Firmato digitalmente da:
lizzadro antonio
Firmato il 16/11/2021 17:43
Seriale Certificato: 18801355
Valido dal 16/06/2020 al 16/06/2023
InfoCert Firma Qualificata 2

PORTS of GENOA
THE SOUTHERN GATEWAY TO EUROPE.

PROGETTO DI FATTIBILITA' TECNICA ED ECONOMICA

CUP C39B18000060006	CIG 7690329440
RIF. PERIZIA	**P.3062**

TITOLO PROGETTO

NUOVA DIGA FORANEA DEL PORTO DI GENOVA
AMBITO BACINO SAMPIERDARENA

TITOLO ELABORATO:

RAPPORTO INDAGINE GEOTECNICA A MARE
FIELD REPORT

ELABORATO N°:
MI046R-PF-D-G-R-013-01

NOME FILE:
MI046R-PF-D-G-R-013-01.docx

DATA	ELABORATO	CONTROLLATO	APPROVATO
4/6/2021	C.Edwards/C.Brandish-Lowe	P.Smorgon	A.Lizzadro

REVISIONE N°	DATA	DESCRIZIONE
00	30/4/2021	EMISSIONE PER APPROVAZIONE
01	4/6/2021	REVISIONE A SEGUITO VERIFICA RINA CHECK

PROGETTISTI	PROGETTAZIONE
Mandataria: TECHNITAL Responsabile dell'integrazione delle prestazioni specialistiche Dott. Ing. Antonio Lizzadro MODIMAR Ingegneria Idraulica e Marittima HR Wallingford Working with water SENER SOCOTEC STUDIO BALLERINI INGEGNERI ASSOCIATI EPF ALBERTO ALBERT INGEGNERE	TECHNITAL Dott. Ing. Antonio Lizzadro

D.E.C.	VERIFICATO	VALIDATO R.U.P.	IL RESP. DELL'ATTUAZIONE
Ing. Francesca Arena	RINA CHECK	Ing. Marco Vaccari	Dott. Umberto Benezzoli
.....	.....	.....	.....

VOLUME I - FIELD OPERATIONS AND PRELIMINARY RESULTS

Genoa Port Extension Geotechnical Survey (PFTE)

Prepared for: TECHNITAL S.p.A and Modimar S.r.l

Geoquip Marine Ref:	GMOP20-G-013-FLD-01
Project No:	GMOP20-G-013
Revision:	B4
Date:	10 February 2021

Geoquip Marine Operations AG
Multergasse 1-3
P.O. Box 743
9001 St. Gallen
Switzerland
Tel +41 71 227 40 00
Fax +41 71 227 40 04
geoquip-marine.com

DOCUMENT CONTROL AND REVISION STATUS

Document Title	Volume I - Field Operations and Preliminary Results
Project	Genoa Port Extension Geotechnical Survey (PFTE)
Client	TECHNITAL S.p.A and Modimar S.r.l
Project No.	GMOP20-G-013
Document Ref.	GMOP20-G-013-FLD-01
Revision No.	B4

Document Distribution		
Copy Number	**Distributed to**	**Date**
Master	GEOQUIP Server	10 February 2021
1	TECHNITAL S.p.A and Modimar S.r.l	10 February 2021

Revision History		Date	Original	Checked	Approved	Client
A1	Draft	08 January 2021	RBB/CJE	CBL		
B1	Issue to COMPANY	12 January 2021	RBB	CBL	TJP	
B2	Issue to COMPANY	15 January 2021	RBB	DG	TJP	
B3	Issue to COMPANY	01 February 2021	RBB	DG	TJP	
B4	Issue to COMPANY	10 February 2021	JWD	CBL	TJP	

Signatory Legend:

CJE	Callum Edwards
CBL	Chris Brandish-Lowe
DG	Dariusz Guzik
RBB	Ryan Benjamin Bates
TJP	Torran Purchase

Geoquip Marine Operations AG designated contact for any queries regarding this document:

Name	Job Title	Telephone	Email
Torran Purchase	Project Manager	+44 7980 611 379	torran.purchase@geoquip-marine.com

EXECUTIVE SUMMARY

Geoquip Marine Operations AG (GEOQUIP) has been contracted by TECHNITAL S.p.A and Modimar S.r.l (COMPANY), for the provision of an interim geotechnical investigation close to the entrance to the Port of Genoa, Italy. The objective of the project is to determine the technical and economic feasibility to construct a new breakwater.

The nominal Scope of Work (SOW) consists of completing 14 boreholes; 7 x continuous PCPT to 40m bsb, 4 x continuous sampling to 40m bsb and 3 x alternating to 80m bsb. An additional alternating borehole was later requested and agreed by the COMPANY totalling 15 boreholes. The proposed borehole locations were in close proximity to the existing breakwater which required close coordination with the local harbour authority to ensure the safety of the operations given marine traffic entering and exiting the existing port.

Water depth measurements were conducted at the start of each location by measuring the drill string length from the Seabed Frame (SBF) on the seabed to the Drill Floor on the vessel with compensation (minimal weight) to ensure that both accurate water depth measurements and undisturbed samples could be obtained from mudline. The measurements are then reduced to sea level at Lowest Astronomical Tide (LAT).

The purpose of the site investigation is to determine soil stratigraphy, classification, engineering parameters and depth to rockhead for a planned offshore breakwater extension.

Fieldwork operations for this project have been conducted from the GEOQUIP owned and operated vessel MV Geoquip Saentis, on which the GEOQUIP owned and operated GMR600 drill rig is installed.

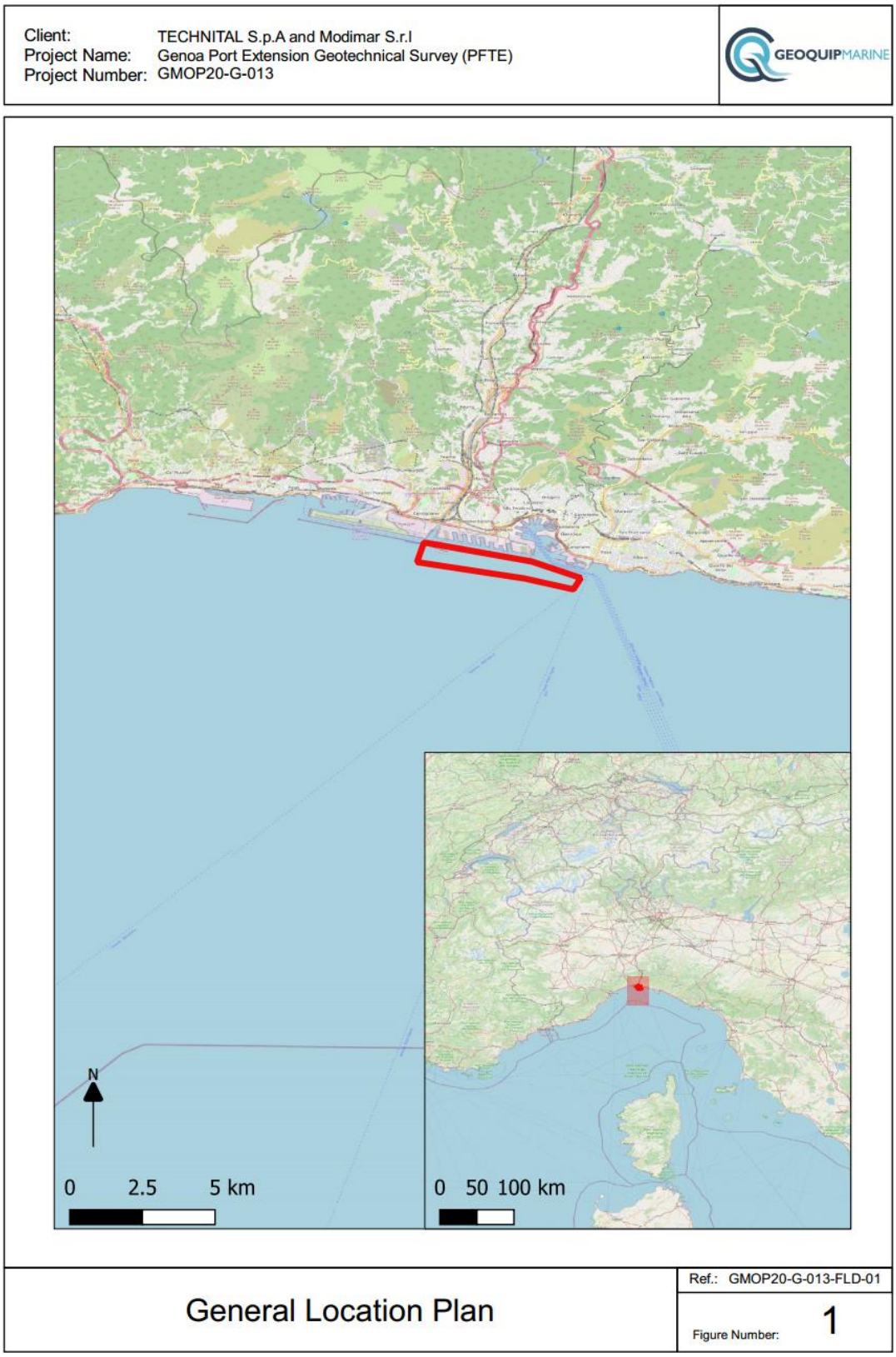
Mobilisation commenced on 10 December 2020 in the port of Genoa, Italy. Details of the operations completed during this mobilisation, including equipment calibrations and verifications are outlined in the subsequent sections and appendices of the Mobilisation report (GMOP20-G-013-MOB-01).

Upon completion of port-based mobilisation activities, the MV Geoquip Saentis departed Genoa port on 11 December 2020 at 17:43hrs LT. The vessel arrived at the first location (PCPT-2) on the morning of 12 December 2020 at 03:55hrs LT to begin the site investigation work for TECHNITAL S.p.A and Modimar S.r.l. Mobilisation was deemed complete at 03:46 on the 12 December 2020, with the signed completion of all onboard calibrations. The fieldworks were conducted between the 12 December 2020 to 5 January 2021. The vessel departed site at 22:20hrs LT 5 January 2021 and arrived at the port of demobilisation (Port of Genoa) at 00:00hrs LT 6 January 2021. All samples were offloaded and released to the COMPANY at 11:42hrs LT 6 January 2021. Client Representatives disembarked the vessel 12:08hrs LT 6 January 2021 deeming completion of demobilisation and completion of project. The project incurred no accidents or injuries.

The geological structure of the investigated area is characterized by a horst and graben formation. Of the locations detailed in this report, the encountered ground conditions varied from predominantly sands and clays within the tectonically depressed sectors of the project area, with a larger proportion of gravel and rock towards the raised horst structures. Rock was encountered at the most eastern locations (CC-1 and PCPT-1) and central locations (CC-5 and PCPT-7).

OVERVIEW MAP

Genoa Port Extension Geotechnical Survey (PFTE)



Map 1 Location Plan for the Completed Scope of Work

REPORTING STRUCTURE

Volume I – Field Report
Field operations and preliminary results
Cover Page
Revision status and QA/QC
Executive summary, including an overview map of investigated points
Table of contents
List of symbols and terms used
Chapter 1: Scope of field operations with description of the soil investigation platform (vessel/rig), overview over investigated points, with maps and coordinates, HSE, and organisation of work
Chapter 2: Log of drilling operations
Chapter 3: In situ testing operations, procedures and preliminary results
Chapter 4: Sampling operations, procedures and preliminary results, including inventory of recovered samples
Chapter 5: Field laboratory operations, procedures and test results
Chapter 6: Preliminary geotechnical borehole logs
Chapter 7: Log of daily field operations
Chapter 8: Positioning and survey. including water depth and tidal measurements
References
Appendix A-Z

Volume II – Factual Report
Measured and derived geotechnical parameters and final results
Cover Page
Revision status and QA/QC
Summary of main report modifications from previous revision
Executive summary, including an overview map of investigated points
Table of contents
List of symbols and terms used
Chapter 1: Summary of soil conditions and stratigraphic schematization, including a short description of general geology in the area.
Chapter 2: Final geotechnical borehole logs and soil profiles, with proposed stratigraphic schematization
Chapter 3: Final in situ test results, including discussion on validity of results
Chapter 4: Laboratory test procedures and final results
Chapter 5: Other test results not included in Section 4
Chapter 6: Other data and results (such as bathymetry, seismic piezometer results. etc)
References

TABLE OF CONTENTS

LIST OF TABLES IN REPORT

LIST OF FIGURES AFTER REPORT

LIST OF TABLES AFTER REPORT

LIST OF APPENDICES

LIST OF SYMBOLS AND ABBREVIATIONS

English

B_q	pore pressure ratio
D_r	relative density
f_s	sleeve friction
m	metre
N_{kt}	cone factor
q_c	measured cone resistance
q_{net}	net cone resistance
q_t	corrected cone resistance
R_f	friction ratio
s_u	undrained shear strength
u_2	measured pore pressure
z	test depth below bottom of the borehole

Greek

α	net area ratio of cone
γ'	submerged unit weight
γ_w	unit weight of water, assumed to be 9.81kN/m^3
Δu	excess pore pressure
σ_{v0}	*in situ* vertical total stress

Abbreviations

BHA	Bottom Hole Assembly
BML	Below Mud Line
CC	Continuous Coring/Sampling Boreholes
COMPANY	TECHNITAL S.p.A and Modimar S.r.l
DGPS	Differential Geographical Positioning System
DOR	Daily Operations Report
DP	Dynamic Positioning
GEOQUIP	Geoquip Marine Operations AG
GMR	Geoquip Marine Derrick Rig
GSI	Geological Strength Index
HSE	Health Safety and Environment
HRAT	High Resolution Acoustic Televiewer
ITRF	International Terrestrial Reference Frame
LAT	Lowest Astronomical Tide
LT	Local Time
ML	Mud Line
OPM	Offshore Project Manager
PCD	Polycrystalline Diamond Bit
PCPT	Piezocone Penetration Test with pore pressure measurement
PLI	Point Load Index
PLT	Point Load Test
PM	Project Manager
QINSy	Quality Integrated Navigation System
RMR	Rock Mass Rating
SCPT	Seismic Cone Penetration Testing
SBF	Seabed Frame
SVP	Sound Velocity Profile
TR	Tip Resistance
USBL	Ultra-short baseline
UU	Unconsolidated Undrained Triaxial

1. PROJECT SUMMARY

1.1 Overview

Geoquip Marine Operations AG (GEOQUIP) were contracted by TECHNITAL S.p.A and Modimar S.r.l (COMPANY) to complete a geotechnical investigation, located in close proximity to the Port of Genoa, Italy. The purpose of the site investigation was to determine soil stratigraphy, classification, engineering parameters and depth to rockhead for a planned breakwater extension.

COMPANY required the completion of a series of boreholes across the site. The nominal and completed scope of work is summarised in Table 1.1 and Table 1.2 respectively.

Fieldwork operations for this project have been conducted from the GEOQUIP owned and operated vessel MV Geoquip Saentis, on which the GEOQUIP owned and operated GMR600 drill rig is installed.

Mobilisation commenced on the 10 December 2020 in the port of Genoa, Italy.

Details of the operations completed during this mobilisation, including equipment calibrations and verifications are outlined in the subsequent sections and appendices of the Mobilisation report (GMOP20-G-013-MOB-01).

Upon completion of port-based mobilisation activities, the MV Geoquip Saentis departed Genoa port on 11 December 2020 at 17:43hrs LT. The vessel arrived at the first location (PCPT-2) on the morning of 12 December 2020 at 03:55hrs LT to begin the site investigation work for COMPANY. Mobilisation was deemed complete at 03:46 on the 12 December 2020, with the signed completion of all onboard calibrations. The fieldworks were conducted between the 12 December 2020 to 5 January 2021. The vessel departed site at 22:20hrs LT 5 January 2021 and arrived at the port of demobilisation (Port of Genoa) at 00:00hrs LT 6 January 2021. All samples were offloaded and released to the COMPANY at 11:42hrs LT 6 January 2021. Client Representatives disembarked the vessel 12:08hrs LT 6 January 2021 deeming completion of demobilisation and completion of project. The project incurred no accidents or injuries.

1.2 Related Documents

Further documents that apply to this project, and which may be referenced herein, include:

- Contract between GEOQUIP and COMPANY
- GEOQUIP Group Integrated Management System Documentation
- GEOQUIP Quality Health Safety and Environment Management System
- GEOQUIP Project Safety Plan including Emergency Response Plan (GMOP20-G-013-PSP-01)
- GEOQUIP Project Execution Plan (GMOP20-G-013-PEP-01)
- GEOQUIP Mobilisation Report (GMOP20-G-013-MOB-01)

1.3 Summary of Fieldworks

The nominal scope of work is summarised in Table 1.1. The completed fieldworks is summarised in

Table 1.2. Nominal and completed borehole locations are presented in Figure 2 and Figure 3, respectively.

Table 1.1 Nominal Scope of Work

Soil Investigation – Sampling and PCPT		
Borehole No (n.)	Target Depth (m)	Type (-)
CC-1	40	CC
PCPT-1	40	PCPT
CC-2	40	CC
PCPT-2	40	PCPT
CC-3	80	0-40m CC/40-80m CC/PCPT
PCPT-3	40	PCPT
CC-4	80	0-40m CC/40-80m CC/PCPT
PCPT-4	40	PCPT
PCPT-5	40	PCPT
CC-5	40	CC
PCPT-7	40	PCPT
CC-7	80	0-40m CC/40-80m CC/PCPT
PCPT-6	40	PCPT
CC-6	40	CC
Total	680	-
Notes: Coring/ Sampling (CC) total length of 340 m PCPT (PCPT) total length of 340 m		

Table 1.2 Summary of Completed Fieldworks

Soil Investigation – Sampling and PCPT			
Borehole No (n.)	Priority	Actual Depth (m)	Type (-)
CC-1	5	16.20	CC
PCPT-1	6	25.00	PCPT
CC-2	8	40.40	CC
PCPT-2	1	41.86	PCPT
CC-3	3	46.15	CC
PCPT-3	2	34.40	PCPT
CC-4	11	80.36	0-40m CC/40-80m CC/PCPT
PCPT-4	7	42.52	PCPT
PCPT-5	4	42.32	PCPT
CC-5	14	22.95	CC
PCPT-7	9	10.85	PCPT
CC-7	10	42.38	CC (1 x PCPT stroke)
PCPT-6	15	47.25	PCPT
PCPT-6A	15a	81.28 (42.20 Drill Out)	PCPT/CC
CC-6	13	47.90	PCPT/CC
PCPT-8	12	4.30	PCPT/CC
PCPT-8A	16	65.05	PCPT/CC
Total	-	648.97	-
Notes: Coring/ Sampling (CC) total length of 168.08m PCPT (PCPT) total length of 244.20m CC/PCPT Alternating total length of 236.69m.			

The addition of PCPT-8 was agreed between GEOQUIP and COMPANY during the campaign. PCPT-6 and PCPT-8 were terminated early due to safety concerns over deteriorating weather conditions. Target depths were not reached and subsequent bump over locations were performed (PCPT-6A and PCPT-8A).

All In situ Test Results; Raw and Derived logs for all the completed locations are presented in Appendix A.

A summary of all Sampling and Offshore Laboratory Testing results is presented in Appendix B. The total number of tests completed offshore are summarised in Table 5.1.

All coordinates and water depths for completed fieldworks are displayed in Table 1. Fieldwork documentation are provided in Appendix C. Water depth measurements were conducted at the start of each location by measuring the drill string length from the Seabed Frame (SBF) on the seabed to the Drill Floor on the vessel with compensation (minimal weight) to ensure that both accurate water depth measurements and undisturbed samples could be obtained from mudline. The measurements are then reduced to sea level at Lowest Astronomical Tide (LAT).

1.4 Geotechnical Drill Rig

All boreholes were completed using the geotechnical drill rig, the GMR600 installed on MV Geoquip Saentis. The GMR600 is a heave-compensated marine drill rig and is located over a central moonpool. The main details of the rig are summarised in Table 1.3 and a full specification is provided in Appendix D.

Table 1.3 GMR600 Drilling Rig

Type	Rotary marine drill
Heave Compensation	4.0m stroke passive heave compensation using nitrogen gas as compensation buffer
Drill String	600m 5½"
Standard drill bits	Winged open centre drag bits
Mud valve	Allows passage of downhole tools without need to break drill string
Drill mud	Typically, seawater miscible biodegradable Guar Gum
Seabed Frame	15t, with hydraulic clamps
Downhole tools	Hydraulic piston/push sampler (70.2mm ID Shelby tubes and 66.2mm ID Shelby tubes), percussion/hammer sampler WISON SCPT (Cone Penetration Test with seismic velocity measurements) 1.6m and 3.0m stroke units, 5 cm^2 and 10cm^2 cones

1.5 Vessel Specification

Brief details of the vessel are given in Table 1.4 below, and a full specification is provided in Appendix D.

Table 1.4 MV Geoquip Saentis

Length Overall	80.50m
Beam	18.0m
Maximum Loaded Draft	6.10m
Main Engines	2 x MAK 8L26 – 4,800 kW, 750 rpm
Dynamic Positioning	IMO Class 2 – Kongsberg K-Pos DP-21
Accommodation (Berths)	55 No.

1.6 HSE Statistics

The project ran for a total of 28 days, from start of project mobilisation to end of demobilisation. During this time there were 14,196 exposure hours based on a 12-hour day. Table 1.5 provides the cumulative total HSE statistics. For full details please refer to the Daily Operation Reports (DORs) presented in Appendix E.

Table 1.5 HSE Statistics

Event	Cumulative total during project
Major Accident/Incident	0
First Aid Case	0
Near Miss	0
Unsafe Act	0
Unsafe Condition	0
Safety Drill	4
Toolbox Talk Etc	136
Safety Meeting	15
OBS Card Received	63
Exposure Hours (12-hour Day)	14,196

1.7 Project Organization

A summary of the various parties involved in the offshore aspects of this site investigation are summarised in Table 1.6.

Table 1.6 Project Organisation

Party	Role	Asset Provision/Responsibility
TECHNITAL S.p.A and Modimar S.r.l (COMPANY)	Client	Project Management Decisions regarding scope of work Fisheries Liaison Officer
Socotec	Client Representatives	Offshore Client Representatives Geological guidance
Geoquip Marine Operations AG (GEOQUIP)	Geotechnical Contractor	Project Management Provision of geotechnical drill rig, drilling personnel and geotechnical personnel, positioning equipment and positioning personnel Production of geotechnical reporting
	Vessel Owners	Vessel Operation Provision of marine crew Food provisions

2. DRILLING OPERATIONS

2.1 Overview

The nominal scope of work and completed fieldworks is summarised in Section 1.3. The total number of geotechnical attempted during fieldworks is summarised below.

- Geotechnical borehole locations: 15
- Bump over locations: 2

All drilling was completed utilising the equipment outlined in Section 1.4. All soft soil boreholes were drilled using winged open centre drag bits. Any locations where competent rock was encountered, a Polycrystalline Diamond Compact (PCD) bit was utilised. Each borehole was flushed and stabilised using a either Guar Gum or a mixture of Guar Gum and BioVis drilling mud. The 15t Seabed Frame (SBF) provided the required reaction during drilling, sampling and testing. Daily Drillers Logs and DORs are presented in Appendix E and a summary of events is outlined in Section 7.

2.2 Operational Constraints

Prior project mobilisation and during the campaign, various borehole locations underwent a seabed assessment by the onboard surveyor and OPM. Locations CC-1, PCPT-1, CC-5 and PCPT-5 were relocated in agreement with COMPANY and Client Representatives due to concerns with obstructions or inclination identified from bathymetry and geophysical data.

Boreholes CC-3, PCPT-3 and PCPT-8A were terminated early due to presence of deep gravels and subsequent threat of hole collapse. Both locations recorded over 20m depth of mixed lithologies gravels. Offshore Client Representative agreed enough data had been collected at all locations and it was reasonable to terminate the boreholes at their respective depths.

Boreholes CC-1, CC-5, PCPT-1 and PCPT-7 were terminated early due to presence of rock. It was agreed between GEOQUIP and COMPANY before the campaign that once competent rock had been encountered, GEOQUIP were to explore a further 3.00m into the competent rock head before terminating the borehole.

Deteriorating weather conditions dominated the latter part of the project with strong southernly swells and erratic northernly winds. As a result, boreholes PCPT-6 and PCPT-8 were terminated early due to safety concerns over deteriorating weather conditions. Target depths were not reached and subsequent bump over locations were performed (PCPT-6A and PCPT-8A).

3. IN SITU TESTING OPERATIONS

3.1 Overview

A total of 13 boreholes involving in situ testing were completed at 10 locations during this campaign. The completed boreholes and subsequent testing regimes are presented below.

A total of 3 continuous PCPT boreholes:

- PCPT-2
- PCPT-3
- PCPT-4

A total of 4 primarily continuous PCPT boreholes with sample collection where necessary:

- PCPT-1
- PCPT-5
- PCPT-6
- PCPT-7

A total of 4 alternating sampling/PCPT boreholes:

- CC-6
- PCPT-6A (bumpover)
- PCPT-8
- PCPT-8A (bumpover)

1 borehole involving continuous sampling from seabed to 40 m, followed by alternating sampling/PCPT to 80 m:

- CC-4

1 primarily continuous sampling borehole with the exception of 1 PCPT stroke:

- CC-7

3.2 Equipment Calibrations and Verifications

All relevant offshore laboratory equipment and PCPT equipment were calibrated during the mobilisation phase of the project.

All PCPT cones were calibrated prior to the project with verifications performed during mobilisation. Calibration certificates and verification data for PCPT cones are presented Appendix D.

3.3 Downhole PCPT Tests

3.3.1 Equipment and Results Overview

All PCPT testing was completed using the GEOQUIP downhole PCPT tool. Several PCPT cones were made available during the project which included both 10cm² compression and subtraction cones. Two tool lengths were available; 1.6m and 3.0m. A summary of the cones used during this project is summarised in Table 2.

During testing, all data was observed topside in real time. The following channels were recorded during testing:

- Penetration depth
- Cone resistance

- Local friction
- Pore water pressure

The initial test depth is referenced using the measured drill string depth below mudline.

Presentation of PCPT results is discussed in Section 6.

3.3.2 Downhole PCPT Testing Procedure

All PCPT testing was conducted by the Tool Operators with direction from the Shift Engineers. PCPT testing was conducted with a rate of penetration of approximately 2cm/s. All tests were taken to full stroke unless the Tool Operator terminated the test early. Refusal of the test may occur for a variety of reasons including but not limited to avoidance of equipment damage and to ensure data integrity.

The testing was completed in accordance with ISO 22476-1 and with GEOQUIP procedures. Nominally all PCPT tests aimed to recover Class 1 for soft or loose soil and application Class 2 in stiff clays and sands. PCPT data acquired are presented graphically against depth in Borehole logs in Appendix A including Raw and Derived results.

3.3.3 Commentary on Downhole PCPT Tests

All the tests achieved application class 1 as per ISO 19901-8 (2014). A summary of PCPT test results including deck to deck offset is presented in Table 3. A good correlation has been found between the logged descriptions of recovered samples and of the interpreted soil behaviour from PCPT data.

The offsets shown in Table 3 follow the ISO 19901-8 (2014) procedure for allowable minimum accuracy for each measured parameter. The offset is calculated off the larger of the relative or absolute values.

3.3.4 Dissipation Test

The dissipation test measures the decay of pore water pressure over a specified amount of time.

A PPDT was undertaken during PCPT at a selected depth as directed by the onboard client representative. To start the test the penetration during the selected PCPT was stopped and the initial pore pressure was recorded. The pore water pressure (u2) was then continuously measured against time in seconds. When the required dissipation value has been met, in this case it was at least 60% dissipation, the dissipation test is deemed complete and the PCPT penetration resumes to complete the PCPT as required.

Dissipation results are presented in Appendix A.

3.3.4.1 Commentary

The majority of the dissipation tests were performed in granular units therefore there was little to no excess pore pressure at the start of the test. These tests have not been included in the report as there was not pore dissipation.

4. SAMPLING OPERATIONS

4.1 Overview

A total of 14 boreholes involving sampling were completed at 12 locations during this campaign. The completed boreholes and subsequent testing regimes are presented below. Presentation of recovered sample results is discussed in Section 6.

A total of 4 continuous sampling boreholes:

- CC-1
- CC-2
- CC-3
- CC-5

A total of 4 primarily continuous PCPT boreholes with sample collection where necessary:

- PCPT-1
- PCPT-5
- PCPT-6
- PCPT-7

A total of 4 alternating sampling/PCPT boreholes:

- CC-6
- PCPT-6A (bumpover)
- PCPT-8
- PCPT-8A (bumpover)

1 borehole involving continuous sampling from seabed to 40 m, followed by alternating sampling/PCPT to 80 m:

- CC-4

1 primarily continuous sampling borehole with the exception of 1 PCPT stroke:

- CC-7

4.2 Equipment Overview

Sampling was conducted by piston sampling with medium-walled Shelby tubes or push sampling with medium and thick-walled Shelby tubes. The equipment combinations available offshore are detailed below in Table 4.1.

Table 4.1 Sampling Equipment Overview

Sampling Tool	Shelby Tube					General soil conditions
	Shelby	D_O (mm)	D_i (mm)	Stroke Length (m)	Catcher	
Push	Thick-wall	76.2 76.2	66.2 76.2	0.45 1	Rigid/plastic No	Very dense sands/gravels
	Medium-wall	76.2	70.2	1	No	Medium to extremely high strength clays/sands
Piston	Thin-wall	76.2	72.2	1	No	Low to medium strength clays
	Medium-wall	76.2	70.2	1	No	Medium to extremely high strength clays/sands
	Thick-wall	76.2 76.2	66.2 76.2	0.45 1	Rigid/plastic No	Very dense sands/gravels
Hammer	N/A	76.2	66.2	0.3	Rigid/plastic	Very dense sands/gravel, weathered rock
	N/A	50.8	40.8	0.3	Rigid/plastic	
Core Barrel	T 2-101	101	83.6	1.5	Yes	Over consolidated clay and rock

Notes:

D_O = Outer diameter

D_i = Inner diameter

Further details are presented in Appendix D.

4.3 Sample Handling Procedure

Sample handling was performed by the Laboratory Technicians and Shift Engineers onboard the vessel with the use of the dedicated soils laboratory onboard. Sample handling, logging and testing was conducted in accordance with relevant standards and with the GEOQUIP procedure GM-MSP-OI-5-3-3. Sampling logging was conducted in accordance with ISO 19901-8 (2014), ISO 14688-1 (2017), ISO 14688-2 (2017) and ISO 14689 (2017). All undisturbed soil samples were stored in the correct vertical orientation. The procedure is summarised below in Table 4.2.

Table 4.2 Sampling Handling Procedure

Item	Procedure
General	Sampling conducted in general to ISO 19901-8 and in accordance with GEOQUIP procedures (GM-MSP-IO-5-3-3) Recover Shelby tube from drill team Proceed to laboratory
Cohesive material	Lab Vane (undisturbed and remoulded) testing conducted if possible All but 6 samples were extruded offshore, these were retained for onshore testing All samples were photographed prior to further processing Samples split All split samples photographed Laboratory Technicians were to complete classification, index and strength testing after the samples are extruded and split. Strength testing completed using torvane, pocket penetrometer and triaxial Unconsolidated Undrained Triaxial (UU) Undisturbed and UU tested (disturbed) samples were preserved in wax and quart tubes Disturbed samples were stored in bags
Granular material	All but 9 samples were extruded offshore, these were retained for onshore testing All samples were photographed prior to further processing Samples split All split samples photographed Lab Technicians were to complete classification, index and quality carbonate content testing after the samples are extruded and split Disturbed samples were stored in bags
Rock	Core liners were opened offshore All cores were photographed prior to further processing All samples photographed Lab Technicians were to complete classification, index, quality carbonate content and strength (PL) testing on selected samples Core liner was re sealed and core boxes stowed Sub samples were sealed, placed in quart tubes, and stored in core boxes

Further details on methodology are presented in Appendix G. Tests completed in the offshore soil laboratory are discussed in Section 5.

4.4 Onshore Laboratory Testing and Sample Offloading

Samples were stored onboard until they were offloaded and handed to the COMPANY.

4.5 Commentary on Sampling Operations

Sampling operations were completed successfully, yielding good quality samples that correlated well with in situ data. All downhole push and piston samples were performed using GEOQUIPs downhole sampling tool. A combination of medium-walled, thick-walled (1.0m without catcher/ 0.6m with catcher) Shelby tubes were used in order to insure a recovery in diverse range of soil conditions from fine grained materials and loose sands to very dense sands and gravel.

The data gaps were in line with GEOQUIP Project Execution Plan (GMOP-G-013-PEP-01) and as agreed with the onboard client representative. In some instances, the sampling regime was revised to allow for quicker borehole progression. At locations PCPT-6A and PCPT-8A, the regime was substituted from 2m sample/6m CPT to 1m sample/9m. Sample recoveries are presented graphically against depth in Appendix A. Sample photographs are available in the Appendix F.

4.6 Commentary on Coring Operations

Coring operations were completed successfully, demonstrating good quality samples that correlated well with prior soil samples and in situ data. All core logs were recovered using GEOQUIPs downhole Triple Tube wireline Leading

Shoe Core Barrel. A range of loose and competent rock was recovered during rock coring operations. Different drills bits were utilised depending rock type encountered. Where possible a 5-wing or PCD bit (dependant on expected geology) was installed before commencing the borehole to ensure good recovery.

Competent rock was found at locations CC-1, PCPT-1, CC-5 and PCP-7. Most locations with rock demonstrated a transition of interbedded clays and rock, often resulting in a marlstone. Other locations exhibited a more definitive transition from soft soils to competent rock.

5. FIELD LABORATORY

5.1 Overview

After recovery and prior to storage, samples were processed and tested in the offshore soil laboratory. Details of these tests are presented in Appendix G. A summary of all offshore test results is presented in Appendix B. The total number of tests completed offshore are summarised in Table 5.1.

Presentation of offshore laboratory results is discussed in Section 6.

Table 5.1 Summary of Tests Completed Offshore

BH ID	Density tests	Water Content Tests	Pocket Penetrometer Tests	Torvane Tests	Miniature Vane Tests	Unconsolidated Undrained Triaxial Tests	Point Load
CC-1	12	14	9	6	2	-	5
PCPT-1	-	-	1	-	-	-	5
CC-2	49	49	54	50	7	1	-
PCPT-2	-	-	-	-	-	-	-
CC-3	37	22	26	22	4	1	-
PCPT-3	-	-	-	-	-	-	-
CC-4	95	21	92	49	5	-	-
PCPT-4	-	-	-	-	-	-	-
PCPT-5	-	2	-	-	-	-	-
CC-5	27	12	-	-	-	-	3
PCPT-7	-	7	-	-	-	-	-
CC-7	66	8	68	60	6	-	1
PCPT-6	1	3	-	-	-	-	-
PCPT-6a	8	-	11	-	-	-	-
CC-6	18	10	16	6	-	-	-
PCPT-8	3	1	-	6	1	-	-
PCPT-8a	17	8	13	-	3	-	-
Total	333	157	290	199	28	2	14

5.2 Classification Tests

This group of tests are used to classify the principal soil type including the material plasticity and particle characteristics as appropriate.

5.2.1 Water Content

Moisture content tests were carried out shortly after extrusion on samples recovered in the field. The results are plotted against depth on the borehole logs presented in Appendix A and also in tabular form in Appendix B.

5.2.2 Density

Bulk (or wet) and dry density was determined on appropriate extruded samples in the field. The results are plotted against depth on the borehole logs presented in Appendix A and also in tabular form in Appendix B.

5.3 Undrained Shear Strength

5.3.1 Torvane and Pocket Penetrometer

Torvane and pocket penetrometer tests were performed in the field on cohesive soil samples to determine the undrained shear strength. The results are plotted against depth on the borehole logs presented in Appendix A and

also in tabular form in Appendix B. Results from torvane and pocket penetrometer predominantly exhibit good correlation with the in-situ test and Unconsolidated Undrained Triaxial test results.

5.3.2 Miniature Vane

Twenty eight miniature laboratory vane tests were completed on cohesive soil in the offshore laboratory in accordance with ISO 19901-8 (2014). This test is most suitable for very soft to firm clays especially when the soil is too soft for conventional unconsolidated undrained triaxial tests.

The test conducted offshore was performed on the sample before it was extruded. The vane utilised had a diameter between 12.7 mm 25.4mm and the rotation rate was set to 60°/min.

On selected offshore samples residual vane test was performed by completing the undisturbed test then quickly rotating the vane a minimum of 5 times before commencing the test again.

The peak result is plotted against depth on the borehole log presented in Appendix A. Both peak and residual results are also available in tabular form in Appendix B.

5.3.3 Unconsolidated Undrained Triaxial

Unconsolidated Undrained Triaxial (UU) tests were conducted on cohesive soil in the offshore laboratory in accordance with ISO 19901 to determine the undrained shear strength. The results are plotted against depth on the borehole logs presented in Appendix A and in tabular form in Appendix B. UU test results predominantly exhibit good correlation with the in-situ test results, torvane and pocket penetrometer results.

Stress versus strain plots of all UU tests completed offshore are presented in Appendix B.

UU tests ran to 15% axial strain and were conducted with confining pressures equal to the total in situ vertical stress or the maximum possible cell pressure.

Results from UUs were used to confirm the relationship between in situ data and undrained shear strength. This is discussed in Section 6.

5.3.4 Point Load Tests

Point load tests (PLT) were conducted on rock samples in accordance with ISRM Suggested Method for Determining Point Load Strength (1985) and ASTM D5731-16. The results are plotted against depth on the borehole logs presented in Appendix A.

5.4 Equipment Calibrations and Verifications

Geotechnical equipment provided onboard is factory or professionally calibrated where appropriate; calibration checks and verifications were carried out during mobilisation. Calibration certificates and verification data for the laboratory equipment are presented in Appendix D.

6. PRELIMINARY BOREHOLE LOGS

6.1 Overview

All PCPT data and sampling data are presented on the borehole logs presented in Appendix A. All composite borehole logs incorporate PCPT and sampling data from the same boreholes inclusive of bump overs.

The following are presented respective logs:

1. Borehole Log
    a. PCPT, sampling and coring key
    b. Soil/Rock Description and Layering
    c. Fracture State (where applicable)
        i. Rock Quality Designation (RQD)
        ii. Solid Core Ratio (SCR)
        iii. Total Core Ratio (TCR)
    d. Raw Results
        i. Depth
        ii. Sleeve Friction
    e. Derived Results
        i. Net Cone Resistance
        ii. Pore Pressure Ratio
        iii. Undrained Shear Strengths from q_{net}
        iv. Relative Density
    f. Offshore laboratory test results
        i. Water Content, and Bulk and Dry Densities
        ii. Undrained Shear Strength from UU, Miniature Vane, Torvane and Pocket Penetrometer
        iii. Strength from Point Load
2. Logs of Raw In Situ Test Results
    a. PCPT key
    b. Raw Results
        i. Depth
        ii. Cone Resistance
        iii. Sleeve Friction
        iv. Excess Pore Pressure
3. Logs of Derived In Situ Test Results
    a. PCPT key
    b. Raw Results
        i. Depth

ii. Sleeve Friction

c. Derived Results

i. Net Cone Resistance

ii. Pore Pressure Ratio

iii. Friction Ratio

6.2 Soil Descriptions and Layering

The soil descriptions presented on the borehole logs are based on the field description of recovered samples and interpretations of the PCPT data.

6.3 PCPT Results

Raw and derived results are presented in Appendix A. A summary of these results including details of calculations is presented in Appendix G.

6.3.1 Undrained Shear Strength

Undrained Shear Strength (s_u) is empirically derived from PCPT data using N_{kt} factors calibrated from undrained shear strength results from Unconsolidated Undrained Triaxial tests completed during fieldworks.

Undrained shear strength can be estimated from PCPT data using the following relationship (Lunne et al., 1997).

$$s_u = \frac{(qt - \sigma_{v0})}{N_{kt}}$$

where:

S_u = Undrained shear strength

qt = Cone resistance, corrected for pore water pressure effects

σ_{v0} = In-situ total vertical stress (total overburden)

N_{kt} = Empirical cone factor

For the entire site a N_{kt} factor range of 15 to 20 has been used based on the available offshore data. This is found to be a suitable most of the cohesive materials encountered. Following the completion of onshore laboratory testing the N_{kt} range should be reviewed.

A graphical representation of the derived undrained shear strength alongside measured laboratory data is presented on the borehole logs presented in Appendix A.

6.3.2 Relative Density

In situ relative density can be determined from the results of PCPTs based on the cone resistance as follows (Jamiolkowski et al., 2003):

$$D_r(dry) = \frac{1}{0.0296} \cdot ln\left[q_c / \left[2.494 \cdot \left[\frac{\sigma'_{v0} \cdot \left[\frac{1 + 2 \cdot K_0}{3}\right]}{100}\right]^{0.46}\right]\right]$$

$$D_r(saturated) = \left[\frac{-1.87 + 2.32 \cdot ln\frac{1000 \cdot q_c}{(100 \cdot \sigma'_{v0})^{0.5}}}{100} + 1\right] \cdot D_r(dry)$$

where: D_r (dry) = Estimated dry relative density (%)

D_r (saturated)	=	Estimated saturated relative density (%)
q_c	=	Measured cone resistance (MPa)
σ'_{v0}	=	Vertical effective overburden stress (kPa)
K_0	=	Coefficient of lateral earth pressure (1.0)

A graphical representation of the relative density is presented on the borehole logs presented in Appendix A.

6.4 Fracture State

6.4.1 Total Core Recovery

The average total core recovery was approximately 63% ranging from 10% to 100%. In general, the TCR increased with depth being generally >75% beyond weathered rockhead.

6.4.2 Solid Core Recovery

The average solid core recovery was approximately 21% ranging from 0% to 73%. In general, the SCR increased with depth.

6.4.3 Rock Quality Designation

The average rock quality designation was approximately 17% ranging from 0% to 73%. In general, the RQD increased with depth.

6.5 Rock Mass Classification

Rock Mass Classification was conducted on rock cores in accordance with ASTM 5878-19, Standard Guides for Using Rock-Mass Classification Systems for Engineering Purposes. Both, Rock Mass Rating (RMR), and Geological Strength Index (GSI), were determined. The RMR is incomplete as the RMR performed here is based on rock cores collected in a marine environment and therefore is unable to accurately provide an assessment of: Groundwater; Strike & Dip Orientation; Discontinuity Length; Separation and therefore should be treated with caution. The criteria used for RMR are presented in the PEP (GMOP-G-013-PEP-01). The results of RMR and GSI are presented in Table 6.1.

Table 6.1 RMR & GSI for CC-1, CC-5 PCPT-1 & PCPT-7

Borehole	Core run number	Depth range (m)	Ratings				RMR Rating	GSI
			A1 – Strength	A2 – RQD	A3 – Spacing of discontinuities	A4 – Condition of discontinuities		
CC-1	CR14A	10.25-10.50	-	-	-	-	-	-
CC-1	CR15	11.00-11.65	7	0	10	10	27	50
CC-1	CR16	12.00-13.00	NR	NR	NR	NR	NR	NR
CC-1	CR16A	12.00-12.25	4	0	5	10	19	25
CC-1	CR17	13.00-13.70	4	8	5	10	27	45
CC-1	CR18	14.00-14.80	2	13	9	20	44	55
CC-1	CR19	15.00-16.10	4	13	10	20	47	60
CC-5	CR19	15.60-15.70	-	-	-	-	-	-
CC-5	CR21C	17.00-17.30	-	-	-	-	-	-
CC-5	CR22	17.50-17.60	-	-	-	-	-	-
CC-5	CR26	19.60-19.85	-	-	-	-	-	-
CC-5	CR27	20.00-20.50	NR	NR	NR	NR	NR	NR
CC-5	CR28	20.50-25.75	-	-	-	-	-	-
CC-5	CR29	21.00-21.30	-	-	-	-	-	-
CC-5	CR30	21.50-21.80	-	-	-	-	-	-
CC-5	CR31	22.00-22.10	-	-	-	-	-	-
CC-5	CR32	22.50-22.95	2	3	8	20	33	25
PCPT-1	CR08A	18.00-19.00	NR	NR	NR	NR	NR	NR
PCPT-1	CR09A	19.00-19.60	-	-	-	-	-	-
PCPT-1	CR10	20.00-20.50	-	-	-	-	-	-
PCPT-1	CR11	21.00-21.70	-	-	-	-	-	-
PCPT-1	CR12	22.00-22.85	7	8	8	0	23	35
PCPT-1	CR13	23.00-23.75	4	3	5	0	12	30
PCPT-1	CR14	24.00-25.00	2	8	8	0	18	25
PCPT-7	CR08B	9.30-10.25	5	13	8	20	46	60
PCPT-7	CR09	10.30-10.85	-	-	-	-	-	10

Notes:

NR No recovery

\- RMR/GSI not determined due to poor recovery or non-competent rock

6.6 Fracture Index

Fracture index have been assessed as number of fractures per core run. The results of FI are presented in Table 6.2 below.

Table 6.2 FI for CC-1,CC-5 PCPT-1 & PCPT-7

Borehole	Core run number	Depth range (m)	FI
CC-1	CR14A	10.25-10.50	-
CC-1	CR15	11.00-11.65	-
CC-1	CR16	12.00-13.00	-
CC-1,	CR16A	12.00-12.25	-
CC-1	CR17	13.00-13.70	1
CC-1	CR18	14.00-14.80	1
CC-1	CR19	15.00-16.10	4
CC-5	CR19	15.60-15.70	-
CC-5	CR21C	17.00-17.30	-
CC-5	CR22	17.50-17.60	-
CC-5	CR26	19.60-19.85	-
CC-5	CR27	20.00-20.50	-
CC-5	CR28	20.50-25.75	-
CC-5	CR29	21.00-21.30	-
CC-5	CR30	21.50-21.80	-
CC-5	CR31	22.00-22.10	-
CC-5	CR32	22.50-22.95	7
PCPT-1	CR08A	18.00-19.00	-
PCPT-1	CR09A	19.00-19.60	-
PCPT-1	CR10	20.00-20.50	-
PCPT-1	CR11	21.00-21.70	-
PCPT-1	CR12	22.00-22.85	2
PCPT-1	CR13	23.00-23.75	2
PCPT-1	CR14	24.00-25.00	6
PCPT-7	CR08B	9.30-10.25	3
PCPT-7	CR09	10.30-10.85	-

Notes:

- FI not determined due to poor recovery or non-intact rock

7. LOG OF FIELD OPERATIONS

A summary of key events is presented below. For more details refer to DORs presented in Appendix E.

Times quoted on the DOR and in the descriptions below are all in local time, GMT +1 hours. Copies of Daily Operations Reports are agreed and signed by the GEOQUIP Offshore Project Manager and the onboard COMPANY Representatives.

Table 7.1 Summary of Field Operations

Date	Time	Event
10th Dec 2020	00:00hrs LT	Mobilisation Commencement
12th Dec 2020	03:46hrs LT	Calibrations Complete
12th Dec 2020	03:46hrs LT	Mobilisation Complete
12th Dec 2020	07:40hrs LT	Broken ground on First Location (PCPT-2)
12th Dec 2020	23:55hrs LT	PCPT-2 Borehole Complete
13th Dec 2020	19:50hrs LT	PCPT-3 Borehole Complete
15th Dec 2020	11:42hrs LT	CC-3 Borehole Complete
16th Dec 2020	02:34hrs LT	PCPT-5 Borehole Complete
17th Dec 2020	06:05hrs LT	CC-1 Borehole Complete
17th Dec 2020	21:45hrs LT	PCPT-1 Borehole Complete
18th Dec 2020	12:15hrs LT	PCPT-4 Borehole Complete
19th Dec 2020	10:05hrs LT	CC-2 Borehole Complete
20th Dec 2020	08:10hrs LT	PCPT-7 Borehole Complete
21st Dec 2020	10:53hrs LT	CC-7 Borehole Complete
21st Dec 2020	15:00hrs LT	Vessel alongside in Port of Genoa. Port call. Take on stores and water.
21st Dec 2020	23:00hrs LT	Vessel departs Port of Genoa. Returns to Site.
23rd Dec 2020	15:50hrs LT	CC-4 Borehole Complete
24th Dec 2020	00:50hrs LT	PCPT-8 Borehole abandoned due to severe weather.
24th Dec 2020	03:15hrs LT	Weather Standby (Start)
25th Dec 2020	23:15hrs LT	Weather Standby (End)
26th Dec 2020	00:07hrs LT	Begin operations at CC-6
26th Dec 2020	22:00hrs LT	Downtime Rig
27th Dec 2020	00:00hrs LT	Ongoing maintenance on top drive
27th Dec 2020	21:20hrs LT	CC-6 Borehole abandoned at 47.90m BSB due to deteriorating weather conditions
28th Dec 2020	14:40hrs LT	Vessel alongside in Port of Genoa. Continued work on top drive.
29th Dec 2020	00:00hrs LT	Waiting on weather. Ongoing preparation for operations
30th Dec 2020	13:40hrs LT	Vessel departs Port of Genoa. Returns to Site.
31st Dec 2020	15:10hrs LT	CC-5 Borehole Complete
31st Dec 2020	18:30hrs LT	Begin operations at PCPT-6
31st Dec 2020	21:45hrs LT	Weather Standby (Start)
31st Dec 2020	23:00hrs LT	Weather Standby (End)
1st Jan 2021	23:44hrs LT	Weather Standby (Start)
2nd Jan 2021	13:55hrs LT	PCPT-6 Borehole abandoned at 47.25m BSB due to deteriorating weather conditions
3rd Jan 2021	12:30hrs LT	Weather Standby (End)
4th Jan 2021	05:07hrs LT	PCPT-6A Borehole Complete
4th Jan 2021	19:20hrs LT	Weather Standby (Start)

Date	Time	Event
5th Jan 2021	01:00hrs LT	Weather Standby (End)
5th Jan 2021	19:52hrs LT	PCPT-8A Borehole Complete
5th Jan 2021	22:50hrs LT	Vessel departs from Site.
6th Jan 2021	00:00hrs LT	Vessel alongside in Port of Genoa.
6th Jan 2021	12:08hrs LT	Samples and Client Representatives offloaded. Demobilisation Complete. Project Complete

8. POSITIONING AND WATER DEPTH MEASUREMENTS

8.1 Overview

Positioning data, results, deployment logs and associated information, including target and actual borehole positions, are provided in Appendix C.

Prior to operations and as part of mobilisation, all positioning equipment underwent calibration or verification, where applicable. The results of these verifications as agreed and signed by COMPANY representative are presented in Appendix D.

8.2 Positioning

The vessel is equipped with two stand-alone DGPS HPR (Sonardyne Ranger 2) systems which operate using two independent differential signal deliveries, the system applies real-time corrections to achieve decimetre accuracy for positioning. The HPR system is linked to QINSy (Quality Integrated Navigation System), GEOQUIP's navigation system.

QINSy can receive, time stamp and log all positioning and peripheral data required throughout the project. Furthermore, QINSy's graphic user interface visually presents the vessels position relative to the project geodesy and proposed worksite location.

QINSy uses WGS-84 for position calculation, with 'online' transformation to local datums in real-time through geodetic datum shift parameters. Vessel and antenna offsets are entered into the system to allow specific positioning datum selection such as moonpool position. Quality control of all positioning system components is continuous, with navigation data logged to paper hard copy and magnetic or optical media as required.

Positioning of the seabed frame was verified using the Ranger 2 system. The HPR transceiver is connected to a hull-mounted pole with the subsea transponder fitted on the seabed frame.

Following equipment installation on the vessel, pre-deployment checks will be completed, and the following calibration and verification procedures were performed prior to departure:

- Vessel and sensor offset measurements
- Positioning system verification (as required)
- Heading system calibration

8.3 Water Depth

Water depth measurements were conducted at the start of each location by measuring the drill string length from the Seabed Frame (SBF) on the seabed to the Drill Floor on the vessel with compensation (minimal weight) to ensure that both accurate water depth measurements and undisturbed samples could be obtained from mudline. The measurements are then reduced to sea level at Lowest Astronomical Tide (LAT). The water depth were additionally measured at each borehole location throughout operations by an echosounder fitted into the vessel's hull 21.3m forward of the Drill String. A continuous log of water depth was recorded for tidal variation purposes using the echosounder. Any tidal variation corrections were applied during drilling operations to ensure the correct borehole depth was being measured from the vessel.

Sound Velocity Profile (SVP) dips were conducted where necessary to allow for calibration of the echosounder.

8.4 Project Geodetics

The project geodetics as supplied by COMPANY are defined below.

Table 8.1 Project Geodetics

Working Spheroid	
Datum:	Roma 40
Spheroid:	WGS84
Semi-major, a:	6378388
Semi-minor, b:	TBC
Inverse flattening, 1/f:	297.00000000

Working Projection	
Grid:	UTM 32N
Projection Type:	Transverse Mercator
Zone:	32N
Central Meridian:	09° 00’00.00’’
Latitude Origin:	00° 00’00.00’’
Grid Easting:	1500000.00
Grid Northing:	0.00
Scale Factor on CM:	0.9996
Units:	Meter

9. REFERENCES

BS 5930, (1999), “Code of Practice for Site Investigations”.

International Standards Organisation (ISO), 14688-1 (2017), Geotechnical Investigation and Testing – Identification and Classification of Soil. Identification and description.

International Standards Organisation (ISO),14688-2 (2017), Geotechnical Investigation and Testing – Identification and Classification of Soil. Principles for a classification.

International Standards Organisation (ISO), 14689-1 (2017), Geotechnical Investigation and Testing – Identification, description and classification of rock.

International Standards Organisation (ISO), 19901-8 (2014), Petroleum and Natural Gas Industries – Specific Requirements for Offshore Structures. Part 8: Marine Soil Investigations.

International Standards Organisation (ISO), 22476-1 (2012), Geotechnical Investigation and Testing – Field testing. Part 1: Electrical cone and piezocone penetration tests.

Jamiolkowski, M., Lo Presti, D. C. F., & Manassero, M. (2001). “Evaluation of relative density and shear strength of sands from CPT and DMT”, Soil behaviour and soft ground construction, pp. 201-238.

Lunne, T., Robertson, P.K. and Powell, J.J.M., (1997), "Cone Penetration Testing", Blackie Academic & Professional, pp. 64-67.

Standard, ASTM. D2850-15.“. Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.” ASTM International.

ISRM Suggested Method for Determining Point Load Strength (1985).

ASTM D5731- 16, Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications.

ASTM 5878-19, Standard Guides for Using Rock-Mass Classification Systems for Engineering Purposes.

FIGURES

Figure 1 General Location Plan

GIS-TEMP-GeneralOverview-RevB1

Client: TECHNITAL S.p.A and Modimar S.r.l
Project Name: Genoa Port Extension Geotechnical Survey (PFTE)
Project Number: GMOP20-G-013

GEOQUIPMARINE

General Location Plan

Ref.: GMOP20-G-013-FLD-01

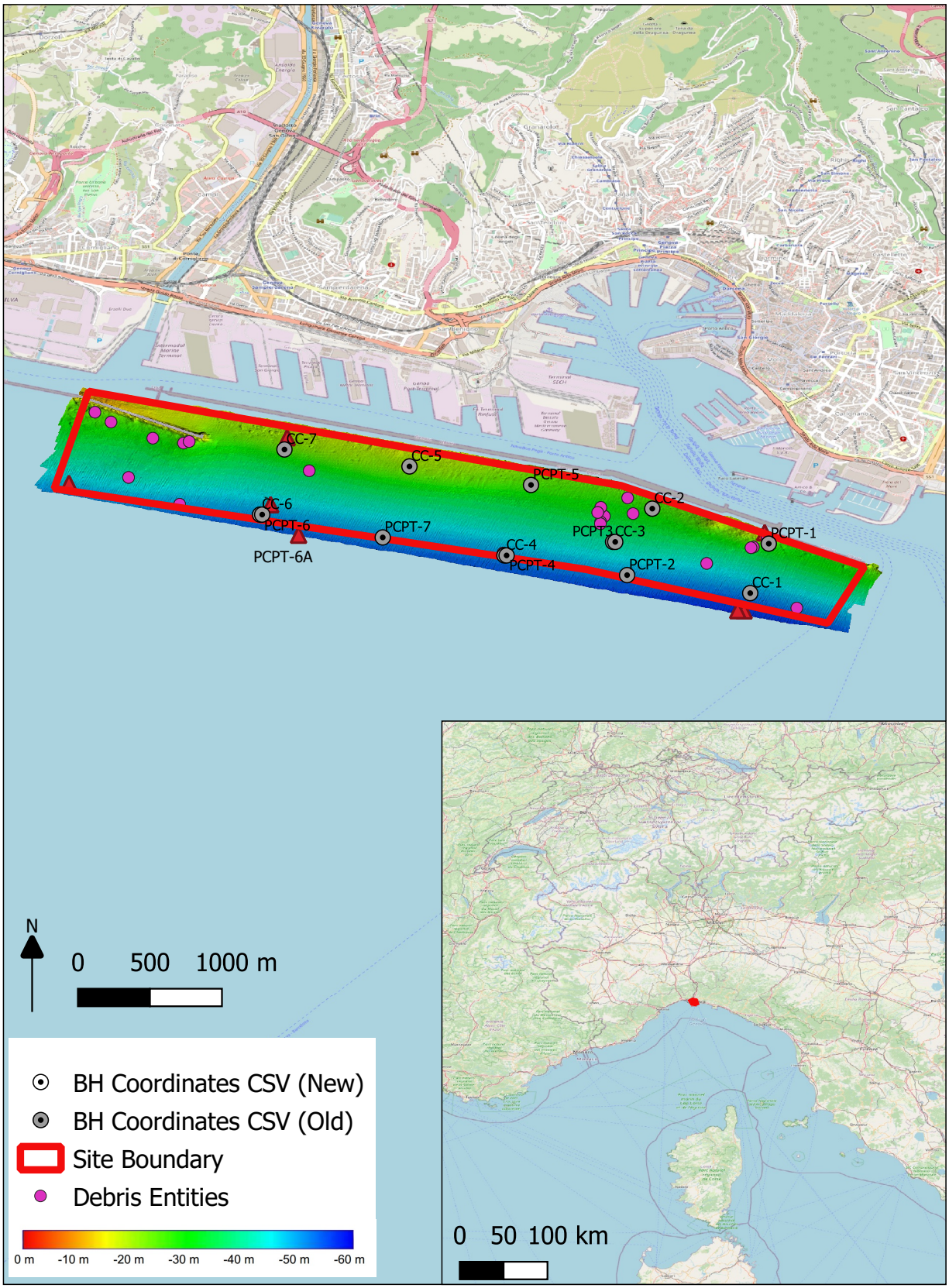
Figure Number: 1

Figure 2 Nominal Borehole Location Plan

GIS-TEMP-GeneralOverview-RevB1

Client: TECHNITAL S.p.A and Modimar S.r.l
Project Name: Genoa Port Extension Geotechnical Survey (PFTE)
Project Number: GMOP20-G-013

GEOQUIPMARINE



Nominal Borehole Location Plan

Ref.: GMOP20-G-013-FLD-01

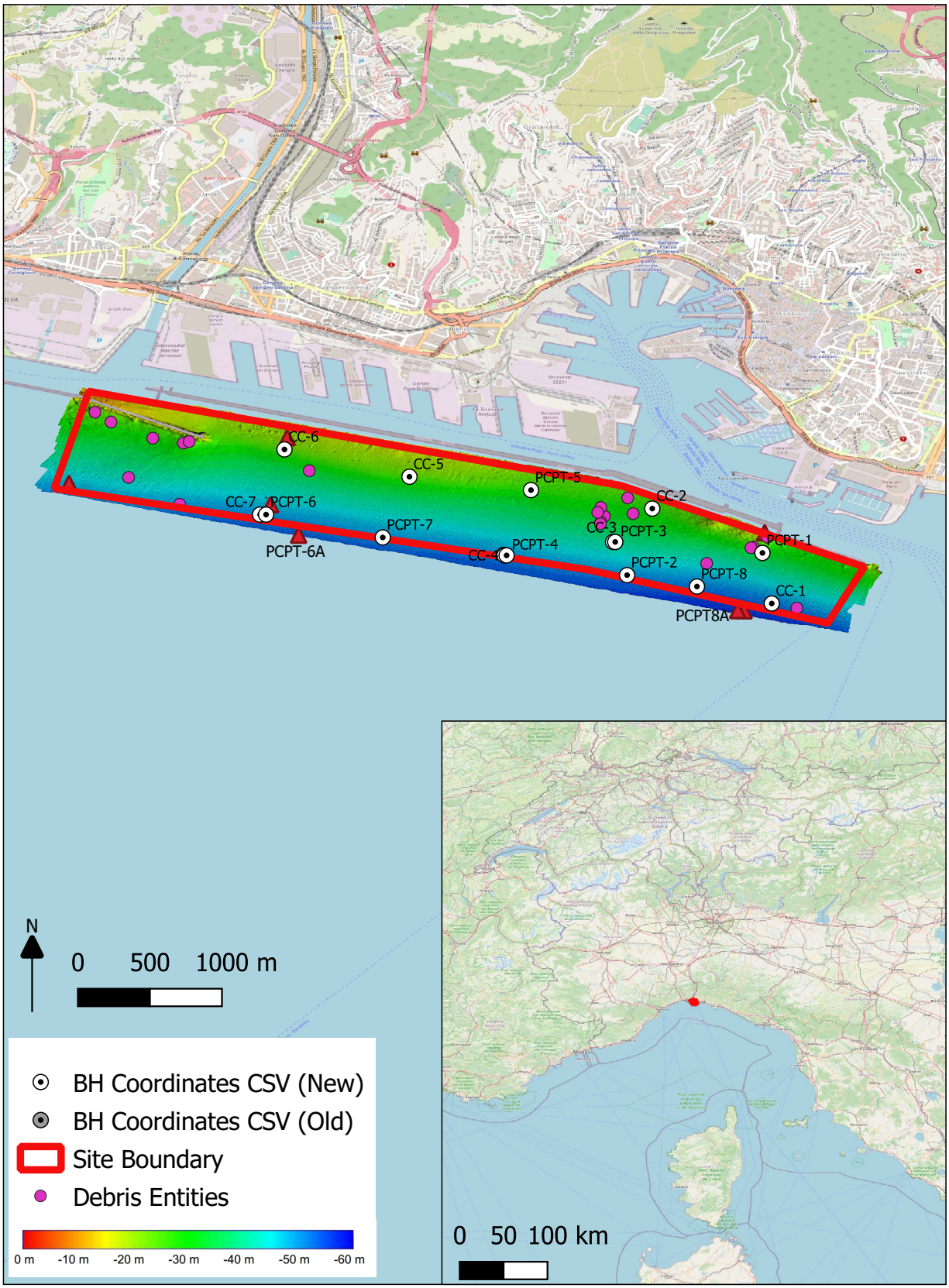
Figure Number: 2

Figure 3 Completed Borehole Location Plan

GIS-TEMP-GeneralOverview-RevB1

Client: TECHNITAL S.p.A and Modimar S.r.l
Project Name: Genoa Port Extension Geotechnical Survey (PFTE)
Project Number: GMOP20-G-013

GEOQUIPMARINE



Completed Borehole Location Plan

Ref.: GMOP20-G-013-FLD-01

Figure Number: 3

TABLES

Table 1 Borehole Summary

Location ID	Target		Actual		Depth (m)	Date Commenced	Water Depth	
	Easting	Northing	Easting	Northing			Drillstring LAT (m)	Echo Sounder (m)
CC-1	49146575.28	1494466.30	1494465.74	49146575.37	16.20	16/12/2020	54.56	53.69
CC-2	1493639.00	4915593.00	1493639.29	4915594.01	40.40	18/12/2020	29.76	29.00
CC-3	1493367.00	4915272.00	1493366.57	4915273.48	46.15	14/12/2020	42.30	42.00
CC-4	1492614.00	4915142.00	1492614.56	4915142.05	80.36	22/12/2020	52.46	52.6
CC-5	1491957.00	4915903.00	1491957.9	4915902.97	22.95	30/12/2020	25.87	25.00
CC-6	1491091.00	4916168.00	1491089.76	4916168.30	47.90	25/12/2020	28.86	28.00
CC-7	1490921.00	4915539.00	1490921.21	4915539.58	42.38	20/12/2020	52.36	52.20
PCPT-1	1494402.16	4915164.12	1494401.45	4915165.63	25.00	17/12/2020	36.46	35.50
PCPT-2	1493464.00	4914951.00	1493463.58	4914952.56	41.86	12/12/2020	52.66	52.27
PCPT-3	1493382.00	4915272.00	1493381.68	4915273.18	34.30	13/12/2020	42.01	41.92
PCPT-4	1492629.00	4915142.00	1492628.33	4915143.62	42.52	17/12/2020	52.48	51.45
PCPT-5	1492799.00	4915773.00	1492799.06	4915774.54	42.32	15/12/2020	30.96	30.20
PCPT-6	1490971.00	4915539.00	1490970.95	49155347.5	47.25	31/12/2020	50.31	50.10
PCPT-6A	1490972.73	4915540.49	1490972.65	49155340.08	81.28	03/01/2020	50.43	50.40
PCPT-7	1491771.00	4915317.00	1491770.27	4915316.78	10.85	19/12/2020	52.56	51.60
PCPT-8	1493948.14	4914839.86	1493948.25	4914839.38	4.30	23/12/2020	54.26	54.40
PCPT-8A	1493946.81	4914843.01	1493946.67	4914843.08	65.05	04/01/2021	52.06	52.20

NOTE

1 Coordinates displayed in local datum, Table 8.1

Table 2 Cone Summary

Cone No.	Cone Type	Tip Area (cm^2)	Sleeve Area (cm^2)	Cone Ratio	Total Meterage (stroke) (m)	Total Meterage (recovery) (m)
190310	Compression	10	150	0.78	92.42	84.16
190313	Compression	10	150	0.77	40.72	37.20
190718	Compression	10	150	0.74	43.14	35.68
190722	Compression	10	150	0.74	166.26	151.36
110904	Subtraction	10	150	0.77	-	-
160106	Subtraction	10	150	0.78	-	-
180703	Subtraction	10	150	0.76	14.58	11.30
190613	Subtraction	10	150	0.73	3.70	2.84
180807	Subtraction	10	150	0.82	8.18	7.10
190409	Subtraction	10	150	0.76	9.00	8.04

NOTE

-	Not used
190722	Damaged due to gravel
190310	Damaged due to gravel

Table 3 PCPT Test Class Summary

Location ID	Test ID	Cone No	Application Class			Deck Reading Difference			Remarks
			Tip	Friction	Pore	Tip (Mpa)	Friction (kPa)	Pore (kPa)	
CC-4	C01	190718	1	1	1	0.050	0.003	2	Sleeve refusal
CC-4	C02	190718	1	1	1	0.000	0.001	1	
CC-4	C03	190718	1	1	1	0.000	0.000	0	Dissipation test at 49.0m
CC-4	C04	190718	1	1	1	0.010	0.000	0	
CC-4	C05	190718	1	1	1	0.010	0.006	0	Tip refusal
CC-4	C06	190718	1	1	1	0.010	0.001	1	
CC-4	C07	190718	1	1	1	0.000	0.001	2	Sleeve refusal
CC-4	C08	190718	1	1	1	0.200	0.000	3	Dissipation test at 65.0m
CC-4	C09	190409	1	1	1	0.130	0.000	7	
CC-4	C10	190409	1	1	1	0.025	0.000	4	
CC-4	C11	190409	1	1	1	0.000	0.002	3	
CC-4	C12	180807	1	1	1	0.020	0.004	11	
CC-6	C01	190718	1	1	1	-0.040	-0.001	3	
CC-6	C02	190718	1	1	1	-0.040	-0.001	3	Dissipation test at 7.0m
CC-6	C03	190718	1	1	1	-0.020	0.000	6	
CC-6	C04	190718	1	1	1	-0.020	0.000	6	Dissipation test at 15.0m
CC-6	C05	190718	1	1	1	-0.020	0.000	6	Dissipation test at 19.0m
CC-6	C06	190310	1	1	1	0.030	0.001	7	Dissipation test at 22.0m
CC-6	C07	190310	1	1	1	-0.040	0.001	-1	
CC-6	C08	190310	1	1	1	0.000	0.001	0	
CC-6	C09	190310	1	1	1	-0.030	0.000	3	
CC-6	C10	190722	1	1	1	0.000	0.000	0	
CC-6	C11	190722	1	1	1	-0.010	-0.001	2	
CC-6	C12	190722	1	1	1	0.000	0.000	-1	
CC-7	C01	190722	1	1	1	-0.020	0.002	-3	Dissipation test
PCPT-1	C01	190313	1	1	1	0.010	0.000	2	
PCPT-1	C02	190313	1	1	1	-0.020	-0.001	1	Dissipation test at 5.5m
PCPT-1	C03	190313	1	1	1	-0.020	-0.001	1	Dissipation test at 8.7m
PCPT-1	C04	190313	1	1	1	0.010	0.001	5	
PCPT-1	C05	190313	1	1	1	0.010	0.001	1	
PCPT-1	C06	190313	1	1	1	-0.260	0.002	1	
PCPT-1	C07	190313	1	3	1	0.150	0.152	0	Max system thrust, sleeve offsets are off, changing the cone
PCPT-1	C08	190613	3	1	3	18.830	-1.021	82	Tip refusal, max system thrust, cone damaged
PCPT-2	C01	190613	1	1	1	0.020	0.029	9	
PCPT-2	C02	190313	1	1	1	0.000	0.000	7	
PCPT-2	C03	190313	1	1	1	0.000	0.000	1	
PCPT-2	C04	190313	1	1	1	0.000	0.000	6	Dissipation test at 10.5m
PCPT-2	C05	190313	1	1	1	0.010	0.000	7	
PCPT-2	C06	190313	1	1	1	0.040	0.000	0	Tip refusal
PCPT-2	C07	190313	1	1	1	-0.280	0.000	0	Tip refusal
PCPT-2	C08	190313	1	1	1	0.390	0.000	3	Tip refusal
PCPT-2	C09	190313	1	1	1	0.220	-0.001	6	Cone damaged

Location ID	Test ID	Cone No	Application Class			Deck Reading Difference			Remarks
			Tip	Friction	Pore	Tip (Mpa)	Friction (kPa)	Pore (kPa)	
PCPT-2	C10	190722	1	1	1	-0.010	0.001	2	
PCPT-2	C11	190722	1	1	1	-0.030	0.002	1	
PCPT-2	C12	190722	1	1	1	0.000	-0.001	1	
PCPT-2	C13	190722	1	1	1	0.010	0.001	-3	
PCPT-2	C14	190722	1	1	1	0.000	0.000	0	
PCPT-2	C15	190722	1	3	1	-0.030	-11.988	-3	Did not clamp properly. Test stopped. Recovery 2.12m. Bottom 12 cm overlap with C16, cropped
PCPT-2	C16	190722	1	1	1	-0.010	0.001	2	
PCPT-3	C01	190718	1	1	1	0.010	0.001	6	Latched high
PCPT-3	C02	190718	1	1	1	0.000	0.000	2	Dissipation test at 4.0 m
PCPT-3	C03	190718		1	1	-0.050	0.001	3	
PCPT-3	C04	190722	1	1	1	0.010	0.000	3	
PCPT-3	C05	190722	1	1	1	0.000	0.003	-2	
PCPT-3	C06	190722	1	1	1	-0.010	0.002	1	
PCPT-3	C07	190722	1	1	1	0.000	0.002	-7	
PCPT-3	C08	190722	1	1	1	0.060	0.001	7	Max system thrust
PCPT-3	C09	190722	1	1	1	-0.010	-0.001	-1	Max system thrust
PCPT-3	C10	190722	1	1	1	0.000	0.000	-7	Max system thrust
PCPT-3	C11	190722	1	1	1	-0.030	0.001	0	Max system thrust
PCPT-3	C12	190722	1	1	1	-0.090	0.000	5	Max system thrust
PCPT-3	C13	190722	1	1	1	-0.230	0.003	1	Sleeve refusal; cone damaged
PCPT-3	C14	190310	1	1	1	0.060	0.001	1	Max system thrust
PCPT-3	C15	190310	1	1	1	-0.030	0.002	-2	Max system thrust
PCPT-3	C16	190310	1	1	1	-0.030	0.000	-2	Max system thrust
PCPT-3	C17	190310	1	1	1	0.000	-0.001	1	Max system thrust
PCPT-3	C18	190310	1	1	1	-0.050	0.000	-17	Max system thrust
PCPT-4	C01	190310	1	1	1	0.000	0.000	1	
PCPT-4	C02	190310	1	1	1	-0.010	0.001	-1	
PCPT-4	C03	190310	1	1	1	-0.020	0.001	0	
PCPT-4	C04	190310	1	1	1	-0.010	0.000	-1	
PCPT-4	C05	190310	1	1	1	-0.020	0.000	-1	Dissipation test at 13.5m
PCPT-4	C06	190310	1	1	1	-0.010	0.000	-2	
PCPT-4	C07	190310	1	1	1	-0.070	-0.001	3	TR>70MPa, SP=300Bar
PCPT-4	C08	190310	1	1	1	-0.010	0.000	-4	
PCPT-4	C09	190310	1	1	1	0.020	0.000	-4	Sleeve refusal
PCPT-4	C10	190722	1	1	1	0.030	0.002	0	Dissipation test at 26.0m
PCPT-4	C11	190722	1	1	1	0.010	0.001	-2	
PCPT-4	C12	190722	1	1	1	0.010	0.001	1	
PCPT-4	C13	190722	1	1	1	-0.010	0.001	0	
PCPT-4	C14	190722	1	1	1	0.010	0.000	-2	
PCPT-4	C15	190722	1	1	1	0.140	0.037	-9	Sleeve refusal
PCPT-5	C01	190310	1	1	1	-0.010	0.001	-5	Test started 0.5m above ML to confirm water depth
PCPT-5	C02	190310	1	1	1	-0.030	0.000	1	

Location ID	Test ID	Cone No	Application Class			Deck Reading Difference			Remarks
			Tip	Friction	Pore	Tip (Mpa)	Friction (kPa)	Pore (kPa)	
PCPT-5	C03	190310	1	1	1	0.010	0.000	0	
PCPT-5	C04	190310	1	1	1	0.010	-0.001	-2	Dissipation test at 10.0 m
PCPT-5	C05	190310	1	1	1	0.020	0.000	2	
PCPT-5	C06	190310	1	1	1	-0.010	0.000	2	
PCPT-5	C07	190310	1	1	1	-0.010	0.000	2	
PCPT-5	C08	190310	1	1	1	0.040	0.000	-2	
PCPT-5	C09	190310	1	1	1	0.010	-0.001	-1	
PCPT-5	C10	190310	1	1	1	-0.020	0.000	2	
PCPT-5	C11	190310	1	1	1	0.010	0.001	3	
PCPT-5	C12	190310	1	1	1	0.010	0.001	-5	
PCPT-5	C13	190310	1	1	1	-0.110	0.000	-1	Test paused by operator at 0.34m due to the rapid tip increase
PCPT-5	C14	190310	1	1	1	-0.020	0.000	1	Cone not responding correctly
PCPT-5	C15	190310	1	1	1	0.230	0.003	-2	
PCPT-5	C16	190313	1	1	1	0.010	0.001	-2	
PCPT-6	C01	190310	1	1	1	0.000	0.000	2	Sleeve not responding; cone changed
PCPT-6	C02	190722	1	1	1	-0.010	0.000	3	
PCPT-6	C03	190722	1	1	1	0.010	0.000	2	Dissipation test at 8.5m
PCPT-6	C04	190722	1	1	1	0.000	0.001	3	
PCPT-6	C05	190722	1	1	1	-0.040	0.001	0	
PCPT-6	C06	190722	1	1	1	-0.050	0.001	-6	Dissipation test at 17.5 m
PCPT-6	C07	190722	1	1	1	0.010	0.001	-2	
PCPT-6	C08	190722	1	1	1	-0.050	0.000	-2	
PCPT-6	C09	190718	1	1	1	-0.040	-0.001	4	
PCPT-6	C10	190718	1	1	1	-0.080	-0.001	5	Test terminated by PCPT operator at 27.98 m due to spike in pressure (300bar). Equipment retrieved to identify issue.
PCPT-6	C11	190722	1	1	1	-0.020	0.000	0	Top 0.32m overlap C10, test depth changed from 27.0 to 27.32m
PCPT-6	C12	190722	1	1	1	0.130	0.001	-3	
PCPT-6	C13	190722	1	1	1	-0.110	-0.001	8	
PCPT-6	C14	190722	1	1	1	0.280	0.001	2	Tip offsets off; cone damaged and replaced
PCPT-6	C15	180807	1	1	2	-0.010	0.146	26	Sleeve refusal
PCPT-6	C16	180807	1	1	1	0.000	0.032	3	Changed Cone
PCPT-6	C17	180703	1	1	1	0.010	-0.026	7	
PCPT-6A	C01	190722	1	1	1	0.010	0.001	5	
PCPT-6A	C02	190722	1	1	1	-0.010	0.000	3	
PCPT-6A	C03	190722	1	1	1	0.000	0.000	1	
PCPT-6A	C04	190722	1	1	1	-0.020	0.001	2	
PCPT-6A	C05	190722	1	1	1	-0.010	0.000	2	
PCPT-6A	C06	190722	1	1	1	0.000	0.000	1	
PCPT-6A	C07	190722	1	1	1	0.000	0.000	5	
PCPT-6A	C08	190722	1	1	1	0.000	0.000	4	
PCPT-6A	C09	190722	1	1	1	-0.010	0.001	6	
PCPT-6A	C10	190722	1	1	1	-0.020	0.000	1	

Location ID	Test ID	Cone No	Application Class			Deck Reading Difference			Remarks
			Tip	Friction	Pore	Tip (Mpa)	Friction (kPa)	Pore (kPa)	
PCPT-6A	C11	190722	1	1	1	-0.020	0.000	8	
PCPT-6A	C12	190722	1	1	1	-0.020	0.000	4	
PCPT-7	C01	190722	1	1	1	0.020	0.001	1	
PCPT-7	C02	190310	1	1	1	0.020	0.001	4	Sleeve refusal
PCPT-7	C03	190310	1	1	1	0.130	-0.001	3	Sleeve refusal
PCPT-7	C04	190310	1	1	1	-0.250	0.011	3	Sleeve refusal; cone damaged, changing the cone
PCPT-7	C05	180807	1	1	1	0.130	-0.015	19	Sleeve refusal
PCPT-7	C06	180807	1	1	1	-0.090	-0.079	1	Max system thrust
PCPT-7	C07	180807	-	-	-	-	-	-	Test terminated due to false data
PCPT-7	C08	180807	1	3	1	0.010	-20643.92	6	Tip refusal
PCPT-8	C01	190722	1	1	1	-0.010	0.000	1	
PCPT-8A	C01	190722	1	1	1	-0.010	0.000	0	Poor data due to possible vessel movement/SBF settlement. Test terminated by PCPT operator.
PCPT-8A	C02	190722	1	1	1	-0.010	0.000	5	
PCPT-8A	C03	190722	1	1	1	-0.020	0.000	4	
PCPT-8A	C04	190722	1	1	1	-0.020	0.000	3	
PCPT-8A	C05	190722	1	1	1	0.010	0.000	0	
PCPT-8A	C06	190722	1	1	1	0.000	0.000	0	
PCPT-8A	C07	190722	1	1	1	0.000	-0.001	4	
PCPT-8A	C08	190722	1	1	1	0.000	-0.001	3	Dissipation test at 27.0m
PCPT-8A	C09	190722	1	1	1	0.000	-0.001	4	
PCPT-8A	C10	190722	1	1	1	-0.080	-0.001	7	Tip refusal
PCPT-8A	C11	190722	1	1	1	0.020	-0.002	5	Tip refusal
PCPT-8A	C12	180703	1	1	1	-0.080	0.000	4	Max system thrust
PCPT-8A	C13	180703	1	1	1	0.000	-0.012	2	Max system thrust
PCPT-8A	C14	180703	1	1	1	-0.060	-0.003	3	Max system thrust
PCPT-8A	C15	180703	1	1	1	-0.010	0.010	9	Max system thrust
PCPT-8A	C16	180703	1	1	1	-0.050	-0.008	8	Max system thrust
PCPT-8A	C17	180703	1	1	1	0.050	0.044	8	Sleeve refusal
PCPT-8A	C18	180703	1	1	1	0.000	-0.047	4	Max system thrust
PCPT-8A	C19	180703	1	1	1	-0.010	0.018	5	Max system thrust
PCPT-8A	C20	180703	1	1	1	-0.010	-0.003	3	Max system thrust
PCPT-8A	C21	180703	1	1	1	0.000	0.003	2	Max system thrust
PCPT-8A	C22	180703	1	1	1	-0.010	-0.022	3	Max system thrust
PCPT-8A	C23	180703	1	1	1	0.030	0.001	4	Max system thrust
PCPT-8A	C24	180703	1	1	1	0.000	-0.015	9	Max system thrust