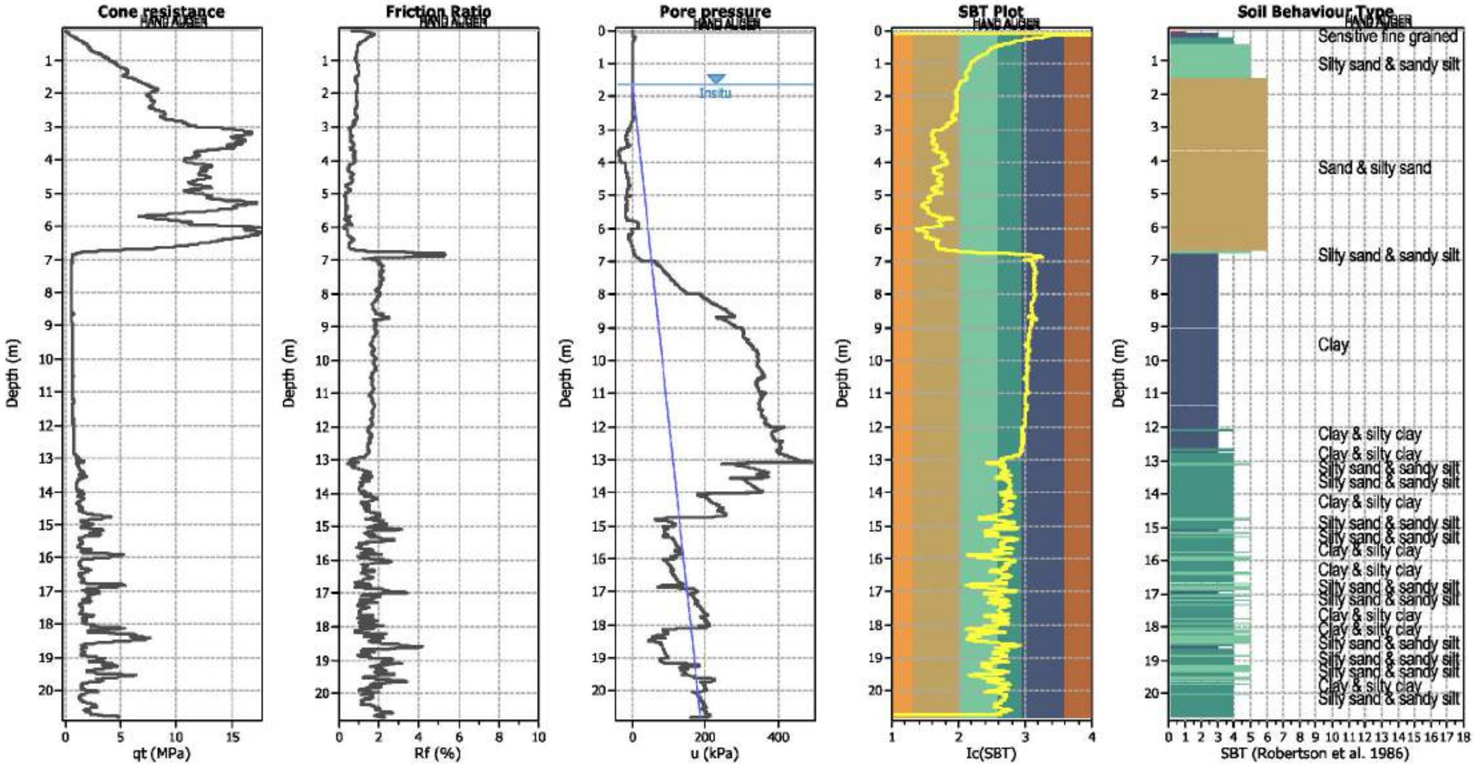
CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

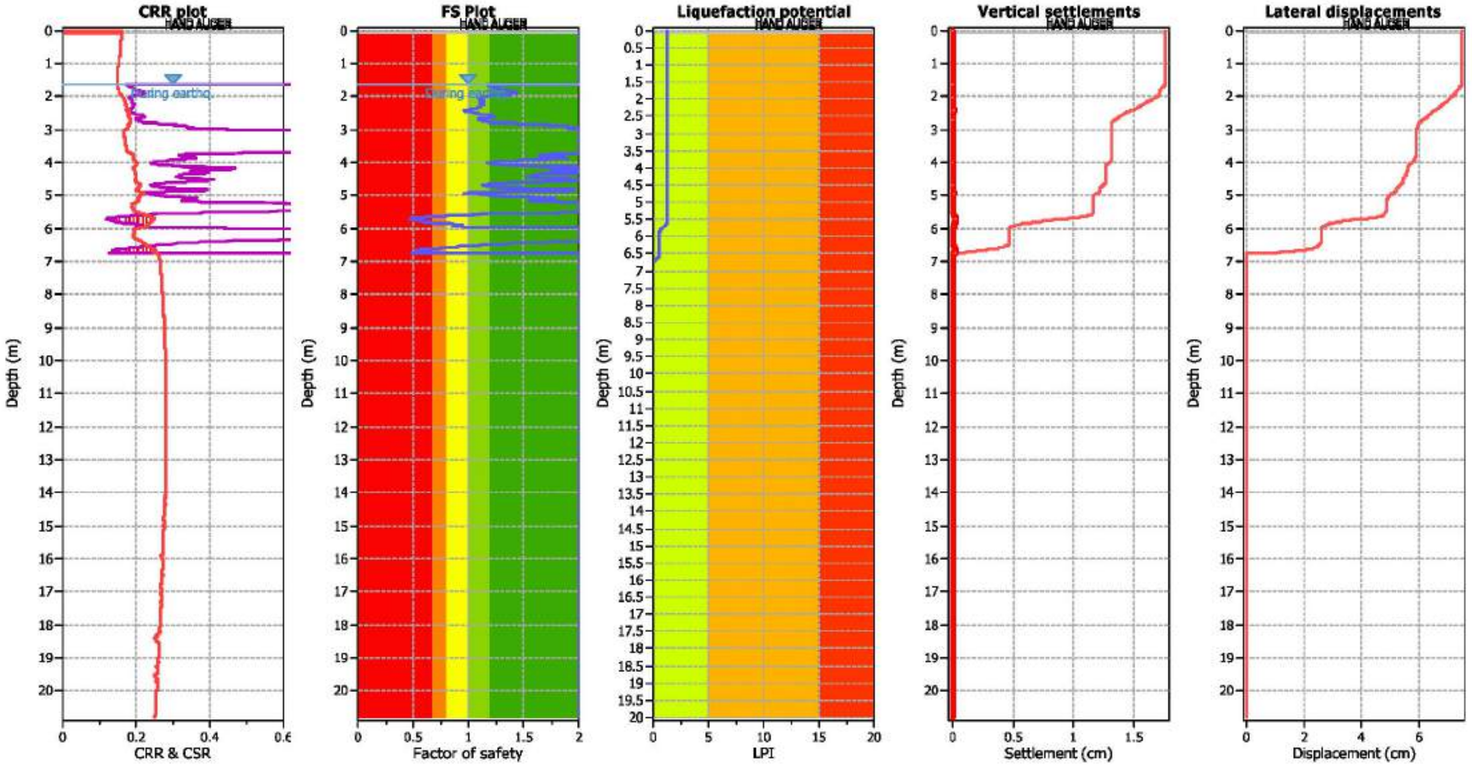
Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬜ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

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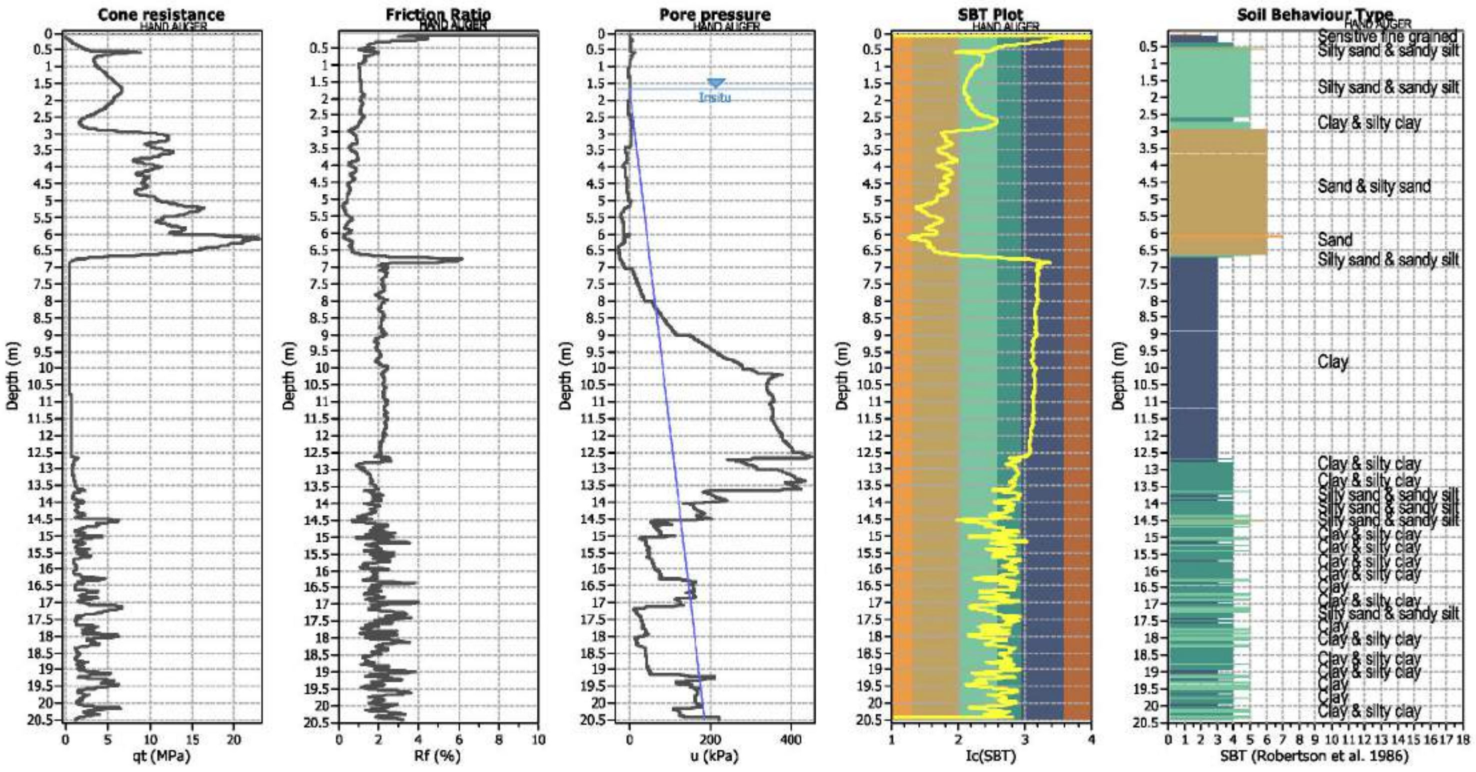
CPT basic interpretation plots



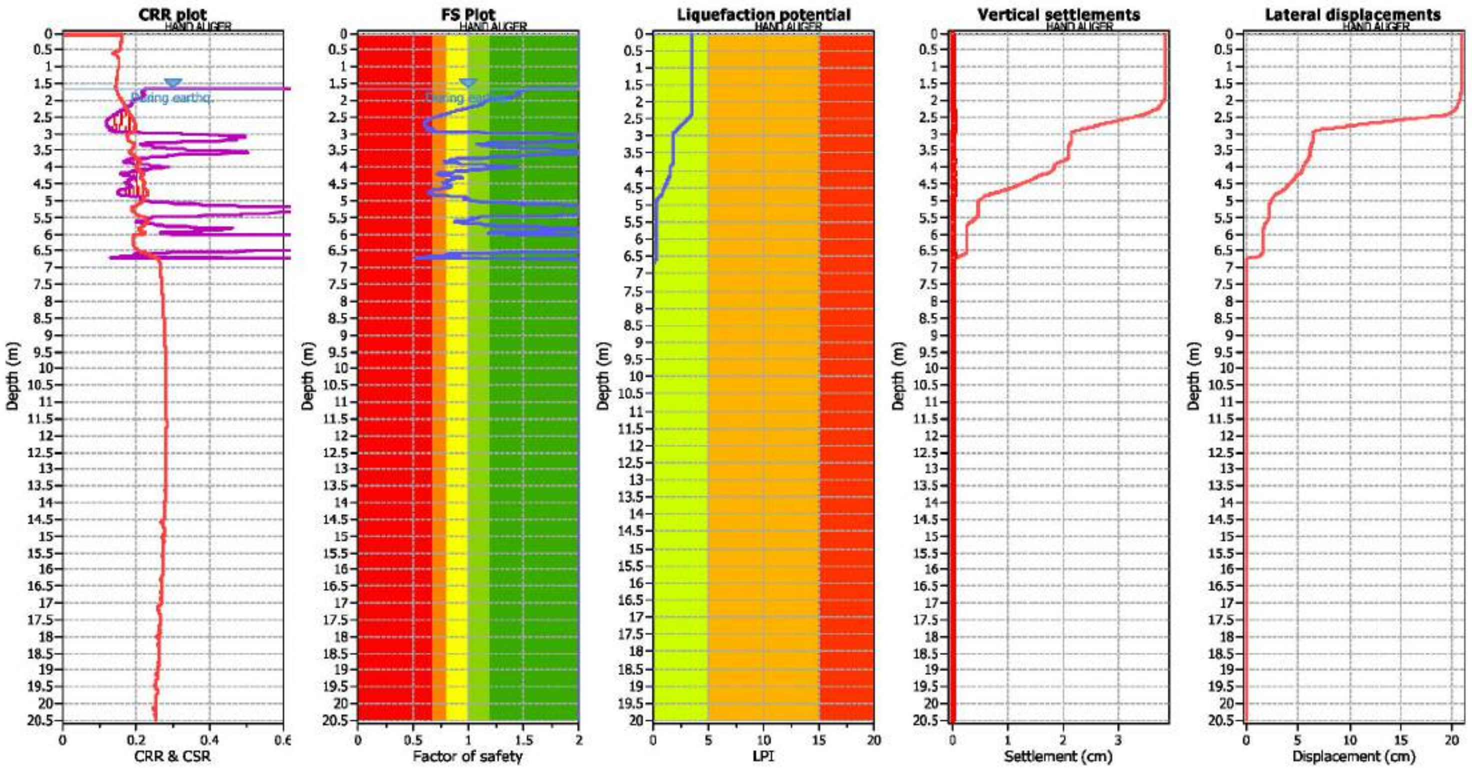
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
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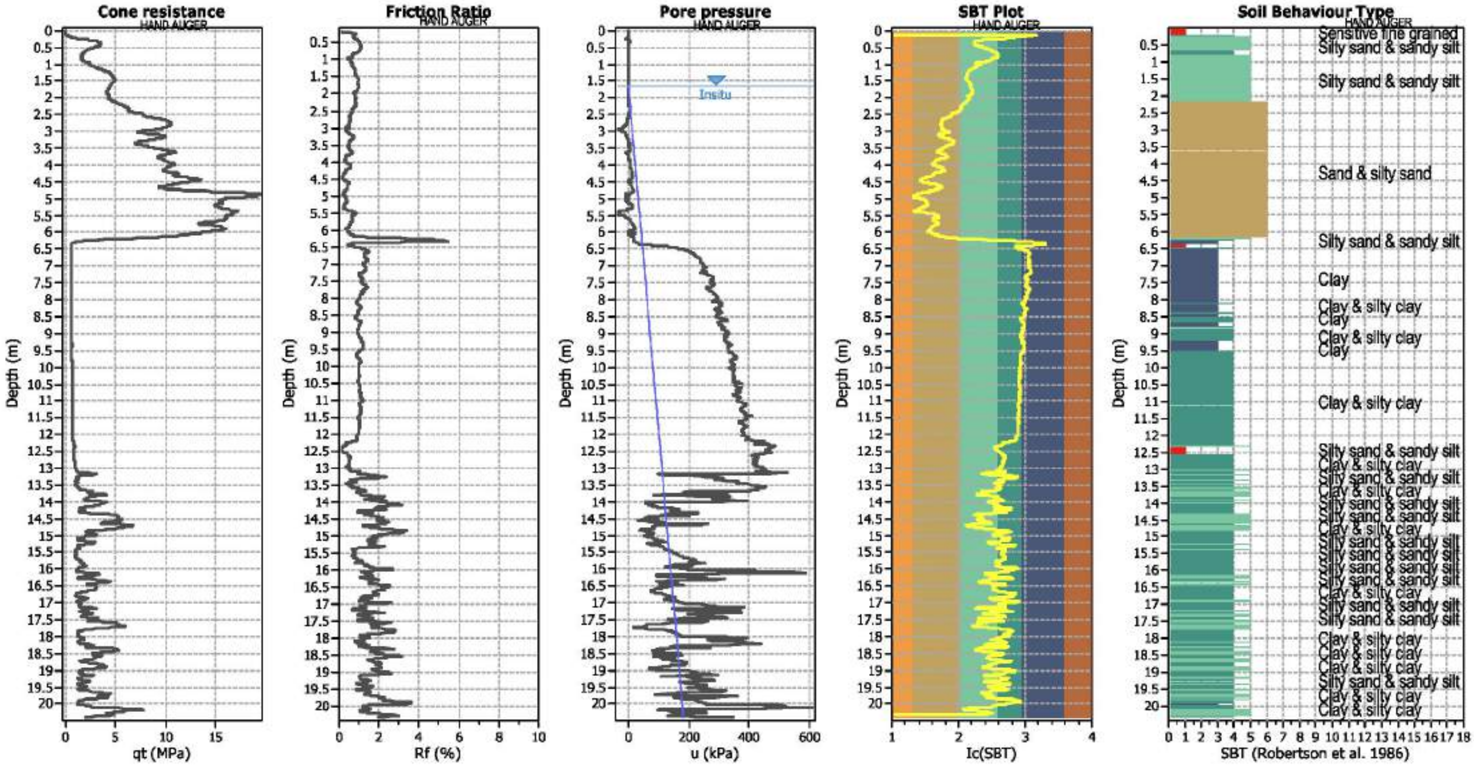
CPT basic interpretation plots



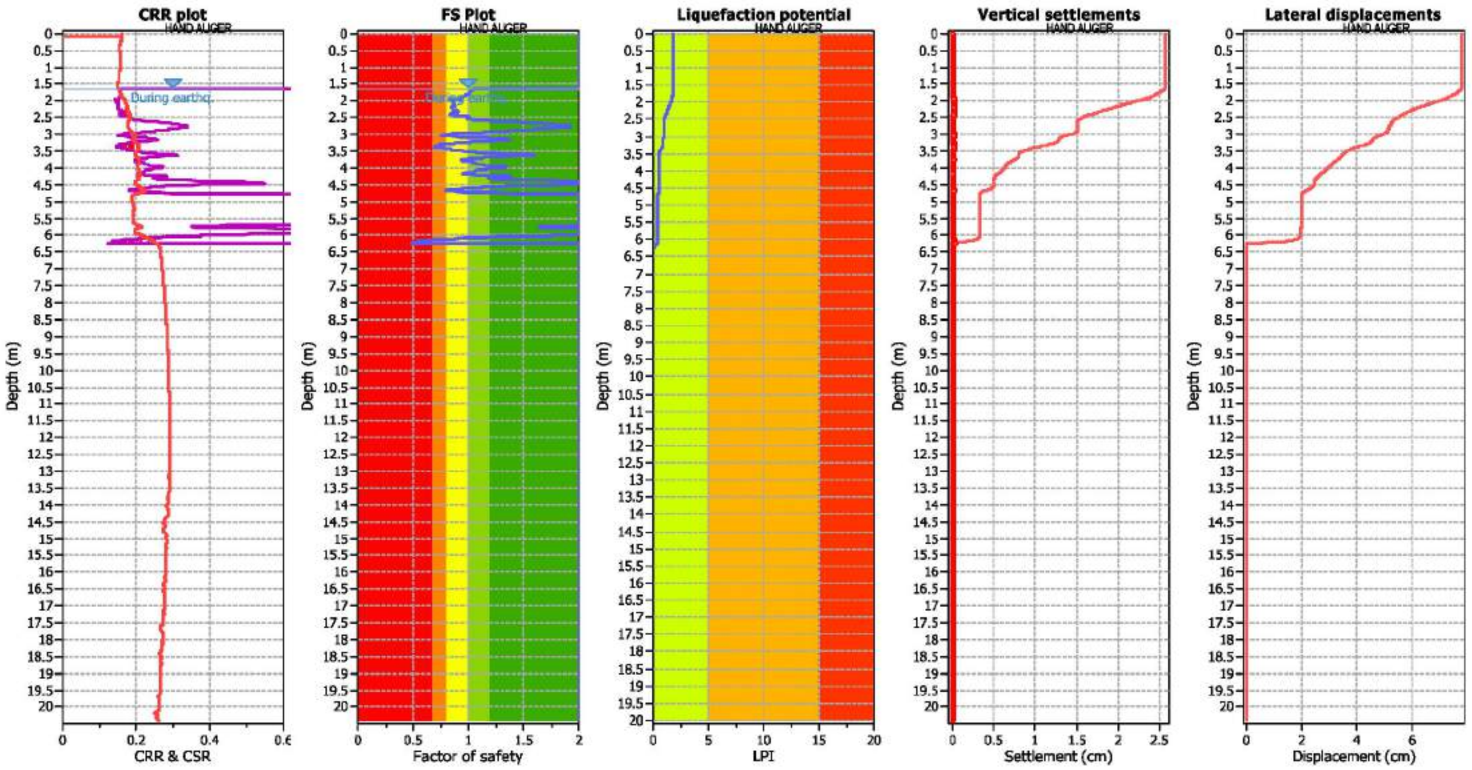
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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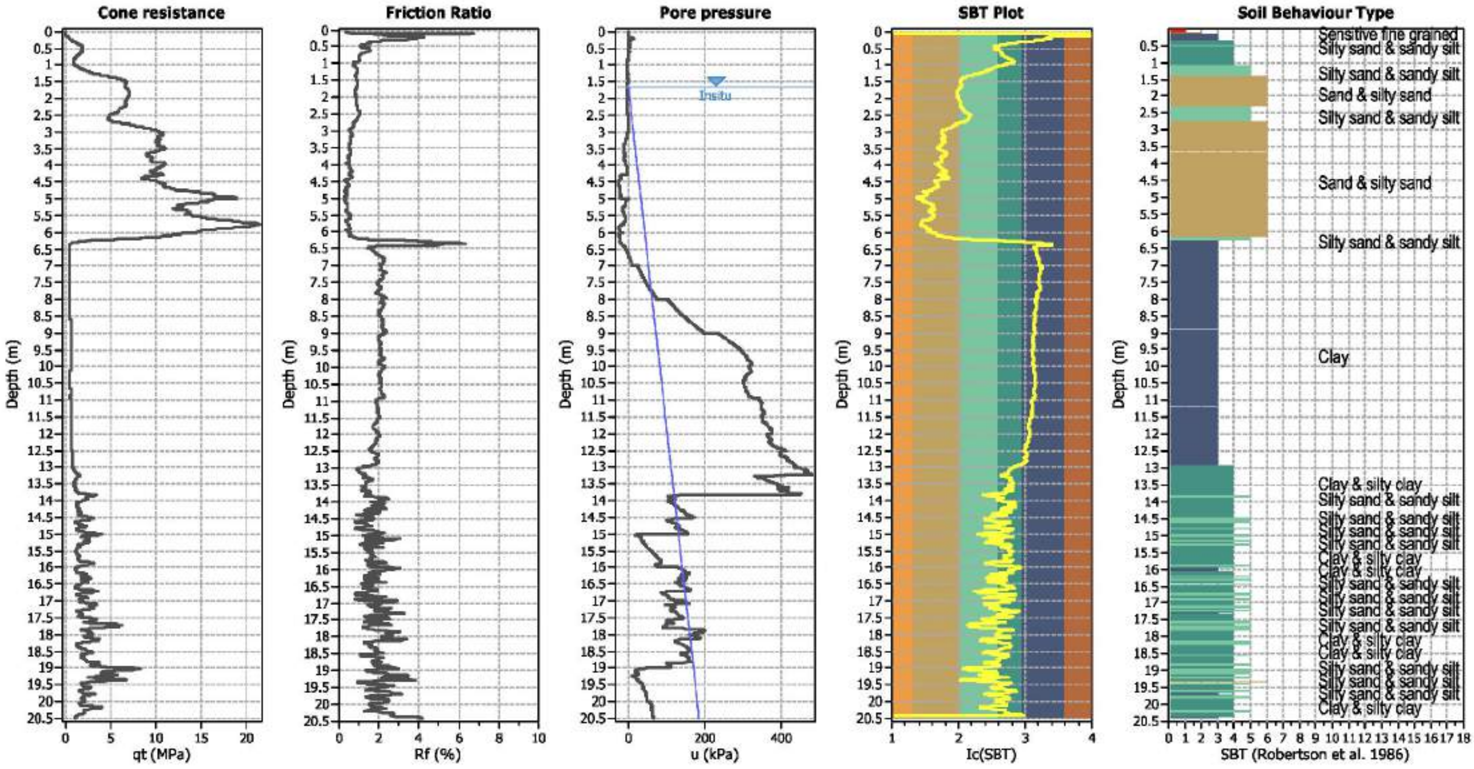
CPT basic interpretation plots



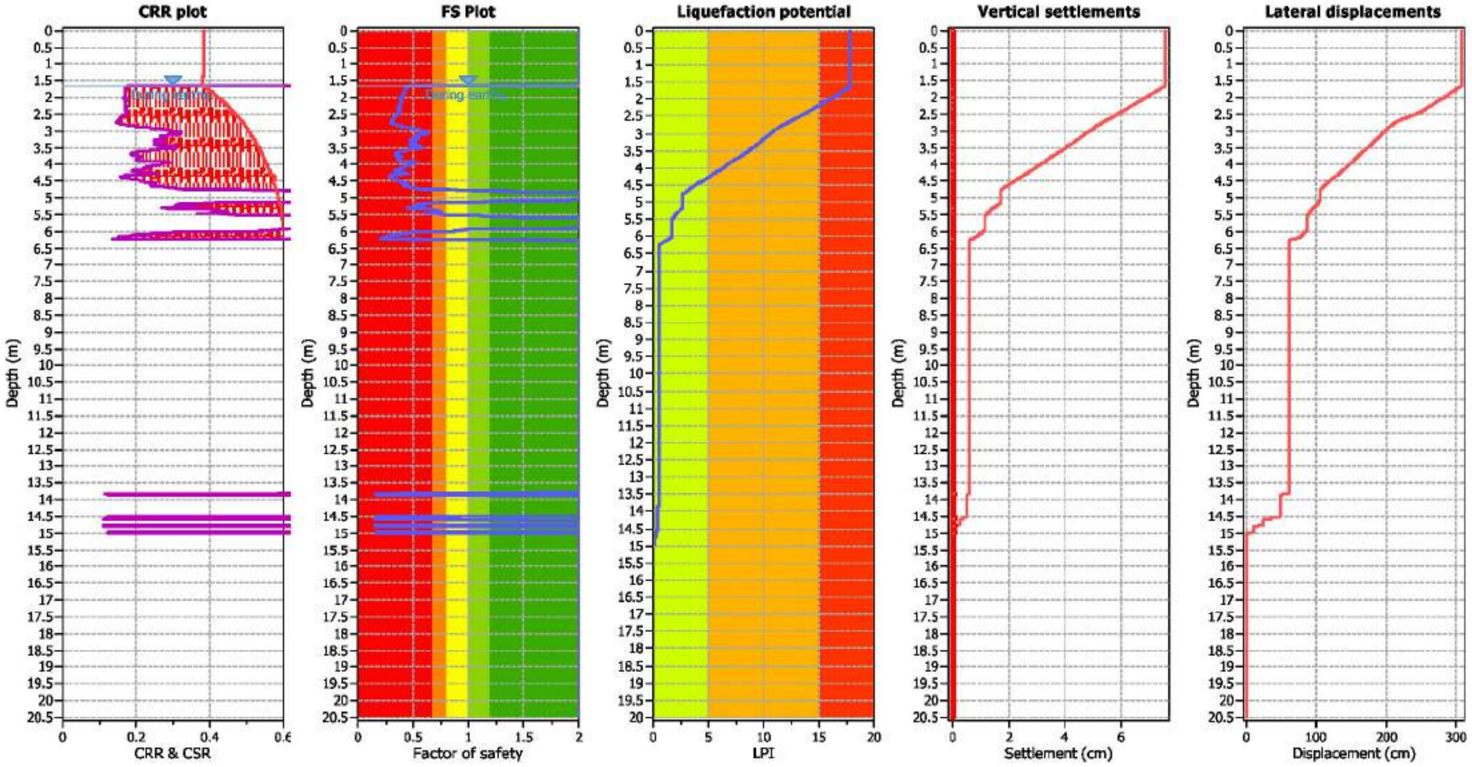
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
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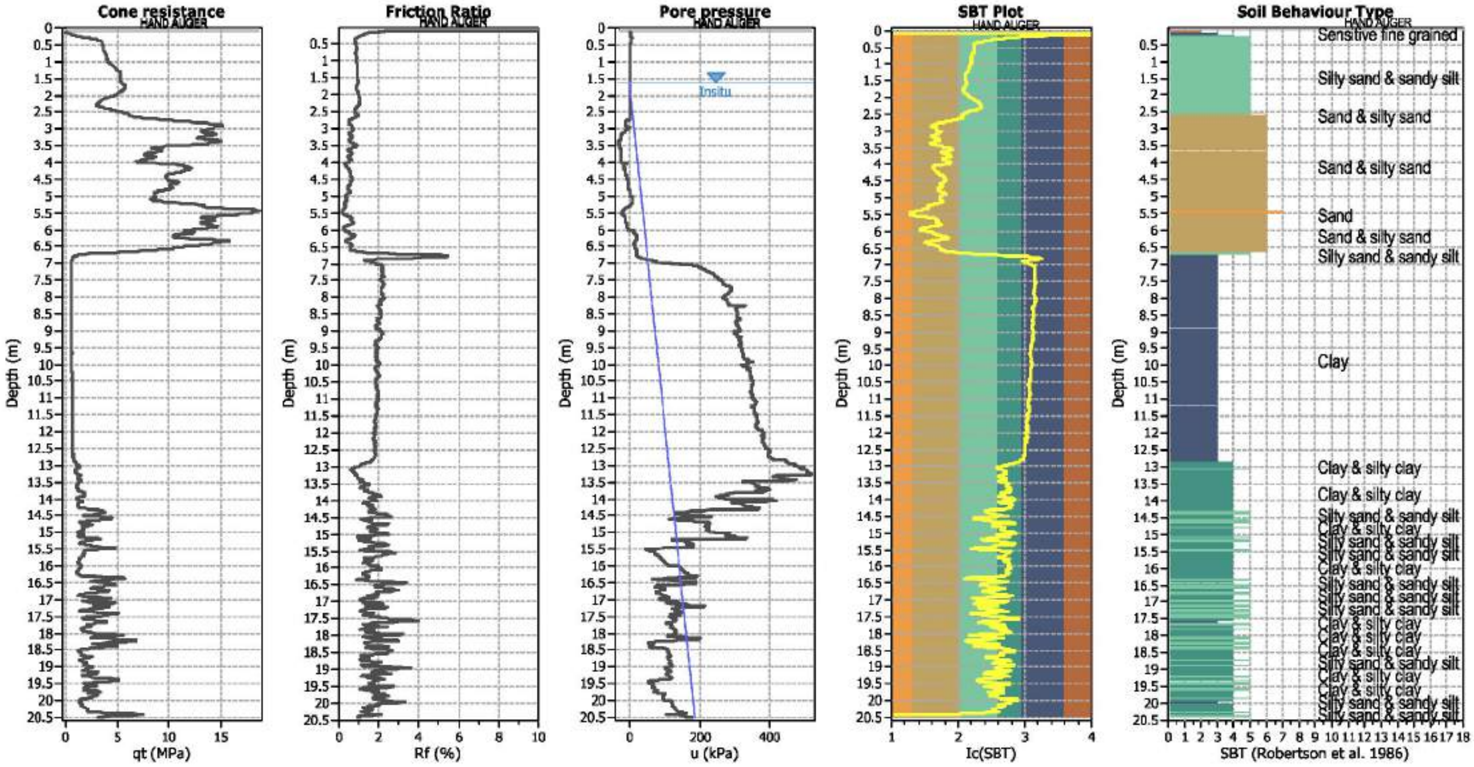
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

🟥 1. Sensitive fine grained
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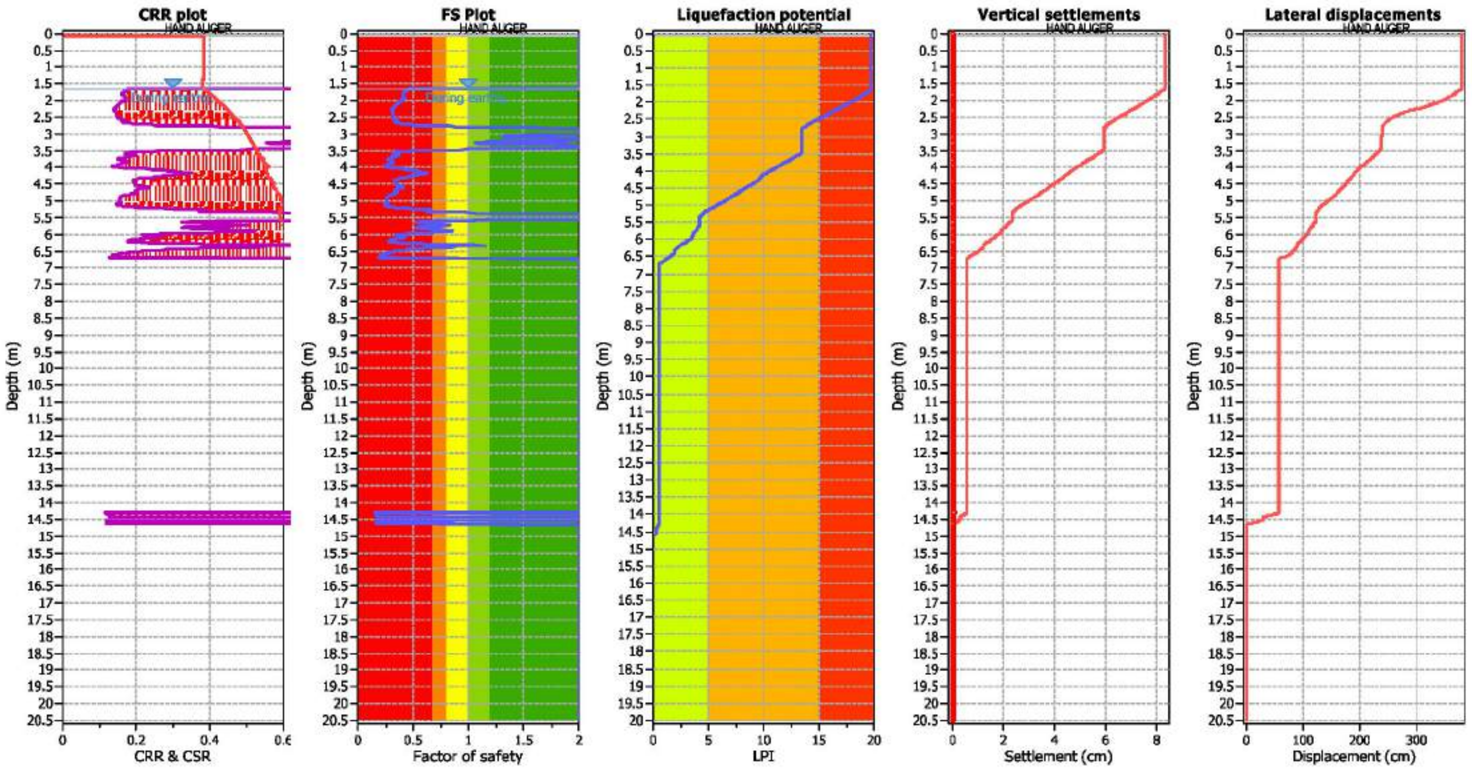
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to
⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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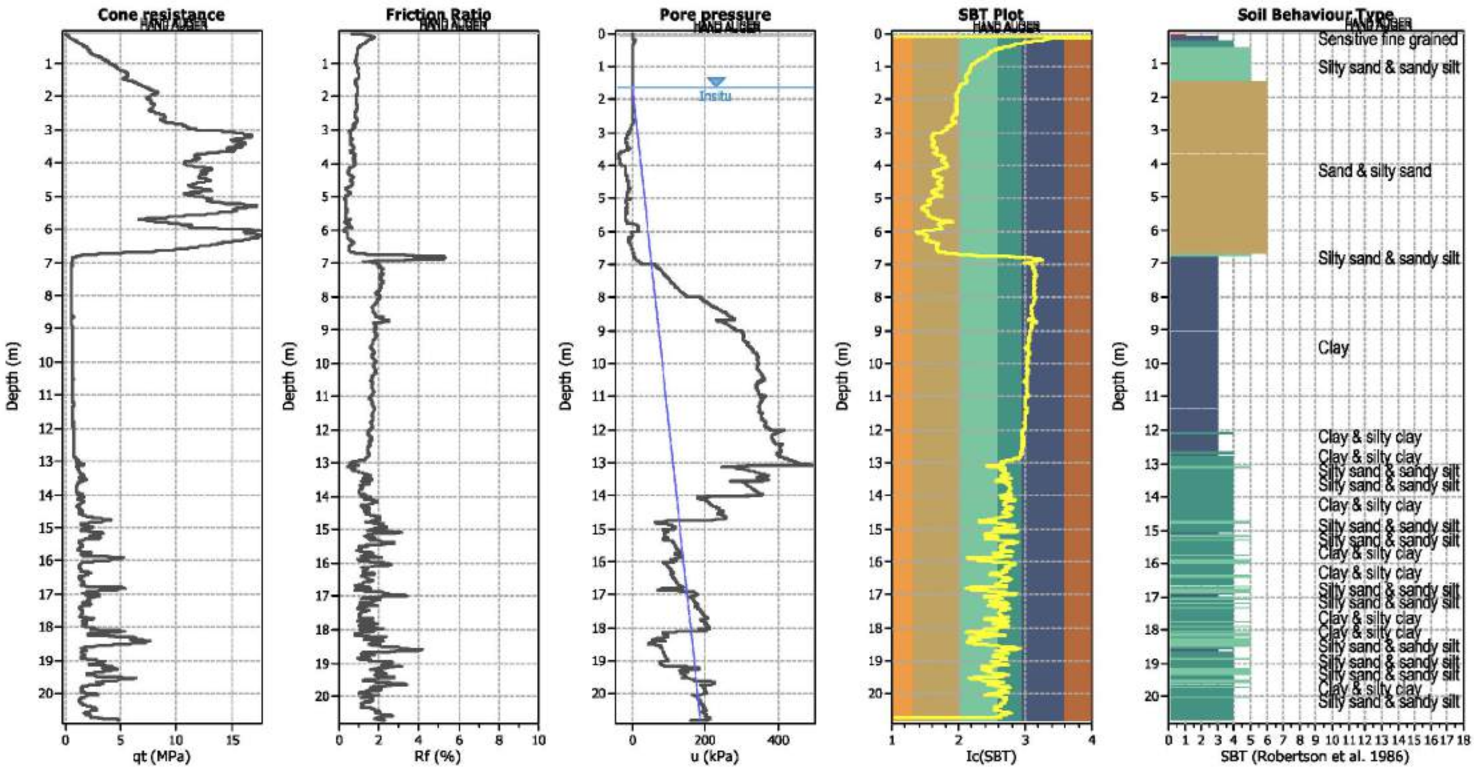
CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

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

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🟨 6. Clean sand to silty sand
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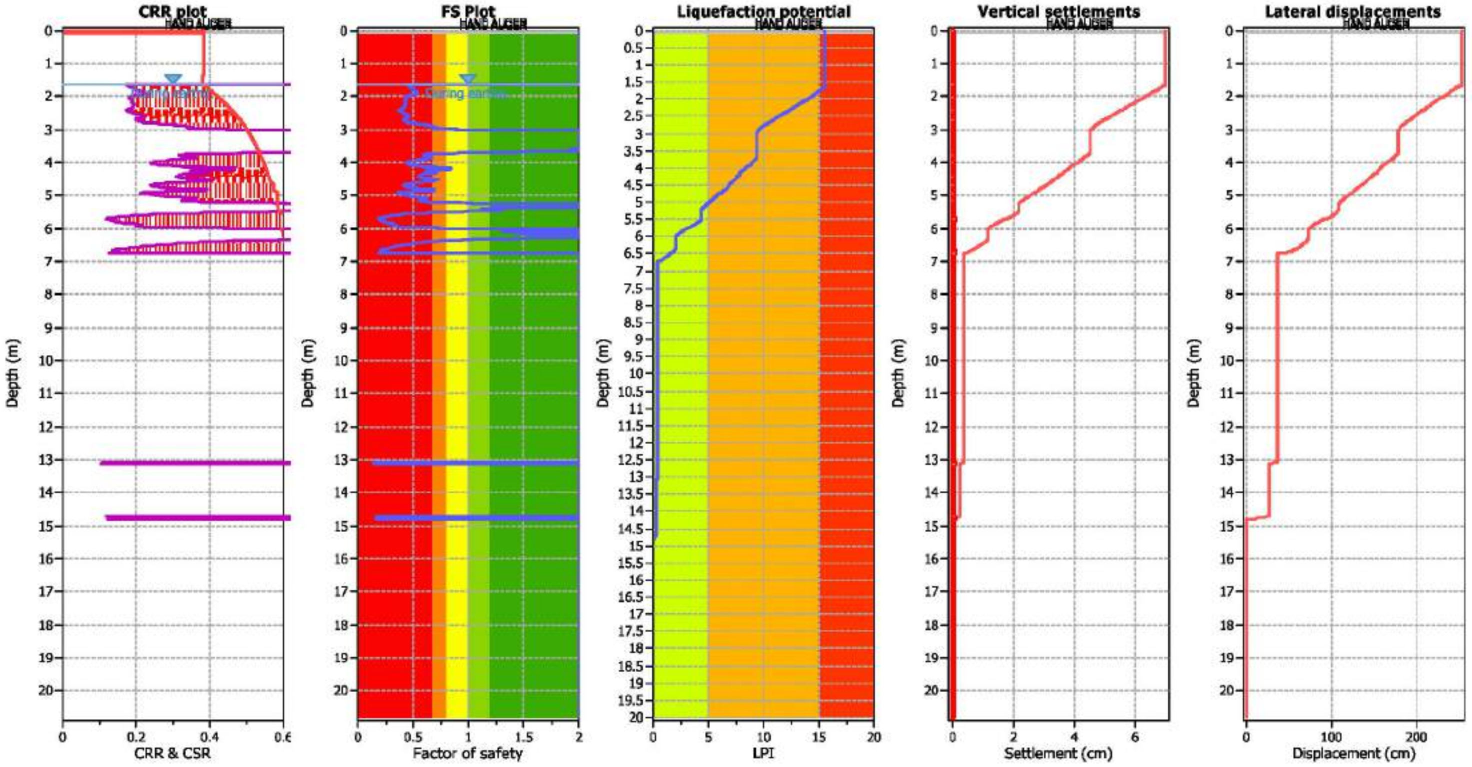
⬛ 8. Very stiff sand to
⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
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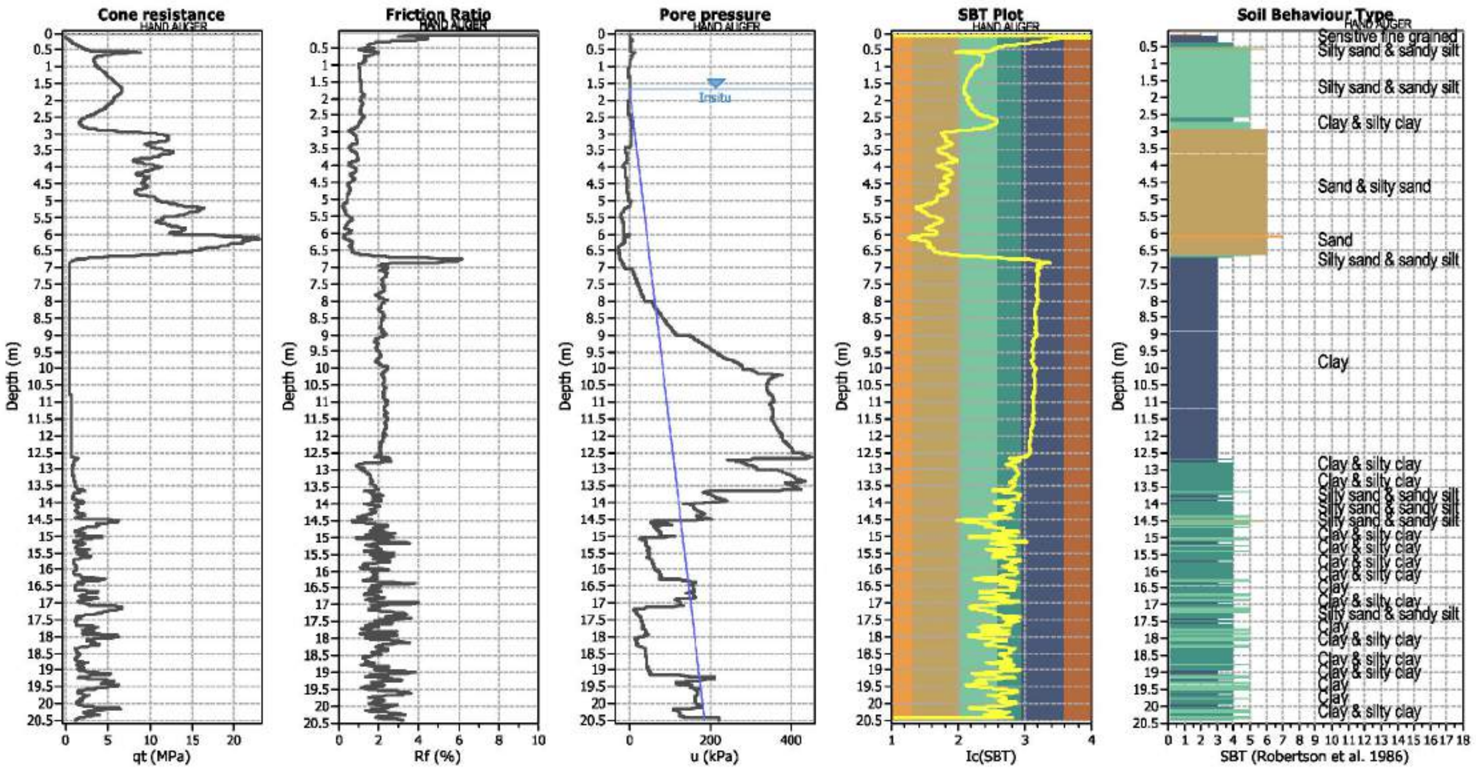
CPT basic interpretation plots



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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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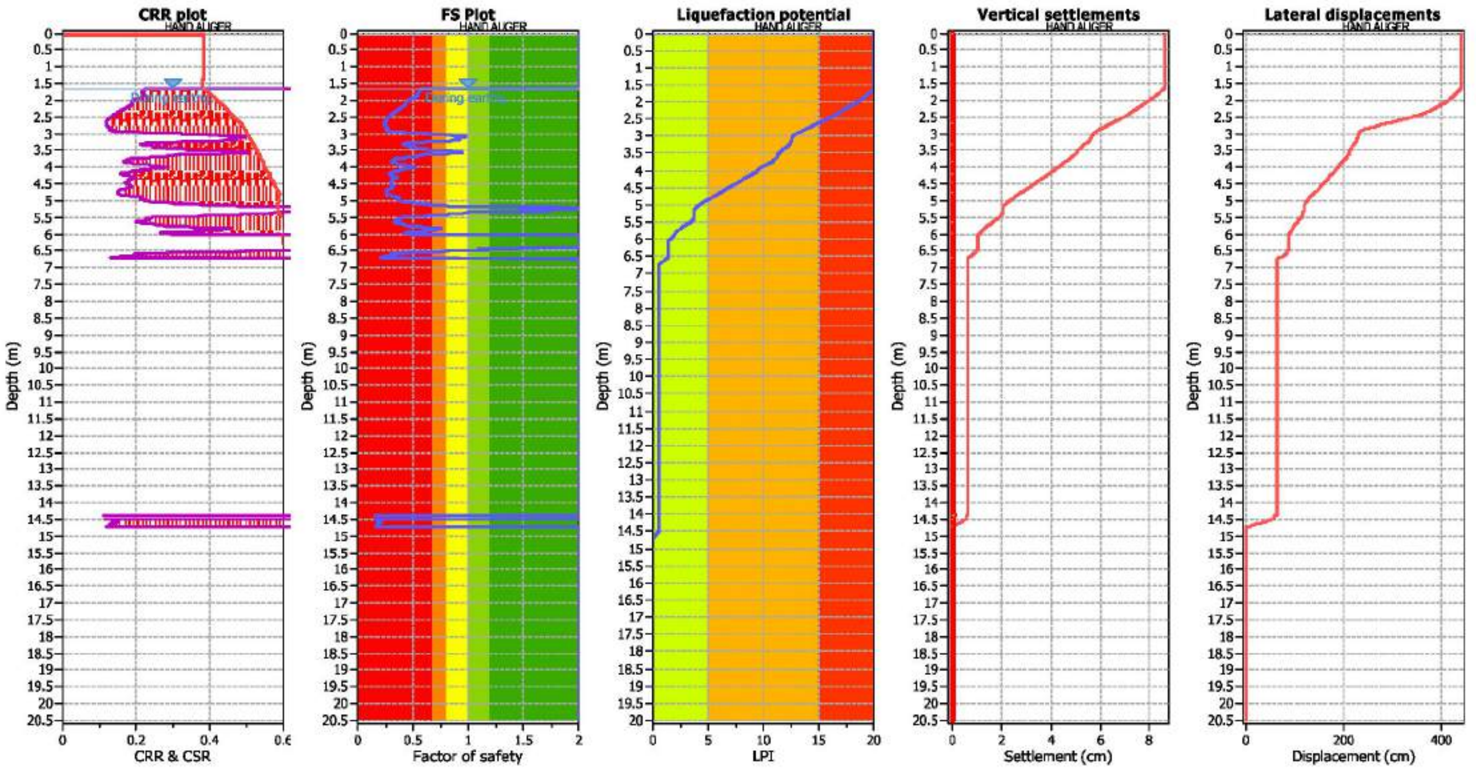
Liquefaction analysis overall plots



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Analysis method: B&I (2014)
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Points to test: Based on Ic value
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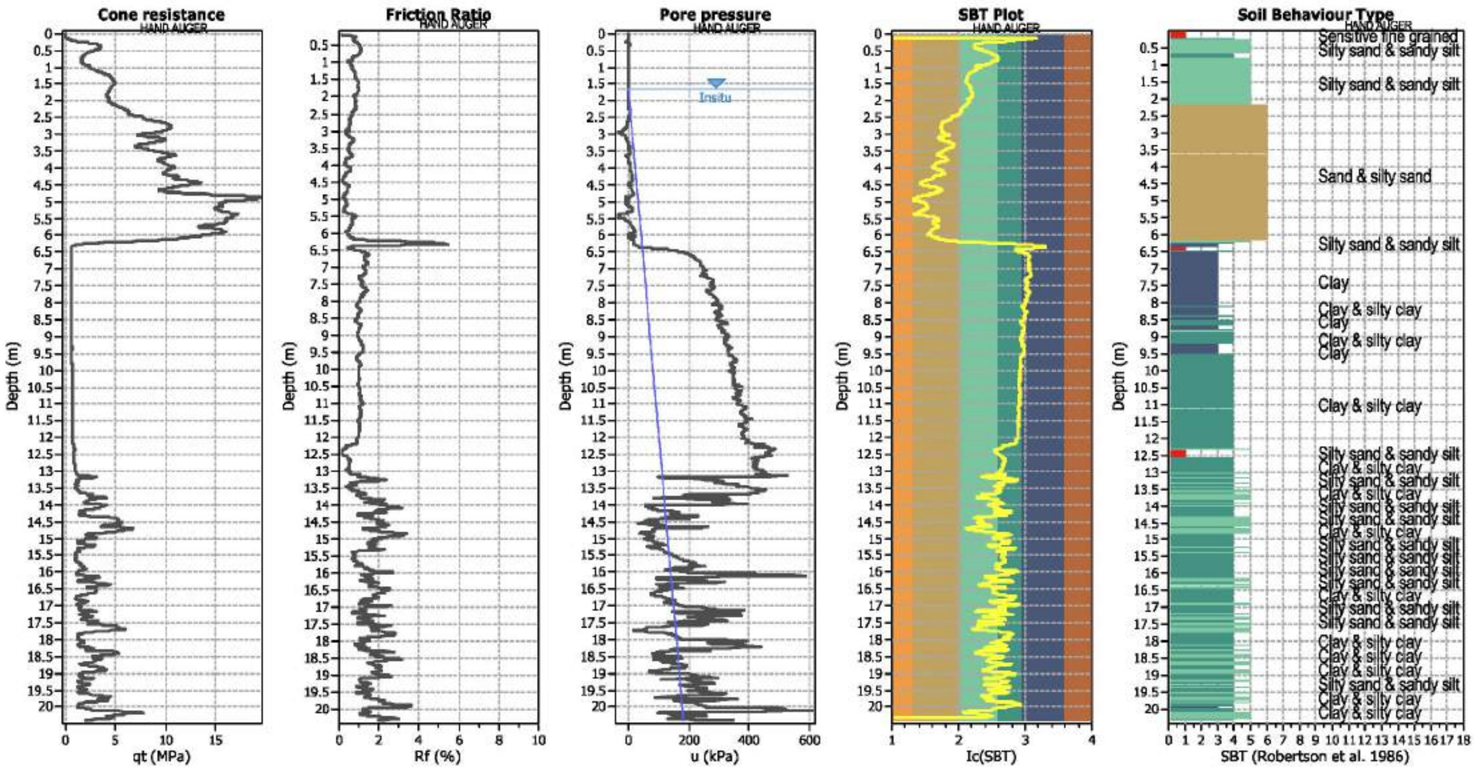
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
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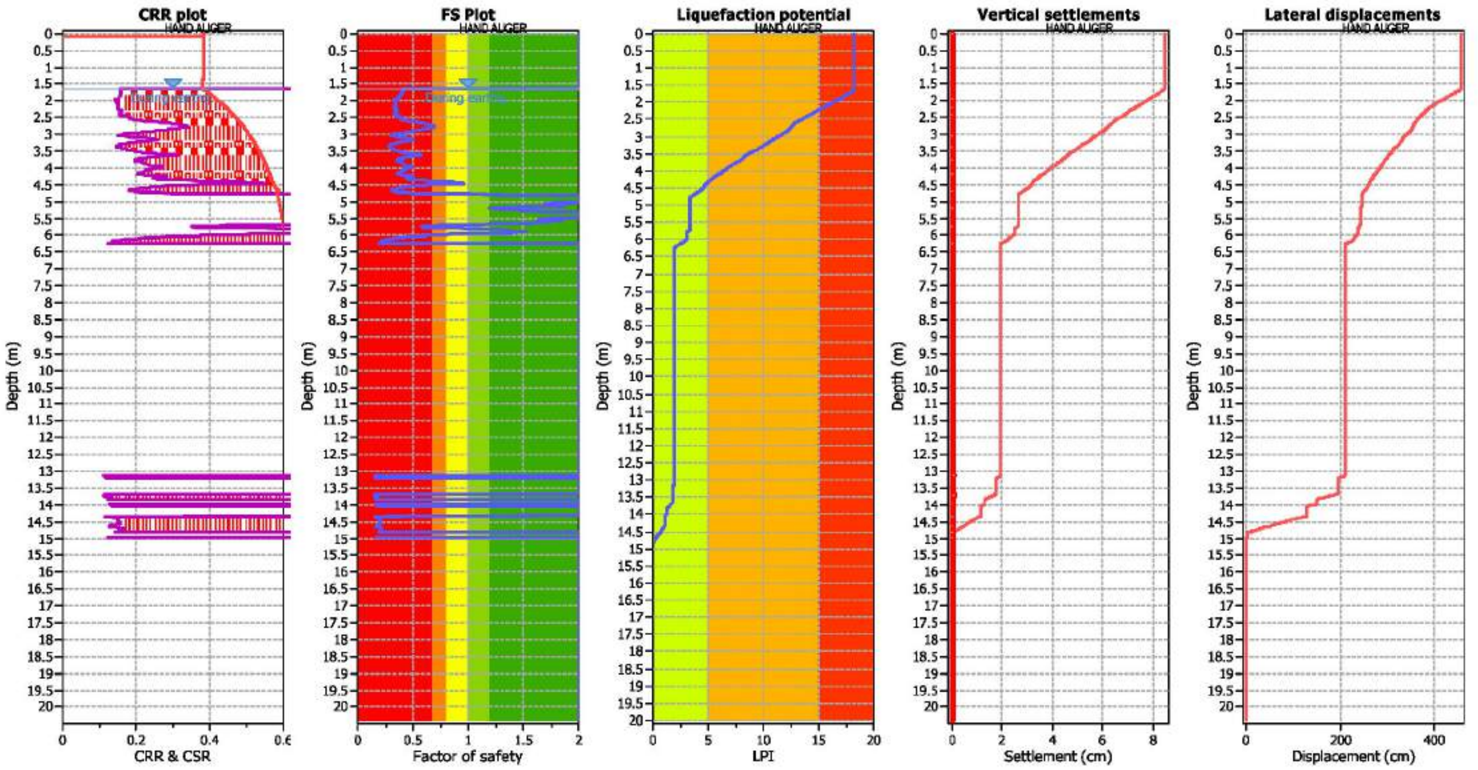
🟫	2. Organic material	🟩	5. Silty sand to sandy silt	⬜	8. Very stiff sand to
🟦	3. Clay to silty clay	🟨	6. Clean sand to silty sand	⬜	9. Very stiff fine grained

Liquefaction analysis overall plots



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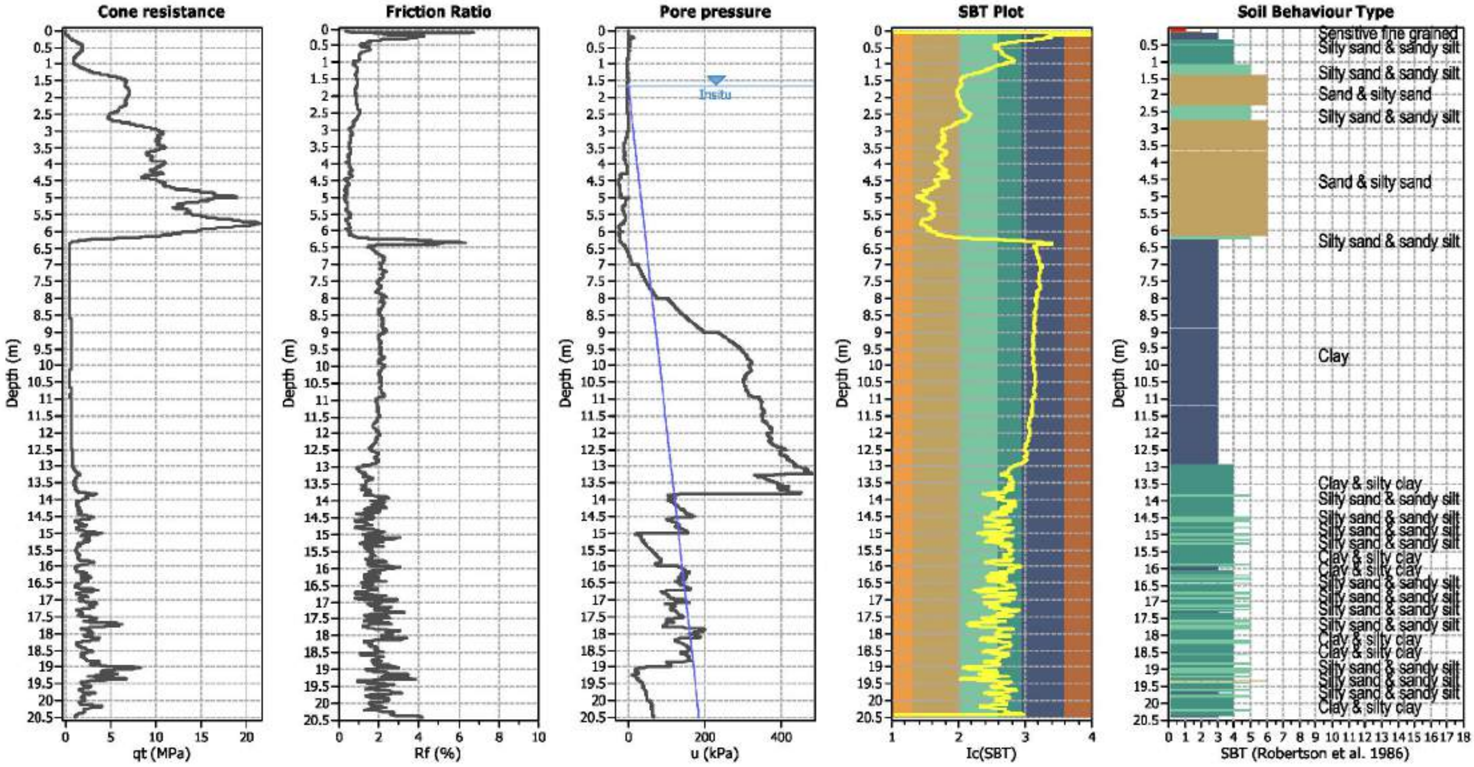

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SBT legend

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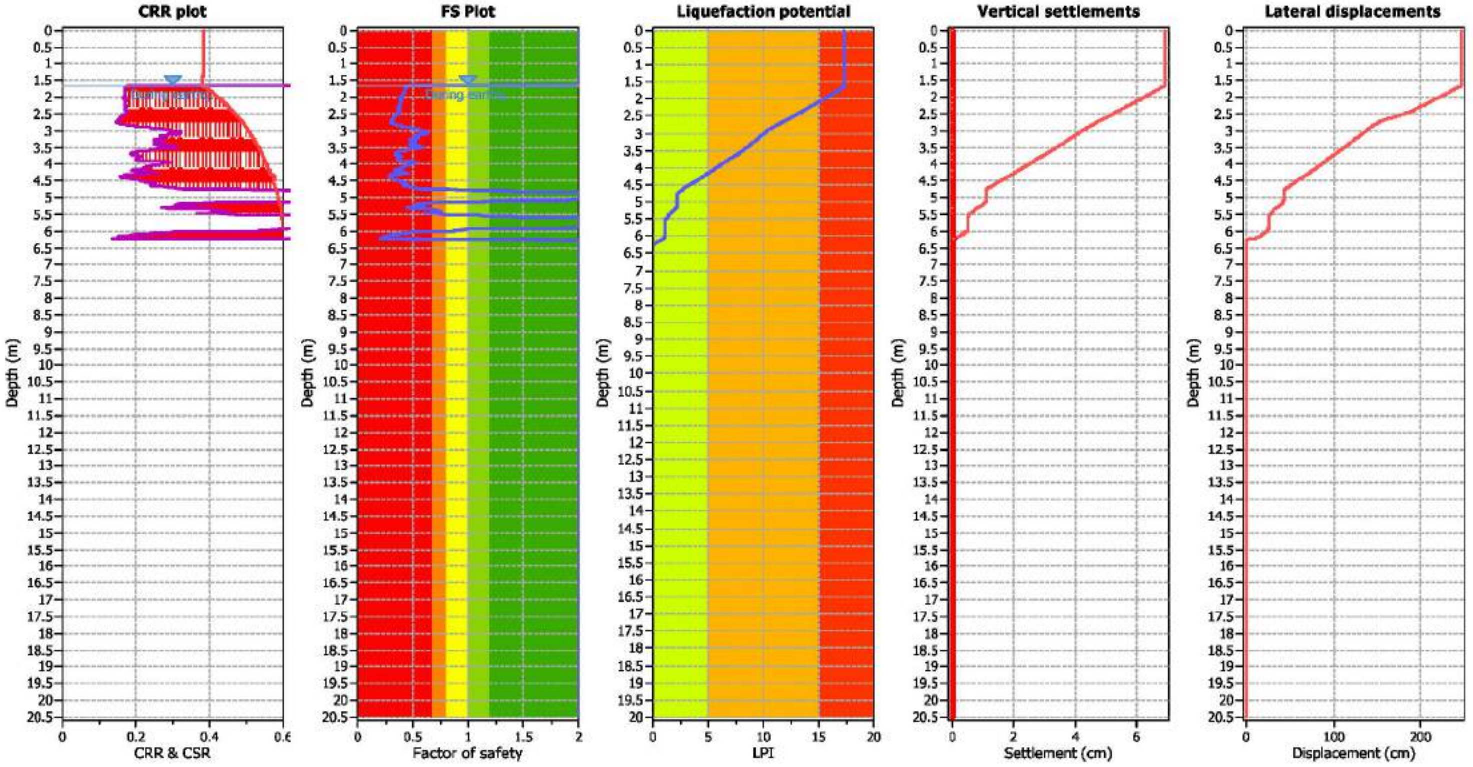
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	☐ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

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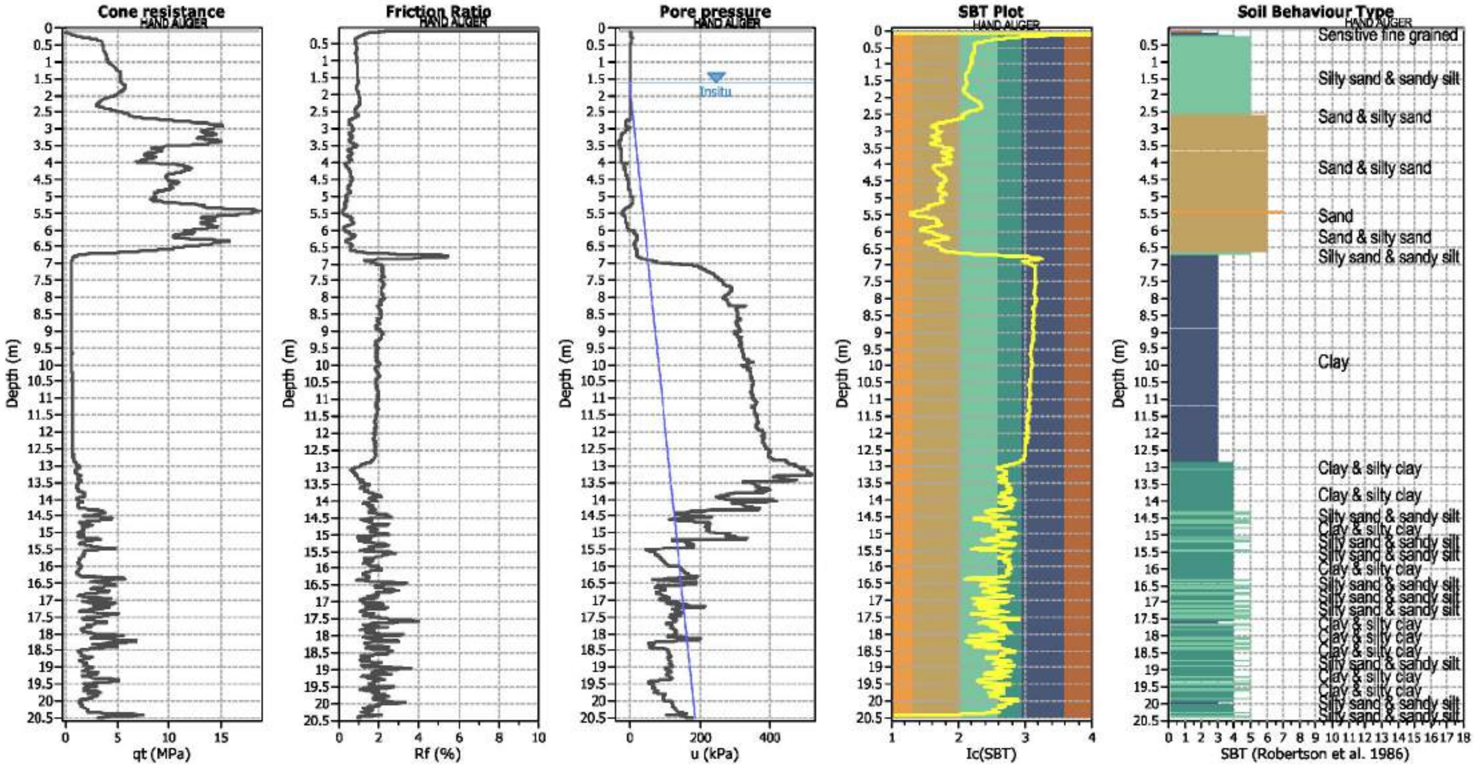
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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
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SBT legend

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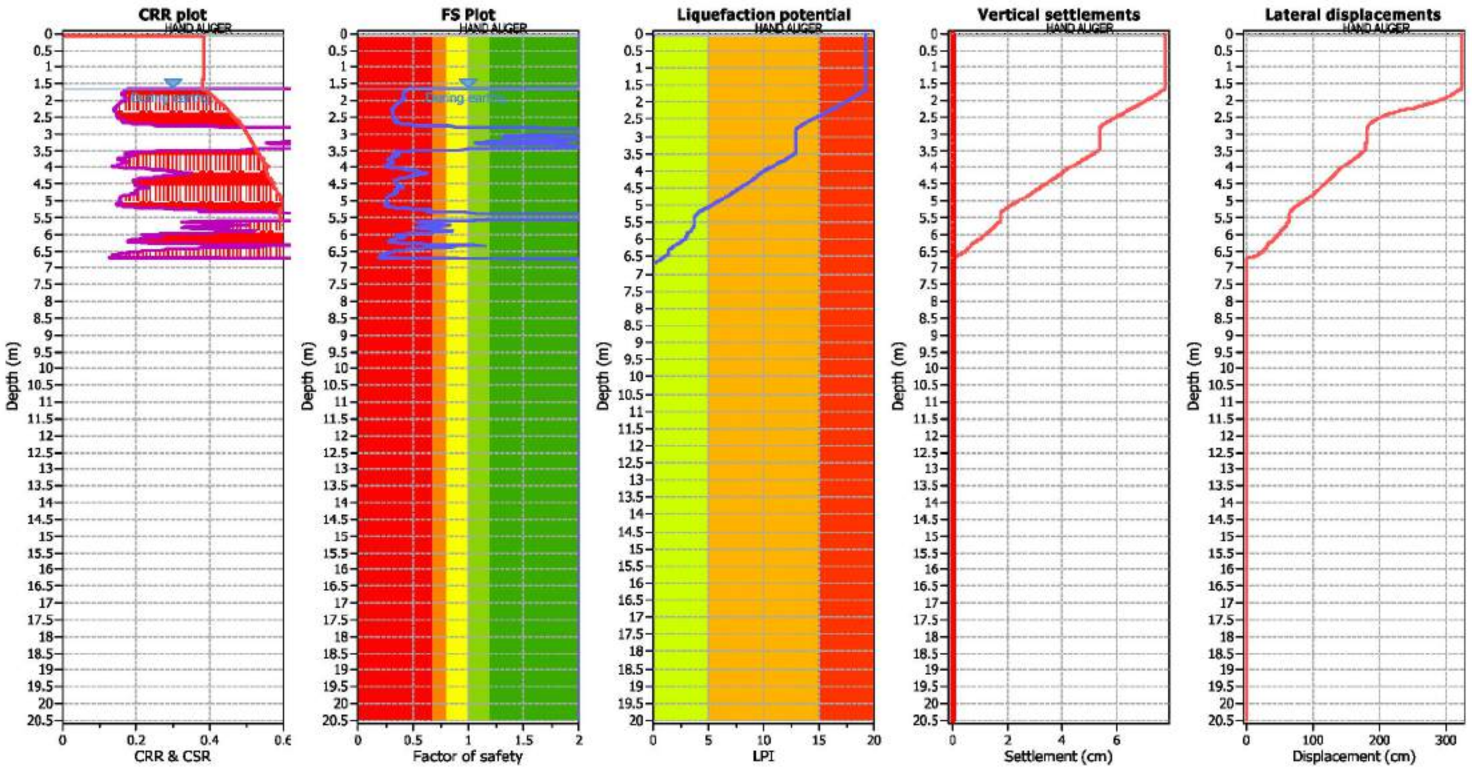
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

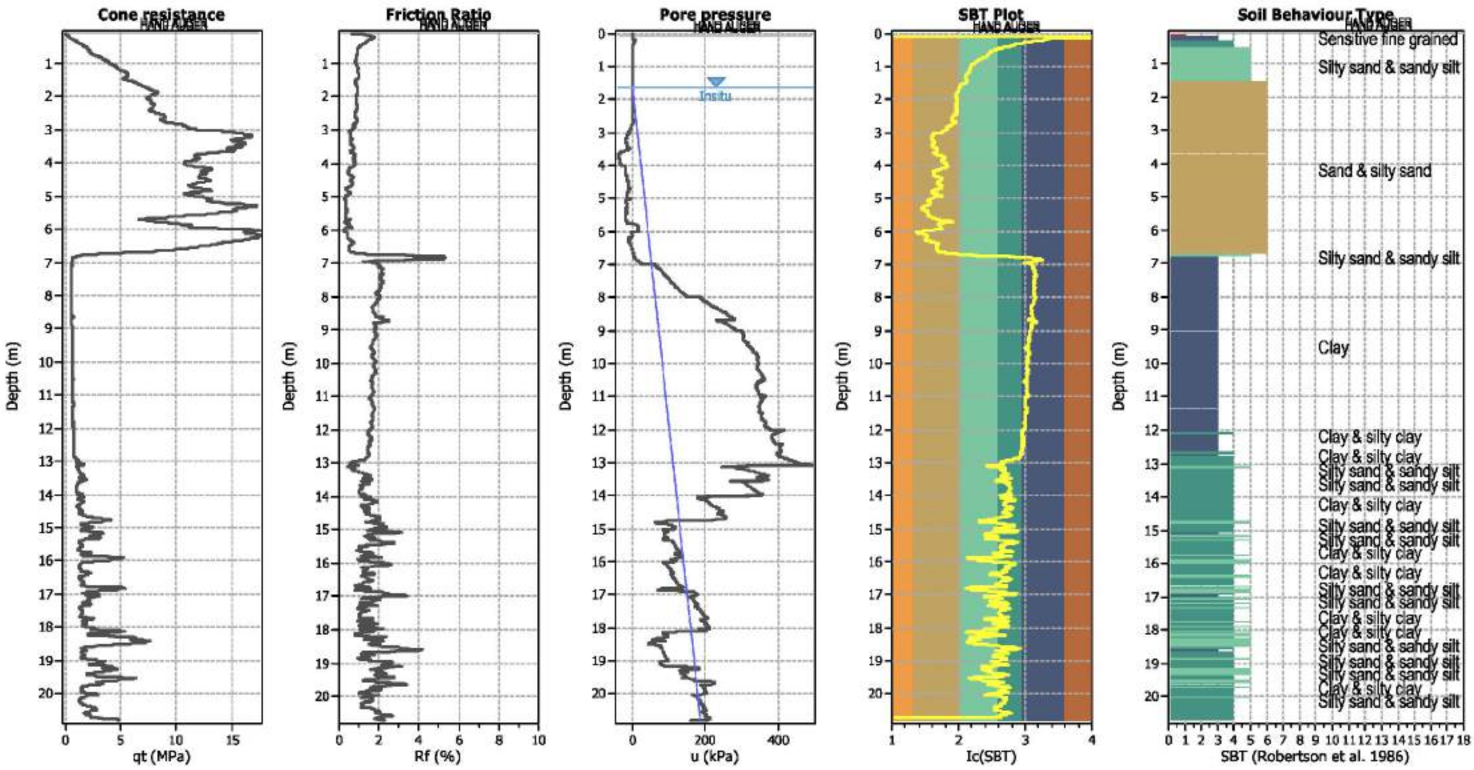
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



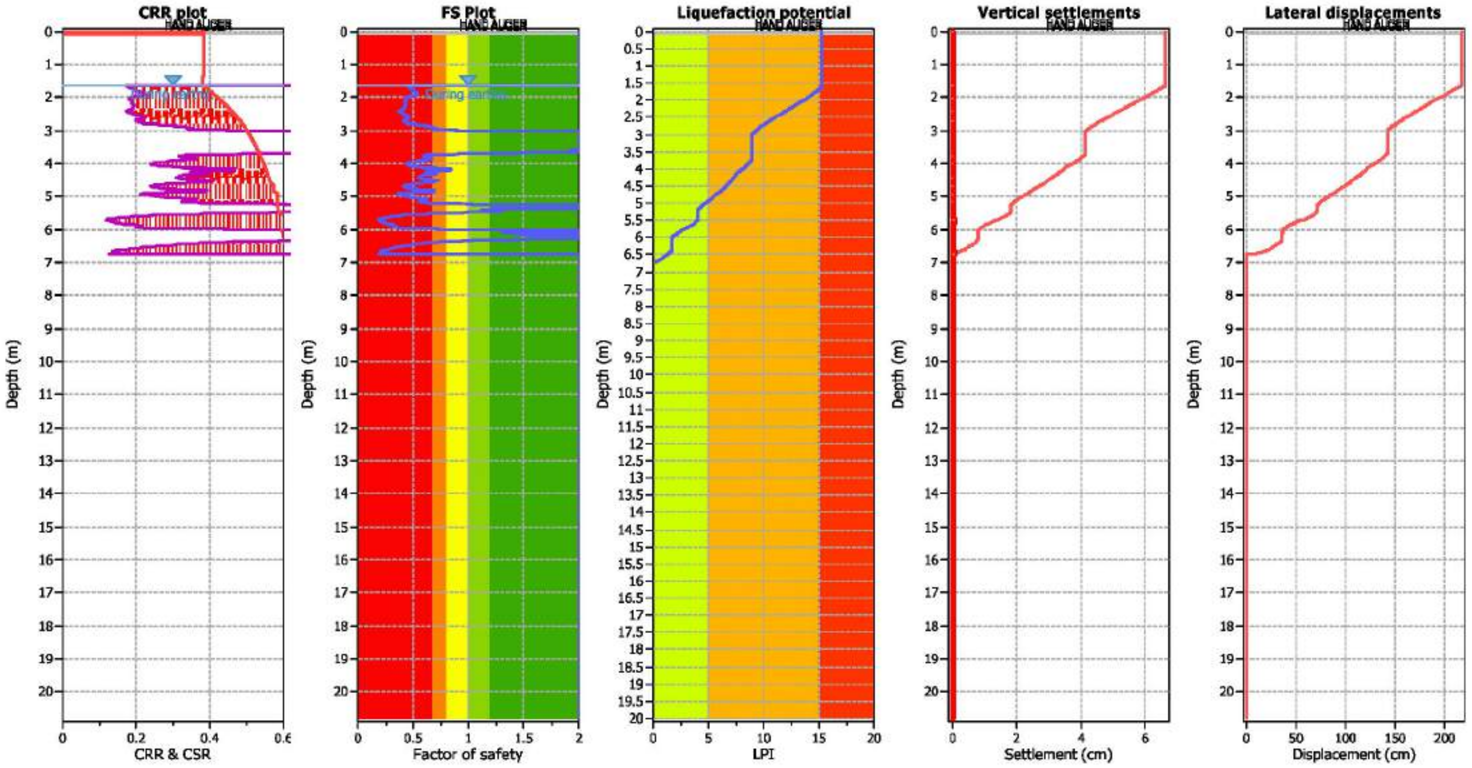
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

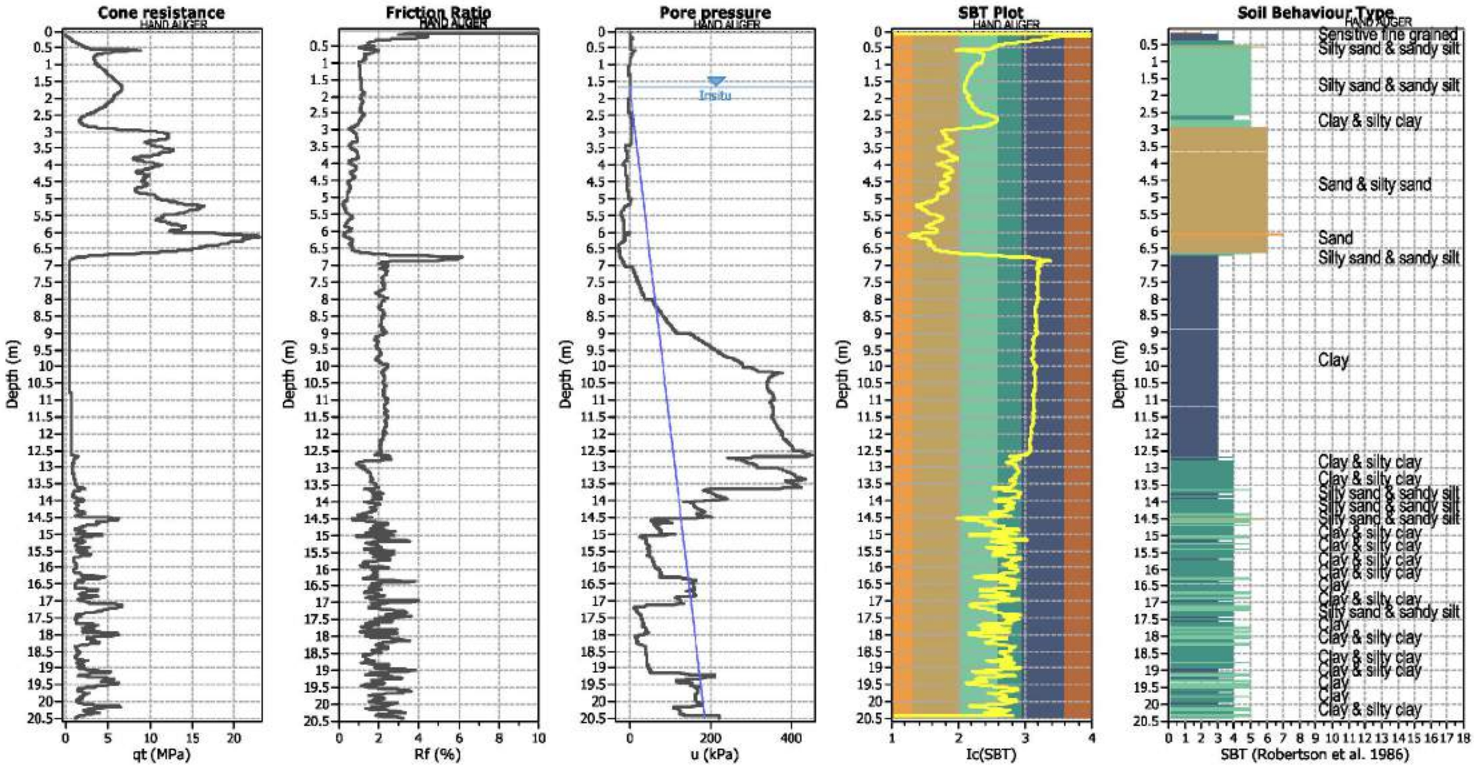
F.S. color scheme

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

LPI color scheme

🟥	Very high risk
🟧	High risk
🟨	Low risk

CPT basic interpretation plots



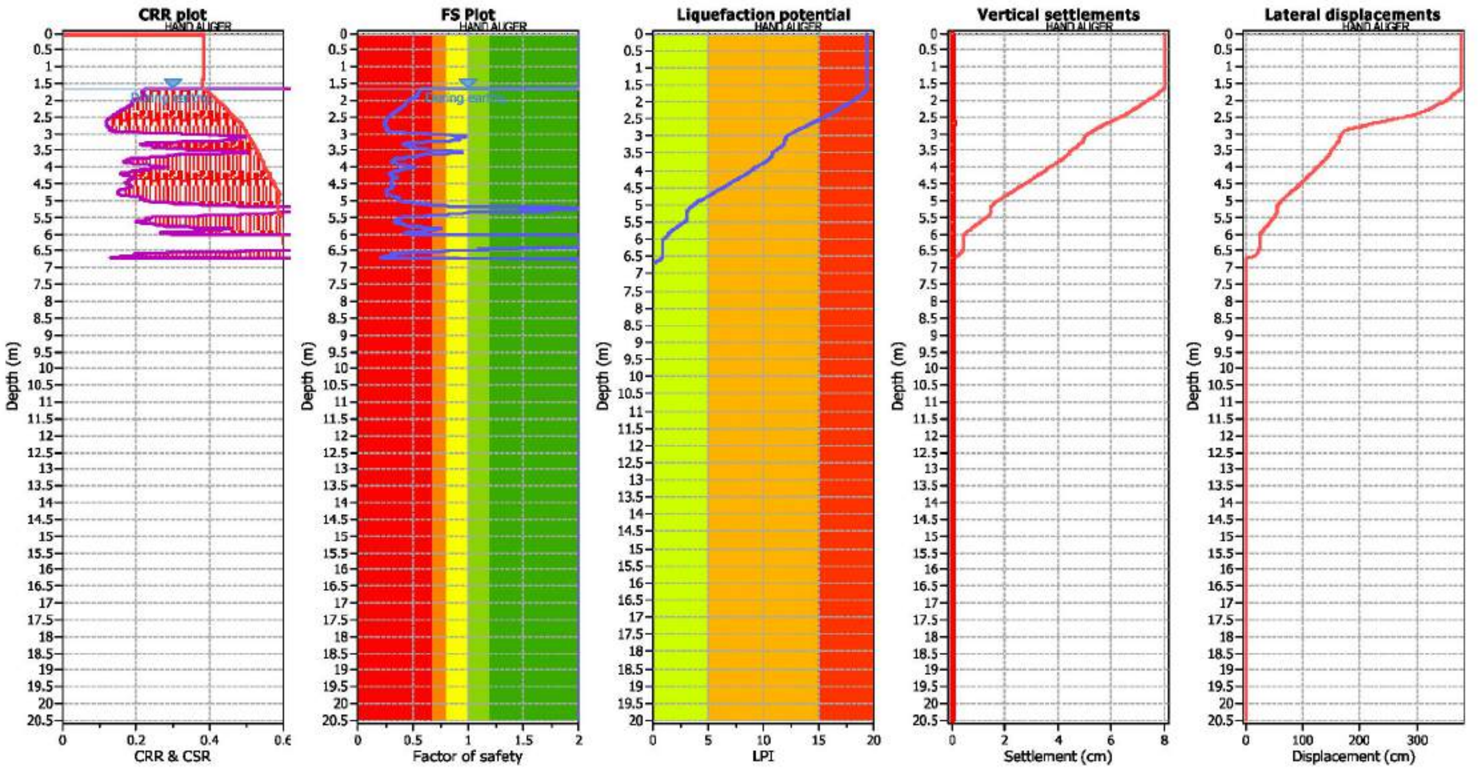
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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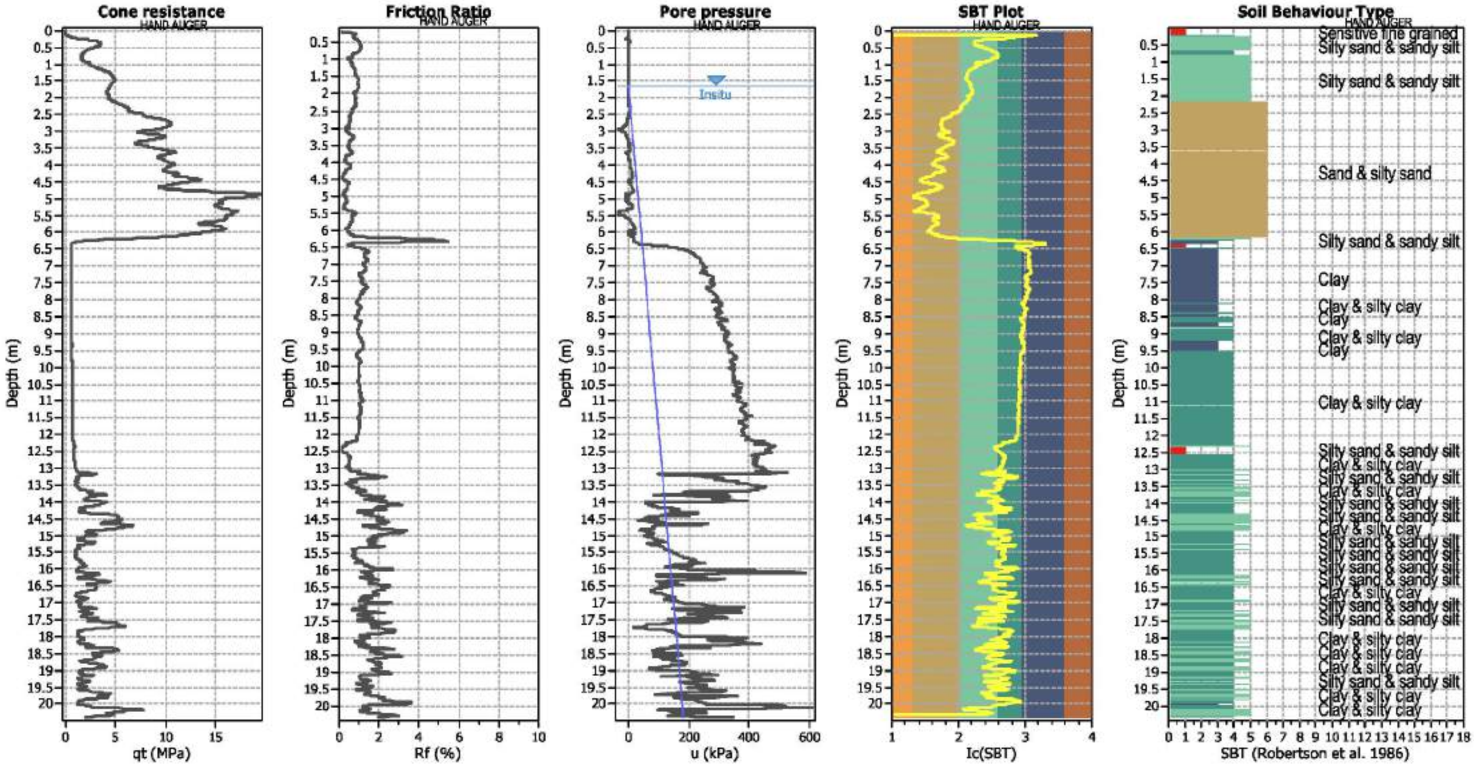
LPI color scheme

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

CPT basic interpretation plots



Input parameters and analysis data

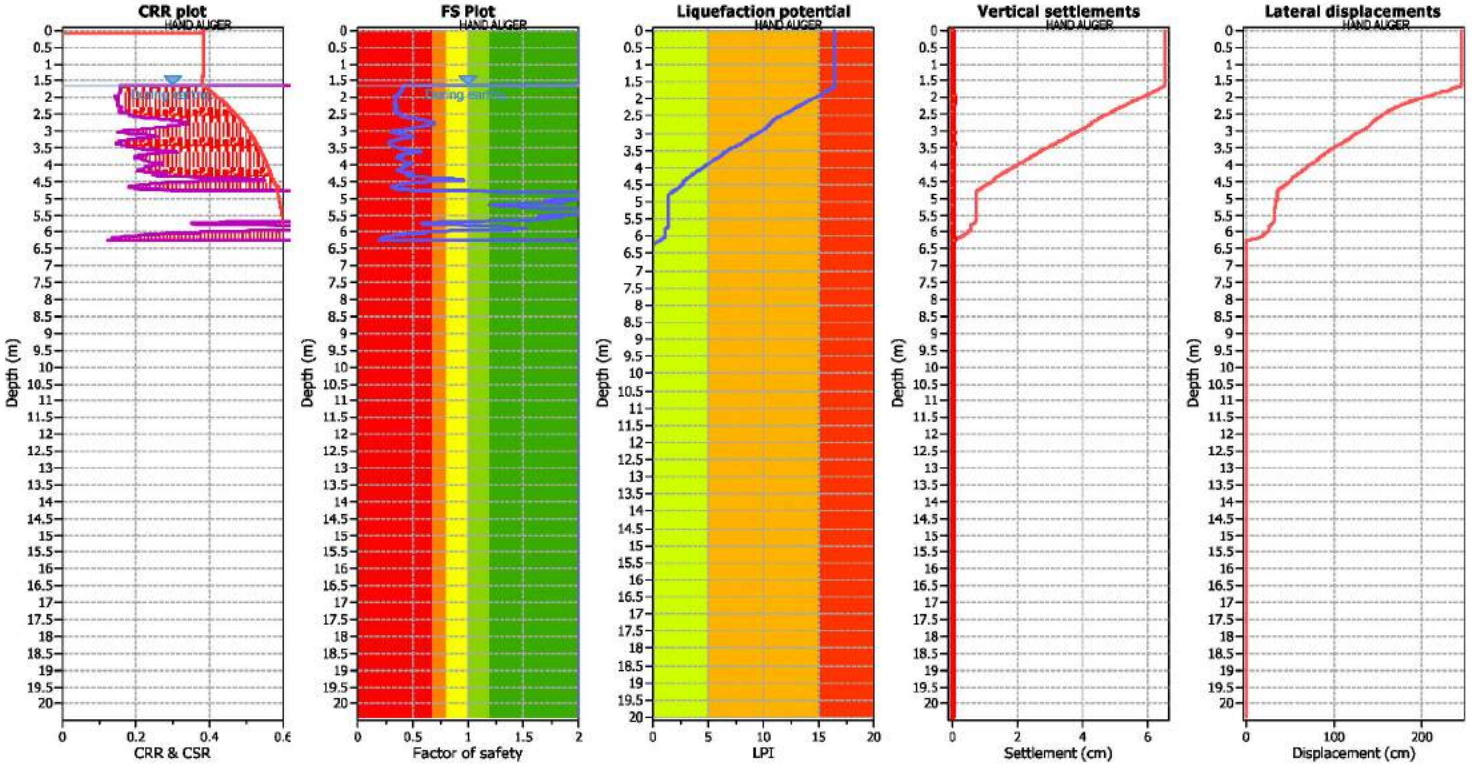
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

CPT name: ULS- CPT05 (10m)

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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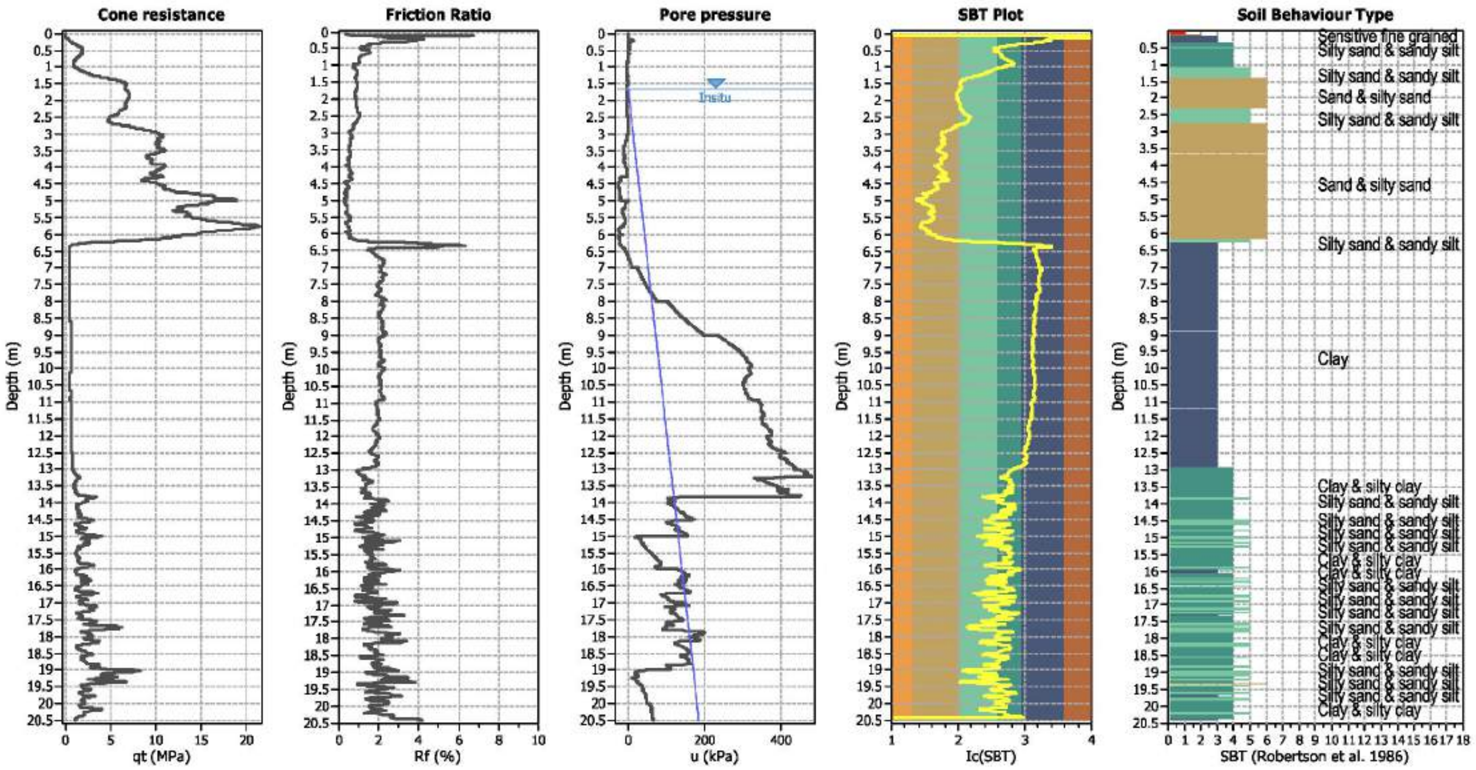
LPI color scheme

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

CPT basic interpretation plots



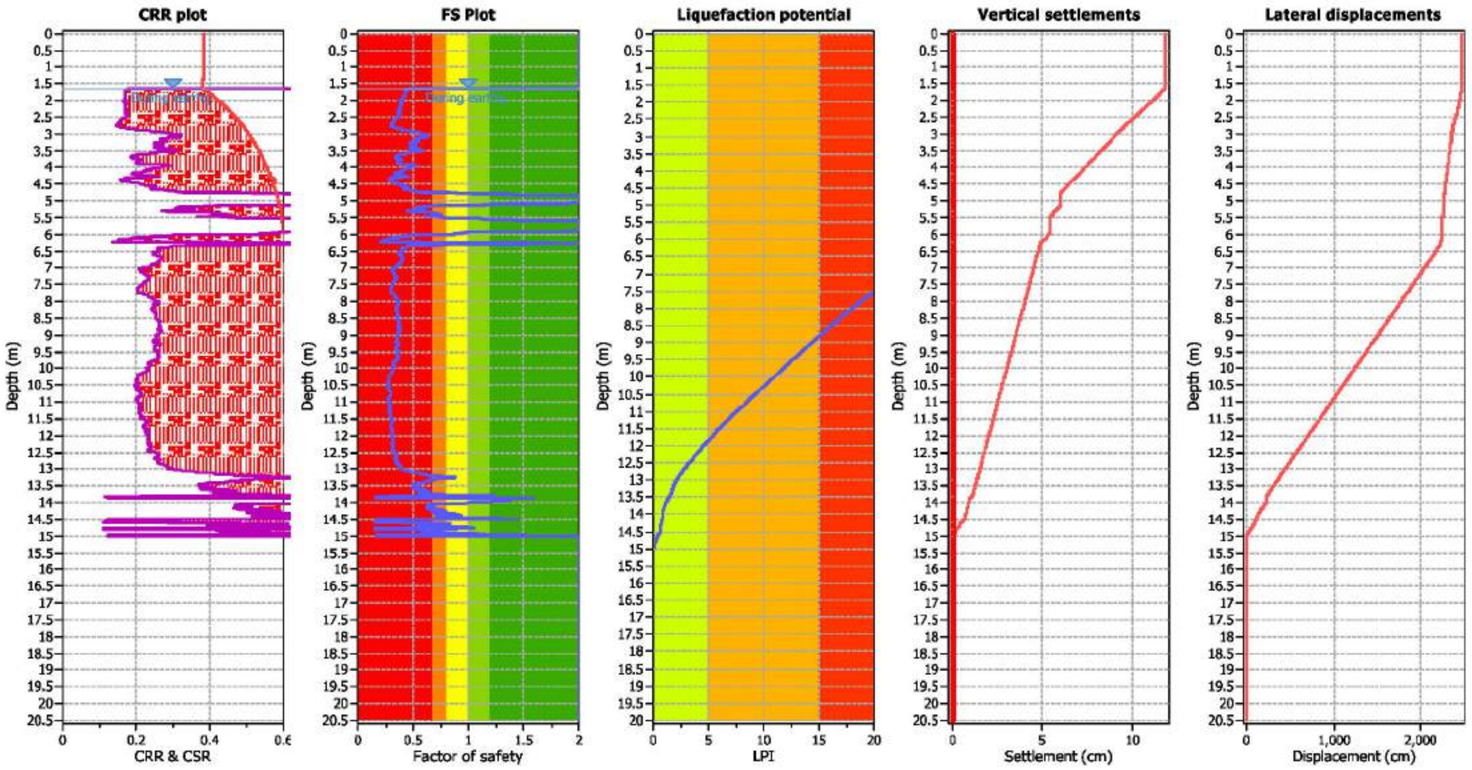
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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
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Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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LPI color scheme

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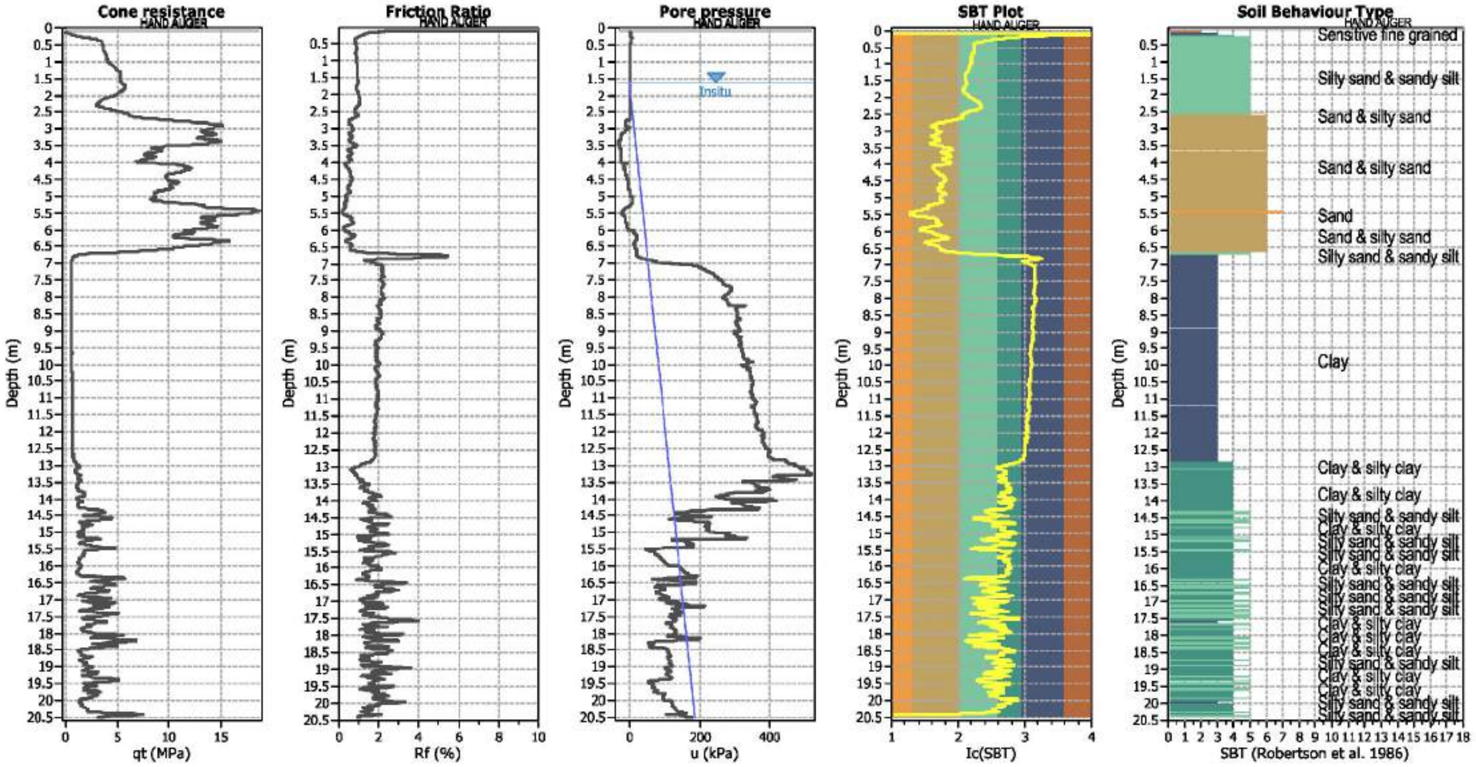
CPT basic interpretation plots



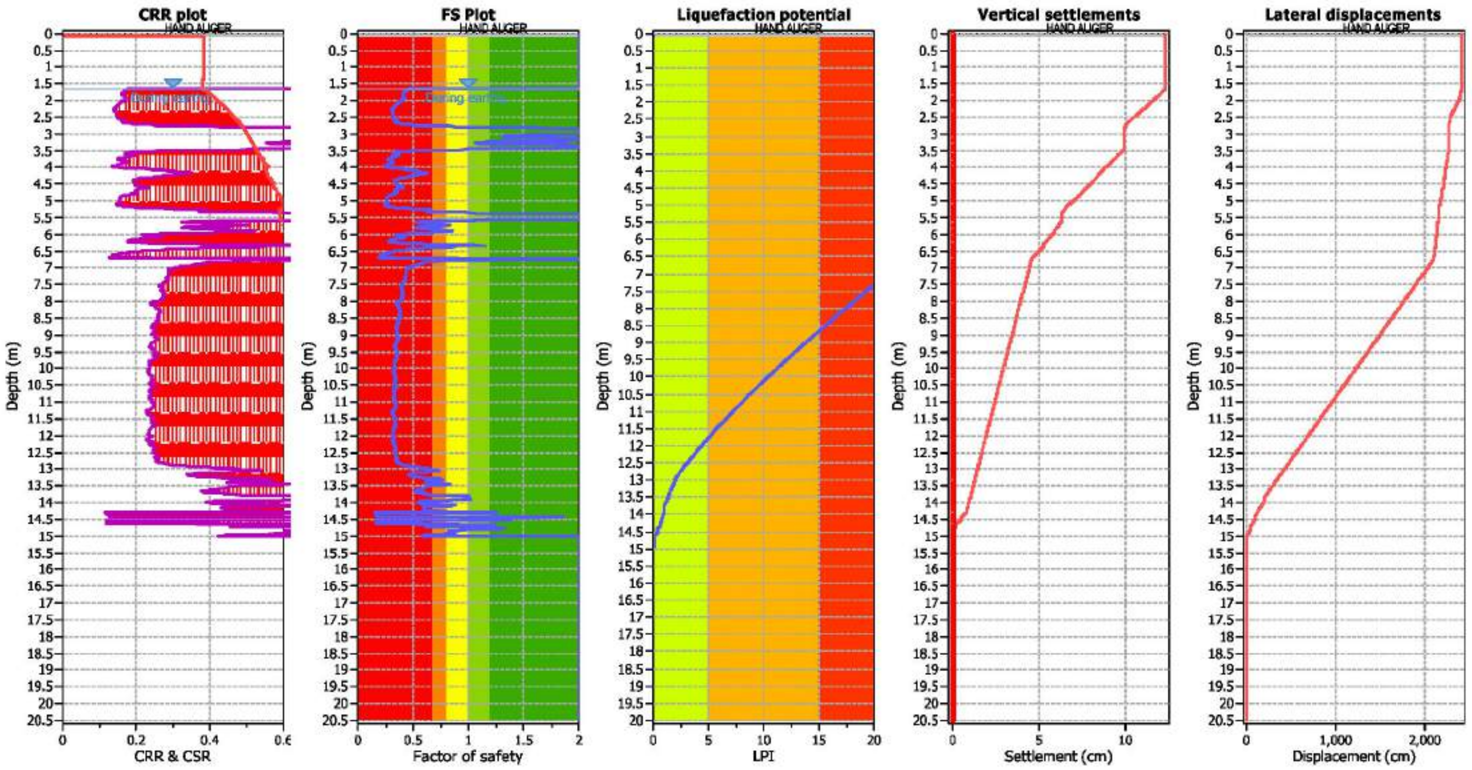
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

- 🟥 Very high risk
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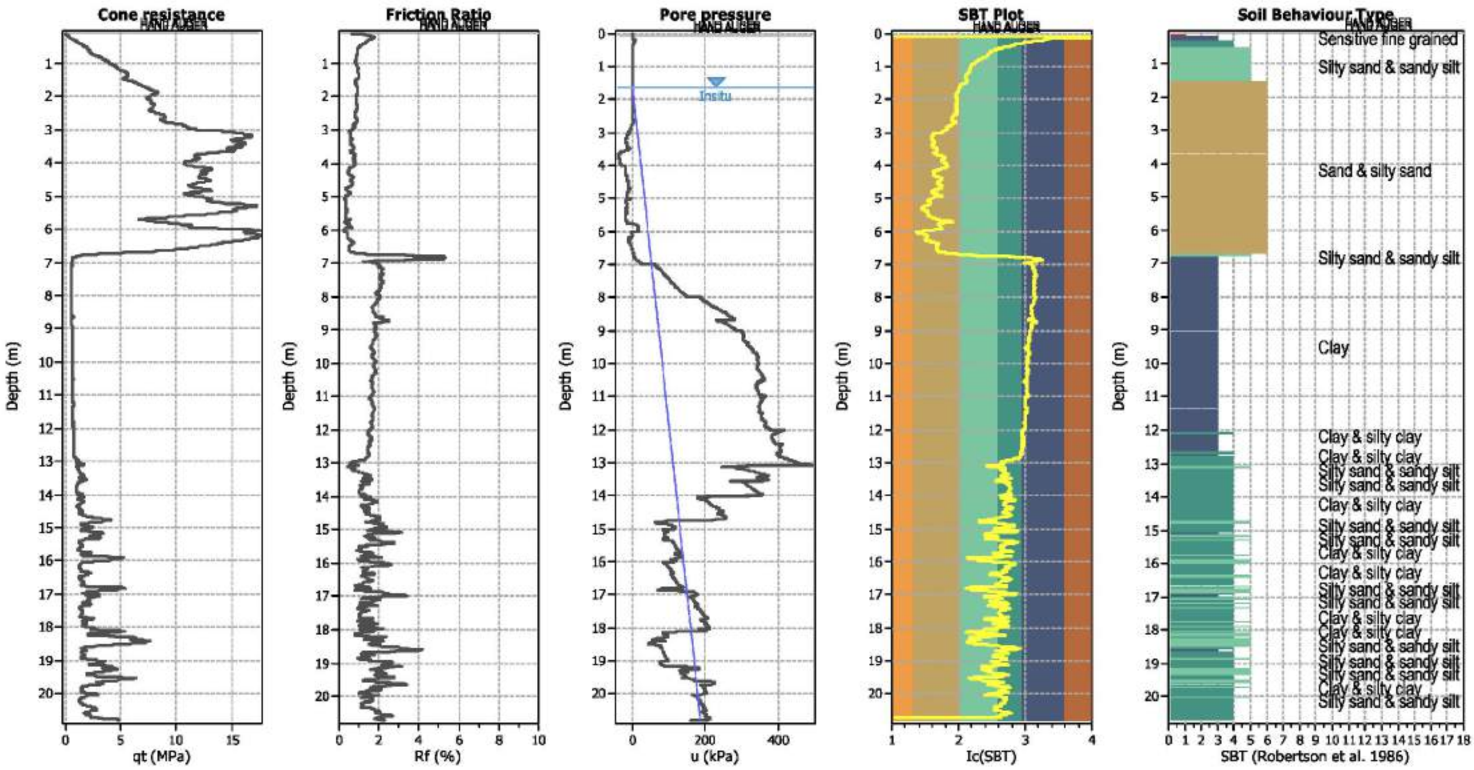
CPT basic interpretation plots



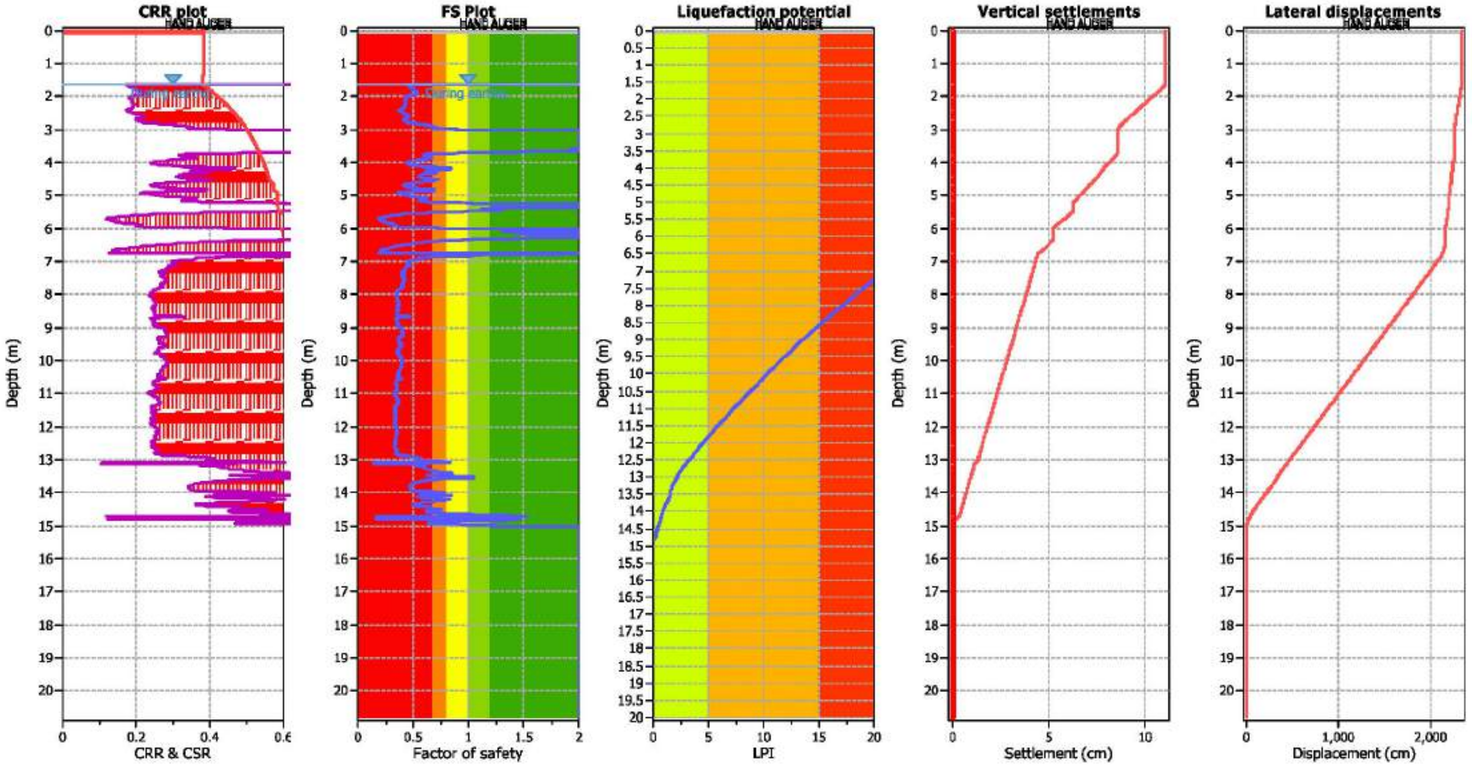
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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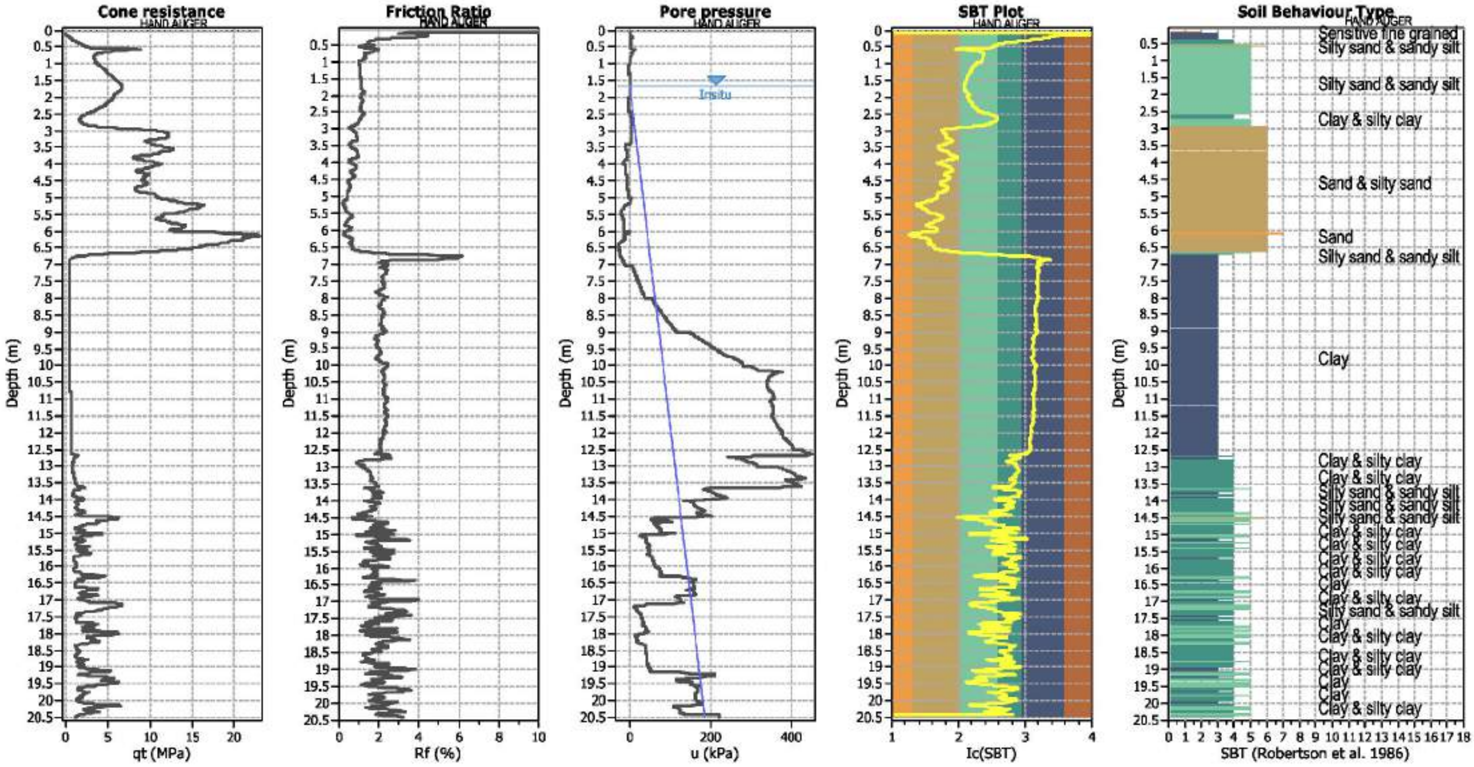
CPT basic interpretation plots



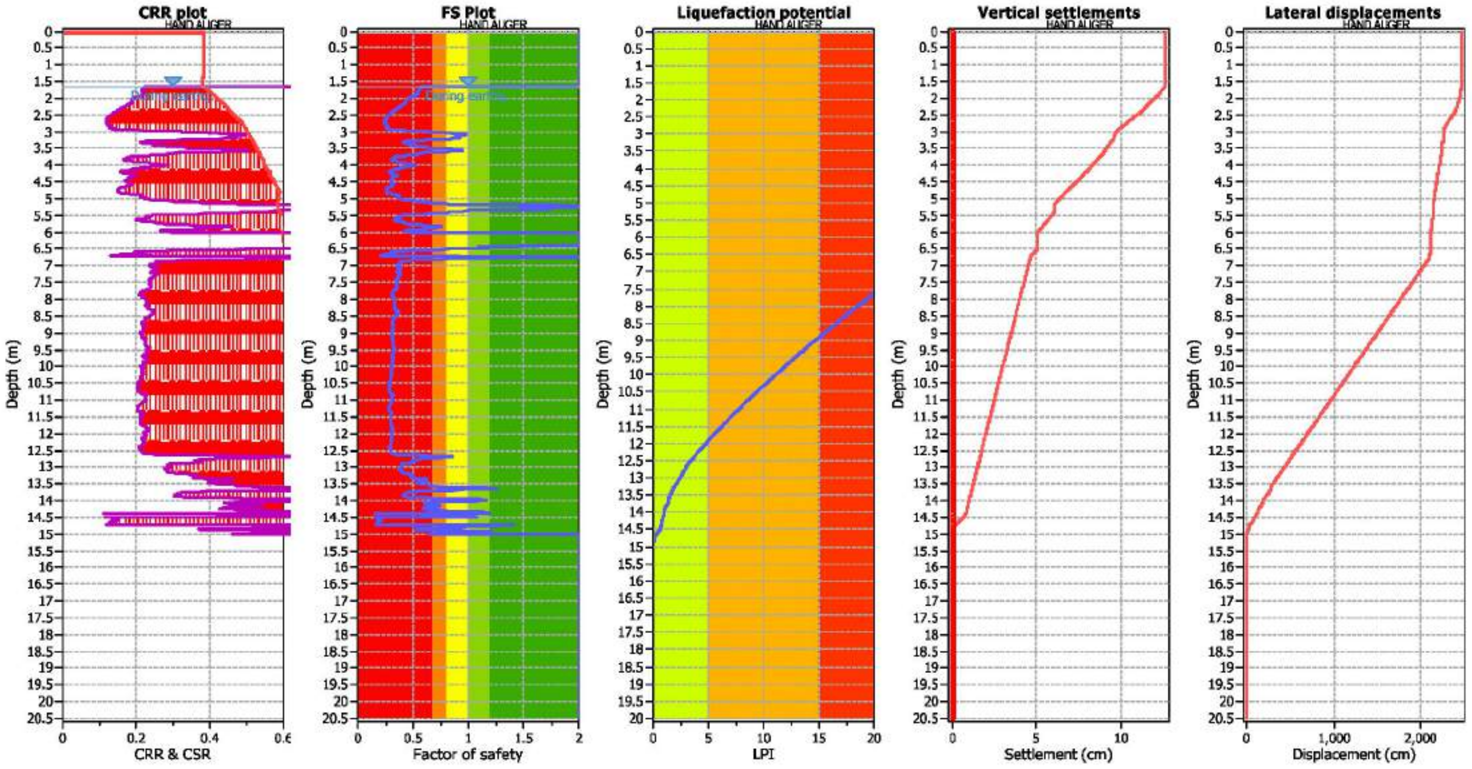
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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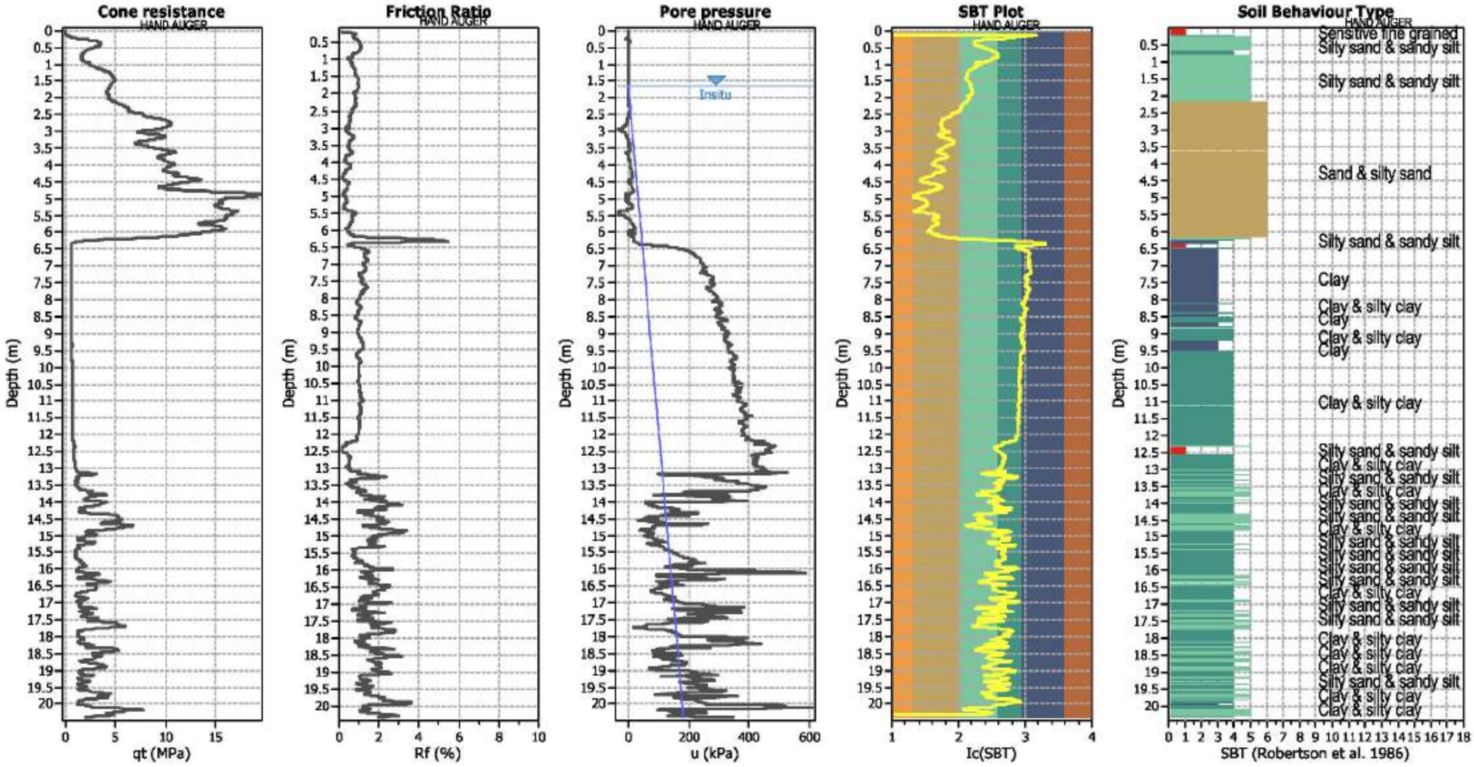
CPT basic interpretation plots



Input parameters and analysis data

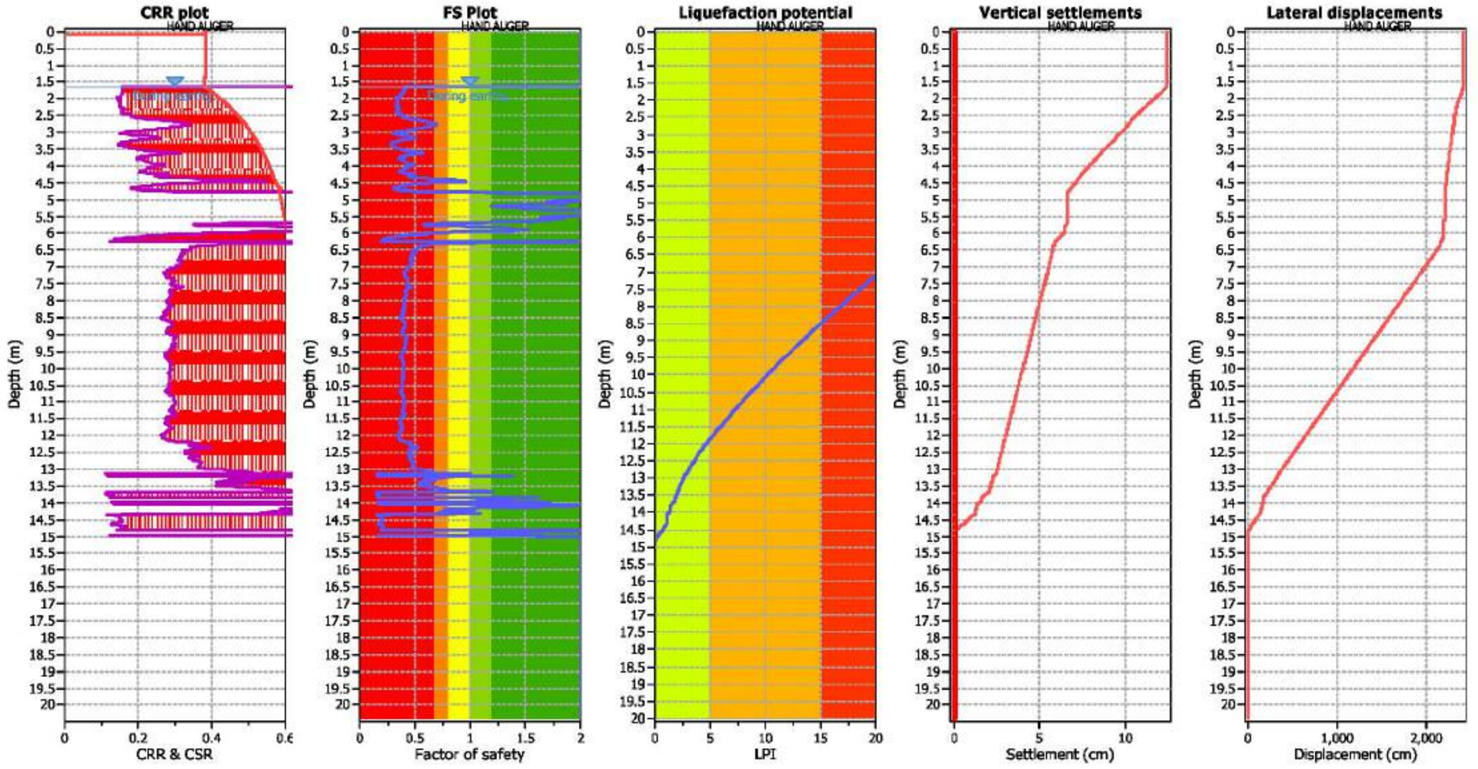
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

CPT name: ULS- CPT05 (CS)

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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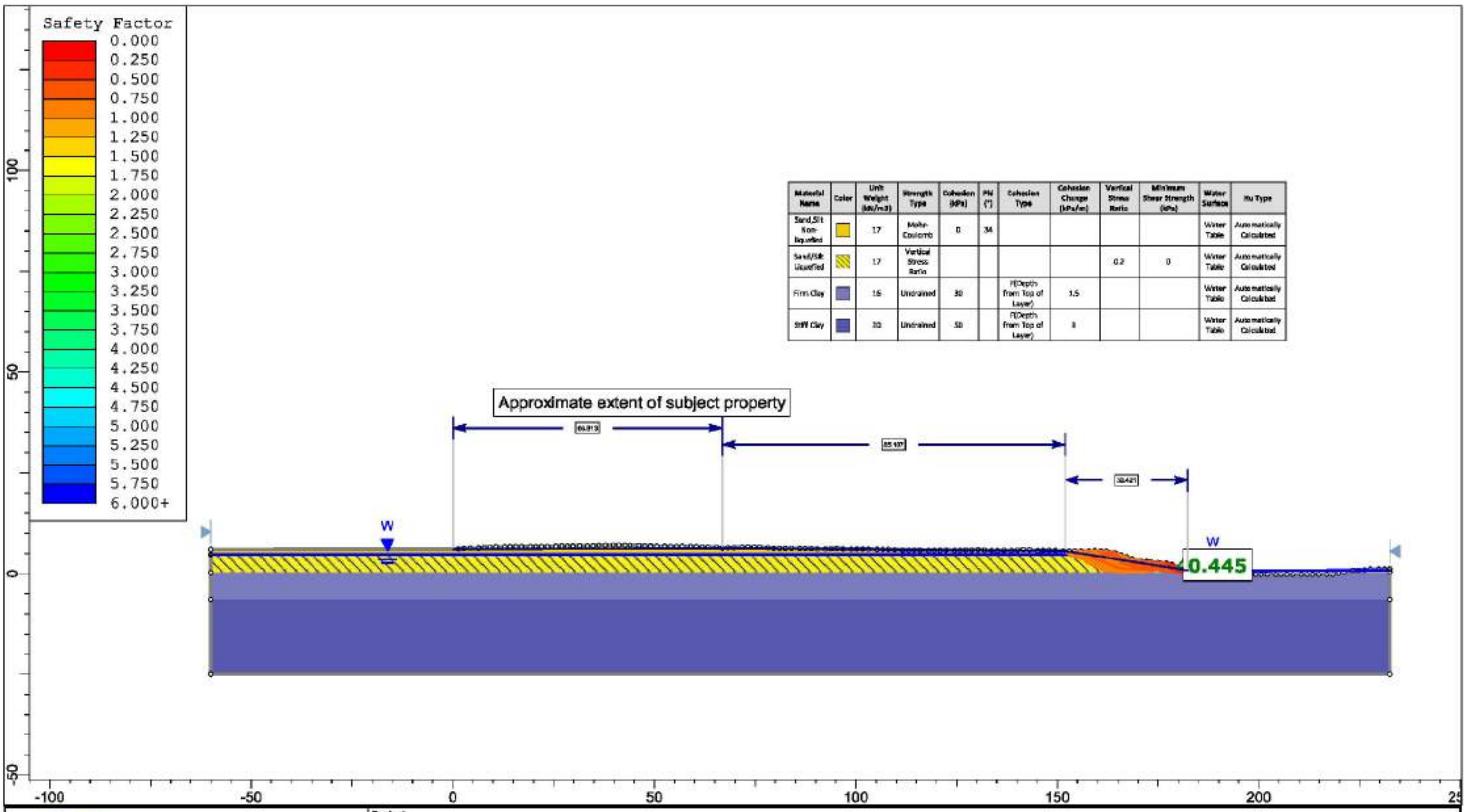
LPI color scheme

🟥	Very high risk
🟧	High risk
🟨	Low risk

APPENDIX E

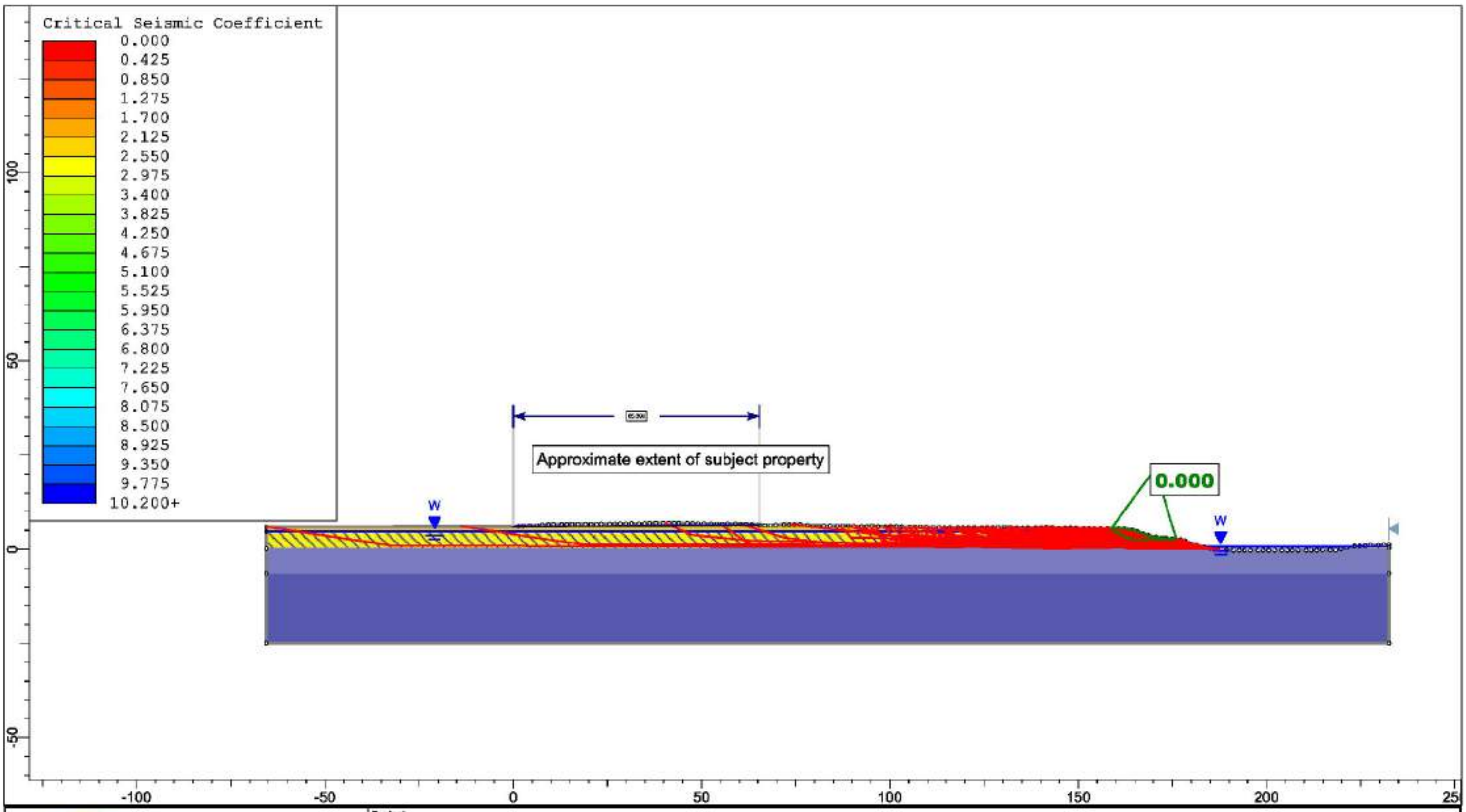
SLOPE STABILITY OUTPUTS



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Cohesion Change (kPa/m)	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type
Sand,Silt Non-liquefied	🟨	17	Mohr-Coulomb	0	34					Water Table	Automatically Calculated
Sand/Silt Liquefied	▨	17	Vertical Stress Ratio					0.2	0	Water Table	Automatically Calculated
Firm Clay	🟪	16	Undrained	30		F(Depth from Top of Layer)	1.5			Water Table	Automatically Calculated
Stiff Clay	🟦	20	Undrained	50		F(Depth from Top of Layer)	8			Water Table	Automatically Calculated

LDE
LAND DEVELOPMENT & ENGINEERING
SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 1	*Scenario*	T/S ratio 0.2 - Static Flow
Drawn By	SS	*Company*	LDE Ltd
Date	31/08/2023	*File Name*	Lateral Spreading Analysis.slmd



SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 4	Scenario	T/S ratio 0.2 - Yield Seismic
Drawn By	SS	Company	LDE Ltd
Date	31/08/2023	File Name	Lateral Spreading Analysis.slmd

NZHG Gisborne Limited

GEOTECHNICAL ASSESSMENT REPORT FOR PROPOSED RESIDENTIAL DWELLING, LOT 7 AND LOT 8

556-560 Aberdeen Road, Te Hapara, Gisborne

Project Reference: 24477
October 13, 2023

DOCUMENT CONTROL

Version	Date	Comments
01	13/10/2023	Issued for Resource Consent. Plan review required prior to submission for Building Consent.

Version	Issued For	Date	Prepared By	Reviewed & Authorised By
01	Issued for Design	13/10/2023	Sahil Sathwara *B.Tech (Civil), MEngNZ* Geotechnical Engineer	Dan Bond *CMEngNZ, PEngGeol.* Associate Engineering Geologist

CONTENTS

1 INTRODUCTION

Land Development & Engineering Ltd (LDE) was engaged by NZHG Gisborne Limited to undertake a geotechnical investigation of a site located at 556 & 560 Aberdeen Road, Gisborne (Figure 1).

The 2,700m^2 site is proposed to be subdivided into 12 Lots for residential development (Figure 1). This geotechnical report pertains to proposed Lot 7 and Lot 8, 556 & 560 Aberdeen Road, Gisborne.

Figure 1 556-560 Aberdeen Road (outlined in blue), with the proposed subdivision outlined in yellow, Lot 7 and 8 highlighted in white. Image source: Tairāwhiti Maps (Gisborne District Council, 2023) Accessed: September 2023

2 PROPOSED DEVELOPMENT

A 12-lot subdivision is proposed at 556 & 560 Aberdeen Road across the property with the legal description Lot 2 DP 1585, PT Lot 1 DP 1585, and Lot 1 DP 1817. The proposed development consists of 7 structures formed of four double-storey duplex buildings, one single-storey building and two standalone dwellings (Figure 1).

The proposed driveway is located centrally of the site to provide access between lots and Aberdeen Road. Proposed access and building platform locations are shown in Figure 1 and Appendix A.

A 93.6m^2 double storey building is proposed across Lot 7 and 8 (Figure 2), with timber framing in accordance with NZS3604 (2011), with weatherboard and sheet wall cladding, profiled metal roofing and a concrete floor or suspended timber floor.

The purpose of this investigation was to determine and assess the nature of the ground beneath the building site to inform our geotechnical recommendations for site development and design of the building's foundations. The investigation was completed to satisfy the requirements of Gisborne District Council (2022) for Resource and Building Consent.

Areas		
	Space Name	Area (m²)
Footprint Per Unit		
	First Floor Footprint	43.4
	Ground Floor Footprint	46.8
		90.2 m²
Unit 1		
	Bath	4.1
	Bedroom 1	10.1
	Bedroom 2	9.2
	Circ.	1.4
	Covered Entry	1.4
	Hall	5.3
	HWC	0.7
	LDY	1.9
	Linen	0.7
	Living / Dining / Kitchen	36.0
	Stair Void	5.2
	Store	1.0
	Store	0.6
	Str.	0.4
	WR 1	0.7
	WR 2	1.3
		80.0 m²
Unit 2		
	Bath	4.1
	Bedroom 1	10.1
	Bedroom 2	9.2
	Circ.	1.4
	Covered Entry	1.4
	Hall	5.3
	HWC	0.7
	LDY	1.9
	Linen	0.7
	Living / Dining / Kitchen	36.0
	Stair Void	5.2
	Store	0.6
	Store	1.0
	Str.	0.4
	WR 1	0.7
	WR 2	1.3
		80.0 m²

Figure 2: (From top to bottom): Floor plans for proposed duplex building across Lot 7 and Lot 8, alongside the architect's drawing (Lot 7-8 is labelled). Image Source: Client supplied.

3 SITE STUDY

3.1 Site Description

The site is located within the established suburb of Te Hapara, Gisborne, approximately 2.0km northwest of the Gisborne CBD. The site is generally flat and is elevated between 6m and 7m (New Zealand Vertical Datum (NZVD) 2016). 556 (LOT 2 PT 1 DP 1585) & 560 (LOT 1 DP 1817) Aberdeen Road, occupy a combined area of approximately 2,700m^2.

3.2 Geomorphology and Geology

556 & 560 Aberdeen Road, occupy flat lying ground which, at one time, comprised the historic foreshore of Tūranganui-a-Kiwa (Poverty Bay). The 1:250,000 geological map of the region (Mazengarb & Speden, 2000) indicates the site is underlain by Holocene aged beach deposits which consist predominantly of sand. The Taruheru River is located approximately 120m to the north; elevation falls relatively gently towards the river until the riverbank, which falls around 6m over some 25m laterally.

The GNS Active Fault Database does not identify any active fault traces or any fault buffer zones affecting the site. The nearest mapped active fault is the Repongaere Fault, located approximately 14 km to the north-west of the properties (GNS Science, 2020).

3.3 Geotechnical Risks

Our review of Gisborne District Council's (GDC) GIS viewer, Tairāwhiti Maps (Gisborne District Council, 2023), and GNS Science's Active Faults Database (GNS Science, 2020) revealed the following:

- 556 & 560 Aberdeen are mapped as being within an area of moderate liquefaction risk.
- The nearest active fault is the Repongaere Fault, located approximately 14 km to the north-west of the properties.
- The site is mapped as yellow tsunami evacuation zone.

In addition to the risk of liquefaction, the nearby riverbanks of the Taruheru River presents the possibility of lateral spreading in a liquefaction-inducing earthquake event.

Our review of the 2023 aerial photographs indicates that the properties were not severely impacted by flooding associated with Cyclone Gabrielle.

3.4 Historical Aerial Photographs

Historical aerial imagery was reviewed as part of this investigation using Retrolens and Google earth aerial

photography, which revealed the following: -

- Residential dwellings were constructed at both properties prior to 1942 (the earliest available aerial photograph with sufficient resolution).
- In the 1942 aerial photograph there appears to be some form of structure/s, a pile of material, or disturbance to the ground beneath the southwest corner of 556 Aberdeen Road. However, the resolution of the aerial photography is not sufficient to reliably determine what occupied the southwest corner of the property.
- A large shed was constructed in the southwest corner of 556 Aberdeen Road sometime between 1942 and 1966, along with smaller auxiliary structures at both properties.
- Several small structures or 'lean-tos' were constructed between 1966 and 1988 across both properties.
- A shed/garage was constructed in the south-east corner of 560 Aberdeen Road.
- Between 1988 and 2021 additions were carried out to the garage/shed in the south-east corner of 560, and the large shed in the southwest corner of 556. The water tank for 560 Aberdeen Road was removed, along with several of the smaller auxiliary structures across both properties.

Figure 3: Historical aerial imagery of the Aberdeen Road Subdivision (Source: (Retrolens.co.nz)), with the location of the individual lots marked in yellow. (a) Aerial imagery from 1942, (b)1966, (c) 1977, (d) 1988.

4 GEOTECHNICAL INVESTIGATION

4.1 Development wide Investigation Scope

Our investigation of the entire site included the following: -

- A walkover assessment of the site and immediate surrounding area to assess its geomorphology and identify any features which may influence our engineering recommendations, or the long-term performance of the ground.

- 15No. 50mm diameter, hand auger boreholes drilled to refusal or 2.5m target depth at the proposed building locations, with measurements of undrained shear strength taken every 0.2m, and associated DCP's to the 2.5m target depth.

- Complete liquefaction analysis of the Five CPTs which were undertaken across the site during the due diligence phase, three at 556 Aberdeen Road and two at 560 Aberdeen Road (Figure 4).

4.2 Lot 7 and Lot 8 Investigation Scope

The investigation of the site, completed on 12 September 2023 included the following work: -

- One, 50mm diameter, hand-auger borehole (HA11), reached target depth of 2.5m below ground level (bgl). Associated DCP test was carried out at test location to the 2.5m target depth within granular materials.
- Measurements of groundwater level within invasive subsurface test hole, following hole completion.

The test locations are shown on the Geotechnical Investigation Plan (Figure 4), and as Appendix A. Logs with details of the relevant testing completed are presented as Appendices B and C.

Figure 4: Geotechnical Investigation Plan for proposed development, Lot 7 and 8 highlighted in white.

5 GROUND CONDITIONS

This section addresses the ground conditions encountered during our investigations.

5.1 Site Stratigraphy

5.1.1 Development Wide

Ground conditions are reasonably consistent across the site. Typically, the property is underlain by topsoil and/or fill to a depth between 0.3m and 0.8m below ground level (bgl), which overlies sand/ silt mixtures to a depth of 1.0m. Underlying this, medium dense to dense sand was encountered to around 6.5m to 7.0m. Deposits of firm clay were encountered from around 6.5m to 7.0m, with stiff silt/clay mixtures extending to depth from approximately 13m.

A copy of the test logs is provided as Appendix B.

5.1.2 Lot 7 and Lot 8 Site Specific Nuances

Topsoil/Fill was encountered in hand auger borehole, HA11 from the existing ground surface to depth of 0.3m. However, we note in adjacent HA10 and HA12 topsoil thicknesses were 0.7m and 0.5m, respectively.

Dynamic penetrometer testing in sands typically ranged between 1 and 4 blows per 50mm penetration below the topsoil to 2.5m depth below existing ground level.

5.2 Groundwater

Groundwater was encountered at depths of between 1.50m and 2.88m across the site. A low-bound groundwater level of 1.65m bgl was adopted in our assessments. Given that testing was completed in the wettest year on record for Gisborne, the groundwater level adopted is considered significantly elevated from typical levels and no further allowance has been applied for seasonal variations.

6 NATURAL HAZARDS

6.1 Definition & Legislation

This section summarises our assessment of the natural hazards that might affect the site including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding, that might affect the property, as generally defined in Section 106 of the Resource Management Act., as well as the hazards as defined in Section 71(3) of the Building Act (2004), including erosion (including coastal erosion, bank erosion, and sheet erosion), falling debris (including soil, rock, snow and ice), subsidence, inundation (including flooding, overland flow, storm surge, tidal effects and ponding), and slippage.

6.2 Seismic Hazard

6.2.1 Surface Fault Rupture

The GNS NZ Geology Web-map and Active Faults Database (GNS Science, 2020) do not show any faults passing beneath the subject site. There also does not appear to be any surface expressions which would indicate the presence of an active fault beneath or within close proximity to the site. We therefore consider the surface fault rupture risk to be low.

6.2.2 Site Subsoil Class

Based on the published geological information for the region, discussed in Section 3.2, and obtained site-specific CPT data, we consider that a seismic site subsoil classification of D- "Deep or Soft Soil" is appropriate as defined by NZS 1170.5 (2004).

6.2.3 Seismic Actions

In accordance with the NZ Building Code and NZS 1170.5 (2004) the structure proposed is considered Importance Level 2 (IL2) with a design working life of 50 years, therefore:

- The Serviceability Limit State (SLS) design earthquake has an annual exceedance probability (AEP) of 1/25, and;
- The Ultimate Limit State (ULS) design earthquake has an AEP of 1/500.

An intermediate state event (ILS) has been considered in accordance with Gisborne District Council's (GDC's) requirements. This design case has an AEP of 1/100.

The modules of the Earthquake Geotechnical Engineering Practice series jointly published by Ministry of Business Innovation and Employment (MBIE) and the New Zealand Geotechnical Society (NZGS) (2021) provides guidance under Section 175 of the Building Act (2004), to assist with ensuring compliance with the Act. We have adopted the ground motions published within Module 1 (2021) for geotechnical design which are summarised in Table 1.

Table 1 - Summary of adopted seismic parameters.

Seismic Parameters	SLS	ILS	ULS
Horizontal Peak Ground Accelerations (PGA), g	0.12	0.28	0.65
Effective magnitude, Mw	6.3	6.8	7.5

6.3 Liquefaction and Cyclic Softening Assessments

6.3.1 Liquefaction

Liquefaction is the term used to describe the temporary, but substantial, loss of strength and stiffness which can occur in saturated, unconsolidated soils that are subjected to strong shaking. In addition to near-total strength loss, liquefaction may also result in the expulsion of sediment and water at the surface, ground, and structure settlement, and in lateral (spreading) displacement of the ground.

The liquefaction potential was assessed with site-specific CPT data using specialist geotechnical software (CLiq Ver.3.3.1.13) in general accordance with NZGS/ MBIE Module 3 Guidance (2021).

Liquefaction triggering was assessed using the method proposed by Boulanger and Idriss (2014).

Liquefaction-induced, free-field, vertical, volumetric strains were estimated using the method proposed by Zhang et al (2002)

A low-bound groundwater level of 1.65m bgl was adopted as discussed in Section 5.2.

6.3.2 Cyclic-Softening

Cyclic softening is a phenomenon that occurs when the strength and stiffness of a soil decreases due to repeated cyclic loading such as that resulting from strong seismic shaking. Relatively soft clay soils are commonly susceptible to this phenomenon, which can be accentuated where these soils are sensitive i.e., there is a significant difference between the soil's peak and residual shear strength.

Due to the presence of the clay rich estuarine soils at this site, we have undertaken a cyclic softening analysis for the ULS design case. The Gisborne 2007 earthquake was of comparable magnitude and PGA to the ILS design case. No liquefaction or induced settlements were identified within the proximity of the subject site because of this earthquake. Accordingly, cyclic softening has been assessed for the ULS design case only.

Our assessments assumed:

- An N_{kt} value of 14 for the clay-like soils, based on previous work undertaken proximally by LDE within the estuarine deposits.
- An estimate of the maximum, post-liquefaction, volumetric strain based on the work by Robertson and Cabal (Robertson & Cabal, 2014) which recommends a default value of 0.5% for clay-like soils.

6.3.3 Liquefaction and Cyclic Softening Results

The results of our analyses are summarised in Table 2; detailed outputs are included as Appendix D.

The Liquefaction Potential Index (LPI) and Liquefaction Severity Number (LSN) are indices used to assess the general performance level of liquefied deposits in accordance with the NZGS/MBIE Module 3 Guidance (2021).

Our analyses indicate that liquefaction-induced settlements are likely to be negligible (<5mm) in a design SLS seismic event.

Under the ILS design case, liquefaction-induced settlements are estimated to be between 20mm and 50mm. As discussed in Section 6.3.2, no liquefaction, or liquefaction-induced settlements were identified within the proximity of the subject site as a result of the Gisborne 2007 earthquake, which had almost identical ground motions. Accordingly, we consider it unlikely that liquefaction would be realised under ILS seismic shaking and conclude that the software is likely to be over-estimating liquefaction potential.

Table 2 - Summary of liquefaction analysis results.

Limit State / AEP	CPT ID	LPI	LSN	Estimated Seismic Volumetric Settlements (mm) [Limited to 10m] (3)			Effects of Liquefaction
				Liquefaction	Cyclic Softening	Total Seismic Settlement	
SLS 1/25 year	CPT-01	0	0	<5 [<5]	-	**<5 [<5]**	**L0**
	CPT-02	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-03	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-04	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-05	0	0	<5 [<5]	-	**<5 [<5]**	
ILS 1/100 year	CPT-01	2	8	~30 [~25]	-	**~30 [~25]**	**L2**
	CPT-02	4	12	~50 [~45]	-	**~50 [~45]**	
	CPT-03	2	5	~20 [~20]	-	**~20 [~20]**	
	CPT-04	4	12	~45 [~40]	-	**~45 [~40]**	
	CPT-05	3	10	~45 [~30]	-	**~45 [~30]**	
ULS 1/500 year	CPT-01	18	23	~75 [~70]	~45	**~120 [~70]**	**L3**
	CPT-02	18	23	~85 [~75]	~40	**~125 [~75]**	
	CPT-03	16	19	~70 [~65]	~40	**~110 [65]**	
	CPT-04	20	24	~85 [~80]	~40	**~125 [65]**	
	CPT-05	18	23	~85 [~65]	~40	**~125 [65]**	
Effects of liquefaction Key		**L0: Insignificant**	**L1: Mild**	**L2 Moderate**	**L3: High**	**L4 Severe**	**L5: Very Severe**

Notes:

- Liquefaction triggering Boulanger and Idriss (2014) methodology limited to upper 15m. Limited to 10m of soil profile shown in square brackets [ ].
- Settlements are free-field estimated settlements and do not include any building-induced settlements.
- Effects of Liquefaction based on NZGS Module 3 (New Zealand Geotechnical Society (NZGS) & Ministry of Business, Innovation and Employment (MBIE), 2021)

Under design ULS seismic shaking, settlements in the order of 110mm to 125mm are estimated. However, given the rationalisation to the Gisborne 2007 earthquake, discussed above, we consider that total, free-field, seismic settlements are likely to less than 100mm.

6.4 Lateral Spreading and Lateral Stretch

Lateral spreading typically occurs in sloping ground or level ground close to slopes or waterways and is most commonly caused by loss of strength due to earthquake-induced liquefaction. Typically, the degree of lateral movement diminishes as the distance from the waterway, or free face, increases.

Liquefaction-induced lateral displacements were estimated in CLiq software using the method proposed by Zhang et al (2004). utilising an Ic cut-off of 2.6, clean sand and overburden corrections, and inferred soil unit weights.

The methods available to predict lateral displacements from CPT data. Both these methods are based upon limited case studies and as such have inherent limitations for broader application. They are known to be highly inaccurate with predictions versus empirical data varying by a factor of two (NZGS Module 3 (2021)) or possibly more. Accordingly, lateral spreading potential was also assessed through numerical modelling, using Slide 2 (Version 9.027) by Rocscience Inc., to provide a more reliable estimate and allow sensitivity analyses to be undertaken.

Both methods, and associated results are discussed below.

6.4.1 CLiq Assessment

Our CLiq assessment adopted the 'Level ground with a free face' approach, because the alternative option (gently sloping ground) was found to estimate lateral displacements in excess of 600mm under the ILS design case.

Our assessment was based on the sites closest proximity to the Taruheru River (117m) and a free face height of 7m (elevation relief from the site to the river) and was completed for each CPT.

Table 3 presents the results of these analyses.

Table 3 - Summary of Lateral Spreading Displacements

CPT ID	SLS 1/25 year (mm)	ILS 1/100 year (mm)	ULS 1/500 year (mm)	Global Lateral Movement (ULS)
CPT01	<5	~105	~315	**Major**
CPT02	<5	~170	~390	**Major**
CPT03	<5	~100	~275	**Minor to Moderate**
CPT04	<5	~250	~460	**Major**
CPT05	<5	~180	~380	**Major**
Global lateral movement categories	**Minor to Moderate 0 to 300mm**	**Major 300 to 500mm**	**Severe >500mm**	

Notes:

- Free-face method adopted limits of lateral spreading to 2H. Chu et al (2006) have compared predicted values of lateral spread using the Zhang et al model with actual measurements of lateral displacement following the 1999 Chi Chi earthquake. They found that predicted values better matched observed values when liquefaction calculations in the CPT profile were limited to a depth of twice the free face height (2H).
- Global lateral movement categories based on MBIE Guidance for TC3 (Ministry of Business Innovation and Employment Hīkina Whakatutuki, 2015)

6.4.2 Numerical Modelling Assessment

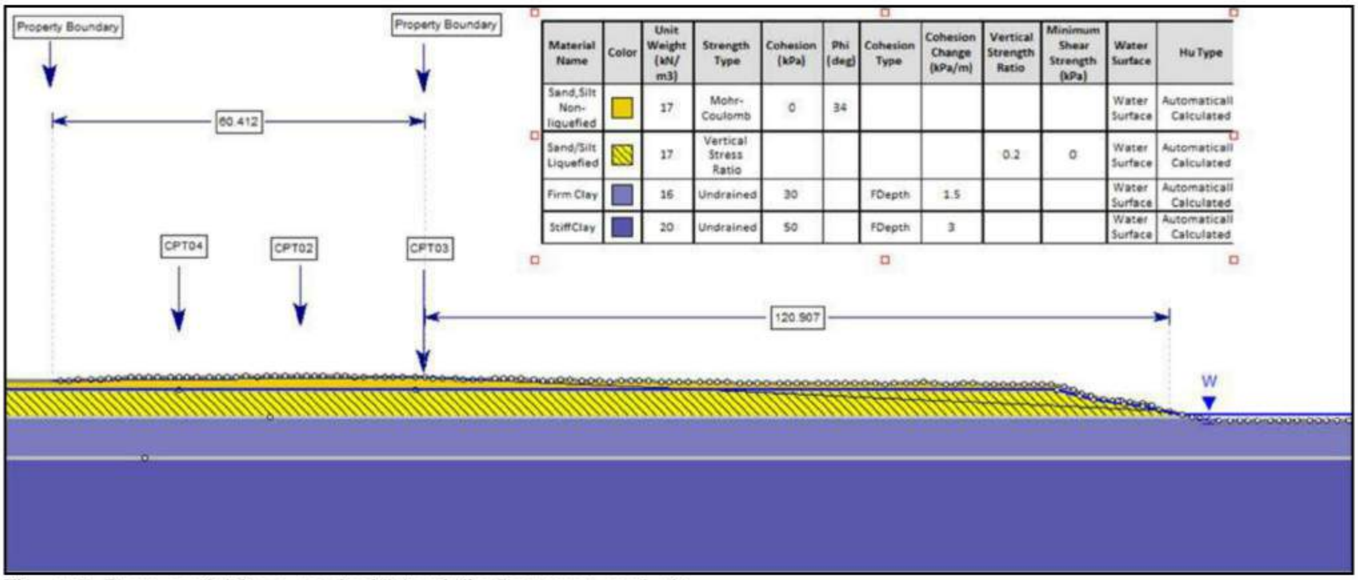
Numerical modelling was used to assess the potential for lateral displacements using Slide 2 as discussed above.

Our modelling assessed non-circular slip surfaces using the 'Cuckoo" search method and adopting the 'Vertical Strength Ratio' material strength model for the liquefied layer.

From past projects and general geological knowledge of this area, it is our experience that the Holocene beach sand transitions to clay-rich deposits towards the river, likely due to a combination of river migration and overbank deposition. In many areas along the Taruheru river a relic river terrace can be clearly identified, however this area had been developed prior to the earliest available historic aerial imagery and consequently the terrace boundary could not be identified.

Accordingly, we have adopted a conservative 'what if.' scenario in our modelling where the liquefied layer has been extended at consistent thickness and elevation to the river.

Figure 5 shows the base model, the surface profile of which was plotted from recent LiDAR data. Note the left side of the model has been manually extended to check the potential for more critical slip surfaces.



Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Cohesion Change (kPa/m)	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type
Sand,Silt Non-liquefied	🟨	17	Mohr-Coulomb	0	34					Water Surface	Automaticall Calculated
Sand/Silt Liquefied	▨	17	Vertical Stress Ratio					0.2	0	Water Surface	Automaticall Calculated
Firm Clay	🟪	16	Undrained	30		FDepth	1.5			Water Surface	Automaticall Calculated
StiffClay	🟦	20	Undrained	50		FDepth	3			Water Surface	Automaticall Calculated

Figure 5: Base model for numerical lateral displacement analysis

The liquefied shear strength to overburden stress (Tau/ Sigma) ratio was derived for the sand/ silt mixtures from statistical analysis of CPT data. The Tau/ Sigma Ratio was found to vary significantly, ranging from 0.08 to 0.98; a value of 0.2 was adopted to provide a moderately conservative estimate for the body of liquefied material. Figure 6 shows a plot of Tau/ Sigma ratio with depth for CPT04.

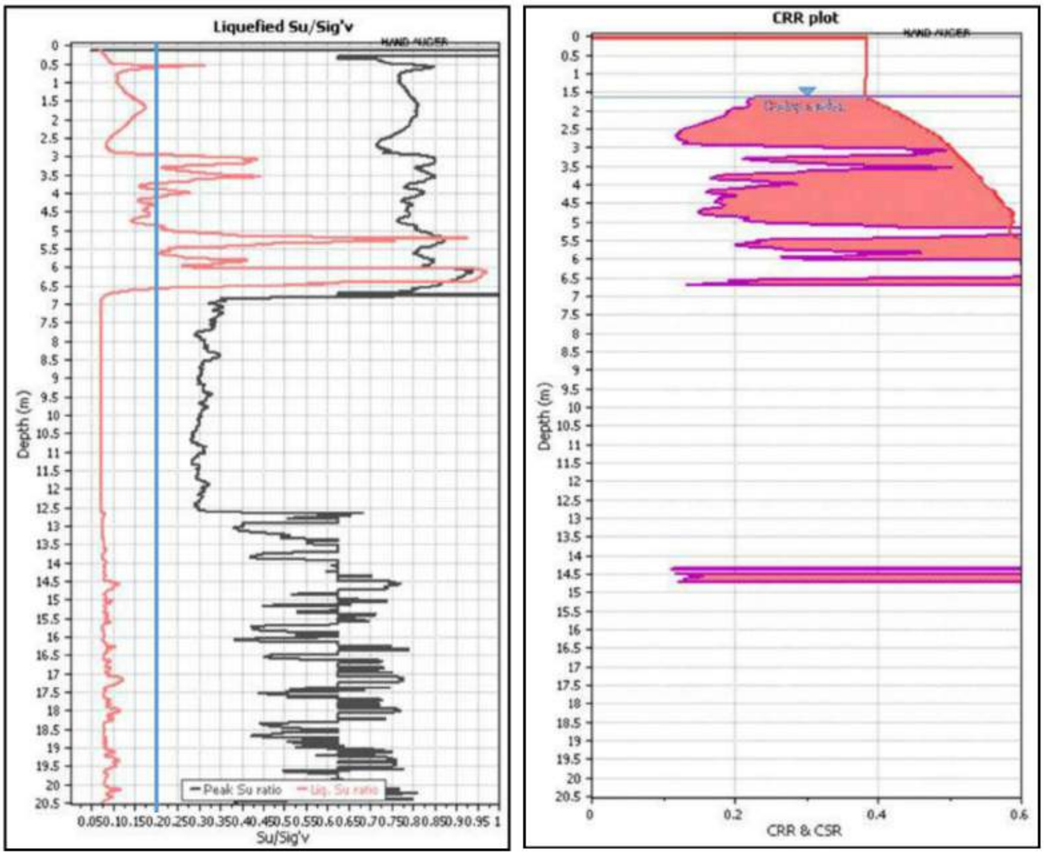


Figure 7: Tau/ Sigma ratio plot for CPT04 and plot showing depth of liquefiable material. Blue line shows value adopted in our modelling.

Two design cases were assessed:

1. Static Flow

   This design case models a post seismic liquefied case to assess the potential for flow failures to impact the subject property.
2. Seismic Yield

   This assessment determines the PGA required for the site to be affected by lateral displacements considering seismic action coincident with the fully liquefied condition. A magnitude of 0.1g was considered reasonable to represent an aftershock occurring within the short-term, liquefied timeframe.

6.4.2.1 Results

The results suggest that the property will not be affected in the static flow scenario with failures extending to a maximum of around 31m from the riverbank, some 85m from the subject property.

Under the seismic yield design case the subject property is estimated to be affected with a PGA of around 0.11g. Accordingly, lateral displacements are not anticipated in this scenario.

Full results are presented in Appendix E.

6.4.3 Conclusions

Numerical modelling indicates that lateral displacements of the magnitude estimated by CLiq are only achieved when full seismic PGAs are applied in the fully liquefied condition. Such a scenario is considered to be of very low probability, and highly conservative. We consider however that there is a reasonable probability of an aftershock occurring during this timeframe.

We conclude that the numerical modelling provides a more realistic estimate of ground performance, particularly given the apparent overestimation of liquefaction affects, discussed in Section 6.3.3. Accordingly, we consider that the subject site has low lateral spreading potential.

6.4.3.1 Lateral Stretch

Lateral stretch is a metric of the amount of differential extension that a portion of land may experience during an episode of lateral spreading. The lateral stretch across a foundation is a main factor in foundation damage due to liquefaction and lateral spreading as a result of a large earthquake.

Given the results of our numerical analyses, discussed above, lateral stretch is not anticipated at the subject site under the design cases assessed.

6.5 Liquefied Bearing

Liquefaction may lead to foundation bearing failure, by either 'punch through' failure or a reduction in bearing capacity when liquefaction occurs within the zone of influence of load bearing foundations.

A preferred foundation option has not been identified for the proposed structures at the time of writing and we have completed liquefied bearing assessments for both raft-type surface structures and piled foundations.

A unit weight of 17kN/m^3 was adopted for both the non-liquefied and liquefied soil layers. An angle of internal friction of 34 degree was adopted for the non-liquefied material.

The Tau/sigma ratio for these assessments was based on site-specific CPT data and taken as 0.075 for the liquefied material within the zone of influence of the foundations.

A low-bound groundwater level was taken as 1.65, as discussed in Section 5.2.

A reduction factor of 0.75 was applied to the ultimate capacities calculated for the proposed, two-storey, duplex buildings, in accordance with MBIE Module 5 (2021) for moderately loaded structures.

6.5.1 Pile Foundation Assessment

Our assessment of pile foundations assumed:

- Ordinary piles embedded to a minimum depth of 0.5m at 0.3m diameter (including concrete cover), and

- Anchor piles embedded to a minimum depth of 0.9m at 0.4m diameter (including concrete cover), and
- 100kPa design load.

Both projected area and 'punch-through' failure mechanisms were assessed.

6.5.1.1 Results

The design load was found to be acceptable in both design cases. Note that our calculations are dependent on the assumptions listed within this Section. Should the pile diameter, pile embedment depth or design loads change, the liquefied bearing capacities will need to be reassessed.

6.5.2 Raft type Surface Structure Foundation Assessment

For the raft-type surface structures assessments were completed for the single-storey and two-storey buildings assuming:

- Foundation widths as presented in the 15% architectural drawings, and
- An embedment depth of 0.2m.

6.5.2.1 Results

Liquefied bearing capacities were calculated to be 19kPa for the proposed single-story buildings and 14kPa for the proposed two-storey duplex structures.

The values presented above are dependent on the assumptions listed. Should the foundation breadth, embedment depth or design loads change, the liquefied bearing capacities will need to be reassessed.

6.6 Equivalent MBIE Technical Category

Considering the rationalisation provided in Section 6.3.3, we consider that seismic ground performance at this site would be equivalent to a TC2 classification in accordance with Table 15.6 of the MBIE Guidance (2015).

6.7 Flood Hazard

The site is not located in a mapped flood hazard zone. GDC aerial imagery post cyclone Gabrielle does not indicate this site experienced significant impacts.

6.8 Tsunami

The Gisborne / East Cape coastline is classified as being at the highest risk in the country of being affected by tsunami. Modelling for the Gisborne region (GNS Science Te Pū Ao, 2016) indicates that the site is sufficiently elevated and is unlikely to be inundated in 1:100, 1:500, and 1:2500-year return period tsunami events, respectively. Civil defence tsunami inundation maps show that the site mapped as a yellow zone, which may be subject to tsunami

hazard in the case of a severe (ie M8.9) local earthquake on the Hikurangi subduction margin (Gisborne District Council Te Kaunihera o Te Tairāwhiti, 2019) .

6.9 Expansive Soils

Cohesive soils containing significant proportions of certain clay minerals can be subject to appreciable volume change caused by variations in soil moisture content, most notably between seasons or from the uptake of water through the root systems of trees and shrubs. This is referred to as soil reactivity or shrink-swell behaviour.

The surficial soils at this site are granular in nature and therefore not subject to expansivity.

6.10 Consolidation Settlement

The topsoil across the site is expected to be subject to consolidation with applied load and is not suitable to support structural loads.

The firm clay beneath the site may also be subject to consolidation settlement depending on the foundation option selected and the structural loads applied. The potential for consolidation settlement within this material should be assessed once the foundation type and structural loads have been determined.

6.11 Natural Hazards Summary

From our assessment of the natural hazards and ground deformation risks presented to the proposed development we consider that the proposed structures can be safely located on the site, provided that the recommendations given in Section 7 are adopted.

7 ENGINEERING RECOMMENDATIONS

7.1 Site Contouring and Topsoiling

The finished ground level should be graded so that water cannot pond against, beneath or around the buildings for the economic life of structure. To achieve this, it will be important that the building platform beneath the topsoil grades away from the site. Contouring should avoid the potential for concentration and discharge of surface water over point locations which could result in soil erosion or instability.

7.2 Access Road Construction

Access is proposed from Aberdeen Road. No major/ significant earthworks are anticipated to form access to the proposed dwellings.

7.3 Foundation Recommendations

7.3.1 Foundation Type

Based on the site investigation and analysis, we consider that foundations comprising pile foundations or raft-type surface structures are suitable for the site conditions providing the recommendations and limitations presented within this section are addressed in design.

7.3.2 Design Considerations

Based on the scope of work completed, the following aspects need to be considered in detailed design:

- Site Class - Class D - Deep or soft soil
- Liquefaction-induced vertical settlements - TC2 equivalent
- Relatively high groundwater level
- Liquefied bearing capacity
- Potential for consolidation settlement

7.3.3 Bearing Capacity and Founding Depth

Foundations must extend beneath any topsoil, uncontrolled fill, organic and/ or otherwise unsuitable material.

For the Lot 7/8 duplex structure we anticipate that a static geotechnical ultimate bearing capacity of 210kPa will be available from the subgrade located below the topsoil, which indicatively is from 0.5m depth. A reduction factor of 0.45 should be applied to this value to give the design bearing strength (q_{dbs}).

A short-term, post-seismic (static), liquefied bearing capacity, equivalent to the values presented in Section 6.5, should be assessed in structural design. Note that these liquefied bearing capacities are contingent on the assumptions listed within Section 6.5. Should these assumptions change in design, the liquefied bearing capacities will need to be reassessed. This may require some iterative design between the geotechnical and structural engineers.

7.4 Surface Water

Surface water from roof, impermeable surfaces, or any slopes should be collected and discharged away from the building to mitigate against flooding, erosion, soil expansivity, and/ or potential instability. The site will be connected to the reticulated network. Rainwater will be collected from the roof and all paved surfaces including parking areas and discharged into the GDC reticulated stormwater network.

7.4.1 Service Pipes

All service pipes, stormwater structures should be designed and constructed to ensure adequate capacity, strength, and water tightness to prevent leakage into the platform through blockage, running under pressure, or structural failure.

All service pipes installed within any fill should be flexible, or flexibly joined, so that they may deflect without breaking if the ground settles.

A record should be kept of the position, type, and size of all subsoil drains, and in particular of their outlets.

7.5 Trees and Shrubs

There are trees within the vicinity scattered across the property which might potentially cause damage through heaving as a result of root growth and/or settlement resulting from soil shrinkage from the moisture uptake of the roots. To reduce the chance of damage to the foundations, we recommend one of the following options:

- Any Trees/ plants that at their mature high will not be a minimum of that height away from the foundation should be removed including its major root structure.
- A root barrier should be designed and installed between the offending plant and the structure.
- Foundation should be taken to a depth no less than 1.0m where damage from the roots of a plant is unlikely.

If new trees, shrubs, or gardens are established near the structure, care should be taken to ensure:

- The vegetation does not interfere with any subfloor ventilation or services to the structure.
- Over-watering of the vegetation does not saturate the ground near the foundations.
- Trees or shrubs with the potential to develop significant root systems should be planted a minimum distance equal to the mature height of the plant away from the foundations.

8 SUSTAINABILITY

Considering sustainability as early as possible in a project's development, could lead to significant project opportunities and wider positive outcomes. Geotechnical opportunities for increased sustainability for this project include:

- Striping and stocking topsoil for reuse (dependant on presence/ levels of contaminants).
- Designing for cut and fill balance where possible.
- Reuse of site won materials, or using materials won from other sites including use of recycled crushed concrete aggregate for hard fill.
- Contributing site investigation data to the New Zealand Geotechnical Database (NZGD) to help reduce the site investigations needed in the future.

- Using local consultants and contractors to reduce transport related emissions.

9 CONCLUSIONS

Following development of the site in accordance with our recommendations, we consider that: -

a) The land in respect of which a consent is sought, or any structure on the land built in accordance with our recommendations, is unlikely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; and

b) Any subsequent use that is likely to be made of the land is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; and

c) Sufficient provision has been made for physical access to each allotment to be created by the subdivision.

10 PLAN REVIEW

Prior to an application for Building Consent, it is important we are given the opportunity to review the final development drawings to ensure the recommendations contained within this report have been followed and interpreted correctly. Following successful review of the development drawings, we are able to update this report to support an application for Building Consent.

11 VERIFICATION

Verification requirements will be provided once the form of the foundations has been determined.

12 LIMITATIONS

This report should be read and reproduced in its entirety including the limitations to understand the context of the opinions and recommendations given.

This report has been prepared exclusively for NZHG Gisborne Limited in accordance with the brief given to us or the agreed scope and they will be deemed the exclusive owner on full and final payment of the invoice. Information, opinions, and recommendations contained within this report can only be used for the purposes with which it was intended. LDE accepts no liability or responsibility whatsoever for any use or reliance on the report by any party other than the owner or parties working for or on behalf of the owner, such as local authorities, and for purposes beyond those for which it was intended.

This report was prepared in general accordance with current standards, codes and best practice at the time of this report. These may be subject to change.

Opinions given in this report are based on visual methods and subsurface investigations at discrete locations designed to the constraints of the project scope to provide the best assessment of the environment. It must be appreciated that the nature and continuity of the subsurface materials between these locations are inferred and that actual conditions could vary from that described herein. We should be contacted immediately if the conditions are found to differ from those described in this report.

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14 GLOSSARY

Compressible Soils:	Compressible soils are those that will undergo a reduction in volume under an imposed load, such as the weight of fill or a structure. This occurs firstly as a result of the expulsion of air and water from the soil void spaces (primary settlement) and secondly due to a restructuring of the soil skeleton to take the load (secondary settlement).
Cyclic Softening:	Cyclic-softening is a related condition to liquefaction can also affect clay soils when subjected to cyclic-loading. Clay soils may significantly soften and led to bearing capacity failure, in addition to post-earthquake consolidation settlements may occur as a result of the earthquake shaking.
Expansive Soils:	Cohesive soils containing significant proportions of certain clay minerals can be subject to appreciable volume change caused by variations in soil moisture content, most notably between seasons or from the uptake of water through the root systems of trees and shrubs. This is also often referred to as soil reactivity or shrink-swell behaviour.
Lateral Spread:	Lateral spread of liquefied soils is the lateral displacement of blocks of land moving laterally towards a free edge (for example a riverbank) or within sloping ground. More lateral movement tends to occur closest to the edge with less movement further back. Lateral spreading may result in large permanent ground displacements including cracks, fissures, vertical officesets and overall settlement of the ground.
Lateral Stretch:	Lateral stretch is the amount of differential extension that a portion of land may experience during an episode of lateral spreading. The lateral stretch across a foundation is a main factor in foundation damage due to liquefaction and lateral spreading because of a large earthquake.
LiDAR	Light Detection and Ranging (LiDAR) is a method of remote sensing topographical survey.
Limit States:	Seismic design criteria for performance-based design. SLS, SLS2 & ULS are prescribed in NZS1170.5 (Standards New Zealand Te Mana Tautikanga O Aotearoa, 2004) • **Serviceability Limit State (SLS):** Functional requirements for the serviceability limit state are assumed to be met if the structure or part can continue to be used as originally intended without the need for repair (SLS1) or can remain operational or continue to be occupied as appropriate (SLS2). SLS earthquakes are considered highly likely to occur during the lifetime of the structure. • **Ultimate Limit State (ULS):** Functional requirements for the ultimate limit state are assumed to be met if: a) People within, and adjacent to the structure are not endangered by the structure or part.

	b) Displacements of the structure are such that there is no contact between any parts of a structure for which contact is not intended, or between separate structures on the same site, if such contact would damage the structures or parts to the extent that persons would be endangered, or detrimentally alter the response of the structure(s) or parts, or reduce the strength of structural elements below the required strength. c) The structure does not deflect beyond a site boundary adjacent to which other structures can be built or collision between the structure and any adjacent existing structures cannot occur. d) There is no loss of structural integrity in either the structure or part. • **Intermediate Limit State (ILS):** ILS is an intermediate seismic event between SLS & ULS although is not a code requirement. The behaviour of soils and geotechnical systems under earthquake shaking may be highly non-linear and even exhibit a pronounced 'step change' in performance with increasing intensity of shaking. For such cases, only considering performance at the SLS and ULS levels of shaking would fail to identify potentially poor and unacceptable performance at intermediate return periods of shaking.
Liquefaction:	Liquefaction is the term used to describe the temporary, but substantial, loss of strength and stiffness which can occur in saturated, unconsolidated soils that are subjected to strong shaking. In addition to near-total strength loss, liquefaction may also result in the expulsion of sediment and water at the surface, ground and structure settlement, and in lateral (spreading) displacement of the ground.
LPI	Liquefaction potential index is a liquefaction damage index. LPI ranges between 0 and 100 and sites with an LPI of 5 indicate a high liquefaction risk and sites with LPI greater than 15 indicate very high risk (Iwasaki et al, 1982). Not to be used as a precise measure of liquefaction-induced ground damage but as an indicator of the general level of liquefaction severity.
LSN	Liquefaction Severity Number is a liquefaction damage index. LSN varies from 0 (representing no liquefaction vulnerability) to more than 100 (representing very high liquefaction vulnerability (van Ballegooy et al, 2013). LSN places greater importance (than LPI) on the thickness of the non-liquefied crust when the groundwater table is close to the ground surface. Not to be used as a precise measure of liquefaction-induced ground damage but as an indicator of the general level of liquefaction severity. LNS was developed based on the observations/ investigations from the Canterbury earthquake sequence
PGA:	Peak Ground Acceleration (PGA) is the maximum ground acceleration during an earthquake as a proportion of gravity.
Punch Through Failure:	Punch through failure occurs when a foundation punches through a crust of non-liquefiable material due to underlying liquefaction occurring and can lead to potential damage to foundations and/ or large settlements.

Technical Category:

Following the 2010 -2011 Canterbury earthquake sequence the Ministry of Business Innovation and Employment (MBIE) assigned three technical categories (TC1, TC2, TC3) across the residential 'green zone' for foundation investigation and design guidance focusing on one and two storey timber-framed dwellings. These categories are broadly defined as below:

- **TC1:** Liquefaction damage is unlikely in future large earthquakes. Standard residential foundation assessment and construction is appropriate.
- **TC2:** Liquefaction damage is possible in future large earthquakes. Standard enhanced foundation repair and rebuild options in accordance with MBIE guidance are suitable to mitigate against this possibility.
- **TC3:** Liquefaction damage is possible in future large earthquakes. Individual engineering assessment is required to select the appropriate foundation repair or rebuild option.
- **TC2/ TC3 Hybrid:** A site that straddles liquefaction settlement limits of TC2 and TC3 where the SLS settlements are assessed as being less than 50 mm but the ULS settlements are assessed at greater than 100mm.

Whilst this guidance is intended for residential buildings in the Canterbury region, they have been widely adopted to convey liquefaction vulnerability across New Zealand.

The Modules:

The New Zealand Geotechnical Society (NZGS) and MBIE jointly published a series of guidelines for Earthquake Geotechnical Engineering Practice. Revision 1 of the Modules was published in November 2021 and they provide guidance under section 175 of the Building Act 2004 to assist parties to comply with their obligations under the Building Act 2004. The following modules currently form the collection:

- **Module 1:** Overview of the guidelines
- **Module 2:** Geotechnical investigation for earthquake engineering
- **Module 3:** Identification, assessment, and mitigation of liquefaction hazards
- **Module 4:** Earthquake resistant foundation design
- **Module 5:** Ground improvement
- **Module 5A:** Specification of ground improvement for residential properties in the Canterbury region
- **Module 6:** Retaining walls

APPENDIX A

SITE PLAN

LEGEND

Project Data

🟨	Proposed Lots Boundary
🟥	Proposed Building Platform
—	Proposed Accessway
◐	Hand Auger + DCP
▽	CPT (Due Diligence)

0 6 12 18 24 m

SCALE A3: 1:350

NOTES

1. Aerial basemap and property boundaries sourced from LINZ Data Service (CC-BY 4.0).
2. Investigation locations shown approximately only.

CLIENT

NZHG Gisborne Limited

PROJECT

Geotechnical Investigation for proposed subdivision
556-560 Aberedeen Road, Te Hapara
Gisborne

DRAWING TITLE

Geotechnical Investigation Plan

LAND DEVELOPMENT & ENGINEERING

PROJECT REF	DRAWING REF	REVISION
24477	GIP	A
DATE	PREPARED BY	CHECKED BY
29/09/2023	SS	RH

FILE PATH

M:\FILES\LDE - Projects\77008-24477\Geo QGIS Zip Folder (ID 79084)\24477 QGIS Site Maps\24477 Aberdeen Rd.qgz

APPENDIX B

HAND AUGER TEST LOGS

Hand Auger Borehole Log

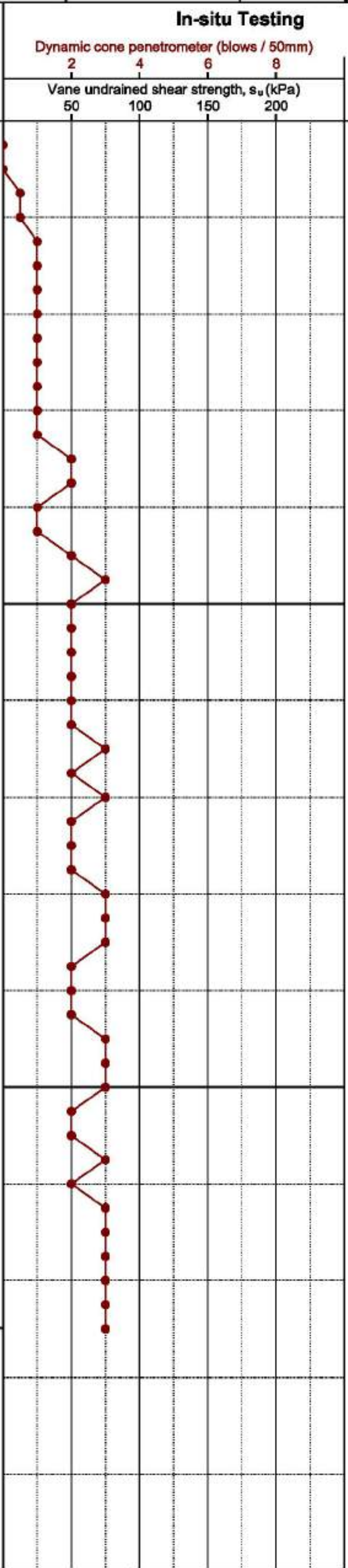
Method: 50mm Hand Auger

Test ID:	HA01	**Project ID:**	24477	**Sheet:**	1 of 1

Client:	NZHG	**Coordinates:**	5709871mN, 2036134mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water
0.0–0.3	TS	SAND, with trace rootlets and silt; dark brown. Very loose; moist; sand, fine to medium.	
0.3–2.5	Holocene Beach Deposits	SAND; brown. Loose; moist; sand, fine to medium. 1.80m: Light grey. 2.20m: Grey with orange mottles. 2.40m: Wet.	Groundwater not encountered

In-situ Testing



Values

Vane ID: N/A

peak / residual (sensitivity)

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5

RL (m): 6.0, 5.5, 5.0, 4.5, 4.0

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

● Vane peak ▼ Standing water level

○ Vane residual ◁ Groundwater inflow

◆ Vane UTP ▷ Groundwater outflow

UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

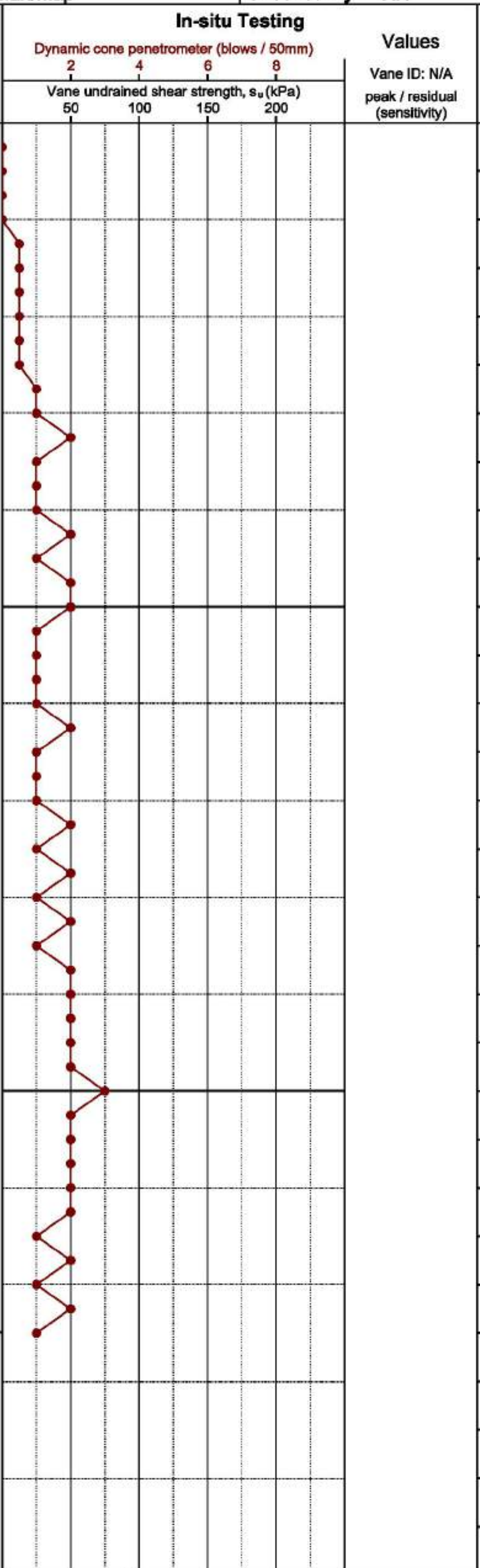
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA02**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709864mN, 2036136mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	RL (m)
0.0 – 0.5	TS	SAND, with minor silt, with trace rootlets; dark brown. Very loose; moist; sand, fine to medium.	Groundwater not encountered	6.5 – 6.0
0.5 – 2.5	Holocene Beach Deposits	SAND; brown. Loose; moist; sand, fine to medium. 1.50m: Grey with orange mottles. 1.70m: Light grey. 2.40m: Wet.		6.0 – 4.0



Hole Depth: 2.50m	**Termination:** TARGET DEPTH	● Vane peak	▼ Standing water level
Remarks:		○ Vane residual	◁ Groundwater inflow
		◆ Vane UTP	▷ Groundwater outflow

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

UTP = Unable to Penetrate

LDE LAND DEVELOPMENT & ENGINEERING

Hand Auger Borehole Log

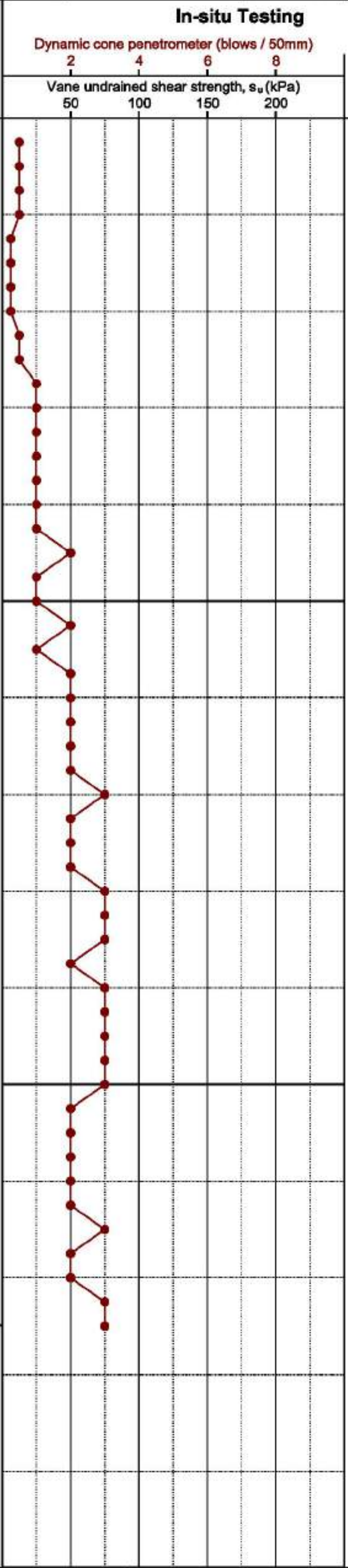
Method: 50mm Hand Auger

Test ID:	HA03
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709847mN, 2036129mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	RL (m)
	Uncontrolled Fill / Topsoil	SAND, with minor silt, with trace rootlets; dark brown. Very loose; moist; sand, fine to medium; trace metal fragments.		
0.5				6.5
	Holocene Beach Deposits	SAND; brown. Loose; moist; sand, fine to medium.		
1.0				6.0
1.5				5.5
		1.80m: Grey with orange mottles.		
		1.90m: Wet.		
2.0				5.0
		2.40m: Saturated.	▼	
2.5				4.5

In-situ Testing



Values

Vane ID: N/A

peak / residual (sensitivity)

Hole Depth: 2.50m	**Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

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Hand Auger Borehole Log

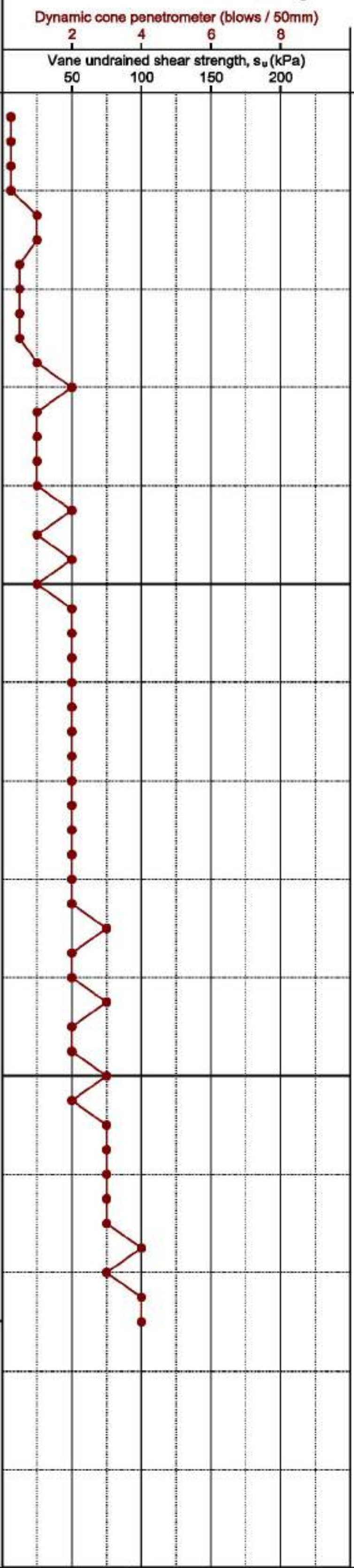
Method: 50mm Hand Auger

Test ID:	**HA04**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709842mN, 2036126mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Graphic Log	Material Description	Water	RL (m)
	TS		SAND, with minor silt, with trace rootlets; dark brown. Loose; moist; sand, fine to medium.		
0.5	Holocene Beach Deposits		SAND; brown. Loose; moist; sand, fine to medium.		6.5
1.0					6.0
1.5					5.5
			1.90m: Wet.		
2.0					5.0
			2.20m: Saturated.	▼	
2.5					4.5

In-situ Testing



Values
Vane ID: N/A
peak / residual
(sensitivity)

Hole Depth: 2.50m	**Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

Hand Auger Borehole Log

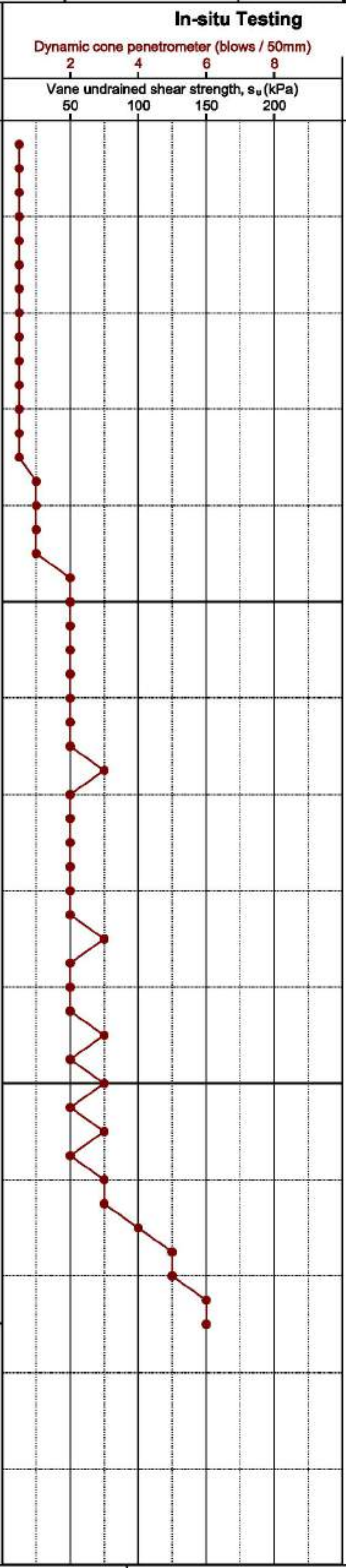
Method: 50mm Hand Auger

Test ID:	**HA05**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709846mN, 2036121mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	7m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	RL (m)
0.0 – 0.5	Uncontrolled Fill / Topsoil	SAND, with minor silt, with trace rootlets and gravel; dark brown. Loose; moist; sand, fine to medium; gravel, fine to medium, subrounded to subangular.		7.0 – 6.5
0.5 – 2.5	Holocene Beach Deposits	SAND; brown. Loose; moist; sand, fine to medium. 1.80m: Brownish grey. 1.90m: Wet. 2.40m: Saturated.	▼ (2.40)	6.5 – 4.5

In-situ Testing



Values

Vane ID: N/A

peak / residual (sensitivity)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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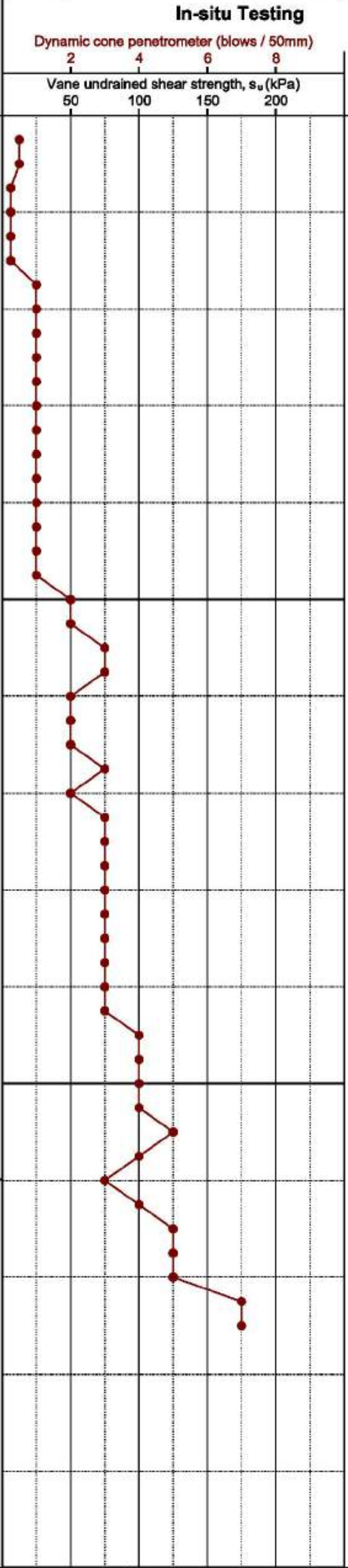
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA06**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709835mN, 2036107mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.2m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water
0.00–0.30	Uncontrolled Fill / Topsoil	SAND, with minor silt, with trace rootlets and gravel; dark brown. Very loose; moist; sand, fine to medium; gravel, fine, subangular.	
0.30–2.20	Holocene Beach Deposits	SAND; brownish orange. Loose; moist; sand, fine to medium. 1.60m: Wet. 1.80m: Heavy orange mottling. 1.90m: Brownish grey. Saturated. 2.00m: Brownish grey with orange mottles. Poor recovery > 50%.	▼



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.20m **Termination:** HOLE COLLAPSE

Remarks:

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA07**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709824mN, 2036090mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m) | **Geology** | **Graphic Log** | **Material Description** | **Water** | **In-situ Testing** | **Values** Vane ID: N/A peak / residual (sensitivity) | **RL (m)**

Uncontrolled Fill / Topsoil

SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine to medium; trace charcoal.

0.40m: Sandy. Sand, fine to medium.

Holocene Beach Deposits

SAND; light brown with orange mottles. Loose; moist; sand, fine to medium.

1.00m: Brownish grey with orange streaks.

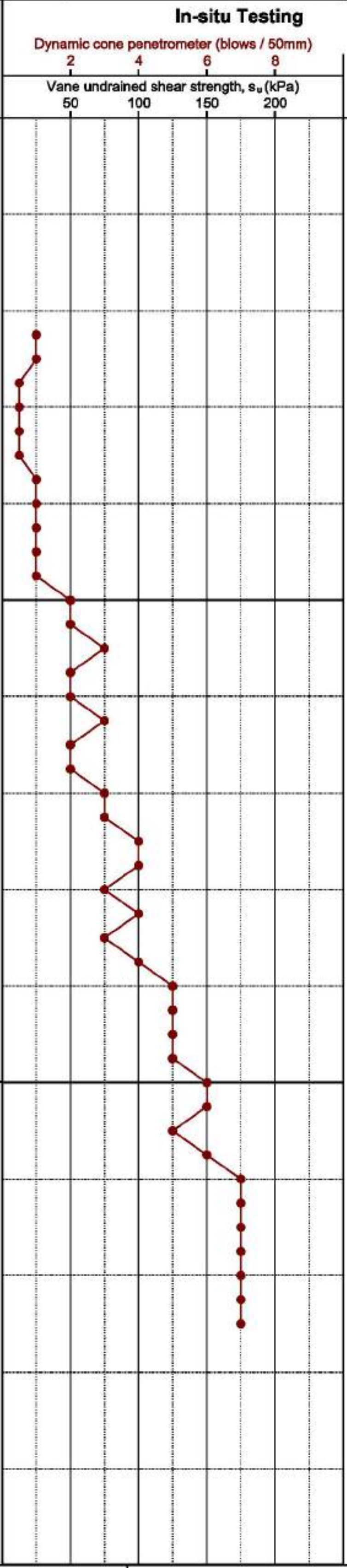
1.20m: Wet.

1.50m: Saturated.

1.70m: Poor recovery > 30%.

Depth: 0.5, 1.0, 1.5, 2.0, 2.5

RL: 5.5, 5.0, 4.5, 4.0, 3.5



Hole Depth: 2.00m | **Termination:** HOLE COLLAPSE

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

Generated with CORE-GS by Geroc - HAxTP Log v9 - 6/10/2023 11:09:26 am

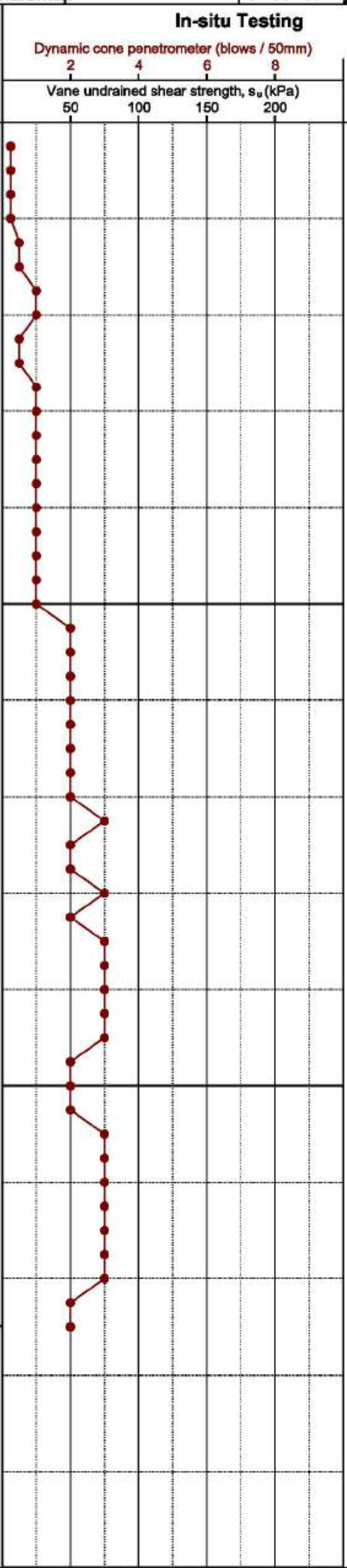
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	HA08		
Project ID:	24477		
Sheet:	1 of 1		
Client:	NZHG	**Coordinates:**	5709850mN, 2036087mE
Project:	Geotechnical Investigation	**System:**	NZTM
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map
Test Date:	12/09/2023		
Logged By:	SS		
Prepared By:	SS		
Checked By:	RH		

Depth (m)	Geology	Material Description	Water	RL (m)
0.0–0.3	Topsoil	SAND, with minor silt, with trace rootlets; dark brown. Very loose; moist; sand, fine to medium.		
0.3–2.5	Holocene Beach Deposits	SAND; light brown. Loose; moist; sand, fine to medium.		
0.5				6.0
1.0				5.5
1.5				5.0
		1.60m: Brownish grey.		
		1.80m: Brownish grey orange streaks.		
2.0		2.00m: Dark brown. Wet.		4.5
		2.30m: Brownish grey.		
		2.40m: Saturated.	▼	
2.5				4.0

In-situ Testing



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow
UTP = Unable to Penetrate

Generated with CORE-GS by Geroc - HAxTP Log v9 - 6/10/2023 11:09:27 am

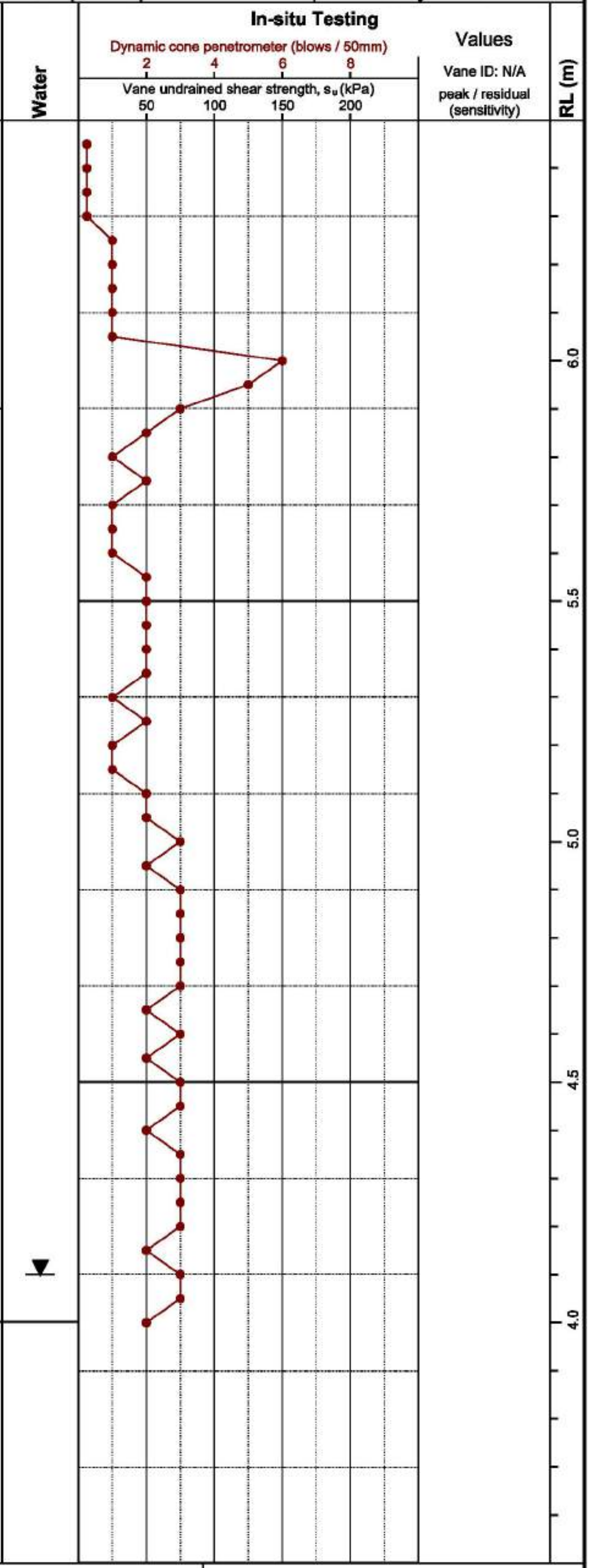
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA09**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709853mN, 2036094mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Graphic Log	Material Description
	Topsoil		SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine. 0.20m: SAND, with minor silt. Sand, fine to medium; trace brick fragments.
0.5			
	Holocene Beach Deposits		SAND; brownish orange. Loose; moist; sand, fine to medium.
1.0			
1.5			1.50m: Brownish grey.
2.0			2.00m: Wet.
			2.40m: Saturated.
2.5			



Hole Depth: 2.50m	**Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

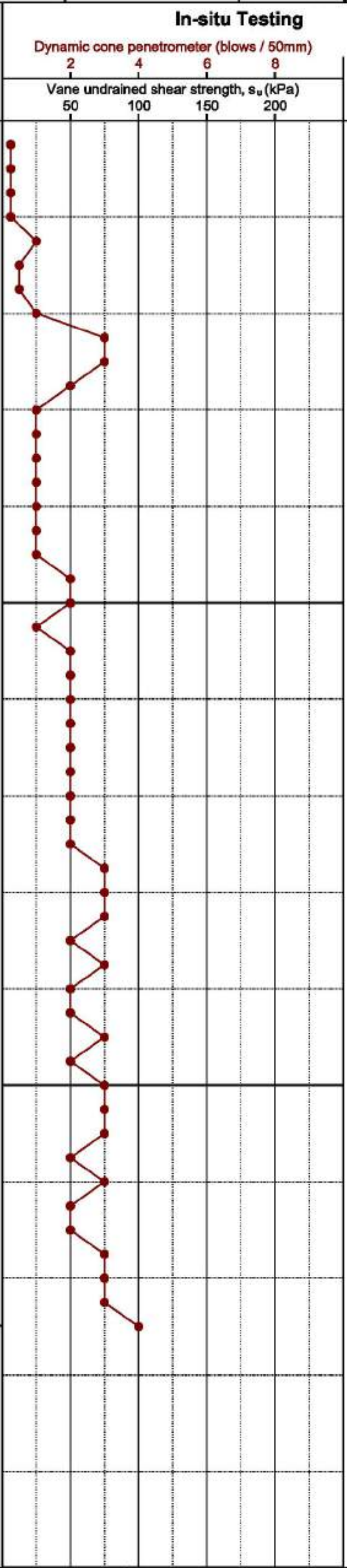
Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA10**
Project ID:	24477
Sheet:	1 of 1

Client:	NZHG	**Coordinates:**	5709860mN, 2036093mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.5m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water
0.0	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine. 0.20m: SAND. Sand, fine to medium.	
0.7	Holocene Beach Deposits	SAND; brownish orange. Loose; moist; sand, fine to medium. 1.70m: Brownish grey. 2.00m: Wet. 2.40m: Dark brown. Saturated.	▼



Values
Vane ID: N/A
peak / residual (sensitivity)

RL (m): 6.0 (0.5 m), 5.5 (1.0 m), 5.0 (1.5 m), 4.5 (2.0 m), 4.0 (2.5 m)

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA11
Project ID: 24477
Sheet: 1 of 1

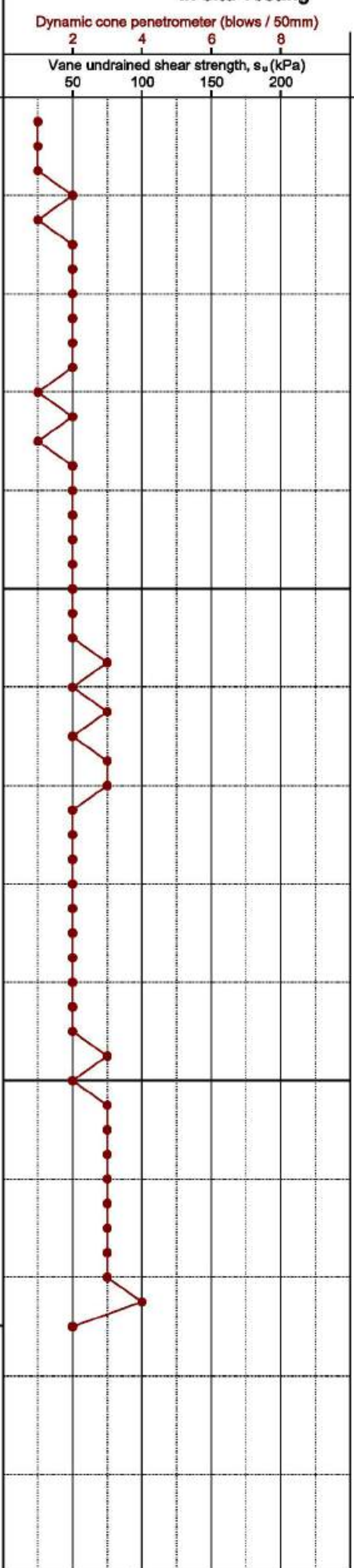
Client: NZHG
Project: Geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne
Test Site: Refer to geotechnical investigation plan

Coordinates: 5709865mN, 2036106mE
System: NZTM
Elevation: 7m (NZVD2016)
Located By: Site plan/map

Test Date: 12/09/2023
Logged By: SS
Prepared By: SS
Checked By: RH

Depth (m)	Geology	Graphic Log	Material Description	Water	RL (m)
	Uncontrolled Fill / Topsoil		SAND, with trace silt and gravel; dark brown. Loose; moist; sand, fine to medium; gravel, fine to medium, subrounded to subangular.	Groundwater not encountered	
0.5 1.0 1.5 2.0 2.5	Holocene Beach Deposits		SAND; brownish orange. Medium dense; moist; sand, fine to medium. 2.30m: Wet.		6.5 6.0 5.5 5.0 4.5

In-situ Testing



Values
Vane ID: N/A
peak / residual (sensitivity)

Hole Depth: 2.50m
Termination: TARGET DEPTH
Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
▼ Standing water level
○ Vane residual
◁ Groundwater inflow
◆ Vane UTP
▷ Groundwater outflow
UTP = Unable to Penetrate

LDE LAND DEVELOPMENT & ENGINEERING

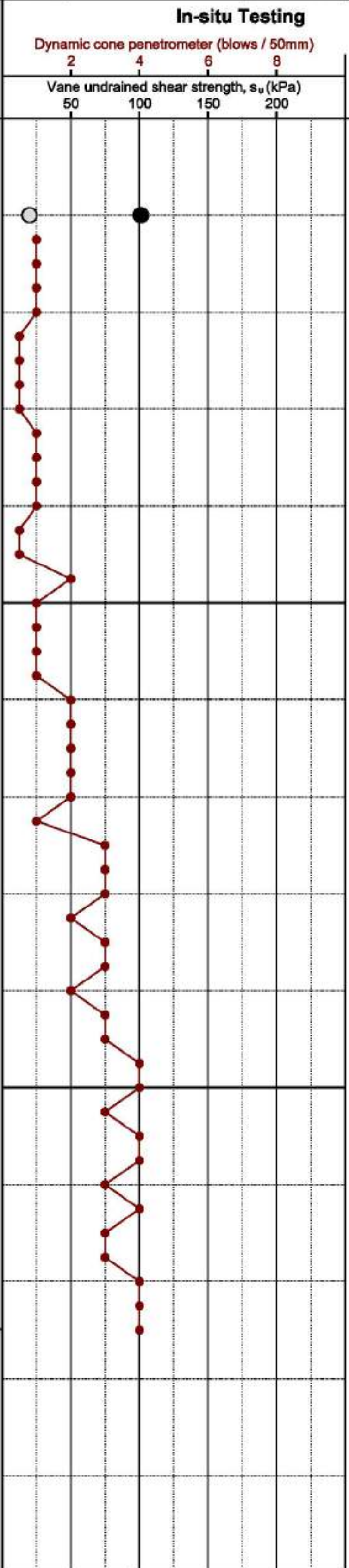
Hand Auger Borehole Log

Method: 50mm Hand Auger

Client:	NZHG	**Coordinates:**	5709880mN, 2036108mE	**Test ID:**	HA12
Project:	Geotechnical Investigation	**System:**	NZTM	**Project ID:**	24477
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Sheet:**	1 of 1
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Test Date:**	12/09/2023
				Logged By:	SS
				Prepared By:	SS
				Checked By:	RH

Depth (m)	Geology	Material Description	Water	Values Vane ID: 2888 peak / residual (sensitivity)
	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine. 0.30m: SAND, with minor silt. Sand, fine to medium. 0.40m: Black.		101 / 20 (5.1)
0.5	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium. 2.00m: Wet. 2.50m: Saturated.		
1.0				
1.5				
2.0				
2.5			▼	

In-situ Testing



RL (m): 6.5, 6.0, 5.5, 5.0, 4.5, 4.0

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

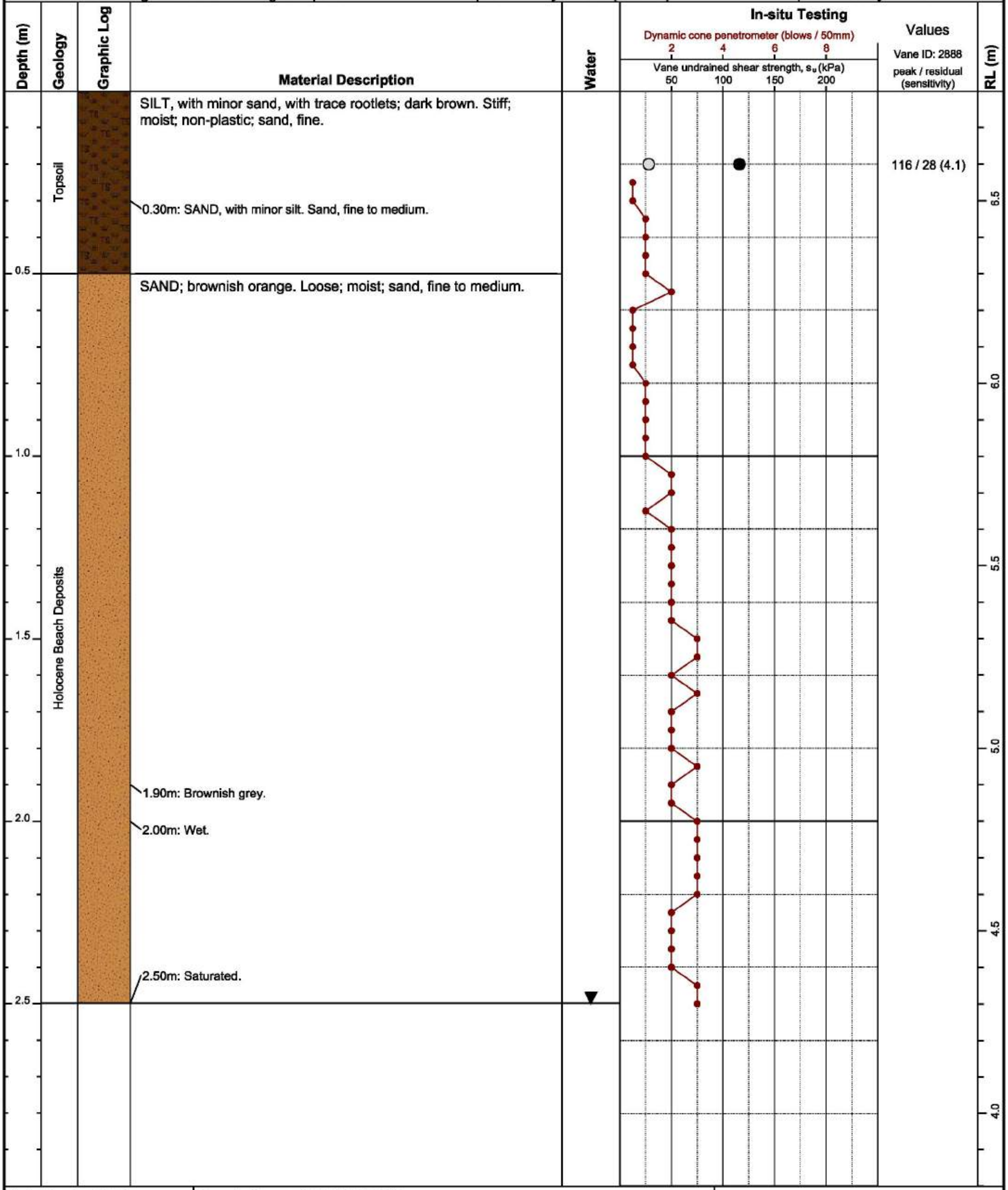
UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID: HA13
Project ID: 24477
Sheet: 1 of 1

Client:	NZHG	**Coordinates:**	5709882mN, 2036101mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH



SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.

0.30m: SAND, with minor silt. Sand, fine to medium.

SAND; brownish orange. Loose; moist; sand, fine to medium.

1.90m: Brownish grey.

2.00m: Wet.

2.50m: Saturated.

Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak	▼ Standing water level
○ Vane residual	◁ Groundwater inflow
◆ Vane UTP	▷ Groundwater outflow

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA14**
Project ID:	24477
Sheet:	1 of 1

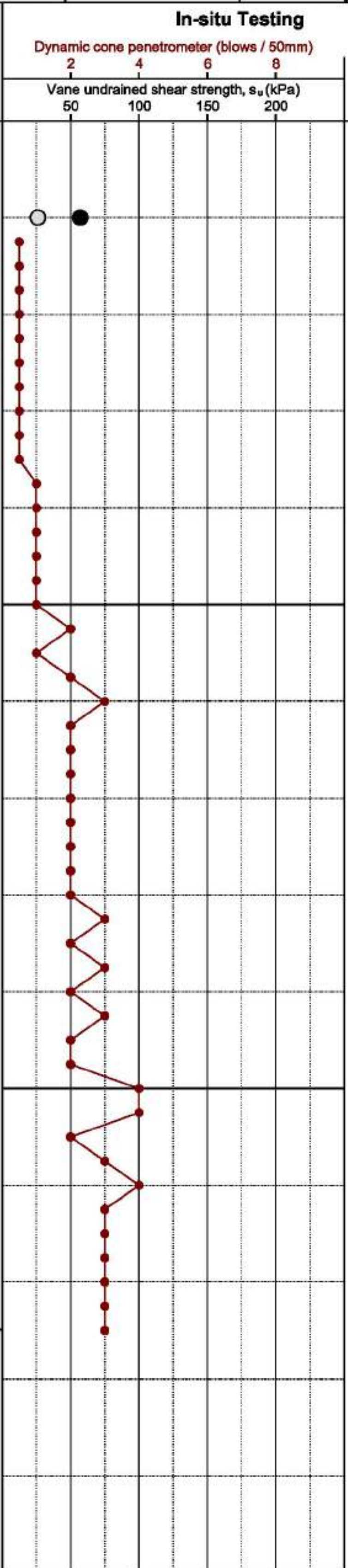
Client:	NZHG	**Coordinates:**	5709887mN, 2036103mE	**Test Date:**	12/09/2023
Project:	Geotechnical Investigation	**System:**	NZTM	**Logged By:**	SS
Location:	556-560 Abeerdeen Rd, Gisborne	**Elevation:**	6.8m (NZVD2016)	**Prepared By:**	SS
Test Site:	Refer to geotechnical investigation plan	**Located By:**	Site plan/map	**Checked By:**	RH

Depth (m)	Geology	Material Description	Water	Values Vane ID: 2888 peak / residual (sensitivity)
0.0	Topsoil	SILT, with minor sand, with trace rootlets; dark brown. Firm; moist; non-plastic; sand, fine.		57 / 26 (2.2)
0.3	Holocene Beach Deposits	SAND; brownish orange. Very loose; moist; sand, fine to medium.		
1.60		1.60m: Brownish grey.		
1.90		1.90m: Wet.		
2.50		2.50m: Saturated.	▼	

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5

RL (m): 6.5, 6.0, 5.5, 5.0, 4.5, 4.0

In-situ Testing



Hole Depth: 2.50m **Termination:** TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow
UTP = Unable to Penetrate

Hand Auger Borehole Log

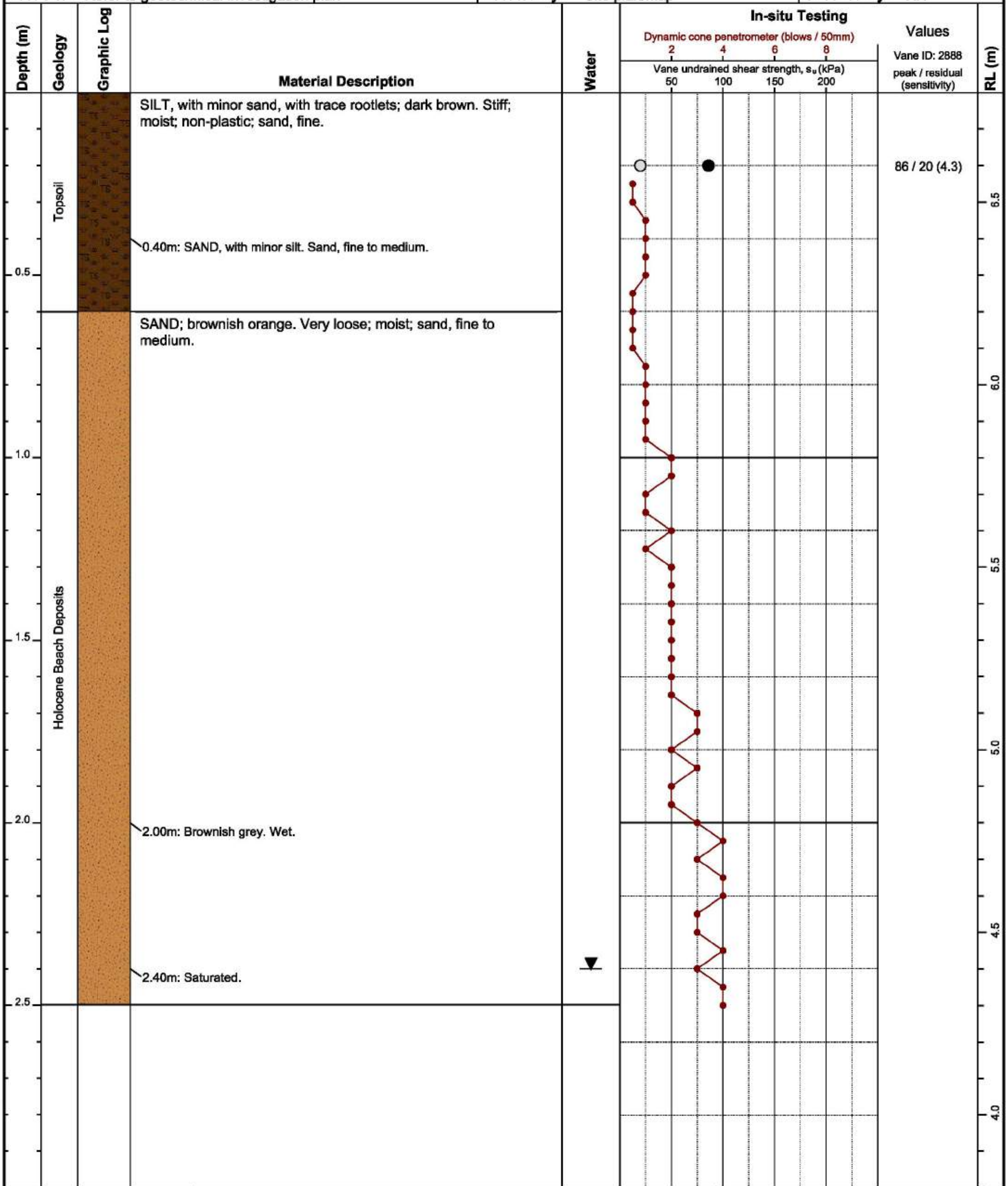
Method: 50mm Hand Auger

Test ID: HA15
Project ID: 24477
Sheet: 1 of 1

Client: NZHG
Project: Geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne
Test Site: Refer to geotechnical investigation plan

Coordinates: 5709885mN, 2036111mE
System: NZTM
Elevation: 6.8m (NZVD2016)
Located By: Site plan/map

Test Date: 12/09/2023
Logged By: SS
Prepared By: SS
Checked By: RH



SILT, with minor sand, with trace rootlets; dark brown. Stiff; moist; non-plastic; sand, fine.

0.40m: SAND, with minor silt. Sand, fine to medium.

SAND; brownish orange. Very loose; moist; sand, fine to medium.

2.00m: Brownish grey. Wet.

2.40m: Saturated.

Hole Depth: 2.50m
Termination: TARGET DEPTH

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak
○ Vane residual
◆ Vane UTP
▼ Standing water level
◁ Groundwater inflow
▷ Groundwater outflow
UTP = Unable to Penetrate

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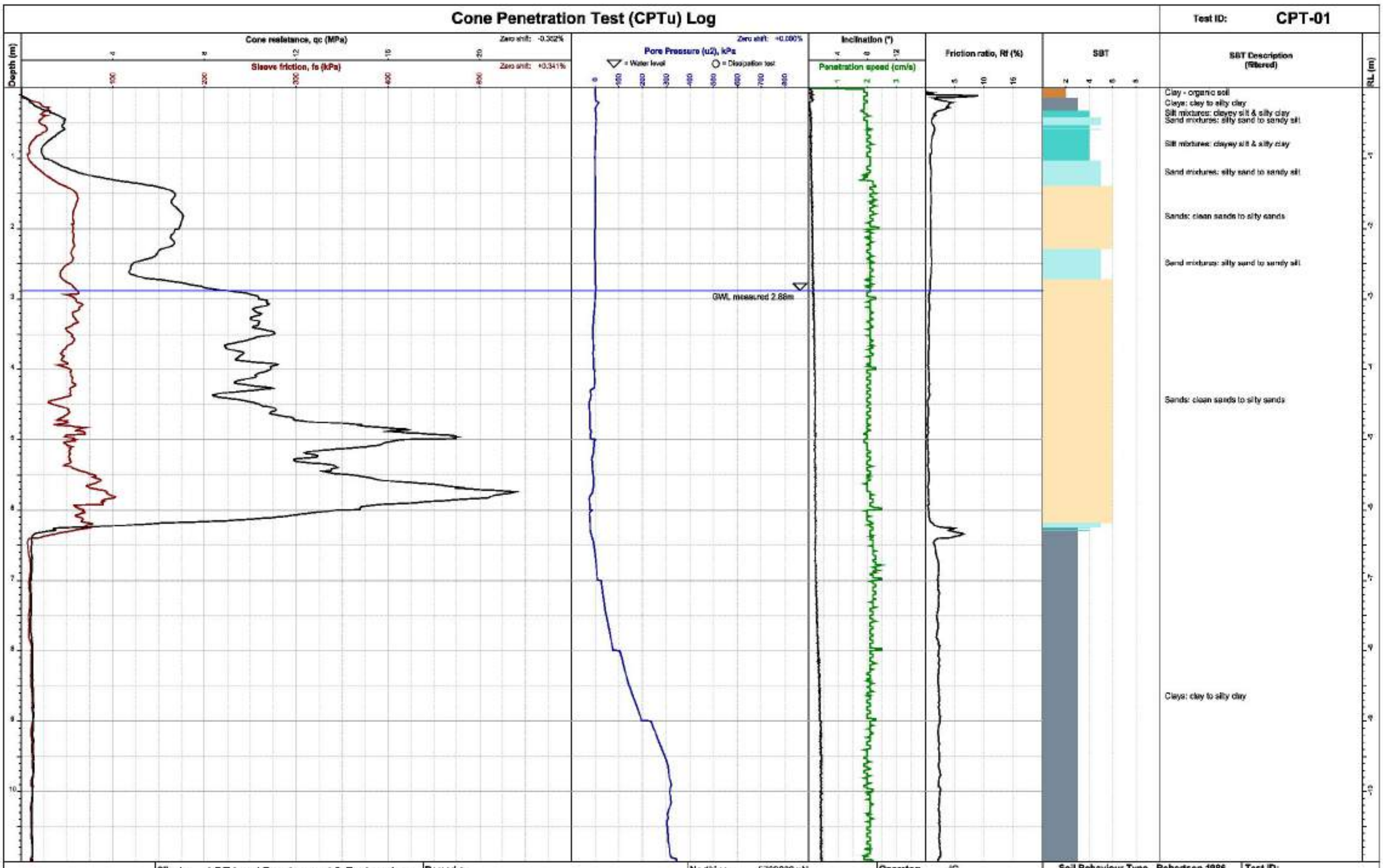
APPENDIX C

CONE PENETRATION TEST LOGS

Cone Penetration Test (CPTu) Log

Test ID: CPT-01



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709883mN
Easting: 2036106mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

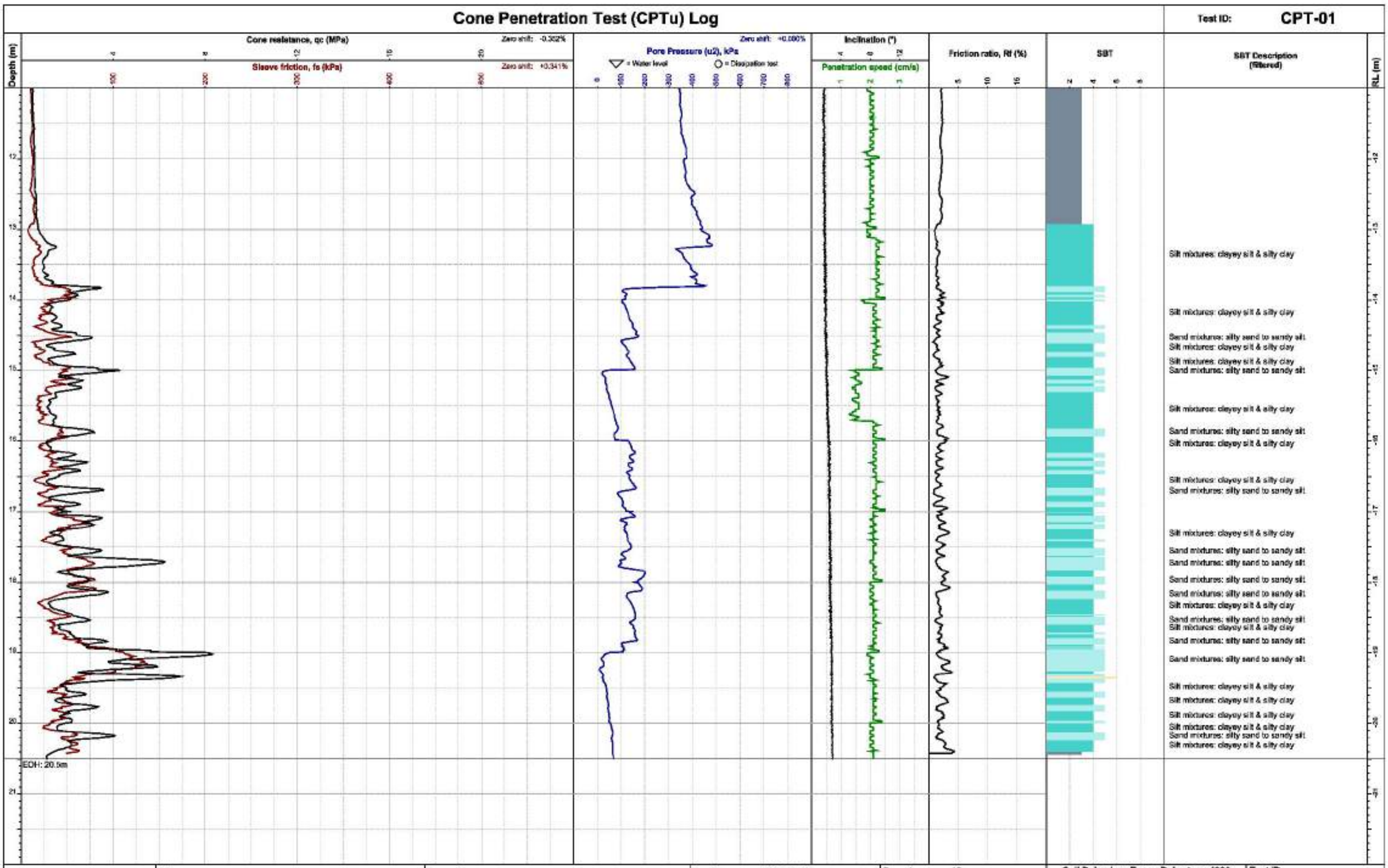
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-01
Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: **CPT-01**



Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt
Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay

Sand mixtures: silty sand to sandy silt

Sand mixtures: silty sand to sandy silt

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay

LAND DEVELOPMENT & ENGINEERING

Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709883mN
Easting:	2036106mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:

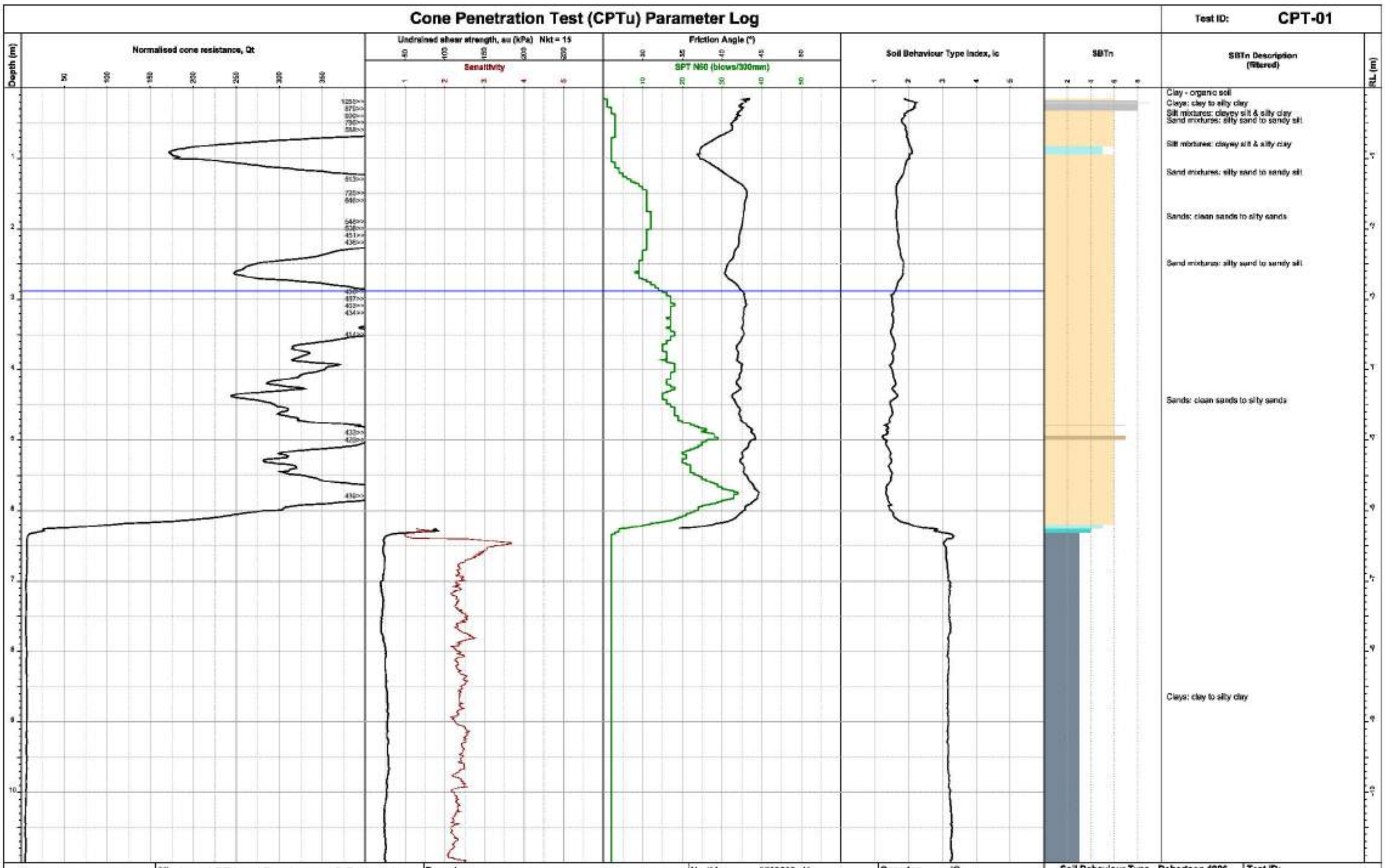
CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:04 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-01



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:04 am

Client:	LDE Land Development & Engineering	**Northing:**	5709883mN
Project:	geotechnical Investigation	**Easting:**	2036106mE
Location:	556-560 Abeerdeen Rd, Gisborne	**System:**	NZTM
		Elevation:	Ground
		Located By:	Phone GPS
		Location:	As per site plan

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

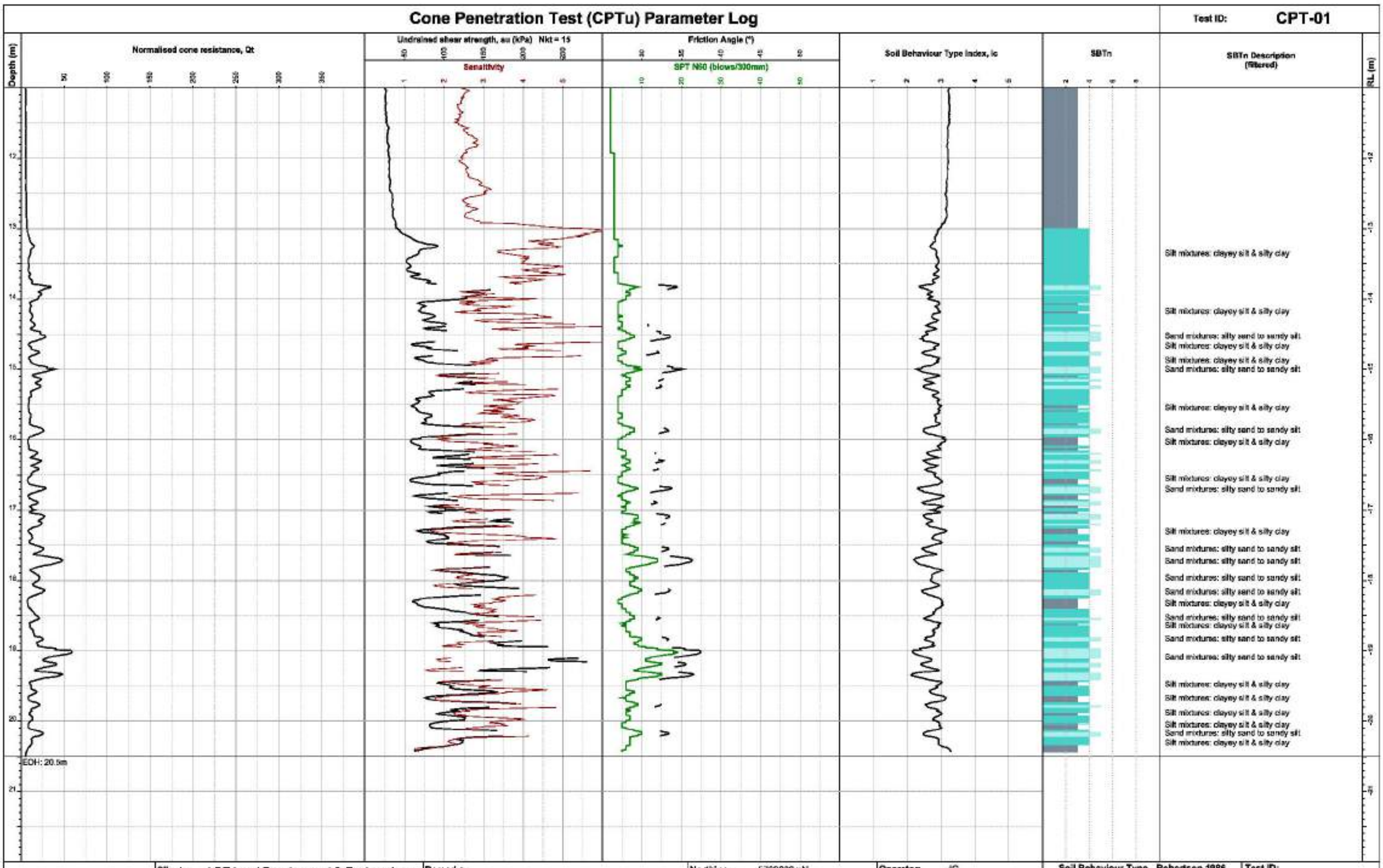
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-01**



LDE LAND DEVELOPMENT & ENGINEERING

Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.88m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709883mN
Easting:	2036106mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID:

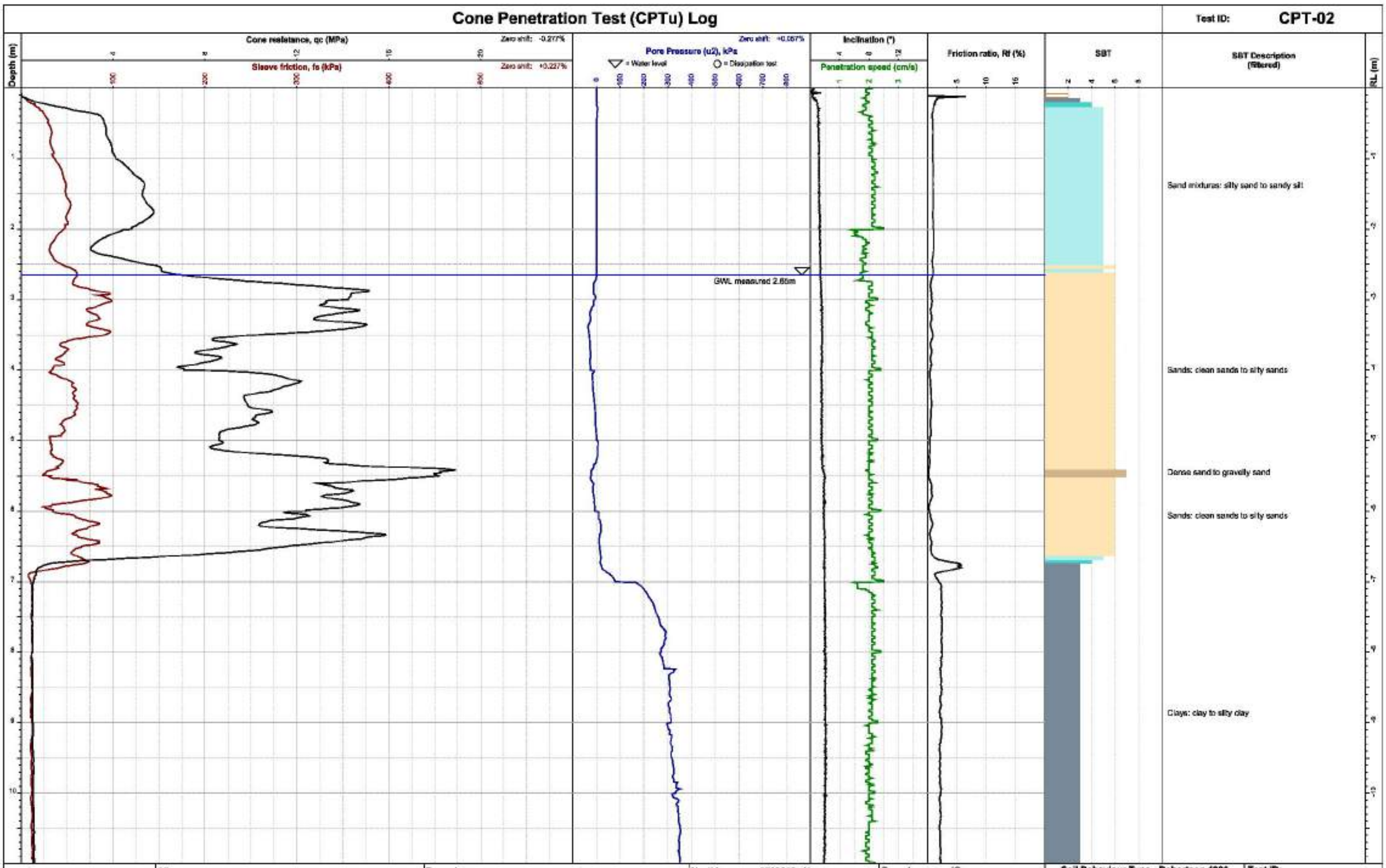
CPT-01

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:06 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-02



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:06 am

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709858mN
Easting: 2036112mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

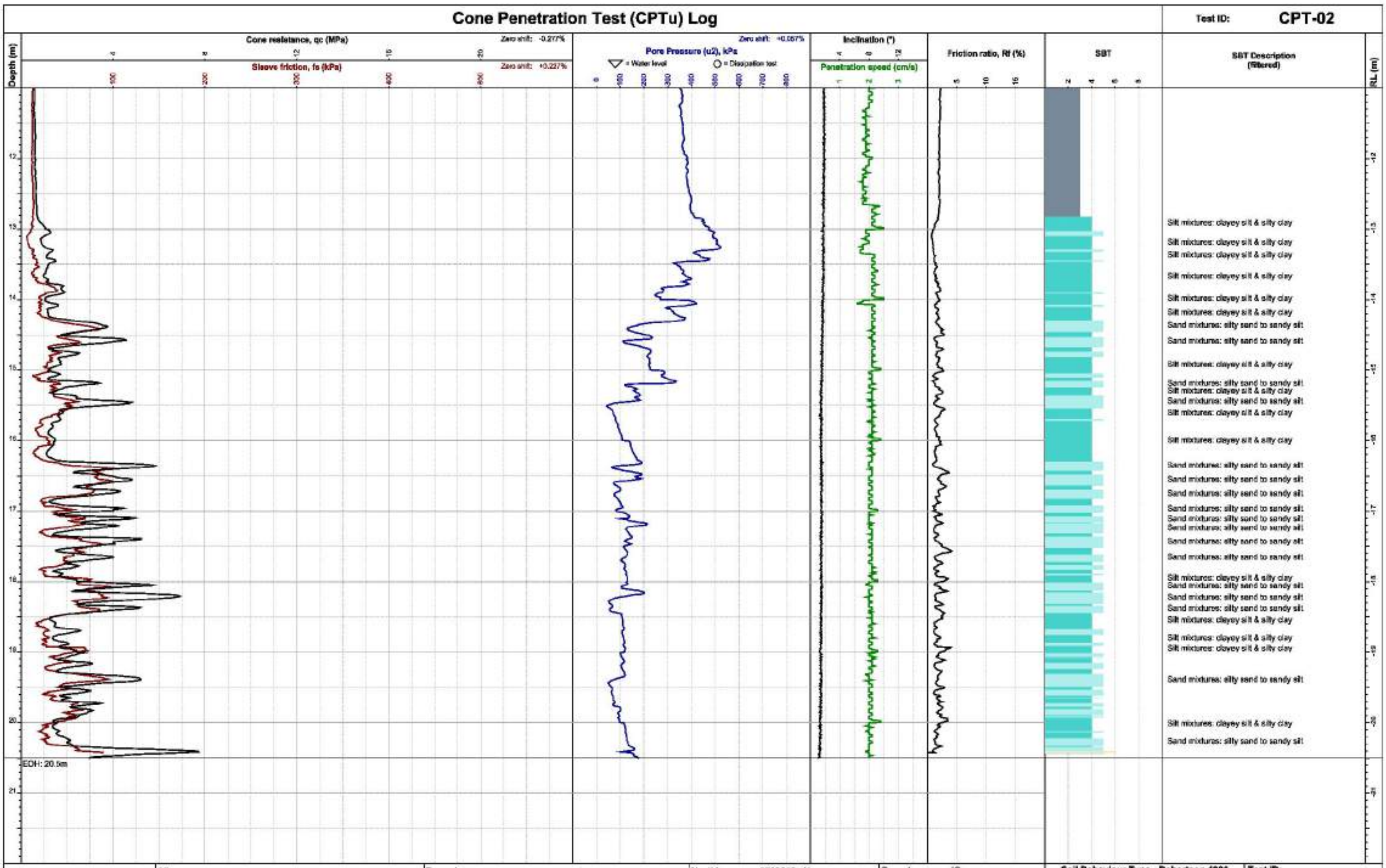
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-02

Project ID: 24477
Depth: 20.5m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: **CPT-02**



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

LDE LAND DEVELOPMENT & ENGINEERING

Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709868mN
Easting:	2036112mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

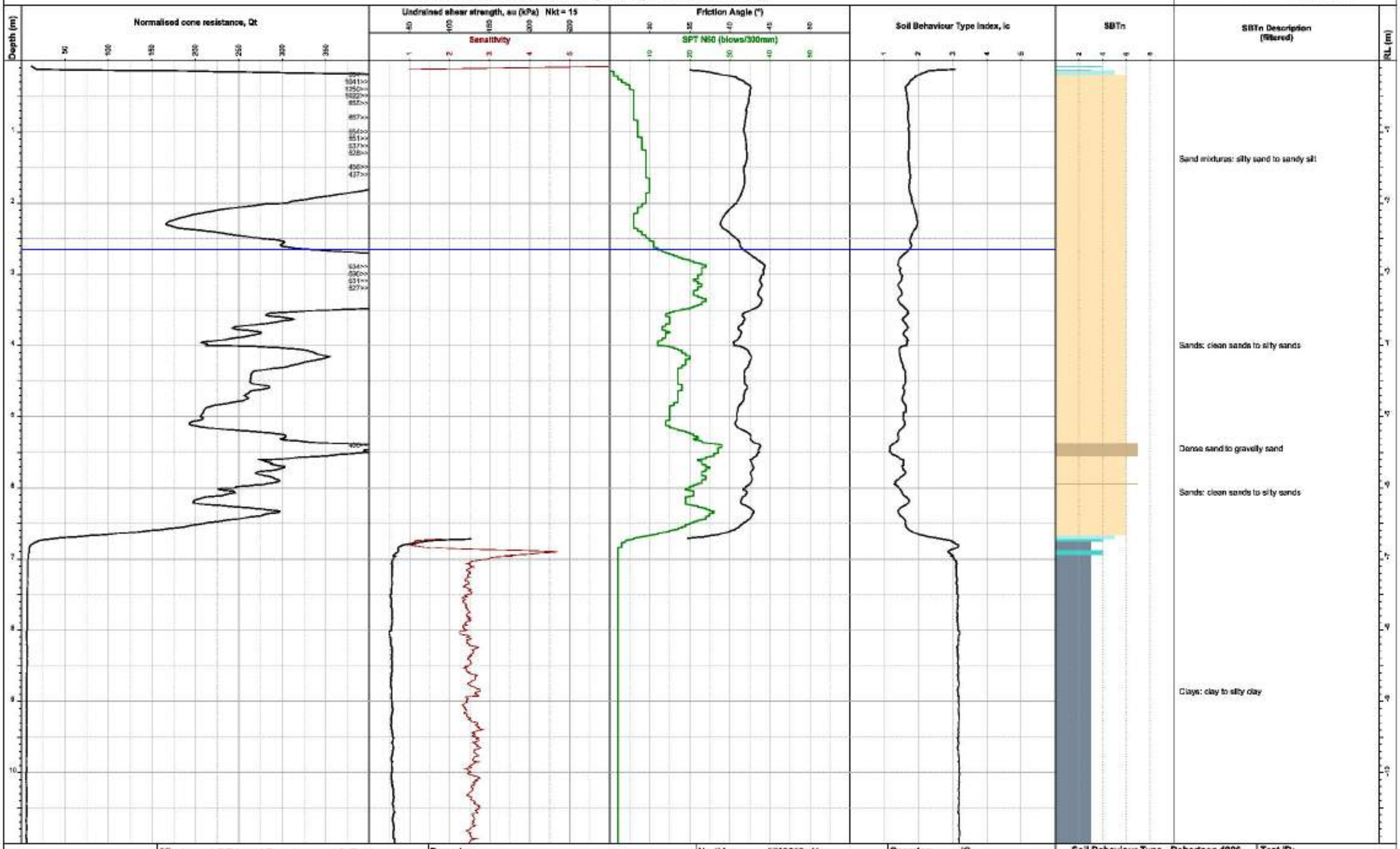
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: **CPT-02**

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-02



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036112mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

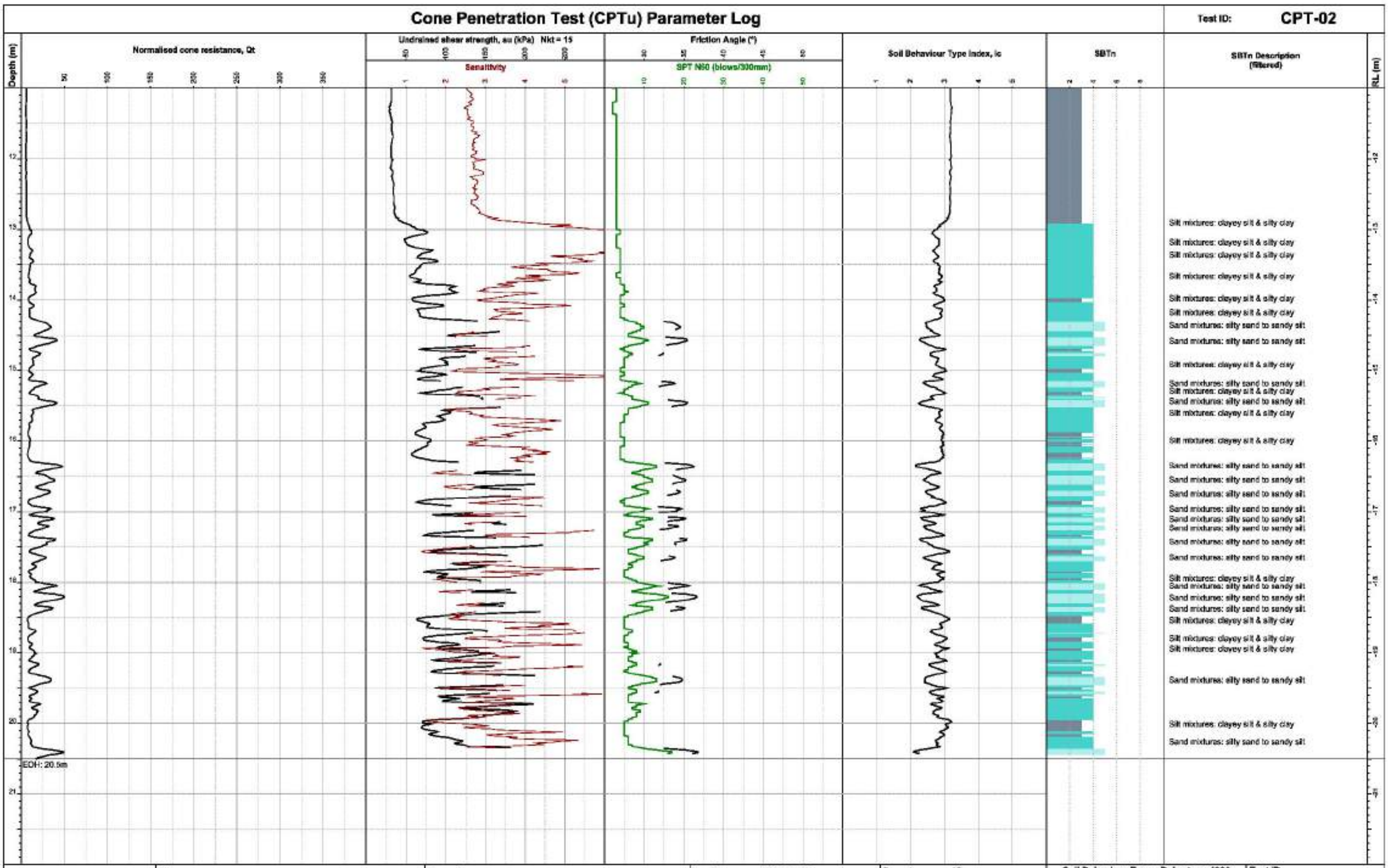
Test ID: CPT-02

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-02



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:07 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.65m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709858mN
Easting: 2036112mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

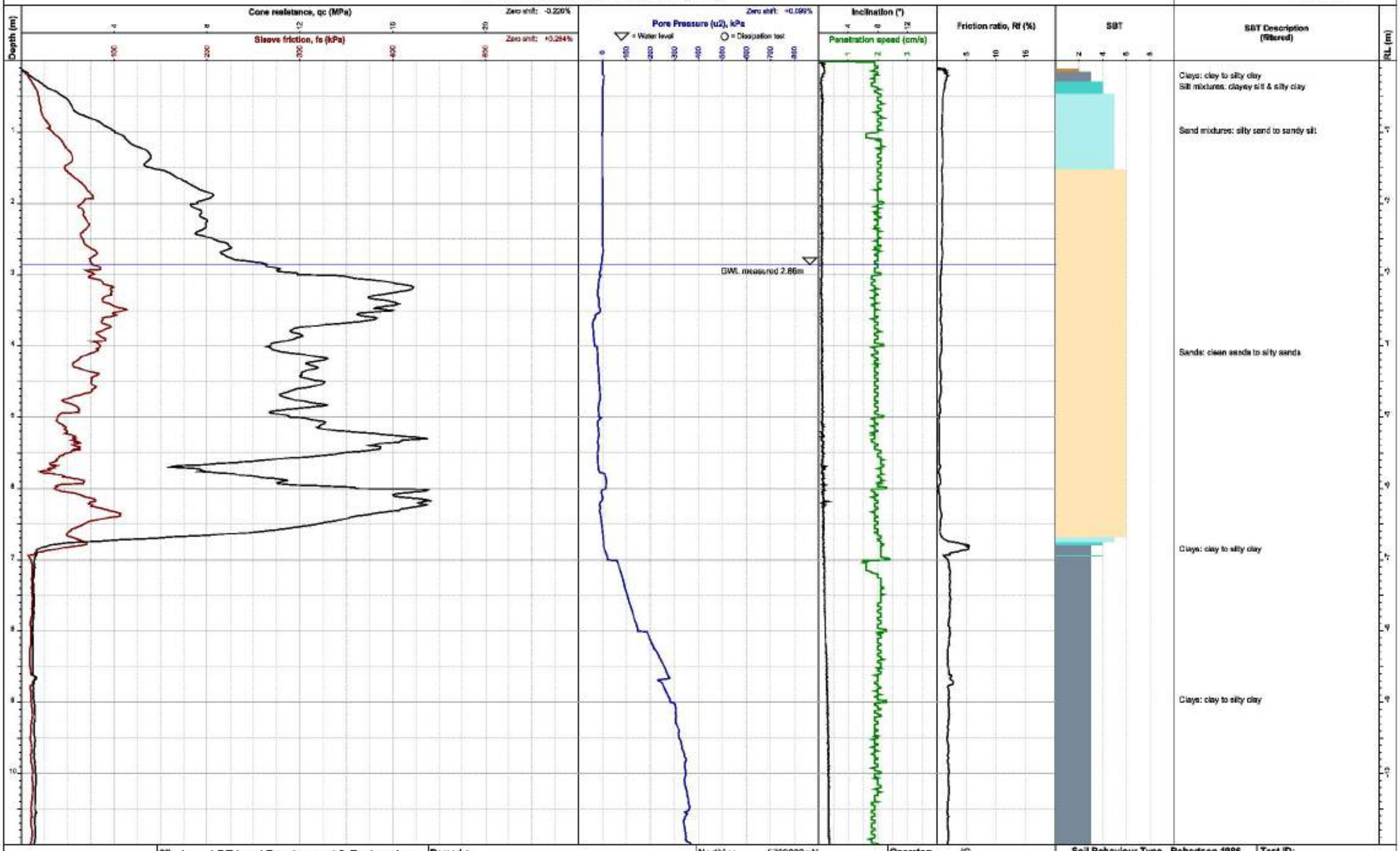
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-02
Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-03



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036135mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

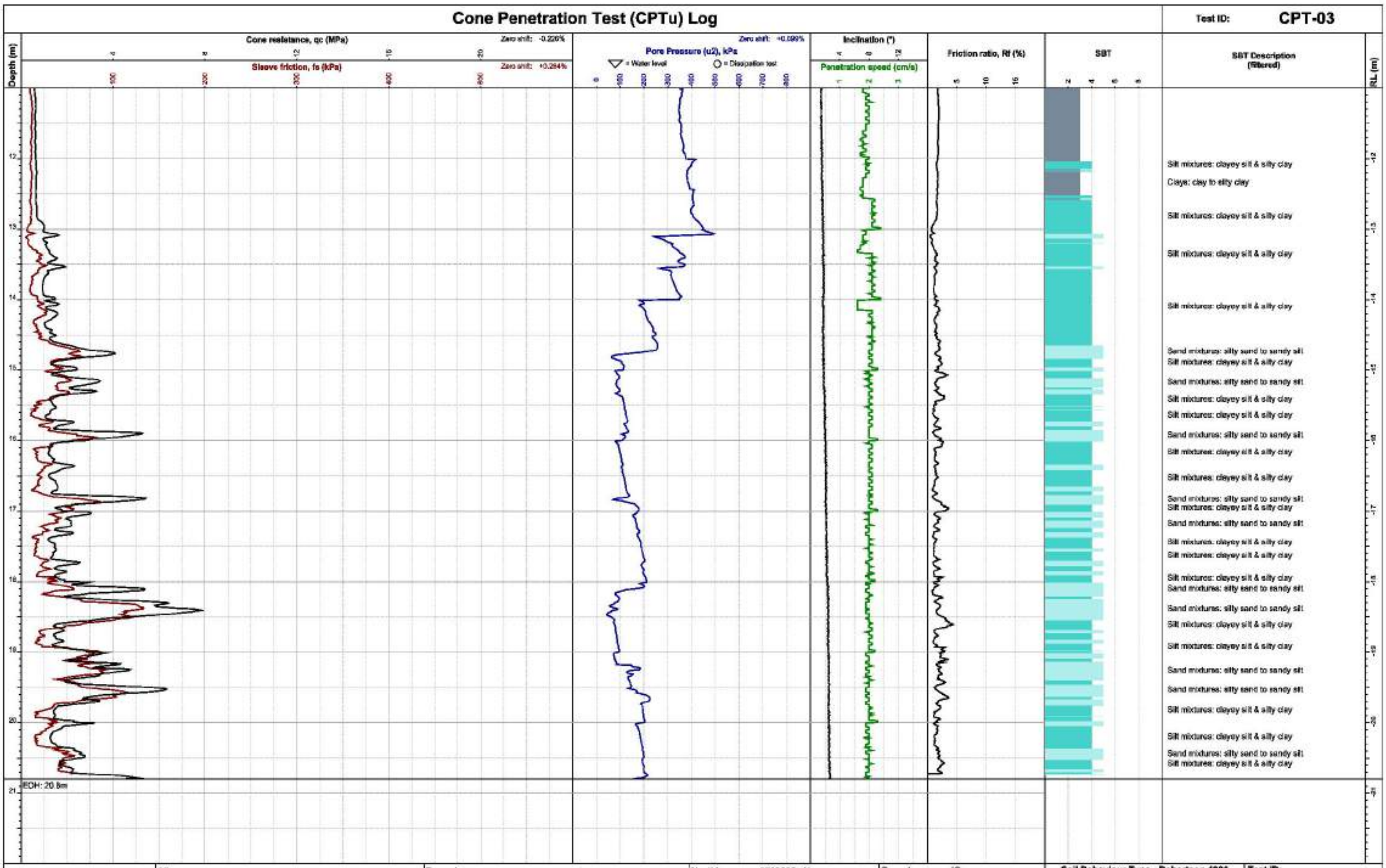
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-03
Project ID: 24477
Depth: 20.8m
Sheet: 1 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-03



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:10 am

LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036136mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

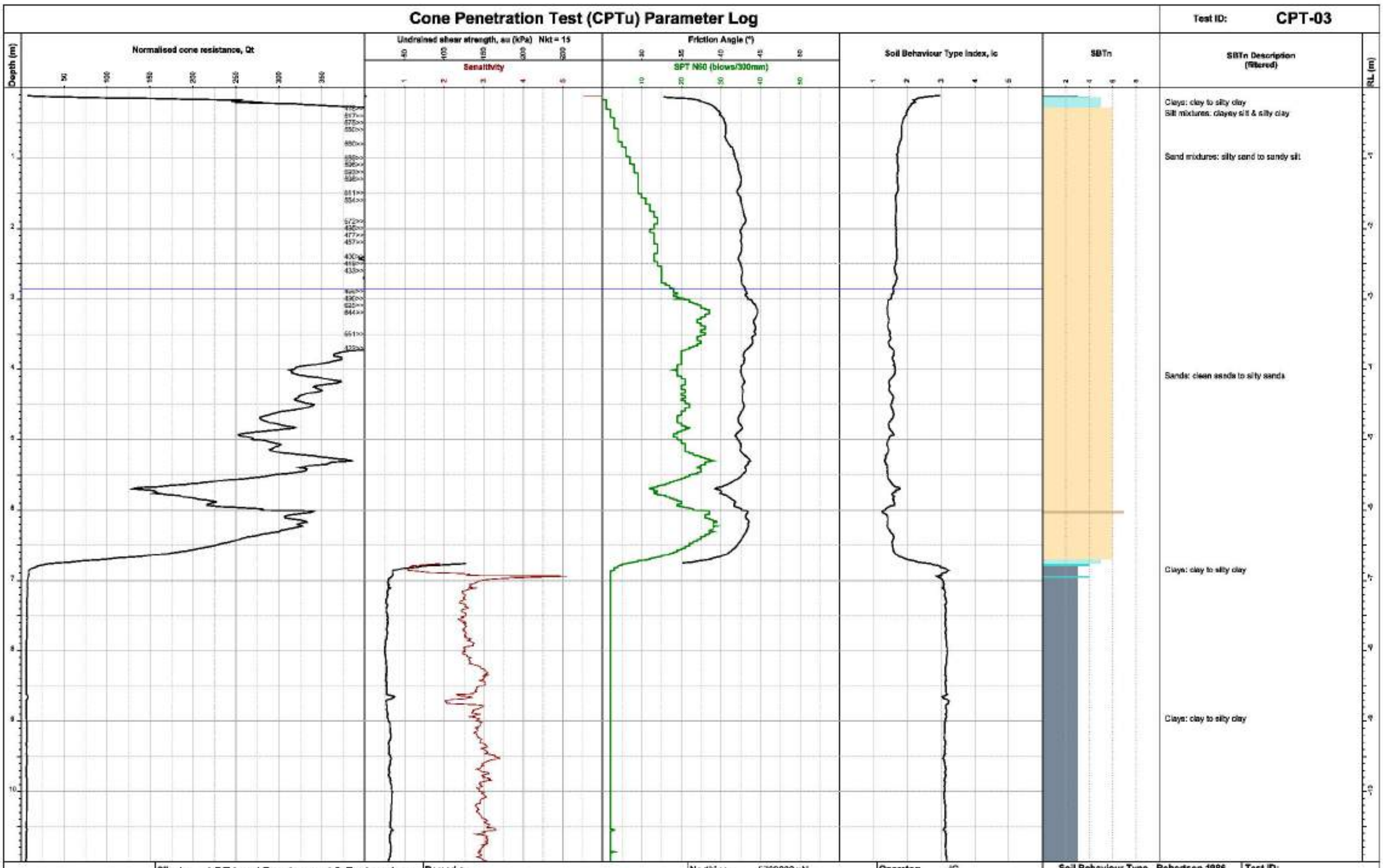
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-03
Project ID: 24477
Depth: 20.8m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-03



Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:10 am

Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709866mN
Easting:	2036135mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

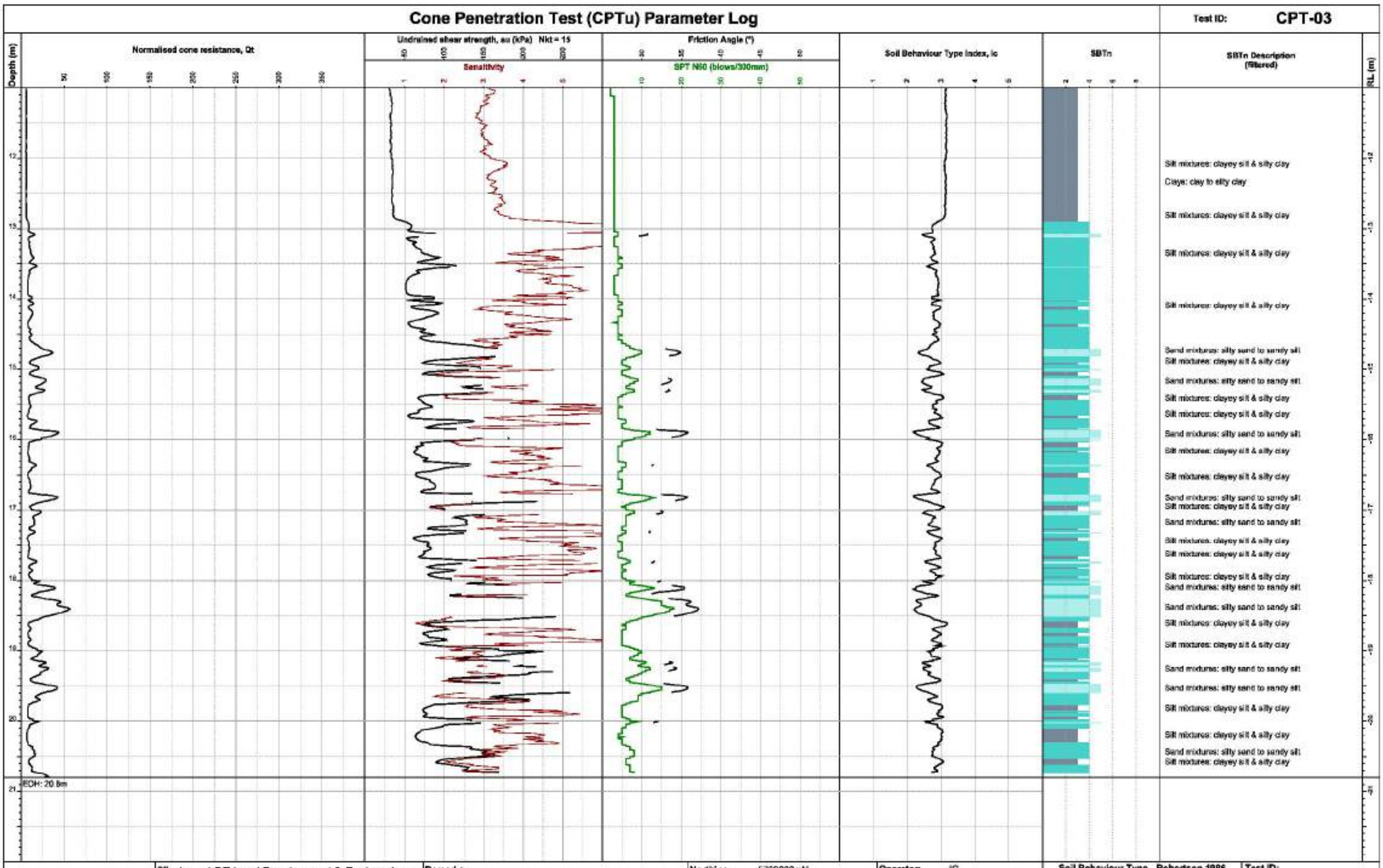
Test ID:

CPT-03

Project ID:	24477
Depth:	20.8m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-03**



LDE LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.86m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709866mN
Easting: 2036135mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

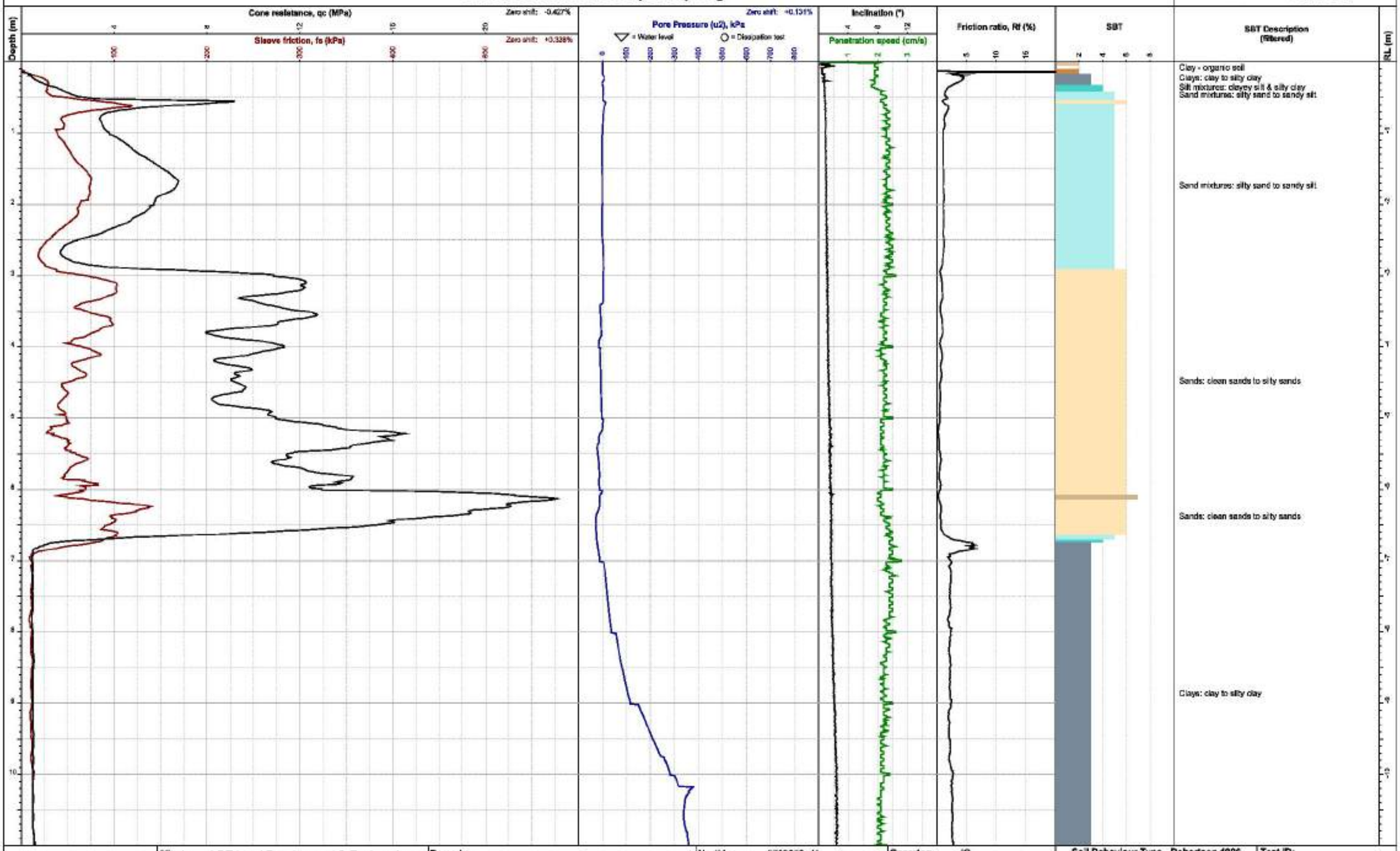
Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: **CPT-03**
Project ID: 24477
Depth: 20.8m
Sheet: 2 of 2
Date: 30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-04



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709856mN
Easting:	2036093mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

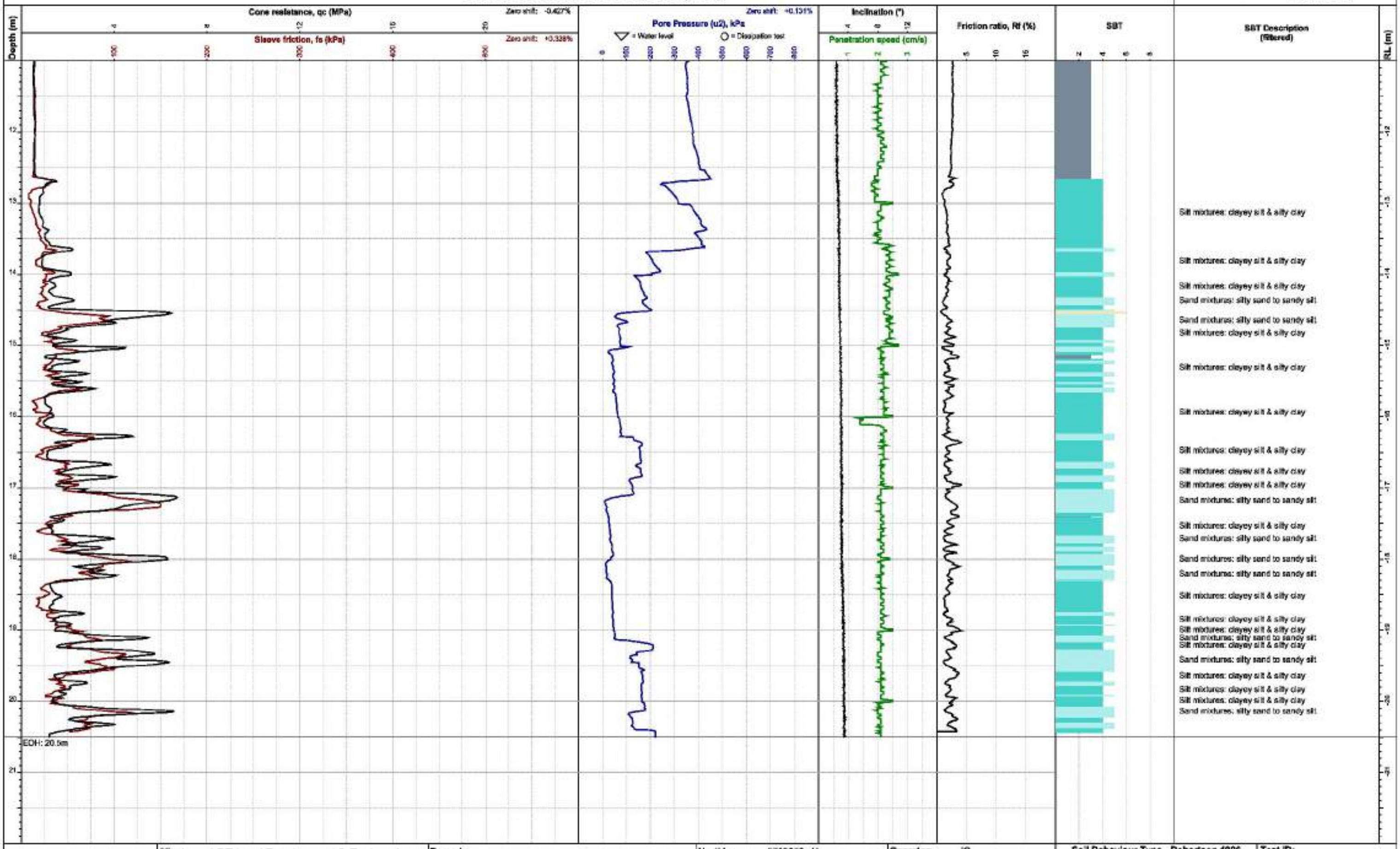
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-04

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Log

Test ID: CPT-04



LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709858mN
Easting:	2036093mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

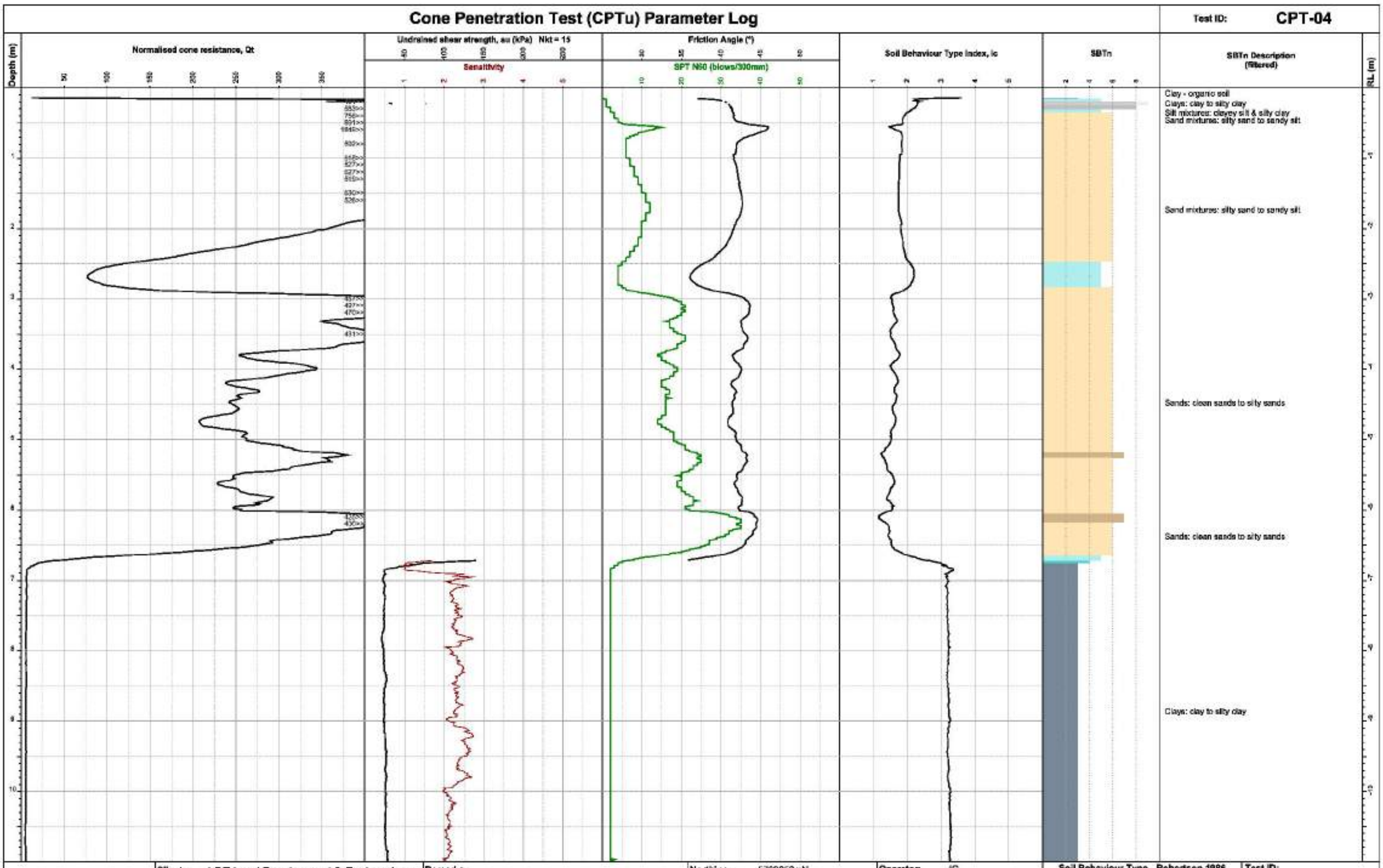
Test ID: CPT-04

Project ID:	24477
Depth:	20.5m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:12 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-04**



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709856mN
Easting:	2036093mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

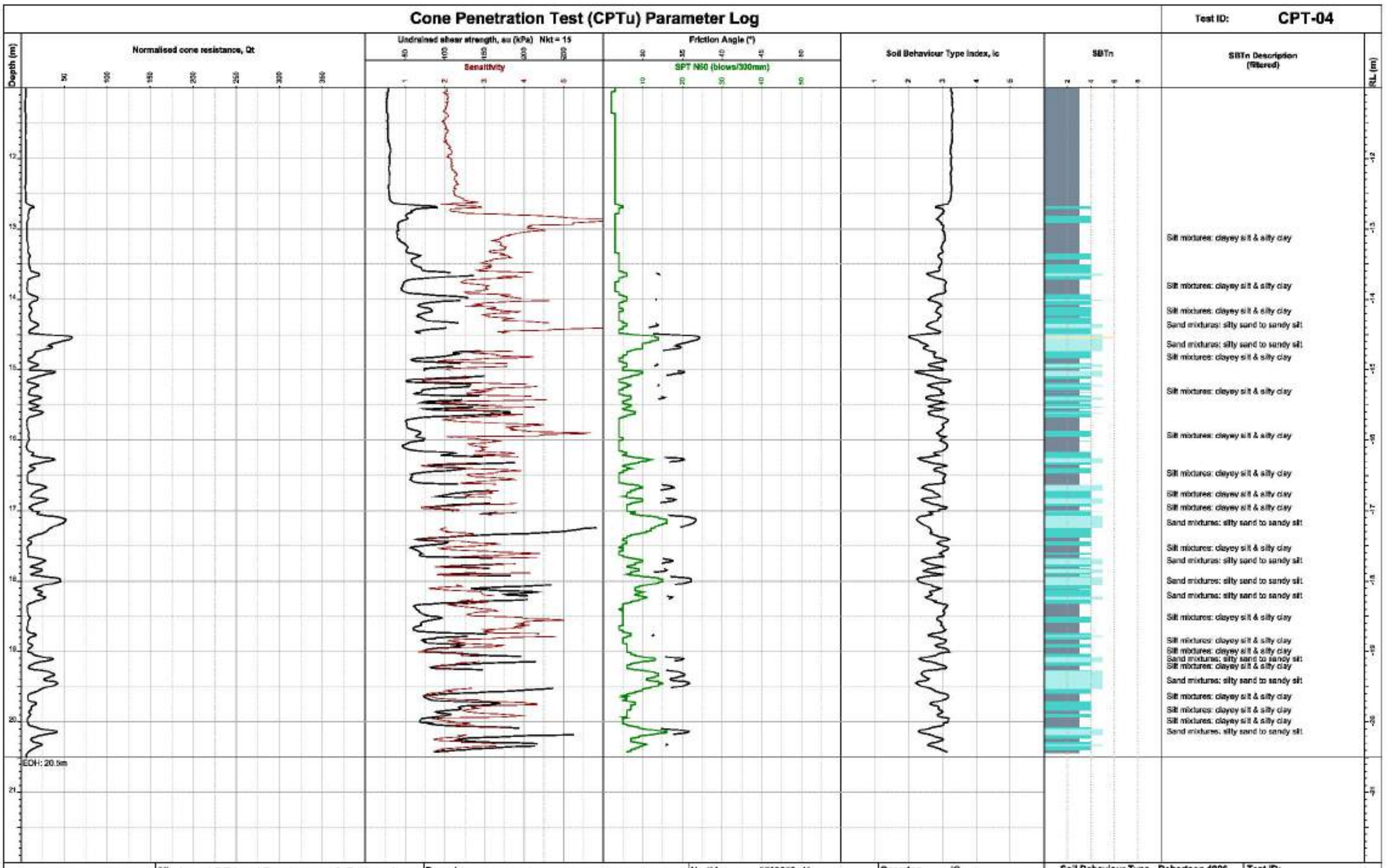
Test ID:

CPT-04

Project ID:	24477
Depth:	20.5m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-04**



Client: LDE Land Development & Engineering

Project: geotechnical Investigation

Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 2.34m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709856mN
Easting: 2036093mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

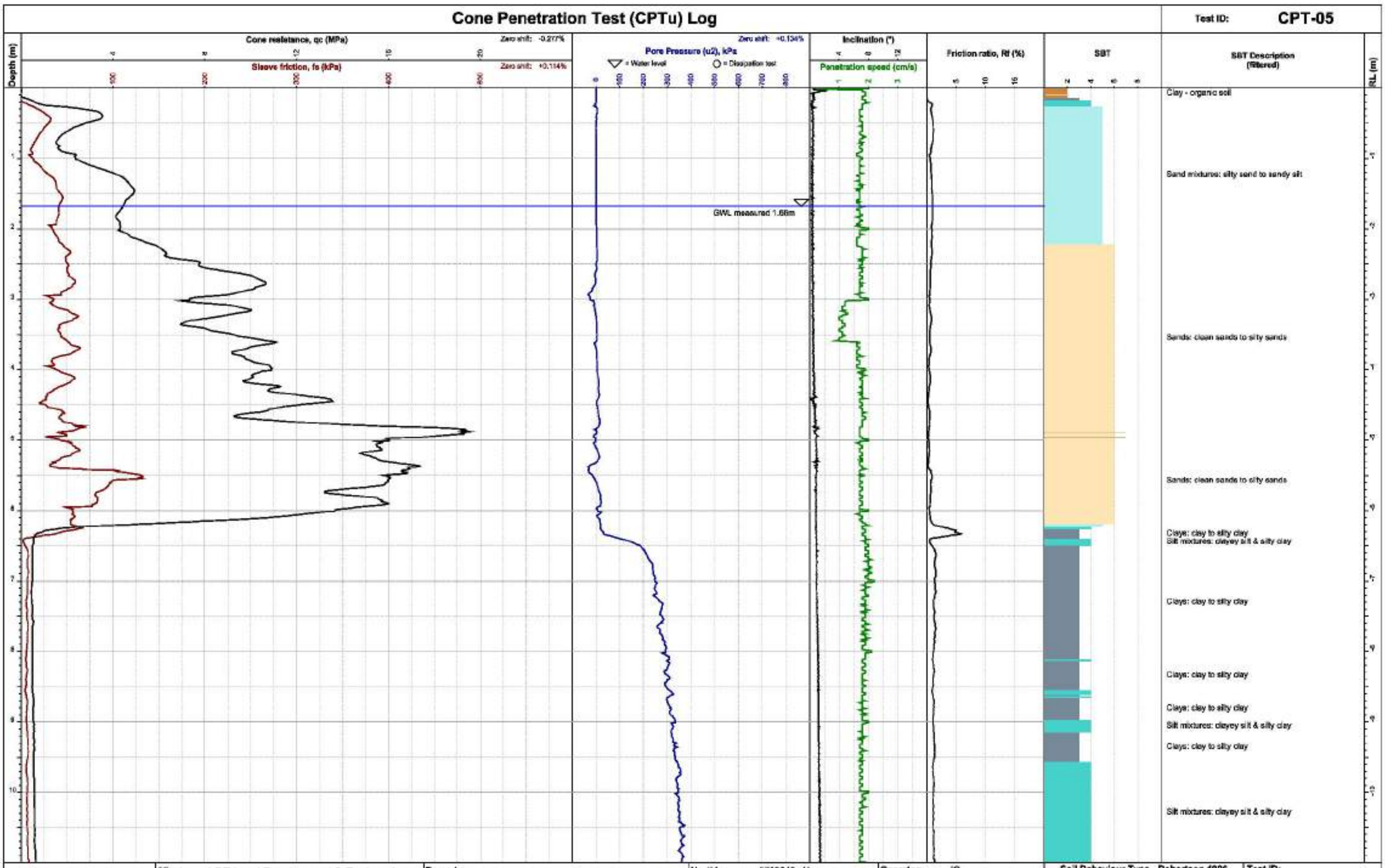
Test ID: **CPT-04**

Project ID: 24477
Depth: 20.5m
Sheet: 2 of 2
Date: 30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:13 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-05



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

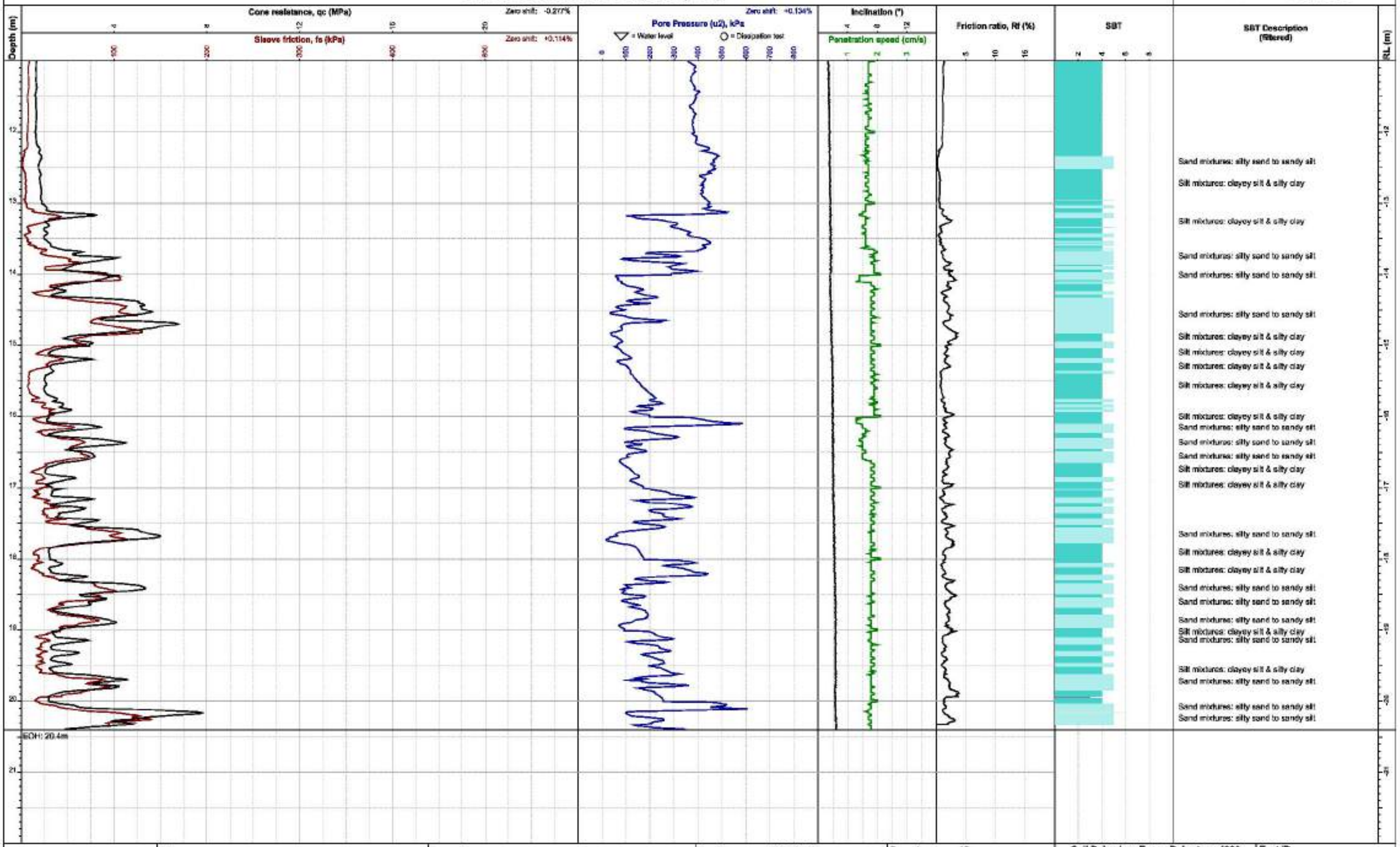
Test ID:
CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	1 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:15 am

Cone Penetration Test (CPTu) Log

Test ID: CPT-05



LAND DEVELOPMENT & ENGINEERING

Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

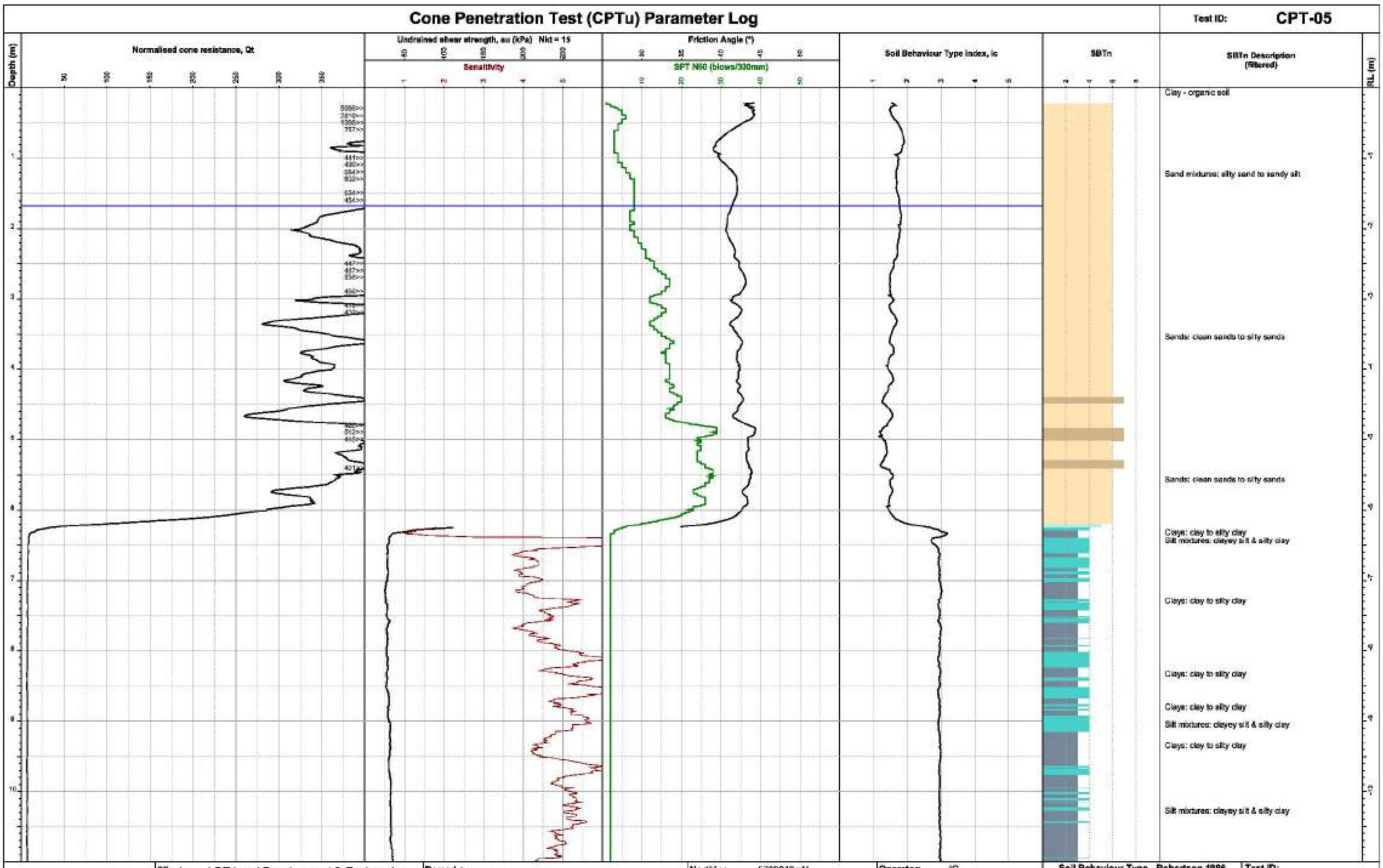
Test ID: CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	2 of 2
Date:	30/05/2023

Generated with CORE-GS by Geroc - CPT Combined A3 v2 - 31/05/2023 9:14:18 am

Cone Penetration Test (CPTu) Parameter Log

Test ID: CPT-05



Client:	LDE Land Development & Engineering
Project:	geotechnical Investigation
Location:	556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing:	5709840mN
Easting:	2036107mE
System:	NZTM
Elevation:	Ground
Located By:	Phone GPS
Location:	As per site plan

Operator:	JC
Rig:	Pagani TG63-150
Cone ID:	Mks1042
Type:	Comp. piezo cone
Cone Area:	10 cm²
Sleeve Area:	150 cm²
Area Ratio:	0.8

Soil Behaviour Type - Robertson 1986

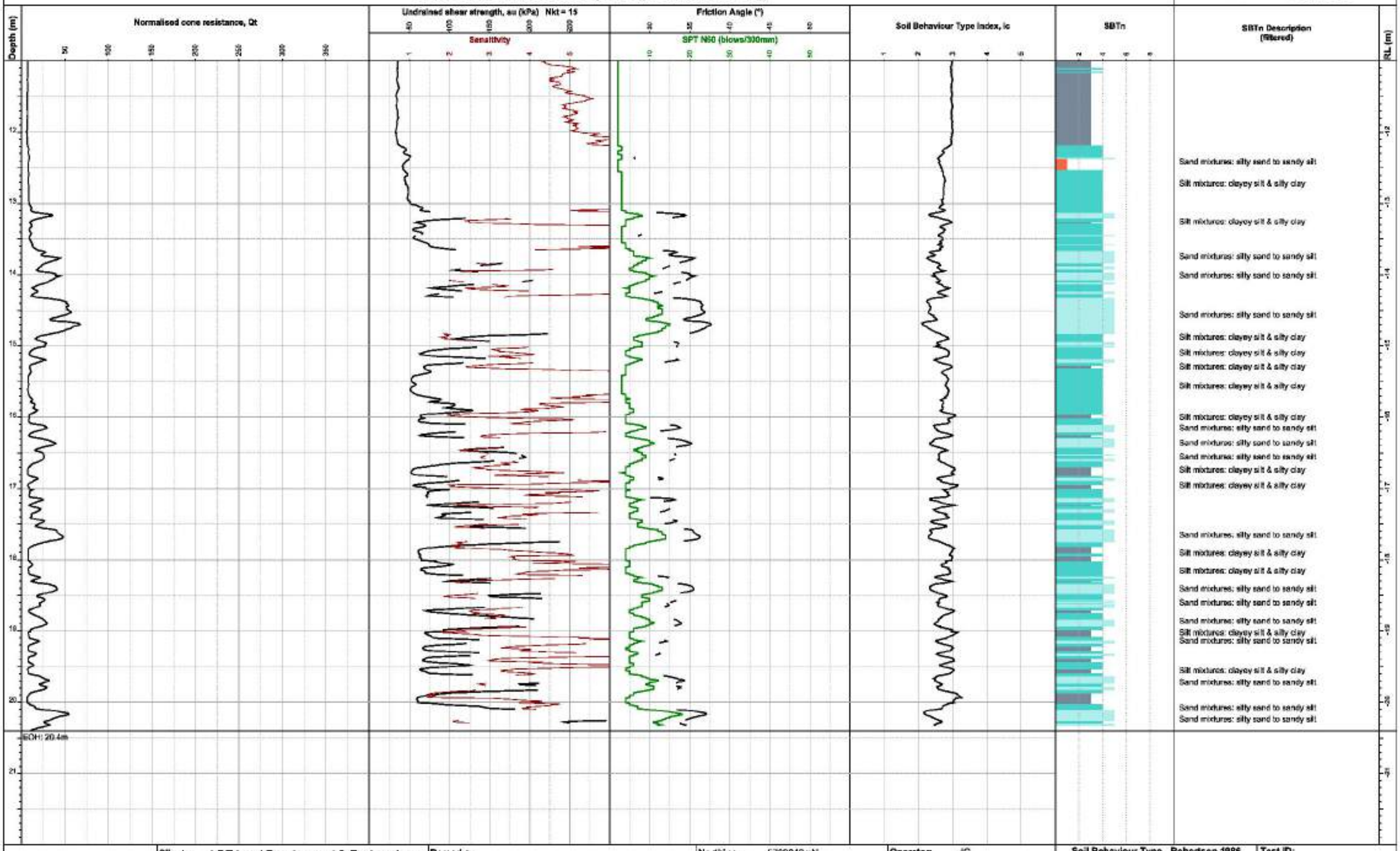
0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: CPT-05

Project ID:	24477
Depth:	20.4m
Sheet:	1 of 2
Date:	30/05/2023

Cone Penetration Test (CPTu) Parameter Log

Test ID: **CPT-05**



Client: LDE Land Development & Engineering
Project: geotechnical Investigation
Location: 556-560 Abeerdeen Rd, Gisborne

Remarks:
Ground water level located at 1.68m
Test according to ISO 22476-1:12 (Class 2)

Termination Reason:
Target depth

Northing: 5709840mN
Easting: 2036107mE
System: NZTM
Elevation: Ground
Located By: Phone GPS
Location: As per site plan

Operator: JC
Rig: Pagani TG63-150
Cone ID: Mks1042
Type: Comp. piezo cone
Cone Area: 10 cm²
Sleeve Area: 150 cm²
Area Ratio: 0.8

Soil Behaviour Type - Robertson 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Test ID: **CPT-05**
Project ID: 24477
Depth: 20.4m
Sheet: 2 of 2
Date: 30/05/2023

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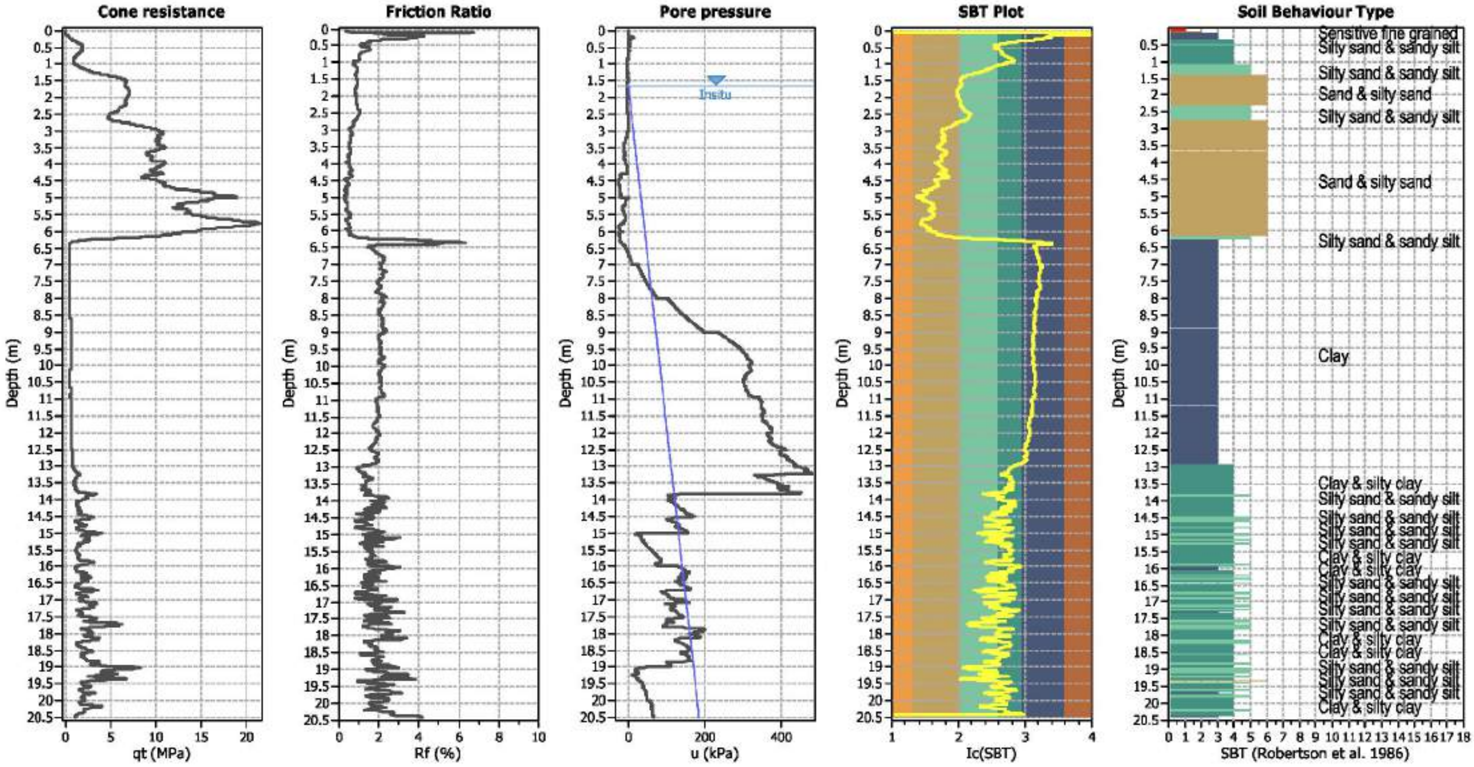
APPENDIX D

LIQUEFATION ANALYSIS RESULTS

CPT basic interpretation plots



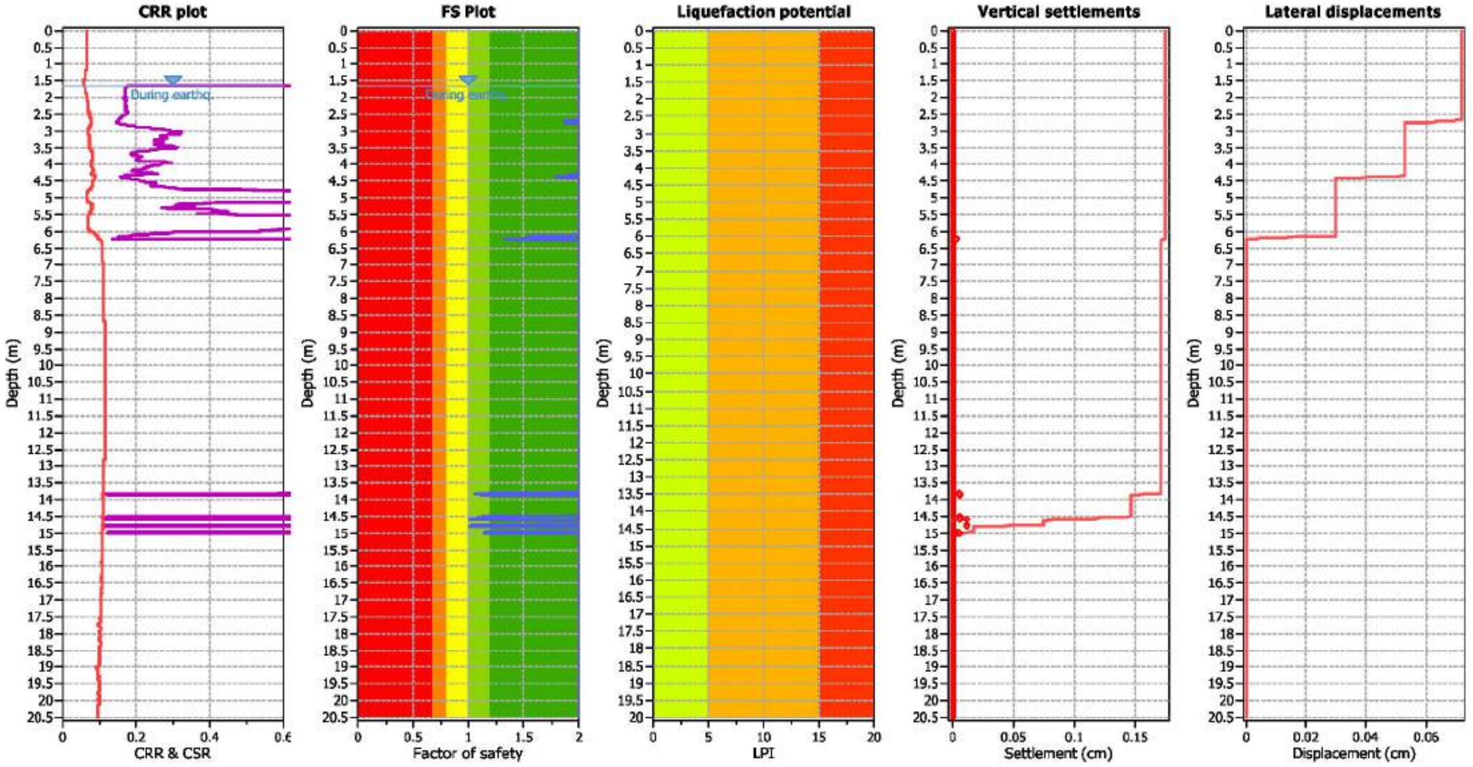
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

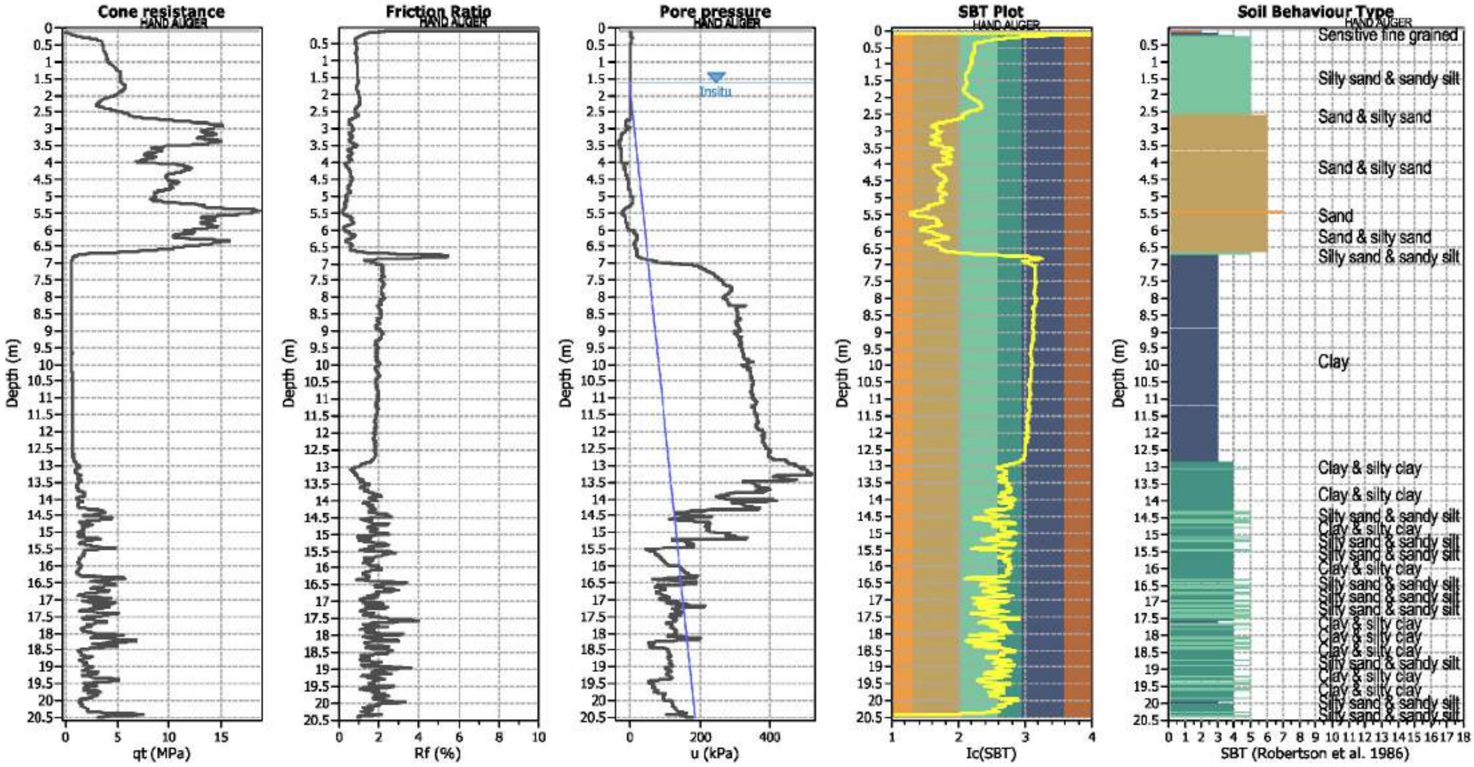
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



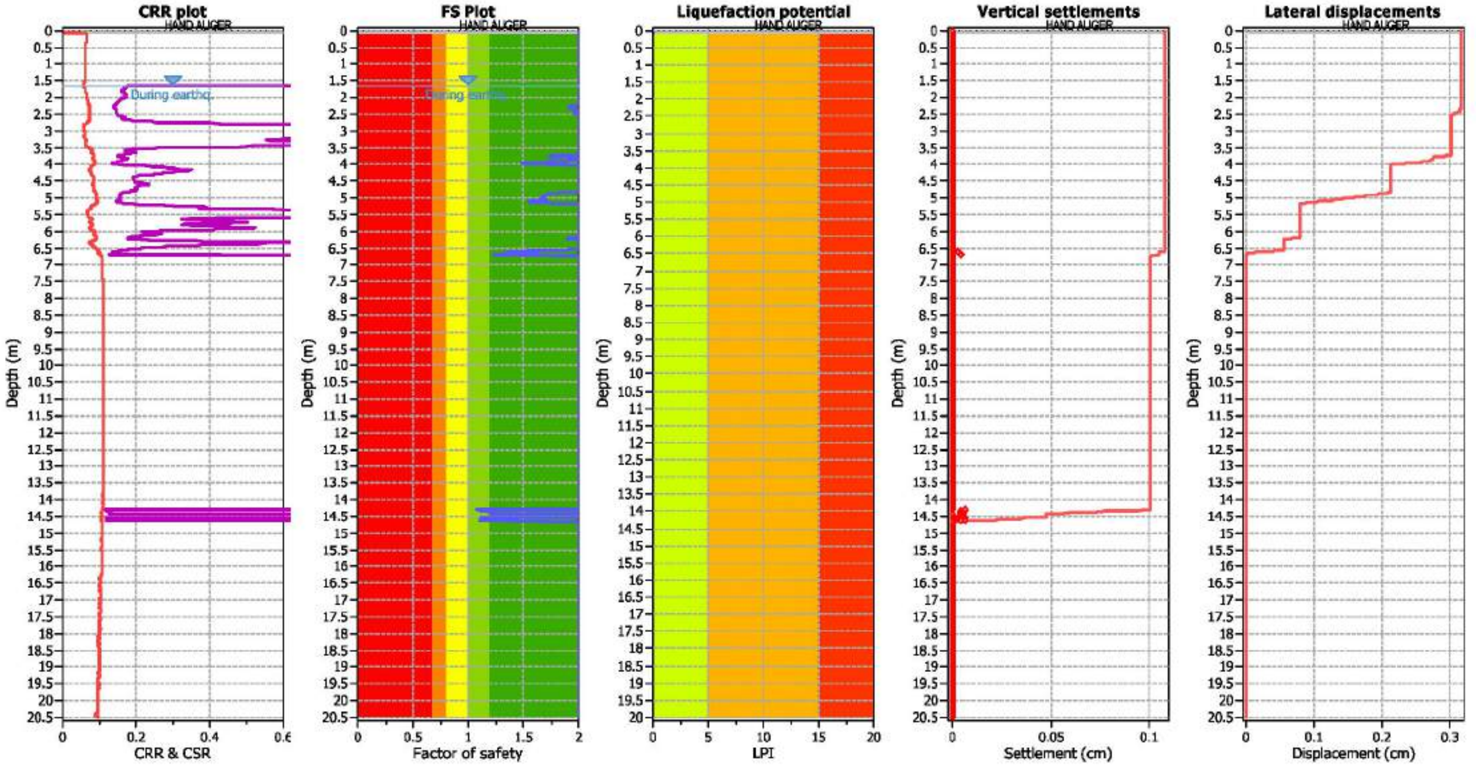
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

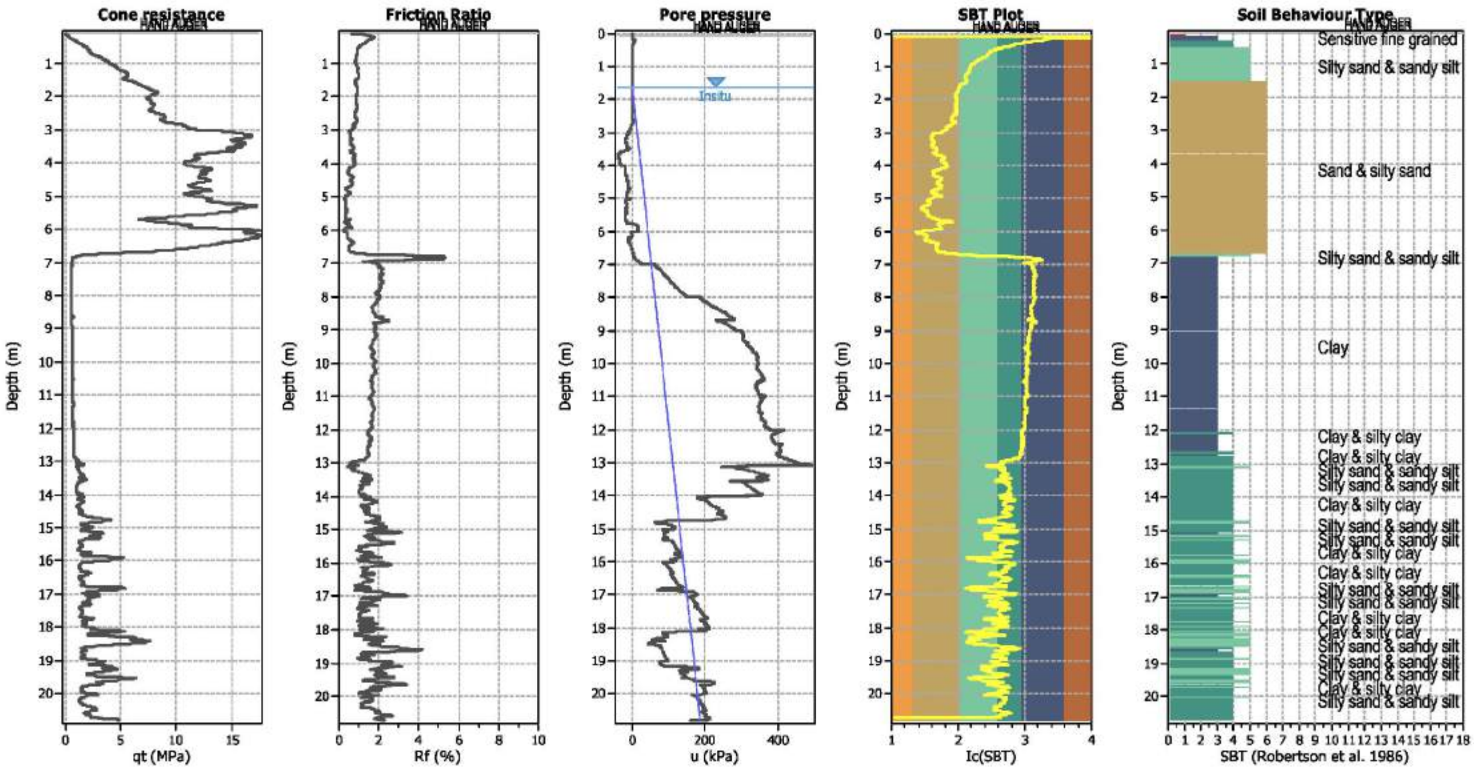
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



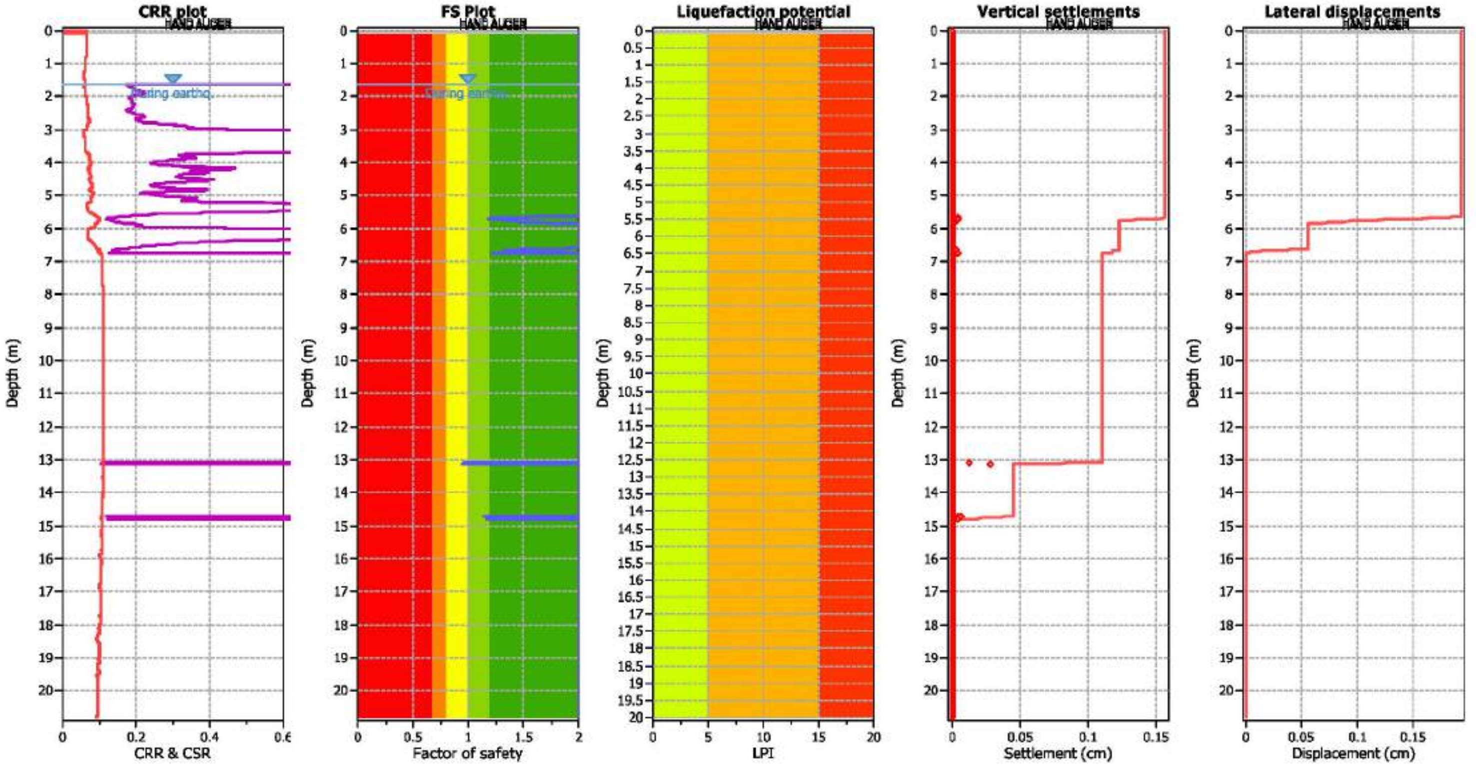
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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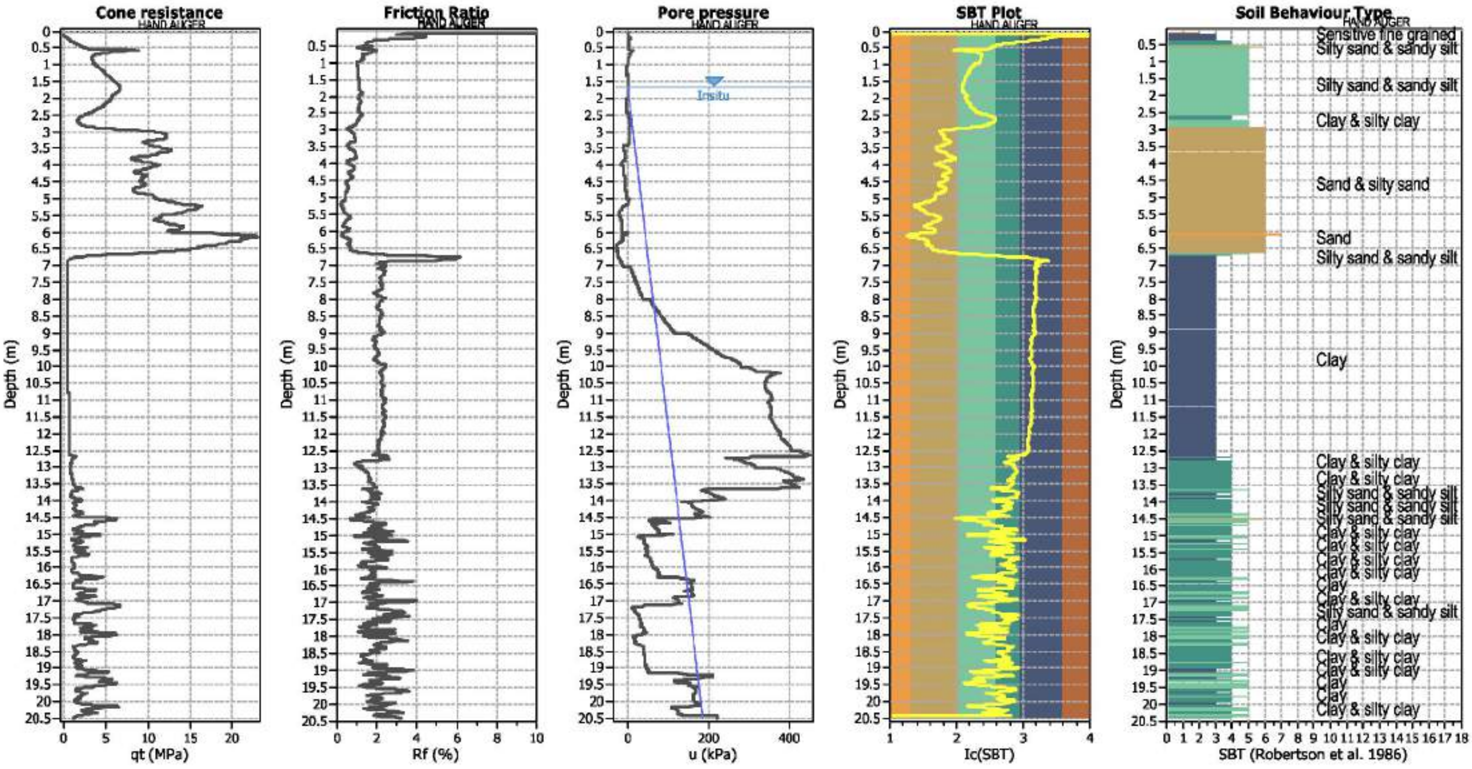
CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

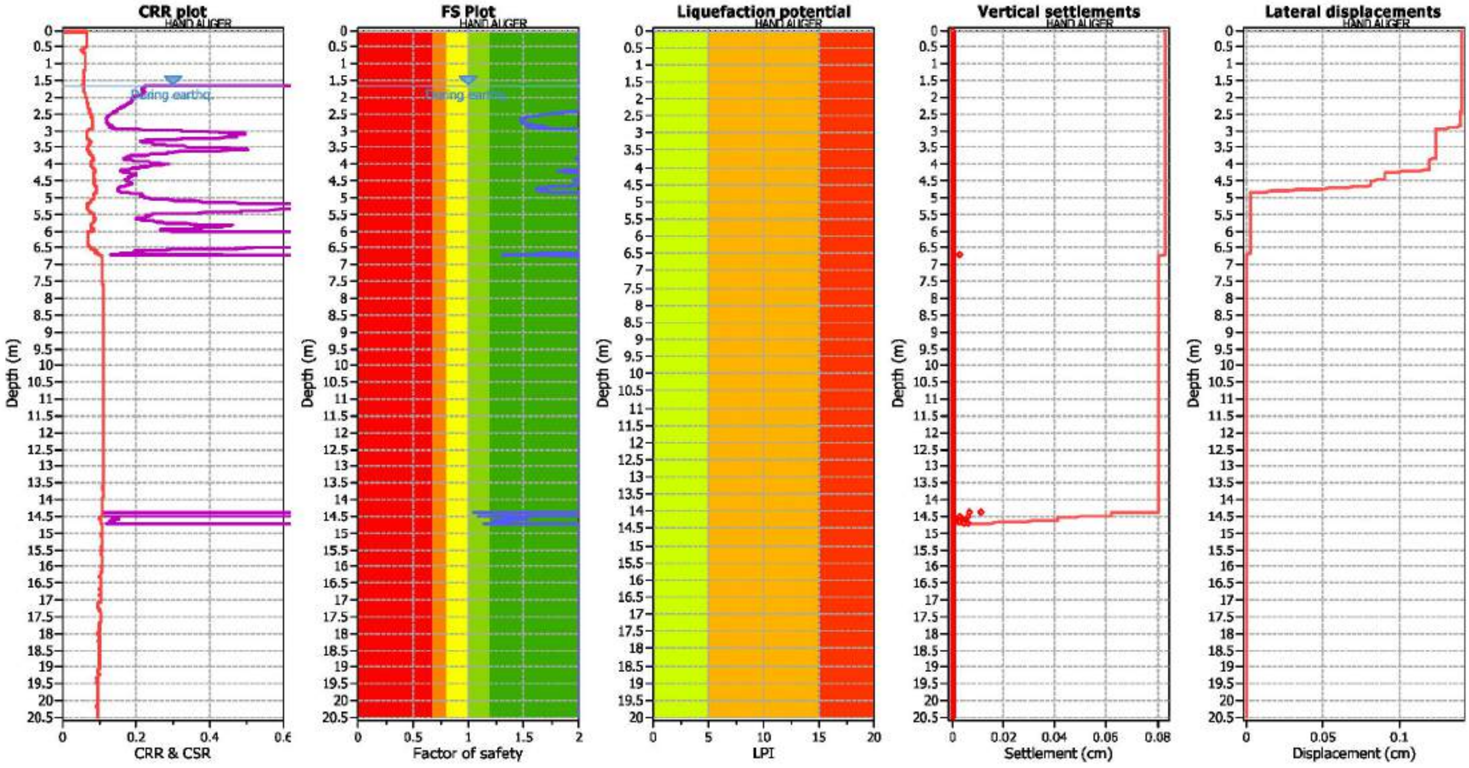
Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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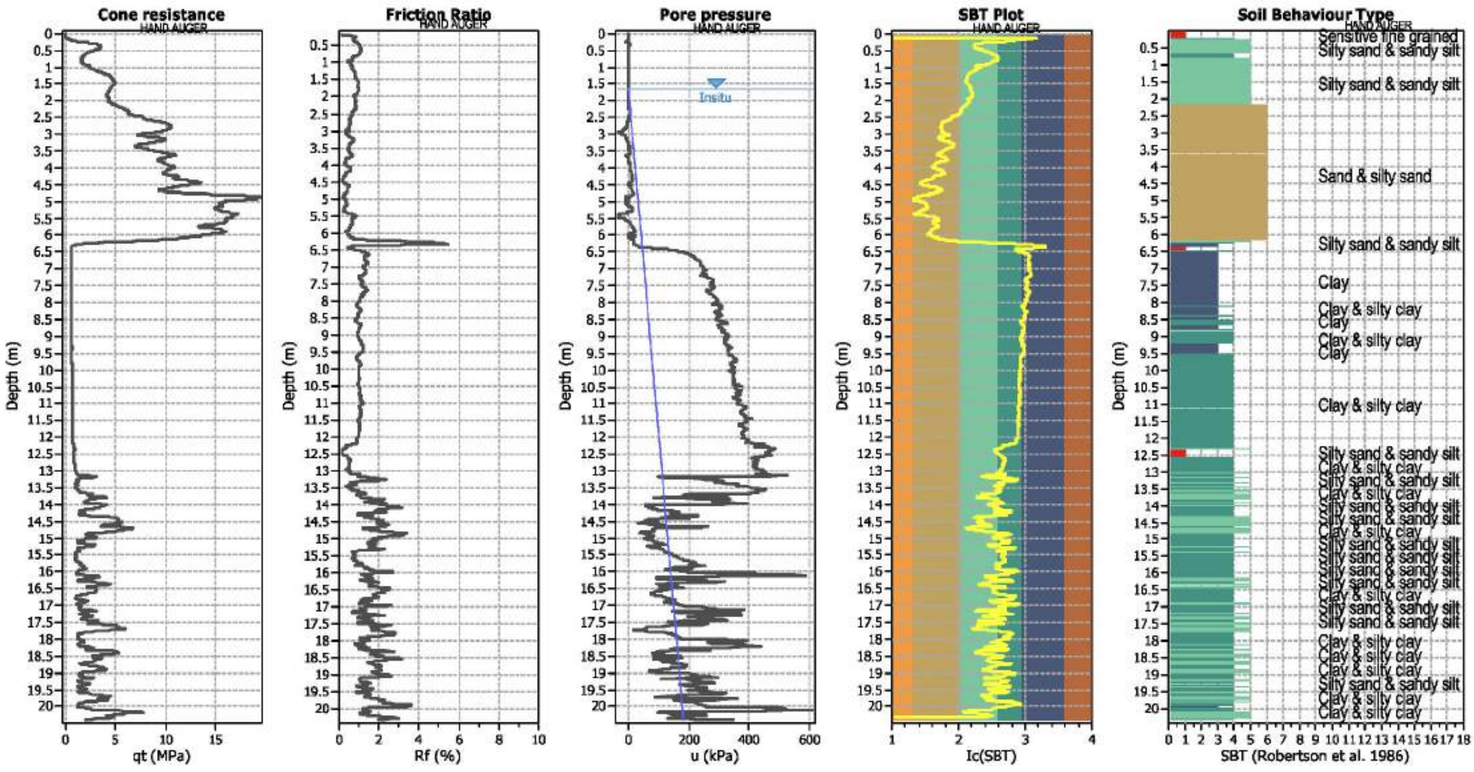
CPT basic interpretation plots



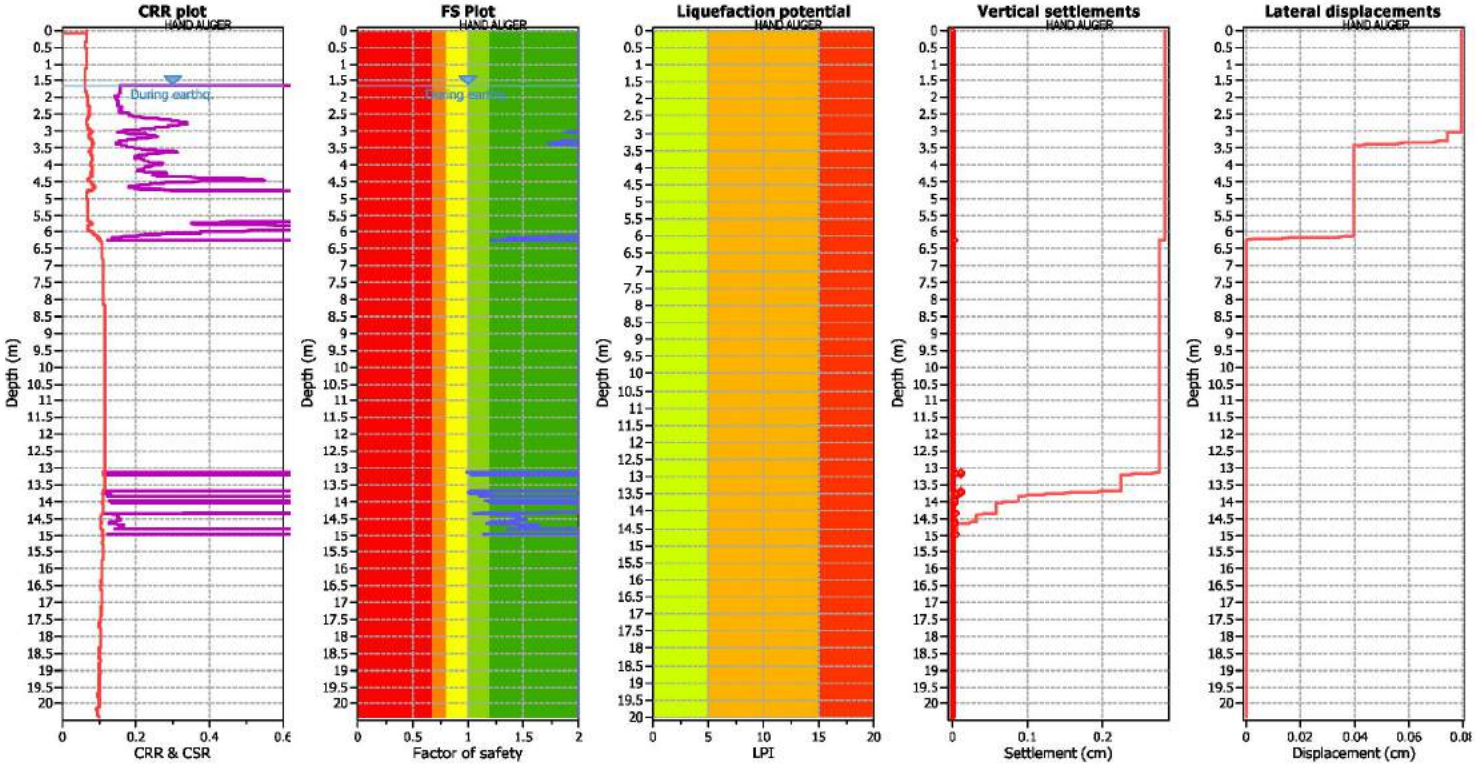
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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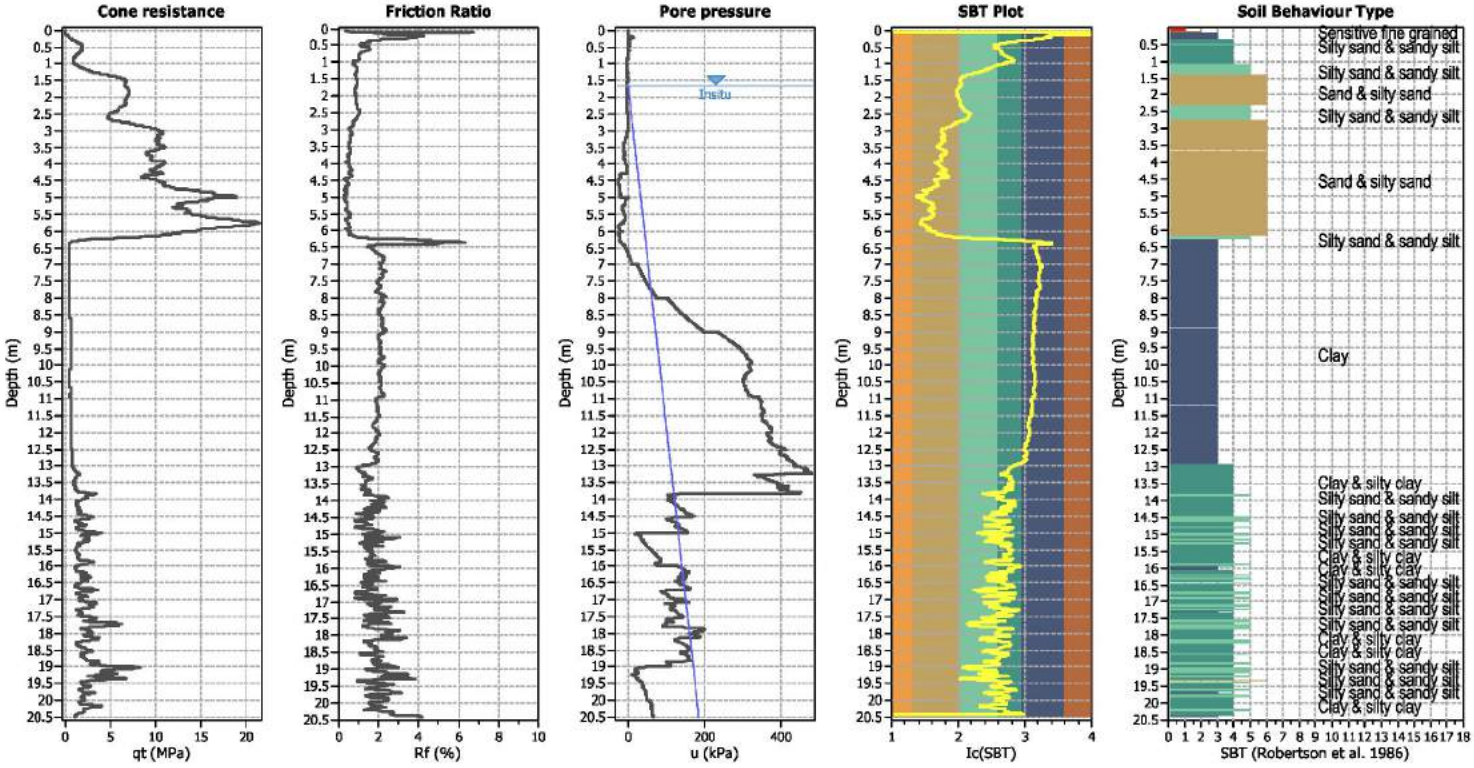
LPI color scheme

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

CPT basic interpretation plots



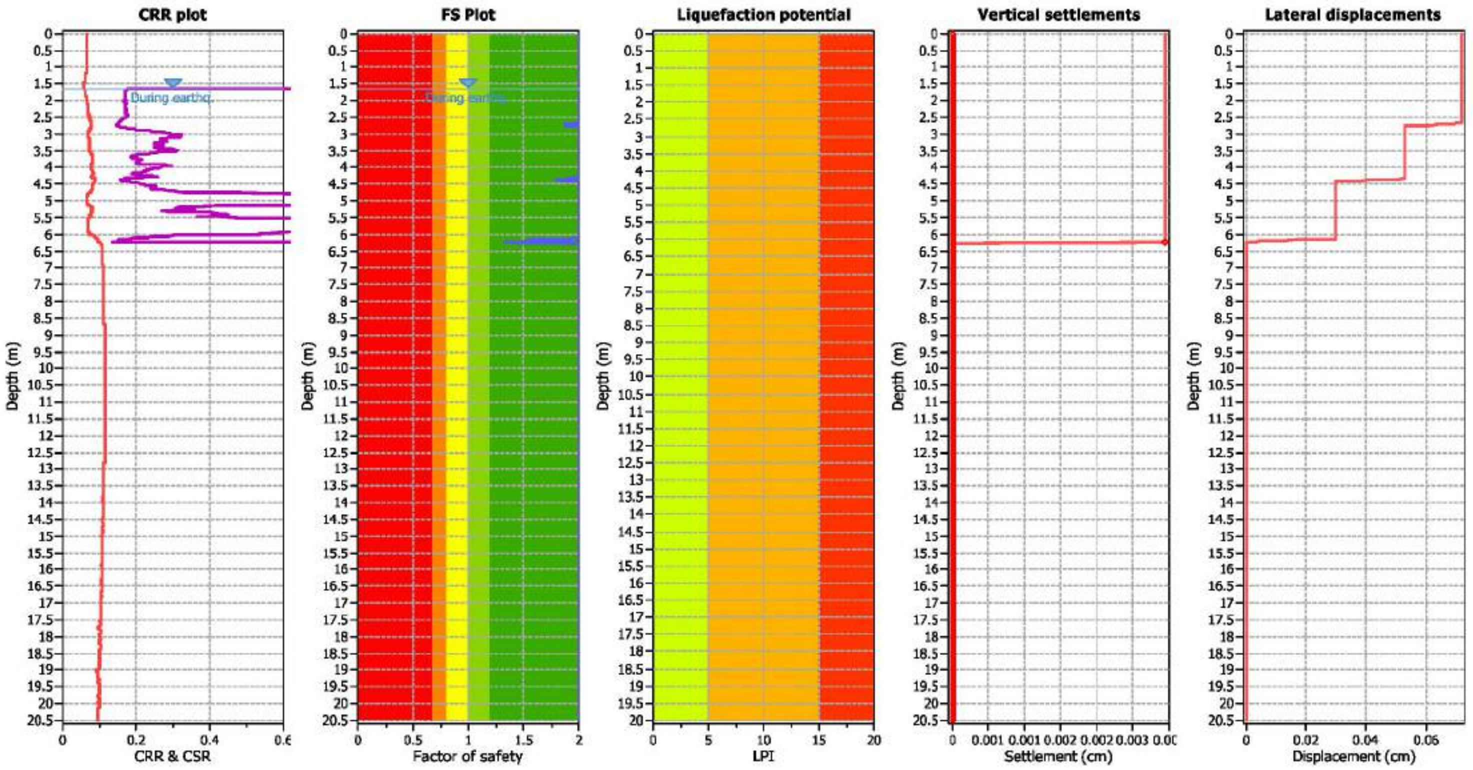
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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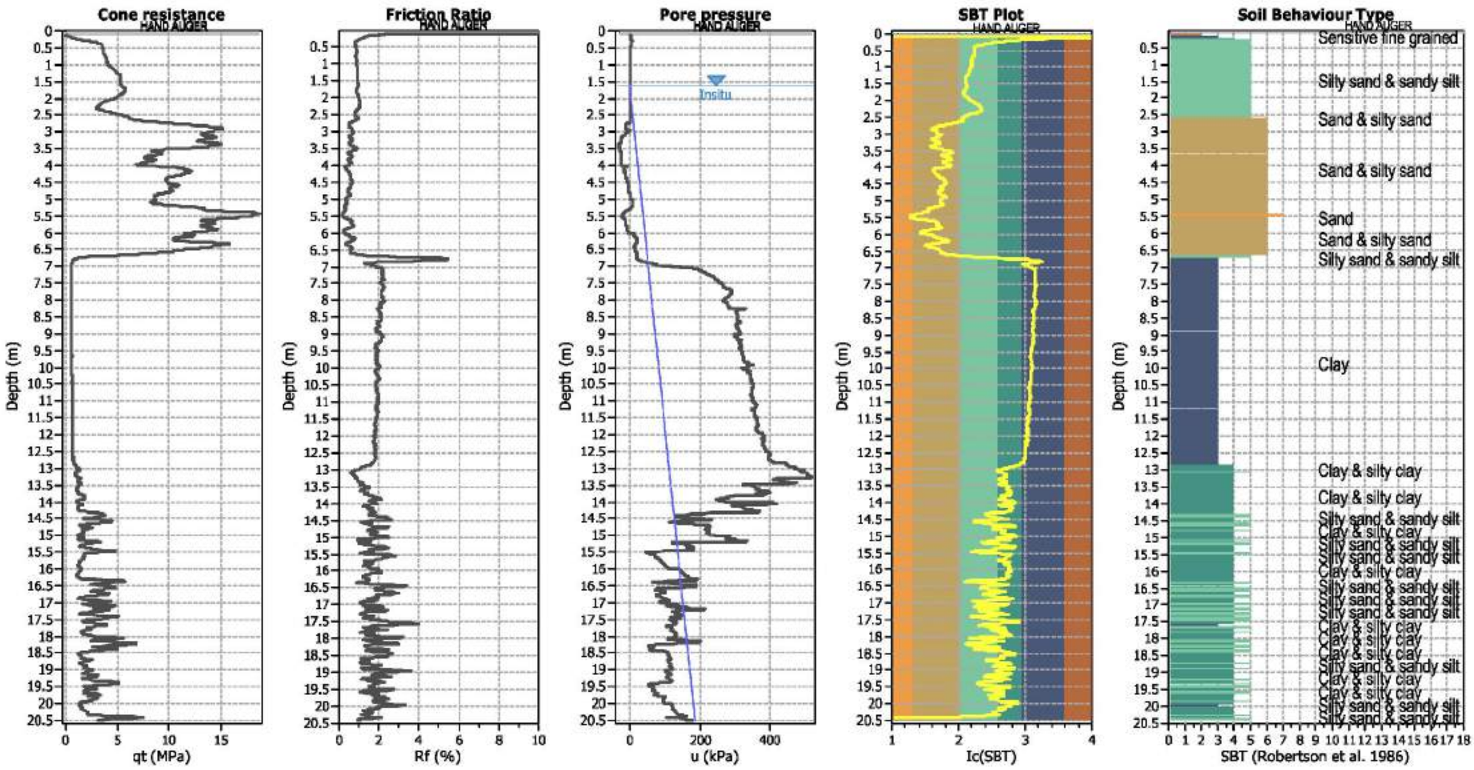
LPI color scheme

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

CPT basic interpretation plots



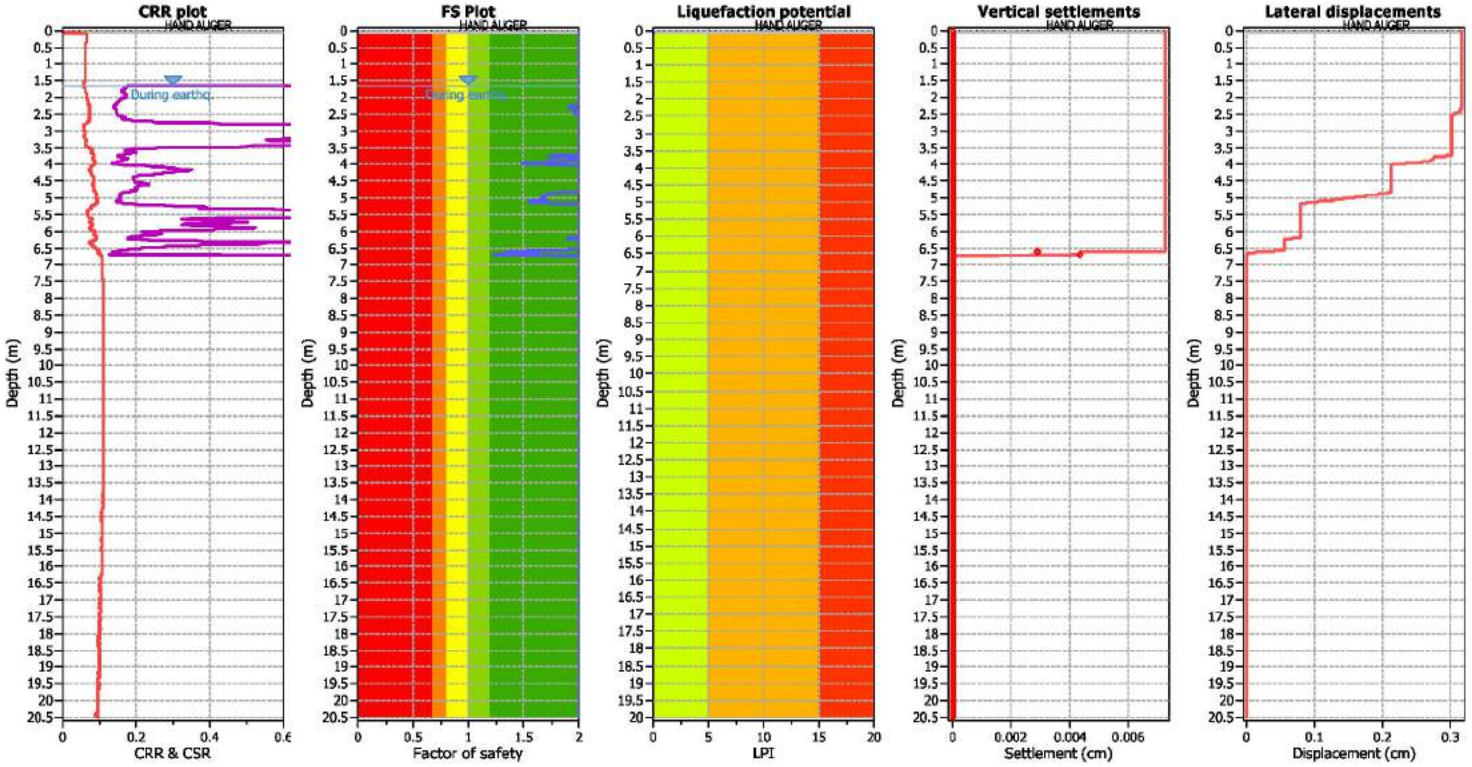
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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- 🟩 Unlike to liquefy
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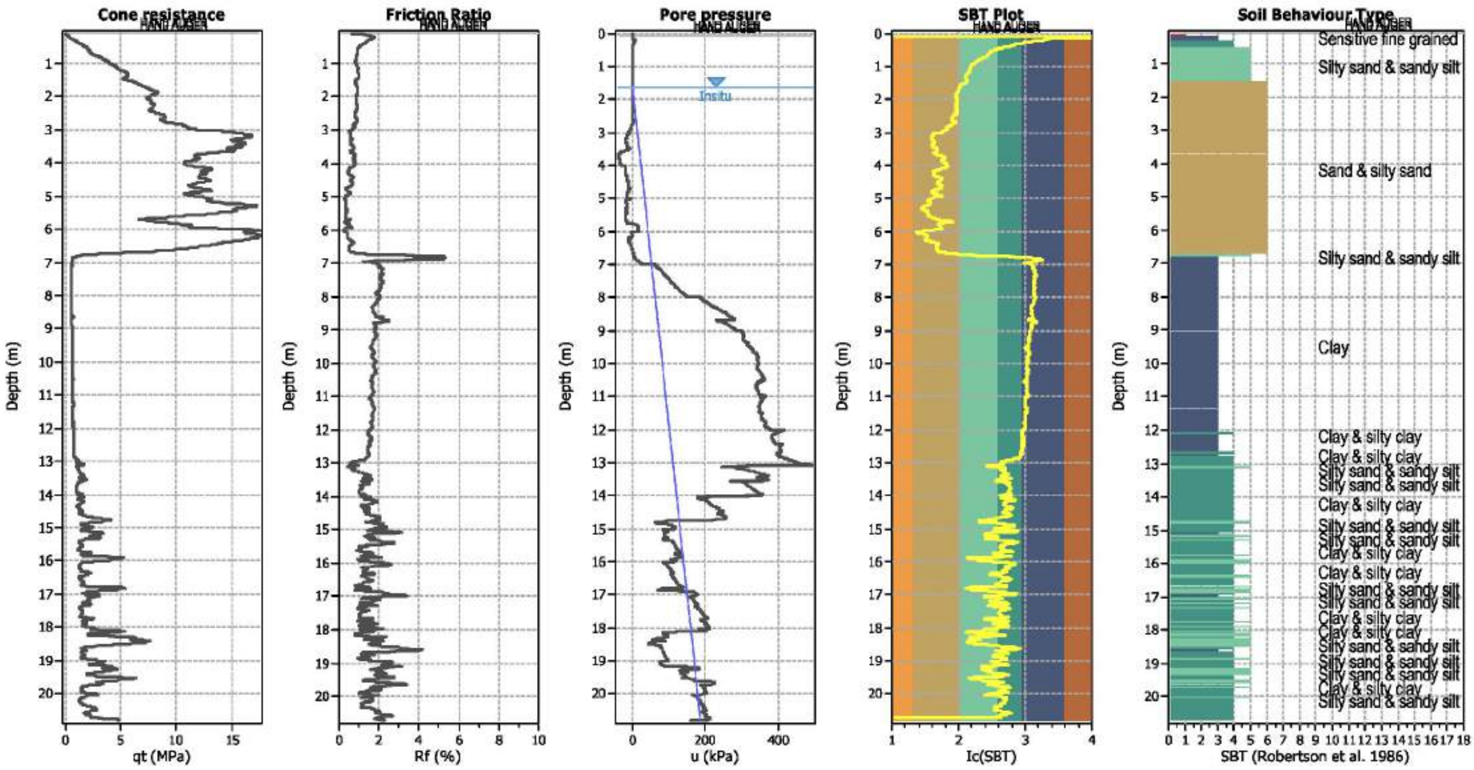
LPI color scheme

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

CPT basic interpretation plots



Input parameters and analysis data

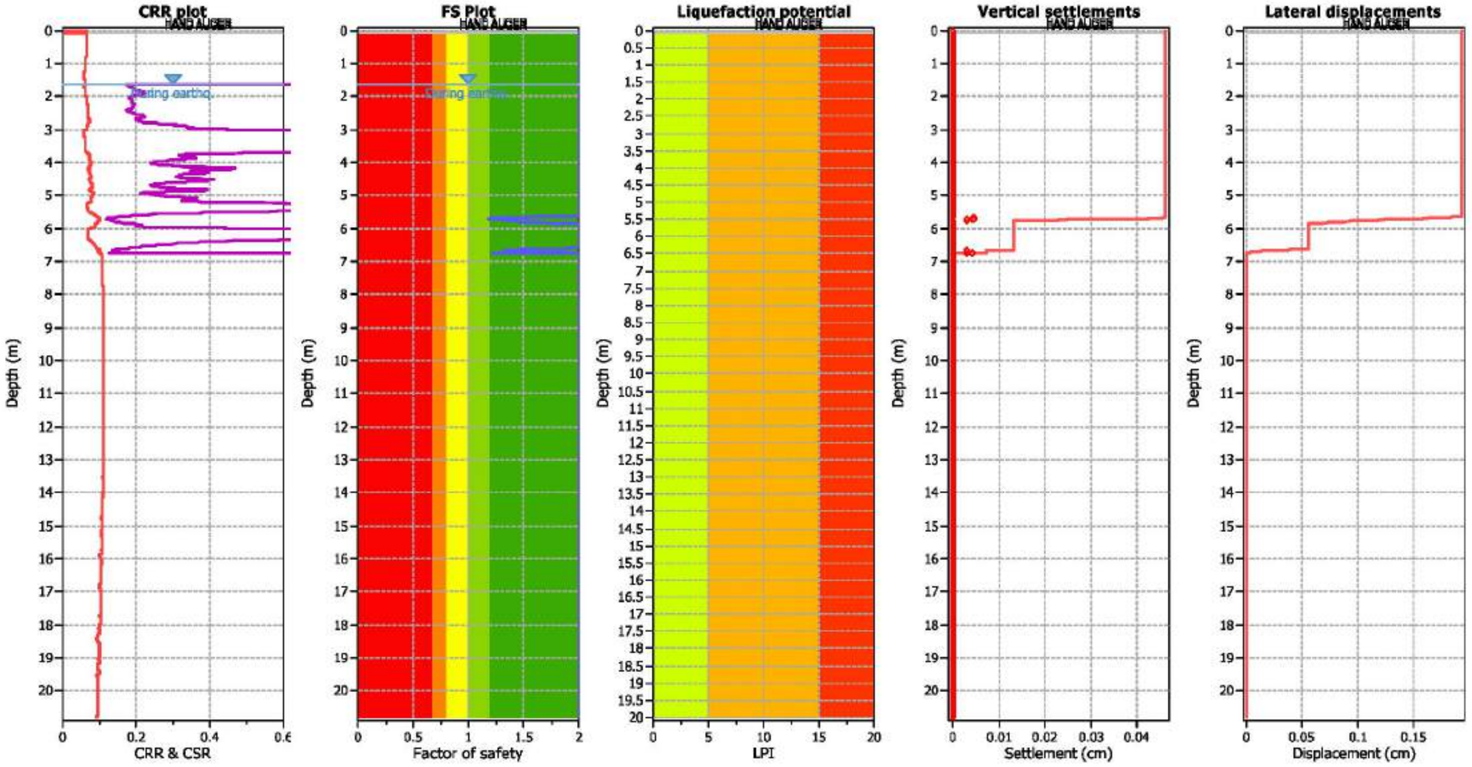
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

CPT name: SLS -CPT03 (10m)

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.12
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

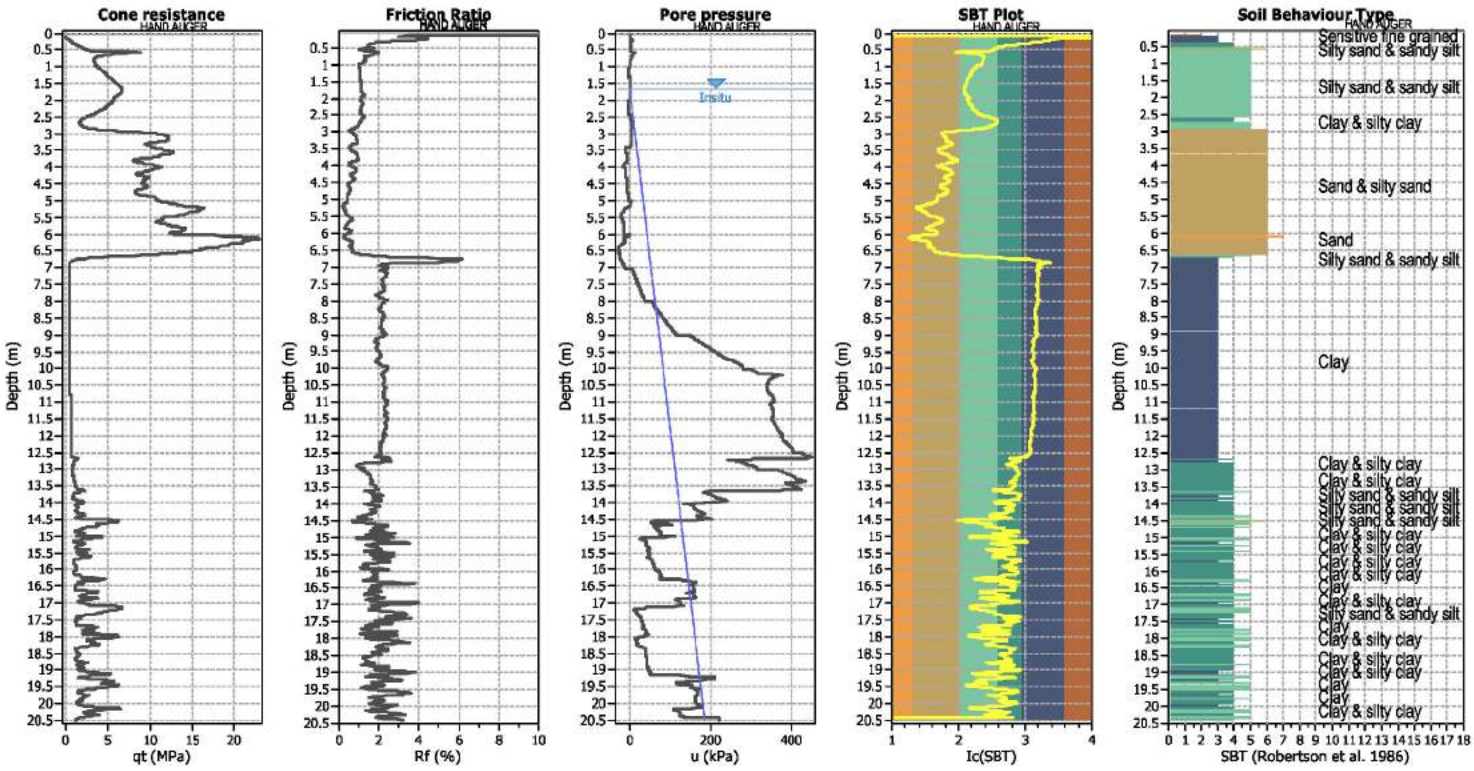
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

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

Project file: M:\LDE - Project\ID2\152DC18A-601D-4CF9-8ACA-6EF80FEBB7A9\0\380000-380999\380559\L\L\24477-Specialist Software Models-Liquefaction- SLS-380559 (ID 380559).clq

CPT basic interpretation plots



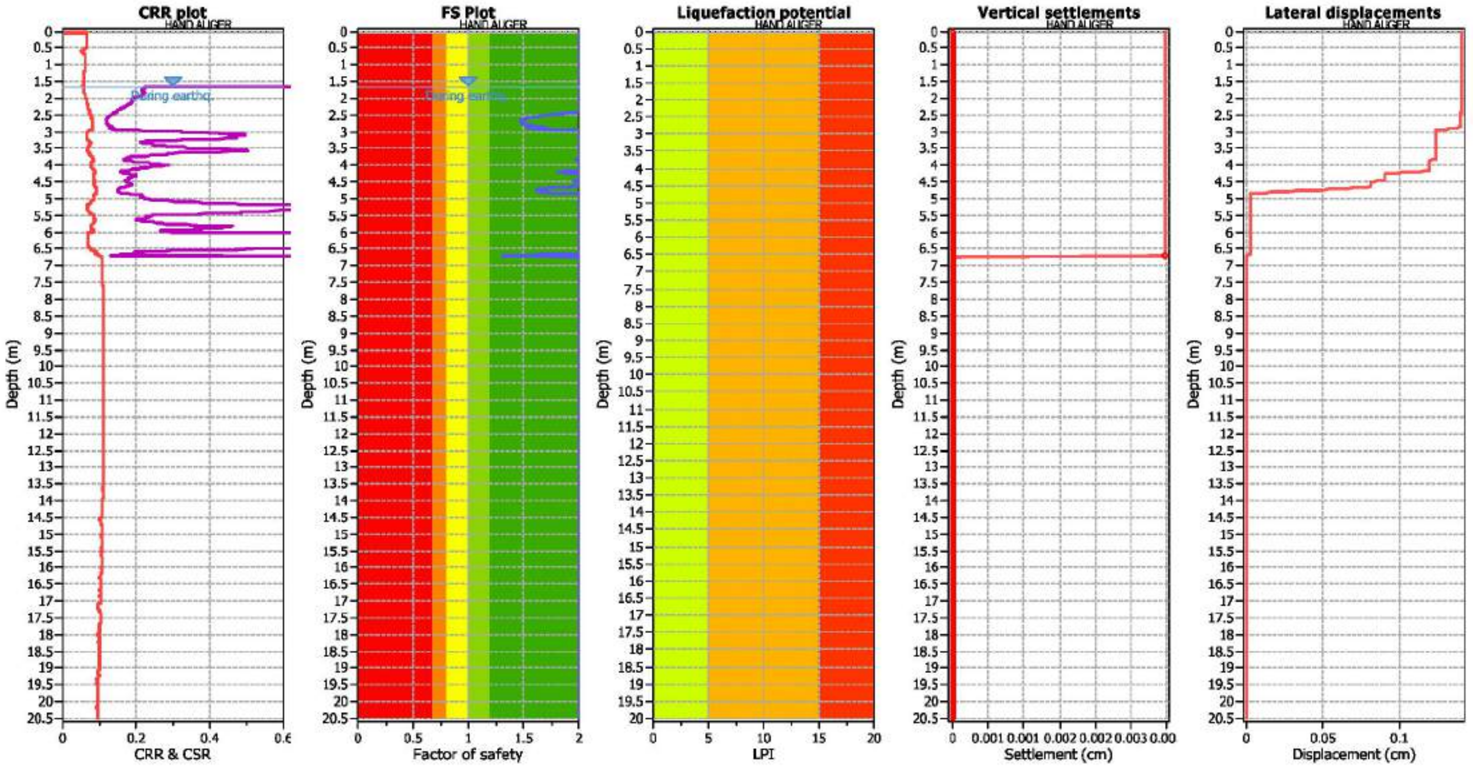
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

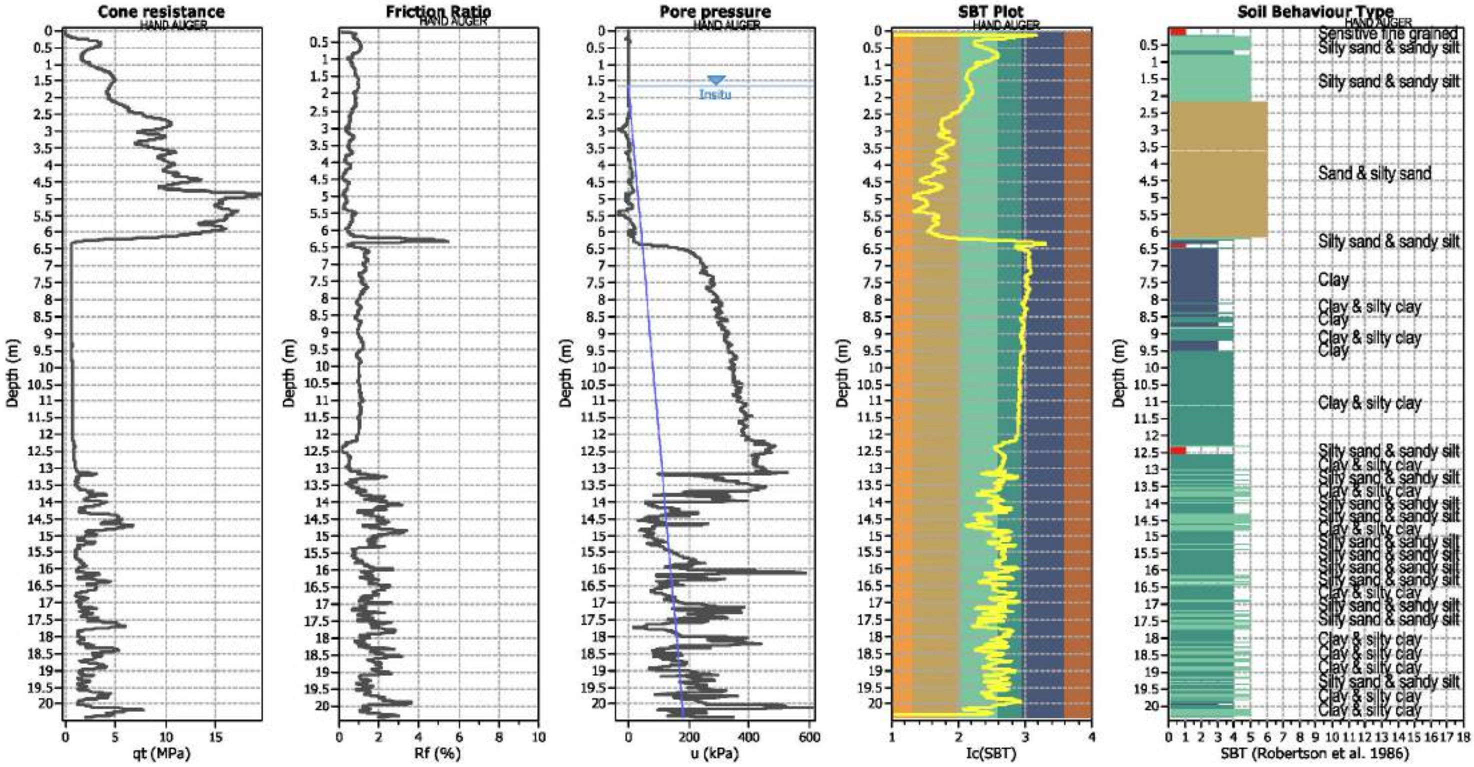
F.S. color scheme

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

LPI color scheme

🟥	Very high risk
🟧	High risk
🟩	Low risk

CPT basic interpretation plots



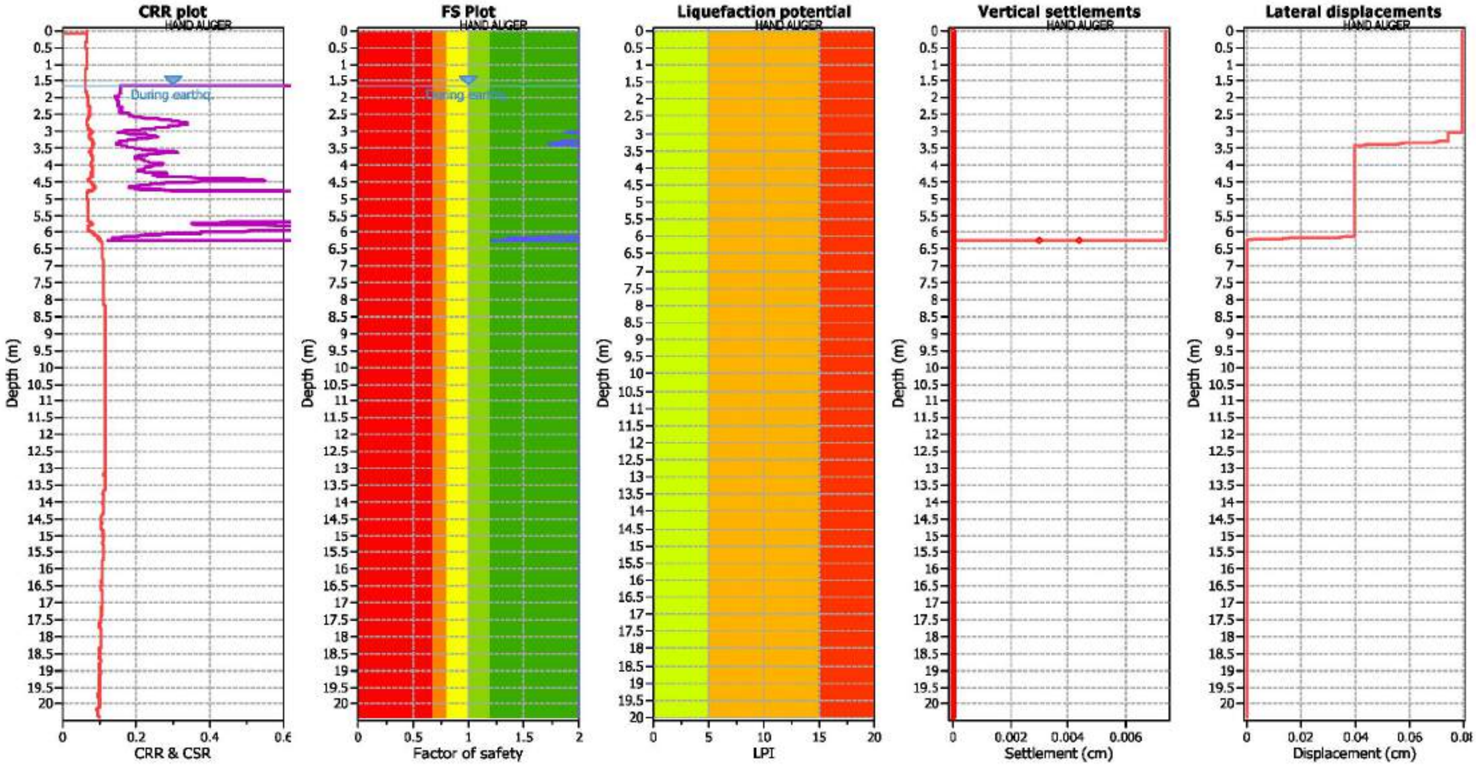
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.12	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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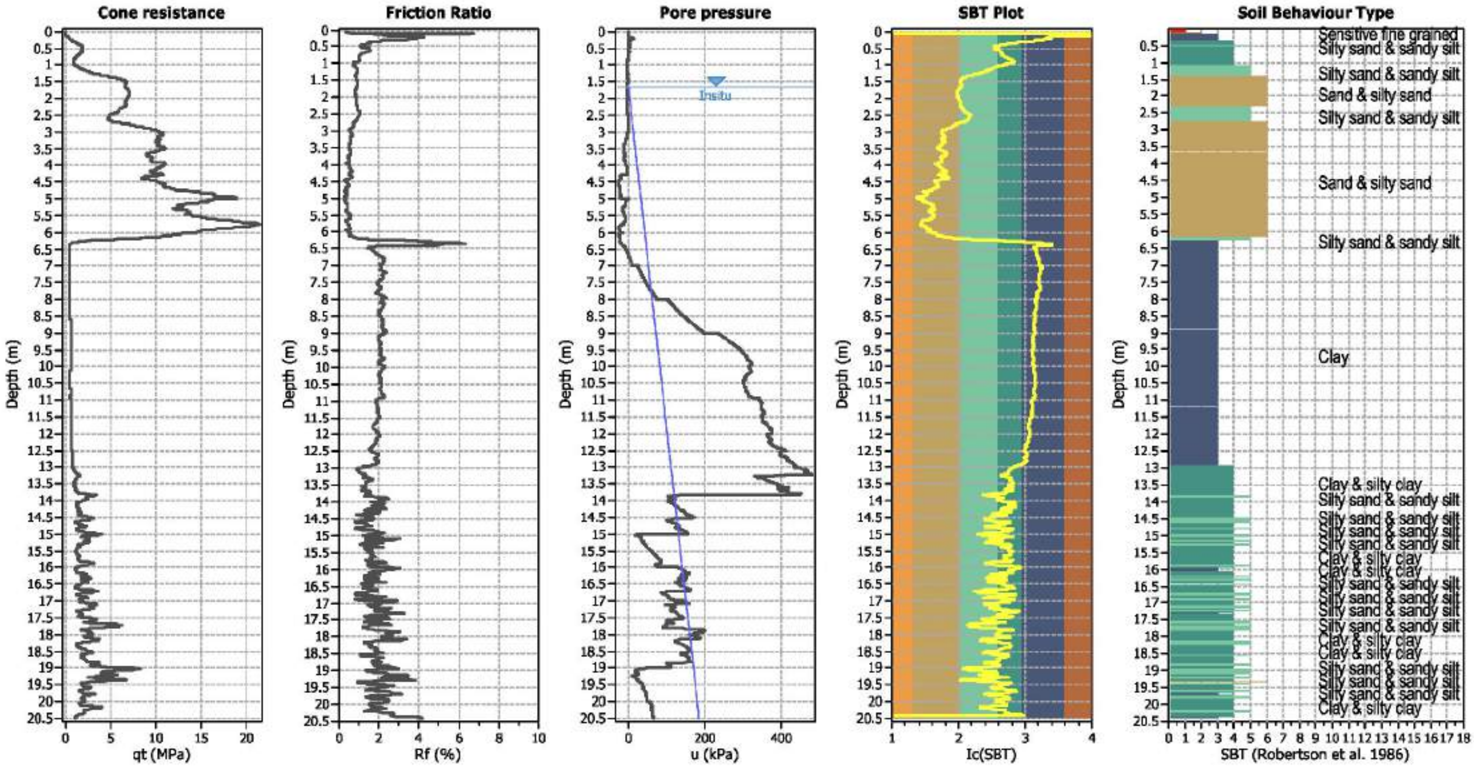
CPT basic interpretation plots



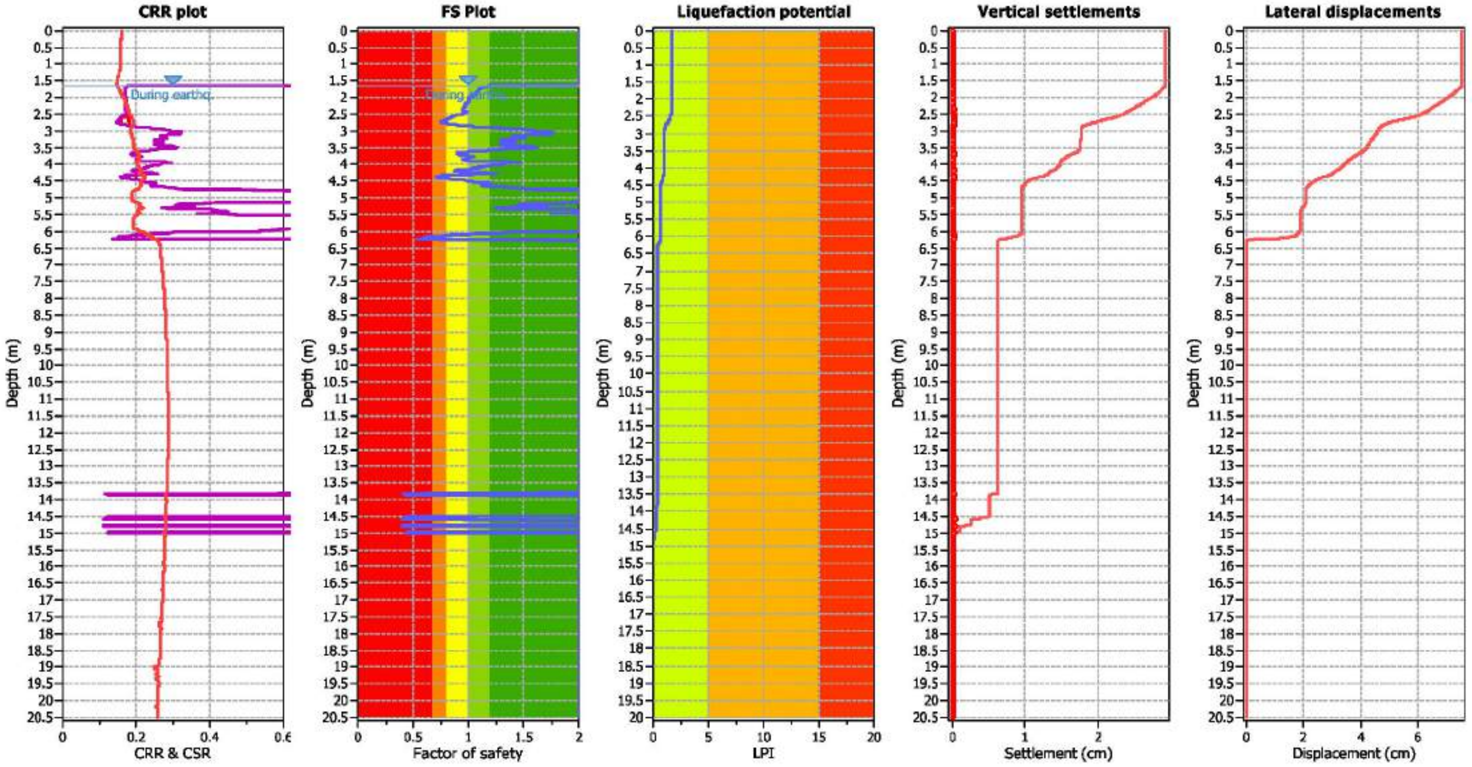
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

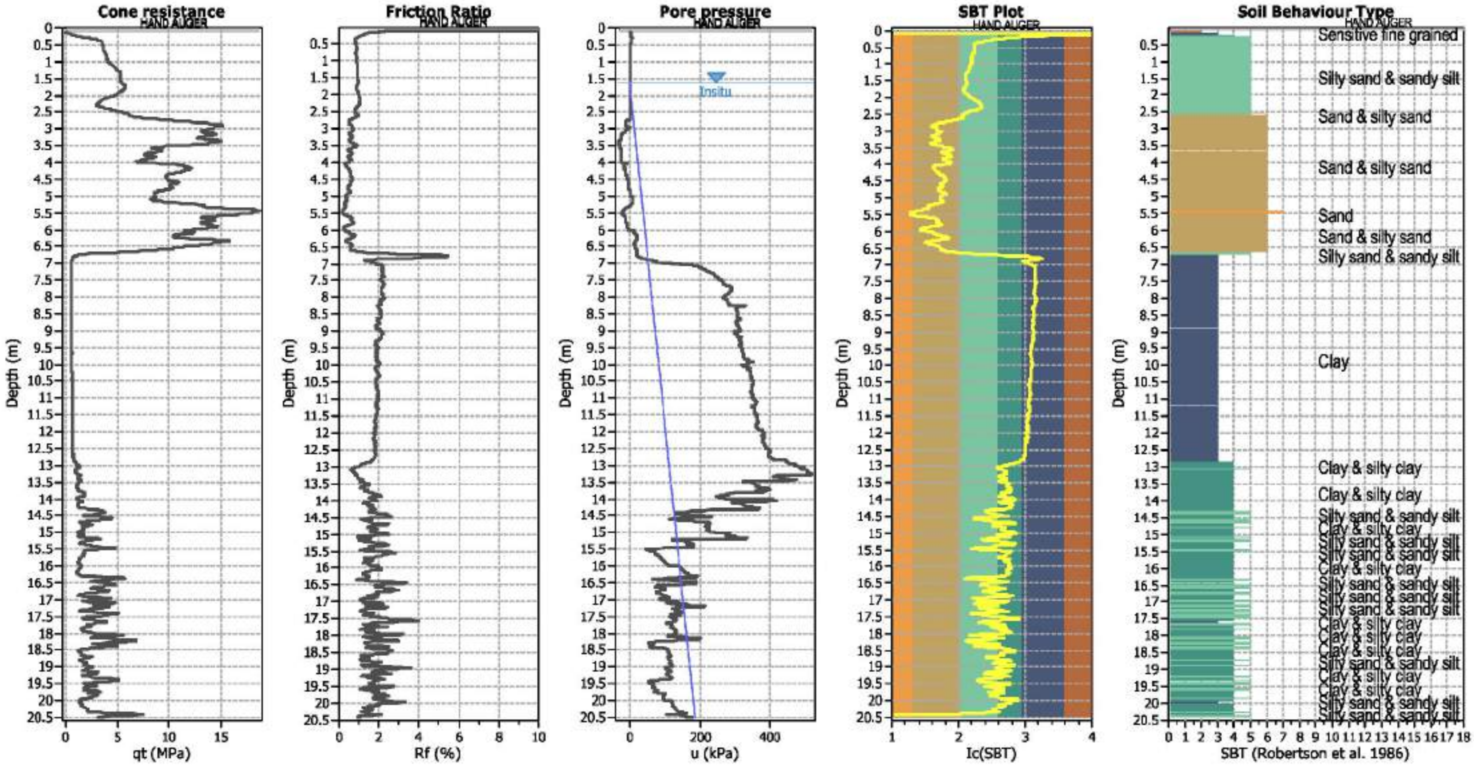
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



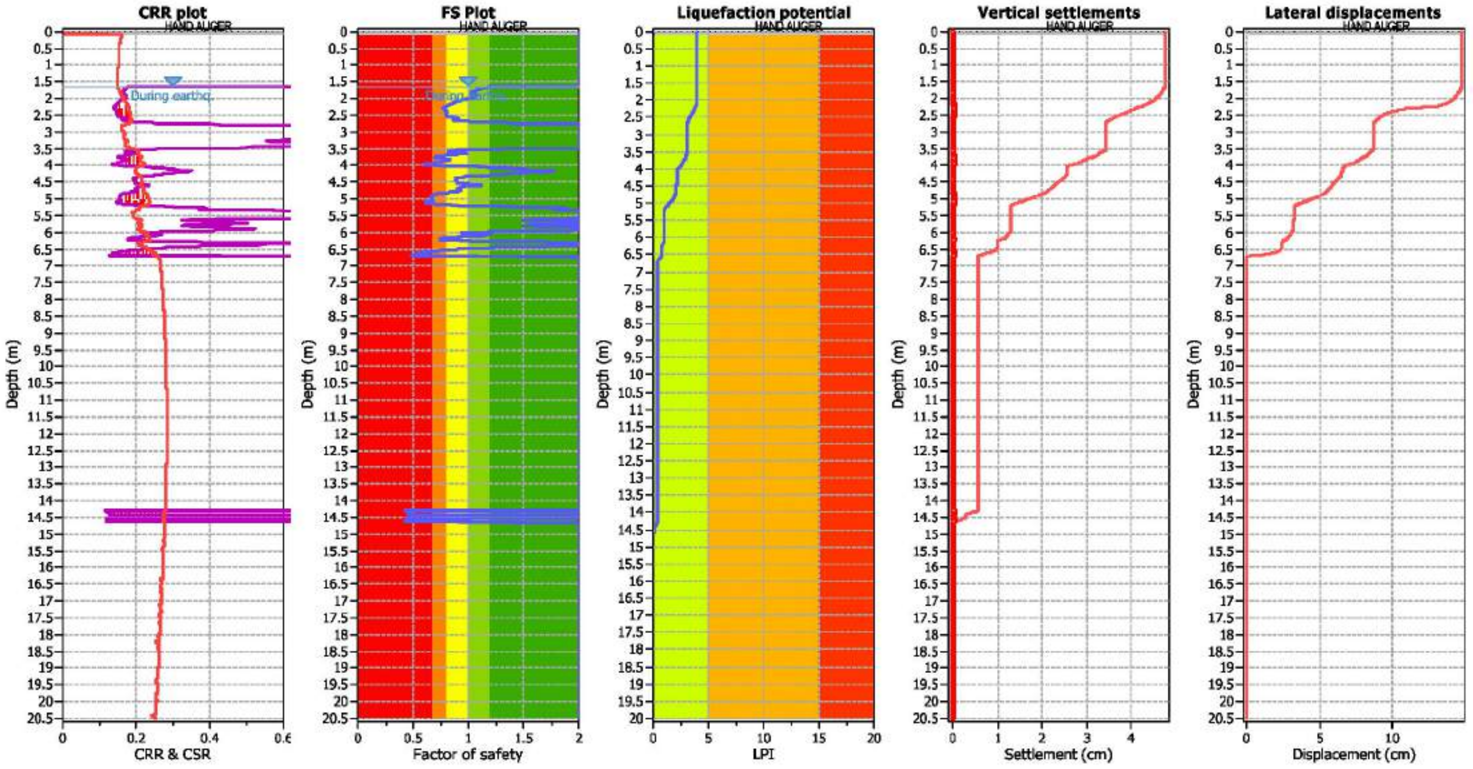
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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LPI color scheme

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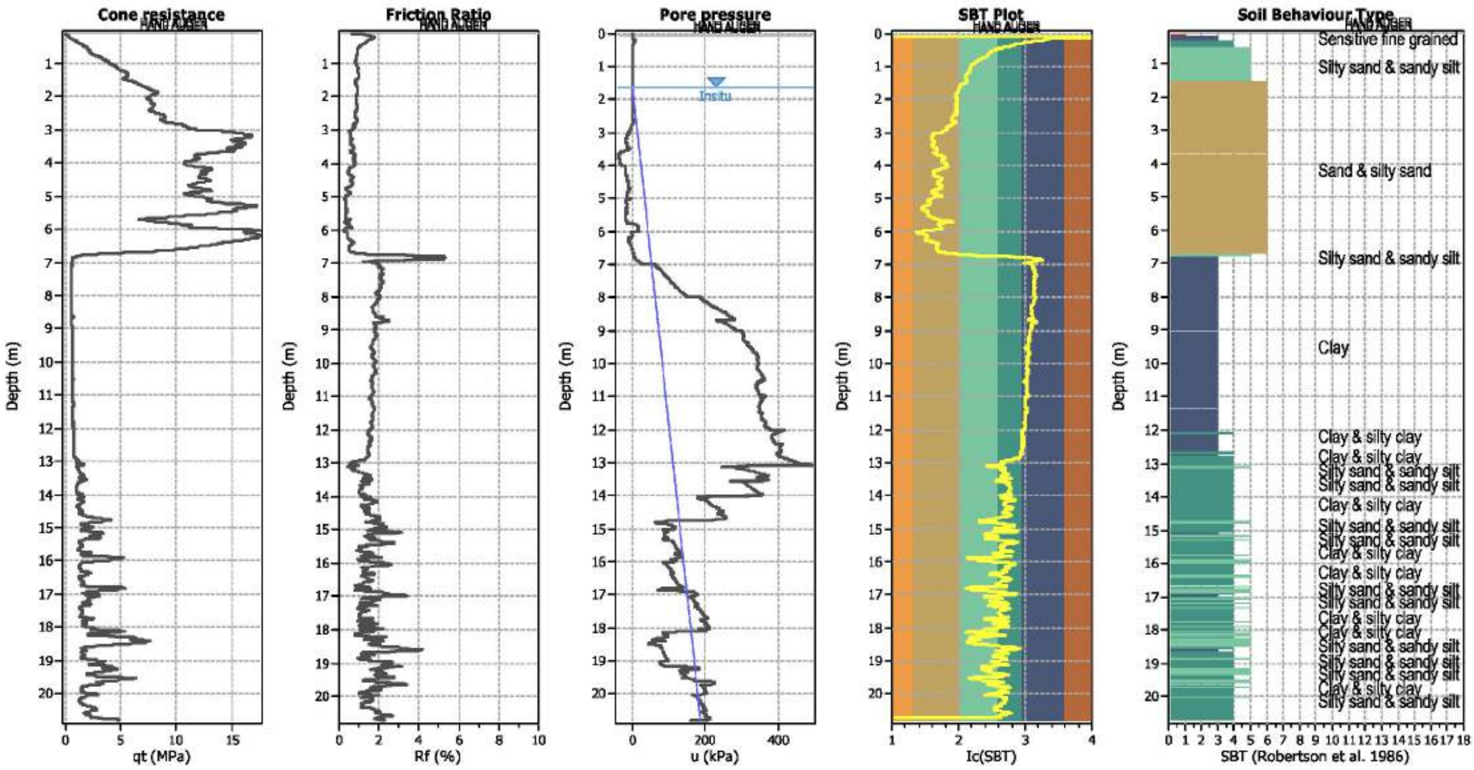
CPT basic interpretation plots



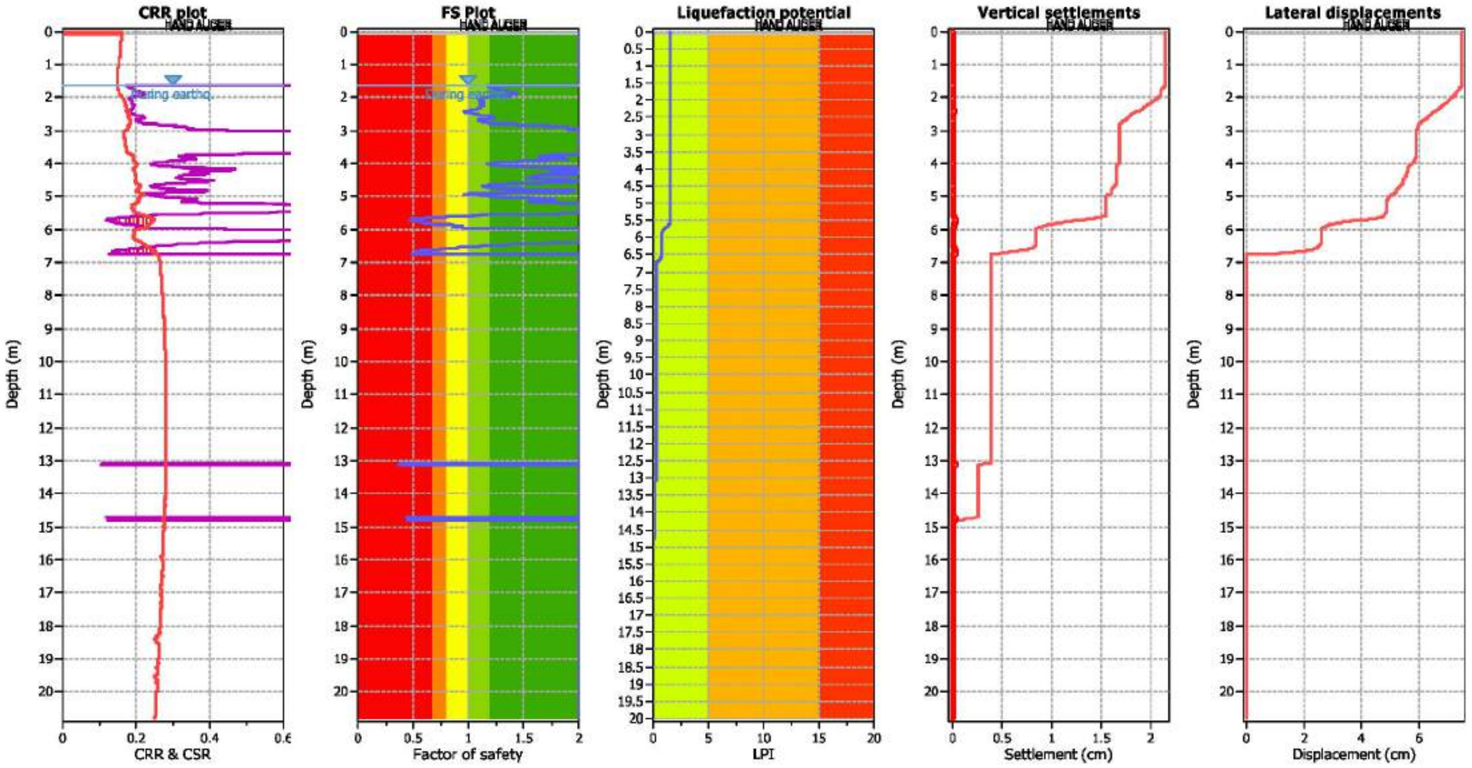
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

F.S. color scheme

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LPI color scheme

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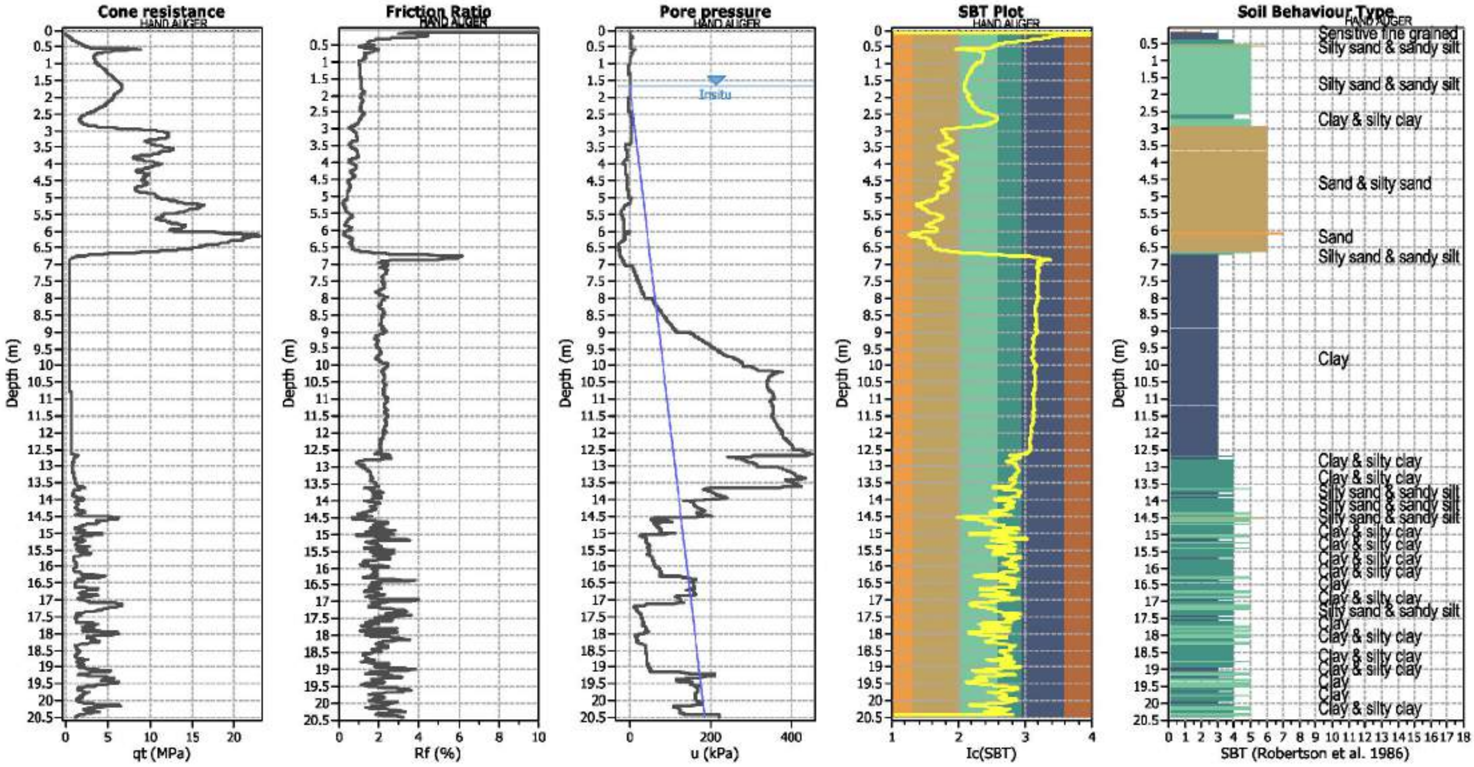
CPT basic interpretation plots



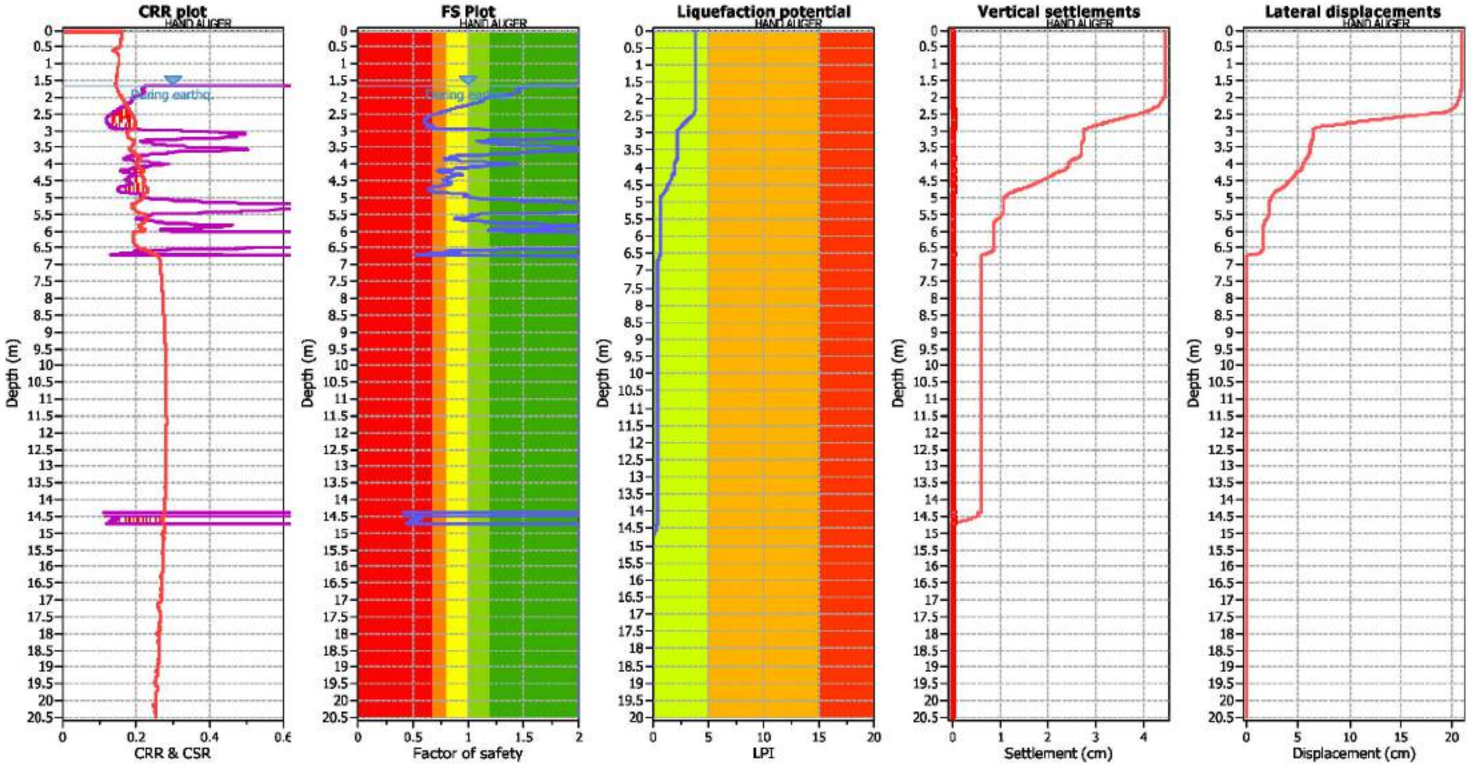
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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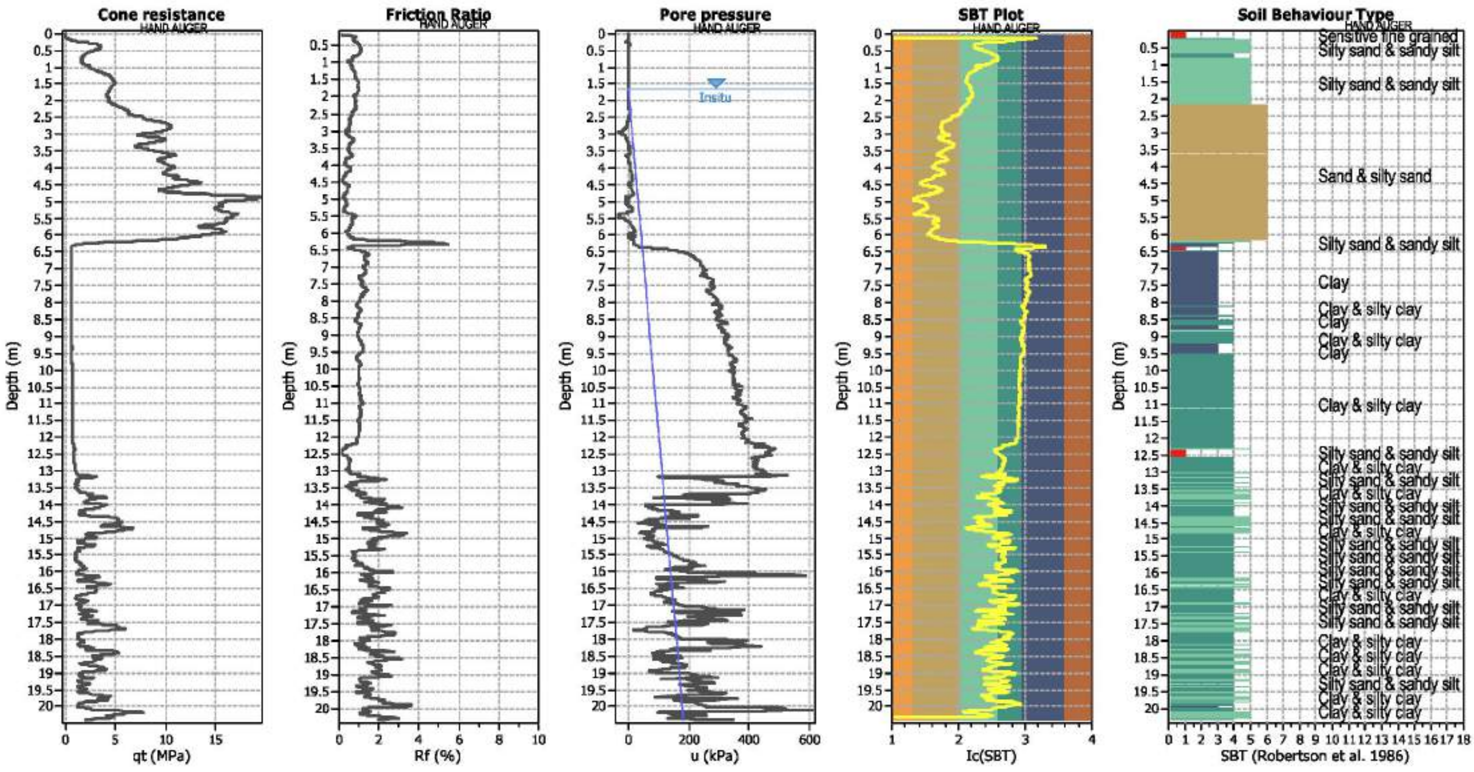
CPT basic interpretation plots



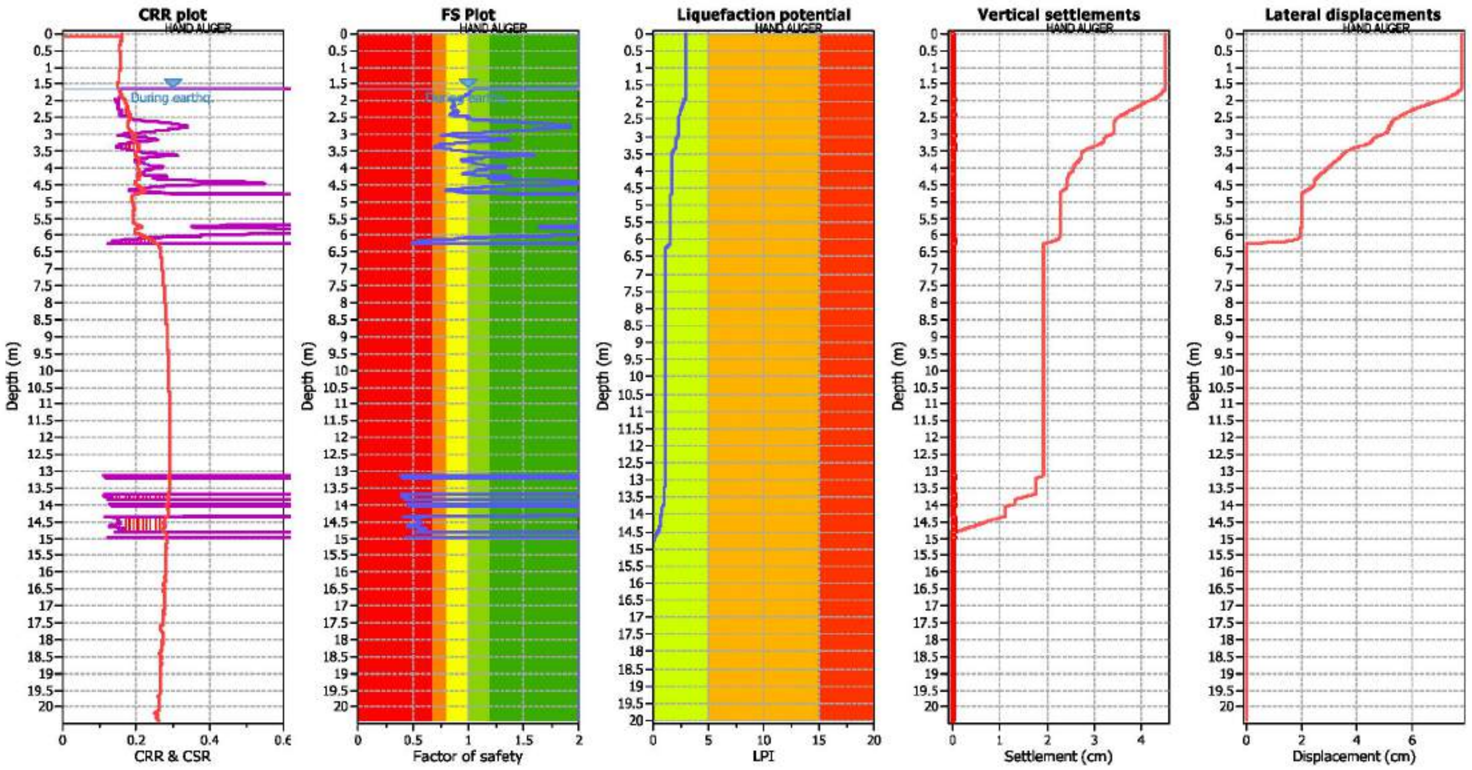
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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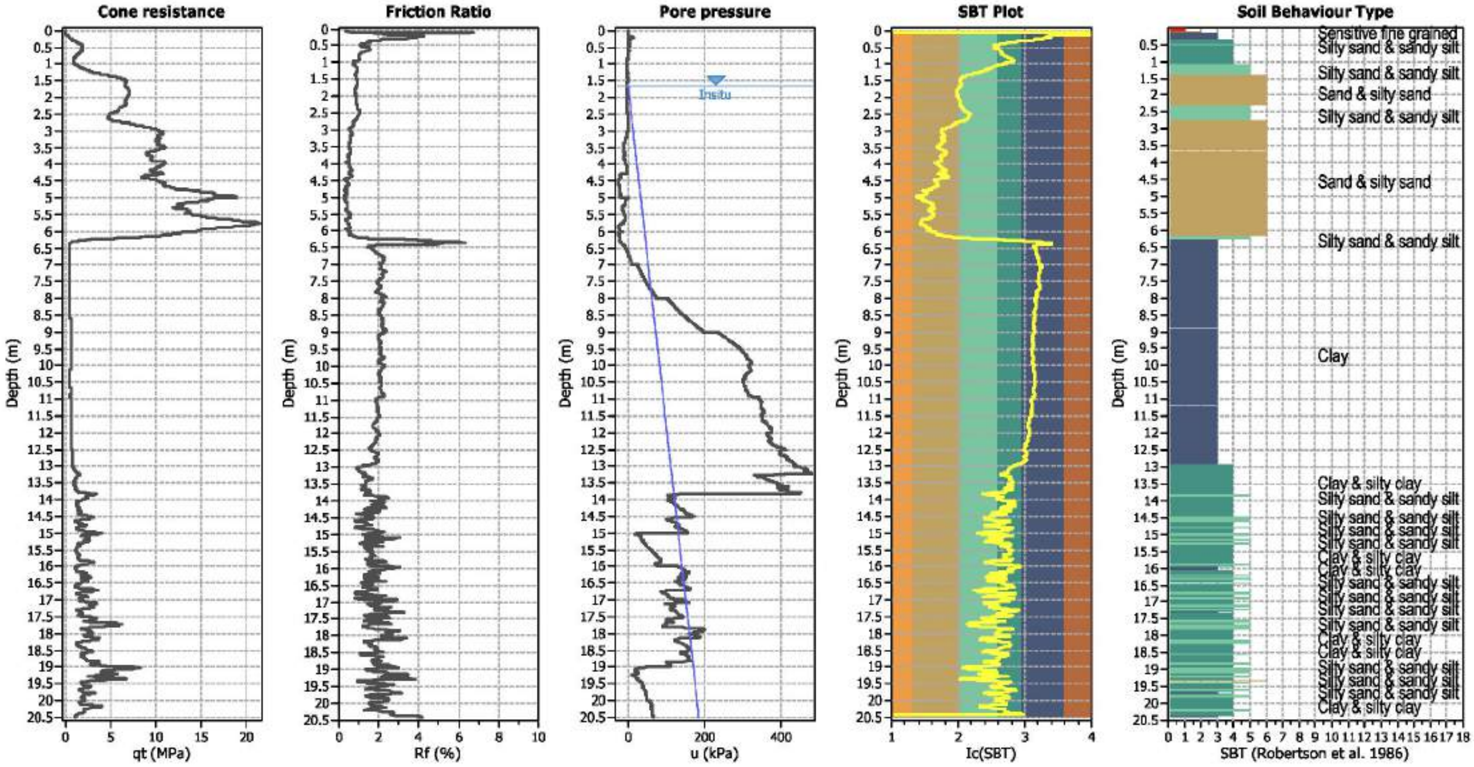
CPT basic interpretation plots



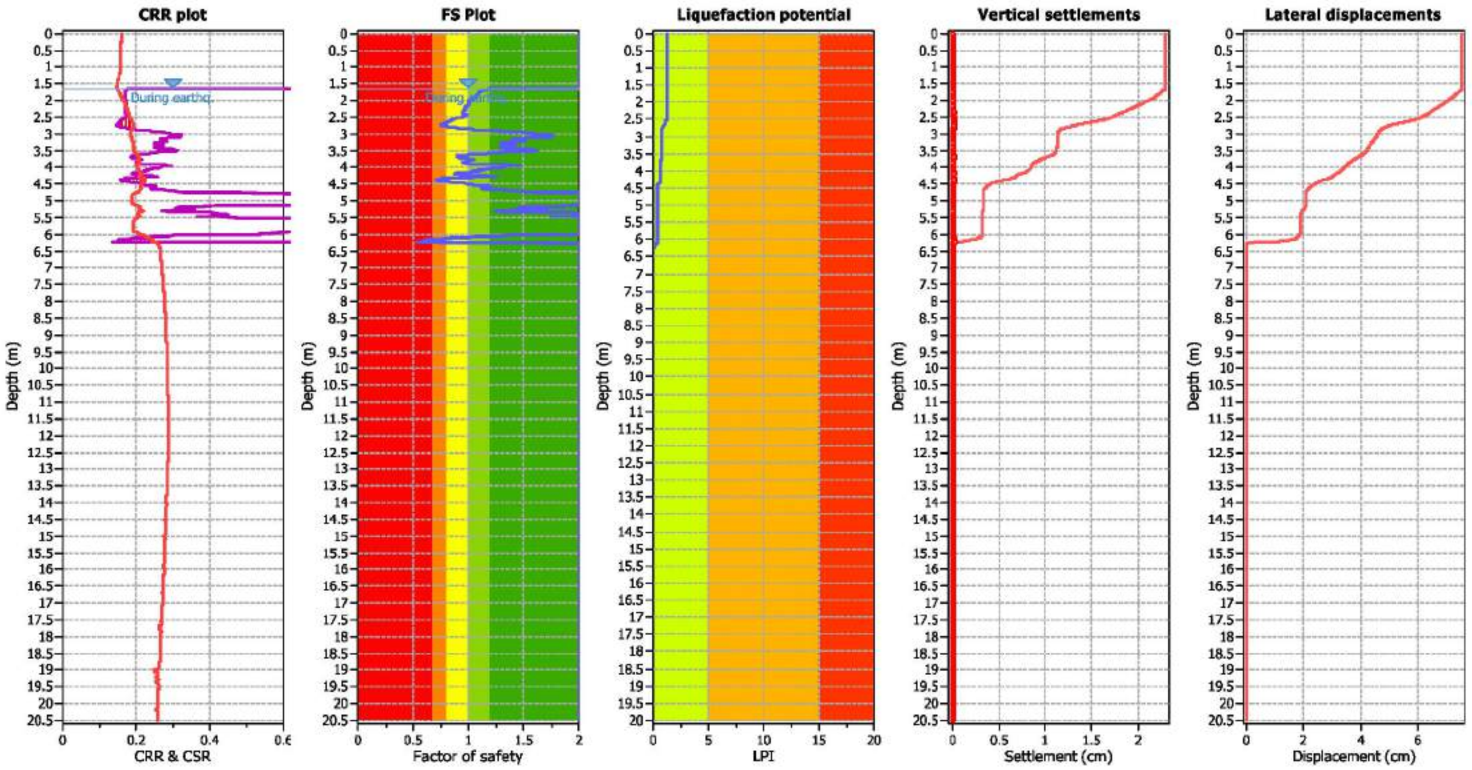
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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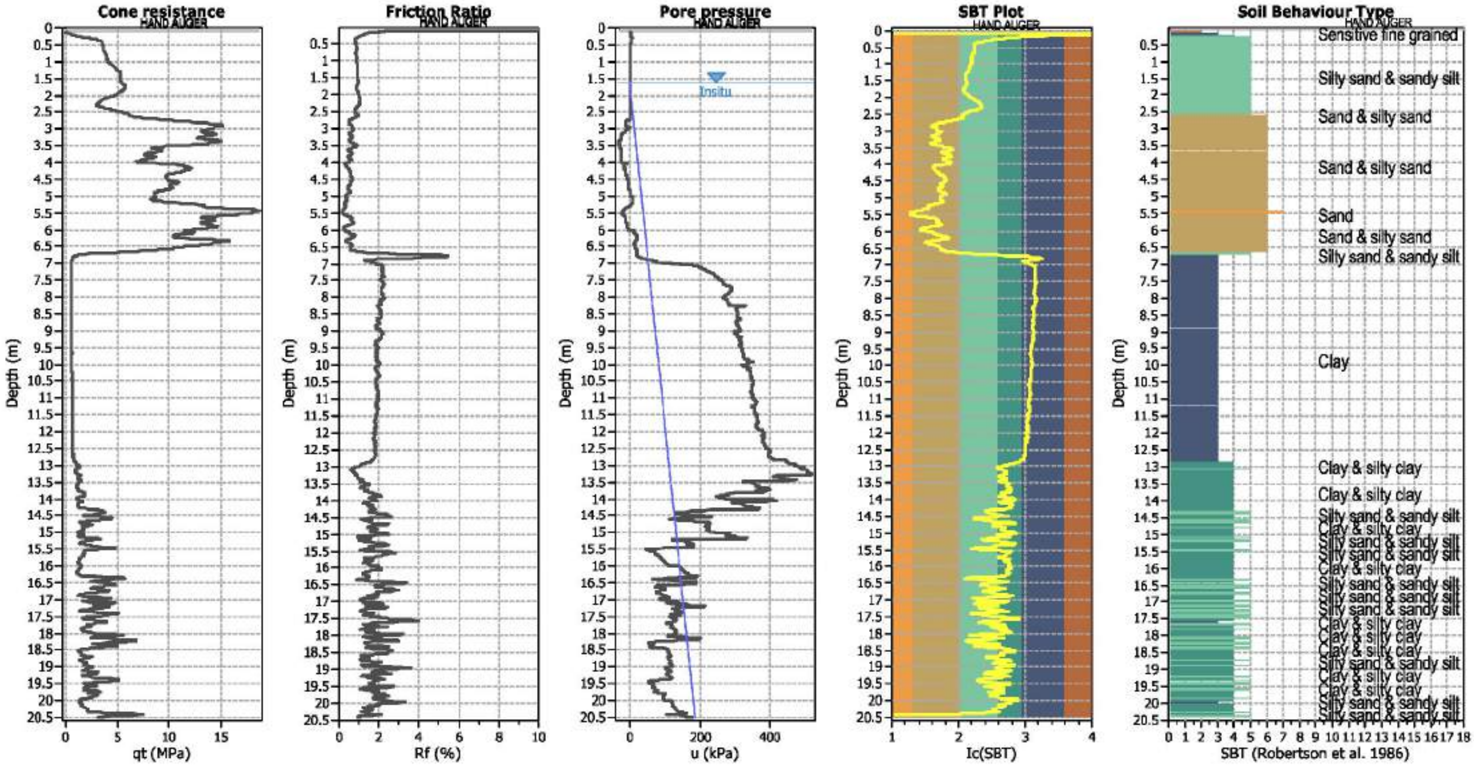
CPT basic interpretation plots



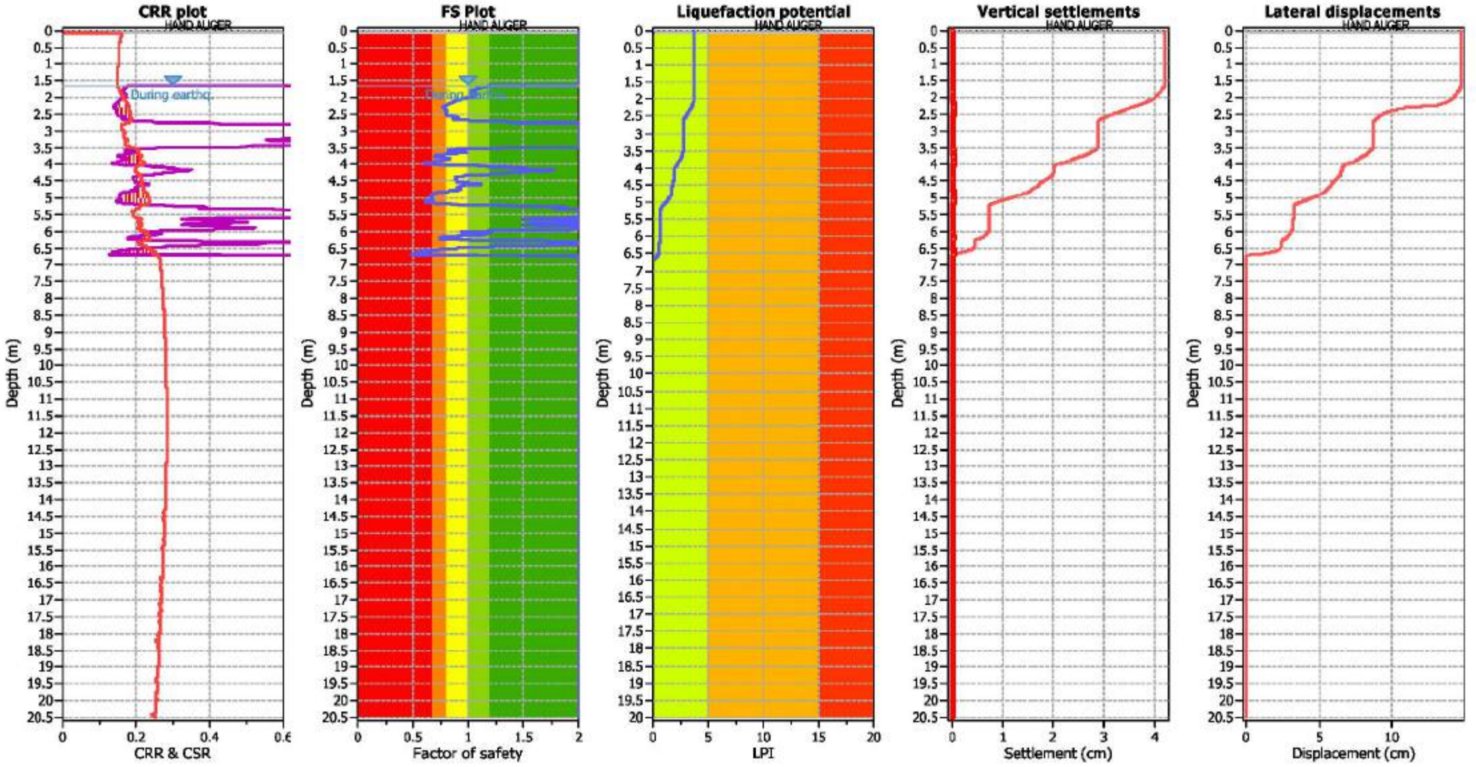
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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LPI color scheme

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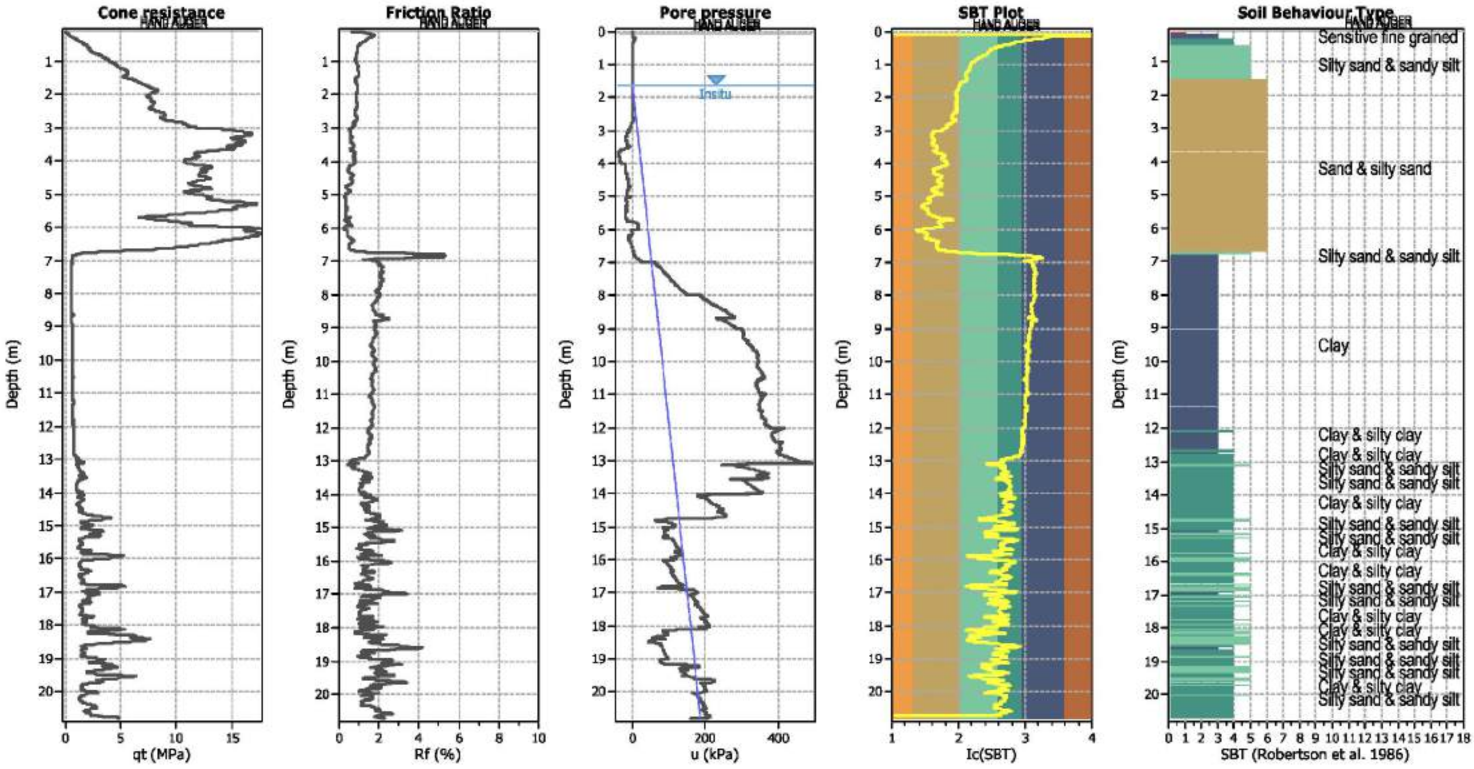
CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

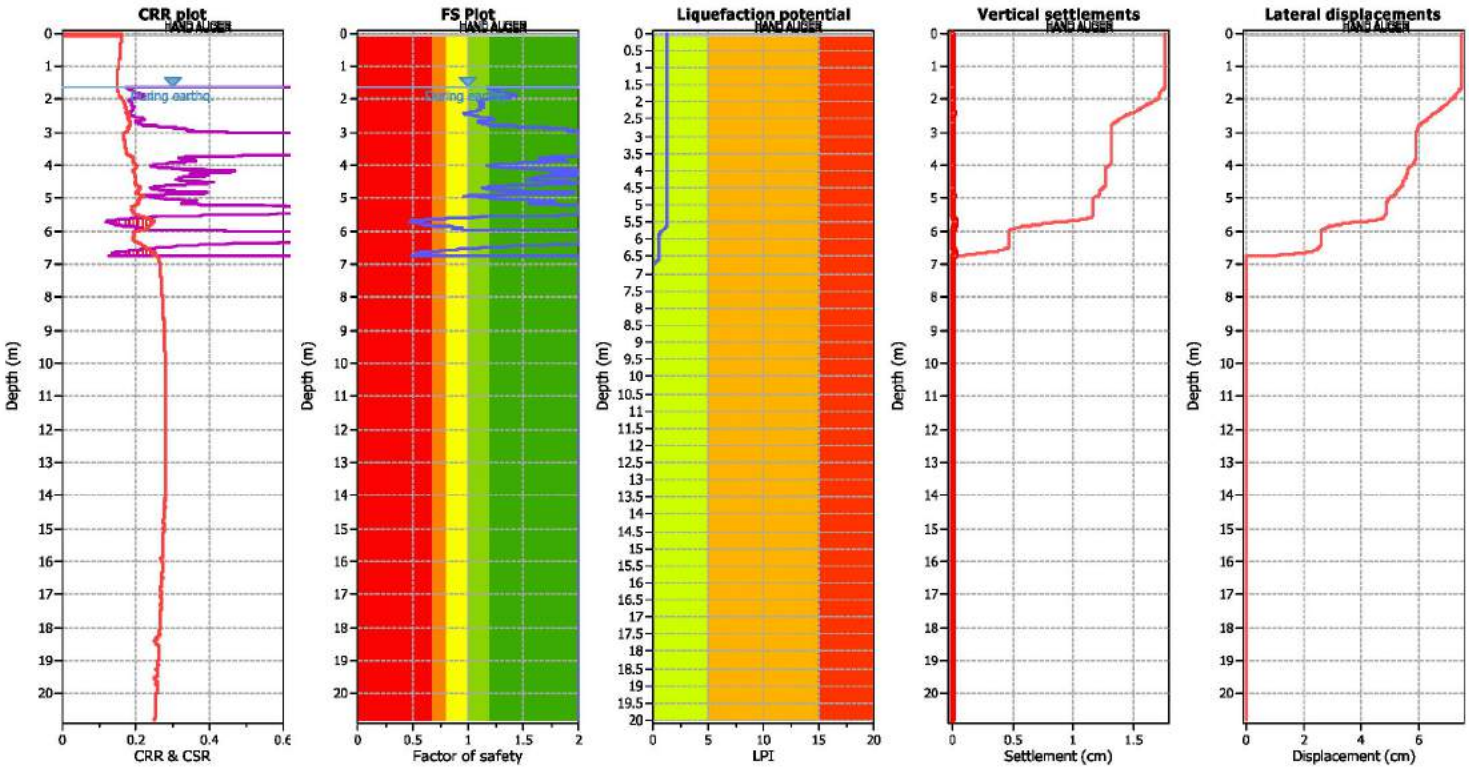
Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

SBT legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to
⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.80
Peak ground acceleration: 0.28
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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LPI color scheme

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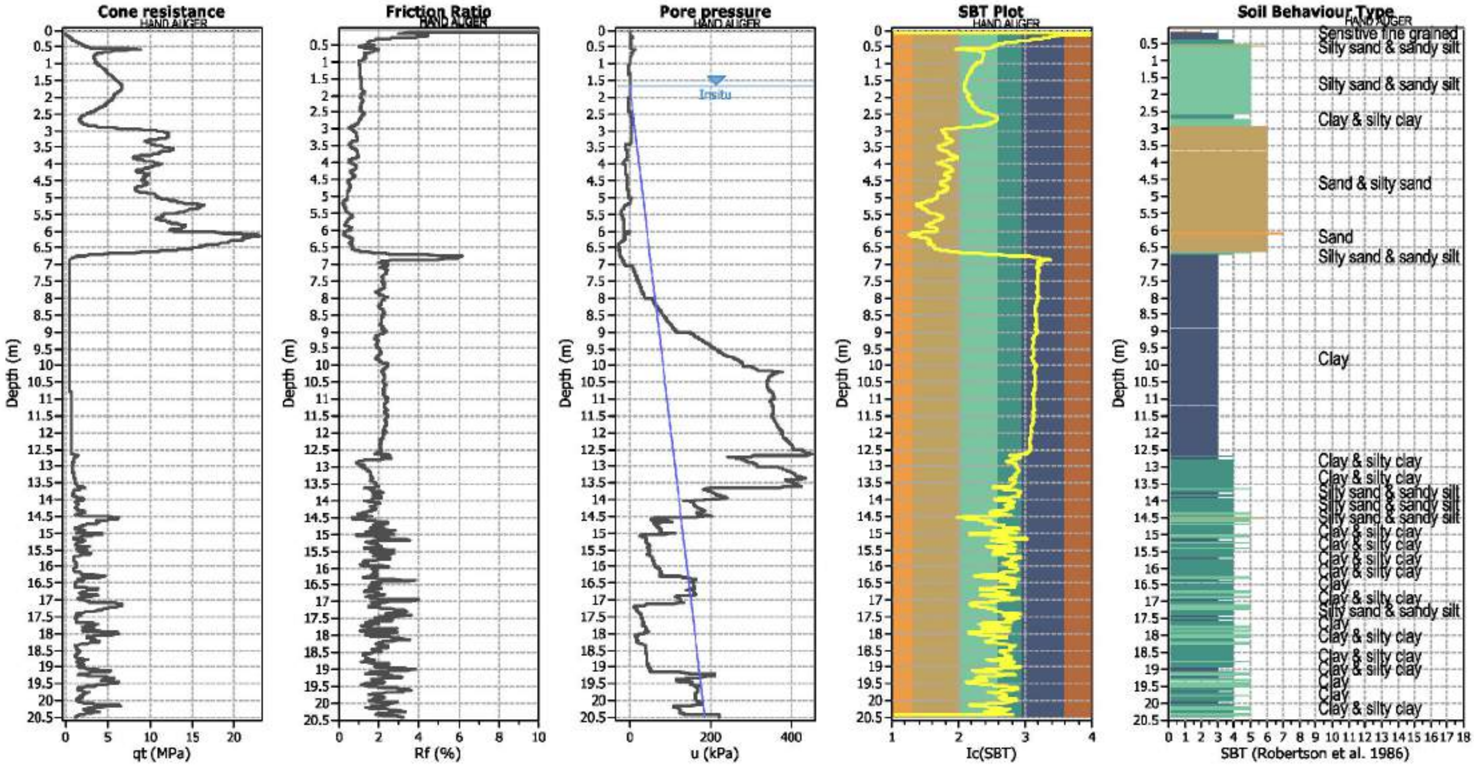
CPT basic interpretation plots



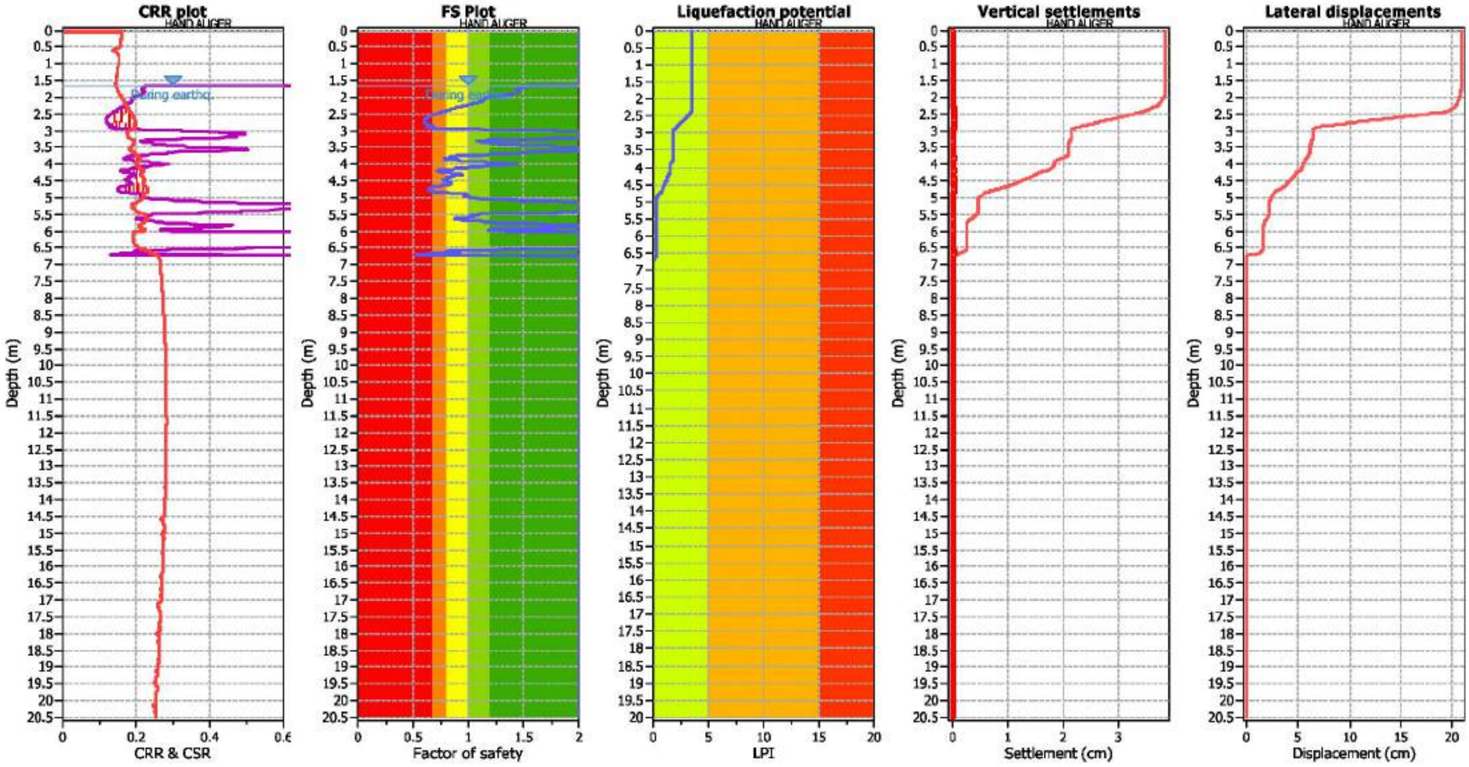
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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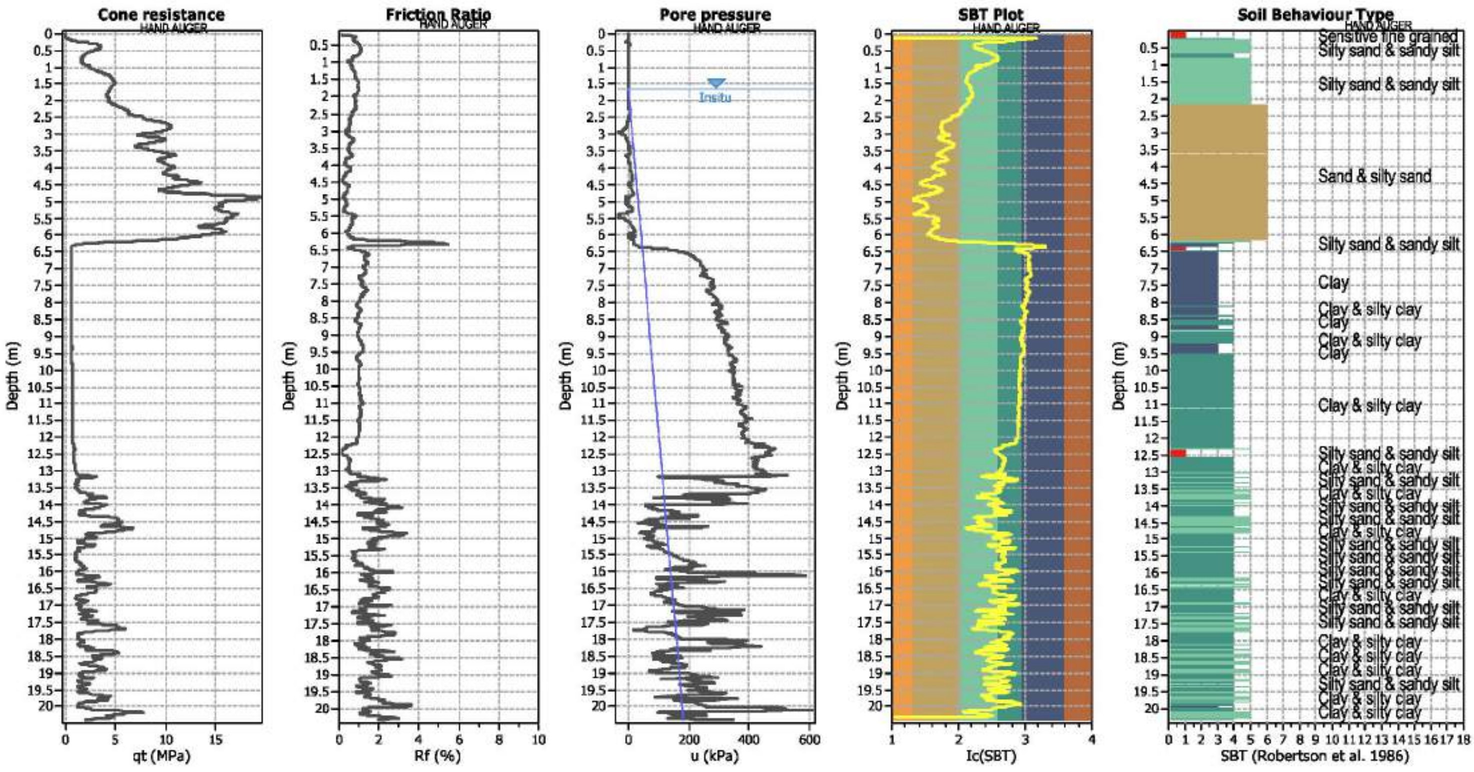
CPT basic interpretation plots



Input parameters and analysis data

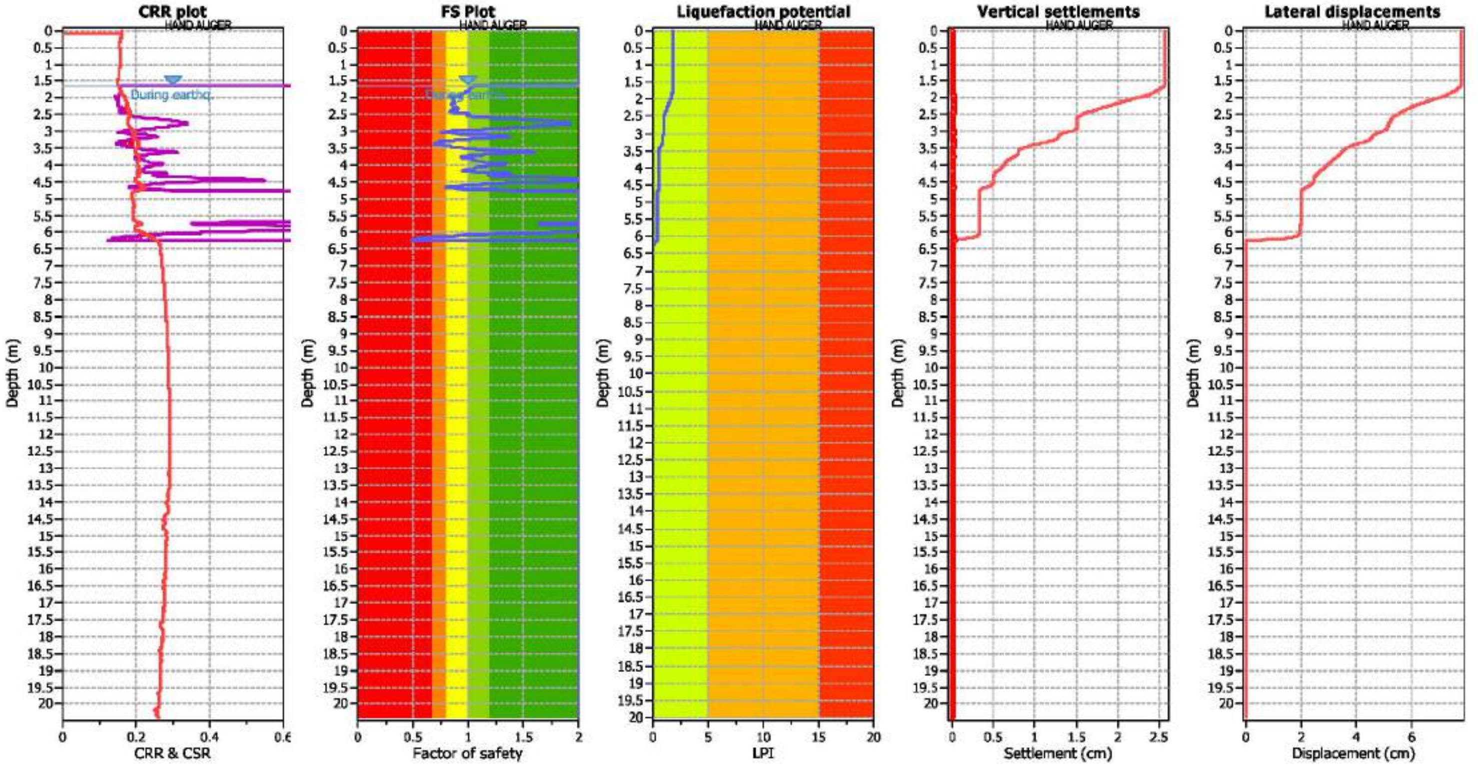
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

CPT name: ILS- CPT05 (10m)

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 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:	6.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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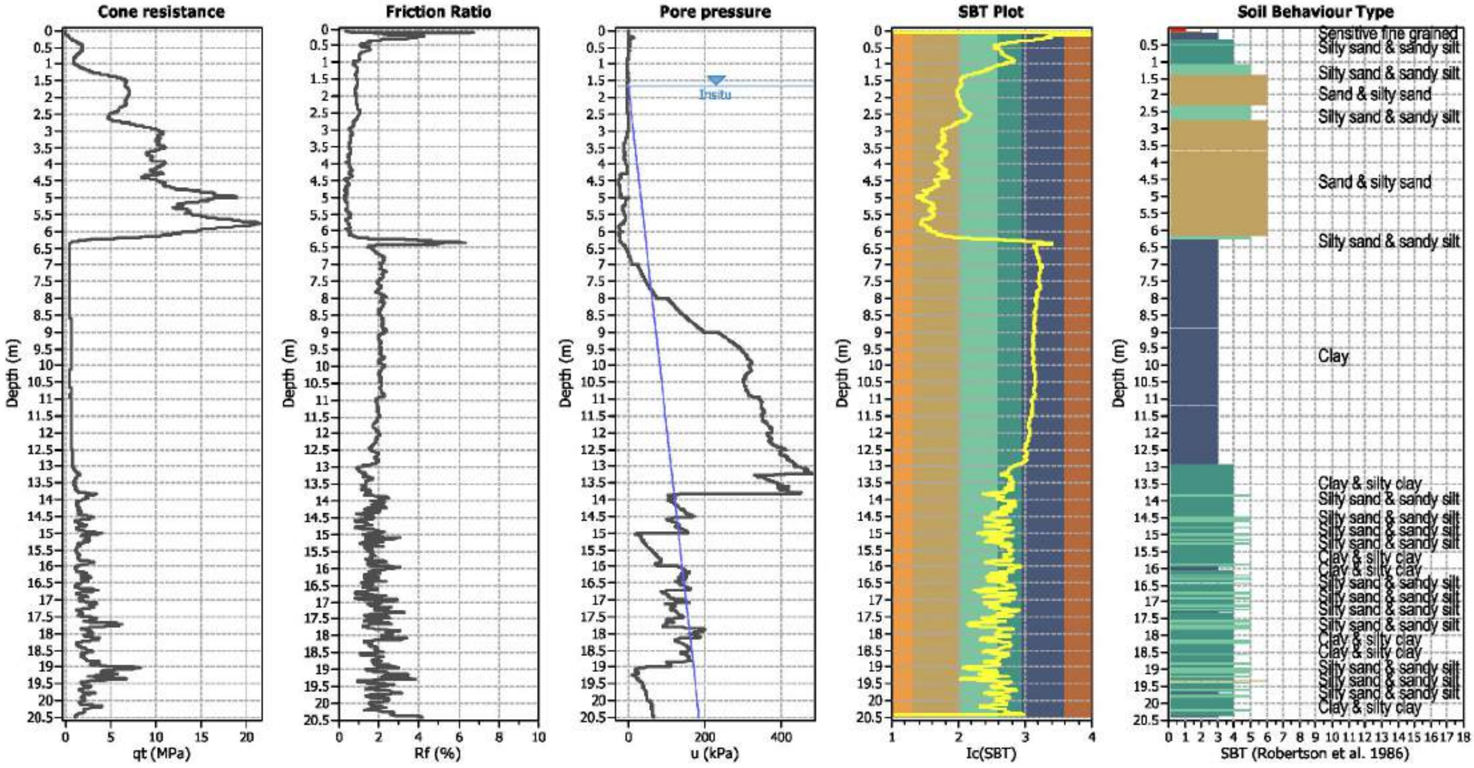
CPT basic interpretation plots



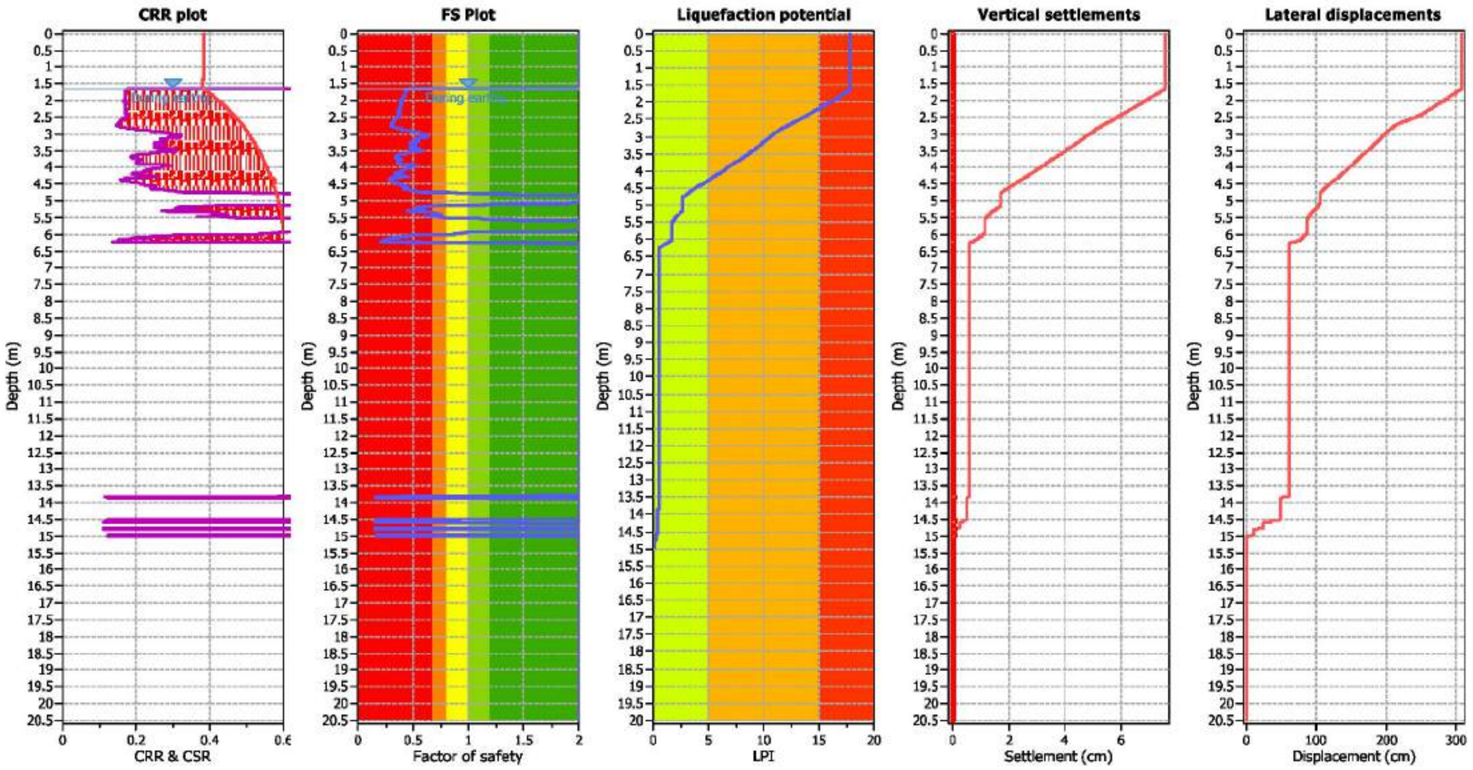
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_{σ} applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

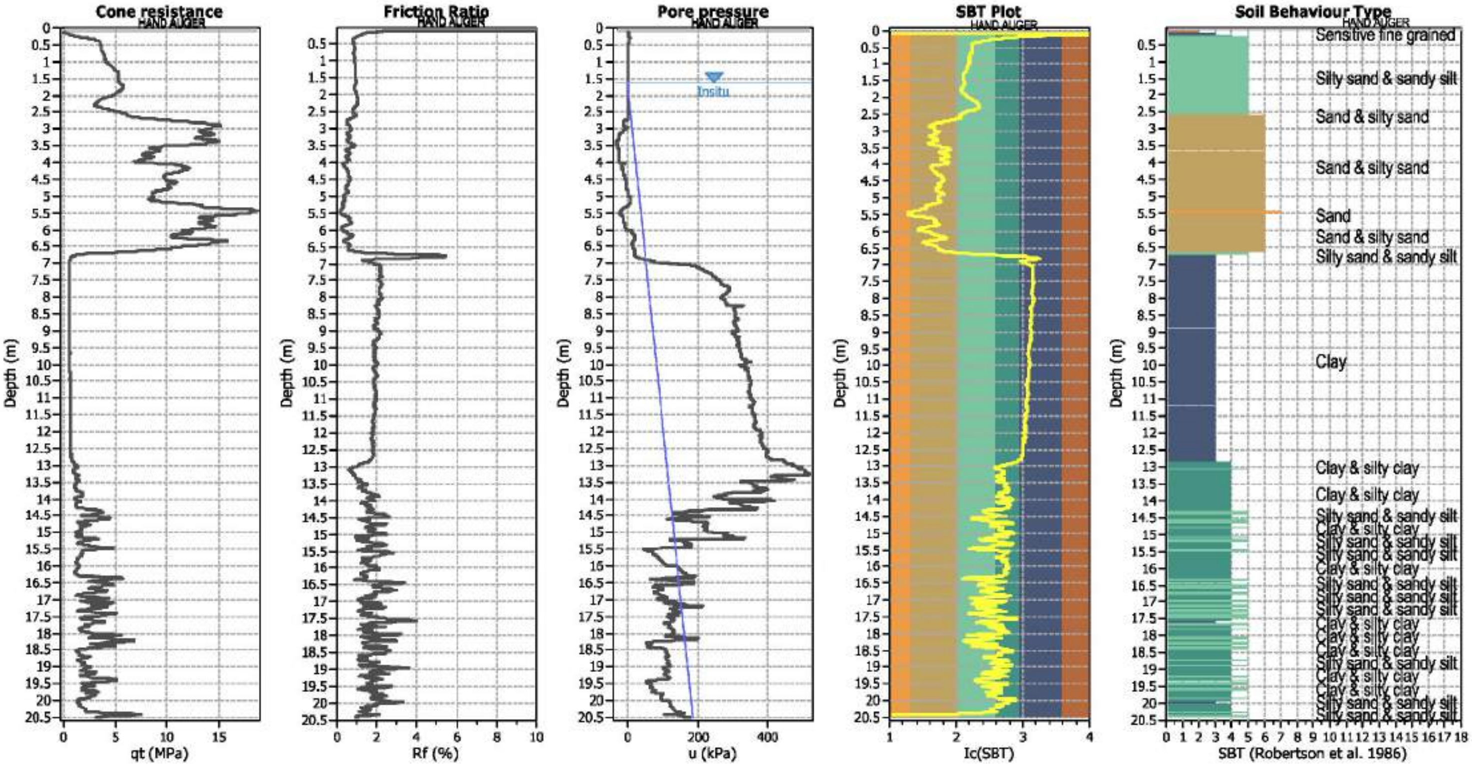
F.S. color scheme

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

LPI color scheme

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

CPT basic interpretation plots



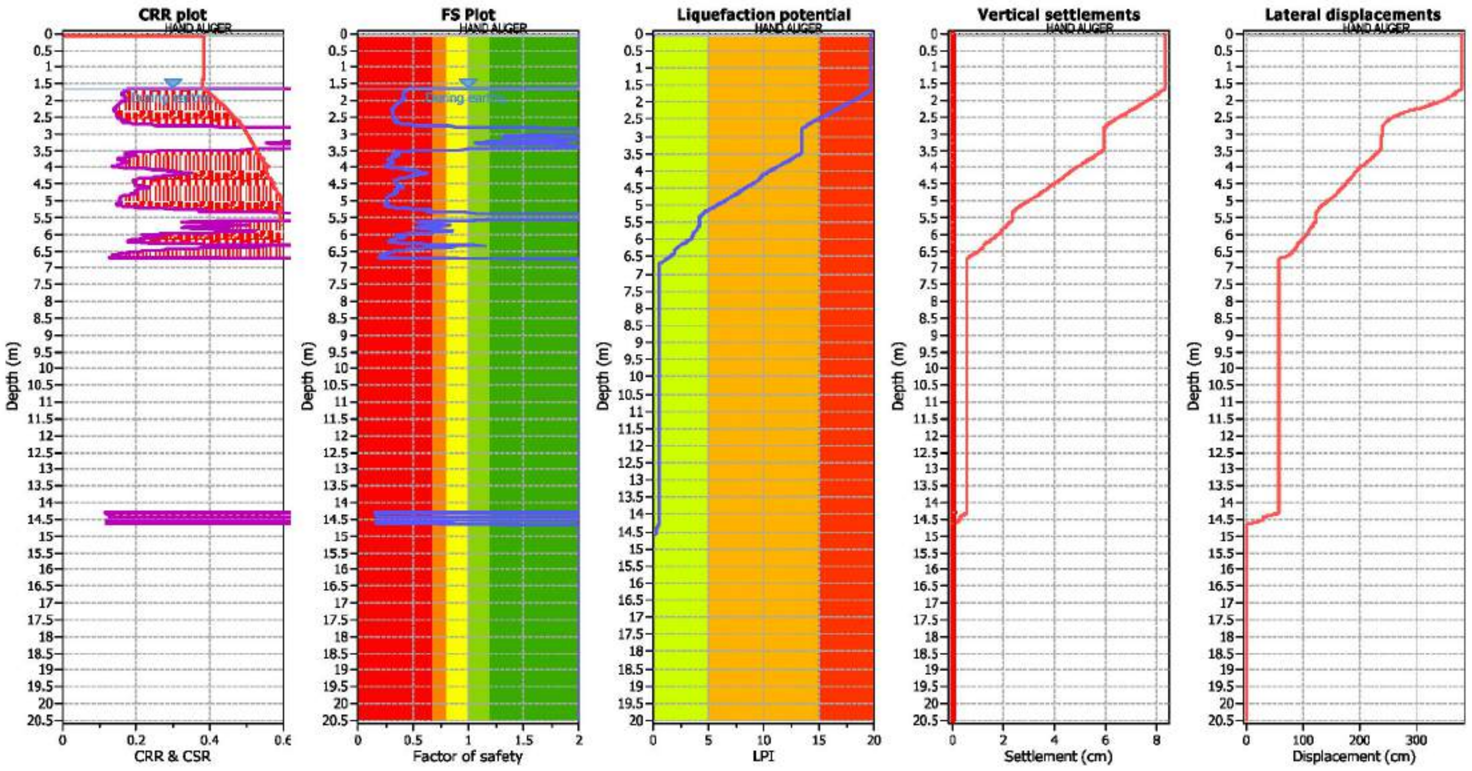
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

F.S. color scheme

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LPI color scheme

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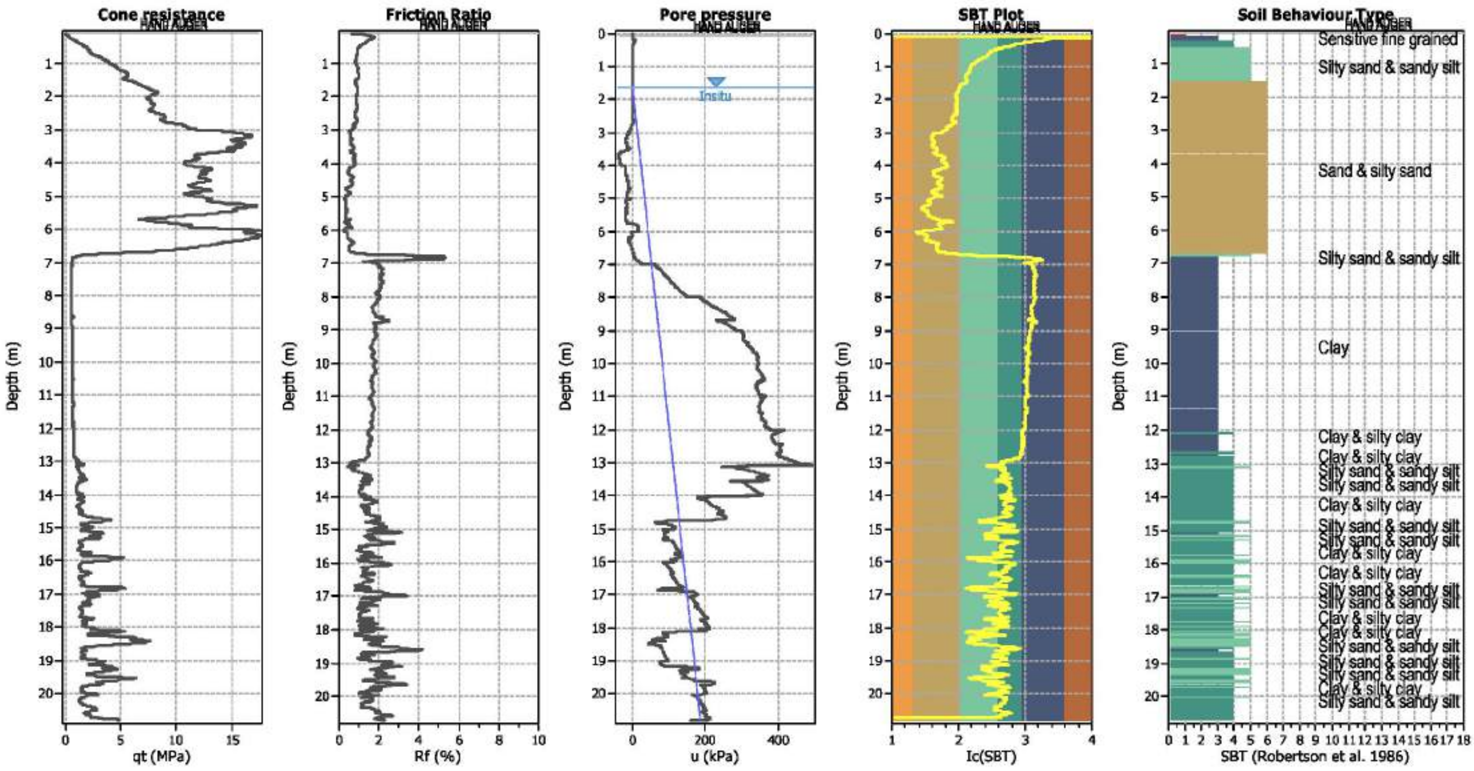
CPT basic interpretation plots



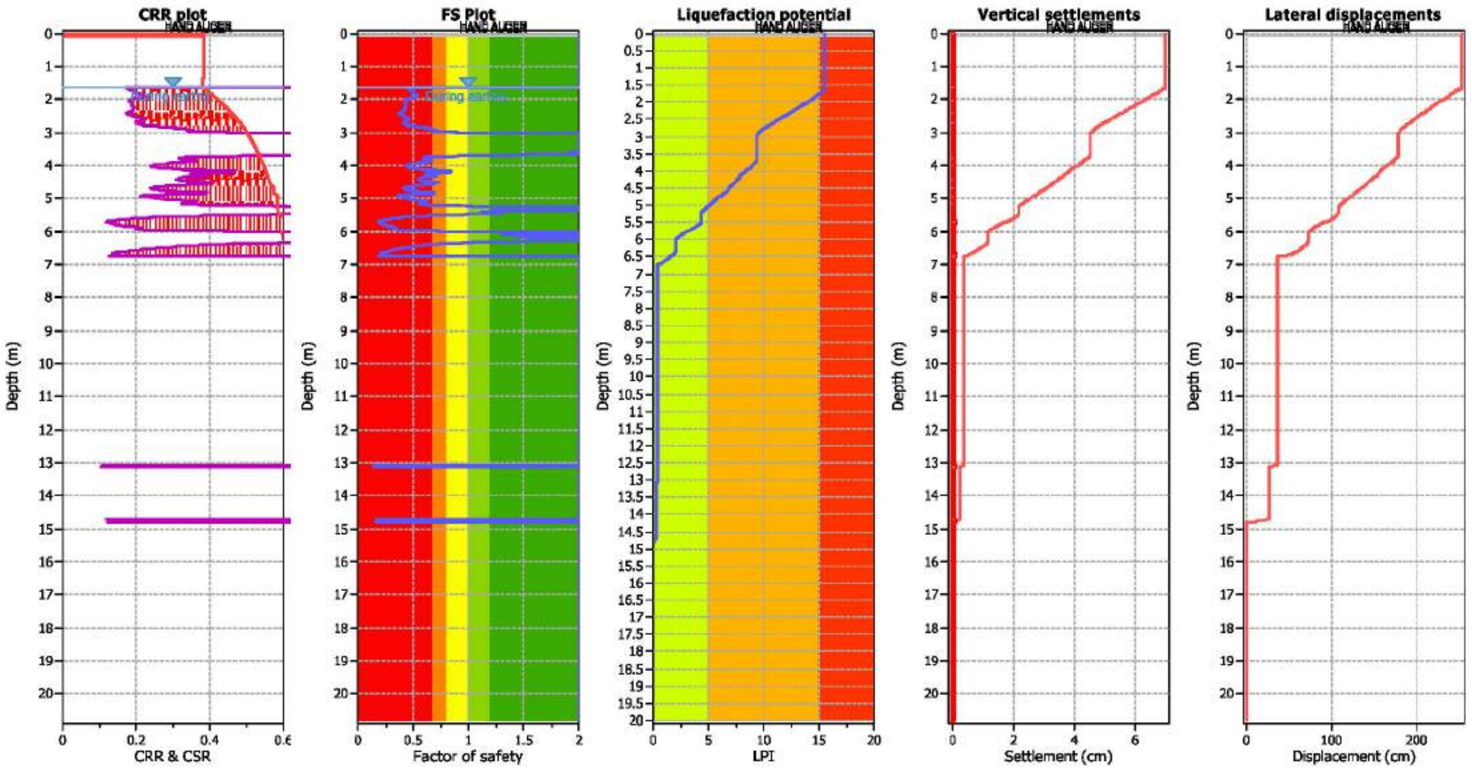
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.65
Depth to water table (insitu): 1.65 m

Depth to GWT (erthq.): 1.65 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 15.00 m

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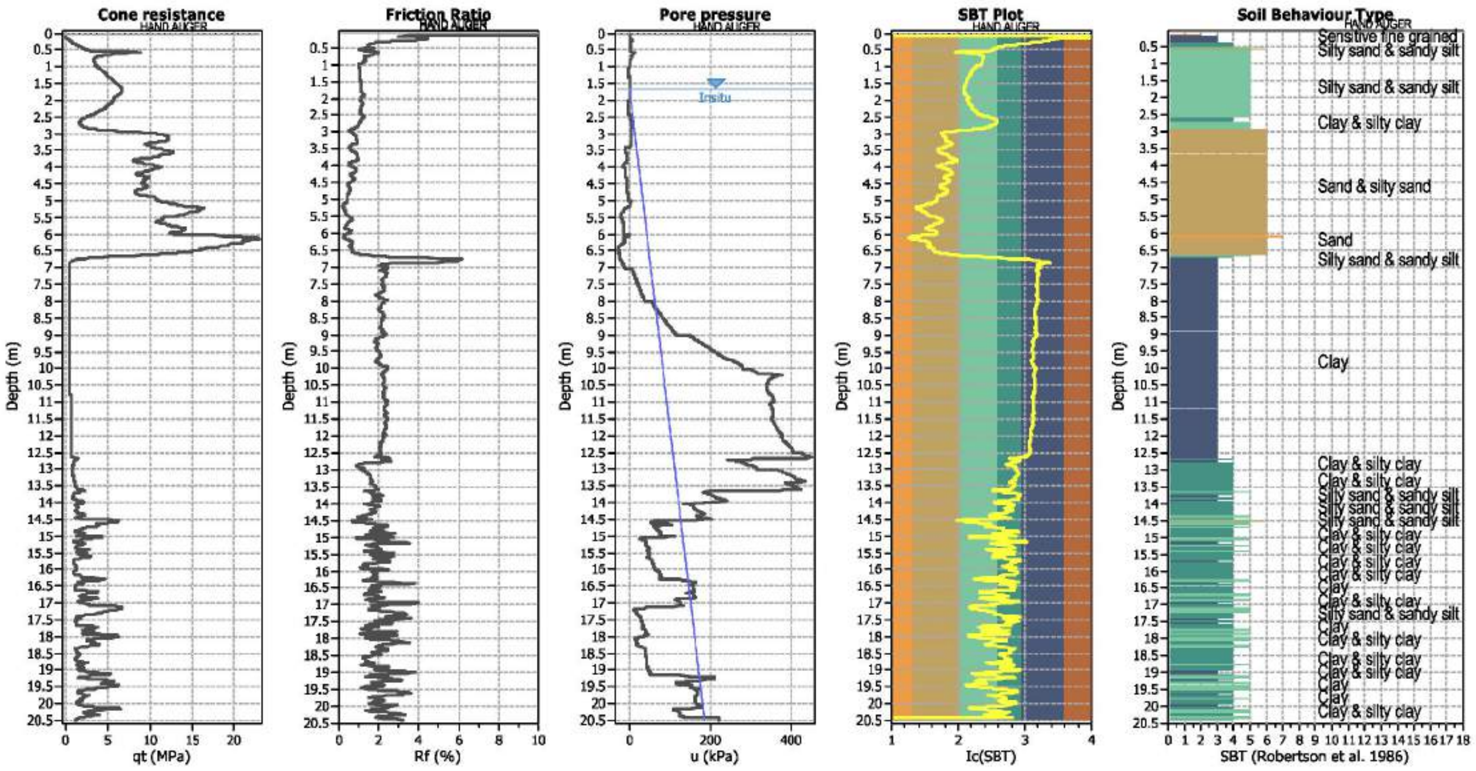
CPT basic interpretation plots



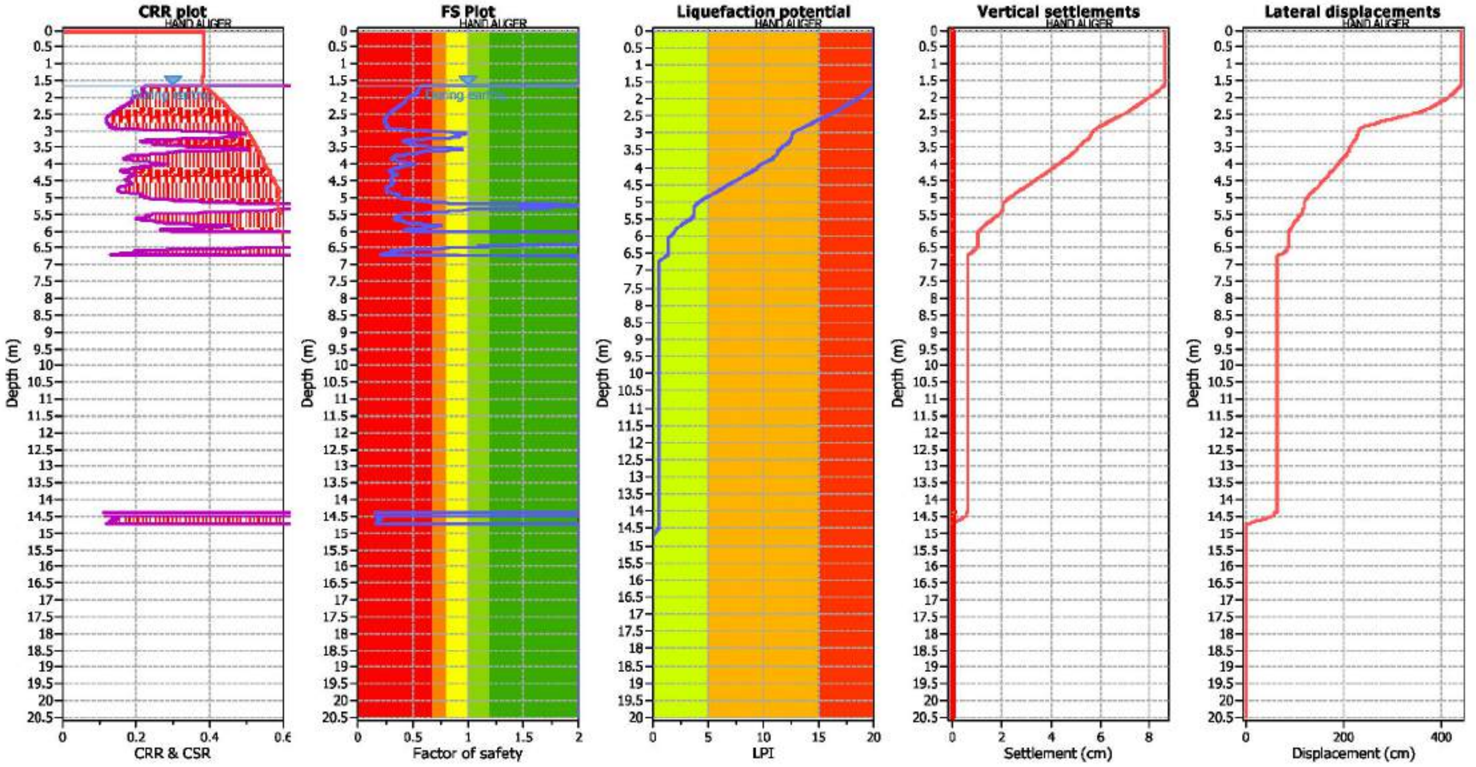
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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LPI color scheme

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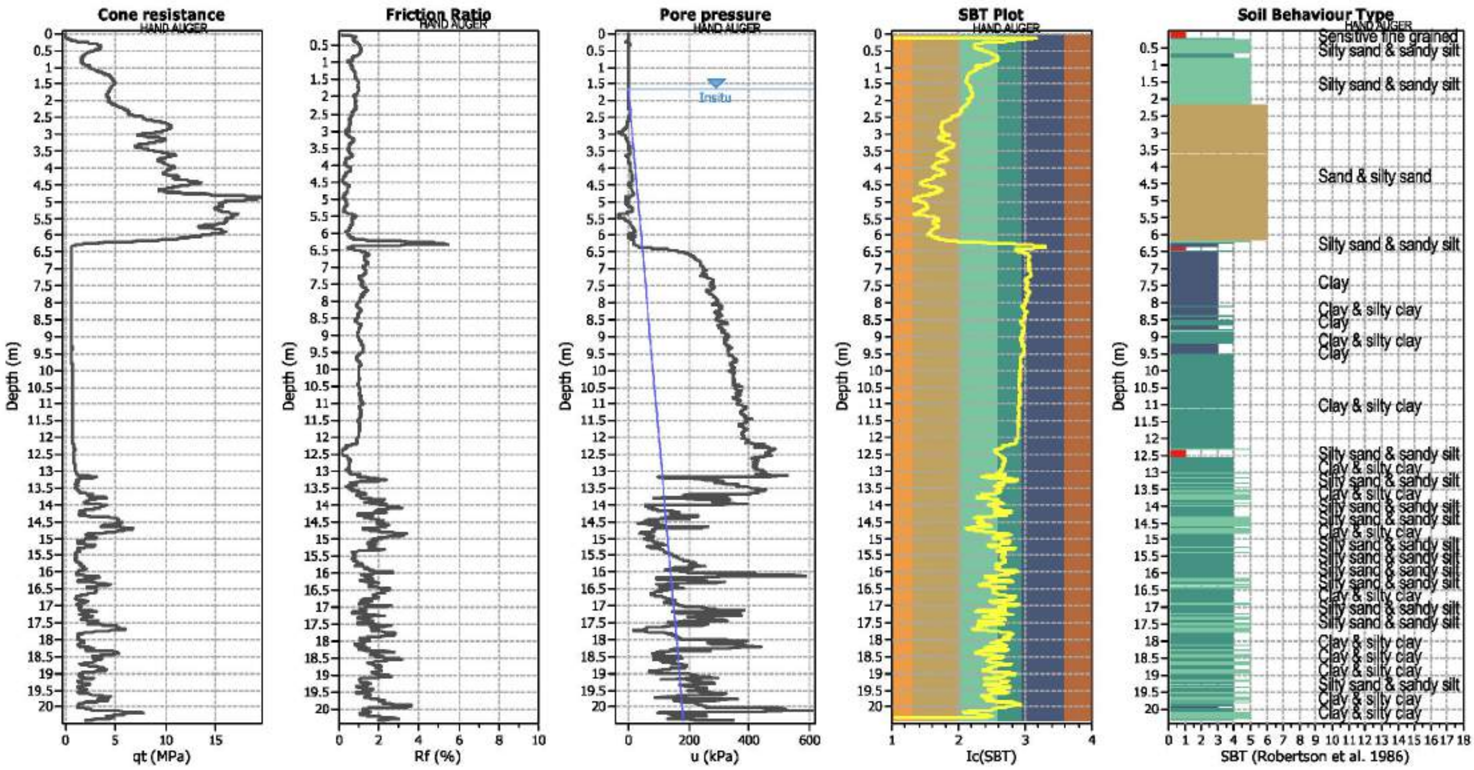
CPT basic interpretation plots



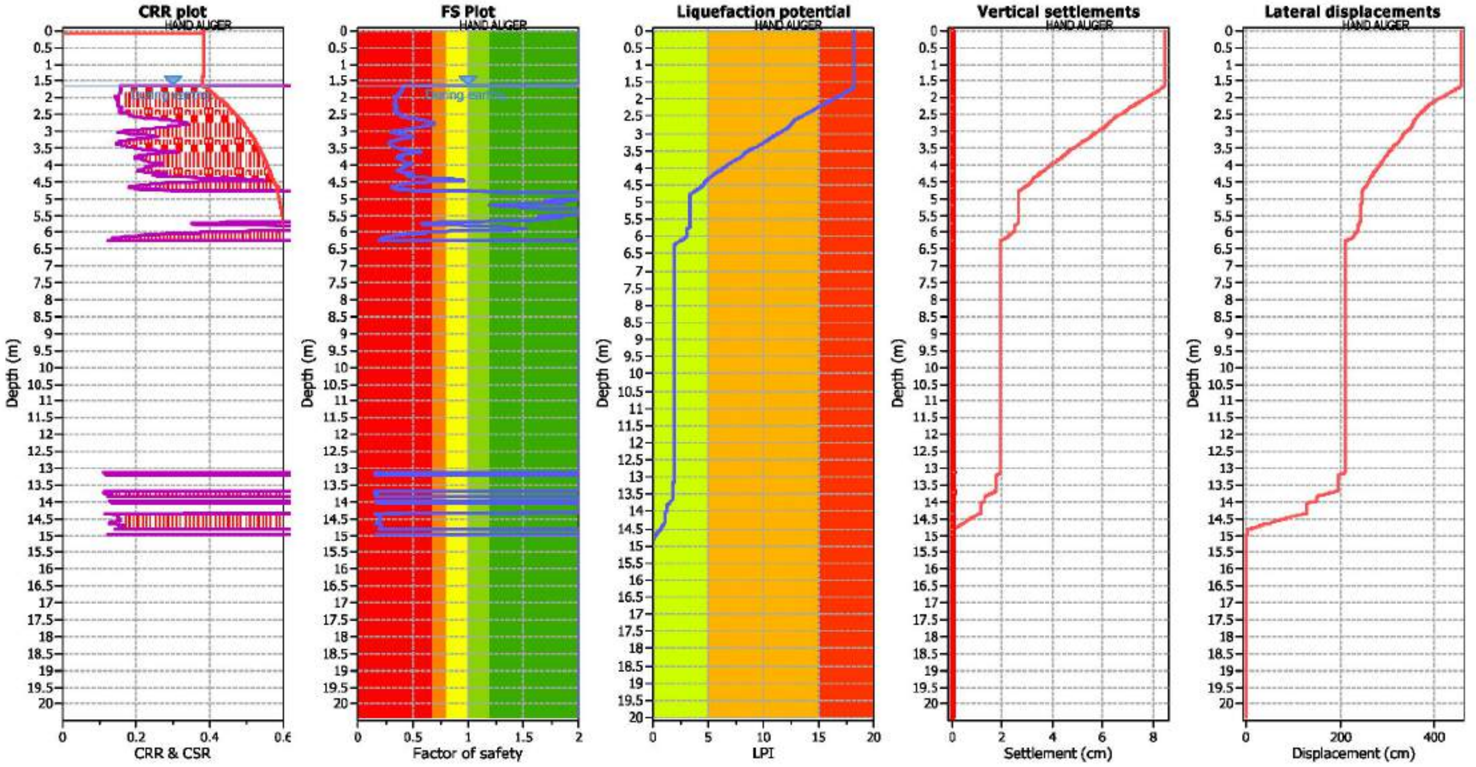
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
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LPI color scheme

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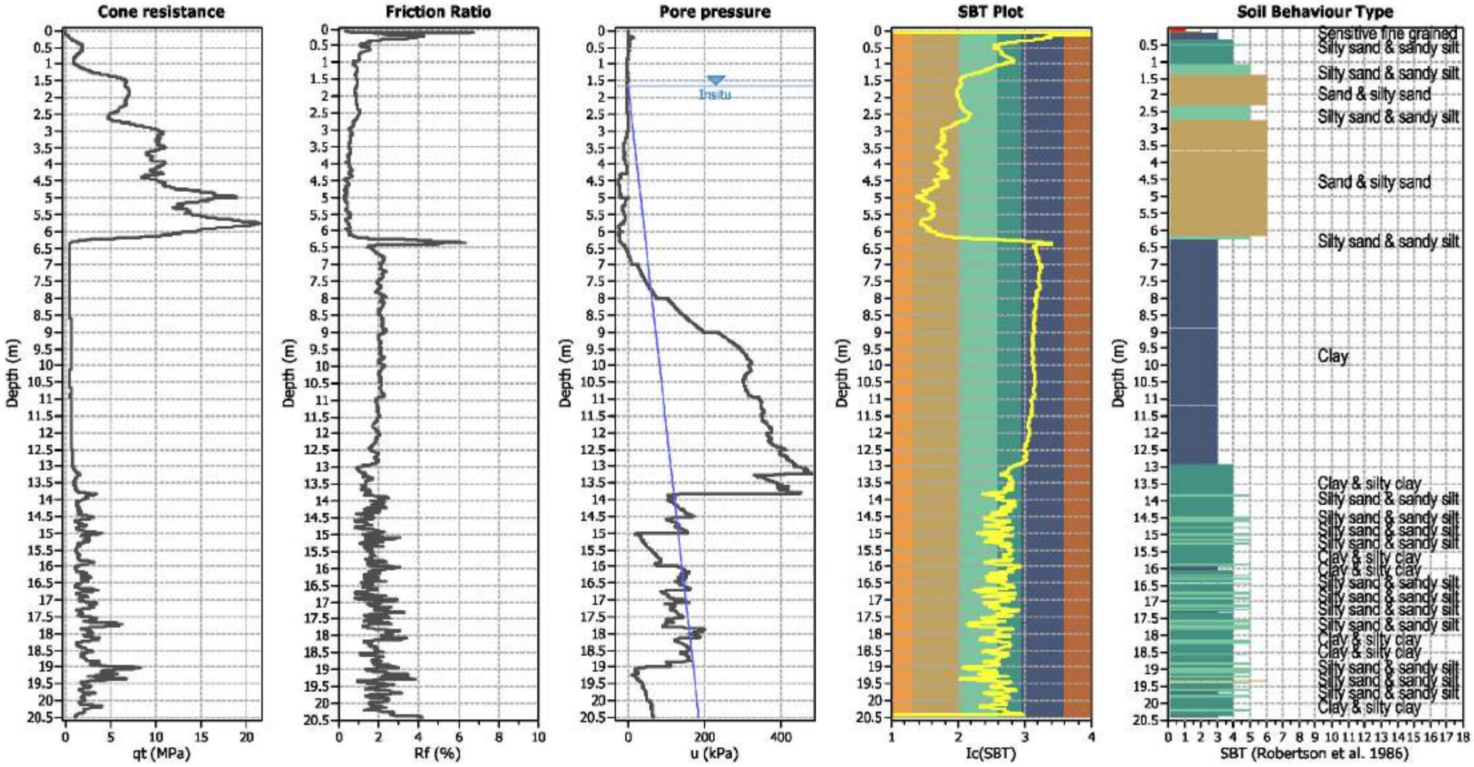
CPT basic interpretation plots



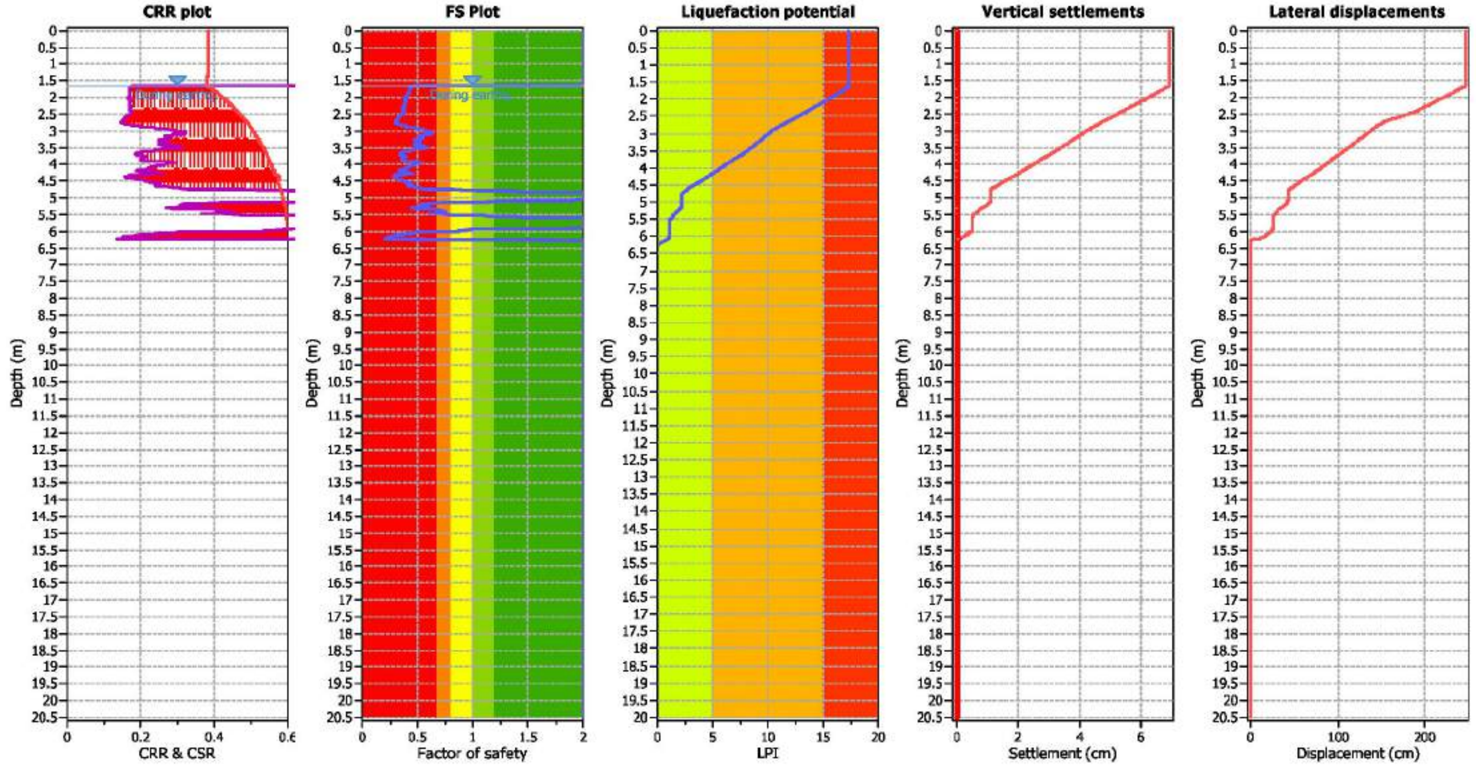
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
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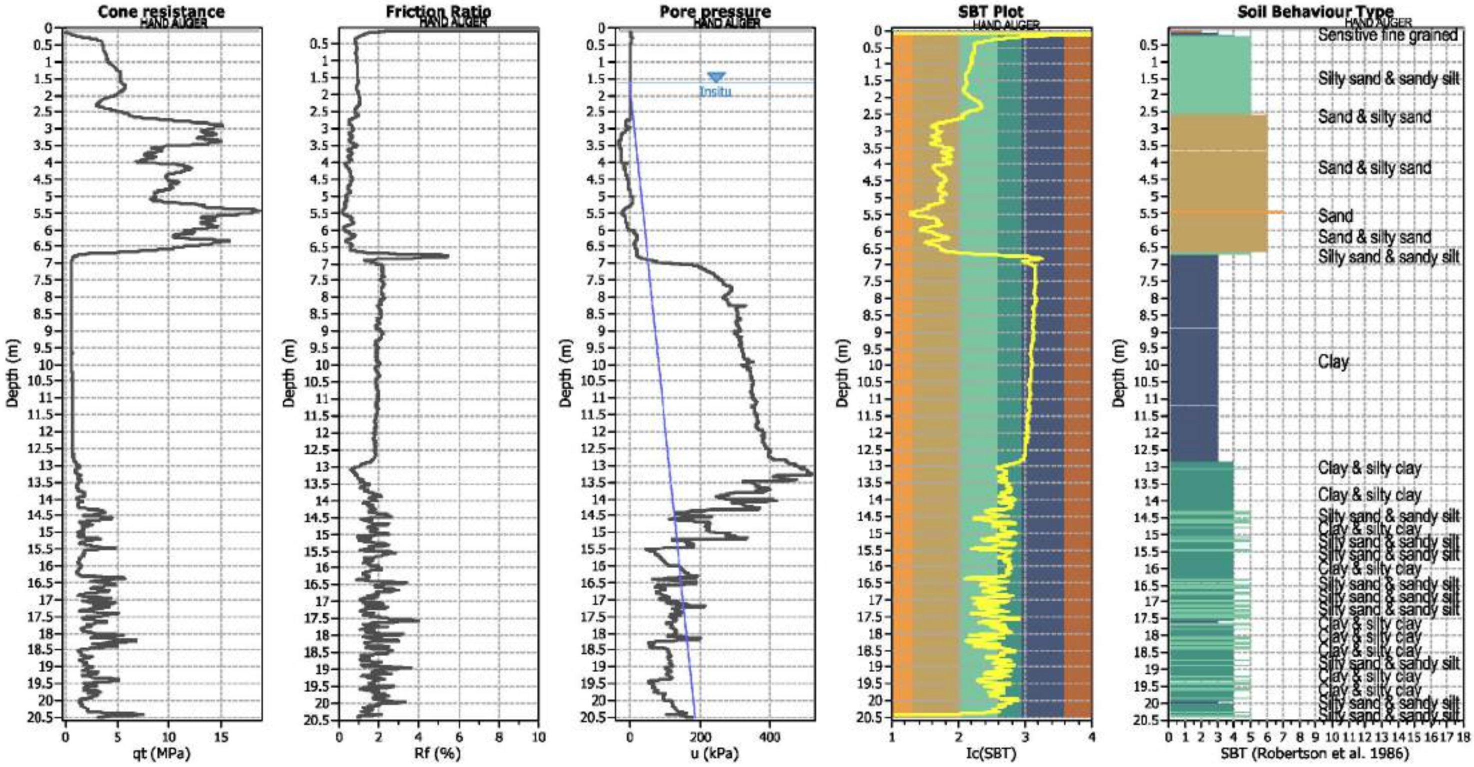
CPT basic interpretation plots



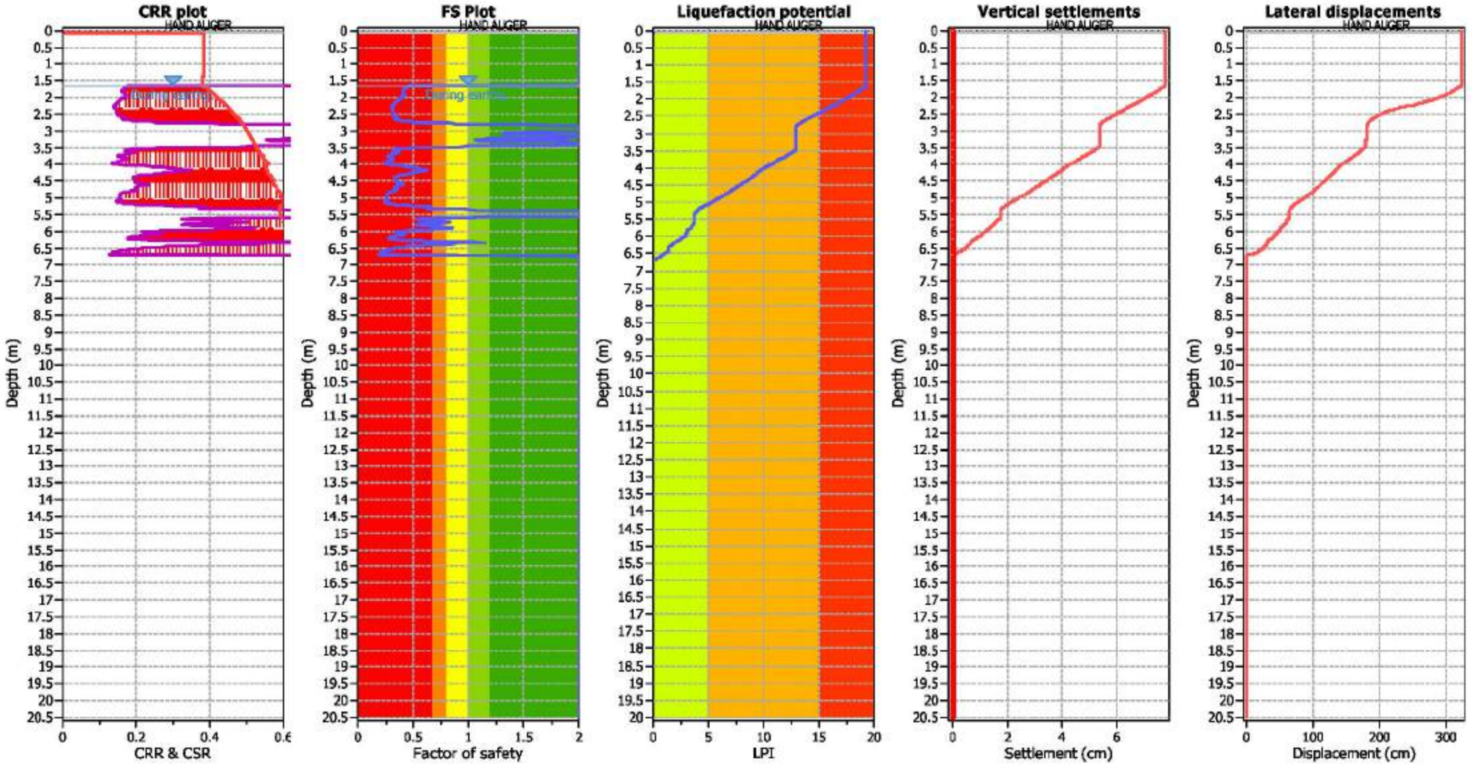
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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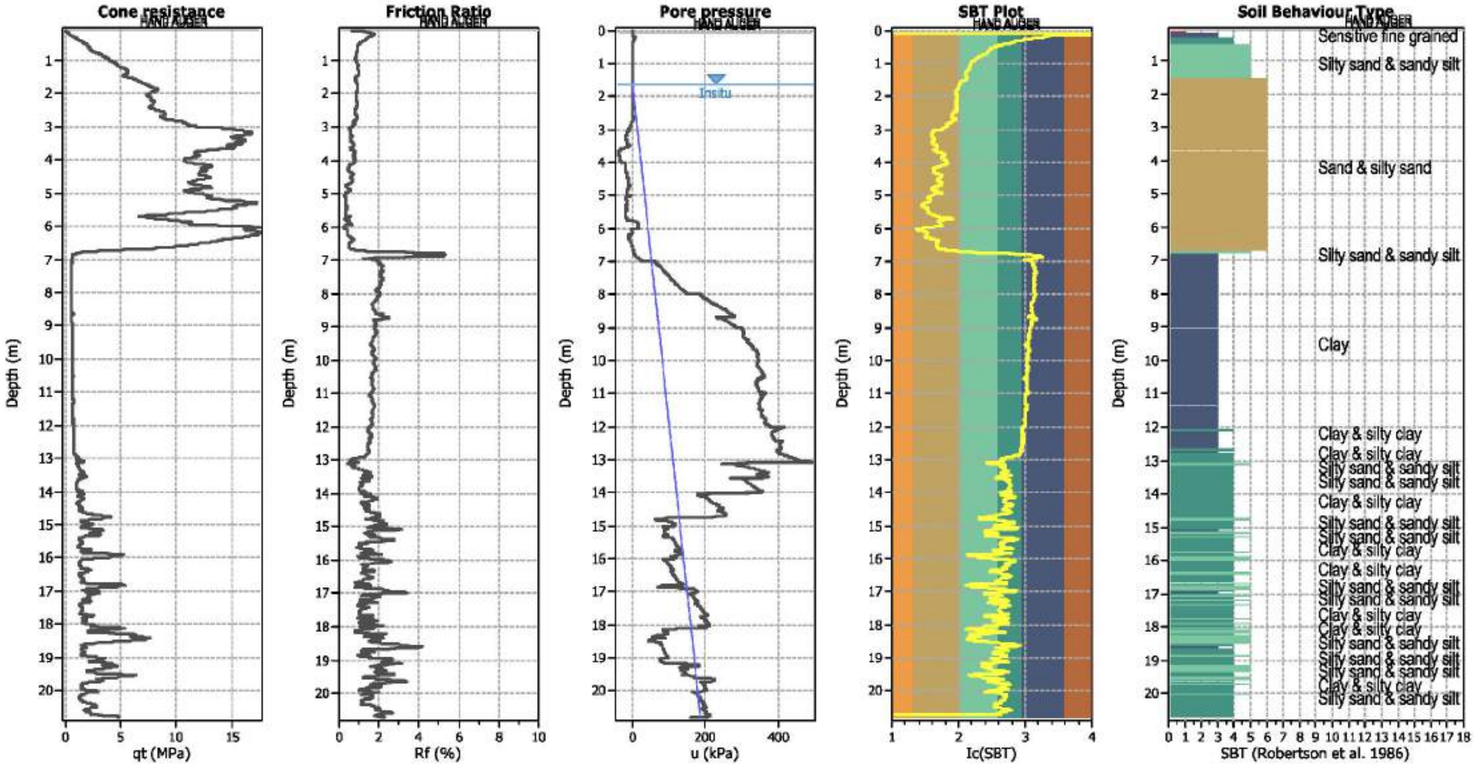
CPT basic interpretation plots



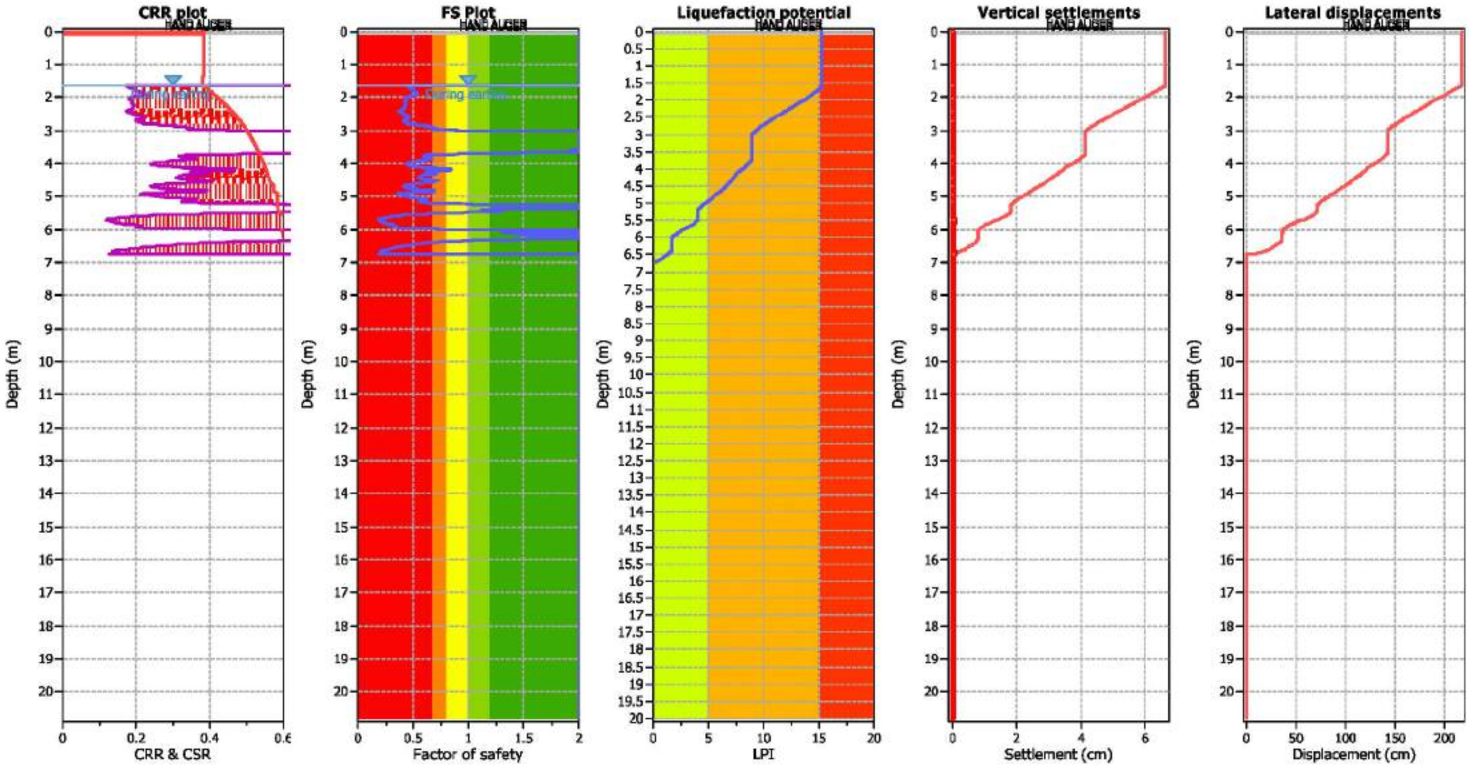
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	7.50
Peak ground acceleration:	0.65
Depth to water table (insitu):	1.65 m
Depth to GWT (erthq.):	1.65 m
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT
Use fill:	No
Fill height:	N/A
Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	Yes
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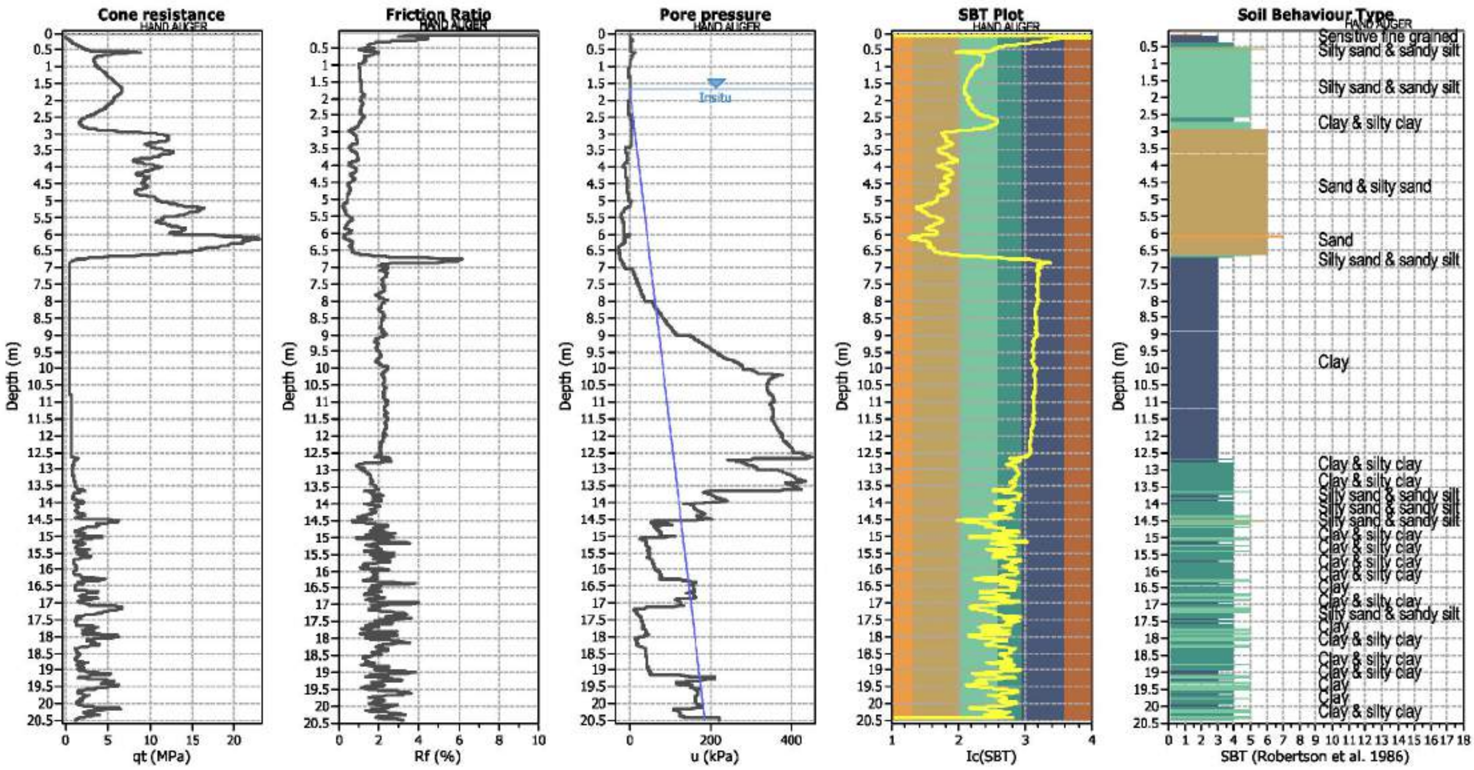
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

🟥	1. Sensitive fine grained	🟩	4. Clayey silt to silty	🟧	7. Gravely sand to sand
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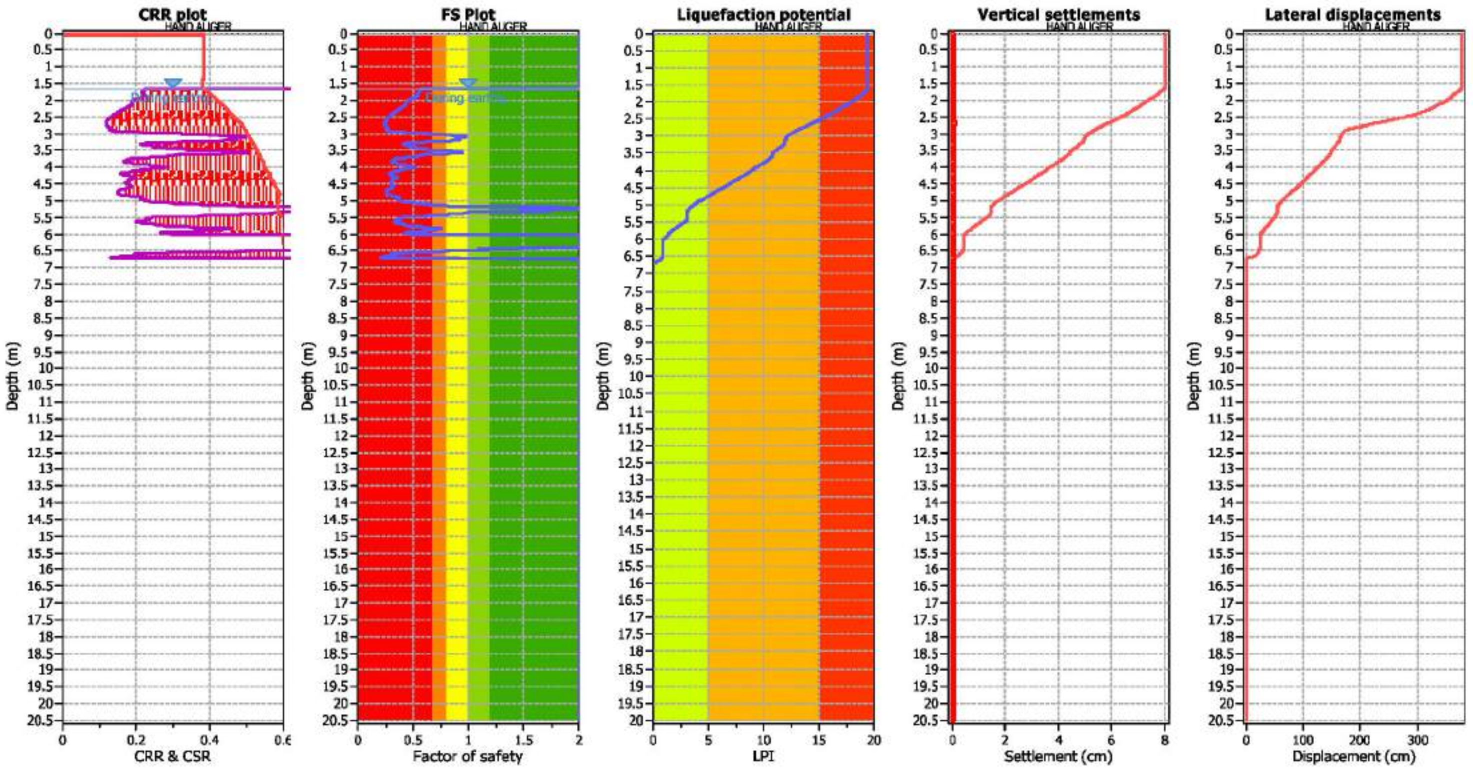
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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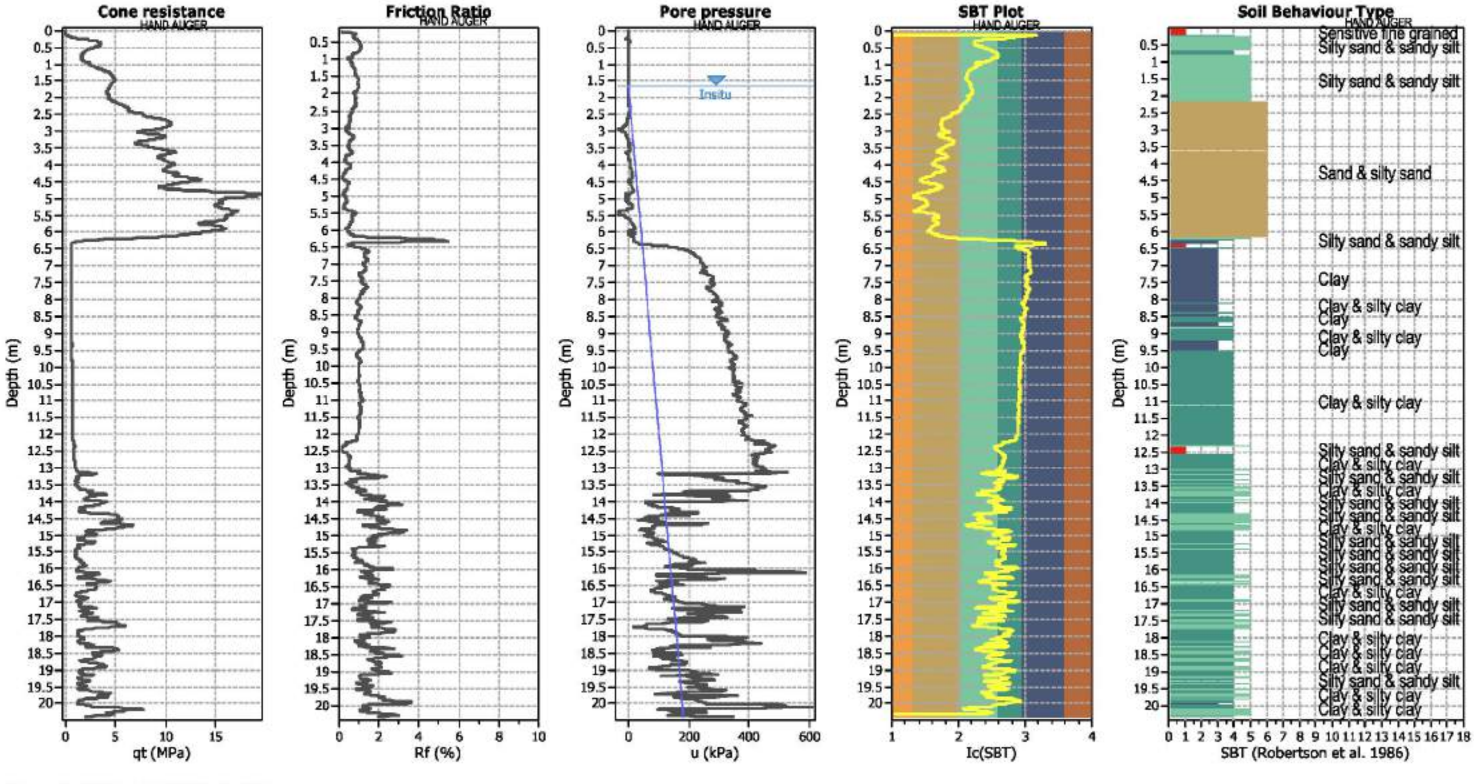
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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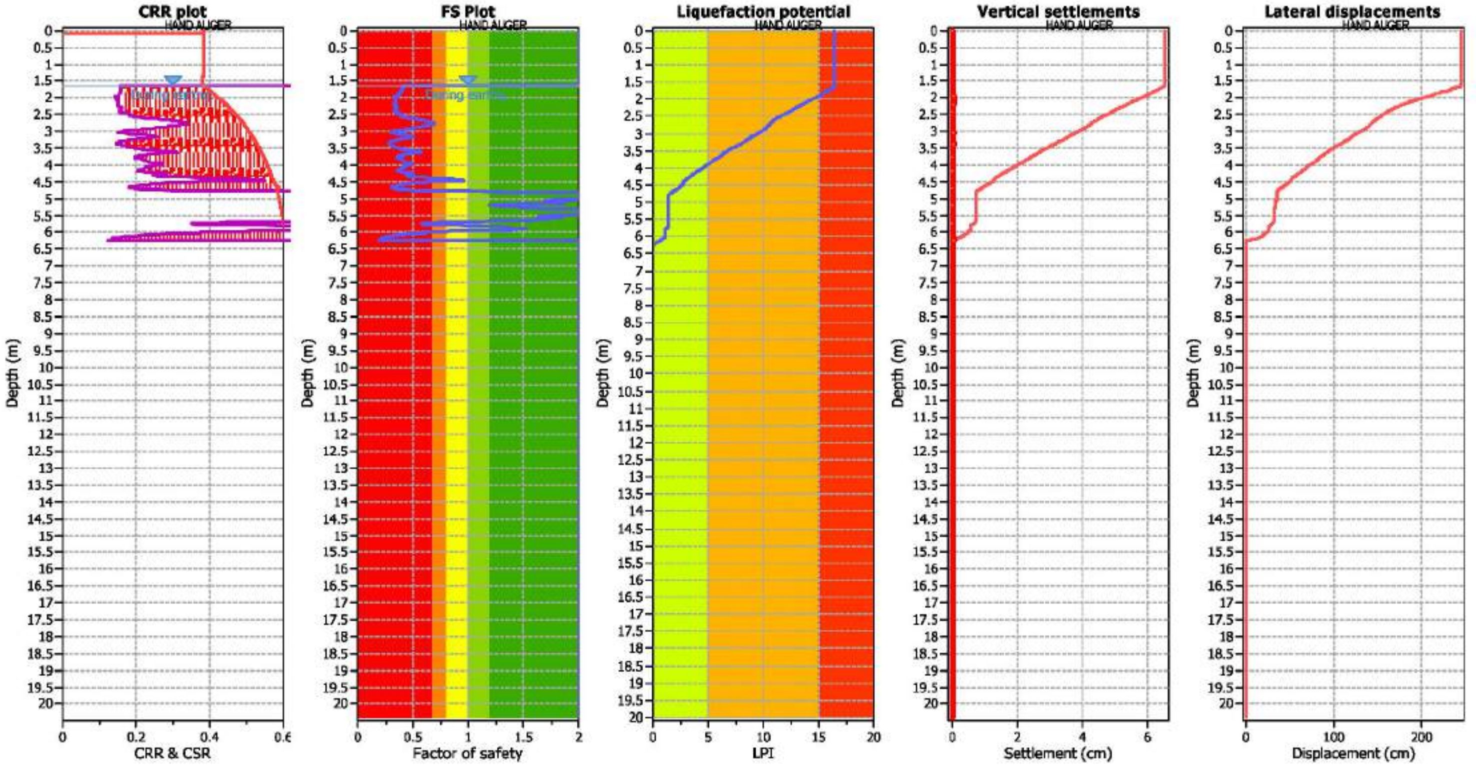
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
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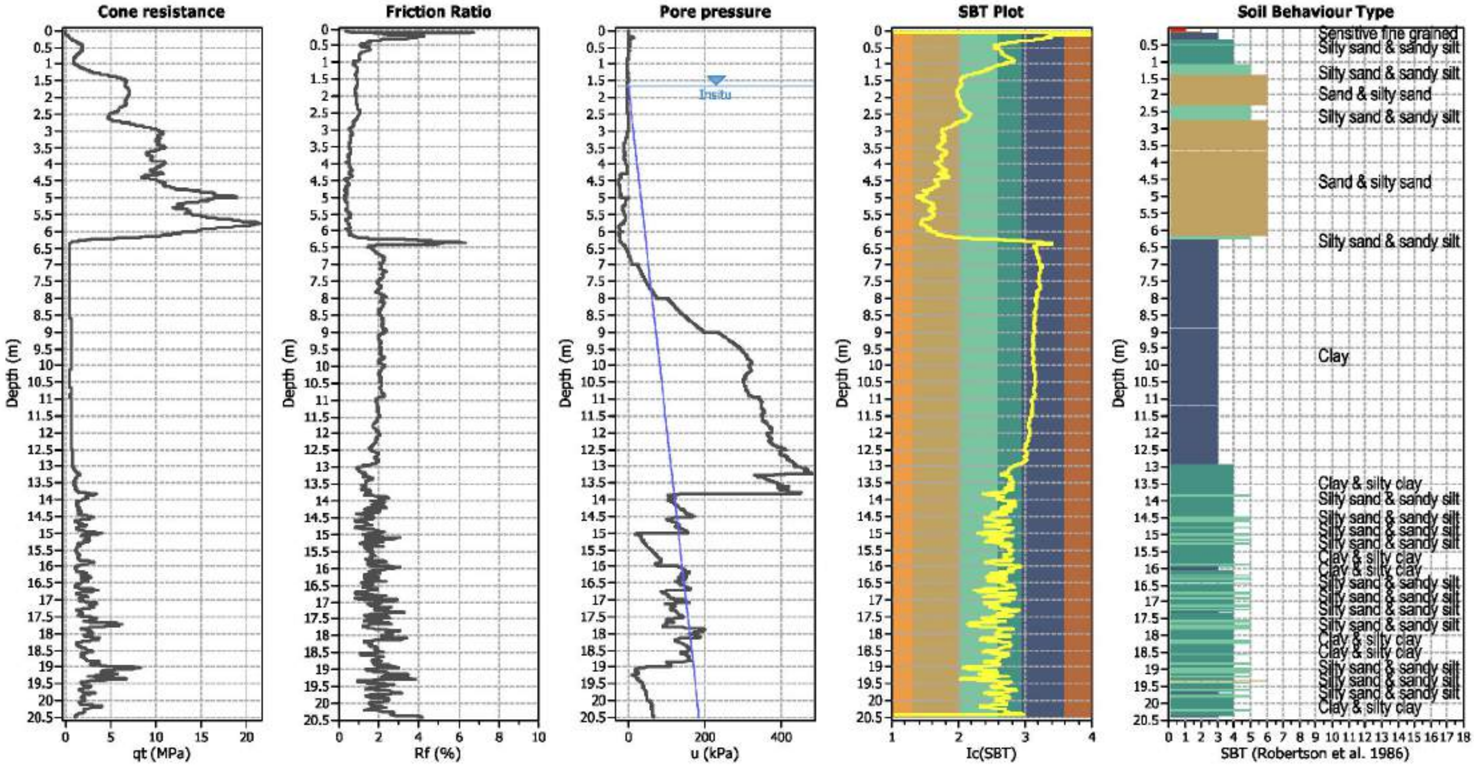


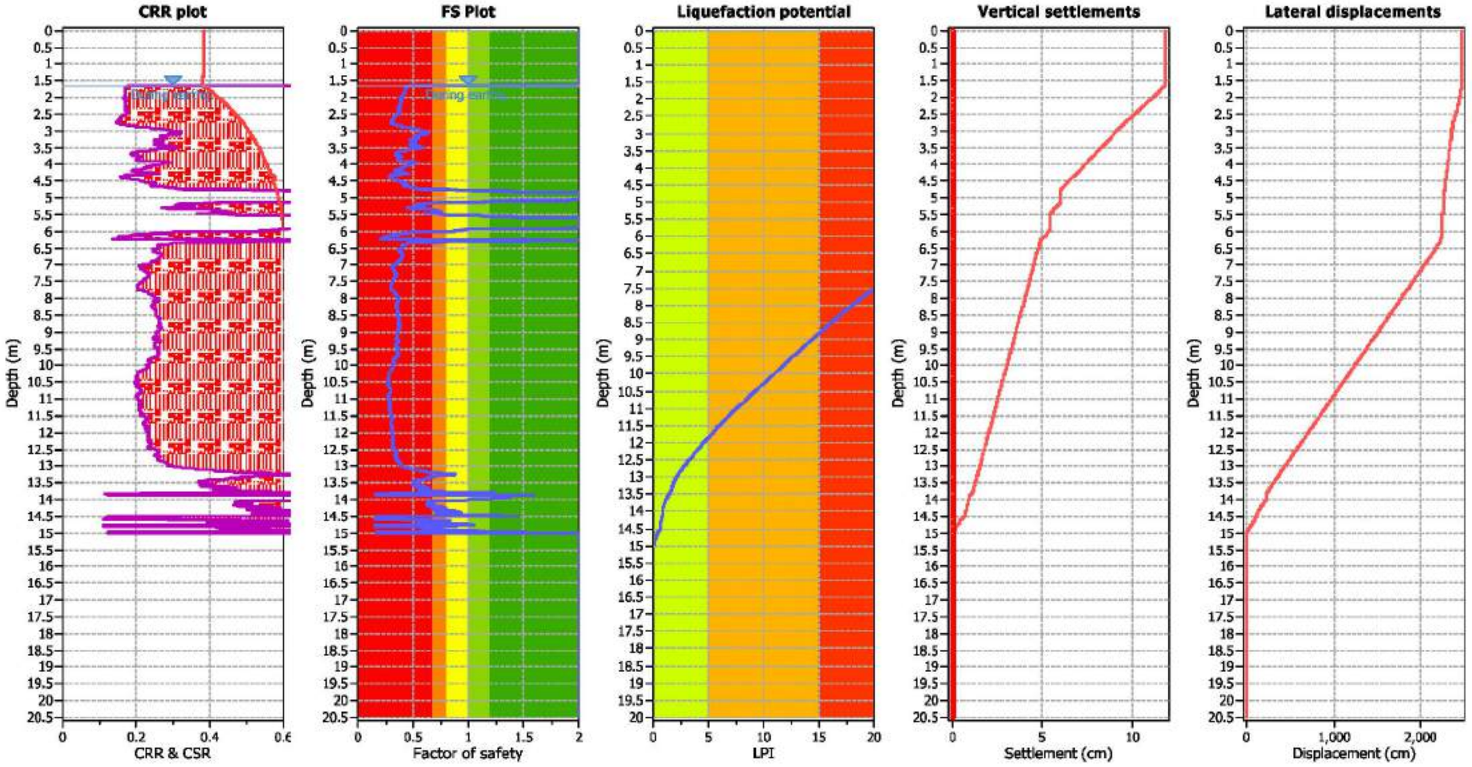
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.65 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.65 m	Fill height:	N/A	Limit depth:	15.00 m

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

Liquefaction analysis overall plots



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F.S. color scheme

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LPI color scheme

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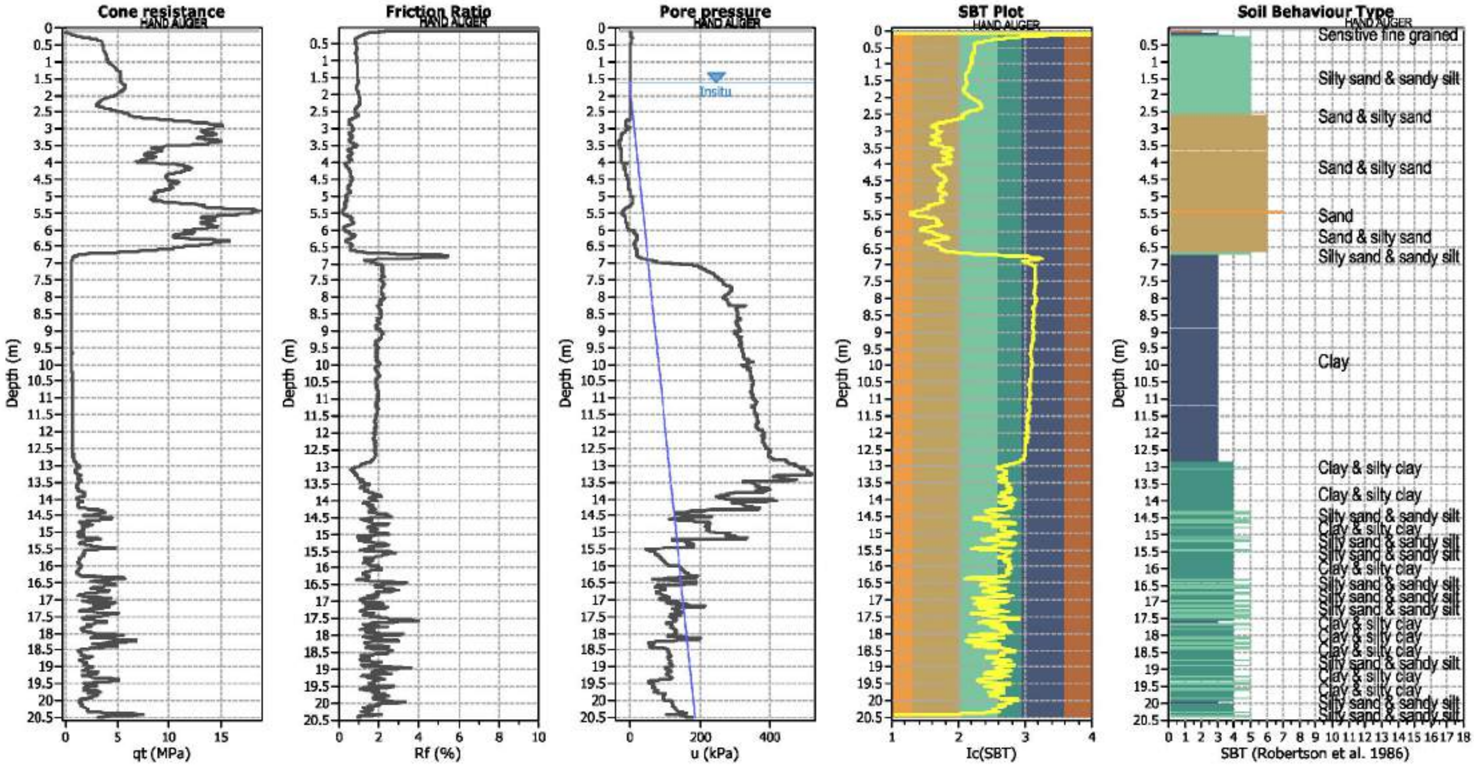
CPT basic interpretation plots



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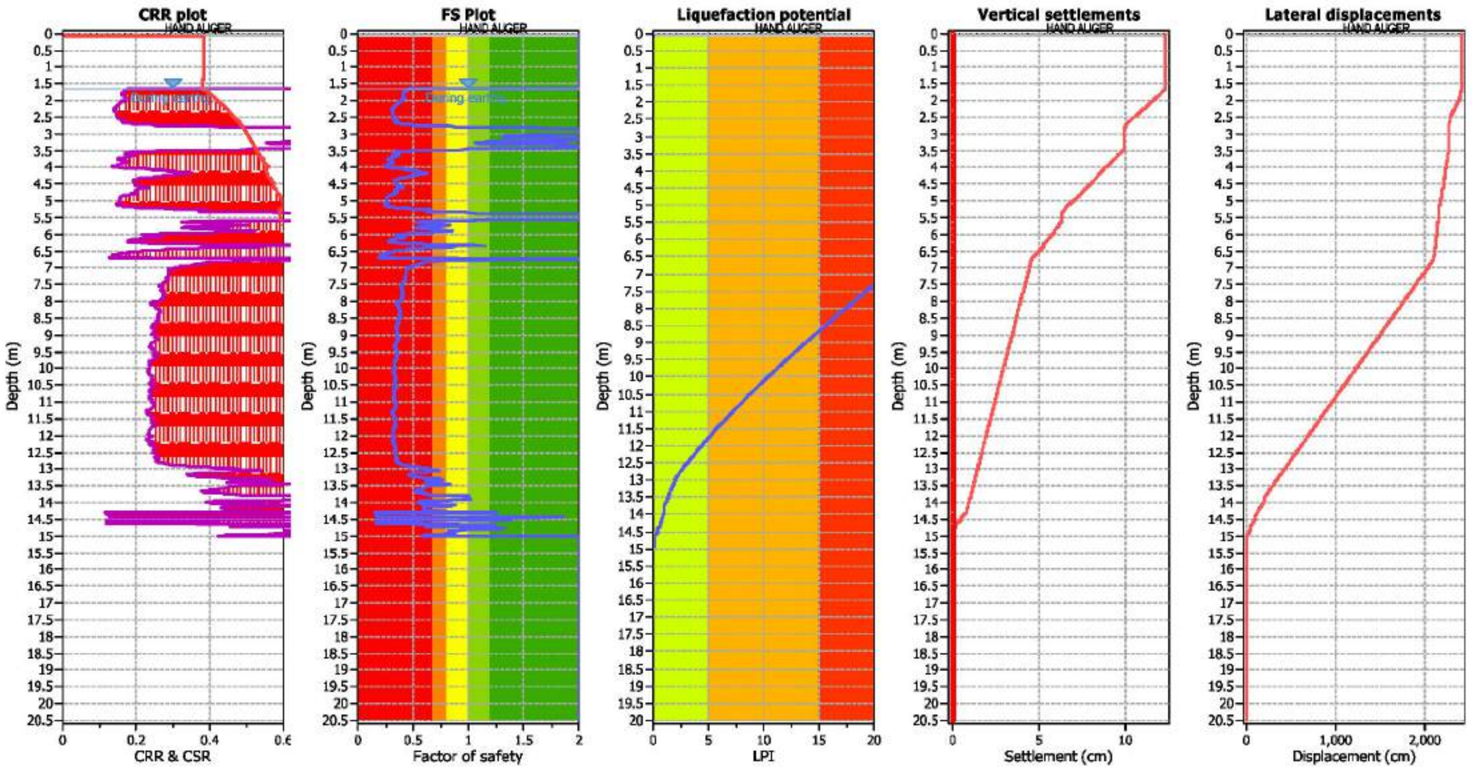
Liquefaction analysis overall plots



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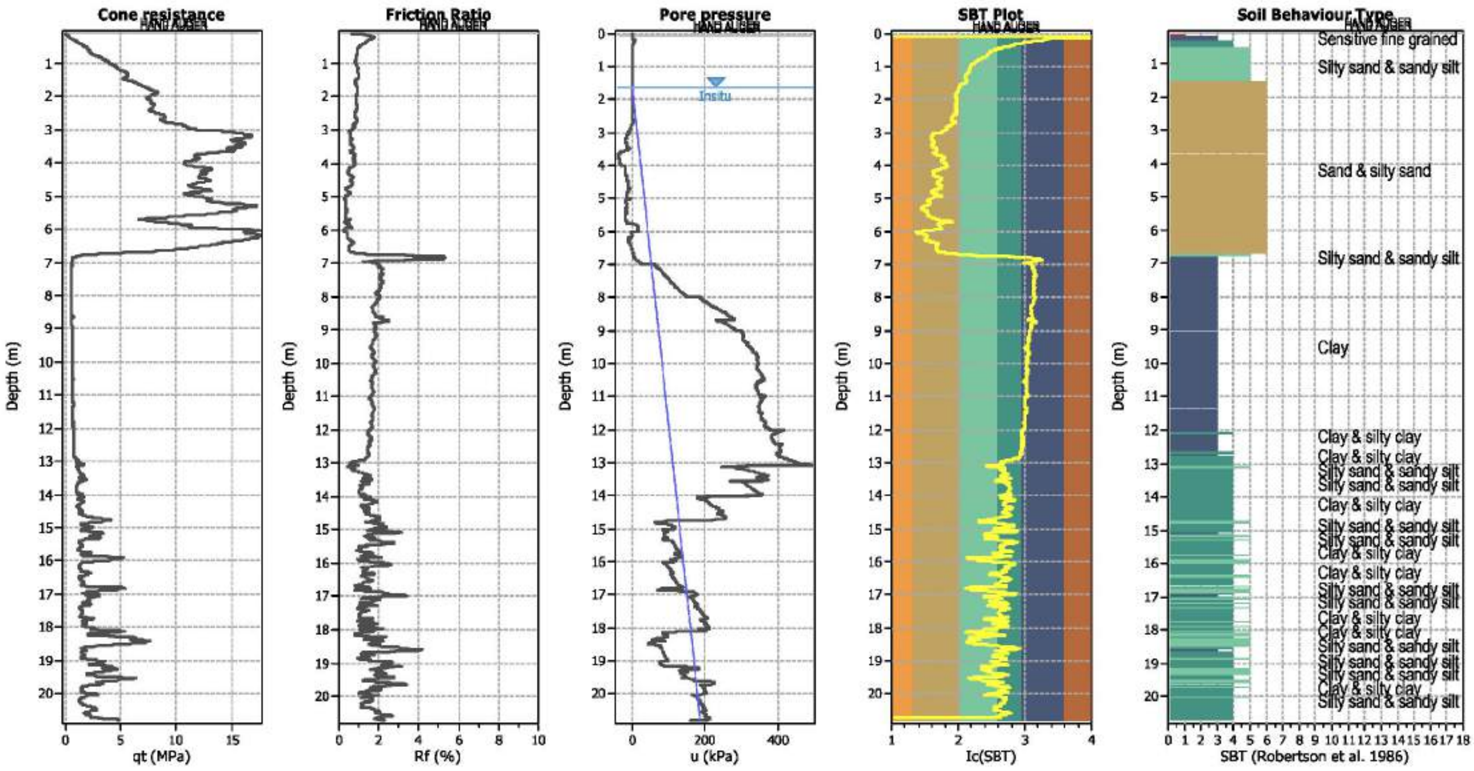

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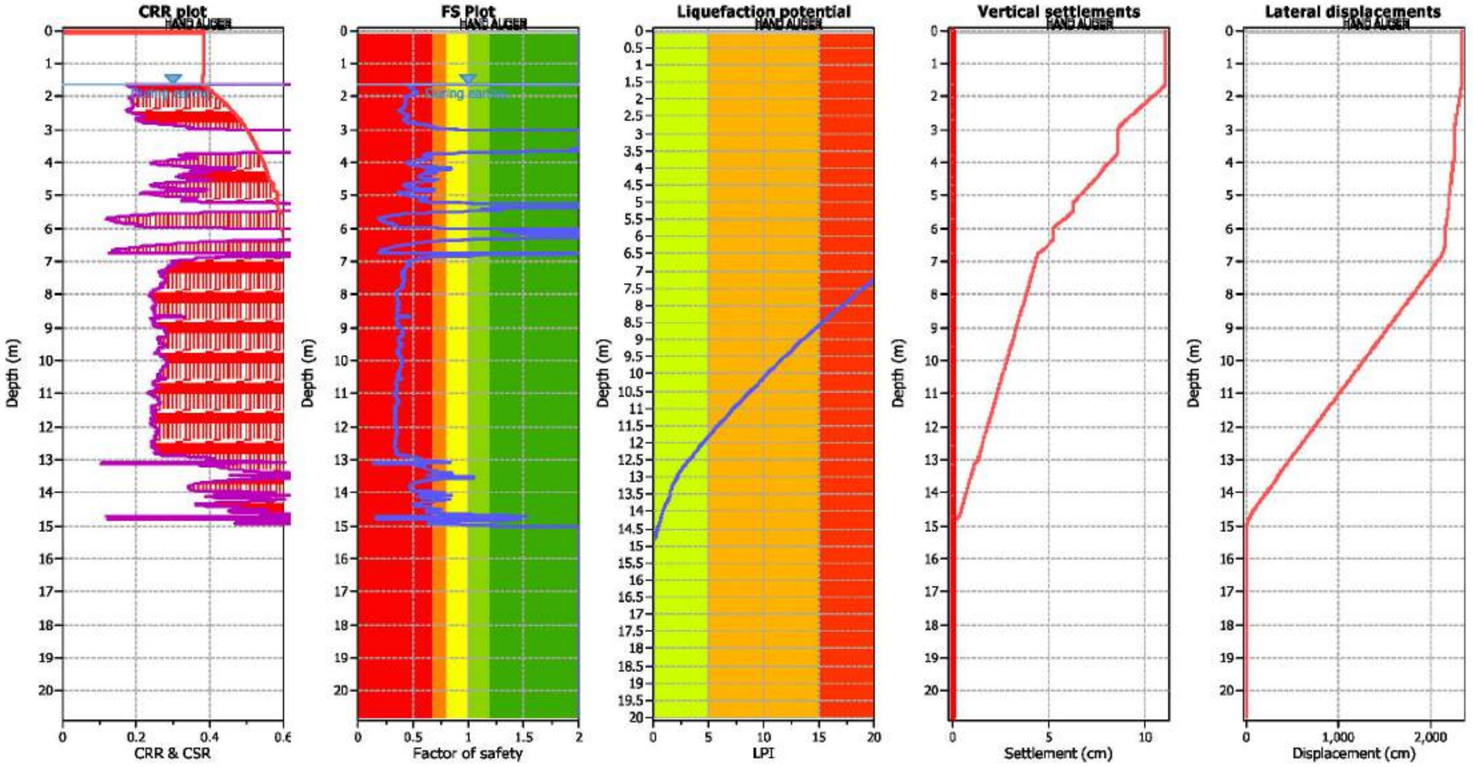

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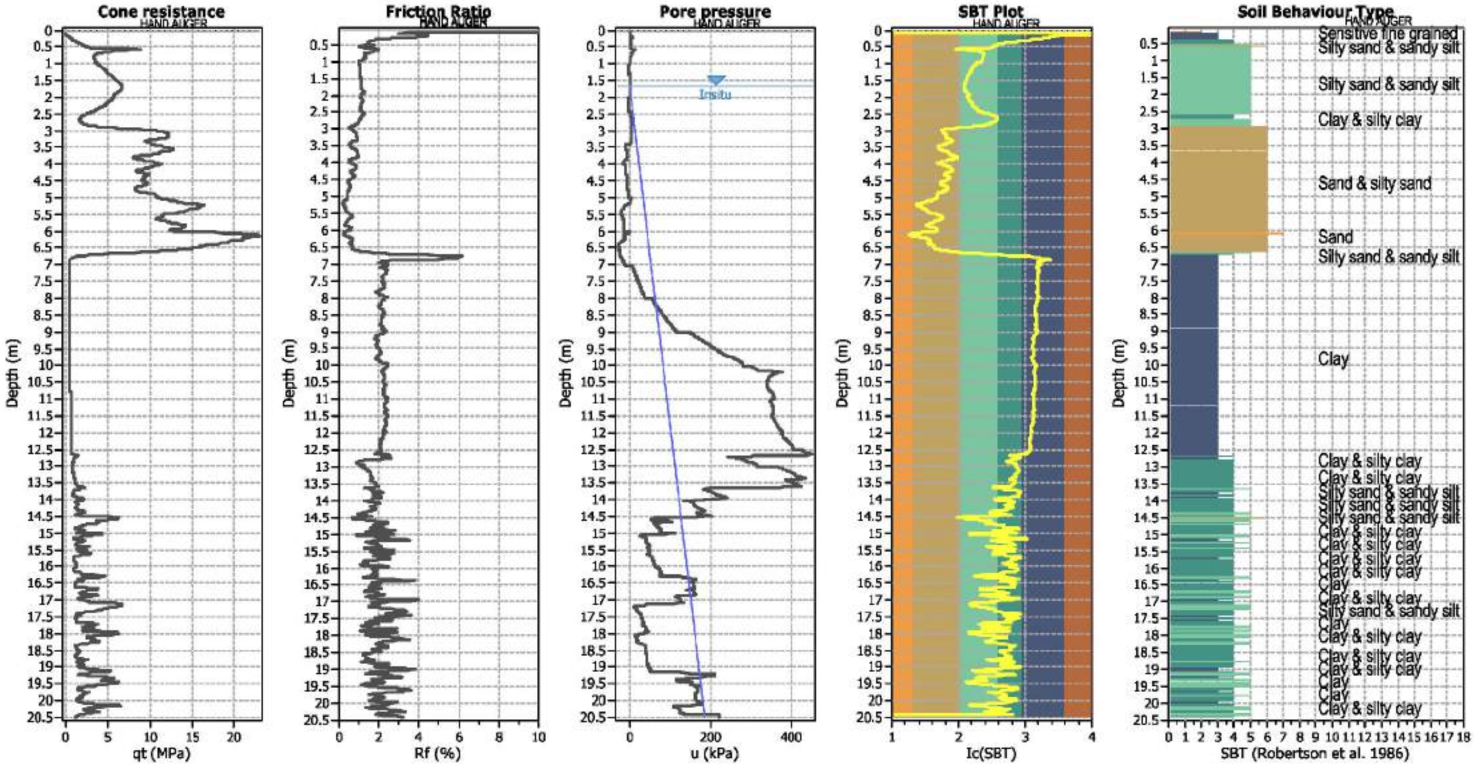

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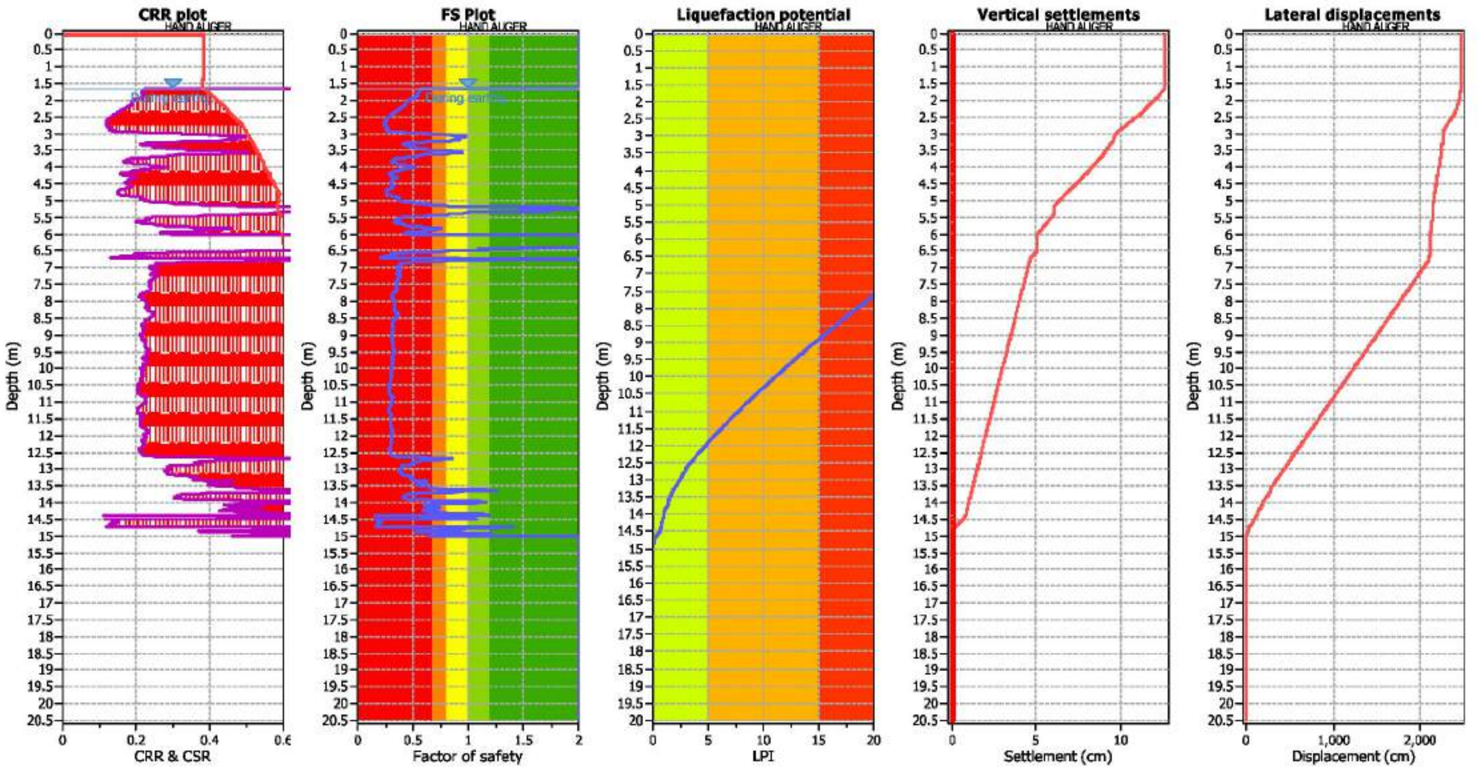

Input parameters and analysis data

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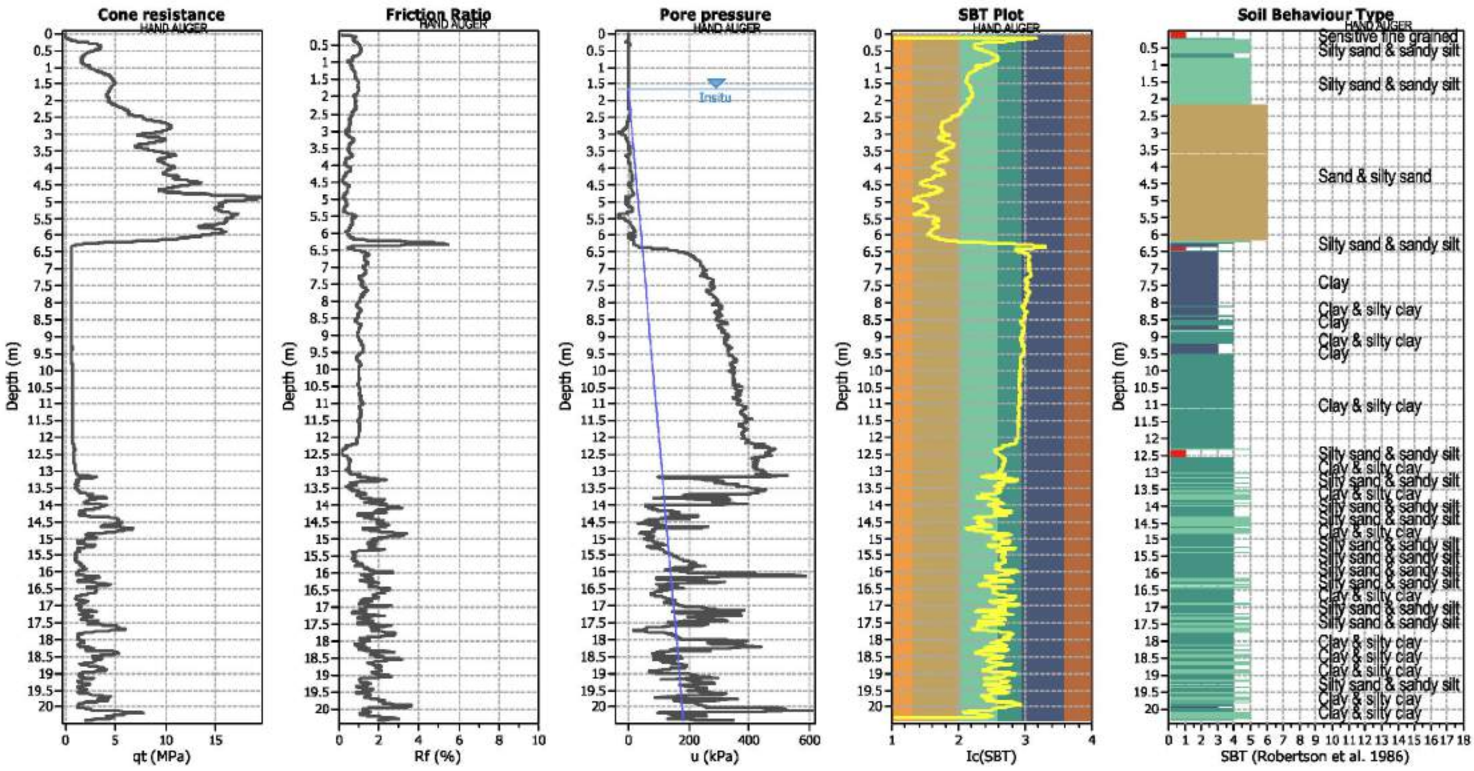

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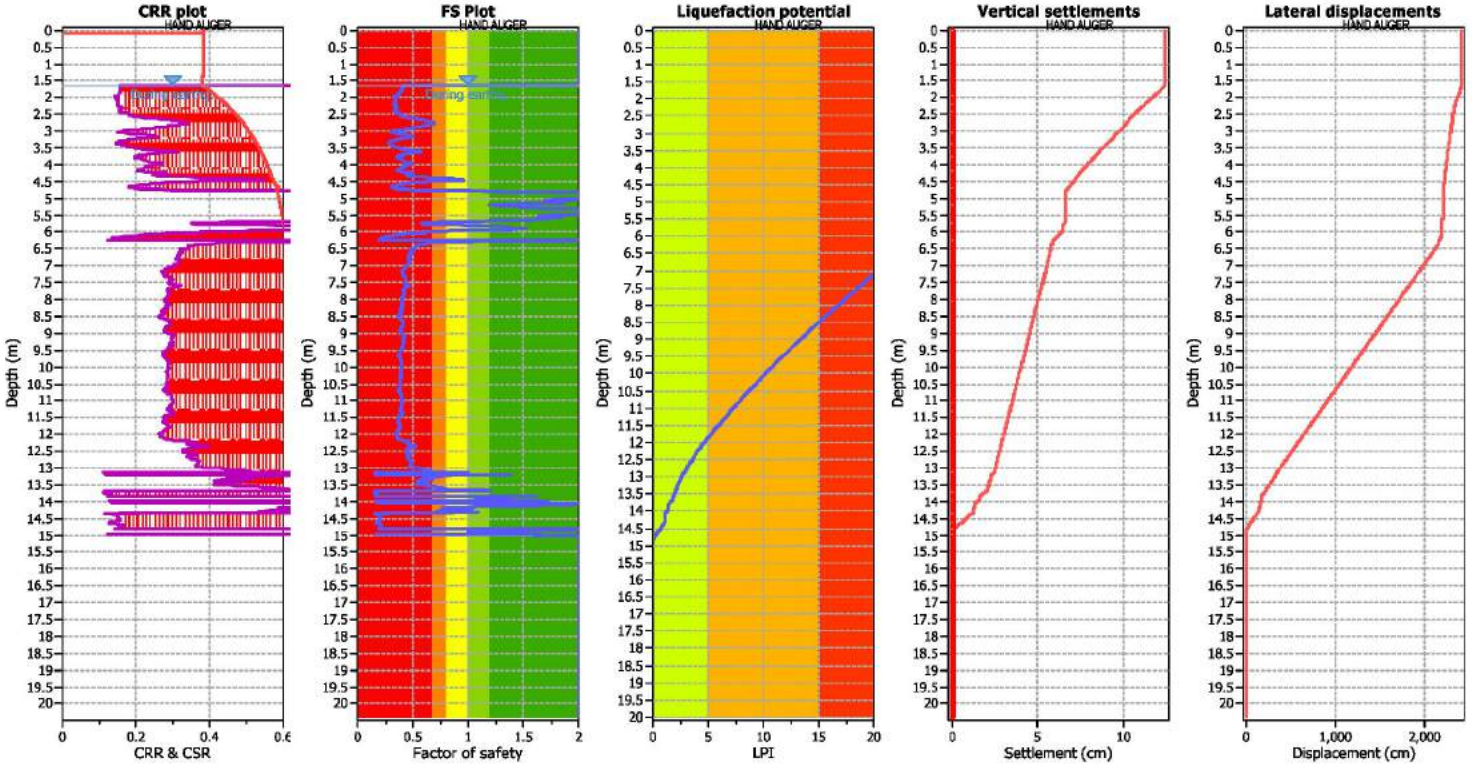

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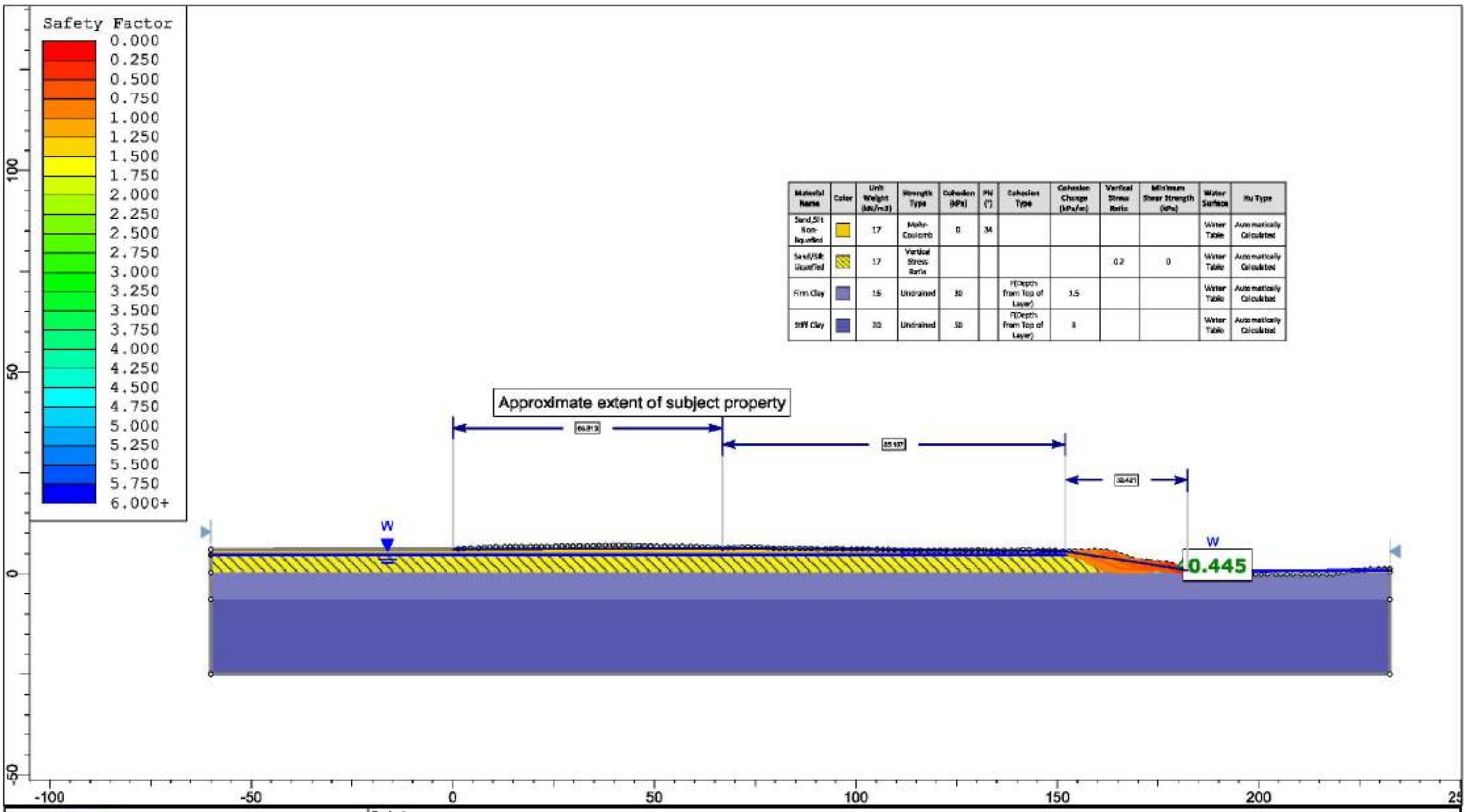
APPENDIX E

SLOPE STABILITY OUTPUTS

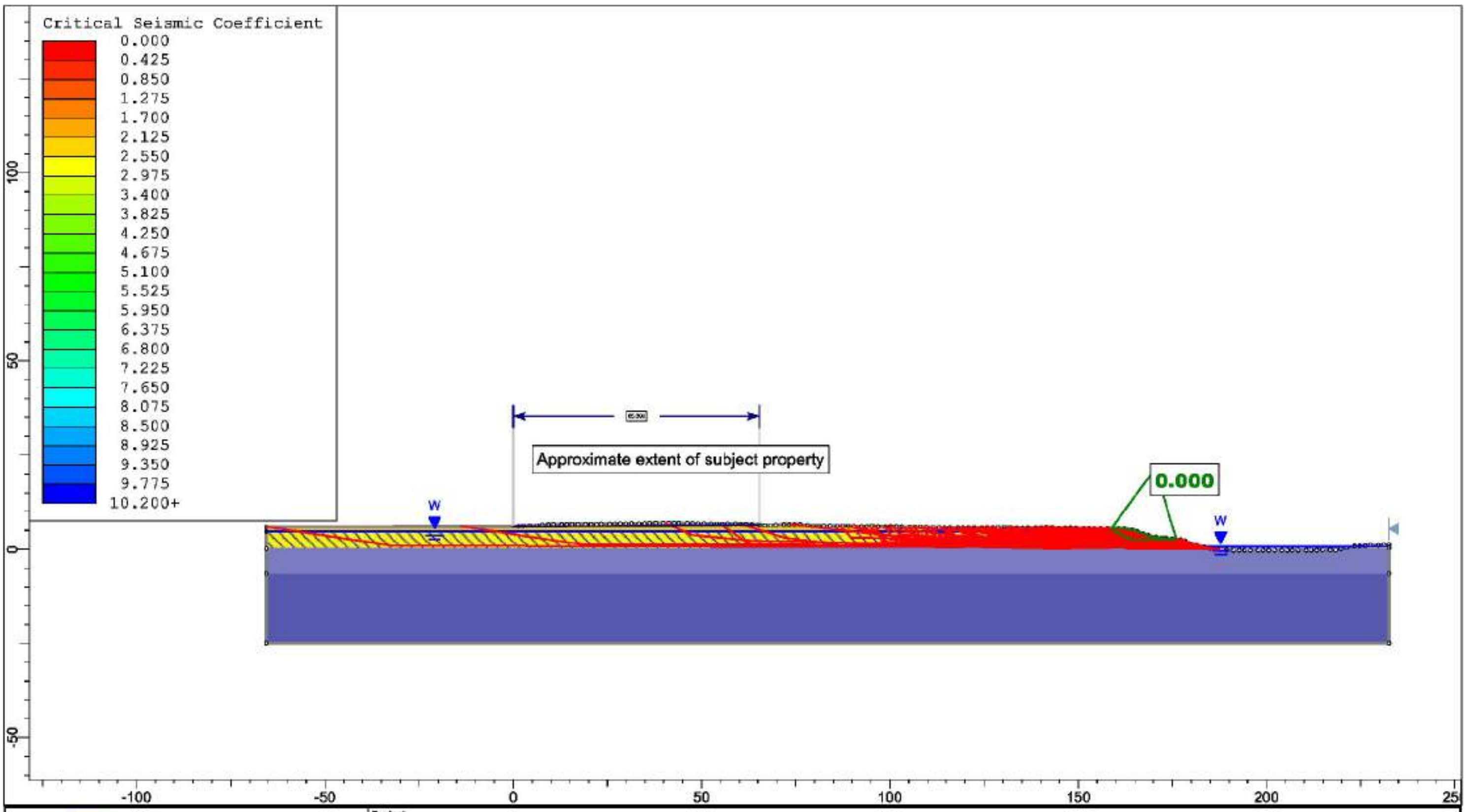


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Cohesion Change (kPa/m)	Vertical Stress Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type
Sand,Silt Non-liquefied	🟨	17	Mohr-Coulomb	0	34					Water Table	Automatically Calculated
Sand/Silt Liquefied	▨	17	Vertical Stress Ratio					0.2	0	Water Table	Automatically Calculated
Firm Clay	🟪	16	Undrained	30		F(Depth from Top of Layer)	1.5			Water Table	Automatically Calculated
Stiff Clay	🟦	20	Undrained	50		F(Depth from Top of Layer)	8			Water Table	Automatically Calculated

LAND DEVELOPMENT & ENGINEERING

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 1	*Scenario*	T/S ratio 0.2 - Static Flow
Drawn By	SS	*Company*	LDE Ltd
Date	31/08/2023	*File Name*	Lateral Spreading Analysis.slmd



SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 4	*Scenario*	T/S ratio 0.2 - Yield Seismic
Drawn By	SS	*Company*	LDE Ltd
Date	31/08/2023	*File Name*	Lateral Spreading Analysis.slmd

NZHG Gisborne Limited

GEOTECHNICAL ASSESSMENT REPORT FOR PROPOSED RESIDENTIAL DWELLING, LOT 9 AND LOT 10

556-560 Aberdeen Road, Te Hapara, Gisborne

Project Reference: 24477
October 13, 2023

DOCUMENT CONTROL

Version	Date	Comments
01	13/10/2023	Issued for Resource Consent. Plan review required prior to submission for Building Consent.

Version	Issued For	Date	Prepared By	Reviewed & Authorised By
01	Issued for Design	13/10/2023	Sahil Sathwara *B.Tech (Civil), MEngNZ* Geotechnical Engineer	Dan Bond *CMEngNZ, PEngGeol.* Associate Engineering Geologist

CONTENTS

1 INTRODUCTION

Land Development & Engineering Ltd (LDE) was engaged by NZHG Gisborne Limited to undertake a geotechnical investigation of a site located at 556 & 560 Aberdeen Road, Gisborne (Figure 1).

The 2,700m² site is proposed to be subdivided into 12 Lots for residential development (Figure 1). This geotechnical report pertains to proposed Lot 9 and Lot 10, 556 & 560 Aberdeen Road, Gisborne.

Figure 1 556-560 Aberdeen Road (outlined in blue), with the proposed subdivision outlined in yellow, Lot 9 and 10 highlighted in white. Image source: Tairāwhiti Maps (Gisborne District Council, 2023) Accessed: September 2023

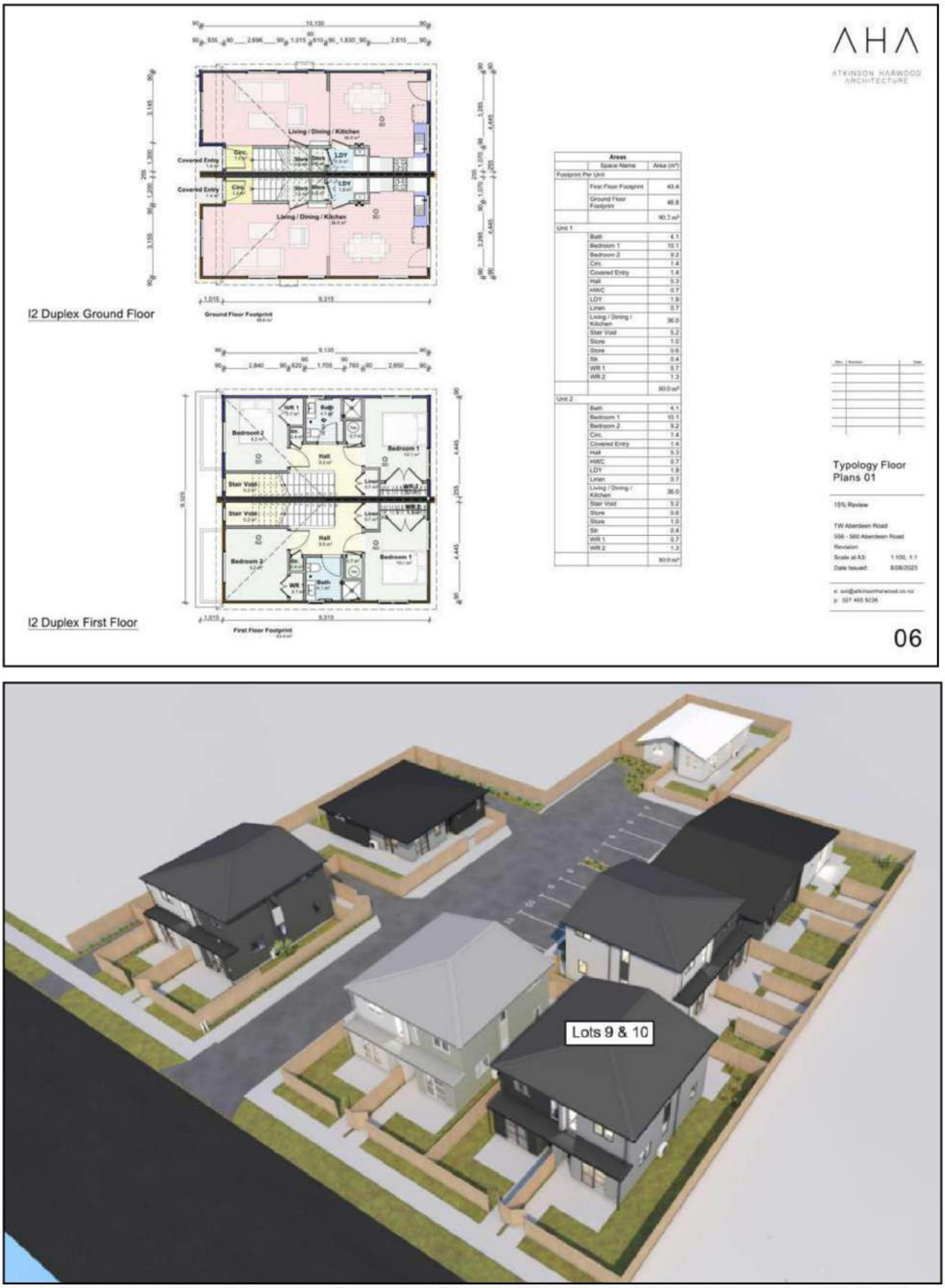
2 PROPOSED DEVELOPMENT

A 12-lot subdivision is proposed at 556 & 560 Aberdeen Road across the property with the legal description Lot 2 DP 1585, PT Lot 1 DP 1585, and Lot 1 DP 1817. The proposed development consists of 7 structures formed of four double-storey duplex buildings, one single-storey building and two standalone dwellings (Figure 1).

The proposed driveway is located centrally of the site to provide access between lots and Aberdeen Road. Proposed access and building platform locations are shown in Figure 1 and Appendix A.

A 93.6m² double storey building is proposed across Lot 9 and 10 (Figure 2), with timber framing in accordance with NZS3604 (2011), with weatherboard and sheet wall cladding, profiled metal roofing and a concrete floor or suspended timber floor.

The purpose of this investigation was to determine and assess the nature of the ground beneath the building site to inform our geotechnical recommendations for site development and design of the building's foundations. The investigation was completed to satisfy the requirements of Gisborne District Council (2022) for Resource and Building Consent.



Areas		
	Space Name	Area (m²)
Footprint Per Unit		
	First Floor Footprint	43.4
	Ground Floor Footprint	46.8
		90.2 m²
Unit 1		
	Bath	4.1
	Bedroom 1	10.1
	Bedroom 2	9.2
	Circ.	1.4
	Covered Entry	1.4
	Hall	5.3
	HWC	0.7
	LDY	1.9
	Linen	0.7
	Living / Dining / Kitchen	36.0
	Stair Void	5.2
	Store	1.0
	Store	0.8
	Str.	0.4
	WR 1	0.7
	WR 2	1.3
		80.0 m²
Unit 2		
	Bath	4.1
	Bedroom 1	10.1
	Bedroom 2	9.2
	Circ.	1.4
	Covered Entry	1.4
	Hall	5.3
	HWC	0.7
	LDY	1.9
	Linen	0.7
	Living / Dining / Kitchen	36.0
	Stair Void	5.2
	Store	0.8
	Store	1.0
	Str.	0.4
	WR 1	0.7
	WR 2	1.3
		80.0 m²

Figure 2: (From top to bottom): Floor plans for proposed duplex building across Lot 9 and 10, alongside the architect's drawing (Lot 9 and 10 is labelled). Image Source: Client supplied.

3 SITE STUDY

3.1 Site Description

The site is located within the established suburb of Te Hapara, Gisborne, approximately 2.0km northwest of the Gisborne CBD. The site is generally flat and is elevated between 6m and 7m (New Zealand Vertical Datum (NZVD) 2016). 556 (LOT 2 PT 1 DP 1585) & 560 (LOT 1 DP 1817) Aberdeen Road, occupy a combined area of approximately 2,700m^2.

3.2 Geomorphology and Geology

556 & 560 Aberdeen Road, occupy flat lying ground which, at one time, comprised the historic foreshore of Tūranganui-a-Kiwa (Poverty Bay). The 1:250,000 geological map of the region (Mazengarb & Speden, 2000) indicates the site is underlain by Holocene aged beach deposits which consist predominantly of sand. The Taruheru River is located approximately 120 m to the north; elevation falls relatively gently towards the river until the riverbank, which falls around 6m over some 25m laterally.

The GNS Active Fault Database does not identify any active fault traces or any fault buffer zones affecting the site. The nearest mapped active fault is the Repongaere Fault, located approximately 14 km to the north-west of the properties (GNS Science, 2020).

3.3 Geotechnical Risks

Our review of Gisborne District Council's (GDC) GIS viewer, Tairāwhiti Maps (Gisborne District Council, 2023), and GNS Science's Active Faults Database (GNS Science, 2020) revealed the following:

- 556 & 560 Aberdeen are mapped as being within an area of moderate liquefaction risk.
- The nearest active fault is the Repongaere Fault, located approximately 14 km to the north-west of the properties.
- The site is mapped as yellow tsunami evacuation zone.

In addition to the risk of liquefaction, the nearby riverbanks of the Taruheru River presents the possibility of lateral spreading in a liquefaction-inducing earthquake event.

Our review of the 2023 aerial photographs indicates that the properties were not severely impacted by flooding associated with Cyclone Gabrielle.

3.4 Historical Aerial Photographs

Historical aerial imagery was reviewed as part of this investigation using Retrolens and Google earth aerial

photography, which revealed the following: -

- Residential dwellings were constructed at both properties prior to 1942 (the earliest available aerial photograph with sufficient resolution).
- In the 1942 aerial photograph there appears to be some form of structure/s, a pile of material, or disturbance to the ground beneath the southwest corner of 556 Aberdeen Road. However, the resolution of the aerial photography is not sufficient to reliably determine what occupied the southwest corner of the property.
- A large shed was constructed in the southwest corner of 556 Aberdeen Road sometime between 1942 and 1966, along with smaller auxiliary structures at both properties.
- Several small structures or 'lean-tos' were constructed between 1966 and 1988 across both properties.
- A shed/garage was constructed in the south-east corner of 560 Aberdeen Road.
- Between 1988 and 2021 additions were carried out to the garage/shed in the south-east corner of 560, and the large shed in the southwest corner of 556. The water tank for 560 Aberdeen Road was removed, along with several of the smaller auxiliary structures across both properties.

Figure 3: Historical aerial imagery of the Aberdeen Road Subdivision (Source: (Retrolens.co.nz)), with the location of the individual lots marked in yellow. (a) Aerial imagery from 1942, (b)1966, (c) 1977, (d) 1988.

4 GEOTECHNICAL INVESTIGATION

4.1 Development wide Investigation Scope

Our investigation of the entire site included the following: -

- A walkover assessment of the site and immediate surrounding area to assess its geomorphology and identify any features which may influence our engineering recommendations, or the long-term performance of the ground.
- 15No. 50mm diameter, hand auger boreholes drilled to refusal or 2.5m target depth at the proposed building locations, with measurements of undrained shear strength taken every 0.2m, and associated DCP's to the 2.5m target depth.
- Complete liquefaction analysis of the Five CPTs which were undertaken across the site during the due diligence phase, three at 556 Aberdeen Road and two at 560 Aberdeen Road (Figure 4).

4.2 Lot 9 and Lot 10 Investigation Scope

The investigation of the site, completed on 12 September 2023 included the following work: -

- Four, 50mm diameter, hand-auger boreholes (HA12, HA13, HA14 and HA15), reached target depth of 2.5m below ground level (bgl). Associated DCP tests were carried out at each test location to the 2.5m target depth within granular materials.
- Measurements of groundwater levels within invasive subsurface test holes, following hole completion.

The test locations are shown on the Geotechnical Investigation Plan (Figure 4), and as Appendix A. Logs with details of the relevant testing completed are presented as Appendices B and C.

Figure 4: Geotechnical Investigation Plan for proposed development, Lot 9 and 10 highlighted in white.

5 GROUND CONDITIONS

This section addresses the ground conditions encountered during our investigations.

5.1 Site Stratigraphy

5.1.1 Development Wide

Ground conditions are reasonably consistent across the site. Typically, the property is underlain by topsoil and/or fill to a depth between 0.3m and 0.8m below ground level (bgl), which overlies sand/ silt mixtures to a depth of 1.0m. Underlying this, medium dense to dense sand was encountered to around 6.5m to 7.0m.
Deposits of firm clay were encountered from around 6.5m to 7.0m, with stiff silt/clay mixtures extending to depth from approximately 13m.

A copy of the test logs is provided as Appendix B.

5.1.2 Lot 9 and Lot 10 Site Specific Nuances

Topsoil/Fill was encountered in hand auger boreholes HA12-HA15 from the existing ground surface to depths of between 0.3m and 0.6m below ground level.

Dynamic penetrometer testing in sands typically ranged between 0.5 and 4 blows per 50mm penetration below the topsoil to 2.5m depth below existing ground level.

5.2 Groundwater

Groundwater was encountered at depths of between 1.50m and 2.88m across the site. A low-bound groundwater level of 1.65m bgl was adopted in our assessments. Given that testing was completed in the wettest year on record for Gisborne, the groundwater level adopted is considered significantly elevated from typical levels and no further allowance has been applied for seasonal variations.

6 NATURAL HAZARDS

6.1 Definition & Legislation

This section summarises our assessment of the natural hazards that might affect the site including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding, that might affect the property, as generally defined in Section 106 of the Resource Management Act., as well as the hazards as defined in Section 71(3) of the Building Act (2004), including erosion (including coastal erosion, bank erosion, and sheet erosion), falling debris (including soil, rock, snow and ice), subsidence, inundation (including flooding, overland flow, storm surge, tidal effects and ponding), and slippage.

6.2 Seismic Hazard

6.2.1 Surface Fault Rupture

The GNS NZ Geology Web-map and Active Faults Database (GNS Science, 2020) do not show any faults passing beneath the subject site. There also does not appear to be any surface expressions which would indicate the presence of an active fault beneath or within close proximity to the site. We therefore consider the surface fault rupture risk to be low.

6.2.2 Site Subsoil Class

Based on the published geological information for the region, discussed in Section 3.2, and obtained site-specific CPT data, we consider that a seismic site subsoil classification of D- "Deep or Soft Soil" is appropriate as defined by NZS 1170.5 (2004).

6.2.3 Seismic Actions

In accordance with the NZ Building Code and NZS 1170.5 (2004) the structure proposed is considered Importance Level 2 (IL2) with a design working life of 50 years, therefore:

- The Serviceability Limit State (SLS) design earthquake has an annual exceedance probability (AEP) of 1/25, and;
- The Ultimate Limit State (ULS) design earthquake has an AEP of 1/500.

An intermediate state event (ILS) has been considered in accordance with Gisborne District Council's (GDC's) requirements. This design case has an AEP of 1/100.

The modules of the Earthquake Geotechnical Engineering Practice series jointly published by Ministry of Business Innovation and Employment (MBIE) and the New Zealand Geotechnical Society (NZGS) (2021) provides guidance under Section 175 of the Building Act (2004), to assist with ensuring compliance with the Act. We have adopted the ground motions published within Module 1 (2021) for geotechnical design which are summarised in Table 1.

Table 1 - Summary of adopted seismic parameters.

Seismic Parameters	SLS	ILS	ULS
Horizontal Peak Ground Accelerations (PGA), g	0.12	0.28	0.65
Effective magnitude, Mw	6.3	6.8	7.5

6.3 Liquefaction and Cyclic Softening Assessments

6.3.1 Liquefaction

Liquefaction is the term used to describe the temporary, but substantial, loss of strength and stiffness which can occur in saturated, unconsolidated soils that are subjected to strong shaking. In addition to near-total strength loss, liquefaction may also result in the expulsion of sediment and water at the surface, ground, and structure settlement, and in lateral (spreading) displacement of the ground.

The liquefaction potential was assessed with site-specific CPT data using specialist geotechnical software (CLiq Ver.3.3.1.13) in general accordance with NZGS/ MBIE Module 3 Guidance (2021).

Liquefaction triggering was assessed using the method proposed by Boulanger and Idriss (2014).

Liquefaction-induced, free-field, vertical, volumetric strains were estimated using the method proposed by Zhang et al (2002)

A low-bound groundwater level of 1.65m bgl was adopted as discussed in Section 5.2.

6.3.2 Cyclic-Softening

Cyclic softening is a phenomenon that occurs when the strength and stiffness of a soil decreases due to repeated cyclic loading such as that resulting from strong seismic shaking. Relatively soft clay soils are commonly susceptible to this phenomenon, which can be accentuated where these soils are sensitive i.e., there is a significant difference between the soil's peak and residual shear strength.

Due to the presence of the clay rich estuarine soils at this site, we have undertaken a cyclic softening analysis for the ULS design case. The Gisborne 2007 earthquake was of comparable magnitude and PGA to the ILS design case. No liquefaction or induced settlements were identified within the proximity of the subject site because of this earthquake. Accordingly, cyclic softening has been assessed for the ULS design case only.

Our assessments assumed:

- An N_{kt} value of 14 for the clay-like soils, based on previous work undertaken proximally by LDE within the estuarine deposits.
- An estimate of the maximum, post-liquefaction, volumetric strain based on the work by Robertson and Cabal (Robertson & Cabal, 2014) which recommends a default value of 0.5% for clay-like soils.

6.3.3 Liquefaction and Cyclic Softening Results

The results of our analyses are summarised in Table 2; detailed outputs are included as Appendix D.

The Liquefaction Potential Index (LPI) and Liquefaction Severity Number (LSN) are indices used to assess the general performance level of liquefied deposits in accordance with the NZGS/MBIE Module 3 Guidance (2021).

Our analyses indicate that liquefaction-induced settlements are likely to be negligible (<5mm) in a design SLS seismic event.

Under the ILS design case, liquefaction-induced settlements are estimated to be between 20mm and 50mm. As discussed in Section 6.3.2, no liquefaction, or liquefaction-induced settlements were identified within the proximity of the subject site as a result of the Gisborne 2007 earthquake, which had almost identical ground motions. Accordingly, we consider it unlikely that liquefaction would be realised under ILS seismic shaking and conclude that the software is likely to be over-estimating liquefaction potential.

Table 2 - Summary of liquefaction analysis results.

Limit State / AEP	CPT ID	LPI	LSN	Estimated Seismic Volumetric Settlements (mm) [Limited to 10m] (3)			Effects of Liquefaction
				Liquefaction	Cyclic Softening	Total Seismic Settlement	
SLS 1/25 year	CPT-01	0	0	<5 [<5]	-	**<5 [<5]**	**L0**
	CPT-02	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-03	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-04	0	0	<5 [<5]	-	**<5 [<5]**	
	CPT-05	0	0	<5 [<5]	-	**<5 [<5]**	
ILS 1/100 year	CPT-01	2	8	~30 [~25]	-	**~30 [~25]**	**L2**
	CPT-02	4	12	~50 [~45]	-	**~50 [~45]**	
	CPT-03	2	5	~20 [~20]	-	**~20 [~20]**	
	CPT-04	4	12	~45 [~40]	-	**~45 [~40]**	
	CPT-05	3	10	~45 [~30]	-	**~45 [~30]**	
ULS 1/500 year	CPT-01	18	23	~75 [~70]	~45	**~120 [~70]**	**L3**
	CPT-02	18	23	~85 [~75]	~40	**~125 [~75]**	
	CPT-03	16	19	~70 [~65]	~40	**~110 [65]**	
	CPT-04	20	24	~85 [~80]	~40	**~125 [65]**	
	CPT-05	18	23	~85 [~65]	~40	**~125 [65]**	
Effects of liquefaction Key		**L0: Insignificant**	**L1: Mild**	**L2 Moderate**	**L3: High**	**L4 Severe**	**L5: Very Severe**

Notes:

- Liquefaction triggering Boulanger and Idriss (2014) methodology limited to upper 15m. Limited to 10m of soil profile shown in square brackets [ ].
- Settlements are free-field estimated settlements and do not include any building-induced settlements.
- Effects of Liquefaction based on NZGS Module 3 (New Zealand Geotechnical Society (NZGS) & Ministry of Business, Innovation and Employment (MBIE), 2021)

Under design ULS seismic shaking, settlements in the order of 110mm to 125mm are estimated. However, given the rationalisation to the Gisborne 2007 earthquake, discussed above, we consider that total, free-field, seismic settlements are likely to less than 100mm.

6.4 Lateral Spreading and Lateral Stretch

Lateral spreading typically occurs in sloping ground or level ground close to slopes or waterways and is most commonly caused by loss of strength due to earthquake-induced liquefaction. Typically, the degree of lateral movement diminishes as the distance from the waterway, or free face, increases.

Liquefaction-induced lateral displacements were estimated in CLiq software using the method proposed by Zhang et al (2004). utilising an Ic cut-off of 2.6, clean sand and overburden corrections, and inferred soil unit weights.

The methods available to predict lateral displacements from CPT data. Both these methods are based upon limited case studies and as such have inherent limitations for broader application. They are known to be highly inaccurate with predictions versus empirical data varying by a factor of two (NZGS Module 3 (2021)) or possibly more. Accordingly, lateral spreading potential was also assessed through numerical modelling, using Slide 2 (Version 9.027) by Rocscience Inc., to provide a more reliable estimate and allow sensitivity analyses to be undertaken.

Both methods, and associated results are discussed below.

6.4.1 CLiq Assessment

Our CLiq assessment adopted the 'Level ground with a free face' approach, because the alternative option (gently sloping ground) was found to estimate lateral displacements in excess of 600mm under the ILS design case.

Our assessment was based on the sites closest proximity to the Taruheru River (117m) and a free face height of 7m (elevation relief from the site to the river) and was completed for each CPT.

Table 3 presents the results of these analyses.

Table 3 - Summary of Lateral Spreading Displacements

CPT ID	SLS 1/25 year (mm)	ILS 1/100 year (mm)	ULS 1/500 year (mm)	Global Lateral Movement (ULS)
CPT01	<5	~105	~315	**Major**
CPT02	<5	~170	~390	**Major**
CPT03	<5	~100	~275	**Minor to Moderate**
CPT04	<5	~250	~460	**Major**
CPT05	<5	~180	~380	**Major**

Global lateral movement categories	**Minor to Moderate 0 to 300mm**	**Major 300 to 500mm**	**Severe >500mm**

Notes:

- Free-face method adopted limits of lateral spreading to 2H. Chu et al (2006) have compared predicted values of lateral spread using the Zhang et al model with actual measurements of lateral displacement following the 1999 Chi Chi earthquake. They found that predicted values better matched observed values when liquefaction calculations in the CPT profile were limited to a depth of twice the free face height (2H).
- Global lateral movement categories based on MBIE Guidance for TC3 (Ministry of Business Innovation and Employment Hīkina Whakatutuki, 2015)

6.4.2 Numerical Modelling Assessment

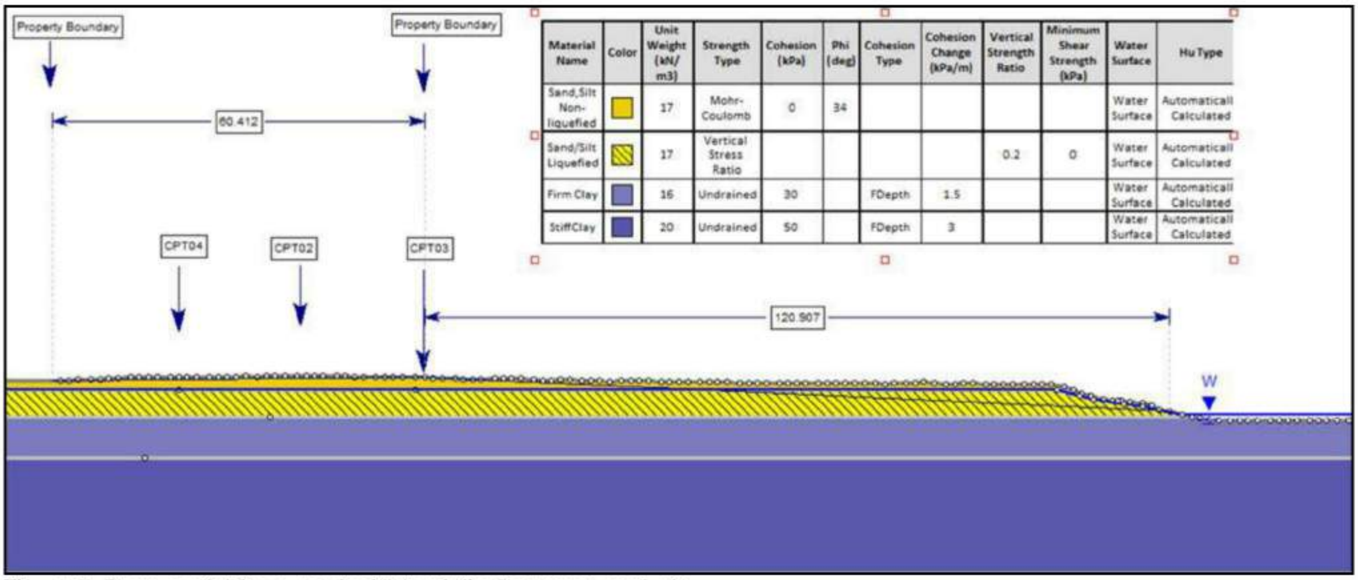
Numerical modelling was used to assess the potential for lateral displacements using Slide 2 as discussed above.

Our modelling assessed non-circular slip surfaces using the 'Cuckoo" search method and adopting the 'Vertical Strength Ratio' material strength model for the liquefied layer.

From past projects and general geological knowledge of this area, it is our experience that the Holocene beach sand transitions to clay-rich deposits towards the river, likely due to a combination of river migration and overbank deposition. In many areas along the Taruheru river a relic river terrace can be clearly identified, however this area had been developed prior to the earliest available historic aerial imagery and consequently the terrace boundary could not be identified.

Accordingly, we have adopted a conservative 'what if.' scenario in our modelling where the liquefied layer has been extended at consistent thickness and elevation to the river.

Figure 5 shows the base model, the surface profile of which was plotted from recent LiDAR data. Note the left side of the model has been manually extended to check the potential for more critical slip surfaces.



Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Cohesion Change (kPa/m)	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type
Sand,Silt Non-liquefied	🟨	17	Mohr-Coulomb	0	34					Water Surface	Automaticall Calculated
Sand/Silt Liquefied	▨	17	Vertical Stress Ratio					0.2	0	Water Surface	Automaticall Calculated
Firm Clay	🟪	16	Undrained	30		FDepth	1.5			Water Surface	Automaticall Calculated
StiffClay	🟦	20	Undrained	50		FDepth	3			Water Surface	Automaticall Calculated

Figure 5: Base model for numerical lateral displacement analysis

The liquefied shear strength to overburden stress (Tau/ Sigma) ratio was derived for the sand/ silt mixtures from statistical analysis of CPT data. The Tau/ Sigma Ratio was found to vary significantly, ranging from 0.08 to 0.98; a value of 0.2 was adopted to provide a moderately conservative estimate for the body of liquefied material. Figure 6 shows a plot of Tau/ Sigma ratio with depth for CPT04.

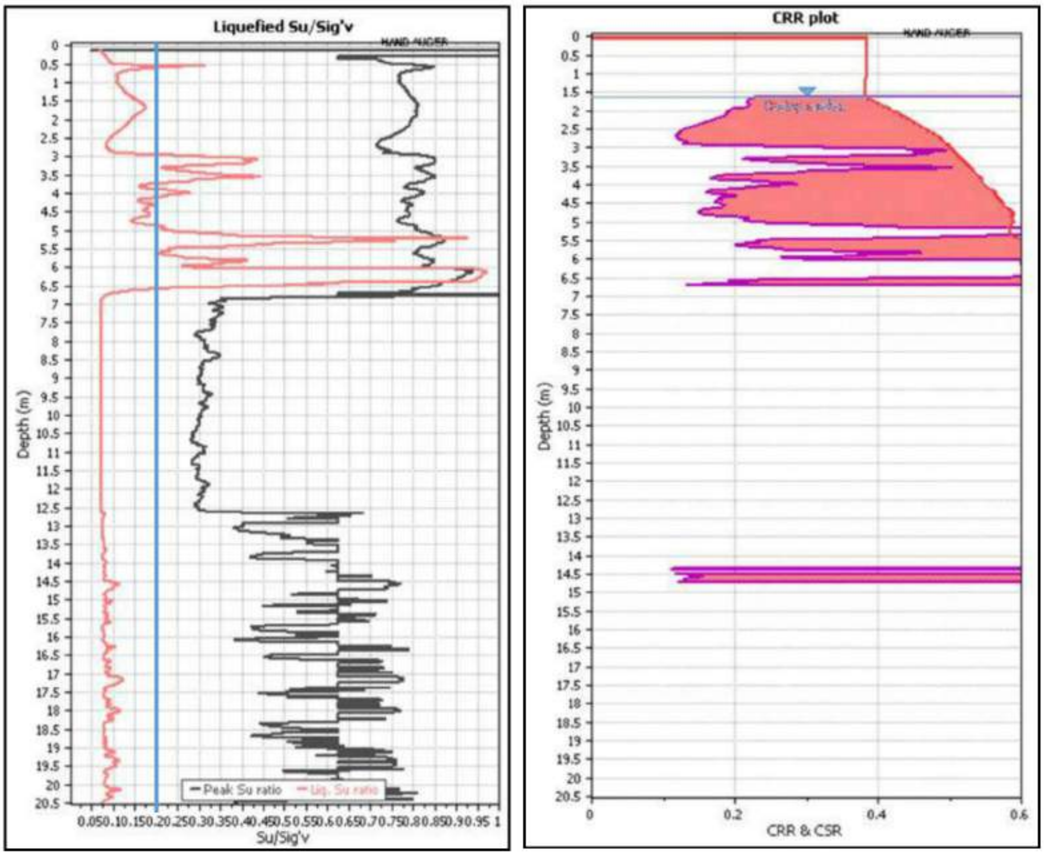


Figure 7: Tau/ Sigma ratio plot for CPT04 and plot showing depth of liquefiable material. Blue line shows value adopted in our modelling.

Two design cases were assessed:

1. Static Flow

   This design case models a post seismic liquefied case to assess the potential for flow failures to impact the subject property.
2. Seismic Yield

   This assessment determines the PGA required for the site to be affected by lateral displacements considering seismic action coincident with the fully liquefied condition. A magnitude of 0.1g was considered reasonable to represent an aftershock occurring within the short-term, liquefied timeframe.

6.4.2.1 Results

The results suggest that the property will not be affected in the static flow scenario with failures extending to a maximum of around 31m from the riverbank, some 85m from the subject property.

Under the seismic yield design case the subject property is estimated to be affected with a PGA of around 0.11g. Accordingly, lateral displacements are not anticipated in this scenario.

Full results are presented in Appendix E.

6.4.3 Conclusions

Numerical modelling indicates that lateral displacements of the magnitude estimated by CLiq are only achieved when full seismic PGAs are applied in the fully liquefied condition. Such a scenario is considered to be of very low probability, and highly conservative. We consider however that there is a reasonable probability of an aftershock occurring during this timeframe.

We conclude that the numerical modelling provides a more realistic estimate of ground performance, particularly given the apparent overestimation of liquefaction affects, discussed in Section 6.3.3. Accordingly, we consider that the subject site has low lateral spreading potential.

6.4.3.1 Lateral Stretch

Lateral stretch is a metric of the amount of differential extension that a portion of land may experience during an episode of lateral spreading. The lateral stretch across a foundation is a main factor in foundation damage due to liquefaction and lateral spreading as a result of a large earthquake.

Given the results of our numerical analyses, discussed above, lateral stretch is not anticipated at the subject site under the design cases assessed.

6.5 Liquefied Bearing

Liquefaction may lead to foundation bearing failure, by either 'punch through' failure or a reduction in bearing capacity when liquefaction occurs within the zone of influence of load bearing foundations.

A preferred foundation option has not been identified for the proposed structures at the time of writing and we have completed liquefied bearing assessments for both raft-type surface structures and piled foundations.

A unit weight of 17kN/m^3 was adopted for both the non-liquefied and liquefied soil layers. An angle of internal friction of 34 degree was adopted for the non-liquefied material.

The Tau/sigma ratio for these assessments was based on site-specific CPT data and taken as 0.075 for the liquefied material within the zone of influence of the foundations.

A low-bound groundwater level was taken as 1.65m, as discussed in Section 5.2.

A reduction factor of 0.75 was applied to the ultimate capacities calculated for the proposed, two-storey, duplex buildings, in accordance with MBIE Module 5 (2021) for moderately loaded structures.

6.5.1 Pile Foundation Assessment

Our assessment of pile foundations assumed:

- Ordinary piles embedded to a minimum depth of 0.5m at 0.3m diameter (including concrete cover), and

- Anchor piles embedded to a minimum depth of 0.9m at 0.4m diameter (including concrete cover), and
- 100kPa design load.

Both projected area and 'punch-through' failure mechanisms were assessed.

6.5.1.1 Results

The design load was found to be acceptable in both design cases. Note that our calculations are dependent on the assumptions listed within this Section. Should the pile diameter, pile embedment depth or design loads change, the liquefied bearing capacities will need to be reassessed.

6.5.2 Raft type Surface Structure Foundation Assessment

For the raft-type surface structures assessments were completed for the single-storey and two-storey buildings assuming:

- Foundation widths as presented in the 15% architectural drawings, and
- An embedment depth of 0.2m.

6.5.2.1 Results

Liquefied bearing capacities were calculated to be 19kPa for the proposed single-story buildings and 14kPa for the proposed two-storey duplex structures.

The values presented above are dependent on the assumptions listed. Should the foundation breadth, embedment depth or design loads change, the liquefied bearing capacities will need to be reassessed.

6.6 Equivalent MBIE Technical Category

Considering the rationalisation provided in Section 6.3.3, we consider that seismic ground performance at this site would be equivalent to a TC2 classification in accordance with Table 15.6 of the MBIE Guidance (2015).

6.7 Flood Hazard

The site is not located in a mapped flood hazard zone. GDC aerial imagery post cyclone Gabrielle does not indicate this site experienced significant impacts.

6.8 Tsunami

The Gisborne / East Cape coastline is classified as being at the highest risk in the country of being affected by tsunami. Modelling for the Gisborne region (GNS Science Te Pū Ao, 2016) indicates that the site is sufficiently elevated and is unlikely to be inundated in 1:100, 1:500, and 1:2500-year return period tsunami events, respectively. Civil defence tsunami inundation maps show that the site mapped as a yellow zone, which may be subject to tsunami

hazard in the case of a severe (ie M8.9) local earthquake on the Hikurangi subduction margin (Gisborne District Council Te Kaunihera o Te Tairāwhiti, 2019) .

6.9 Expansive Soils

Cohesive soils containing significant proportions of certain clay minerals can be subject to appreciable volume change caused by variations in soil moisture content, most notably between seasons or from the uptake of water through the root systems of trees and shrubs. This is referred to as soil reactivity or shrink-swell behaviour.

The surficial soils at this site are granular in nature and therefore not subject to expansivity.

6.10 Consolidation Settlement

The topsoil across the site is expected to be subject to consolidation with applied load and is not suitable to support structural loads.

The firm clay beneath the site may also be subject to consolidation settlement depending on the foundation option selected and the structural loads applied. The potential for consolidation settlement within this material should be assessed once the foundation type and structural loads have been determined.

6.11 Natural Hazards Summary

From our assessment of the natural hazards and ground deformation risks presented to the proposed development we consider that the proposed structures can be safely located on the site, provided that the recommendations given in Section 7 are adopted.

7 ENGINEERING RECOMMENDATIONS

7.1 Site Contouring and Topsoiling

The finished ground level should be graded so that water cannot pond against, beneath or around the buildings for the economic life of structure. To achieve this, it will be important that the building platform beneath the topsoil grades away from the site. Contouring should avoid the potential for concentration and discharge of surface water over point locations which could result in soil erosion or instability.

7.2 Access Road Construction

Access is proposed from Aberdeen Road. No major/ significant earthworks are anticipated to form access to the proposed dwellings.

7.3 Foundation Recommendations

7.3.1 Foundation Type

Based on the site investigation and analysis, we consider that foundations comprising pile foundations or raft-type surface structures are suitable for the site conditions providing the recommendations and limitations presented within this section are addressed in design.

7.3.2 Design Considerations

Based on the scope of work completed, the following aspects need to be considered in detailed design:

- Site Class - Class D - Deep or soft soil
- Liquefaction-induced vertical settlements - TC2 equivalent
- Relatively high groundwater level
- Liquefied bearing capacity
- Potential for consolidation settlement

7.3.3 Bearing Capacity and Founding Depth

Foundations must extend beneath any topsoil, uncontrolled fill, organic and/ or otherwise unsuitable material.

For the Lot 9/10 duplex structure we anticipate that a static geotechnical ultimate bearing capacity of 210kPa will be available from 0.7m depth. Some localised deepening of foundations is anticipated in the vicinity of HA12 and HA13. A reduction factor of 0.45 should be applied to this value to give the design bearing strength (q_{dbs}).

A short-term, post-seismic (static), liquefied bearing capacity, equivalent to the values presented in Section 6.5, should be assessed in structural design. Note that these liquefied bearing capacities are contingent on the assumptions listed within Section 6.5. Should these assumptions change in design, the liquefied bearing capacities will need to be reassessed. This may require some iterative design between the geotechnical and structural engineers.

7.4 Surface Water

Surface water from roof, impermeable surfaces, or any slopes should be collected and discharged away from the building to mitigate against flooding, erosion, soil expansivity, and/ or potential instability. The site will be connected to the reticulated network. Rainwater will be collected from the roof and all paved surfaces including parking areas and discharged into the GDC reticulated stormwater network.